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

July 11, 2019

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

SUBJECT: JAMES A. FITZPATRICK NUCLEAR POWER PLANT – ISSUANCE OF AMENDMENT NO. 325 RE: REACTIVITY ANOMALIES SURVEILLANCE (EPID L-2018-LLA-0266)

Dear Mr. Hanson:

The U.S. Nuclear Regulatory Commission (the Commission) has issued the enclosed Amendment No. 325 to Renewed Facility Operating License No. DPR-59 for the James A. FitzPatrick Nuclear Power Plant. The amendment consists of changes to the Technical Specifications (TSs) and the Facility Operating License in response to your application dated October 2, 2018.

The amendment modifies TS 3.1.2, "Reactivity Anomalies," to change the method used to perform the reactivity anomaly surveillance. Specifically, the amendment allows performance of the surveillance based on the difference between the monitored (i.e., actual) core reactivity and the predicted core reactivity. The surveillance was previously performed based on the difference between the monitored control rod density and the predicted control rod density.

A copy of the Safety Evaluation is also enclosed. Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

Carleen J. Parker, Project Manager
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-333

Enclosures:
1. Amendment No. 325 to DPR-59
2. Safety Evaluation

cc: Listserv

EXELON FITZPATRICK, LLC

AND

EXELON GENERATION COMPANY, LLC

DOCKET NO. 50-333

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 325
Renewed Facility Operating License No. DPR-59

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

   A. The application for amendment by Exelon FitzPatrick, LLC and Exelon Generation Company, LLC (collectively, the licensees) dated October 2, 2018, 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-59 is hereby amended to read as follows:

   2. <u>Technical Specifications</u>

      The Technical Specifications contained in Appendix A, as revised through Amendment No. 325, are hereby incorporated in the renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 90 days.

FOR THE NUCLEAR REGULATORY COMMISSION

James G. Danna, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Renewed Facility Operating
License and Technical Specifications

Date of Issuance: July 11, 2019

ATTACHMENT TO LICENSE AMENDMENT NO. 325

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

RENEWED FACILITY OPERATING LICENSE NO. DPR-59

DOCKET NO. 50-333

Replace the following page of the License with the attached revised page. The revised page is identified by amendment number and contains marginal lines indicating the areas of change.

Remove	Insert
Page 3	Page 3

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Remove	Insert
3.1.2-1	3.1.2-1
3.1.2-2	3.1.2-2

(4) Exelon Generation Company pursuant to the Act and 10 CFR Parts 30, 40, and 70, to receive, possess, and use, at any time, 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, components or tools.

(5) 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 renewed operating license shall be deemed to contain and is subject to the conditions specified in the following Commission regulations in 10 CFR Chapter I: Part 20, Section 30.34 of Part 30, Section 40.41 of Part 40, Sections 50.54 and 50.59 of Part 50, and Section 70.32 of Part 70; and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

Exelon Generation Company is authorized to operate the facility at steady state reactor core power levels not in excess of 2536 megawatts (thermal).

(2) Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 325, are hereby incorporated in the renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications.

(3) Fire Protection

Exelon Generation Company shall implement and maintain in effect all provisions of the approved fire protections program as described in the Final Safety Analysis Report for the facility and as approved in the SER dated November 20, 1972; the SER Supplement No. 1 dated February 1, 1973; the SER Supplement No. 2 dated October 4, 1974; the SER dated August 1, 1979; the SER Supplement dated October 3, 1980; the SER Supplement dated February 13, 1981; the NRC Letter dated February 24, 1981; Technical Specification Amendments 34 (dated January 31, 1978), 80 (dated May 22, 1984), 134 (dated July 19, 1989), 135 (dated September 5, 1989), 142 (dated October 23, 1989), 164 (dated August 10, 1990), 176 (dated January 16, 1992), 177 (dated February 10, 1992), 186 (dated February 19, 1993), 190 (dated June 29, 1993), 191 (dated July 7, 1993), 206 (dated February 28, 1994), and 214 (dated June 27, 1994); and NRC Exemptions and associated safety evaluations dated April 26, 1983, July 1, 1983, January 11, 1985,

3.1 REACTIVITY CONTROL SYSTEMS

3.1.2 Reactivity Anomalies

LCO 3.1.2 The reactivity difference between the measured core k_{eff} and the predicted core k_{eff} shall be within $\pm$ 1% $\Delta k/k$.

