



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

January 13, 2020

Mr. Kevin Cimorelli
Site Vice President
Susquehanna Nuclear, LLC
769 Salem Boulevard
NUCSB3
Berwick, PA 18603-0467

SUBJECT: SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2 - ISSUANCE OF AMENDMENT NOS. 274 AND 256 TO ADOPT TECHNICAL SPECIFICATIONS TASK FORCE TRAVELER, TSTF-535, REVISION 0, "REVISE SHUTDOWN MARGIN DEFINITION TO ADDRESS ADVANCED FUEL DESIGNS" (EPID L-2019-LLA-0154)

Dear Mr. Cimorelli:

The U.S. Nuclear Regulatory Commission (the Commission) has issued the enclosed Amendment No. 274 to Renewed Facility Operating License No. NPF-14 and Amendment No. 256 to Renewed Facility Operating License No. NPF-22 for the Susquehanna Steam Electric Station, Units 1 and 2, respectively. These amendments consist of changes to the technical specifications (TSs) in response to your application dated July 15, 2019.

The license amendment requests proposed changes to adopt Technical Specifications Task Force (TSTF) Traveler TSTF-535, Revision 0, "Revise Shutdown Margin Definition to Address Advanced Fuel Designs," and revise TS 5.6.5b to allow application of Advanced Framatome methodologies for loading Framatome fuel type ATRIUM 11. The enclosed amendments are for the TSTF-535 portion of the application. If approved, the adoption of Framatome fuel type ATRIUM 11 will be addressed in separate amendments and issued later.

The enclosed amendments revise the TS definition of "shutdown margin" to require its calculation at a reactor moderator temperature of 68 degrees Fahrenheit or a higher temperature that represents the most reactive state throughout the operating cycle.

K. Cimorelli

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A copy of the related safety evaluation is also enclosed. Notice of Issuance will be included in the Commission's Biweekly *Federal Register* Notice.

Sincerely,



Sujata Goetz, Project Manager
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-387 and 50-388

Enclosures:

1. Amendment No. 274 to
License No. NPF-14
2. Amendment No. 256 to
License No. NPF-22
3. Safety Evaluation

cc: Listserv



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

SUSQUEHANNA NUCLEAR, LLC

ALLEGHENY ELECTRIC COOPERATIVE, INC.

DOCKET NO. 50-387

SUSQUEHANNA STEAM ELECTRIC STATION, UNIT 1

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No.274
Renewed License No. NPF-14

1. The U.S. Nuclear Regulatory Commission (NRC or the Commission) has found that:
 - A. The application for the amendment filed by Susquehanna Nuclear, LLC, dated July 15, 2019, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's 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 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.

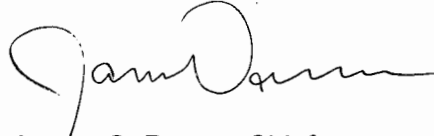
2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment and paragraph 2.C.(2) of Renewed Facility Operating License No. NPF-14 is hereby amended to read as follows:

- (2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A, as revised through Amendment No. 274, and the Environmental Protection Plan contained in Appendix B are hereby incorporated in the license. Susquehanna Nuclear, LLC 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 issuance. Once approved, Amendment No. 274 for Unit 1 will be implemented prior to loading ATRIUM 11 fuel into the core during the spring 2022 refueling outage.

FOR THE NUCLEAR REGULATORY COMMISSION



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

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

Date of Issuance: January 13, 2020

ATTACHMENT TO LICENSE AMENDMENT NO. 274
SUSQUEHANNA STEAM ELECTRIC STATION, UNIT 1
RENEWED FACILITY OPERATING LICENSE NO. NPF-14
DOCKET NO. 50-387

Replace the following page of the Renewed Facility Operating License with the attached revised page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

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Replace the following page of the Appendix A Technical Specifications with the attached revised page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

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- (3) Susquehanna Nuclear, LLC, 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 as sealed neutron sources for reactor startup, sealed neutron sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;
 - (4) Susquehanna Nuclear, LLC, pursuant to the Act and 10 CFR Parts 30, 40, and 70 to receive, possess, and use in amounts as required any byproduct, source or special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and
 - (5) Susquehanna Nuclear, LLC, pursuant to the Act and 10 CFR Parts 30, 40, 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 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 or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

Susquehanna Nuclear, LLC is authorized to operate the facility at reactor core power levels not in excess of 3952 megawatts thermal in accordance with the conditions specified herein. The preoperational tests, startup tests and other items identified in License Conditions 2.C.(36), 2.C.(37), 2.C.(38), and 2.C.(39) to this license shall be completed as specified.

