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

January 10, 2022

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 – REGULATORY AUDIT SUMMARY RELATED TO LICENSE AMENDMENT REQUEST TO MODIFY THE LICENSING BASIS OF THE SPENT FUEL POOL AND SHUTDOWN COOLING SYSTEM (EPID L-2021-LLA-0112)

Dear Mr. Rhoades:

By letter dated June 14, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21165A406), supplemented by letters dated August 13, October 25, November 4, and November 30 (ADAMS Accession Nos. ML21225A353, ML21298A043, ML21308A507, and ML21334A342, respectively), Exelon Generation Company, LLC submitted an application for a proposed amendment for Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2. The proposed license amendment would revise the Updated Final Safety Analysis Report and the Technical Requirements Manual for Calvert Cliffs Nuclear Power Plant, Units 1 and 2, to allow for a full core offload without the availability of supplementing the spent fuel pool cooling system with one loop of the shutdown cooling system during certain refueling outages. The proposed amendment also includes a change in the calculational methodology used in the spent fuel pool heat-up analysis.

To enhance the review of Exelon's request, the U.S. Nuclear Regulatory Commission (NRC) staff conducted an audit of supporting documents from July 26 to September 9, 2021. The staff audited the requested documents to confirm certain information relied upon in the license amendment request. A summary of the regulatory audit is enclosed, as well as the topics discussed during teleconferences held in support of the audit.

During the regulatory audit, NRC staff identified additional information that was needed to complete the review of the subject license amendment request. Separate correspondence containing a request for additional information was transmitted to Mr. Frank Mascitelli on October 5, 2021 (ADAMS Accession No. ML21287A093).

If you have any questions regarding this issue, please contact me at (301) 415-1081 or Andrea.Mayer@nrc.gov.

Sincerely,

Andrea G. Mayer

Digitally signed by Andrea G. Mayer
Date: 2022.01.10 12:56:12 -05'00'

Andrea G. Mayer, 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. Regulatory Audit Summary
2. Audit Questions for Exelon during Audit Teleconferences

cc: Listserv

REGULATORY AUDIT SUMMARY RELATED TO LICENSE AMENDMENT REQUEST TO MODIFY THE SPENT FUEL POOL LICENSING BASIS TO ALLOW FOR FULL CORE OFFLOAD DURING CERTAIN REFUELING OUTAGES

EXELON GENERATION COMPANY, LLC

CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2

DOCKET NOS. 50-317 AND 50-318

1.0 BACKGROUND

A regulatory audit is a planned license or regulation-related activity that includes the examination and evaluation of docketed and non-docketed information. The audit was conducted with the intent to gain understanding, to verify information, and to identify information that will require docketing to support the basis of a licensing or regulatory decision.

By letter dated June 14, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21165A406), as supplemented by letters dated August 13, October 25, November 4, and November 30 (ADAMS Accession Nos. ML21225A353, ML21298A043, ML21308A507, and ML21334A342, respectively), Exelon Generation Company, LLC (Exelon) submitted a license amendment request (LAR) for Calvert Cliffs Nuclear Power Plant, Units 1 and 2 (Calvert Cliffs 1 and 2). The licensee's August 13, 2021, supplement superseded the original LAR. When the "LAR" is referenced in this audit summary, the staff is referring to the August 13, 2021 supplement. In its LAR, Exelon requested changes to the Calvert Cliffs Updated Final Safety Analysis Report (UFSAR) for the spent fuel pool cooling (SFPC) system to allow for a full core offload without being supplemented with one train of the shutdown cooling system for certain refueling outages, including a change in calculational methodology for the SFP heatup analysis. In addition, the licensee developed a new section of the Technical Requirements Manual (TRM), Section 15.9.5, "Full Core Offload." This new section of the TRM provides administrative controls to ensure that full core offloads without the availability of supplementation of shutdown cooling (SDC) system are conducted within the bounds of the licensing basis.

The U.S. Nuclear Regulatory Commission (NRC) staff performed a preliminary review of the LAR and determined that a regulatory audit would assist in reviewing the licensee's calculations supporting the LAR and timely completion of the review. The regulatory audit was performed consistent with NRC Office of Nuclear Reactor Regulation Office Instruction LIC-111, Revision 1, "Regulatory Audits," dated October 31, 2019 (ADAMS Accession No. ML19226A274).

2.0 AUDIT ACTIVITIES

The NRC staff conducted a regulatory audit that consisted of a document review via an electronic reading room and a series of video conferences with the licensee from July 26 to September 9, 2021. An audit plan was provided to Exelon by letter dated July 20, 2021 (ADAMS Accession No. ML21200A074), which contained the subject areas, weekly video conference dates, and logistics for the audit. The staff held an audit kick-off meeting on July 26,

2021. The audit was originally planned to end on August 26, 2021, but was extended to September 9, 2021, to allow the staff to complete document reviews and ask clarifying questions. The list of documents uploaded by the licensee in response to the NRC staff's request and examined by the audit team is provided in Section 4.0 below.