APPLICABILITY: MODES 1 and 2

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Core reactivity difference not within limit.	A.1 Restore core reactivity difference to within limit.	72 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 3	12 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.2.1	Verify core reactivity difference between the measured core k_{eff} and the predicted core k_{eff} is within $\pm$ 1% $\Delta k/k$.	Once within 24 hours after reaching equilibrium conditions following startup after fuel movement within the reactor pressure vessel or control rod replacement AND 1000 MWD/T thereafter during operations in MODE 1

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 325

EXELON FITZPATRICK, LLC

EXELON GENERATION COMPANY, LLC

DOCKET NO. 50-333

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

TO RENEWED FACILITY OPERATING LICENSE NO. DPR-59

1.0 INTRODUCTION

By letter dated October 2, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18275A060), Exelon Generation Company, LLC (Exelon, the licensee) submitted a request for changes to the James A. FitzPatrick Nuclear Power Plant (FitzPatrick) Technical Specifications (TSs). The proposed amendment would modify TS 3.1.2, "Reactivity Anomalies," to change the method used to perform the reactivity anomaly surveillance. Specifically, the amendment would allow performance of the surveillance based on the difference between the monitored (i.e., actual) core reactivity and the predicted core reactivity. The surveillance is currently performed based on the difference between the monitored control rod density and the predicted control rod density.

2.0 REGULATORY EVALUATION

The following explains the use of general design criteria (GDC) for FitzPatrick. The construction permit for FitzPatrick was issued by the Atomic Energy Commission (AEC) on May 20, 1970, and the operating license was issued on October 17, 1974. The plant design criteria for the construction phase are listed in the Updated Final Safety Analysis Report (UFSAR) Chapter 1.5, "Principal Design Criteria." On February 20, 1971, the AEC published in the *Federal Register* (36 FR 3255) a final rule that added Appendix A to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "General Design Criteria for Nuclear Power Plants." As discussed in the NRC's Staff Requirements Memorandum for SECY-92-223, dated September 18, 1992 (ADAMS Accession No. ML003763736), the Commission decided not to apply the final GDC to plants with construction permits issued prior to May 21, 1971. At the time of promulgation of Appendix A to 10 CFR Part 50, the Commission stressed that the final GDC were not new requirements and were promulgated to more clearly articulate the licensing requirements and practice in effect at that time. Each plant licensed before the final GDC were formally adopted was evaluated on a plant-specific basis, determined to be safe, and licensed by the Commission.

Even though FitzPatrick's construction permit was issued prior to May 21, 1971, the FitzPatrick UFSAR, Chapter 16.6, "Conformance to AEC Design Criteria," evaluates FitzPatrick against the 10 CFR 50 Appendix A GDCs. Also, the initial AEC safety evaluation of FitzPatrick, dated November 20, 1972 (ADAMS Accession No. ML19182A200), Chapter 14.0, states "Based on our evaluation of the design and design criteria for the James A. FitzPatrick Nuclear Power Plant, we conclude that there is reasonable assurance that the intent of the General Design Criteria for Nuclear Power Plants, published in the Federal Register on May 21, 1971 as Appendix A to 10 CFR part 50, will be met." Therefore, the NRC staff reviews amendments to the FitzPatrick license using the 10 CFR 50 Appendix A GDC unless there are specific criteria identified in the UFSAR.

In Section 4.1 of Attachment 1 to the licensee's application dated December 2, 2018, the licensee cited the following GDCs as being applicable to the proposed amendment:

- GDC 26, "Reactivity control system redundancy and capability"
- GDC 28, "Reactivity limits"
- GDC 29, "Protection against anticipated operational occurrences"

Consistent with the requirements in GDC 26, GDC 28, and GDC 29: (1) reactivity shall be controllable such that subcriticality is achievable and maintainable under cold conditions (most reactive conditions); and (2) specified applicable fuel design limits must not be exceeded during normal operation and anticipated operational occurrences.

The NRC's regulatory requirements related to the content of the TSs are contained in 10 CFR 50.36, "Technical specifications." Paragraph (c)(2)(i) of 10 CFR 50.36 states, in part, that limiting conditions for operation (LCOs) "are the lowest functional capability or performance levels of equipment required for safe operation of the facility." Paragraph (c)(3) of 10 CFR 50.36 states that surveillance requirements (SRs) "are requirements relating to test, calibration, or inspection to assure that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the limiting conditions for operation will be met."

As shown in Attachment 2 of the licensee's application dated October 2, 2018, the proposed amendments would revise FitzPatrick TS 3.1.2 to change LCO 3.1.2 and SR 3.1.2.1. The specific changes are discussed below.