(2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A, as revised through Amendment No. 274, and the Environmental Protection Plan contained in Appendix B are hereby incorporated in the license. Susquehanna Nuclear, LLC shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

For Surveillance Requirements (SRs) that are new in Amendment 178 to Facility Operating License No. NPF-14, the first performance is due at the end of the first surveillance interval that begins at implementation of Amendment 178. For SRs that existed prior to Amendment 178, including SRs with modified acceptance criteria and SRs whose frequency of performance is being extended, the first performance 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 178.

1.1 Definitions

RATED THERMAL POWER (RTP)	RTP shall be a total reactor core heat transfer rate to the reactor coolant of 3952 MWt.
REACTOR PROTECTION SYSTEM (RPS) RESPONSE TIME	The RPS RESPONSE TIME shall be that time interval from when the monitored parameter exceeds its RPS trip setpoint at the channel sensor until de-energization of the scram pilot valve solenoids. 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.
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	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 η Surveillance Frequency intervals, where η is the total number of systems, subsystems, channels, or other designated components in the associated function.
THERMAL POWER	THERMAL POWER shall be the total reactor core heat transfer rate to the reactor coolant.
TURBINE BYPASS SYSTEM RESPONSE TIME	The TURBINE BYPASS SYSTEM RESPONSE TIME consists of the time from when the turbine bypass control unit generates a turbine bypass valve flow signal



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SUSQUEHANNA NUCLEAR, LLC

ALLEGHENY ELECTRIC COOPERATIVE, INC.

DOCKET NO. 50-388

SUSQUEHANNA STEAM ELECTRIC STATION, UNIT 2

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 256
Renewed License No. NPF-22

1. The U.S. Nuclear Regulatory Commission (NRC or the Commission) has found that:
 - A. The application for the amendment filed by Susquehanna Nuclear, LLC, dated July 15, 2019, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's 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 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.

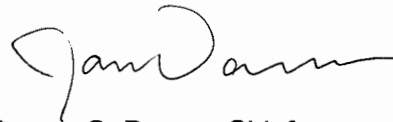
2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment and paragraph 2.C.(2) of Renewed Facility Operating License No. NPF-22 is hereby amended to read as follows:

- (2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A, as revised through Amendment No. 256, and the Environmental Protection Plan contained in Appendix B are hereby incorporated in the license. Susquehanna Nuclear, LLC 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 issuance. Once approved, Amendment No. 256 for Unit 2 will be implemented prior to loading ATRIUM 11 fuel into the core during the spring 2021 refueling outage.

FOR THE NUCLEAR REGULATORY COMMISSION



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

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

Date of Issuance: January 13, 2020

ATTACHMENT TO LICENSE AMENDMENT NO.256
SUSQUEHANNA STEAM ELECTRIC STATION, UNIT 2
RENEWED FACILITY OPERATING LICENSE NO. NPF-22
DOCKET NO. 50-388

Replace the following page of the Renewed Facility Operating License with the attached revised page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

REMOVE
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Replace the following page of the Appendix A Technical Specifications with the attached revised page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

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- (3) Susquehanna Nuclear, LLC, 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 as sealed neutron sources for reactor startup, sealed neutron sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;
- (4) Susquehanna Nuclear, LLC, pursuant to the Act and 10 CFR Parts 30, 40, and 70 to receive, possess, and use in amounts as required any byproduct, source or special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and
- (5) Susquehanna Nuclear, LLC, pursuant to the Act and 10 CFR Parts 30, 40, 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 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 or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

Susquehanna Nuclear, LLC is authorized to operate the facility at reactor core power levels not in excess of 3952 megawatts thermal in accordance with the conditions specified herein. The preoperational tests, startup tests and other items identified in License Conditions 2.C.(20), 2.C.(21), 2.C.(22), and 2.C.(23) to this license shall be completed as specified.