In preparation for each audit video conference, the NRC staff prepared questions related to document reviews and the LAR. These questions are included in Enclosure 2. Audit activities for each subject area are summarized below.

Reactor Core and Spent Fuel Pool Decay Heat Analysis

The NRC staff reviewed Chapters 1 through 8, Appendix D, and Appendix E of calculation CA06535, Revision 2, "SFP Decay Heat for 24-M VAP and Framatome Core with App. K Power Uprate." Staff reviewed the documentation to confirm that the calculation considers offload size, decay time, power history, and inventory of previously discharged assemblies. Staff also performed confirmatory calculations to verify the conservatism of decay heat load evaluation. No outstanding issues or additional information needs were identified in the reactor core and spent fuel pool decay heat analysis subject area.

Spent Fuel Pool Heat-up Analysis

The NRC staff reviewed ILD Calculation, Revision 0, "CCNPP Spent Fuel Pool Heat-up Analysis," as referenced in the LAR, and asked Audit Questions 1 through 3 of Enclosure 2 during the August 5, 2021, teleconference. The licensee provided clarification and revised the calculation to Revision 1, which is referenced in the LAR. The staff reviewed Revision 1 of the calculation and its attachments 1 through 7 which correspond to Cases 1 through 7 as described in the LAR. The staff reviewed inputs, assumptions, and methodologies, and performed spot check calculations to verify the licensee's calculations.

In Section 3.2, "Spent Fuel Pool Heat-up Analysis (Reference 2)," of the LAR, the licensee provides an assumption that the high bay water temperature is 90 °F. During the September 2, 2021, video conference the staff noted that it could not find this assumption being used in any analysis supporting the LAR available in the electronic reading room. The licensee stated that this assumption was not used in the analysis but was provided in the LAR to address a staff's question during the July 13, 2021, public meeting on the LAR (ADAMS Accession No. ML21228A074).

The NRC staff did not identify any outstanding issues or additional information needs in the spent fuel pool heat-up analysis subject area.

Impact of SFP Temperature Rise on the Criticality Analyses

The staff reviewed the following calculations (CA): CA06011 Revision 0, "Unit 1 Spent Fuel Pool Enrichment Limit with Soluble Boron Credit;" CA06015 Revision 0, "Unit 2 Spent Fuel Pool Criticality Analysis with Soluble Boron Credit but without Boraflex Credit;" CA07456 Revision 0, "Unit 1 Spend Fuel Pool Enrichment Limit with Soluble Boron Credit for Areva Fuel;" and CA07142 Revision 0, "Unit 2 Spent Fuel Pool Criticality Analysis with Soluble Boron and Burnup Credit for Areva Fuel." The staff observed that the existing criticality calculations bound the conditions proposed in the LAR. The NRC staff did not identify any outstanding issues or additional information needs in the criticality analysis subject area.

Structural Integrity of the SFP

The NRC staff reviewed the calculations referenced in CA09085, “Spent Fuel Pool,” and asked Question 4 in Enclosure 2 during an August 12, 2021, video conference. The staff also reviewed the Calvert Cliffs UFSAR Sections 5.6.1, 6.3.5.1, 9.4.4, and Appendix 5A, and identified that the maximum calculated thermal stresses for concrete and reinforcing steel in CA09085 are higher than the maximum thermal stresses presented in the UFSAR Section 5.6.1.6. Because it was not clear how the code acceptance criteria were met for these load combinations including thermal loads used for the spent fuel pool walls and pool liner, the staff issued a request for additional information (RAI) on October 5, 2021 (ADAMS Accession No. ML21287A093).

Single Failure Analysis

The NRC staff reviewed Revision 1 of the ILD calculation, which included a spreadsheet corresponding to Case 7 described in the LAR (heat up of the SFP in the case of total loss of SFPC with 1,830 fuel assemblies in the pool). The staff reviewed inputs, assumptions, methodology, and verified the time to boiloff from the time the SFP reaches 150 °F. The staff also performed confirmatory calculations of the boil off rate. The NRC staff did not identify any outstanding issues or additional information needs in the single failure analysis subject area.

3.0 AUDIT TEAM

NRC audit team members:

- Hanry Wagage, Senior Safety and Plant Systems Engineer, Team Leader
- Adam Rau, General Engineer
- George Wang, Civil Engineer (Structural)
- Angelo Stubbs, Senior Safety and Plant Systems Engineer
- Muhammad Razzaque, Nuclear Engineer
- Michael Marshall, Senior Project Manager

4.0 DOCUMENTS PROVIDED IN THE ELECTRONIC READING ROOM

The NRC staff reviewed the documents listed in the below table which were made available for review in the licensee’s electronic reading room. The staff notes that the licensee revised and reissued calculations ILD-DLV-00316 and ECP-21-000209 during the audit based on staff questions. Revision 1 of both calculations is reflected below and in the LAR.

