



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

June 23, 2015

Mr. Ernest J. Harkness
Site Vice President
FirstEnergy Nuclear Operating Company
Mail Stop A-PY-A290
P.O. Box 97, 10 Center Road
Perry, OH 44081-0097

**SUBJECT: PERRY NUCLEAR POWER PLANT, UNIT NO. 1 - ISSUANCE OF
AMENDMENT CONCERNING ADOPTION OF TSTF-535, "REVISE
SHUTDOWN MARGIN DEFINITION TO ADDRESS ADVANCED FUEL
DESIGNS" (TAC NO. MF4791) (L-14-137)**

Dear Mr. Harkness:

The U.S. Nuclear Regulatory Commission has issued the enclosed Amendment No. 169 to Facility Operating License No. NPF-58 for Perry Nuclear Power Plant, Unit No. 1. The amendment consists of changes to the technical specifications (TSs) in response to your application dated September 12, 2014.

The amendment modifies the TS definition of shutdown margin (SDM) to require calculation of SDM at the reactor moderator temperature corresponding to the most reactive state throughout the operating cycle.

E. Harkness

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A copy of our safety evaluation is also enclosed. The Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

A handwritten signature in cursive script, appearing to read "Kimberly J. Green".

Kimberly J. Green, Senior Project Manager
Plant Licensing Branch III-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-440

Enclosures:

1. Amendment No. 169 to NPF-58
2. Safety Evaluation

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

FIRSTENERGY NUCLEAR OPERATING COMPANY

FIRSTENERGY NUCLEAR GENERATION, LLC

OHIO EDISON COMPANY

DOCKET NO. 50-440

PERRY NUCLEAR POWER PLANT, UNIT NO. 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 169
License No. NPF-58

1. The U.S. Nuclear Regulatory Commission (the Commission) has found that:
 - A. The application for license filed by FirstEnergy Nuclear Operating Company, et al., (the licensee, FENOC) dated September 12, 2014, 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 Facility Operating License No. NPF-58 is hereby amended to read as follows:

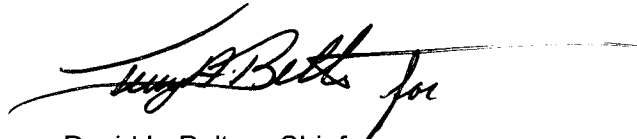
Enclosure 1

(2) Technical Specifications

The Technical Specifications contained in Appendix A and the Environmental Protection Plan contained in Appendix B, as revised through Amendment No. 169, are hereby incorporated into the license. FENOC shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

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

FOR THE NUCLEAR REGULATORY COMMISSION

A handwritten signature in black ink, appearing to read "David L. Pelton", followed by a horizontal line and the word "for" in cursive.

David L. Pelton, Chief
Plant Licensing Branch III-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Facility Operating License
and Technical Specifications

Date of Issuance: June 23, 2015

ATTACHMENT TO LICENSE AMENDMENT NO. 169

FACILITY OPERATING LICENSE NO. NPF-58

DOCKET NO. 50-440

Replace the following pages of the Facility Operating License and 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

License NPF-58

- 4 -

TS

1.0-6

INSERT

License NPF-58

- 4 -

TS

1.0-6

renewal. Such sale and leaseback transactions are subject to the representations and conditions set forth in the above mentioned application of January 23, 1987, as supplemented on March 3, 1987, as well as the letter of the Director of the Office of Nuclear Reactor Regulation dated March 16, 1987, consenting to such transactions. Specifically, a lessor and anyone else who may acquire an interest under these transactions are prohibited from exercising directly or indirectly any control over the licenses of PNPP Unit 1. For purposes of this condition the limitations of 10 CFR 50.81, as now in effect and as may be subsequently amended, are fully applicable to the lessor and any successor in interest to that lessor as long as the license for PNPP Unit 1 remains in effect; these financial transactions shall have no effect on the license for the Perry Nuclear facility throughout the term of the license.