LCO 3.1.2 currently reads as follows:

> The reactivity difference between the measured rod density and the predicted rod density shall be within ± 1% $\Delta k/k$.

The proposed amendment would revise LCO 3.1.2 to read as follows:

> The reactivity difference between the measured core k_{eff} and the predicted core k_{eff} shall be within ± 1% $\Delta k/k$.

SR 3.1.2.1 currently reads as follows:

> Verify core reactivity difference between the measured rod density and the predicted rod density is within ± 1% Δk/k.

The proposed amendment would revise SR 3.1.2.1 to read as follows:

> Verify core reactivity difference between the measured core k_{eff} and the predicted core k_{eff} is within ± 1% Δk/k.

The reactivity anomaly check required by the FitzPatrick TSs serves, in part, to satisfy the above GDCs by comparing the observed reactivity behavior of the core (at hot operating conditions) to the expected reactivity behavior that was calculated prior to the start of operation for a particular cycle. This ensures that certain assumptions in the design-basis accident and transient safety analyses remain valid. Any difference between these two observations is compared to the TS 3.1.2 acceptance criterion of ±1% Δk/k and if the criterion is not met, the action required by the TS is then taken.

3.0 TECHNICAL EVALUATION

3.1 Current Method for Reactivity Anomaly Check

The measure of criticality is the effective neutron multiplication factor, k-effective, or k_{eff}. The multiplication factor is the ratio of the rate of neutron production (e.g., through fission) to neutron loss (e.g., due to absorption or leakage). Criticality is achieved when k_{eff} is equal to 1.0 (i.e., neutron population is constant). When k_{eff} is less than 1.0, the reactor is subcritical. When k_{eff} is greater than 1.0, the reactor is supercritical. Reactivity is the measure of the fractional change in neutron population and is defined as $(k_{eff} -1)/k_{eff}$. Therefore, in a critical reactor, reactivity is equal to zero. Although reactivity is unitless, it is assigned the units of Δk/k for convenience.

The FitzPatrick TSs currently require that the reactivity anomaly check be done by comparing a predicted control rod density (calculated prior to the start of operation for a given cycle) to an actual control rod density. The comparison is done at the frequencies specified by SR 3.1.2.1. As described in the application dated October 2, 2018:

> The current method of performing the reactivity anomaly surveillance uses rod density for the comparison primarily because early core monitoring systems did not calculate core critical K_{eff} values for comparison to design values. Instead, rod density was used as a convenient representation of core reactivity.
>
> Allowing the use of direct comparison to K_{eff}, as opposed to rod density, provides for a more direct measurement of core reactivity conditions and eliminates the limitations that exist for performing the core reactivity comparisons with rod density.

Comparison of predicted control rod density to actual control rod density is done via a set of reactivity anomaly curves. Development of the curves begins with predicted critical core k_{eff} values, which have been calculated for projected operating states and conditions throughout the life of the cycle, and their associated derived control rod patterns. A calculation is made of the number of notches the control rod blades are inserted in these rod patterns as well as the average number of notches required to make a change of ±1% Δk/k around the predicted critical core k_{eff} values. The notches are converted to control rod density and plotted as a function of cycle exposure to produce a predicted control rod density curve with upper and lower bounds that represent the ±1% Δk/k TS acceptance criterion. As a result, the comparison is based on critical k_{eff}, but with a "translation" of acceptance criteria to control rod density.

Under the current method, an anomaly would be the difference between the predicted and measured control rod density in the reactor under the existing conditions (e.g., time in cycle, power level, and control rod pattern). The observed anomaly is then translated into a reactivity difference between the two values (the measured versus the predicted control rod density) for comparison to the TS limit of ±1% Δk/k. If the limit is exceeded, the licensee has 72 hours to restore the core reactivity difference to within the limit. If the completion time cannot be met, the plant must be in MODE 3 within the next 12 hours.

The licensee stated that, while being a convenient measurement of core reactivity, the control rod density method has limitations, such as differing impacts on reactivity from deeply inserted central control rods versus control rods on the outer edge of the core, or shallowly inserted rods. The licensee indicated that it is not uncommon for reactivity anomaly concerns to arise during operation simply because of greater use of near-edge or shallowly inserted control rods than anticipated, when in fact no true anomaly exists.

