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

October 5, 2015

Mr. Paul Fessler, Senior VP
and Chief Nuclear Officer
DTE Electric Company
Fermi 2 - 210 NOC
6400 North Dixie Highway
Newport, MI 48166

SUBJECT: FERMI, UNIT 2 - STAFF ASSESSMENT OF INFORMATION PROVIDED PURSUANT TO TITLE 10 OF THE *CODE OF FEDERAL REGULATIONS* PART 50, SECTION 50.54(f), SEISMIC HAZARD REEVALUATIONS FOR RECOMMENDATION 2.1 OF THE NEAR-TERM TASK FORCE REVIEW OF INSIGHTS FROM THE FUKUSHIMA DAI-ICHI ACCIDENT (TAC NO. MF3861)

Dear Mr. Fessler:

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information pursuant to Title 10 of the *Code of Federal Regulations*, Part 50, Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The purpose of that request was to gather information concerning, in part, seismic hazards at each operating reactor site and to enable the NRC staff, using present-day NRC requirements and guidance, to determine whether licenses should be modified, suspended, or revoked.

By letter dated March 31, 2014, DTE Electric Company (DTE), responded to this request for Fermi, Unit 2 (Fermi 2).

The NRC staff has reviewed the information provided related to the reevaluated seismic hazard for Fermi 2 and, as documented in the enclosed staff assessment, determined that you provided sufficient information in response to Enclosure 1, Items (1) -(3), (5), (7) and the comparison portion of Item (4) of the 50.54(f) letter. Further, the staff concludes that the licensee's reevaluated seismic hazard is suitable for other actions associated with Near-Term Task Force Recommendation 2.1, "Seismic".

Contigent upon the NRC's review and acceptance of DTE's seismic risk evaluation including the high frequency confirmation, and spent fuel pool evaluation (i.e., Items (4), (8), and (9)) for Fermi 2, the Seismic Hazard Evaluation identified in Enclosure 1 of the 50.54(f) letter will be completed.

If you have any questions, please contact me at (301) 415-1617 or at Frankie.Vega@nrc.gov.

Sincerely,

Frankie Vega, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No. 50-341

Enclosure:
Staff Assessment of Seismic
Hazard Evaluation and Screening Report

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO SEISMIC HAZARD AND SCREENING REPORT

FERMI, UNIT 2

DOCKET NO. 50-341

1.0 INTRODUCTION

By letter dated March 12, 2012 (NRC, 2012a), the U.S. Nuclear Regulatory Commission (NRC or Commission) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) "Conditions of license" (hereafter referred to as the "50.54(f) letter"). The request and other regulatory actions were issued in connection with implementing lessons-learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the "Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident" (NRC, 2011b).[1] In particular, the NRC Near-Term Task Force (NTTF) Recommendation 2.1, and subsequent Staff Requirements Memoranda (SRM) associated with Commission Papers SECY-11-0124 (NRC, 2011c) and SECY-11-0137 (NRC, 2011d), instructed the NRC staff to issue requests for information to licensees pursuant to 10 CFR 50.54(f).

Enclosure 1 to the 50.54(f) letter requests that addressees perform a reevaluation of the seismic hazards at their sites using present-day NRC requirements and guidance to develop a ground motion response spectrum (GMRS).

The required response section of Enclosure 1 requests that each addressee provide the following information:

(1) Site-specific hazard curves (common fractiles and mean) over a range of spectral frequencies and annual exceedance frequencies,

(2) Site-specific, performance-based GMRS developed from the new site-specific seismic hazard curves at the control point elevation,

(3) Safe Shutdown Earthquake (SSE) ground motion values including specification of the control point elevation,

(4) Comparison of the GMRS and SSE. High-frequency evaluation (if necessary),

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[1] Issued as an enclosure to Commission Paper SECY-11-0093 (NRC, 2011a).

(5) Additional information such as insights from NTTF Recommendation 2.3 walkdown and estimates of plant seismic capacity developed from previous risk assessments to inform NRC screening and prioritization,

(6) Interim evaluation and actions taken or planned to address the higher seismic hazard relative to the design basis, as appropriate, prior to completion of the risk evaluation (if necessary),

(7) Statement if a seismic risk evaluation is necessary,

(8) Seismic risk evaluation (if necessary), and

(9) Spent fuel pool (SFP) evaluation (if necessary).

Present-day NRC requirements and guidance with respect to characterizing seismic hazards use a probabilistic approach in order to develop a risk-informed performance-based GMRS for the site. Regulatory Guide (RG) 1.208, A Performance-based Approach to Define the Site-Specific Earthquake Ground Motion (NRC, 2007), describes this approach. As described in the 50.54(f) letter, if the reevaluated seismic hazard, as characterized by the GMRS, is not bounded by the current plant design-basis SSE, further seismic risk evaluation of the plant is merited.

