August 8, 2011

TSTF-11-09
PROJ0753

Attn: Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: Transmittal of TSTF-535, Revision 0, "Revise Shutdown Margin Definition to Address Advanced Fuel Designs"

Enclosed for NRC review is Revision 0 of TSTF-535, "Revise Shutdown Margin Definition to Address Advanced Fuel Designs." TSTF-535 is applicable to Boiling Water Reactor (BWR) plants.

Any NRC review fees associated with the review of TSTF-535 should be billed to the Boiling Water Reactor Owners' Group.

Should you have any questions, please do not hesitate to contact us.

Norman J. Stringfellow (PWROG/W)

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Enclosure

cc: Robert Elliott, Technical Specifications Branch, NRC
Michelle Honcharik, Licensing Processes Branch, NRC

11921 Rockville Pike, Suite 100, Rockville, MD 20852
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Administration by EXCEL Services Corporation

Technical Specification Task Force
Improved Standard Technical Specifications Change Traveler

Revise Shutdown Margin Definition to Address Advanced Fuel Designs

NUREGs Affected: ☐ 1430 ☐ 1431 ☐ 1432 ☑ 1433 ☑ 1434

Classification 1) Technical Change | Recommended for CLIIP?: Yes

Correction or Improvement: Correction | NRC Fee Status: Not Exempt

Benefit: Increases Equipment Operability

See attached.

Revision History

OG Revision 0 Revision Status: Active

Revision Proposed by: BWROG

Revision Description:
Original Issue

Owners Group Review Information

Date Originated by OG: 19-Apr-11

Owners Group Comments
Revised to include BWROG comments.

Owners Group Resolution: Approved Date: 19-May-11

TSTF Review Information

TSTF Received Date: 19-Jul-11 Date Distributed for Review 19-Jul-11

OG Review Completed: ☑ BWOG ☑ WOG ☑ CEOG ☑ BWROG

TSTF Comments:
(No Comments)

TSTF Resolution: Approved Date: 08-Aug-11

NRC Review Information

NRC Received Date: 08-Aug-11

Affected Technical Specifications

1.1 Definitions - Shutdown Margin

1. SUMMARY DESCRIPTION

The proposed change revises the definition of Shutdown Margin (SDM) to require 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. This change is needed to address new Boiling Water Reactor (BWR) fuel designs which may be more reactive at shutdown temperatures above 68°F.

2. DETAILED DESCRIPTION

Shutdown Margin (SDM) requirements are specified to ensure:

a. The reactor can be made subcritical from all operating conditions, 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.

NUREG-1433 and NUREG-1434, the Standard Technical Specifications for BWR/4 and BWR/6 plants, respectively, Section 1.1, "Definitions," define 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."

In a letter from Global Nuclear Fuel (GNF) to the U.S. Nuclear Regulatory Commission dated November 8, 2010 (Reference 1), GNF stated the Technical Specification (TS) definition of 68°F moderator temperature for the shutdown margin evaluation may not be the most reactive condition for some fuel designs. For fuel products through GE14, the maximum reactivity condition for SDM always occurs at a moderator temperature of 68°F and the SDM is calculated at this temperature.

For cores with GNF2 fuel or other modern designs, it is possible that the most reactive moderator temperature may occur at a temperature above 68°F. For normal reload core designs, even those with 100% GNF2 fuel, it is expected that the maximum reactivity

condition at beginning-of-cycle (BOC) will remain at 68°F. However, later in the cycle there is the possibility of a more limiting SDM at a temperature greater than 68°F.

The proposed change revises the definition of SDM to address this situation by changing the introductory sentence and item b of the definition to require calculating SDM at 68°F or a higher temperature corresponding to the most reactive state throughout the operating cycle. The revised definition will state:

> "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 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." (Changes are shown in bold.)

A model application is included in the proposed change. The model may be used by licensees desiring to adopt TSTF-535 following NRC approval.

