UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 26, 2021

Mr. David P. Rhoades
Senior Vice President
Exelon Generation Company, LLC
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2 – ISSUANCE OF AMENDMENT NOS. 339 AND 317 REGARDING ACCIDENT TOLERANT FUEL LEAD TEST ASSEMBLIES (EPID L-2019-LLA-0282)

Dear Mr. Rhoades:

The U.S. Nuclear Regulatory Commission (the Commission) has issued the enclosed Amendment No. 339 to Renewed Facility Operating License No. DPR-53 and Amendment No. 317 to Renewed Facility Operating License No. DPR-69 for the Calvert Cliffs Nuclear Power Plant (Calvert Cliffs), Units 1 and 2. These amendments consist of changes to the Technical Specifications and Renewed Facility Operating Licenses in response to your application dated December 12, 2019 (Agencywide Documents Access and Management System Accession No. ML19347A779).

These amendments permit the use of accident tolerant fuel lead test assemblies and make an administrative change to the technical specifications. Up to two lead test assemblies of the Framatome PROtect™ fuel design may be loaded into the Calvert Cliffs, Units 1 and 2, reactors for up to three cycles.

NOTICE: Enclosure 4 to this letter contains Proprietary Information. Upon separation from Enclosure 4, this letter is DECONTROLLED.

A copy of our related safety evaluation is enclosed. Notice of issuance will be included in the Commission's monthly *Federal Register* notice.

Sincerely,

/RA/

Michael L. Marshall, Jr., Senior Project Manager
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-317 and 50-318

Enclosures:
1. Amendment No. 339 to DPR-53
2. Amendment No. 317 to DPR-69
3. Safety Evaluation (Non-Proprietary)
4. Safety Evaluation (Proprietary)

cc w/o Enclosure 4: Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

EXELON GENERATION COMPANY, LLC

DOCKET NO. 50-317

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT 1

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 339
Renewed License No. DPR-53

1. The U.S. Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Exelon Generation Company, LLC (Exelon, the licensee) dated December 12, 2019, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Renewed Facility Operating License No. DPR-53 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 339, are hereby incorporated into this license. Exelon Generation shall operate the facility in accordance with the Technical Specifications.

In addition, the license is amended by changes to Appendix C, Additional Conditions, as indicated in the attachment to this license amendment, and paragraph 2.C.(3) of Renewed Facility Operating License No. DPR-53 is hereby amended to read as follows:

(3) Additional Conditions

The Additional Conditions contained in Appendix C as revised through Amendment No. 339 are hereby incorporated into this license. Exelon Generation shall operate the facility in accordance with the Additional Conditions.

3. This license amendment is effective as of the date of its issuance and shall be implemented prior to loading the lead test assemblies into the core.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

James G. Danna, Chief
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Renewed Facility Operating License, Technical Specifications, and Appendix C, Additional Conditions

Date of Issuance: January 26, 2021

ATTACHMENT TO LICENSE AMENDMENT NO. 339

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT 1

RENEWED FACILITY OPERATING LICENSE NO. DPR-53

DOCKET NO. 50-317

Replace the following page of the Renewed Facility Operating License with the attached revised page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

Remove Page	Insert Page
3	3

Replace the following page of the Appendix A Technical Specifications with the attached revised page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

Remove Page	Insert Page
2.0-1	2.0-1

Insert the following page of the Appendix C Additional Conditions. The new page is identified by amendment number and contains a marginal line indicating the area of change.

Remove Page	Insert Page
N/A	13

(4) Exelon Generation pursuant to the Act and 10 CFR Parts 30, 40, and 70, to receive, possess, and use, in amounts as required, any byproduct, source, and special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and

(5) Exelon Generation pursuant to the Act and 10 CFR Parts 30 and 70 to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. This license is deemed to contain and is subject to the conditions set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act, and the rules, regulations, and orders of the Commission, now or hereafter applicable; and is subject to the additional conditions specified and incorporated below:

(1) Maximum Power Level

Exelon Generation is authorized to operate the facility at steady-state reactor core power levels not in excess of 2737 megawatts-thermal in accordance with the conditions specified herein.