No.	Exelon Document No.	Title	Rev. No.	Date
1	ILD-DLV-00316	CCNPP Spent Fuel Pool Heat-up Analysis	1	8/12/2021
2	CA06535	SFP Decay Heat for 24-M VAP and Framatome Core with App. K Power Uprate	2	2/24/2021
3	CA03959	Spent Fuel Pool Heat Removal Capability	0	9/5/1997
4	CA09085	Spent Fuel Pool	0	6/11/1969
5	CA06011	Unit 1 Spent Fuel Pool Enrichment Limit with Soluble Boron Credit	0	12/11/2002
6	CA06015	Unit 2 Spent Fuel Pool Criticality Analysis with	0	6/10/2003

No.	Exelon Document No.	Title	Rev. No.	Date
		Soluble Boron Credit But Without Boraflex Credit		
7	CA07456	Unit 1 Spent Fuel Pool Enrichment Limit with Soluble Boron Credit For Areva Fuel	0	10/13/2010
8	CA07142	Unit 2 Spent Fuel Pool Criticality Analysis with Soluble Boron And Burnup Credit For Areva Fuel	0	9/28/2010
9	CA06067	Validation of Calvert Cliffs Fuel Handling Accident For Increased Fuel Rod Pressure Of 1400 PSIG	0	3/11/2004
10	ECP-21-000209	Modify Spent Fuel Pool Decay Heat Analysis for Full Core Offload	1	8/13/2021

5.0 RESULTS OF THE AUDIT

During the audit, the NRC staff confirmed information that supported statements made in the LAR. However, the staff identified additional information that is needed to support the staff's regulatory findings. Therefore, subsequent to the audit's conclusion, an RAI was sent to the licensee on October 5, 2021 (ADAMS Accession No. ML21287A093). The audit exit meeting was held on September 9, 2021.

Audit Questions for Exelon During Audit Teleconferences

Discussed during August 5, 2021, Audit Teleconference:

1. In Appendix A of the ILD calculation, related to the figure showing Chesapeake Bay Temperatures:
    a. No legend is provided; identify the five different curves shown.
    b. A text box on the top indicates that "MAX TEMPERATURE IN 2021 = 46.8°F ON 3/14/2021." However, this text box has an arrow pointing to 87°F on 8/13/21. Please explain.
    c. The following text is given below the figure: "3/14/2021 MIN= 41.8F, AVE= 28F, MAX= 48.1F." Please explain how AVE is lower than MIN.
    d. Design Input 2.9 states that "Attachment A provides a plot of Chesapeake Bay temperatures, including average daily temperatures from 1995 to 2020. From this bay temperature is taken to be 42°F for February." However, the plot provided in Appendix A shows data from 1/1/21 through 12/31/21 but not for the range specified. Please (i) explain the apparent discrepancy in data range and (ii) confirm whether the bay temperature of 42°F for February was for 2021 or for the range of 1995 to 2020.

2. Section 3.2 of the LAR, under "Design Inputs," the licensee states that "[t]he full core decay heat as a function of time since shutdown is taken from Table D8-11 of [CA06535 Rev. 0002, 'SFP Decay Heat for 24-M VAP and Framatome Core with App. K Power Uprate.']" The staff checked the full-core decay heat value used for Case 1 of the ILD calculation with CA06535 to find a minor difference: for example, at 10 days after shutdown of the reactor, CA06535 shows 2.38E7 Btu/hr while the ILD calculation has used 2.35E7 Btu/hr. Please explain the variation.

3. In the spreadsheet for Case 1 of the ILD calculation:
    a. How did you calculate the cooling capacity of the spent fuel pool, $Q_{cooling}$, in Column I?
    b. An input value of 2.02E7 Btu/hr is shown for Q_{stored}, which has been used in the calculation. However, Cells D2:G4 provides a table for "Q_{stored} Calc," which appears to have no relevance to Q_{stored} that was used in the calculation. Please explain.

4. According to calculation CA09085, the "Spent Fuel Pool Walls were analyzed for thermal loads in accordance with methods presented in ACI 505."
    a. Which docketed document contains the design and code information for the SFP wall design?
    b. What version is being referenced for American Concrete Institute (ACI) 505? Provide concrete temperature design information contained in ACI 505.

5. Exelon has stated that calculation ECP 21-000209, which is referenced in the LAR and uploaded to electronic reading room, is a draft document and for the staff's information. Generally, the NRC does not make licensing decisions based on draft information. When will a final ECP 21-000209 be completed and made available to the audit team?