- (b) Further, the licensees are also required to notify the NRC in writing prior to any change in: (i) the terms or conditions of any lease agreements executed as part of these transactions; (ii) the PNPP Operating Agreement; (iii) the existing property insurance coverage for PNPP Unit 1; and (iv) any action by a lessor or others that may have an adverse effect on the safe operation of the facility.

- C. This license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now and hereafter in effect; and is subject to the additional conditions specified or incorporated below:

- (1) Maximum Power Level

FENOC is authorized to operate the facility at reactor core power levels not in excess of 3758 megawatts thermal (100% power) in accordance with the conditions specified herein.

- (2) Technical Specifications

The Technical Specifications contained in Appendix A and the Environmental Protection Plan contained in Appendix B, as revised through Amendment No. 169, are hereby incorporated into the license. FENOC shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

- (3) Antitrust Conditions

- a. FirstEnergy Nuclear Generation, LLC and Ohio Edison Company

1.1 Definitions (continued)

SHUTDOWN MARGIN (SDM)	<p>SDM shall be the amount of reactivity by which the reactor is subcritical or would be subcritical throughout the operating cycle assuming that:</p> <ol style="list-style-type: none">The reactor is xenon free;The moderator temperature is $\geq 68^{\circ}\text{F}$, corresponding to the most reactive state; andAll control rods are fully inserted except for the single control rod of highest reactivity worth, which is assumed to be fully withdrawn. With control rods not capable of being fully inserted, the reactivity worth of these control rods must be accounted for in the determination of SDM.
STAGGERED TEST BASIS	<p>A STAGGERED TEST BASIS shall consist of the testing of one of the systems, subsystems, channels, or other designated components during the interval specified by the Surveillance Frequency, so that all systems, subsystems, channels, or other designated components are tested during n Surveillance Frequency intervals, where n is the total number of systems, subsystems, channels, or other designated components in the associated function.</p>
THERMAL POWER	<p>THERMAL POWER shall be the total reactor core heat transfer rate to the reactor coolant.</p>
TURBINE BYPASS SYSTEM RESPONSE TIME	<p>The TURBINE BYPASS SYSTEM RESPONSE TIME consists of two components:</p> <ol style="list-style-type: none">The time from initial movement of the main turbine stop valve or control valve until 80% of the turbine bypass capacity is established; andThe time from initial movement of the main turbine stop valve or control valve until initial movement of the turbine bypass valve. <p>The response time may be measured by means of any series of sequential, overlapping, or total steps so that the entire response time is measured.</p>



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO AMENDMENT NO. 169 TO FACILITY OPERATING LICENSE NO. NPF-58

FIRSTENERGY NUCLEAR OPERATING COMPANY

FIRSTENERGY NUCLEAR GENERATION, LLC

OHIO EDISON COMPANY

PERRY NUCLEAR POWER PLANT, UNIT NO. 1

DOCKET NO. 50-440

1.0 INTRODUCTION

By application dated September 12, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14255A150), FirstEnergy Nuclear Operating Company (the licensee or FENOC) requested changes to the technical specifications (TSs) for the Perry Nuclear Power Plant, Unit 1 (PNPP or Perry). Specifically, the licensee requested to adopt U.S. Nuclear Regulatory Commission (NRC or Commission)-approved Technical Specifications Task Force (TSTF) Standard Technical Specifications (STS) Change Traveler TSTF-535, "Revise Shutdown Margin Definition to Address Advanced Fuel Designs" (ADAMS Accession No. ML112200436), dated August 8, 2011.

The proposed change would modify the TS definition of shutdown margin (SDM) to require calculation of SDM at the reactor moderator temperature corresponding to the most reactive state throughout the operating cycle (68 °F or higher). The purpose is to address newer boiling water reactor fuel designs, which may be more reactive at shutdown temperatures above 68 °F. This license amendment request is consistent with NRC-approved TSTF Traveler TSTF-535.