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 339, are hereby incorporated into this license. Exelon Generation shall operate the facility in accordance with the Technical Specifications.

(a) For Surveillance Requirements (SRs) that are new, in Amendment 227 to Facility Operating License No. DPR-53, the first performance is due at the end of the first surveillance interval that begins at implementation of Amendment 227. For SRs that existed prior to Amendment 227, including SRs with modified acceptance criteria and SRs whose frequency of performance is being extended, the first performance is due at the end of the first surveillance interval that begins on the date the Surveillance was last performed prior to implementation of Amendment 227.

(3) Additional Conditions

The Additional Conditions contained in Appendix C as revised through Amendment No. 339 are hereby incorporated into this license. Exelon Generation shall operate the facility in accordance with the Additional Conditions.

(4) Secondary Water Chemistry Monitoring Program

Exelon Generation shall implement a secondary water chemistry monitoring program to inhibit steam generator tube degradation. This program shall include:

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 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.

Appendix C (Cont'd.)

Additional Conditions

Facility Operating License No. DPR-53

Amendment No.	Additional Condition	Implementation Date
339	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 339.	With implementation of this Amendment
339	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 339. .	With implementation of this Amendment
339	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 339.	With implementation of this Amendment

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

EXELON GENERATION COMPANY, LLC

DOCKET NO. 50-318

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT 2

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 317
Renewed License No. DPR-69

1. The U.S. Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Exelon Generation Company, LLC (Exelon, the licensee) dated December 12, 2019, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Renewed Facility Operating License No. DPR-69 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 317, are hereby incorporated into this license. Exelon Generation shall operate the facility in accordance with the Technical Specifications.

In addition, the license is amended by changes to Appendix C, Additional Conditions, as indicated in the attachment to this license amendment, and paragraph 2.C.(5) of Renewed Facility Operating License No. DPR-69 is hereby amended to read as follows:

(5) Additional Conditions

The Additional Conditions contained in Appendix C as revised through Amendment No. 317 are hereby incorporated into this license. Exelon Generation shall operate the facility in accordance with the Additional Conditions.

3. This license amendment is effective as of the date of its issuance and shall be implemented prior to loading the lead test assemblies into the core.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

James G. Danna, Chief
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Renewed Facility Operating License, Technical Specifications, and Appendix C, Additional Conditions

Date of Issuance: January 26, 2021

ATTACHMENT TO LICENSE AMENDMENT NO. 317

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT 2

RENEWED FACILITY OPERATING LICENSE NO. DPR-69

DOCKET NO. 50-318

Replace the following pages of the Renewed Facility Operating License with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the area of change.

Remove Page	Insert Page
3	3
4	4

Calvert Cliffs Nuclear Power Plant, Unit 2, uses the same Appendix A Technical Specifications as Calvert Cliffs Nuclear Power Plant, Unit 1. Accordingly, the Unit 1 Renewed Facility Operating License has been updated with the following page, which is applicable to both Units 1 and 2.

Remove Page	Insert Page
2.0-1	2.0-1

Insert the following page of the Appendix C Additional Conditions. The new page is identified by amendment number and contains a marginal line indicating the area of change.

Remove Page	Insert Page
N/A	13

(4) Exelon Generation pursuant to the Act and 10 CFR Parts 30, 40, and 70, to receive, possess, and use, in amounts as required, any byproduct, source, and special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and

(5) Exelon Generation pursuant to the Act and 10 CFR Parts 30 and 70 to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. This license is deemed to contain and is subject to the conditions set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act, and the rules, regulations, and orders of the Commission, now or hereafter applicable; and is subject to the additional conditions specified and incorporated below:

(1) Maximum Power Level

Exelon Generation is authorized to operate the facility at steady-state reactor core power levels not in excess of 2737 megawatts-thermal in accordance with the conditions specified herein.

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 317, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications.

(a) For Surveillance Requirements (SRs) that are new, in Amendment 201 to Facility Operating License No. DPR-69, the first performance is due at the end of the first surveillance interval that begins at implementation of Amendment 201. For SRs that existed prior to Amendment 201, including SRs with modified acceptance criteria and SRs whose frequency of performance is being extended, the first performance is due at the end of the first surveillance interval that begins on the date the Surveillance was last performed prior to implementation of Amendment 201.

