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

June 26, 2019

Mr. Paul Fessler
Senior Vice President and
Chief Nuclear Officer
DTE Electric Company
Fermi 2 – 260 TAC
6400 North Dixie Highway
Newport, MI 48166

SUBJECT: FERMI 2 - RELIEF FROM THE REQUIREMENTS OF THE ASME CODE (EPID: L-2019-LLR-0023)

Dear Mr. Fessler:

By letter dated February 28, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19059A327), DTE Electric Company (the licensee) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for relief from certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, requirements for stud hole threads in the reactor pressure vessel (RPV) flange at Fermi 2.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee requested to apply ASME Code Case N-864, "Reactor Vessel Threads in Flange Examination," to eliminate the volumetric examination requirements of Section XI of the ASME Code for stud hole threads in the RPV flange at Fermi 2 for the fourth 10-year inservice inspection (ISI) interval.

The NRC staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that the licensee has demonstrated that the proposed alternative provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all the regulatory requirements set forth in 10 CFR 50.55a(z)(1). All other ASME Code, Section XI, requirements for which relief was not specifically requested and approved in the subject requests for relief remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector. Therefore, the NRC staff authorizes the use of relief request RR-A41 for the examination of the RPV flange threads at Fermi 2 for the fourth ISI interval from May 2, 2019, to December 31, 2029.

If you have any questions, please contact the Project Manager, Sujata Goetz at 301-415-8004 or via e-mail at Sujata.Goetz@nrc.gov.

Sincerely,

/RA Joel S. Wiebe for/

Lisa M. Regner, Acting Branch Chief
Plant Licensing Branch III
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No 50-341

Enclosure:
Safety Evaluation

cc: Listserv

SUBJECT: FERMI, UNIT 2 - RELIEF FROM THE REQUIREMENTS OF THE ASME CODE (EPID: L-2019-LLR-0023) DATED JUNE 26, 2019

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST NO. RR-A41 REGARDING THREADS IN FLANGE EXAMINATION

DTE ELECTRIC COMPANY

FERMI 2

DOCKET NO. 50-341

1.0 INTRODUCTION

By letter dated February 28, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19059A327), DTE Electric Company (the licensee) requested relief from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, for stud hole threads in the reactor pressure vessel (RPV) flange.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee requested to apply ASME Code Case N-864, "Reactor Vessel Threads in Flange Examination," to eliminate the volumetric examination requirements of Section XI of the ASME Code for stud hole threads in the RPV flange at Fermi 2, for the fourth 10-year inservice inspection (ISI) interval.

2.0 REGULATORY EVALUATION

The regulations in 10 CFR 50.55a(g)(4) state, in part, that ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in Section XI of the applicable editions and addenda of the ASME Code to the extent practical within the limitations of design, geometry, and materials of construction of the components.

The regulations in 10 CFR 50.55a(z) state, in part, that alternatives to the requirements in paragraphs (b) through (h) of 10 CFR 50.55a may be authorized by the NRC if the licensee demonstrates that: (1) the proposed alternative provides an acceptable level of quality and safety, or (2) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Based on the above, and subject to the following technical evaluation, the NRC staff finds that regulatory authority exists for the licensee to request the use of an alternative and the NRC to authorize the proposed alternative.

3.0 TECHNICAL EVALUATION

3.1 Licensee's Relief Request

3.1.1 Component Identification

The relief request (RR) applies to ASME Code, Section XI, Examination Category B-G-1, "Pressure Retaining Bolting, Greater Than 2 in. [inch] (50 mm) In Diameter," Item No. B6.40, "Threads in Flange," at Fermi 2.

3.1.2 Applicable Code Edition and Addenda

The applicable ASME Code of Record for the fourth 10-year ISI interval for Fermi 2, is ASME Code, Section XI, 2013 Edition with no Addenda.

3.1.3 Applicable ASME Code Requirement

The specific examination requirement for the threads in the RPV flange is volumetric examination of 100 percent of the flange threaded stud holes every ISI interval. The examination area is defined in Figure IWB-2500-12, "Closure Stud and Threads in Flange Stud Hole," of the ASME Code, Section XI.