2.0 REGULATORY EVALUATION

2.1 Background

In water-moderated reactors, water is used to slow down, or moderate, high-energy fast neutrons to low-energy thermal neutrons through multiple scattering interactions. The low-energy thermal neutrons are much more likely to cause fission when absorbed by the fuel. However, not all of the thermal neutrons are absorbed by the fuel; a portion of them are instead absorbed by the water moderator. The amount of moderator and fuel that is present in the core heavily influences the fractions of thermal neutrons that are absorbed in each.

Water-moderated reactors are designed such that they tend to operate in what is known as an under-moderated condition. In this condition, the ratio of the moderator-to-fuel in the core is small enough that the overall effectiveness of water as a moderator decreases with increasing temperature; fewer neutrons are absorbed in the moderator due to the decrease in its density, but this is overshadowed by the reduction in the number of neutrons that moderate from high fission energy to the lower energy level needed to cause fission. The result is a decrease in power and temperature, a negative reactivity feedback effect where the reactor becomes self-regulating. However, if the amount of moderator becomes too large with respect to the amount of fuel, the reactor can enter an over-moderated condition. In this condition, the overall effectiveness of water as a moderator increases with increasing temperature; the reduction in the number of neutrons absorbed in the moderator outweighs the loss in neutrons reaching lower energies. This causes an increase in power that leads to a further increase in temperature creating a potentially dangerous positive reactivity feedback cycle.

As practical examples in support of the proposed changes to the definition of SDM, TSTF-535 discussed SDM with regards to General Electric (GE)14 and Global Nuclear Fuel 2 (GNF2) fuels. TSTF-535 indicated that for historical fuel products through GE14, the maximum reactivity condition for SDM always occurred at a moderator temperature of 68 °F because these fuel products were designed so that the core is always under-moderated when all control rods are inserted, except for the single most reactive rod. In cores with GNF2 fuel, TSTF-535 stated that it is expected that the maximum reactivity condition at beginning of cycle will remain at 68 °F, but that later in cycle the most limiting SDM may occur at a temperature greater than this, indicating that with this fuel design the core could potentially achieve an over-moderated condition.

2.2 Technical Specification Changes

FENOC adoption of TSTF-535 for Perry, Unit 1, proposes to revise the technical specification (TS) definition of SDM to require calculation of SDM at the reactor moderator temperature corresponding to the most reactive state throughout the operating cycle (68 °F or higher).

The current definition of SDM in Section 1.1, "Definitions," of the Perry, Unit 1, TS is:

SDM shall be the amount of reactivity by which the reactor is subcritical or would be subcritical assuming that:

- a. The reactor is xenon free;
- b. The moderator temperature is 68 °F; and
- c. All control rods are fully inserted except for the single control rod of the highest reactivity worth, which is assumed to be fully withdrawn. With control rods not capable of being fully inserted, the reactivity worth of these control rods must be accounted for in the determination of SDM.

The licensee proposes the following changes (shown in **bold**) to the definition of SDM in accordance with TSTF-535:

SDM shall be the amount of reactivity by which the reactor is subcritical or would be subcritical **throughout the operating cycle** assuming that:

- a. The reactor is xenon free;
- b. The moderator temperature is ≥ 68 °F, **corresponding to the most reactive state**; and
- c. All control rods are fully inserted except for the single control rod of the highest reactivity worth, which is assumed to be fully withdrawn. With control rods not capable of being fully inserted, the reactivity worth of these control rods must be accounted for in the determination of SDM.

2.3 Regulatory Review

Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Appendix A, General Design Criteria (GDC) 26, "Reactivity control system redundancy and capability," and GDC 27, "Combined reactivity control systems capability," respectively require that reactivity within the core be controllable to ensure subcriticality is achievable and maintainable under cold conditions, with appropriate margin for stuck rods; and that reactivity within the core be controllable to assure that under postulated accident conditions and with appropriate margin for stuck rods the capability to cool the core is maintained.