(3) Less Than Four Pump Operation

The licensee shall not operate the reactor at power levels in excess of five (5) percent of rated thermal power with less than four (4) reactor coolant pumps in operation. This condition shall remain in effect until the licensee has submitted safety analyses for less than four pump operation, and approval for such operation has been granted by the Commission by amendment of this license.

(4) Environmental Monitoring Program

If harmful effects or evidence of irreversible damage are detected by the biological monitoring program, hydrological monitoring program, and the

radiological monitoring program specified in the Appendix B Technical Specifications, Exelon Generation (the licensee) will provide to the staff a detailed analysis of the problem and a program of remedial action to be taken to eliminate or significantly reduce the detrimental effects or damage.

(5) Additional Conditions

The Additional Conditions contained in Appendix C as revised through Amendment No. 317 are hereby incorporated into this license. Exelon Generation shall operate the facility in accordance with the Additional Conditions.

(6) Secondary Water Chemistry Monitoring Program

Exelon Generation shall implement a secondary water chemistry monitoring program to inhibit steam generator tube degradation. This program shall include:

a. Identification of a sampling schedule for the critical parameters and control points for these parameters;

b. Identification of the procedures used to quantify parameters that are critical to control points;

c. Identification of process sampling points;

d. Procedure for recording and management of data;

e. Procedures defining corrective actions for off control point chemistry conditions; and

f. A procedure identifying the authority responsible for the interpretation of the data and the sequence and timing of administrative events required to initiate corrective action.

(7) Mitigation Strategy

Exelon Generation shall develop and maintain strategies for addressing large fires and explosions that include the following key areas:

(a) Fire fighting response strategy with the following elements:

1. Pre-defined coordinated fire response strategy and guidance
2. Assessment of mutual aid fire fighting assets
3. Designated staging areas for equipment and materials
4. Command and control
5. Training of response personnel

(b) Operations to mitigate fuel damage considering the following:

Appendix C (Cont'd.)

Additional Conditions

Facility Operating License No. DPR-69

Amendment No.	Additional Condition	Implementation Date
317	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 317.	With implementation of this Amendment
317	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 317. .	With implementation of this Amendment
317	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 317.	With implementation of this Amendment

ENCLOSURE 3

NON-PROPRIETARY SAFETY EVALUATION

RELATED TO

AMENDMENT NO. 339 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-53

AMENDMENT NO. 317 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-69

EXELON GENERATION COMPANY, LLC

CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2

DOCKET NOS. 50-317 AND 50-318

Proprietary information pursuant to Section 2.390 of Title 10 of
the *Code of Federal Regulations* has been redacted from this document.
Redacted information is identified by blank space enclosed within [[double brackets]].

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO

AMENDMENT NO. 339 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-53

AMENDMENT NO. 317 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-69

EXELON GENERATION COMPANY, LLC

CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2

DOCKET NOS. 50-317 AND 50-318

1.0 INTRODUCTION

By letter dated December 12, 2019 (Reference 1), Exelon Generation Company, LLC (Exelon or the licensee) submitted a license amendment request (LAR) for changes to the Calvert Cliffs Nuclear Power Plant, Units 1 and 2 (Calvert Cliffs 1 and 2 or CCNPP), Technical Specifications (TSs) and Renewed Facility Operating Licenses. The proposed changes would permit the loading and irradiating of accident tolerant fuel lead test assemblies (LTAs). Up to two LTAs of the Framatome PROtect™ fuel design may be loaded into the Calvert Cliffs, Units 1 and 2, reactors for up to three cycles.

In Attachment 1 of the LAR, Exelon proposed the following license conditions (LCs):

- 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.

- 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 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 TBD.

The licensee states that the proposed LCs 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."

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.

Additionally, the license proposed an administrative change to TS 2.1.1.2 to reflect the fuel vendor's name change. The vendor's name has changed from AREVA to Framatome.

