SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED

TO AMENDMENT NO. 237 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-29

AND AMENDMENT NO. 232 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-30

EXELON GENERATION COMPANY, LLC

AND

MIDAMERICAN ENERGY COMPANY

QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-254 AND 50-265

1.0 INTRODUCTION

By letter to the Nuclear Regulatory Commission (NRC, the Commission) dated November 20, 2007 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML073250364), Exelon Generation Company, LLC (the licensee) requested a change to revise the values of the safety limit minimum critical power ratio (SLMCPR) in Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2 Technical Specification (TS) Section 2.1.1, "Reactor Core Safety Limits." Specifically, the proposed change would delete the Unit 2 fuel-specific SLMCPR requirements for Global Nuclear Fuel (GNF) GE14 fuel and consolidate the QCNPS SLMCPR requirements into a bounding dual-unit requirement.

Currently, TS 2.1.1.2, "Safety Limit Minimum Critical Power Ratio," states:

> For Unit 1, MCPR shall be ≥ 1.11 for two recirculation loop operation or ≥ 1.13 for single recirculation loop operation.
>
> For Unit 2, MCPR for GNF fuel shall be ≥ 1.09 for two recirculation loop operation, or ≥ 1.10 for single recirculation loop operation. MCPR for Westinghouse fuel shall be ≥ 1.11 for two recirculation loop operation or ≥ 1.13 for single recirculation loop operation.

The proposed change will revise TS 2.1.1.2 to read as follows:

> For two recirculation loop operation, MCPR shall be ≥ 1.11, or for single recirculation loop operation, MCPR shall be ≥ 1.13.

For Unit 2, Cycle 20, the licensee continues to transition from GE14 fuel manufactured by GNF to Westinghouse SVEA-96 Optima2 fuel. Cycle 20 is the second cycle in which reload quantities of SVEA-96 Optima2 fuel is being installed in QCNPS, Unit 2. Therefore, the reference core for Cycle 20 contains both GNF GE14 and Westinghouse SVEA-96 Optima2

fuel. It consists of 236 twice-burned GE14 bundles located on or near the periphery of the 724 bundle core.

The NRC-approved Westinghouse methodology calculates a unique SLMCPR value for each of the two fuel types present in the core. The current license amendment request (LAR) however proposes to conservatively adopt the higher SLMCPR for the Westinghouse fuel for all the bundles in the core, including the co-resident GE14 fuel.

2.0 REGULATORY EVALUATION

The NRC staff finds that the licensee, in Section 5.2 of its submittal, identified the applicable regulatory requirements.

In its regulatory evaluation, the NRC staff considered the applicable General Design Criteria (GDC), the licensee's use and application of NRC-approved methods, and limitations applied thereto. The NRC staff also evaluated the proposed license amendment in terms of conformance with the Standard TSs.

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix A, GDC 10 states 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 (AOOs).

Additionally, Section 4.4, "Thermal and Hydraulic Design," of NUREG-0800, Revision 3, "NRC Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," dated June 1996, states, in part, that the critical power ratio (CPR) is to be established such that at least 99.9 percent of the fuel rods in the core would not be expected to experience departure from nucleate boiling or boiling transition during normal operation or AOOs.

The guidance provided by NUREG-0800 forms the basis for the NRC staff's review and ensures that the requirements of GDC 10 are met.

3.0 TECHNICAL EVALUATION

The NRC staff has reviewed the licensee's technical and regulatory analyses in support of its proposed license amendment which are described in Sections 4.0 and 5.0 of the licensee's submittal. The detailed evaluation below will support the conclusion 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) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

The minimum critical power ratio (MCPR) safety limit is assessed based on core and fuel operating characteristics that are typically determined by a lattice physics code. The operating characteristics are then input to a critical power correlation, which is determined by a fuel vendor, based on extensive experimental data relevant to a particular fuel design. The critical power correlation then yields a minimum critical power ratio for the core.

The core-wide MCPR is then increased by a margin. The margin is determined by statistical convolution of uncertainties in the SLMCPR determination process. These uncertainties may

include, among other things, experimental CPR correlation uncertainty, uncertainties arising from the use of computer codes, manufacturing uncertainties in the fuel, and power distribution uncertainties.

As stated above, many aspects of the method that Westinghouse used to asses the SLMCPR for Unit 2, Cycle 20, are generically approved. The sections that follow describe the NRC staff's review of plant and cycle-specific compliance with the NRC limitations applied to those methods.

3.1 Use of NRC-Approved Methods

The CPR correlation developed for Westinghouse SVEA-96 Optima2 fuel is described in WCAP-16081-P-A, "10x10 SVEA Fuel Critical Power Experiments and CPR Correlation: SVEA-96 Optima 2" (ADAMS Accession No. ML051260171), which was approved by the NRC staff safety evaluation dated May 24, 2000. Westinghouse used this correlation to model the CPR performance of the Westinghouse SVEA-96 Optima2 fuel that will be loaded into the Unit 2 Cycle 20 core. WCAP-16081-P-A presents the correlations that are based on methods discussed in topical report, CENPD-300-P-A, "Reference Report for Boiling Water Reactor Reload Fuel." CENPD-300-P-A was approved by the NRC by a safety evaluation dated May 24, 1996.

