

Ms. Steinman,

By letter dated September 14, 2021, Exelon Generation, licensee at the time, submitted a request to amend the Quad Cities Nuclear Power Station, Units 1 and 2 (Quad Cities) Facility Operating Licenses as necessary to utilize the Global Nuclear Fuels (GNF) GNF-3 fuel design (Agencywide Document Access and Management System (ADAMS) Accession No. ML21257A419). On February 1, 2022 (ADAMS Accession No. ML22032A333), Exelon Generation Company, LLC was renamed Constellation Energy Generation, LLC. The NRC staff has determined that additional information is needed to complete its review. The following is the NRC staff's request for additional information (RAI). As discussed during a clarification call held March 9, 2022, a response of 30 days was agreed upon. Therefore, the staff anticipates a response by April 11, 2022. During the clarification call Constellation noted that Draft RAI EXHB-RAI-1 was previously provided on the docket. Therefore, that DRAFT RAI is not part of the RAI. Draft RAI EXHB-RAI-1 was:

EXHB-RAI-1

BACKGROUND:

The letter dated September 21, 2021 stated that proposed changes are based, in part, on atmospheric dispersion factors (χ/Qs) for accident releases to the exclusion area boundary (EAB), low-population zone (LPZ), and control room.

REGULATORY BASIS

Section 50.67 of 10 CFR requires, in part, that: (i) An individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the postulated fission product release, would not receive a radiation dose in excess of 25 rem total effective dose equivalent (TEDE), (ii) An individual located at any point on the outer boundary of the low population zone, who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage), would not receive a radiation dose in excess of 25 rem TEDE, and (iii) Adequate radiation protection is provided to permit access to and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem TEDE for the duration of the accident.

Appendix A to 10 CFR Part 50, GDC 19, requires, in part, that the control room be maintained in a safe, habitable condition under accident conditions by providing adequate protection from a dose that would not exceed 5 rem TEDE for the duration of the accident.

ISSUE

In order to complete its review of the LAR, the NRC staff requires additional information on the meteorological considerations used to evaluate the personnel exposures inside the control room as well as the radiological consequences at the EAB and LPZ. Resolution of these concerns is needed to complete a technical review and to determine whether the NRC regulatory requirements in 10 CFR 50.67 and 10 CFR Part 50, Appendix A, GDC 19 are met. Therefore, the NRC staff requests the following additional information.

REQUEST

So that the staff may perform a confirmatory analysis of the atmospheric dispersion χ/Q values for the control room intake, EAB, and LPZ, provide the datasets and input/output files in native format that support the atmospheric dispersion factors and calculations in Ref. 9.14. These include:

- a. The onsite meteorological dataset in RG 1.23 format
- b. ARCON96 input and output files
- c. PAVAN input and output files

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NRC/NRR/DORL/LPL3

REQUEST FOR ADDITIONAL INFORMATION

RELATED TO THE LICENSE AMENDMENT REQUEST

TO TRANSITION TO GNF3 FUEL

CONSTELLATION ENERGY GENERATION, LLC

QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-254 AND 50-265

This document contains proprietary information pursuant to Title 10 of the Code of Federal Regulations Section 2.390.

Proprietary information is identified by bolded text enclosed within double brackets as shown here [[]].

INTRODUCTION

By letter dated September 14, 2021, Exelon Generation, licensee at the time, submitted a request to amend the Quad Cities Nuclear Power Station, Units 1 and 2 (Quad Cities) Facility Operating Licenses as necessary to utilize the Global Nuclear Fuels (GNF) GNF-3 fuel design (Agencywide Document Access and Management System (ADAMS) Accession No. ML21257A419). On February 1, 2022 (ADAMS Accession No. ML22032A333), Exelon Generation Company, LLC was renamed Constellation Energy Generation, LLC.

SFNB GEXL RAIs

BACKGROUND

Part of the amendment included is the review and approval of the report NEDC-33930P, Revision 0, "GEXL98 Correlation for ATRIUM 10XM Fuel." The report summarizes the development of the ATRIUM 10XM GEXL98 correlation. The ATRIUM 10XM GEXL98 correlation will be used to determine the critical power performance of the Framatome (formerly AREVA) ATRIUM 10XM fuel in a mixed core of ATRIUM 10XM and GNF fuel. This report describes the process used in the development of the GEXL98 correlation for prediction of critical power for the ATRIUM 10XM fuel and the determination of the overall uncertainty of that correlation in prediction of the ATRIUM 10XM critical power performance.

