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

June 24, 2020

Mr. Bryan C. Hanson
Senior Vice President
Exelon Generation Company, LLC
President and Chief Nuclear Officer (CNO)
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2 - REGULATORY AUDIT SUMMARY REPORT RELATED TO LICENSE AMENDMENT REQUEST TO INCREASE ALLOWABLE MAIN STEAM ISOLATION VALVE LEAKAGE (EPID L-2019-LLA-0045)

Dear Mr. Hanson:

By letter to the U.S. Nuclear Regulatory Commission (NRC) dated March 5, 2019, as supplemented by letters dated May 23, 2019, July 22, 2019, February 24, 2020, and March 31, 2020, Exelon Generation Company, LLC submitted a license amendment request that would revise the combined main steam isolation valve (MSIV) leakage rate limit for all four steam lines in Technical Specification (TS) 3.6.1.3, “Primary Containment Isolation Valves (PCIVs),” Surveillance Requirement (SR) 3.6.1.3.10; add a new TS 3.6.2.6, ‘‘Residual Heat Removal (RHR) Drywell Spray’’; and revise TS 3.6.4.1, “Secondary Containment,” SR 3.6.4.1.1.

To enhance the NRC’s review of the request, the staff conducted an audit from May 11 - 15, 2020. The staff’s audit focused on reviewing information referenced in the response to the staff’s request for additional information provided by the letter dated March 31, 2020. A summary report of the regulatory audit is enclosed.

The NRC staff did not identify any issues during its audit, nor did it identify the need for additional information related to the topic of the audit. Should you have any questions contact me at (301) 415-3733, or via e-mail at robert.kuntz@nrc.gov.

Sincerely,

/RA/

Robert F. Kuntz, Senior Project Manager
Plant Licensing Branch III
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-254 and 50-265

Enclosure:
Regulatory Audit Summary

cc: Listserv

SUBJECT: QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2 - REGULATORY AUDIT SUMMARY REPORT RELATED TO LICENSE AMENDMENT REQUEST TO INCREASE ALLOWABLE MAIN STEAM ISOLATION VALVE LEAKAGE (EPID L-2019-LLA-0045) DATED JUNE 24, 2020

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NAME	NSalgado	RKuntz	
DATE	06/24/2020	06/24/2020	

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REGULATORY AUDIT SUMMARY REPORT

RELATED TO LICENSE AMENDMENT REQUEST

REGARDING INCREASED ALLOWABLE MAIN STEAM ISOLATION VALVE LEAKAGE

EXELON GENERATION COMPANY, LLC

QUAD CITIES NUCELAR POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-254 AND 50-265

Date of Audit:

May 11 – 15, 2020

Scope of Audit:

The scope of the regulatory audit included information referenced in Exelon Generation Company, LLC's (Exelon's) responses to ARCB-RAI-3 provided in the letter dated March 31, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20091H576). The response to ARCB-RAI-3 included Calculation No. QDC-0000-N-1481, Revision 4, which states, in part, that "for additional information on the models, data, and results refer to QDC-0000-N-2373." However, Calculation No. QDC-0000-N-2373 Revision 0 was not provided.

Audit Location:

The audit was conducted remotely via access through an electronic portal. Access to the documents via the electronic portal was controlled in accordance with the following conditions:

- The online reference portal is password-protected, and passwords are assigned to those directly involved in the review on a need-to-know basis;
- The online reference portal is sufficiently secure to prevent staff from printing, saving, or downloading any documents; and
- Conditions of use of the online reference portal are displayed on the login screen and require concurrence by each user.

NRC Audit Team Members:

Mark Blumberg, Technical Reviewer
Richard Clement, Technical Reviewer
Robert Kuntz, Project Manager
Michael Salay, Technical Reviewer

Document Audited:

Calculation QDC-0000-N-1481, Revision 4

Audit Observations:

From a review of Calculation No. QDC-0000-N-2373, "AST LOCA Aerosol Removal Factors and Margin Assessment," Revision 0, which was provided by the online portal, the NRC staff noted the following observations. The acceptability of the proposed license amendment request (LAR) is not addressed by the observations documented below. The NRC staff's evaluation of the response to ARCB-RAI-3 will be discussed in the NRC staff's safety evaluation (SE) for the LAR.