3. TECHNICAL EVALUATION

Title 10 of the Code of Federal Regulations (CFR), Part 50, Appendix A, "General Design Criteria," (GDC), GDC 26, "Reactivity control system redundancy and capability," states:

> "Two independent reactivity control systems of different design principles shall be provided. One of the systems shall use control rods, preferably including a positive means for inserting the rods, and shall be capable of reliably controlling reactivity changes to assure that under conditions of normal operation, including anticipated operational occurrences, and with appropriate margin for malfunctions such as stuck rods, specified acceptable fuel design limits are not exceeded. The second reactivity control system shall be capable of reliably controlling the rate of reactivity changes resulting from planned, normal power changes (including xenon burnout) to assure acceptable fuel design limits are not exceeded. <u>One of the systems shall be capable of holding the reactor core subcritical under cold conditions.</u>" (Emphasis added).

In BWR plants, the control rods are used to hold the reactor core subcritical under cold conditions. The control rod reactivity worth must be sufficient to ensure the core is subcritical by the amount of the SDM. The SDM is the additional amount of negative reactivity needed to offset the reactivity worth of changes in moderator and fuel

temperature, the decay of fission product poisons, failure of a control rod to insert, and reactivity insertion accidents.

For cores licensed with GNF methods, the licensing basis requirements for SDM are specified in GESTAR II (NEDE-24011-P-A-17) (Reference 2), Section 3.2.4.1, "Shutdown Reactivity," which 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."

The GESTAR II requirement is consistent with the NRC Standard Review Plan (NUREG-0800) Chapter 4.3, "Nuclear Design," which states:

> "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."

While the Standard Review Plan does not precisely prescribe that the temperature of minimum shutdown margin be determined, the requirement of shutting down the reactor and maintaining it in a shutdown condition suggests that considering a range of thermal and exposure conditions is appropriate in the determination of the minimum SDM.

For historical fuel products through GE14, the maximum reactivity condition for SDM always occurs at a moderator temperature of 68°F (the minimum expected reactor moderator temperature) and the SDM is calculated at this temperature. These fuel products are designed so that the core is always under moderated when all control rods are inserted except for the single most reactive rod. In this under moderated condition, higher coolant temperatures result in a lower water density and less moderation. Therefore, specifying use of a minimum coolant temperature of 68°F in the SDM calculation results in the most limiting SDM value.

In cores with GNF2 fuel, or other modern fuel designs with increased moderation, it is possible for the most reactive condition to exist at a moderator temperature greater than 68°F. For normal reload core designs, even those with all GNF2 fuel, it is expected that the maximum reactivity condition at BOC will remain at 68°F. The strong local absorption effects of gadolinia in fresh fuel make the core under moderated. Later in the cycle, as gadolinia is depleted, all cores become less under moderated and there is the possibility that the maximum reactivity condition is at a temperature greater than 68°F. Thus, late in the fuel cycle the most limiting SDM may occur at a temperature greater than 68°F.

The proposed change to the definition ensures that SDM is calculated using the appropriate limiting conditions for all fuel types.

Pending revision to the Technical Specification definition of SDM, the vendor or licensee SDM calculations for cores with GNF2 fuel or similar fuel from other vendors are being performed over a temperature range that ensures the limiting SDM is determined.

4. REGULATORY EVALUATION

4.1 Applicable Regulatory Requirements/Criteria

GDC 26, "Reactivity control system redundancy and capability," states that one of the reactivity control systems shall be capable of holding the reactor core subcritical under cold conditions.

NUREG-0800, "Standard Review Plan," states that the reactivity control systems must be capable of maintaining the reactor in the cold shutdown condition at any time during operation.

The 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.

4.2 No Significant Hazards Consideration Determination

The proposed change revises the definition of Shutdown Margin (SDM) to require calculation of the SDM at a reactor moderator temperature of 68°F or a higher temperature that represents the most reactive state throughout the operating cycle. This change is needed to address new fuel designs which may be more reactive at shutdown temperatures above 68°F.

The industry has evaluated whether or not a significant hazards consideration is involved with the proposed amendment by focusing on the three standards set forth in 10 CFR 50.92, Issuance of Amendment:

1. Does the proposed amendment involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No

   The proposed change revises the definition of SDM for Boiling Water Reactor (BWR) plants. SDM is not an initiator to any accident previously evaluated. Accordingly, the proposed change to the definition of SDM has no effect on the probability of any accident previously evaluated. SDM is an assumption in the analysis of some previously evaluated accidents and inadequate SDM could lead to an increase in consequences for those accidents. However, the proposed change revises the SDM definition to ensure that the correct SDM is determined for all BWR fuel types at all times during the fuel cycle. As a result, the proposed change does not adversely affect the consequences of any accident previously evaluated.

Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. Does the proposed amendment create the possibility of a new or different kind of accident from any previously evaluated?

Response: No

The proposed change revises the definition of SDM for BWR plants. The change does not involve a physical alteration of the plant (i.e., no new or different type of equipment will be installed) or a change in the methods governing normal plant operations. The change does not alter assumptions made in the safety analysis regarding SDM.

Therefore, the proposed change does not create the possibility of a new or different kind of accident from any previously evaluated.

3. Does the proposed amendment involve a significant reduction in a margin of safety?

Response: No

The proposed change revises the definition of SDM for BWR plants. The proposed change does not alter the manner in which safety limits, limiting safety system settings or limiting conditions for operation are determined. The proposed change ensures that the SDM assumed in determining safety limits, limiting safety system settings or limiting conditions for operation is correct for all BWR fuel types at all times during the fuel cycle.

Therefore, the proposed change does not involve a significant reduction in a margin of safety.

4.3 Conclusions

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

5. ENVIRONMENTAL CONSIDERATION

Evaluation of the proposed change has determined that the change does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, or (iii) a significant increase in the individual or cumulative occupational radiation exposure. Accordingly, the proposed change meets the eligibility criterion for categorical exclusion set forth in 10

CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), an environmental assessment of the proposed change is not required.

6. REFERENCES

1. Letter from A. Lingenfelter (Global Nuclear Fuel) to U.S. Nuclear Regulatory Commission, "Temperature Dependent Strong-Rod-Out Cold Shutdown Margin," dated November 8, 2010.

2. NEDE-24011-P-A-17, "General Electric Standard Application for Reactor Fuel (GESTAR II)," September 2010.

Model Application

[DATE] 10 CFR 50.90

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: PLANT NAME
DOCKET NO. 50-[xxx]
APPLICATION TO REVISE TECHNICAL SPECIFICATIONS TO ADOPT TSTF-535, "REVISE SHUTDOWN MARGIN DEFINITION TO ADDRESS ADVANCED FUEL DESIGNS"

Dear Sir or Madam:

Pursuant to 10 CFR 50.90, [LICENSEE] is submitting a request for an amendment to the Technical Specifications (TS) for [PLANT NAME, UNIT NOS.].

The proposed amendment modifies the TS definition of "Shutdown Margin " (SDM) to require calculation of the SDM at a reactor moderator temperature of 68°F or a higher temperature that represents the most reactive state throughout the operating cycle. This change is needed to address new Boiling Water Reactor (BWR) fuel designs which may be more reactive at shutdown temperatures above 68°F.

Attachment 1 provides a description and assessment of the proposed changes. Attachment 2 provides the existing TS pages marked up to show the proposed changes. Attachment 3 provides revised (clean) TS pages.

Approval of the proposed amendment is requested by [date]. Once approved, the amendment shall be implemented within [ ] days.

In accordance with 10 CFR 50.91, a copy of this application, with attachments, is being provided to the designated [STATE] Official.

[In accordance with 10 CFR 50.30(b), a license amendment request must be executed in a signed original under oath or affirmation. This can be accomplished by attaching a notarized affidavit confirming the signature authority of the signatory, or by including the following statement in the cover letter: "I declare under penalty of perjury that the foregoing is true and correct. Executed on (date)." The alternative statement is pursuant to 28 USC 1746. It does not require notarization.]

If you should have any questions regarding this submittal, please contact [NAME, TELEPHONE NUMBER].

Sincerely,

[Name, Title]

Attachments:
1. Description and Assessment
2. Proposed Technical Specification Changes (Mark-Up)
3. Revised Technical Specification Pages

cc: NRC Project Manager
NRC Regional Office
NRC Resident Inspector
State Contact

ATTACHMENT 1 - DESCRIPTION AND ASSESSMENT

1.0 DESCRIPTION

The proposed amendment modifies the Technical Specifications (TS) definition of "Shutdown Margin " (SDM) to require calculation of the SDM at a reactor moderator temperature of 68°F or a higher temperature that represents the most reactive state throughout the operating cycle. This change is needed to address new Boiling Water Reactor (BWR) fuel designs which may be more reactive at shutdown temperatures above 68°F.

