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

March 9, 2018

Mr. Dean Curtland
Site Director, Duane Arnold Energy Center
NextEra Energy Duane Arnold, LLC
3277 DAEC Road
Palo, IA 52324-9785

SUBJECT: DUANE ARNOLD ENERGY CENTER – ISSUANCE OF LICENSE AMENDMENT NO. 304 RE: REVISION TO TECHNICAL SPECIFICATION 3.1.2, REACTIVITY ANOMALIES (EPID L-2017-LLA-0218)

Dear Mr. Curtland:

The U.S. Nuclear Regulatory Commission (NRC, the Commission) has issued the enclosed License Amendment No. 304 to NextEra Energy Duane Arnold, LLC (licensee) for Renewed Facility Operating License No. DPR-49 for the Duane Arnold Energy Center. The amendment consists of changes to the technical specifications (TSs) in response to your application dated April 20, 2017 (TSCR-164).[1]

The amendment revises TS 3.1.2, "Reactivity Anomalies," with a change to the method of calculating core reactivity for the purpose of performing the reactivity anomaly surveillance. Specifically, the revised TS changes Limited Conditions for Operation 3.1.2 and Surveillance Requirement 3.1.2.1.

Additional information on the amendment changes and the NRC staff's evaluation is documented in Enclosure 2 of this letter.

The Notice of Issuance will be included in the Commission's next biweekly *Federal Register* notice.

Sincerely,

/RA/

Mahesh L. Chawla, Project Manager
Plant Licensing Branch III
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-331

Enclosures:
1. Amendment No. 304 to DPR-49
2. Safety Evaluation

cc w/enclosures: ListServ

[1] Agencywide Document Access Management System (ADAMS) Accession No. ML17111A631.

UNITED STATES
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NEXTERA ENERGY DUANE ARNOLD, LLC

DOCKET NO. 50-331

DUANE ARNOLD ENERGY CENTER

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 304
Renewed License No. DPR-49

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

   A. The application for amendment by NextEra Energy Duane Arnold, LLC dated April 20, 2017, 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 Operating License and Technical Specifications as indicated in the attachment to this license amendment and paragraph 2.C.(2) of Renewed Facility Operating License No. DPR-49 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 304, are hereby incorporated in the license. NextEra Energy Duane Arnold, LLC shall operate the facility in accordance with the Technical Specifications.

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

FOR THE NUCLEAR REGULATORY COMMISSION

David J. Wrona, Chief
Plant Licensing Branch III
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Operating License
and Technical Specifications

Date of Issuance: March 9, 2018

ATTACHMENT TO LICENSE AMENDMENT NO. 304

DUANE ARNOLD ENERGY CENTER

RENEWED FACILITY OPERATING LICENSE NO. DPR-49

DOCKET NO. 50-331

Replace page 3 of Renewed Facility Operating License No. DPR-49 with the attached page 3. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

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

Remove	Insert
3.1-5	3.1-5
3.1-6	3.1-6

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; 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

NextEra Energy Duane Arnold, LLC is authorized to operate the Duane Arnold Energy Center at steady state reactor core power levels not in excess of 1912 megawatts (thermal).

(2) Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 304, are hereby incorporated in the license. NextEra Energy Duane Arnold, LLC shall operate the facility in accordance with the Technical Specifications.

(a) For Surveillance Requirements (SRs) whose acceptance criteria are modified, either directly or indirectly, by the increase in authorized maximum power level in 2.C.(1) above, in accordance with Amendment No. 243 to Facility Operating License DPR-49, those SRs are not required to be performed until their next scheduled performance, which is due at the end of the first surveillance interval that begins on the date the Surveillance was last performed prior to implementation of Amendment No. 243.

(b) Deleted.

(3) Fire Protection Program

NextEra Energy Duane Arnold, LLC shall implement and maintain in effect all provisions of the approved fire protection program that comply with 10 CFR 50.48(a) and 10 CFR 50.48(c), as specified in the licensee amendment request dated August 5, 2011 (and supplements dated October 14, 2011, April 23, 2012, May 23, 2012, July 9, 2012, October 15, 2012, January 11, 2013, February 12, 2013, March 6, 2013, May 1, 2013, May 29, 2013, two supplements dated July 2, 2013, and supplements dated August 5, 2013 and August 28, 2013) and as approved in the safety evaluation report dated September 10, 2013. Except where NRC approval for changes or deviations is required by 10 CFR 50.48(c), and provided no other regulation, technical specification, license condition or requirement would require prior NRC approval, the licensee may make changes to the fire protection program without prior approval of the Commission if those changes satisfy the provisions set forth in 10 CFR 50.48(a) and 10 CFR 50.48(c), the change does not require a change to a technical specification or a license condition, and the criteria listed below are satisfied.