- The assumed 2-micron Aerosol Mass Median Diameter (AMMD) and geometric standard deviation (GSD) of 2.0 particle size is from SAND2017-2651, "A Note on Aerosol Removal by Gravitational Settling in a Horizontal Steam Pipe," dated April 2019 (ADAMS Accession No. ML19094A465). The 2-micron AMMD particle size is used as an initial condition to recalculate the aerosol removal rates in the sensitivity analyses, and to assert that adequate margin is present in the QDC-0000-N-1481 Revision 4 calculated dose when using the existing AEB-98-03 aerosol deposition with a 40th percentile settling velocity including drywell spray. The QDC-0000-N-1481 Revision 4 calculated dose was revised and provided in response to ARCB RAI-2.

  In Section 5.1, "Plotting Aerosol Concentration from the State-of-the-Art Report on Nuclear Aerosols and AEB-98-03" of SAND2017-2651, it states, in part, that "Normalized aerosol concentration in a nuclear reactor system can be expressed as a lognormal distribution following the recommendations set forth in the 'State-of-the-Art Report on Nuclear Aerosols,' which state a range of AMMD from 1.0 to 2.0-micron and a GSD of 2.0."

  Section 5.1.4, "Applicability of Prior Licensing Basis," of RG 1.183 Revision 0, states, in part, that "The numeric values that are chosen as inputs to the analyses required by 10 CFR 50.67 should be selected with the objective of determining a conservative postulated dose." Further, it states, in part, that "If a range of values or a tolerance band is specified, the value that would result in a conservative postulated dose should be used."

  The assumed 2.0-micron AMMD particle size is at upper end of the 1.0 to 2.0-micron AMMD particle size range. Smaller diameter particles are expected to result in larger post-LOCA doses, since the rate at which particles settle or fall out (aerosol settling velocity) is proportional the square of the particle diameter. Therefore, larger diameter particles settle quicker than smaller diameter particles. The NRC staff did not find information in QDC-0000-N-2373 for not using the 1-micron AMMD particle size in the sensitivity analysis that would be expected to result in larger post-LOCA doses compared to using the 2.0-micron AMMD particle size.

- The methodology for determining the aerosol particle size distribution in the drywell as a function of time and the removal of those particles due to drywell sprays uses the equations from NUREG/CR-5966, "A Simplified Model of Aerosol Removal by Containment Sprays," dated June 1993 (ADAMS Accession No. ML063480542). The source particle size probability density function and cumulative density function in terms of the aerodynamic diameter and resultant average particle size (AMMD) are used to calculate the 20-group particle size distribution for the aerosol source ("20-group method").

- The methodology for determining the aerosol removal rates in the main steam lines (MSLs) is based on AEB 98-03, “Assessment of Radiological Consequences for the Perry Pilot Plant Application using the Revised (NUREG-1465) Source Term,” dated December 1998 (ADAMS Accession No. ML011230531) and on SAND2017-2651. The conversion of the equivalent particle diameter to aerodynamic diameter is based on SAND2017-2651. In the RADTRAD computer code model, the effective aerosol removal rate for gravitational settling assumes the aerosol removal reaches steady-state conditions over the defined time intervals to address the time-dependent change in the particle size distribution, and assumes well-mixed volumes connected in series using the drywell as the source of aerosols.

- The MSIV leakage pathway in the RADTRAD model is adjusted to test the sensitivity of the revised aerosol removal factors by modeling each MSL separately (as shown in the response to ARCB-RAI-3). The main change is that the MSL is modeled as 3 well-mixed nodes rather than 2 well-mixed nodes to create 3 well-mixed volumes and separate sprayed and unsprayed volumes in the RADTRAD model.

- The sensitivity analyses provided in QDC-0000-N-2373 evaluates the breathing rate; impaction of aerosols on the first MSIV; and condenser holdup and deposition. A departure from RG 1.183 on the reduced breathing rate assumption in the control room (results in a reduced postulated dose) is acknowledged in the sensitivity analysis. The assumed breathing rate for a member of the public at the boundaries of the exclusion area and the low population zone are not reduced for calculating the postulated offsite doses.

- The calculations for determining the aerosol mass in each particle size group as a function of time (out to 4 hours when drywell sprays are terminated) uses the equations from NUREG/CR-5966, AEB-98-03, and SAND2017-2651. These calculations are referenced in QDC-0000-N-2373 but are not included in QDC-0000-N-2373. The resulting time-dependent particle size distribution in the drywell shifts to a smaller particle size over time which is used to determine the aerosol removal lambdas in the MSLs.

- The conclusion in QDC-0000-N-2373 states, in part, that “Based on the results of the calcuation it is concluded that the existing AEB-98-03 20-group model in QDC-0000-N-1484 is adequately conservative, given the potential margin provided by the condenser.”