2.0 REGULATORY EVALUATION

2.1 Applicable Requirements

Section 50.46, "Acceptance criteria for emergency core cooling systems (ECCSs) for light-water nuclear power reactors," of Title 10 of the *Code of Federal Regulations* (10 CFR) requires nuclear power reactors fueled with uranium oxide pellets within cylindrical Zircaloy or ZIRLO cladding to be provided with an ECCS with certain performance requirements.

Appendix A, "General Design Criteria for Nuclear Power Plants" (GDC), to 10 CFR Part 50 contains general design criteria for nuclear power plants.

GDC 10, "Reactor design," requires that:

> The reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.

GDC 27, "Combined reactivity control systems capability," requires that:

> The reactivity control systems shall be designed to have a combined capability, in conjunction with poison addition by the emergency core cooling system, of reliably controlling reactivity changes to assure that under postulated accident conditions and with appropriate margin for stuck rods the capability to cool the core is maintained.

GDC 35, "Emergency core cooling," requires that:

> A system to provide abundant emergency core cooling shall be provided. The system safety function shall be to transfer heat from the reactor core following

> any loss of reactor coolant at a rate such that (1) fuel and clad damage that could interfere with continued effective core cooling is prevented and (2) clad metal-water reaction is limited to negligible amounts.

Calvert Cliffs 1 and 2 were not licensed to the 10 CFR Part 50, Appendix A GDC. The Atomic Energy Commission published the final rule that added Appendix A to 10 CFR Part 50 in the *Federal Register* (36 FR 3255) on February 20, 1971, with the rule effective on May 21, 1971. The Commission did not apply the final GDC to plants with construction permits issued prior to May 21, 1971, which includes Calvert Cliffs 1 and 2.

The plant design criteria for Calvert Cliffs 1 and 2 are listed in the Updated Final Safety Analysis Report (UFSAR), Section 1.4, "Principal Architectural and Engineering Criteria for Design." Calvert Cliffs 1 and 2 Principal Architectural and Engineering Criteria 1.4.2.c and 1.4.2.d are similar to GDC 10. Calvert Cliffs 1 and 2 Principal Architectural and Engineering Criteria 1.4.2.i and 1.4.2.j are similar to GDC 27. Calvert Cliffs 1 and 2 Principal Architectural and Engineering Criterion 1.4.5 is similar to GDC 35. Since the applicable Calvert Cliffs 1 and 2 principal architectural and engineering design criteria are sufficiently similar to the applicable GDC, the NRC staff used the regulatory guidance for reviews against GDC 10, GDC 27, and GDC 35.

2.2 Applicable Guidance

Regulatory guidance for the review of fuel system materials and designs and adherence to GDC 10, GDC 27, and GDC 35 is provided in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR [Light-Water Reactor] Edition" (SRP), Section 4.2, "Fuel System Design" (Reference 2). In accordance with SRP Section 4.2, the objectives of the fuel system safety review are to provide assurance that:

1. the fuel system is not damaged as a result of normal operation and anticipated operational occurrences (AOOs),
2. fuel system damage is never so severe as to prevent control rod insertion when it is required,
3. the number of fuel rod failures is not underestimated for postulated accidents, and
4. coolability is always maintained.

The PROtect™ LTAs contain fuel rods with Chromium-coated M5® cladding and chromia-doped fuel pellets. Interim staff guidance for the review of chrome-coated zirconium alloy cladding is provided in ATF-ISG-2020-01, "Supplemental Guidance Regarding the Chromium-Coated Zirconium Alloy Fuel Cladding Accident Tolerant Fuel Concept, Interim Staff Guidance," (Reference 3), and was used in conjunction with the SRP to complete this review.

2.1 Applicable Previous NRC Approvals

In addition, the NRC staff has previously reviewed and approved chromia-doped fuel pellet properties and models for boiling-water reactor applications (Reference 4). This prior approval will be relied upon in the staff's review of this LTA application. As shown below, the staff's prior safety evaluation assessed the applicability of 10 CFR 50.46 to chromia-doped fuel pellets.

> The introduction of chromia-doped fuel pellets does not directly alter the applicability of the 10 CFR 50.46 analytical requirements and prescriptive limits

associated with maintaining adequate cladding ductility; however, changes in fuel properties and performance may alter the accident progression and influence PCT [peak cladding temperature] and MLO [maximum cladding oxidation] calculation.