APPLICABLE REGULATORY REQUIREMENTS

GDC 10 in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix A, is the principal regulation associated with this report. This criterion introduces the concept of specified acceptable fuel design limits (SAFDLs). In essence, SAFDLs are those limits placed on certain variables to ensure that the fuel does not fail. One such SAFDL is associated with critical power performance. Because the decrease in heat transfer following critical power could result in fuel failure, a SAFDL is used to demonstrate that critical power does not occur during normal operation and anticipated operational occurrences (AOOs). Therefore, fuel failure is precluded during normal operation and AOOs.

SRP Section 4.4 includes the SAFDLs used in accounting for the uncertainties involved in developing and predicating critical power performance model and ensuring that fuel failure is precluded: "At least 99.9 percent of the fuel rods in the core will not experience a critical power during normal operation or AOOs."

In order to determine that the GEXL98 correlation for ATRIUM 10XM can satisfy the associated SAFDL, the NRC staff requests the following information.

SFNB-RAI-2

For the data submitted, identify which of the data points were used for training and which of the data points were used for validation.

SFNB-RAI-3

Provide a summary of the random subspace analysis performed which demonstrated that the GEXL98 correlation was relatively insensitive to the training data chosen.

SFNB-RAI-4

Demonstrate that the application domain of GEXL98 is bounded by the application domain of ACE/ATRIUM-10 XM. Specifically address the $[\text{ }]$ limit.

SFNB-RAI-5

[[

]] Justify the use of GEXL98 correlation's uncertainty in these subregions as it seems that uncertainty in these subregions should be higher.

SFNB-RAI-6

Will the GEXL98 correlation be implemented in computer codes other than the one used to perform the validation analysis? If so, provide the criteria which will be used to ensure an appropriate implementation.

SFNB-RAI-7

BACKGROUND

Section 3.3, "Core Inventory Update and Resulting Dose Consequences," of Attachment 1 to the September 14, 2021, submittal, states that the core inventory at reactor shutdown with no isotopic decay assumed, was calculated for use in the post-loss-of-coolant accident (post-LOCA) and control rod drop accident (CRDA) dose analyses. For the post-CRDA dose consequence analysis, consistent with section S.2.2.3.1.4 of General Electric Licensing Topical Report NEDE-24011P-A, "General Electric Standard Application for Reactor Fuel" (GESTAR-II), US Supplement, the number of fuel rods that would reach 170 calories per gram (cal/gm) is used.

The 170 cal/gm acceptance criterion is understood to refer to a threshold, above which fuel rods are assumed to fail, as predicted by a transient simulation of the postulated CRDA. This estimated number of failed fuel rods is used to determine the fuel inventory released to the coolant.

APPLICABLE REGULATORY REQUIREMENTS

The regulatory requirements applicable to the CRDA include General Design Criteria (GDCs) 13 and 28 contained in Appendix A, "General Design Criteria for Nuclear Power Plants," to part 50, "Domestic Licensing of Production and Utilization Facilities," of Title 10, "Energy" of the *Code of Federal Regulations* (10 CFR 50 Appendix A). However, Quad Cities Units were licensed prior to the promulgation of these criteria and hence meet the intent of the draft Principal Design Criteria published in 1967 by the Atomic Energy Commission, as discussed in Chapter 3 of the Quad Cities Updated Final Safety Analysis Report.

The analogous criteria to GDC 13, "Instrumentation and Control," within the Quad Cities Licensing Basis are Criterion 12, "Instrumentation and Control Systems," Criterion 13, "Fission Process Monitors and Controls," and Criterion 14, "Core Protection Systems." These criteria require the availability of instrumentation to monitor variables and systems over their anticipated ranges to assure safety, and of appropriate controls to maintain these variables and systems within prescribed operating ranges. These criteria apply because the sequence of events associated with the CRDA includes automatic actuations of protection systems, and potentially manual actions, and the sequence of events must be justified based on the expected values of the relevant monitored parameters and instrument indications.

