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

January 7, 2019

Mr. Keith J. Polson
Senior Vice President and
Chief Nuclear Officer
DTE Electric Company
Fermi 2 - 260 TAC
6400 North Dixie Highway
Newport, MI 48166

SUBJECT: FERMI 2 - ISSUANCE OF AMENDMENT RE: TECHNICAL SPECIFICATIONS TASK FORCE (TSTF) TRAVELER TSTF-535, REVISION 0, "REVISE SHUTDOWN MARGIN DEFINITION TO ADDRESS ADVANCED FUEL DESIGNS" (EPID L-2018-LLA-0070)

Dear Mr. Polson:

The U.S. Nuclear Regulatory Commission (the Commission) has issued the enclosed amendment No. 213 to Renewed Facility Operating License No. NPF-43 for Fermi 2. This amendment consists of changes to the technical specifications in response to your application dated March 14, 2018 (Agencywide Documents Access and Management System Accession No. ML18073A137).

The proposed amendment modifies the technical specifications definition of "Shutdown Margin" to require calculation of the shutdown margin at a reactor moderator temperature of 68 degrees Fahrenheit (° 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 fuel designs which may be more reactive at shutdown temperatures above 68 °F.

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

Sincerely,

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

Docket No. 50-341

Enclosures:
1. Amendment No. 213 to NPF-43
2. Safety Evaluation

cc: Listserv

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

DTE ELECTRIC COMPANY

DOCKET NO. 50-341

FERMI 2

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 213
Renewed License No. NPF-43

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

   A. The application for amendment by DTE Electric Company (DTE, the licensee), dated March 14, 2018, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Renewed Facility Operating License No. NPF-43 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. 213, and the Environmental Protection Plan contained in Appendix B, are hereby incorporated into this renewed license. DTE Electric Company shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. The license amendment is effective as of its date of issuance and shall be implemented within 45 days.

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 Renewed Facility
Operating License No. NPF-43
and Technical Specifications

Date of Issuance: January 7, 2019

ATTACHMENT TO LICENSE AMENDMENT NO. 213

RENEWED FACILITY OPERATING LICENSE NO. NPF-43

FERMI 2

DOCKET NO. 50-341

Replace the following pages of the Renewed Facility Operating License No. NPF-43 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.

Renewed Facility Operating License No. NPF 43

REMOVE	INSERT
- 4 -	- 4 -

Technical Specifications

REMOVE	INSERT
1.1-6	1.1-6

(2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A, as revised through Amendment No. 213, and the Environmental Protection Plan contained in Appendix B, are hereby incorporated into this renewed license. DTE Electric Company shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

(3) Antitrust Conditions

DTE Electric Company shall abide by the agreements and interpretations between it and the Department of Justice relating to Article I, Paragraph 3 of the Electric Power Pool Agreement between DTE Electric Company and Consumers Power Company as specified in a letter from The Detroit Edison Company to the Director of Regulation, dated August 13,1971, and the letter from Richard W. McLaren, Assistant Attorney General, Antitrust Division, U.S. Department of Justice, to Bertram H. Schur, Associate General Counsel, Atomic Energy Commission, dated August 16, 1971.

(4) Deleted

(5) Deleted

(6) Deleted

(7) Deleted

(8) Deleted

(9) Modifications for Fire Protection (Section 9.5.1, SSER #5 and SSER #6)*

DTE Electric Company shall implement and maintain in effect all provisions of the approved fire protection program as described in its Final Safety Analysis Report for the facility through Amendment 60 and as approved in the SER through Supplement No. 5, subject to the following provision:

(a) DTE Electric Company may make changes to the approved fire protection program without prior approval of the Commission only if those changes would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire.

*The parenthetical notation following the title of many license conditions denotes the section of the Safety Evaluation Report (SER) and/or its supplements wherein the license condition is discussed.

1.1 Definitions (continued)

RATED THERMAL POWER (RTP)	RTP shall be a total reactor core heat transfer rate to the reactor coolant of 3486 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: a. The reactor is xenon free; b. The moderator temperature is $\geq$ 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.

(continued)

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 213

TO RENEWED FACILITY OPERATING LICENSE NO. NPF-43

DTE ELECTRIC COMPANY

FERMI 2

DOCKET NO. 50-341

1.0 INTRODUCTION

By application dated March 14, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18073A137), DTE Electric Company (DTE, the licensee) requested changes to the technical specifications (TS) for Fermi 2. Specifically, the licensee requested to adopt U.S. Nuclear Regulatory Commission (NRC or Commission)-approved Technical Specifications Task Force (TSTF) Traveler TSTF-535, "Revise Shutdown Margin Definition to Address Advanced Fuel Designs," Revision 0 (ADAMS Accession No. ML112200436), dated August 8, 2011.