In this prior review, the staff concluded that 10 CFR 50.46 remained applicable to chromia-doped fuel pellets. Note that the above position was with respect to unrestricted, unlimited batch application, as opposed to limited LTA quantities. Nevertheless, the same logic remains valid. The 10 CFR 50.46 analytical requirements and prescriptive limits remain applicable to chromia-doped fuel pellets. Section 3.0 of this safety evaluation addresses the impact of any changes in fuel properties on the ECCS performance demonstration.

3.0 TECHNICAL EVALUATION

The NRC staff reviewed the licensee's proposed TS changes and LCs against objectives in SRP Section 4.2. To assist in its review, the NRC staff completed the following actions:

- Audited modifications to existing approved analytical models and methods, calibration and validation of these modified models, and supporting empirical database (Reference 6) to confirm that they were consistent with to the description provided in the LAR.

- Audited underlying Framatome engineering calculations supporting the LTA evaluation and safety demonstration (Reference 6) to confirm they were consistent with to the description provided in the LAR.

- Completed independent, confirmatory Fuel Analysis under Steady-state and Transients (FAST) code calculations (Reference 6) to confirm that the modified analytical models and methods were acceptable to capture the impacts of chromia-doped fuel pellets and chrome-coated cladding on the fuel rod thermal-mechanical design calculations.

As described in Attachment 2 of the LAR, up to two LTAs of the Framatome PROtect™ fuel design may be loaded into Calvert Cliffs 1 and/or 2. 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 <u>not</u> 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.

In its LAR, the licensee states:

> 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 were 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; ECCS limits; nuclear limits such as shutdown margin, transient analysis limits and accident analysis limits) are met.

The NRC staff's review focused on the modifications to the previously approved analytical codes and methods.

3.1 Nuclear Design

Section 3.2 of Attachment 2 of the LAR describes nuclear safety and design considerations. The core loading pattern will be designed to ensure the LTAs have a Total Integrated Radial Peaking Factor (Fr^T) that is at least **[[ ]]** lower than the core leading value throughout the cycles. This power setback is not as aggressive as prior LTA campaigns, which generally preserve a 5 percent peaking factor reduction. However, the licensee is not relying on the LTA's placement in a non-limiting core location as per the LTA provision in Calvert Cliffs 1 and 2 TS 4.2.1, "Fuel Assemblies."

The modeling techniques capture the impact of the Chromia dopant and Cr-coating on the nuclear properties of the fuel. The modeling techniques are reasonable, because they incorporate the large experimental testing database developed by Framatome on the properties of the chromia-doped fuel pellets and chrome-coated M5 cladding into previously approved methods The power peaking factor setback was achieved for Cycle 24, and ample margin existed in likely loading locations for Cycles 25 and 26. All the reload checklist parameters and requirements (e.g., peaking, moderator temperature coefficient, burnup, residence time along periphery) were satisfied.

The licensee stated that the online core monitoring with the POWERTRAX Core Monitoring System will not be affected by the LTAs, and the ability to accurately calculate the reactor three-dimensional power shape will not be affected. The NRC staff evaluated this statement and finds it reasonable, given that the core physics parameters specifically capture the effects of chromia-doped pellets and chrome-coated cladding and that there is no change in the neutron spectrum. Therefore, the NRC staff finds that the design with the proposed change will continue to assure that under postulated accident conditions and with appropriate margin for stuck rods, the capability to cool the core is maintained.

3.2 Fuel Thermal-Mechanical Design

Section 3.3 of Attachment 2 of the LAR describes the LTA fuel rod thermal-mechanical design calculations. These design analyses include:

- cladding fatigue
- cladding oxidation
- internal pin pressure
- cladding creep collapse
- fuel centerline melt
- transient cladding strain
- cladding stress and buckling

The currently licensed fuel rod thermal-mechanical methods, including RODEX2, are not fully applicable to PROtect LTAs. Framatome's approved version of the COPERNIC fuel performance code was modified to model the thermal-mechanical behavior of the chromia-doped fuel pellets during irradiation. Modifications are consistent with the chromia-doped fuel properties and models incorporated into the approved RODEX4 fuel performance model (boiling-water reactor only) described in Reference 5. The modified version of COPERNIC was benchmarked to the measured data available for chromia-doped fuel rods.