Among other things, 10 CFR 50.36(c)(2)(ii) requires the establishment of a limiting condition for operation (LCO) for a process variable, design feature, or operating restriction that is an initial condition of a design-basis accident or transient analysis that either assumes the failure of or presents a challenge to the integrity of a fission product barrier. The TS definition of SDM and the LCOs placed on SDM serve, in part, to satisfy GDCs 26 and 27 by ensuring there is always sufficient negative reactivity worth available to offset the positive reactivity worth of changes in moderator and fuel temperature, the decay of fission product poisons, the failure of a control rod to insert, and reactivity insertion accidents. Given this margin, the core can be held subcritical for conditions of normal operation, including anticipated operational occurrences.

The NRC's guidance for the format and content of licensee TSs can be found in NUREG-1434, "Standard Technical Specifications (STS) General Electric Plants, BWR/6," April 2012 (ADAMS Accession No. ML12104A195).

Revision 3 of NUREG-0800, "Standard Review Plan (SRP) for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 4.3, "Nuclear Design," dated March 2007 (ADAMS Accession No. ML070740003), provides the review guidance for reactivity control systems and SDM to help ensure compliance with GDCs 26 and 27.

The licensee's proposed change revises the definition of SDM to ensure that these regulatory criteria are met for all fuel types at any time in core life.

3.0 TECHNICAL EVALUATION

3.1 Current Definition of Shutdown Margin

In boiling-water reactor (BWR) plants, the control rods are used to hold the reactor core subcritical under cold conditions. The control rod negative reactivity worth must be sufficient to ensure the core is subcritical by a margin known as the SDM. It is the additional amount of negative reactivity worth needed to maintain the core subcritical by offsetting the positive reactivity worth that can occur during the operating cycle due to changes in moderator and fuel temperature, the decay of fission product poisons, the failure of a control rod to insert, and reactivity insertion accidents. Specifically, Section 1.1, "Definitions," of the STS defines SDM as the amount of reactivity by which the reactor is subcritical or would be subcritical assuming that the reactor is: (1) xenon free, (2) the moderator is 68 °F, and (3) all control rods are fully inserted except for the rod of highest worth, which is assumed to be fully withdrawn.

The three criteria provided in the definition help exemplify what has traditionally been the most reactive design condition for a reactor core. Xenon is a neutron poison produced by fission product decay and its presence in the core adds negative reactivity worth. Assuming the core is xenon free removes a positive reactivity offset and is representative of fresh fuel at the beginning of cycle.

The minimum temperature the reactor moderator is anticipated to experience is 68 °F, making it the point at which the moderator will be at its densest and, therefore, capable of providing the highest positive reactivity worth. By assuming the highest worth rod is fully withdrawn, the core can be designed with adequate shutdown margin to ensure it remains safely shutdown even in the event of a stuck control rod, as required by GDCs 26 and 27.

Determination of the SDM under the aforementioned conditions yields a conservative result that, along with the requirements set forth in Section 3.1.1 of the TS, helps ensure:

- a. the reactor can be made subcritical from all operating conditions and transients and design basis events,
- b. the reactivity transients associated with postulated accident conditions are controllable within acceptable limits, and
- c. the reactor will be maintained sufficiently subcritical to preclude inadvertent criticality in the shutdown condition.

3.2 Proposed Definition of Shutdown Margin

The specified moderator temperature of 68 °F facilitates the maximum reactivity condition only if the core exists in an under-moderated condition. In addition to burnable poisons, many modern fuel designs also incorporate partial length rods for increased neutron economy which are employed in order to extend the operating cycle. Both of these affect the ratio of moderator to fuel. The strong local absorption effects of the burnable poisons in fresh fuel make the core under-moderated. As burnable poisons are depleted during the fuel cycle, the core becomes less under-moderated, potentially leading to a slightly over-moderated condition wherein the

core will be more reactive at a moderator temperature higher than the 68 °F specified in the SDM definition. Thus, the maximum core reactivity condition and the most limiting SDM may occur later in the fuel cycle at a temperature greater than 68 °F. Consequently, calculation of the SDM at the currently defined moderator temperature of 68 °F may not accurately determine the available margin.

TSTF-535 therefore proposed a change to the definition of SDM to enable calculation of the SDM at a reactor moderator temperature of 68 °F or a higher temperature corresponding to the most reactive state throughout the operating cycle. SDM would be calculated using the appropriate limiting conditions for all fuel types at any time in core life.