3.1 REACTIVITY CONTROL SYSTEMS

3.1.2 Reactivity Anomalies

LCO 3.1.2 The reactivity difference between the monitored 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 monitored 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
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING LICENSE AMENDMENT REQUEST TO REVISE

TECHNICAL SPECIFICATION 3.1.2,

REACTIVITY ANOMALIES

NEXTERA ENERGY DUANE ARNOLD, LLC

DUANE ARNOLD ENERGY CENTER

DOCKET NO. 50-331

1.0 INTRODUCTION

By application dated April 20, 2017, NextEra Energy Duane Arnold, LLC (NextEra, the licensee) submitted a license amendment request (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17111A631), to the U.S. Nuclear Regulatory Commission (NRC or Commission) for Duane Arnold Energy Center (DAEC). The proposed amendment would modify technical specifications (TS) 3.1.2, "Reactivity Anomalies," to change the method used to perform the reactivity anomaly surveillance. The new method 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

2.1 TS Surveillance Description

The reactivity anomaly surveillance required by the TSs serves, in part, to satisfy the applicable general design criteria (GDC), discussed below in Section 2.3, by comparing the observed reactivity behavior of the core (at hot operating conditions) to the expected reactivity behavior that was calculated during the core design process. 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 acceptance criterion of ±1% delta (Δ)k/k and if the criterion is not met, the action required by the TS is then taken.

2.2 Current TS Versus Proposed TS Changes

2.2.1 Licensing Conditions for Operation (LCO) 3.1.2

The DAEC TS LCO 3.1.2 currently reads as follows:

> The reactivity difference between the monitored rod density and the predicted rod density shall be within ± 1% Δk/k.

The proposed amended TS LCO 3.1.2 reads as follows:

> The reactivity difference between the monitored core k_{eff} and the predicted core k_{eff} shall be within ± 1% Δk/k.

2.2.2 Surveillance Requirement (SR) 3.1.2.1

The DAEC SR 3.1.2.1 currently reads as follows:

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

The proposed amended SR 3.1.2.1 reads as follows:

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

2.3 Applicable Regulatory Requirements

The Commission's regulatory requirements related to the content of the TSs are contained in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section 50.36. The regulation at 10 CFR 50.36 requires applicants for nuclear power plant operating licenses to include proposed TSs as part of the application. The regulation requires, in part, that the TSs include items in the following categories: (1) safety limits, limiting safety systems settings, and limiting control settings; (2) LCO; (3) SRs; (4) design features; and (5) administrative controls. However, the regulation does not specify the particular requirements to be included in TSs.

Paragraph (c)(2)(i) of 10 CFR 50.36 states, in part, that:

> Limiting conditions for operation 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, in part, that:

> Surveillance requirements 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.

10 CFR Part 50, Appendix A, GDC 26, "Reactivity control system redundancy and capability,"[2] GDC 28, "Reactivity limits,"[3] and GDC 29, "Protection against anticipated operational occurrences,"[4] require that reactivity within the core be controllable to ensure that subcriticality is achievable and maintainable under cold conditions (most reactive conditions). Additionally, these GDCs specify that applicable fuel design limits must not be exceeded during normal operations and anticipated operational occurrences.

3.0 TECHNICAL EVALUATION

3.1 Staff Evaluation of Current TS Versus Proposed TS Changes

3.1.1 Current Method for Reactivity Anomaly Check

The measure of criticality is the effective neutron multiplication factor, k_{eff}. The multiplication factor is the ratio of the rate of neutron production 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 $\Delta k/k$ for convenience.

As described in the licensee's application (Reference 1), the licensee currently assesses reactivity anomalies at DAEC by using control rod density to provide a convenient representation for k_{eff}. This method is utilized primarily because early core monitoring systems did not directly calculate core k_{eff} values for comparison to design values. The DAEC 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 particular cycle) to an actual control rod density. The comparison is done at the frequency specified by the associated surveillance requirement.

Specifically, 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 and also the number of average notches required to make a change of ±1% $\Delta k/k$ 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% $\Delta k/k$ 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% $\Delta k/k$. In the event that the limit is exceeded, the licensee has

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[2] DAEC updated final safety analysis report (UFSAR), Section 3.1.2.3.7

[3] DAEC UFSAR, Section 3.1.2.3.9

[4] DAEC UFSAR, Section 3.1.2.3.10

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 shallow inserted control rods than anticipated, when in fact no true anomaly exists.

3.1.2 Proposed Method for Reactivity Anomaly Check

The proposed change to the TS 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 impact the required frequency of surveillance or any condition within the SR.

The licensee stated that DAEC utilizes the Global Nuclear Fuels (GNF) core monitoring system ACUMEN, which incorporates the three-dimensional (3D) core simulator code PANACEA Version 11 (PANAC11). The system allows for a direct comparison of predicted core k_{eff} to measured core k_{eff}. Measured core k_{eff} is calculated by PANAC11 using measured plant operating data provided by ACUMEN. 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}.