The modified COPERNIC code provides a reasonable, best-estimate prediction of centerline temperature, steady-state and transient fission gas release, and steady-state and transient rod diameter change (i.e., fuel thermal expansion and gaseous swelling) relative to the empirical database. The staff performed sensitivity calculations using a version of the NRC's FAST code modified to capture the properties and performance of the chromia-doped fuel and chrome-coated cladding. Confirmatory FAST calculations were performed for rod internal pressure, transient cladding strain, and fuel centerline melt. The NRC staff concluded the modified COPERNIC code is reasonable based on the conservative modifications made to Framatome's thermal-mechanical analysis methodology and on the results of the staff's independent analyses using FAST.

Based on the review of Framatome's COPERNIC modifications, planned code validation, and the staff's independent, confirmatory FAST calculations, the modified analytical models and methods were acceptable to capture the impacts of chromia-doped fuel pellets and chrome-coated cladding on the fuel rod thermal-mechanical design calculations.

Any impacts of the chromia-doped pellets and chrome-coated M5® cladding on the fuel assembly mechanical design are expected to be insignificant and will be evaluated. The PROtect LTAs are based on the Advanced CE14X14 HTP Framatome fuel assembly design, and therefore, the existing fuel assembly mechanical design methodology and acceptance criteria remain applicable. Therefore, the NRC staff finds that the design, with the proposed change, will continue to provide appropriate margin to assure acceptable fuel design limits are not exceeded during normal operation and anticipated operational occurrences.

3.3 Fuel Seismic/Loss-of-Coolant Accident Applied Loads

Section 3.3 of Attachment 2 of the LAR describes the impact of the LTAs on the fuel seismic analysis (which also includes loss-of-coolant accident (LOCA) applied loads and combined loads).

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). The licensee stated that 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. The PROtect LTAs are based on the Advanced CE14X14 HTP Framatome fuel assembly design, and therefore, the existing fuel seismic/LOCA applied loads methodology and acceptance criteria remain applicable.

3.4 Thermal-Hydraulic Design

As stated on page 3-8 of Attachment 3 of Reference 1, Framatome will perform thermal-hydraulic design evaluations 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 correlations to the LTAs. The NRC staff finds this work scope sufficient to provide reasonable assurance that the presence of the PROtect LTAs will not negatively impact the co-resident fuel.

3.5 Loss-of-Coolant Accidents

Section 3.3 of Attachment 2 of the LAR describes the impact of the LTAs on the ECCS performance demonstration required by 10 CFR 50.46. The licensee identified and evaluated the LTA characteristics with the potential to impact the LOCA analyses, particularly the use of chromia-doped pellets and chromium-coated cladding. The licensee considered the resulting changes to the following physical phenomena as having the potential to affect the peak cladding temperature calculated in the LOCA analyses:

- fuel thermal conductivity and stored energy
- fission gas release and rod internal pressure
- high temperature steam oxidation
- high temperature swelling and rupture
- cladding emissivity.

The licensee stated that its existing LOCA evaluation models do not contain approved physical models necessary to address all design characteristics of the proposed LTAs. However, the licensee indicated that, following the performance of a technical evaluation to assess impacts from the above phenomena, the expected behavior of the LTAs under LOCA conditions is sufficiently understood. The licensee's technical evaluation was informed by sensitivity analyses using the S-RELAP5 thermal-hydraulic system code upon which Framatome's LOCA evaluation models are based, along with fuel rod initial conditions calculated using the COPERNIC code.

The licensee stated in its submittal that the results of its technical evaluation will confirm satisfaction of applicable acceptance criteria in 10 CFR 50.46. Based on the small number of LTAs, minimal changes from the co-resident fuel (which dictate the system response), Calvert's

large margin to the regulatory acceptance criteria for PCT, and the process described for developing penalty factors associated with the LTAs, the NRC staff concludes that the licensee has acceptably addressed the impacts of the proposed LTAs on its analyses of the postulated LOCA event, consistent with the requirements of 10 CFR 50.46. Additionally, the NRC staff finds that the design with the proposed change will continue to not interfere with the ability of the ECCS to provide abundant emergency core cooling.