Discussed during August 12, 2021 Audit Teleconference:

6. Calculation ECP 21-000209, Attachment 03, states: "Pumps, piping, fittings, and valves have maximum temperature limits near or at 150F and could be challenged by the SFP temperature change." How did you reconcile this?

7. In the ILD calculation, Attachment A figure:
    a. What do the dark red and blue lines represent? Temperature data for 2021? Or, for 2019-2021?
    b. A text box indicates that "MIN TEMPERATURE IN 2021 = 35.2°F ON 2/17/2021." However, "Average Feb Bay Temp on 2019-2021.pdf" data shows a minimum value of 35.95224°F for 2/17/2021. Please explain the apparent discrepancy.

8. Section 3.4 of Attachment 1 to the LAR states: "The Service Water (SRW) is assumed to be 5 °F warmer than the bay temperature of 42 °F. This is based on historical data from the plant and a design temperature difference of 5 °F on the Service Water heat exchangers. Therefore, in this analysis at February conditions, the SRW temperature is taken to be 47°F." However, Cell 9B of the spreadsheet for Case 1 of the ILD calculation gives an SRW temperature of 50 °F. Please explain the apparent discrepancy.

Discussed during August 19, 2021 Teleconference:

10. Section 2.2, "Detailed Licensing Bases Changes," in Attachment 1 to the LAR supplement dated August 13, 2021, proposes changes to UFSAR Section 9.4, "Spent Fuel Pool Cooling System," including the following: "In the case of total loss of SFPC with 1830 fuel assemblies in the pool, it would take 6.5 hours to raise the pool temperature from 150 °F to 212 °F."

    Section 3.8, "Single Failure Analysis," of Attachment 1 to the LAR states the following:

    > In the case of total loss of SFPC with 1830 fuel assemblies in the pool, it would take 6.5 hours to raise the pool temperature from 150 °F to 212 °F. The maximum boil-off rate for this condition is 93.9 gallons per minute (gpm). The time to heat up the bulk water to boiling provides sufficient time to establish an alternate means of cooling, and the makeup rate exceeds the rate of water loss due to boil-off.

    Although, Section 3.8 provides the following references, it is not clear to the staff which reference supports the above information (LAR References 7, 18, and 19, respectively):

    - DWG 60730SH0001, "Chemical and Volume Control System"
    - AOP-6F, "Spent Fuel Pool Cooling System Malfunctions," Revision 00701
    - OI-03B-1(2), "Shutdown Cooling," Revisions 03400(03100)

    Please provide the document and any calculations supporting the above information.

11. Section 3.2, Spent Fuel Pool Heat-up Analysis (Reference 2)," in Attachment 1 to the LAR states the following:

Case 3 represents the most realistic scenario for the Spring 2022 RFO with a full core offload and two cooling loops in operations. Case 3 also considers a reasonable stored fuel decay heat estimate of 125 fuel assemblies that are 330 days old, with the rest conservatively assumed to be two years old. Case 3 illustrates that a full core offload with two cooling loops in service could begin as early as 2.98 days. To provide further guidance for Case 3, the SFP Temperature vs. Time Since Shutdown is plotted in Figure 2 with a fuel discharge starting time of 5 days.

Of the seven cases discussed in Section 3.2, only Case 7 has a fuel discharge starting time of 5 days; however, Case 7 assumes "loss of both cooling loops at time of fuel discharge completion" from which it deviates from the case shown in Figure 2. Therefore, the staff is unable to find a calculation supporting Figure 2. Please provide a calculation supporting Figure 2.

Discussed during September 2, 2021 Audit Teleconference:

12. In the licensee's model described in the LAR, decay heat from the full-core offload is assessed assuming that each offloaded assembly has an "average" decay heat load. This model may be non-conservative if assemblies with higher decay heat loads are moved from the core to the spent fuel pool first. How will this be taken into account during the full-core offload?

13. Section 3.2, "Spent Fuel Pool Heat-up Analysis (Reference 2)," of Attachment 1 to the LAR lists the following assumption: "According to References 5 and 6 [ECP-16-000587, 'Hot Bay water issue;' and CA10191 Rev 0000, "Justification for Continuous operation Hot Bay Water Issue"], the high Bay water temperature is 90 °F." However, the staff could not find this assumption being used in the analysis supporting the LAR. Please explain.

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2 – REGULATORY AUDIT SUMMARY RELATED TO LICENSE AMENDMENT REQUEST TO MODIFY THE LICENSING BASIS OF THE SPENT FUEL POOL AND SHUTDOWN COOLING SYSTEM (EPID L-2021-LLA-0112) DATED JANUARY 10, 2022

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