In support of the proposed change, TSTF-535 cited the requirements for SDM as specified in Topical Report NEDO-24011-A, Revision 18, "General Electric Standard Application for Reactor Fuel (GESTAR II)," dated April 2011 (ADAMS Package Accession No. ML111120038). Section 3.2.4.1 of GESTAR II states:

The core must be capable of being made subcritical, with margin, in the most reactive condition throughout the operating cycle with the most reactive control rod fully withdrawn and all other rods fully inserted.

TSTF-535 also cited SRP, Section 4.3, which states the following concerning the review of control systems and SDM:

The adequacy of the control systems to assure that the reactor can be returned to and maintained in the cold shutdown condition at any time during operation. The applicant shall discuss shutdown margins (SDM). Shutdown margins need to be demonstrated by the applicant throughout the fuel cycle.

Although the licensing basis requirements for SDM in GESTAR II are only applicable for cores licensed with GNF methods, they are consistent with the review procedures set forth in the SRP, which are provided to help ensure compliance with GDCs 26 and 27. TSTF-535 stated that while the SRP does not prescribe the temperature at which the minimum SDM should be determined, the requirement of shutting down the reactor and maintaining it in a shutdown condition "at any time during operation" suggests that considering a range of thermal and exposure conditions would be appropriate in the determination of the minimum SDM. Because newer fuel designs employ elements such as partial length rods and burnable absorbers, which may cause the maximum core reactivity conditions and the most limiting SDM to occur later in the fuel cycle at a temperature greater than 68 °F, the NRC staff agrees with the TSTF-535 assessment in this regard. Additionally, the NRC staff finds that allowing calculation of the SDM at the most limiting core reactivity condition is prudent with respect to ensuring compliance with GDCs 26 and 27 and concludes that the proposed changes to the TSs are acceptable.

The impetus for TSTF-535 was to provide for a more broadly applicable SDM definition in recognition of modern fuel designs, for which the core may not be in its most reactive condition at 68 °F. The proposed language would require the licensee to consider all temperatures equal to or exceeding 68 °F, and all times in the operating cycle. This change places an additional responsibility on any implementing licensee to identify the most limiting time-in-cycle and temperature, a change that is effectively more restrictive than the current definition. Therefore,

the change can be considered acceptable for any facility that currently, and appropriately so, adheres to the current definition of SDM that is contained in the STS. Based on these considerations, the NRC staff concludes that the change is applicable to any BWR, including Perry, Unit 1, regardless of its fuel design. The NRC staff also finds that the revised definition is consistent with the 10 CFR 50.36 requirements pertaining to LCOs, because it ensures that the LCOs for SDM consider a broadly conservative range of potential initial conditions in the anticipated operational occurrence analyses.

3.3 Summary

The NRC staff has reviewed the licensee's implementation of TSTF-535 proposed revisions to the definition of SDM. Based on the considerations discussed above, the NRC staff concludes that the proposed revisions are acceptable and will provide a conservative and improved approach to the calculation of SDM that ensures use of the appropriate limiting conditions for all fuel types at any time in the life of the core. The NRC staff finds the proposed revisions serve to satisfy the requirements set forth in GDCs 26 and 27, as discussed in NUREG-0800, Chapter 4.3, "Nuclear Design." Additionally, the NRC staff concludes the proposed changes to the definition of SDM would require the licensee to calculate SDM in consideration of the most limiting conditions in the core. Therefore, the revised SDM definition is acceptable for BWR facilities, including Perry, Unit 1, using any current fuel design.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Ohio State official was notified of the proposed issuance of the amendment. 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 and there has been no public comment on such finding (79 FR 70216; November 25, 2014). 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: M. Razzaque

Date of issuance: June 23, 2015

E. Harkness

- 2 -

A copy of our safety evaluation is also enclosed. The Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

/RA/

Kimberly J. Green, Senior Project Manager
Plant Licensing Branch III-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-440

Enclosures:

1. Amendment No. 169 to NPF-58
2. Safety Evaluation

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