3.6 Non-Loss-of-Coolant Accident Transients

Section 3.3 of Attachment 2 of the LAR describes the impact of the LTAs on the Calvert Cliffs 1 and 2 UFSAR Chapter 14 non-LOCA safety analyses. The staff agrees that a large subset of the safety analyses (e.g., peak pressure transients) is not influenced by local fuel parameters. As stated on page 3-8 of Attachment 3 of Reference 1, Framatome will complete a detailed evaluation and demonstrate that the applicable UFSAR sections remain valid.

The UFSAR Chapter 14 safety analyses, which could be influenced by local fuel parameters, include: (1) events which experience a sudden power excursion (e.g., main steam line break, inadvertent control bank withdrawal), and (2) events which experience a reduction in reactor coolant system flow rate (e.g., locked reactor coolant pump rotor, loss of forced reactor coolant flow). As described in Section 3.2, the staff reviewed the methods for defining transient over-power limits for fuel centerline melt and transient cladding strain. This addresses two of the three specified acceptable fuel design limits related to local fuel parameters. As stated in in Section 3.3 of Attachment 2 of Reference 1 of the LAR, the final specified acceptable fuel design limit influenced by local fuel parameters departure from nucleate boiling will be addressed for each reload. As described in Section 3.4, the existing core thermal-hydraulic models and critical heat flux correlation will be demonstrated to be applicable to the PROtect LTA design. As described in Section 3.1, additional thermal margin (relative to the lead fuel rod power peaking factors) is available to credit in these future departure from nucleate boiling evaluations.

The postulated control rod ejection accident is also influenced by local fuel parameters. To reduce potential impacts, the PROtect LTA will not be placed in a rodded core location.

Therefore, the NRC staff finds that the design with the proposed change will continue to assure that under postulated accident conditions, and with appropriate margin for stuck rods, the capability to cool the core is maintained.

3.7 Accident Source Term

The licensee stated that the radiological source term (i.e., timing, magnitude, and chemical form of fission products released during an accident) will not be significantly affected by the LTAs. The NRC staff evaluated this statement and finds it reasonable because the fissile material (i.e., low enriched uranium) has not changed, and the fuel form and chemical properties are not significantly different. Given the low population of PROtect fuel rods (less than 1.0 percent of core population), the only accident source term that has the potential to be significantly impacted is the fuel handling accident. The docketed fuel handling accident dose assessment assumed all 176 fuel rods in the assembly fail and release their gas gap inventory. Hence, this assumption is not challenged by the PROtect fuel rods. Furthermore, the Regulatory Guide 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors,” radionuclide source term (Table 3 gas gap fractions) represents very

conservative, composite worst-case source terms that remain applicable and bounding relative to the LTA fuel rods.

3.8 Fuel Handling, Storage, and Shipping

Attachment 2 of the LAR provides an assessment of the impacts of the PROtect LTA features on fuel handling, storage, and shipping. These topics associated with the spent fuel pool, new fuel vault, fuel shipping package, and fuel handling equipment are clearly outside the scope of this LAR to modify TSs related to the core location of LTAs, fuel centerline melt temperature limits, and operating rod internal pressure limits. Therefore, the staff is appropriately not making a finding related to this extraneous material provided in the LAR.

The licensee is responsible for ensuring that the use of the LTAs remains within its licensing basis beyond the proposed changes requested in this LAR, or if outside of its current licensing basis, to complete the appropriate regulatory action to modify its license accordingly.

3.9 Technical Specification Changes and License Conditions

Attachment 5 of the LAR provides markups of the proposed TS changes and LCs. The proposed change to TS 2.1.1.2 involves a name change for the fuel supplier. This is administrative, and therefore, acceptable.

The first LC, shown below, pertains to the planned LTA irradiation campaign. Inclusion of this LC allows the licensee to evaluate the performance of the LTAs for future operating cycles using the modified methods and criteria described in this LAR.