(2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A, as revised through Amendment No. 256, and the Environmental Protection Plan contained in Appendix B are hereby incorporated in the license. Susquehanna Nuclear, LLC shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

For Surveillance Requirements (SRs) that are new in Amendment 151 to Facility Operating License No. NPF-22, the first performance is due at the end of the first surveillance interval that begins at implementation of Amendment 151. For SRs that existed prior to Amendment 151, including SRs with modified acceptance criteria and SRs whose frequency of performance is being extended, the first performance 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 151.

1.1 Definitions

RATED THERMAL POWER (RTP)	RTP shall be a total reactor core heat transfer rate to the reactor coolant of 3952 MWt.
REACTOR PROTECTION SYSTEM (RPS) RESPONSE TIME	The RPS RESPONSE TIME shall be that time interval from when the monitored parameter exceeds its RPS trip setpoint at the channel sensor until de-energization of the scram pilot valve solenoids. 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.
SHUTDOWN MARGIN (SDM)	SDM shall be the amount of reactivity by which the reactor is subcritical or would be subcritical throughout the operating cycle assuming that: <ol style="list-style-type: none"> a. The reactor is xenon free; b. The moderator temperature is $\geq 68^{\circ}\text{F}$, corresponding to the most reactive state; and c. All 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	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.
THERMAL POWER	THERMAL POWER shall be the total reactor core heat transfer rate to the reactor coolant.
TURBINE BYPASS SYSTEM RESPONSE TIME	The TURBINE BYPASS SYSTEM RESPONSE TIME consists of the time from when the turbine bypass control unit generates a turbine bypass valve flow signal



UNITED STATES
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WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 274 TO

RENEWED FACILITY OPERATING LICENSE NO. NPF-14

AND AMENDMENT NO. 256 TO

RENEWED FACILITY OPERATING LICENSE NO. NPF-22

SUSQUEHANNA NUCLEAR, LLC

ALLEGHENY ELECTRIC COOPERATIVE, INC.

SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2

DOCKET NOS. 50-387 AND 50-388

1.0 INTRODUCTION

By letter dated July 15, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19196A270), Susquehanna Nuclear, LLC (the licensee) requested changes to the Susquehanna Steam Electric Station (Susquehanna), Units 1 and 2, Technical Specifications (TSs). Specifically, the licensee requested to adopt U.S. Nuclear Regulatory Commission (NRC, the Commission)-approved Technical Specifications Task Force (TSTF) Improved Standard Technical Specifications Change Traveler TSTF-535, Revision 0, "Revise Shutdown Margin Definition to Address Advanced Fuel Designs" (ADAMS Accession No. ML112200436), dated August 8, 2011.

The license amendment request also proposed to revise TS 5.6.5b to allow application of Advanced Framatome methodologies for loading Framatome fuel type ATRIUM 11. If approved, the adoption of Framatome fuel type ATRIUM 11 will be addressed in separate license amendments and safety evaluation later.

The amendments to adopt TSTF-535 would revise the TS definition of "shutdown margin" (SDM) to require calculation of the SDM at a reactor moderator temperature of 68 degrees Fahrenheit (°F) or a higher temperature that represents the most reactive state throughout the operating cycle.

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 the thermal neutrons are absorbed by the fuel; a portion is instead absorbed by the water moderator. The amount of moderator and fuel that is present in the core heavily influences the number of thermal neutrons that are absorbed in each.

Water-moderated reactors are designed to operate in what is known as an under-moderated condition. In this condition, the ratio of the water-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 water 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 water 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 water 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 regarding fuel assembly-General Electric 14 (GE14) and Global Nuclear Fuel-2 (GNF2) fuels. TSTF-535 states that for historical fuel products leading up to, and including GE14, the maximum reactivity condition for SDM always occurs at a moderator temperature of 68 °F. GE14 and GNF2 fuels 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 assumes that the maximum reactivity condition at the beginning of cycle will remain at 68 °F, but later in the cycle, the most limiting SDM may occur at a higher temperature. Thus, the GNF2 fuel design could potentially cause an over-moderated condition in the core and an unwanted increase in power.

2.2 Description of the Proposed TS Changes

The licensee's adoption of TSTF-535 for Susquehanna, Units 1 and 2, proposes to revise the 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 Susquehanna, Units 1 and 2, TS is:

SHUTDOWN MARGIN (SDM)

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 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 $\geq 68^{\circ}\text{F}$, **corresponding to the most reactive state**; and
- c. All 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.