The licensee recently transitioned from the 3D MONICORE core monitoring system to the ACUMEN core monitoring system, both of which were developed by GNF. The ACUMEN system is a version of the 3D MONICORE system designed to run on Windows-based computer platforms; the functionality, methodology, and technical equivalence of the underlying 3D MONICORE nuclear kernel remain unchanged. By letter dated August 21, 2016 (Reference 2), the NRC approved the use of the ACUMEN system for referencing in license applications after concluding the ACUMEN and 3D MONICORE systems are equivalent. This equivalency includes the power distribution uncertainties. By letter dated March 11, 1999 (Reference 3), the NRC approved the power distribution uncertainty for the 3D MONICORE system by accepting licensing topical report NEDC-32694P, "Power Distribution Uncertainties for Safety Limit MCPR [Minimum Critical Power Ratio] Evaluations," with limitations, for referencing in license applications. Further, by letter dated November 10, 1999 (Reference 4), 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. Succinctly, the codes and methodologies to be utilized by DAEC as part of the amendment are all NRC-approved.

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 above in Section 3.1.1 of this safety evaluation; (2) provides for a

technically superior comparison; and (3) is a simple and straightforward approach utilizing appropriate computer codes and methods.

The NRC staff notes that the licensee's proposed TSs change for DAEC is similar to the Boiling Water Reactor (BWR)/6 Standard TSs for reactivity anomalies, in that it performs the reactivity difference comparison using core k_{eff}. Although DAEC is a BWR/4 plant, it has the hardware and software in place (ACUMEN, PANAC11) to allow direct comparison of predicted k_{eff} to measured k_{eff} as described in the basis for the comparable BWR/6 surveillance (Reference 5). Additionally, the staff recognizes that there is a fleet precedent established regarding the licensee's proposed TS changes which is consistent with several other BWR/3 and BWR/4 designs that have implemented a similar TS change. As indicated in Section 4.2, "Precedent," of the DAEC application (Reference 1), the sites that have adopted this TS change include: Peach Bottom, Units 2 and 3; Hatch, Units 1 and 2; Limerick, Units 1 and 2; Brunswick, Units 1 and 2; Quad Cities, Units 1 and 2; and Dresden, Units 2 and 3.

The licensee also assessed the impact of this request on the DAEC 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.

3.2 Technical Conclusion

Based on the NRC staffs evaluation above, the staff has determined 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 licensee's proposed TS changes are acceptable for implementation at DAEC.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the appropriate official for the State of Iowa was notified of the NRC's proposed issuance of the amendment on January 23, 2018. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. 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 (*Federal Register* 82 FR 27889, dated June 19, 2017), and there has been no public comment on such finding. 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.

7.0 REFERENCES

1. Letter from Dean Curtland (NextEra Energy Duane Arnold, LLC) to U.S. Nuclear Regulatory Commission, "License Amendment Request (TSCR-164), Revision to Technical Specification 3.1.2, Reactivity Anomalies," April 20, 2017, ADAMS Accession No. ML17111A631.

2. Letter from K. Hsueh (NRC) to J. Head (GE-Hitachi Nuclear Energy Americas), "Final Safety Evaluation for Amendment 42 to Global Nuclear Fuel - Americas Topical Report NEDE-24011-P-A-US General Electric Standard Application for Reactor Fuel (GESTAR II) Supporting the Transition from the 3D-MONICORE Core Monitoring System to ACUMEN (CAC No. MF7438)," August 31, 2016, ADAMS Accession No. ML16243A022.

3. Letter from F. Akstulewicz (NRC) to G. Watford (GE), "Acceptance for referencing of Licensing Topical Reports NEDC-32601P, Methodology and Uncertainties for Safety Limit MCPR Evaluations; NEDC-32694P, Power Distribution Uncertainties for Safety Limit MCPR Evaluation; and Amendment 25 to NEDE-24011-P-A on Cycle-Specific Safety Limit MCPR (TAC Nos. M97490, M99069, and M97491)," March 11, 1999, ADAMS Accession No. ML993140059.

4. Acceptance letter MFN-035-99, S. Richards (NRC) to G. Watford (GE), "Amendment 26 to GE Licensing Topical Report NEDE-24011-P-A, "GESTAR II" – Implementing Improved GE Steady-State Methods (TAC No. MA6481)," November 10, 1999, ADAMS Accession No. ML993230184.

5. NUREG-1434, "Standard Technical Specifications General Electric Plants, BWR/6," Volume 2, Revision 3, ADAMS Accession Nos. ML041910223 and ML041910224.

Principle Contributor: K. Heller, NRR

Date of Issuance: March 9, 2018

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