2.0 ASSESSMENT

2.1 Applicability of Published Safety Evaluation

[LICENSEE] has reviewed the model safety evaluation dated [DATE] as part of the Federal Register Notice of Availability. This review included a review of the NRC staff's evaluation, as well as the information provided in TSTF-535. [As described in the subsequent paragraphs,] [LICENSEE] has concluded that the justifications presented in the TSTF-535 proposal and the model safety evaluation prepared by the NRC staff are applicable to [PLANT, UNIT NOS.] and justify this amendment for the incorporation of the changes to the [PLANT] TS.

2.2 Optional Changes and Variations

[LICENSEE is not proposing any variations or deviations from the TS changes described in the TSTF-535, Revision 0, or the applicable parts of the NRC staff's model safety evaluation dated [DATE].] [LICENSEE is proposing the following variations from the TS changes described in the TSTF-535, Revision 0, or the applicable parts of the NRC staff's model safety evaluation dated [DATE].]

[The [PLANT] TS utilize different [numbering][and][titles] than the Standard Technical Specifications on which TSTF-535 was based. Specifically, [describe differences between the plant-specific TS numbering and/or titles and the TSTF-535 numbering and titles.] These differences are administrative and do not affect the applicability of TSTF-535 to the [PLANT] TS.]

3.0 REGULATORY ANALYSIS

3.1 No Significant Hazards Consideration Determination

[LICENSEE] requests adoption of TSTF-535, Revision 0, "Revise Shutdown Margin Definition to Address Advanced Fuel Designs," which is an approved change to the standard technical specifications (STS), into the [PLANT NAME, UNIT NOS] Technical Specifications (TS). The proposed amendment modifies the TS definition of "Shutdown Margin " (SDM) to require calculation of the SDM at a reactor moderator temperature of 68°F or a higher temperature that represents the most reactive state throughout the operating cycle.

[LICENSEE] has evaluated whether or not a significant hazards consideration is involved with the proposed amendment(s) by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of amendment," as discussed below:

1. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No.

   The proposed change revises the definition of SDM. SDM is not an initiator to any accident previously evaluated. Accordingly, the proposed change to the definition of SDM has no effect on the probability of any accident previously evaluated. SDM is an assumption in the analysis of some previously evaluated accidents and inadequate SDM could lead to an increase in consequences for those accidents. However, the proposed change revises the SDM definition to ensure that the correct SDM is determined for all fuel types at all times during the fuel cycle. As a result, the proposed change does not adversely affect the consequences of any accident previously evaluated.

   Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

   Response: No.

   The proposed change revises the definition of SDM. The change does not involve a physical alteration of the plant (i.e., no new or different type of equipment will be installed) or a change in the methods governing normal plant operations. The change does not alter assumptions made in the safety analysis regarding SDM.

   Therefore, the proposed change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. Does the proposed change involve a significant reduction in a margin of safety?

   Response: No.

   The proposed change revises the definition of SDM. The proposed change does not alter the manner in which safety limits, limiting safety system settings or limiting conditions for operation are determined. The proposed change ensures that the SDM assumed in determining safety limits, limiting safety system settings or limiting conditions for operation is correct for all BWR fuel types at all times during the fuel cycle.

   Therefore, the proposed change does not involve a significant reduction in a margin of safety.

Based on the above, [LICENSEE] concludes that the proposed change presents no significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and, accordingly, a finding of "no significant hazards consideration" is justified.

3.2 Conclusions

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

4.0 ENVIRONMENTAL EVALUATION

The proposed change would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, or would change an inspection or surveillance requirement. However, the proposed change does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed change meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed change.

1.1 Definitions

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: 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 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 two components: a. The time from initial movement of the main turbine stop valve or control valve until 80% of the turbine bypass capacity is established and b. The time from initial movement of the main turbine stop valve or control valve until initial movement of the turbine bypass valve. 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.]

1.1 Definitions

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: 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 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.
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THERMAL POWER	THERMAL POWER shall be the total reactor core heat transfer rate to the reactor coolant.
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