Westinghouse performed the Unit 2 Cycle 20 SLMCPR analysis using plant- and cycle-specific parameters based on the core loading pattern as provided in the licensee's letter dated November 20, 2007. Westinghouse used the NRC-approved neutronic methods, discussed in the Combustion Engineering Nuclear Power, LLC, topical report CENPD-390-P-A, "The Advanced PHOENIX and POLCA Codes for Nuclear Design of Boiling Water Reactors," dated December 2000 (ADAMS Accession No. ML010100348) to analyze the planned operating strategy. Its application to Dresden Nuclear Power Station Units 2 and 3 and QCNPS Units 1 and 2 was approved in an NRC letter dated April 4, 2006 (ADAMS Accession No. ML060750258). The licensee confirmed the nuclear design using CASMO-4/MICROBURN-B2, which is discussed in Siemens Power Corporation topical report EMF-2158(P)(A), "Siemens Power Corporation Methodology for Boiling Water Reactors: Evaluation and Validation of CASMO-4/MICROBURN-B2," dated October 1999 (ADAMS Accession No. ML003698553).

The NRC staff understands that CASMO-4/MICROBURN-B2 was used by the licensee as a verification tool, and its analysis does not constitute the analysis of record for the Unit 2 Cycle 20 core design. This code system is not explicitly approved by the NRC for modeling Westinghouse fuel, and the uncertainties discussed in EMF-2158(P)(A) are not necessarily applicable to, or used in, the Unit 2 Cycle 20 core design. The NRC staff notes, however, that the core design has been verified by the licensee.

3.2 Limitations to NRC-Approved Methods

The Westinghouse methodology determines a separate SLMCPR value for each fuel type present in the core. Westinghouse developed the USAG14 correlation to model the co-resident GE14 fuel. USAG14 is used to determine the conservative adder to be applied to the operating limit minimum critical power ratio (OLMCPR) for the legacy fuel to ensure fuel safety limit protection. The NRC staff did not generically review and approve the Westinghouse CPR correlation for GE14 fuel. Therefore, the use of this method must be reviewed and approved on a plant- and cycle-specific basis.

3.3 SLMCPR For Westinghouse SEVA-96 Optima2 Fuel

The SLMCPR was determined in accordance with the approved methods discussed in Section 3.1 of this safety evaluation. WCAP-16081-P-A provides the CPR correlation adaptation and validation for 10x10 SVEA-96 Optima2 fuel for input to the methods described in CENPD-300-P-A. Upon approval of these topical reports, the NRC issued several conditions that must be satisfied by the licensee that are relevant to the SLMCPR determination. The NRC staff reviewed the conditions applied to the approval of each topical report. A condition imposed on the CPR correlation for Westinghouse SVEA-96 Optima2 fuel applies limitations to the range of parameters over which the CPR correlation is valid. The range of parameters envelops the operating range expected for Unit 2, Cycle 20. Therefore, the NRC staff concludes that WCAP-16081-P-A has been applied correctly to model the fresh, Westinghouse SVEA-96 Optima2 fuel for Unit 2 Cycle 20.

The Westinghouse BWR licensing methodology described in CENPD-300-P-A presents overall, generic approaches for performing the required safety analyses. However, the NRC staff safety evaluation report (SER) and the supporting technical evaluation report for CENPD-300-P-A defined the specific acceptable methodology and delineated the important conditions and limitations.

The NRC staff reviewed the limitations in the SER approving CENPD-300-P-A and determined that for Unit 2, Cycle 20, the licensee applied the methodologies from CENPD-300-P-A consistent with the manner specified in limitations 1 through 6 and 8 of the SER approving CENPD-300-P-A. The NRC staff also finds that limitation 7 of the SER relies on evaluation of the plant and cycle-specific conditions, and pertains to the legacy fuel. Therefore, limitation 7 does not apply to the SLMCPR for Westinghouse SVEA-96 Optima2 fuel. The NRC staff concludes that the licensee applied an NRC-approved methodology in an acceptable manner and the proposed SLMCPR for the Westinghouse SVEA-96 Optima2 fuel is acceptable.

3.4 SLMCPR For Co-Resident GE14 Fuel

The NRC staff reviewed the licensee's submittal regarding the SLMCPR determined by Westinghouse for the co-resident GE14 fuel, and the SLMCPR applied to the fuel by the licensee. The staff considered Westinghouse's compliance with the limitations on the CENPD-300-P-A methodology, and additional information required to validate the assumptions that Westinghouse made regarding the legacy fuel, to determine the acceptability of the SLMCPR as proposed by the licensee.