The proposed change would revise the TS definition of shutdown margin (SDM) to require its calculation at the reactor moderator temperature corresponding to the most reactive state throughout the operating cycle (68 degrees Fahrenheit (°F) or higher). The purpose of this TSTF is to address newer boiling-water reactor (BWR) fuel designs, which are more reactive from moderators at temperatures above 68 °F.

The licensee stated that it did not propose any variations or deviations from the TS changes, as described in TSTF-535, or the applicable parts of the NRC staff's model safety evaluation. The availability of this TS improvement was announced in the *Federal Register* on August 14, 2018 (83 FR 40346), as part of the consolidated line item improvement process.

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 neutrons are much more likely to cause fission of a uranium atom when absorbed by the fuel. The rate at which uranium atoms fission over time is called reactivity. However, not all the neutrons cause the fuel to fission. Some of the neutrons are instead, absorbed by the water. The amount of water and fuel that is present in the core heavily influences the number of thermal neutrons that are absorbed.

Water-moderated reactors are designed to operate in an "under-moderated condition." In this under-moderated 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. As temperature increases, fewer neutrons are absorbed by the moderator (water) due to the decrease in its density (water molecules are spread further apart). At the same time, the increase in reactivity is overshadowed by fewer neutrons being moderated (i.e., slowed enough to cause fissions), which reduces overall reactivity. The result is a decrease in power and temperature which produces a negative reactivity feedback effect so that the reactor becomes self-regulating.

However, if the amount of the moderator becomes too large with respect to the amount of fuel, the reactor can enter an over-moderated condition. In over-moderated conditions, the effectiveness of water as a moderator increases with the temperature. The number of neutrons moderated (i.e., slowed down) enough to cause fission out numbers the neutrons lost by absorption in the moderator. This causes an increase in power that leads to a further increase in temperature creating a potentially dangerous positive reactivity feedback cycle.

The TSTF-535 discussion regarding SDM focuses on fuel assembly-GE [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 TS Changes

The licensee's adoption of TSTF-535 for Fermi 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 Fermi 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 proposed to add the following statements, shown in bold and underlined, to the current definition of SDM in accordance with TSTF-535:

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 $\geq 68°F$, **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.

2.3 Regulatory Review

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

In addition, 10 CFR 50.36(c)(2)(ii) requires the establishment of a limiting condition for operations (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 Criteria 26 and 27, which ensure sufficient negative reactivity worth is present to offset the positive reactivity worth 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. 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, Specifications" (ADAMS Accession No. ML12104A192).

The procedures for the review of control systems and SDM to help ensure consistency with Criteria 26 and 27 and are contained in Revision 3 of NUREG-0800, "Standard Review Plan (SRP) for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR [Light-Water Reactor] Edition," Section 4.3, "Nuclear Design," Revision 3, dated March 2007 (ADAMS Accession No. ML070740003).

3.0 TECHNICAL EVALUATION

3.1 Current Definition of SDM

In BWR plants, the control rods are used to maintain 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 Fermi 2 TSs defines SDM as the amount of reactivity by which the reactor is subcritical or would be subcritical assuming that: (1) the reactor is xenon free, (2) the moderator temperature is 68 °F, and (3) all control rods are fully inserted except for the single control rod of highest reactivity 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. The most reactive design condition for a reactor core includes fresh, xenon-free fuel. This is because a xenon free core possesses a greater amount of positive reactivity worth that the control rods must offset, to maintain the core subcritical.

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 shutdown even in the event of a stuck control rod as discussed in 10 CFR 50, Appendix A, Criteria 26 and 27.

Determination of the SDM under the aforementioned conditions yields a conservative result that, along with the requirements set forth in Fermi 2's TS Section 3.1.1, "Shutdown Margin," helps ensure that:

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.

This is consistent with 10 CFR Part 50, Appendix A, Criteria 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 is 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 used to extend the operating cycle. Both partial length rods and moderator temperature of 68 °F 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 where the core becomes more reactive at a moderator temperature higher than the 68 °F as 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 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.

The TSTF-535 references the requirements for SDM found 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, "Shutdown Reactivity," of GESTAR II states, in part:

> 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 TSTF-535 also cites SRP Section 4.3, "Nuclear Design," which states on page 4.3-3, 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.

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 and 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 calculating the SDM at the most limiting core reactivity condition is prudent with respect to meeting 10 CFR Part 50, Appendix A, Criteria 26 and 27.

3.3 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 discussion 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 concludes the proposed revisions serve to satisfy 10 CFR Part 50, Appendix A, Criteria 26 and 27. 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 Fermi 2.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Michigan State official was notified on October 30, 2018, 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 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 published in the *Federal Register* on August 14, 2018 (83 FR 40346). 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: C. Tilton
K. Heller

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3.3 Technical Evaluation Summary

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Principal Contributor: C. Tilton
K. Heller

Date of issuance: January 7, 2019

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