> 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 Nos. 339/317.

The second LC, shown below, relates to the applicability of TS 2.1.1.2 fuel melting temperature to the chromia-doped pellets. While this safety limit is not applicable, Section 3.2 describes the analytical methods and criteria which will be used to assess the performance of the LTAs with respect to over-power transients and approach to the fuel centerline melt specified acceptable fuel design limit.

> 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 Nos. 339/317.

The third LC, shown below, relates to the applicability of a RODEX2 acceptance criteria (core operating limit report licensing restriction #7) to the LTA. As described in Section 3.2, the LTAs will be evaluated with a modified version of the COPERNIC fuel rod thermal-mechanical model. The approved COPERNIC methodology allows predicted rod internal pressure to exceed

system pressure provided cladding creep does not exceed fuel irradiation swelling (i.e., no clad lift-off).

> 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 Nos. 339/317.

Based on the NRC staff's assessment of the analytical methods and criteria that will be used to judge the performance of the LTA fuel rods during normal operation and under anticipated operational occurrences and postulated accident conditions, the staff finds the above LCs acceptable.

3.10 Technical Conclusion

Based upon review of the information provided in Attachment 2 of the LAR and independent, confirmatory FAST calculations, the staff finds the analytical methods and acceptance criteria being used to assess the performance of the PROtect™ LTAs acceptable. The proposed TS change and three LCs do not negatively impact public health and safety.

To provide further assurance, as the licensee stated on page 3-10 of Attachment 3 of Reference 1, "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 STATE CONSULTATION

In accordance with the Commission's regulations, the Maryland State official was notified of the proposed issuance of the amendments on December 2, 2020. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendments change a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendments involve no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding published in the *Federal Register* on March 24, 2020 (85 FR 16683). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

6.0 CONCLUSION

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

7.0 REFERENCES

1. Rafferty-Czincila, Shannon, Exelon Generation Company, LLC, letter to U.S. Nuclear Regulatory Commission, "License Amendment Request to Utilize Accident Tolerant Fuel Lead Test Assemblies," December 12, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19347A779).

2. U.S. Nuclear Regulatory Commission, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR [Light-Water Reactor] Edition," NUREG-0800, "Fuel System Design," Section 4.2, Revision 3, March 2007 (ADAMS Accession No. ML070740002).

3. U.S. Nuclear Regulatory Commission, ATF-ISG-2020-01, "Supplemental Guidance Regarding the Chromium-Coated Zirconium Alloy Fuel Cladding Accident Tolerant Fuel Concept, Interim Staff Guidance," January 2020 (ADAMS Accession No. ML19343A121).

4. Morey, Dennis C., U.S. Nuclear Regulatory Commission, Letter to Peters, Gary, Framatome Inc., "Final Safety Evaluation For Framatome Inc. Topical Report ANP-10340P, Revision 0, "Incorporation Of Chromia-Doped Fuel Properties In AREVA Approved Methods" (CAC NO. MF7707; EPID L-2016-TOP-0004)," May 23, 2018 (ADAMS Package Accession No. ML18129A020).

5. Framatome Inc., ANF-10340NP-A, Revision 0, "Incorporation of Chromia-Doped Fuel Properties in AREVA Approved Methods, Topical Report," May 2018 (ADAMS Accession No. ML18171A119).

6. Marshall, Michael L., U.S. Nuclear Regulatory Commission, Letter to Hanson, Bryan C., Exelon Generation Company, LLC, "Calvert Cliffs Nuclear Power Plant, Units 1 and 2 - Regulatory Audit Summary Regarding License Amendment Request for Accident-Tolerant Fuel Lead Test Assemblies License Amendment Request (EPID L-2019-LLA-0282) (Non-Proprietary Version)," January 14, 2021 (ADAMS Accession No. ML20230A193).

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Date: January 26, 2021

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2 – ISSUANCE OF AMENDMENT NOS. 339 AND 317 REGARDING ACCIDENT TOLERANT FUEL LEAD TEST ASSEMBLIES (EPID L-2019-LLA-0282) DATED JANUARY 26, 2021

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