3.2 Proposed Method for Reactivity Anomaly Check

The proposed change to TS 3.1.2 would eliminate the translation of core k_{eff} into control rod density. Instead, the revised method for evaluating a potential reactivity anomaly would compare the measured core k_{eff} and the predicted core k_{eff} directly. The proposed TS change will not change the frequency of surveillance or any condition within the SR.

FitzPatrick utilizes the Global Nuclear Fuels (GNF) three-dimensional (3D) core monitoring software system, 3D MONICORE, which incorporates the 3D core simulator code PANACEA Version 11 (PANAC11). The core monitoring software system allows for a direct comparison of predicted core k_{eff} to monitored core k_{eff}. Measured core k_{eff} is calculated by PANAC11 using measured plant operating data provided by 3D MONICORE. The predicted core k_{eff}, as a function of cycle exposure, is developed using PANAC11 prior to the start of each operating cycle. The PANAC11-computed core k_{eff} behavior from the previous cycle is used as the starting point for the calculation. Any fuel vendor recommended adjustments due to planned changes in fuel design, core design, or operating strategy for the upcoming cycle are also incorporated into the development of the predicted core k_{eff}.

By letter dated March 11, 1999 (ADAMS Accession No. ML993140059), the NRC approved the power distribution uncertainty for the 3D-MONICORE core surveillance system by accepting NEDC-32694P, "Power Distribution Uncertainties for Safety Limit MCPR Evaluation," with limitations, for referencing in license applications. Further, by letter dated November 10, 1999 (ADAMS Accession No. ML993230184), the NRC staff documented an evaluation of a version of the PANACEA core simulator code referred to as PANAC11. In that evaluation, the NRC staff concluded that a proposed improvement in General Electric (GE) steady-state methods (reflected in PANAC11) was acceptable and appropriate for inclusion into the GE licensing topical report for core design, NEDE-24011-P-A.

The NRC staff notes that the licensee's proposed TS changes for FitzPatrick are similar to the Boiling Water Reactor (BWR)/6 Standard TSs (ADAMS Accession No. ML12104A195) for reactivity anomalies, in that both perform the reactivity difference comparison using core k_{eff}. Although FitzPatrick is a BWR/4 plant, it has the hardware and software in place (e.g., 3D

MONICORE, PANAC11) to allow direct comparison of predicted k_{eff} to measured k_{eff}, as described in the TSs basis for the comparable BWR/6 SR (ADAMS Accession No. ML12104A196).

The NRC staff has reviewed the information provided by the licensee and concludes that the use of monitored (i.e., actual) to predicted core k_{eff} instead of rod density: (1) eliminates the limitations described in Section 3.1 of this safety evaluation (SE), (2) provides for a technically superior comparison, and (3) is a simple and straightforward approach utilizing appropriate computer codes and methods.

The licensee also assessed the impact of this request on the FitzPatrick transient and accident analyses and determined that the proposed changes will not affect any of the transient and accident analyses. This is because only the method of performing the reactivity anomaly surveillance is changing, and the proposed method will provide an adequate and acceptable comparison as discussed above. Furthermore, the anomaly check will continue to be performed at the current required frequency. The NRC staff agrees with this assessment and therefore concludes that the proposed surveillance will continue to ensure that the assumptions in the transient and accident analysis regarding core reactivity remain valid with this change.

3.3 Technical Evaluation Conclusion

The NRC staff has reviewed the licensee's request to revise TS 3.1.2 and, based on the discussion above in SE Sections 3.1 and 3.2, concludes that the proposed TS revisions are acceptable and will provide an improved approach for the determination of reactivity anomalies. Therefore, the NRC staff concludes that the proposed amendment is acceptable.

Exelon's application dated October 2, 2018, also provided proposed changes to the TS Bases to be implemented with the associated TS changes discussed above. The TS Bases pages were provided for information only and will be revised in accordance with the TS Bases Control Program.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the New York State official was notified of the proposed issuance of the amendment on June 5, 2019. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 and changes surveillance requirements. The NRC staff has determined that the amendment involves 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 amendment involves no significant hazards consideration, and there has been no public comment on such finding (November 20, 2018; 83 FR 58610). Accordingly, the amendment meets 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 amendment.

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 amendment will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: A. Kevin Heller

Date: July 11, 2019

SUBJECT: JAMES A. FITZPATRICK NUCLEAR POWER PLANT – ISSUANCE OF AMENDMENT NO. 325 RE: REACTIVITY ANOMALIES SURVEILLANCE (EPID L-2018-LLA-0266) DATED JULY 11, 2019

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ADAMS Accession No.: ML19157A203 *by memo dated **by email dated

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