3.1.4 Licensee's Proposed Alternative and Basis for Use

The licensee is proposing to use ASME Code Case N-864 as an alternative to eliminate the examination of threads in RPV flanges required by Examination Category B-G-1, Item No. B6.40, of the ASME Code, Section XI, for the duration of the fourth 10-year ISI interval. This request is based on an evaluation by the Electric Power Research Institute (EPRI) documented in EPRI Technical Report No. 3002007626 (EPRI report), "Nondestructive Evaluation: Reactor Pressure Vessel Threads in Flange Examination Requirements," dated March 2016 (ADAMS Accession No. ML16221A068). The licensee's submittals included the generic stress analysis and the flaw tolerance evaluation from the EPRI report, with additional plant-specific information to demonstrate applicability of the EPRI results to Fermi 2. The submittal also included potential degradation mechanisms and operating experience for threads in RPV flanges from the EPRI report. Additionally, the licensee described maintenance activities it performs each time the RPV closure head is removed, to detect and mitigate general degradation prior to returning the reactor to service. Specifically, the licensee stated that the threads in the RPV flange are inspected for damage, cleaned, and lubricated prior to reinstallation of the RPV studs.

3.1.5 Duration of Proposed Alternative

The RR is applied for the fourth ISI interval at Fermi 2 from May 2, 2019, to December 31, 2029.

3.2 NRC Staff's Evaluation

The licensee referred to the EPRI report for the technical basis for the proposed alternative in ASME Code Case N-864. ASME Code Case N-864 was not approved by the NRC as indicated in NRC Regulatory Guide 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," Revision 18. However, since the licensee requested only a 10-year application of this code case, the NRC staff evaluation focused on whether the examination of

threads in RPV flanges at Fermi 2 can be eliminated for 10 years, not whether the examination of threads in RPV flanges at Fermi 2 can be eliminated completely as stated in ASME Code Case N-864. Hence, consistent with all previous safety evaluations (SEs) on this subject for various plants, the NRC staff evaluated the applicability of the major sections of the EPRI report to RR-A41 for 10 years. These sections that the licensee included in its submittal are Section 4, "Operating Experience," Section 5, "Evaluation of Potential Degradation Mechanisms," and Section 6, "Stress Analysis and Flaw Tolerance Evaluation."

Sections 4 and 5 of the EPRI report regarding potential degradation mechanisms and operating experience have already been accepted by the NRC staff, as indicated in the June 26, 2017, letter to Exelon regarding an RR for 19 units held by Exelon Generation Company (ADAMS Accession No. ML17170A013). Therefore, the NRC staff's evaluation is limited to the plant-specific applicability of the generic analyses contained in Section 6 of the EPRI report for Fermi 2.

3.2.1 Stress Analysis

The NRC staff authorized a similar alternative "Vogtle Electric Generating Plant, Units 1 and 2, and Joseph M. Farley Nuclear Plant, Unit 1 - Alternative to Inservice Inspection Regarding Reactor Pressure Vessel Threads Inflange Inspection" (ADAMS Accession No. ML17006A109), approving the use of the generic stress analysis for Vogtle Electric Generating Plant, Units 1 and 2, and Joseph M. Farley Nuclear Plant, Unit 1. Therefore, the current evaluation focuses on the licensee's plant-specific parameters for Fermi 2, that affects the generic stress analysis results of the RPV flange threads. In RR-A41, the licensee summarized its plant-specific information in Table 1, "Comparison of Fermi 2 Parameters to Values Used in Bounding Analysis," and Table 2, "RPV Flange Thread Geometry."

<u>Evaluation of the Plant Parameters in Table 1 of RR-A41</u>

Table 1 of the submittal provides information on six key Fermi 2, plant parameters: (1) number of studs, (2) stud nominal diameter, (3) RPV inside diameter at stud hole, (4) flange thickness at stud hole, (5) design pressure, and (6) preload stress. Table 1 shows that the stud nominal diameter for Fermi 2, is slightly higher than that in the generic stress analysis and the preload stress for Fermi 2, is much less than the corresponding generic value, indicating that the combined effect due to these two parameters are bounded by the generic analysis. Consequently, only the other four parameters need to be evaluated. Three are used to calculate the operating pressure load per stud through the following equation:

$$\text{Load per stud} = \pi\,(\text{design pressure})(\text{RPV inside diameter at stud hole})^2/(4\text{x}\text{No. of studs})$$

The NRC staff verified the licensee's calculation and confirmed that the load per stud for Fermi 2 is less than the corresponding generic value. Therefore, these three additional parameters are also bounded by the generic analysis.

The last parameter (flange thickness at stud hole) leaves less RPV flange material in front of the critical crack front for Fermi 2. This is not evaluated by the licensee in the submittal. Table 1 shows that the RPV flange thickness at the stud hole is 14 inches versus 16 inches for the generic stress analysis and is not bounded by the generic analysis. However, this issue was evaluated generically by the NRC staff in the May 30, 2018, SE for a similar RR for FitzPatrick Nuclear Power Plant (ADAMS Accession No. ML18039A854). The May 30, 2018, SE

concluded that the generic stress analysis can be applied to an RPV flange thickness at stud hole as low as 13.5 inches. Therefore, this last parameter is acceptable.