  The NRC staff notes that RADTRAD inputs for the base sensitivity case (S0) [Case 1 – without condenser] and condenser credit case (S3) [Case 2 – with condensor receiving leakage from the steam line node between the MSIVs] are not included in Appendix B of QDC-0000-N-2373. Appendix B includes the RADTRAD inputs for two sensitivity cases: (S6) condenser credit with control room breathing rate and MSIV impaction, and (S7) without condenser credit with control room breathing rate and MSIV impaction case.

- The response to ARCB-RAI-3, stated, in part, that:

  > A further conservatism that is not currently modeled in QDC-0000-N-1481 is the holdup and aerosol deposition provided by the condenser. Depending on the event scenario, multiple pathways could exist to route activity to the condenser including the drain lines and the turbine itself. In

> this sensitivity, the leakage is assumed to travel to the condenser through the drain lines from the main steam line piping between the MSIVs. This conservatively neglects any holdup and deposition in the outboard main steam line piping. Modelling the release to the condenser from the piping between the MSIV is consistent with other plants in the Exelon fleet (e.g., LaSalle and Limerick). Operating experience associated with the North Anna earthquake and post-Fukushima evaluations have shown that components and piping systems typically used in this release path are sufficiently rugged to ensure they are capable of performing some level of radioactivity removal during and following a safe shutdown earthquake (SSE). Thus, it is reasonable to assume that the condenser pathway could be made available for mitigating the consequences of MSIV leakage.
>
> The data used to calculate the steam line and condenser aerosol removal rates are provided in Tables RAI-3b and 3c and are essentially duplicated from QDC-0000-N-1481 Sections 7.2 and 7.3.

And,

> The sensitivity results also demonstrate that the condenser is very effective at substantially reducing the dose consequences. Even if this capability is limited to a small fraction of the reduction shown in the sensitivity analyses in Table RAI-3e, the condenser credit has the capability to ensure post-LOCA releases remain well within the 10 CFR 50.67 limits.

The assumption that multiple pathways (including the drain lines to the condenser) exist and that is it is considered reasonable to assume that the condenser pathway could be made available, was used to recalculate the accident doses in the sensitivity analysis. The results are used to assert that adequate margin is present in the QDC-0000-N-1481 calculated dose.

Section 5.1.2, “Credit for Engineered Safeguard Features,” of RG 1.183, states, in part, that:

> Credit may be taken for accident mitigation features that are classified as safety-related, are required to be operable by technical specifications, are powered by emergency power sources, and are either automatically actuated or, in limited cases, have actuation requirements explicitly addressed in emergency operating procedures. The single active component failure that results in the most limiting radiological consequences should be assumed. Assumptions regarding the occurrence and timing of a loss of offsite power should be selected with the objective of maximizing the postulated radiological consequences.

Section 6.5, “Credit for Engineered Safeguard Features,” in Appendix A of RG 1.183, states, in part, that:

> A reduction in MSIV releases that is due to holdup and deposition in main steam piping downstream of the MSIVs and in the main condenser,

> including the treatment of air ejector effluent by offgas systems, may be credited if the components and piping systems used in the release path are capable of performing their safety function during and following a safe shutdown earthquake (SSE). The amount of reduction allowed will be evaluated on an individual case basis. References A-9 and A-10 provide guidance on acceptable models.

The NRC staff did not find information in QDC-0000-N-2373 supporting the assumption (e.g., design evaluation for the possible operator actions or assessment of the modifications necessary to ensure the pathway is available) for crediting the condenser in the sensitivity analysis.

- The response to ARCB-RAI-3 stated that the outboard steam line up to the turbine stop valve (TSV) at QCNPS is seismically qualified, so including holdup and deposition in this piping as part of the outboard compartment (third well-mixed node in Figure RAI-3b) conforms with the requirements of RG 1.183. The data used to calculate the steam line and condenser aerosol removal rates are provided in Tables RAI-3b and 3c and are duplicated from QDC-0000-N-1481 Sections 7.2 and 7.3. The sensitivity case results are summarized in Table RAI-3e: Sensitivity Study Results in the response to ARCB-RAI-3. However, the NRC staff notes that the LAR, as supplemented, states that all four MSL piping sections between the RPV nozzle and outboard MSIVs (not from the outboard steam line up to the TSV) used in the MSIV leakage release paths remain intact and can perform their safety function during and following an SSE. The NRC staff did not find information in QDC-0000-N-2373 supporting the assertion that the outboard steam line up to the TSV and the TSV at QCNPS are seismically qualified.

Summary of Audit Activities:

The NRC staff did not identify any issues during its audit, nor did it identify the need for additional information related to the topic of the audit.