There is an editorial difference between NUREG-1433, Revision 4.0, Volume 1, "Standard Technical Specifications, General Electric Plants BWR/4" (STS) (ADAMS Accession No. ML12104A192), and the proposed Susquehanna, Units 1 and 2, TS definition for SDM. The last sentence of the definition of SDM in the Susquehanna, Units 1 and 2, TS, which states, "With control rods not capable of being fully inserted, the reactivity worth of these control rods must be accounted for in the determination of SDMs," is separated from subheading "c" and is stated as its own paragraph. In the STS, that same sentence is included in subheading "c." Therefore, in addition to the changes described in TSTF-535, the licensee proposes modifying the layout of the paragraph on SDM to include this sentence of the definition of SDM under subheading c. The NRC staff has determined that this is an editorial change that has no technical impact and is, therefore, acceptable.

2.3 Regulatory Review

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants" (GDC) 26, "Reactivity control system redundancy and capability," and GDC 27, "Combined reactivity control systems capability," both require that reactivity within the core be controllable to ensure subcriticality is achievable and maintainable under cold conditions. Reactivity must also have appropriate margin for stuck rods and it must be controllable to assure that under postulated accident conditions, 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 enough 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 the licensee's TS can be found in NUREG-1433, "Standard Technical Specifications [STS], GE BWR/4 Plants, Revision 4.0, Volume 1, and 2 (ADAMS Accession No. ML12104A192 and ML12104A193).

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 procedures concerning the review of control systems and SDM to help ensure compliance with GDCs 26 and 27.

3.0 TECHNICAL EVALUATION

3.1 Current Definition of SDM

In BWR plants, the control rods are used to hold the reactor core subcritical under cold conditions. The control rod negative reactivity worth must be enough 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 Susquehanna TS 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 SDM to ensure it remains safely shut down even in the event of a stuck control rod, as required by GDCs 26 and 27.

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

- (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.

- (c) The reactor will be maintained sufficiently subcritical to preclude inadvertent criticality in the shutdown condition.

This is consistent with 10 CFR Part 50, Appendix A, GDCs 26 and 27.

3.2 Proposed Definition of SDM

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 that are employed to extend the operating cycle. Both 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.

Consistent with TSTF-535, the licensee proposed changes 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.

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 Accession No. ML111120046), 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 cites SRP Section 4.3, "Nuclear Design," which states, in part, 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. 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" as stated by SRP Section 4.3 above suggests that considering a range of thermal and exposure conditions would be appropriate in the determination of the minimum SDM.

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 purpose of TSTF-535 is to provide 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 at all times in the operating cycle. This change places an additional responsibility on the licensee to identify the most limiting time-in-cycle and temperature, which is a change that is more restrictive than the current definition. The proposed changes to TS 1.1 ensure that the LCO for SDM covers a broad conservative range of potential initial conditions in the anticipated operational occurrence analyses. 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 TS are acceptable.

3.3 Variation from TSTF-535

This variation aligns the Susquehanna, Units 1 and 2, TS with the STS. This is an editorial change that removes blank spaces from the SDM definition in Susquehanna, Units 1 and 2, TS and does not change its wording or its requirements. The NRC staff finds that it does not impact the conclusion that TSTF-535 is applicable to the Susquehanna, Units 1 and 2, TS, nor does it affect the NRC's conclusion that the change is acceptable as documented in the Federal Register Notice. Therefore, the NRC staff finds this proposed change to be acceptable.

3.4 Technical Evaluation 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 the use of the appropriate limiting conditions for all fuel types at any time in the life of the core. The NRC staff concludes that the proposed revisions serve to satisfy the requirements set forth in GDCs 26 and 27. The NRC staff concludes that 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 Susquehanna, Units 1 and 2.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Pennsylvania State official was notified of the proposed issuance of the amendments on November 26, 2019. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendments change requirements with respect to the installation or use of facility components 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

published in the *Federal Register* on October 22, 2019 (84 FR 56482). 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) 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: K. Bucholtz

Date: January 13, 2020

SUBJECT: SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2 - ISSUANCE OF AMENDMENT NOS. 274 AND 256 TO ADOPT TECHNICAL SPECIFICATIONS TASK FORCE TRAVELER, TSTF-535, REVISION 0, "REVISE SHUTDOWN MARGIN DEFINITION TO ADDRESS ADVANCED FUEL DESIGNS" (EPID L-2019-LLA-0154) DATED JANUARY 13, 2020

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