3.4.1 USAG14 Correlation for Operating Limit Minimum Critical Power Ratio

Westinghouse uses a critical power correlation that has been renormalized to predict the performance of the legacy fuel. The USAG14 CPR correlation was developed from the Westinghouse CPR correlation by varying key parameters important to the CPR correlation such as mass flux, enthalpy, and pressure. The correlation prediction was corrected using operational and experimental data. The CPR correlation predictions were validated using the results of core-specific GEXL correlation predictions, which were developed from actual, full-scale bundle data. The Westinghouse methodology also adds a multiplicative factor to the USAG14 CPR prediction such that a conservative adder to the OLMCPR is developed.

Limitation 7 of the safety evaluation approving CENDP-300-P-A states, "The ABB/CE methodology for determining the operating limit minimum critical power ratio for non-ABB/CE

fuel as described in CENPD-300-P and additional submittals is acceptable only when each licensee application of the methodology identifies the value of the conservative adder to the OLMCPR. The correlation applied to the experimental data to determine the value of the adder must be shown to meet the 95/95 statistical criteria. In addition, the licensee's submittal must include the justification for the adder and reference the appropriate supporting documentation."

The licensee complied with this approach and established the conservative multiplier. As stated in Section 3.2 of this safety evaluation, the multiplier used to justify use of the USAG14 correlation has not been generically reviewed and approved by the staff, nor has the USAG14 correlation. While the NRC staff concludes that Limitation 7 of the SER to CENPD-300P-A has been satisfied, this conclusion is specific to this review and not generically applicable. The USAG14 correlation has been applied in an acceptable manner for Unit 2, Cycle 20, based on compliance with Limitation 7 of the SER to CENPD-300-P-A.

3.4.2 Variation to Westinghouse SLMCPR Methodology

Consistent with the Westinghouse methodology described in CENPD-300P-A, the treatment of the SLMCPR in mixed cores containing non-Westinghouse fuel **[[**

]] The Cycle 18 SLMCPR was determined by GNF based on plant- and cycle-specific analyses using GNF's NRC-approved methodology and uncertainties as supplemented with Unit 2-specific uncertainties. The GNF evaluation used the GEXL14 correlation for GE14 fuel. The GNF evaluation confirmed that the Dual Loop Operation (DLO) and Single Loop Operation (SLO) SLMCPRs of 1.09 and 1.10, respectively, were appropriate for Cycle 18. **[[**

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For Unit 2 Cycle 20, the licensee elected to adopt the SLMCPR assessed for the Westinghouse SVEA-96 Optima2 fuel core-wide. This will increase the licensed SLMCPR for the GE14 fuel by a value of 0.02 from the previous cycle value of 1.09. Additionally, Westinghouse stated that **[[**

]] The NRC staff agrees that application of the SLMCPR for SVEA-96 Optima fuel to twice burnt GE14 fuel is sufficiently conservative.

Based on above, the NRC staff finds that there is reasonable assurance that the proposed SLMCPR will provide adequate protection of the fuel cladding integrity safety limit for the GE14 fuel.

3.4.3 Review of Part 21 Issues

A notice submitted by GE in accordance with 10 CFR Part 21, "Reporting of Defects and Noncompliance," identified potential non-conservatisms related to the critical power

determination for GE14 and GE12 fuel with Zircaloy spacers. The licensee indicated that this 10 CFR Part 21 notification concerns GE14 fuel, and that the Westinghouse correlation used for the GE14 fuel was developed using GE data corrected for the issue identified in the 10 CFR Part 21 notification. The NRC staff finds consideration and resolution of the 10 CFR Part 21 issue acceptable.

3.4.4 Summary of SLMCPR for GE14 Fuel

The licensee provided adequate information to justify the revised methods applied by Westinghouse to determine the SLMCPR for GE14 fuel in the core. In consideration of the information provided by the licensee, identification of the OLMCPR adder, and the 10 CFR Part 21 issue resolution, the NRC staff finds that the proposed SLMCPR for GE14 fuel for Unit 2 Cycle 20 is acceptable.

3.5 Single Loop Operation SLMCPR

During reactor operation with a single recirculation loop in service, the licensee proposed an SLMCPR value of 1.13. This value has additional conservatism beyond that approved for dual recirculation loop operation to account for core flow uncertainty. The NRC staff reviewed the licensee's applications of core flow uncertainty to the SLMCPR and found it acceptable because the single recirculation loop SLMCPR provides adequately conservative margin for core flow uncertainty associated with single recirculation loop operation. Therefore, the single recirculation loop SLMCPR is acceptable for Unit 2 Cycle 20.

3.6 Technical Conclusion

In consideration of the information discussed above, the NRC staff finds that the proposed amendment is acceptable. Specifically, the Unit 2 determination of SLMCPR, ≥ 1.11 for two recirculation loop operation, and ≥ 1.13 for single recirculation loop operation, reflects the recently analyzed values based on acceptable approach. In addition, the revision of TS 2.1.1.2, to delete the Unit 2 fuel-specific SLMCPR requirements for GNF GE14 fuel and consolidate the Unit 1 and Unit 2 SLMCPR requirements into a bounding dual-unit requirement, is acceptable.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Illinois State official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendments change the requirements with respect to installation or use of a facility's 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 (72 FR 71712). 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) 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.

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