The analogous criterion to GDC 28, "Reactivity Limits" within the Quad Cities Licensing Basis is Criterion 32, "Maximum Reactivity Worth of Control Rods." This criterion requires that the potential effects of a sudden or large change of reactivity, such as a dropped control rod, cannot (a) rupture the reactor coolant boundary or (b) disrupt the core, its support structures, or other vessel internals sufficiently to impair the effectiveness of emergency core cooling. This criterion applies because (1) the transient fuel enthalpy must be assessed for whether cladding failure or fuel rupture is predicted and to what extent; (2) the coolability of the core following the event must be established; and (3) the maximum reactor coolant pressure must be predicted to demonstrate stress limits for the reactor pressure vessel are not exceeded. These requirements provide assurance that fuel damage and reactor vessel pressure will not be excessive in the CRDA.

Finally, 10 CFR 50.67, "Accident Source Term," also applies, insofar as it establishes radiation dose limits for individuals at the boundary of the exclusion area and at the outer boundary of the low population zone. The fission product inventory released from all failed fuel rods is an input to the radiological evaluation; hence, an underprediction of the number of failed fuel rods following a postulated CRDA could lead to a nonconservative estimation of the post-CRDA dose, leading to inadequate assurance that the requirements of 10 CFR 50.67 are met.

ISSUE

The amendment proposes to transition from cold-worked, stress-relieved (CWSR) Zircaloy-2 cladding associated with the ATRIUM10 fuel design, to recrystallized, annealed (RXA) Zircaloy-2 cladding associated with the GNF-3 fuel design. The RXA cladding is more susceptible to fuel failure due to pellet-cladding mechanical interaction (PCMI) than the resident CWSR fuel cladding. In addition, given the new basis for the post-CRDA consequences, it is not clear how this basis addresses high-temperature cladding failure, molten fuel cladding failure, the magnitude of the predicted pressure surge, or core coolability. Such information is required to determine whether the CRDA analysis used to determine input to the post-CRDA radiological consequence analysis is consistent with the Quad Cities licensing basis design criteria identified above.

REQUEST

Demonstrate that the number of post-CRDA failed fuel rods discussed in the September 14, 2021, submittal accounts for the following three fuel damage mechanisms: (1) PCMI; (2) high temperature cladding failure; and (3) molten fuel cladding failure. Additionally, demonstrate that core coolability is maintained, and the reactor coolant pressure boundary remains intact, following this postulated event. In demonstrating the above, provide justification for any acceptance criteria, e.g., deposited fuel enthalpy, selected.

STSB-RAI-1

BACKGROUND

TS 5.6.5, "Core Operating Limits Report (COLR)," provides the list of approved methods to be used in determining the core operating limits. The transition to GNF3 fuel requires addition of a new topical report, NEDC-33930P, "GEXL98 Correlation for ATRIUM 10XM Fuel", to TS 5.6.5.b to be able to document the GNF correlation applicable to the ATRIUM 10XM fuel for use in the previously approved GESTAR II methodologies for performing licensing analysis.

Quad Cities TS 5.6.5, "Core Operating Limits Report (COLR)," currently requires, "The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following documents."

APPLICABLE REGULATORY REQUIREMENTS

10 CFR 50.36(c)(5), "Administrative controls," requires that provisions relating to organization and management, procedures, recording keeping, review and audit, and reporting necessary to assure operation of the facility in a safe manner must be included in a licensee's TS.

ISSUE

Standard Technical Specifications – General Electric BWR/4 Plants NUREG-1433, Vol. 1, Rev. 5, "Standard Technical Specifications General Electric BWR/4Plants: Specifications", Section 5.6.3, "Core Operating Limits Report" Reviewer's Note states, "Identify the Topical Report(s) by number, title, date, and NRC staff approval document or identify the staff Safety Evaluation Report for a plant specific methodology by NRC letter and date."

REQUEST

As described above, the amendment request proposed a change to the Quad Cities, TS 5.6.5.b to add a COLR reference to Report 006N8642-P. The guidance provided in NRC Generic Letter 88-16, "Removal of Cycle-Specific Parameter Limits from Technical Specifications," recommends that the staff Safety Evaluation (SE) for a plant-specific methodology by NRC letter and date be included in the citation of plant-specific methodology. This formatting would also be consistent with TS 5.6.5 and the guidance provided in NUREG-1433, Revision 5, "Standard Technical Specifications General Electric BWR/4 plants." Therefore, describe how the proposed TS change would ensure that the NRC staff SE is considered in COLR revisions or revise the citation similar to the following (as underlined):

006N8642-P, Revision 1, "Justification of PRIME Methodologies for Evaluating TOP and MOP Compliance for non-GNF Fuels," January 2022, as approved by NRC Staff SE dated XXX XX, 20XX.