Evaluation of the RPV Flange Thread Geometry in Table 2 of RR-A41

Table 2 of the submittal provides information on the RPV flange thread geometry which shows that for Fermi 2 the pitch is 8 threads per inch and the depth of threads is 0.0675 inch. In the generic stress analysis, the corresponding values are 8 threads per inch and 0.06500 inch. The NRC staff evaluated differences of this magnitude in thread geometry on the final Stress Intensity Factor "K" results in the June 26, 2017, SE for the RR for the 19 units and concluded that the impact is negligible. The same conclusion applies to Fermi 2.

Loads and Resulting Stresses

As stated above, the preload stress and the load per stud due to pressure for Fermi 2, are bounded by the generic analysis. In addition, in a letter dated December 21, 2012 (ADAMS Accession No. ML13004A134), the NRC staff found that the maximum heat-up rate specified in Technical Specifications 3.4.10, "RCS P/T [reactor coolant system; pressure/temperature] Limits," is also bounded by the generic heat-up rate of 100 degrees Fahrenheit (°F) per hour. Therefore, all applied loads for Fermi 2, are bounded by the generic loads. In conclusion, the NRC staff determined that the generic stress analysis results apply to Fermi 2.

3.2.2 Flaw Tolerance Analysis

The licensee referenced the flaw tolerance analysis (linear elastic fracture mechanics) in the EPRI report as part of its basis to support the proposed alternative. Similar to the evaluation of the stress analysis, the NRC staff evaluation of the licensee's flaw tolerance analysis focused on the effect of the generic analysis results due to the RPV flange information: (1) the flange material property and the bolt-up temperature, and (2) the reduced flange thickness.

Evaluation of the Effect of the RPV Flange Material Property and the Bolt-Up Temperature on Applied Stress Intensity Factor (K)

Regarding the first effect, the licensee provided its RPV flange RT_{NDT} of 10 °F and bolt-up temperature of ≥ 72 °F for Fermi 2 in Table 4 of RR-A41. Since preload is the dominant contributor to applied K, evaluation of the allowable K at the lowest P/T limits temperature is appropriate. Applying the ($T-RT_{NDT}$) of 62 °F to the fracture toughness (K_{IC}) equation in ASME Code, Section XI, Appendix A, the NRC staff verified the licensee's calculated K_{IC} value of 104.85 ksi√ in. Applying the acceptance criteria of ASME Code, Section XI, IWB-3600 (with safety margin of √10), the NRC staff verified that the allowed applied K would be 33.16 ksi√in, which is greater than all maximum K values in Table 3 for the preload case of the generic analysis. Therefore, considering the first plant-specific information, the NRC staff determined that Fermi 2 is bounded by the generic flaw tolerance analysis.

Evaluation of the Effect of the Unbounded Parameter on Applied K

Regarding the second effect, the NRC staff examined the generic RPV flange model schematics (Figures 6-2 and 6-8 of the EPRI report) and the Fermi 2 geometry features in Table 1 of the submittal. The NRC staff noted that the May 30, 2018, SE also supported the flaw tolerance analysis considering an RPV flange thickness at stud hole as low as 13.5 inches. Since the corresponding thickness is 14 inches (more than 13.5 inches), the NRC staff found that the

applied K for Fermi 2, is also bounded by the applied K in the generic flaw tolerance analysis, even though the thickness between the stud hole and the RPV flange outer edge is smaller than the generic model.

Regarding use of the crack growth analysis in the EPRI report to support the proposed alternative, the NRC staff finds it to be acceptable because the assumption of 400 occurrences of preload and 4000 occurrences for heat-up/cooldown for an 80-year period in the generic analysis are conservative for Fermi 2.

3.2.3 Licensee's Supplemental Bases

The licensee described maintenance activities it performs each time the RPV closure head is removed to detect and mitigate general degradation prior to returning the reactor to service. Specifically, the licensee stated that the threads in the RPV flange are inspected for damage, cleaned, and lubricated prior to reinstallation of the RPV studs. The NRC staff considers these activities beneficial to flaw detection and could potentially reduce flaw initiation.

In summary, the conservative nature of the stress and flaw tolerance analyses supports the licensee's proposed alternative of not performing the ASME Code required examination of the RPV flange threads for the fourth 10-year ISI interval at Fermi 2.

4.0 CONCLUSION

As set forth above, the NRC staff has determined that the licensee has demonstrated that the proposed alternative provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes the use of RR-A41 for the examination of the RPV flange threads at Fermi 2 for the fourth ISI interval from May 2, 2019, to December 31, 2029.

All other requirements of the ASME Code, Section XI, for which relief has not been specifically requested remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: Simon Sheng, NRR/DMLR/MVIB

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