By letter dated November 27, 2012 (Keithline, 2012), the Nuclear Energy Institute (NEI) submitted Electric Power Research Institute (EPRI) report "Seismic Evaluation Guidance: Screening, Prioritization, and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1 Seismic" (EPRI, 2012), hereafter called the SPID. The SPID supplements the 50.54(f) letter with guidance necessary to perform seismic reevaluations and report the results to the NRC in a manner that will address the Requested Information Items in Enclosure 1 of the 50.54(f) letter. By letter dated February 15, 2013 (NRC, 2013b), the NRC staff endorsed the SPID.

The required response section of Enclosure 1 to the 50.54(f) letter specifies that Central and Eastern United States (CEUS) licensees provide their Seismic Hazard and Screening Report (SHSR) by 1.5 years after issuance of the 50.54(f) letter. However, in order to complete its update of the EPRI seismic ground motion models (GMM) for the CEUS (EPRI, 2013), industry proposed a six-month extension to March 31, 2014, for submitting the SHSR. Industry also proposed that licensees perform an expedited assessment, referred to as the Augmented Approach, for addressing the requested interim evaluation (Item 6 above), which would use a simplified assessment to demonstrate that certain key pieces of plant equipment for core cooling and containment functions, given a loss of all alternating current (ac) power, would be able to withstand a seismic hazard up to two times the design-basis. Attachment 2 to the April 9, 2013, letter (Pietrangelo, 2013) provides a revised schedule for plants needing to perform (1) the Augmented Approach by implementing the Expedited Seismic Evaluation Process (ESEP) and (2) a seismic risk evaluation. By letter dated May 7, 2013 (NRC, 2013a), the NRC determined that the modified schedule was acceptable and by letter dated August 28, 2013 (NRC, 2013c), the NRC determined that the updated GMM (EPRI, 2013) is an acceptable GMM for use by CEUS plants in developing a plant-specific GMRS.

By letter dated April 9, 2013 (Pietrangelo, 2013), industry agreed to follow the SPID to develop the SHSR for existing nuclear power plants. By letter dated September 10, 2013 (Conner, 2013), DTE Electric Company (DTE, the licensee) submitted partial site response information for Fermi, Unit 2 (Fermi 2). By letter dated March 31, 2014 (Conner, 2014), DTE submitted is SHSR. By letter dated December 18, 2014 (Kaminskas, 2014), the licensee supplemented its SHSR with additional information.

2.0 REGULATORY BACKGROUND

The structures, systems, and components (SSCs) important to safety in operating nuclear power plants are designed either in accordance with, or meet the intent of Appendix A to 10 CFR Part 50, General Design Criteria (GDC) 2: "Design Bases for Protection Against Natural Phenomena;" and Appendix A to 10 CFR Part 100, "Reactor Site Criteria." The GDC 2 states that SSCs important to safety at nuclear power plants shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

For initial licensing, each licensee was required to develop and maintain design bases that, as defined by 10 CFR 50.2, identify the specific functions that an SSC of a facility must perform, and the specific values or ranges of values chosen for controlling parameters as reference bounds for the design. The design bases for the SSCs reflect appropriate consideration of the most severe natural phenomena that had been historically reported for the site and surrounding area. The design bases also considered limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The seismic design bases for currently operating nuclear power plants were either developed in accordance with, or meet the intent of GDC 2 and 10 CFR Part 100, Appendix A. Although the regulatory requirements in Appendix A to 10 CFR Part 100 are fundamentally deterministic, the NRC process for determining the seismic design-basis ground motions for new reactor applications after January 10, 1997, as described in 10 CFR 100.23, requires that uncertainties be addressed through an appropriate analysis such as a probabilistic seismic hazard analysis (PSHA).

Section 50.54(f) of 10 CFR states that a licensee shall at any time before expiration of its license, upon request of the Commission, submit written statements, signed under oath or affirmation, to enable the Commission to determine whether or not the license should be modified, suspended, or revoked. On March 12, 2012, the NRC staff issued requests for licensees to reevaluate the seismic hazards at their sites using present-day NRC requirements and guidance, and identify actions planned to address plant-specific vulnerabilities associated with the updated seismic hazards.

Attachment 1 to Enclosure 1 of the 50.54(f) letter described an acceptable approach for performing the seismic hazard reevaluation for plants located in the CEUS. Licensees are expected to use the CEUS Seismic Source Characterization (CEUS-SSC) model in NUREG-2115 (NRC, 2012b) along with the appropriate EPRI (2004, 2006) ground motion models. The SPID provided further guidance regarding the appropriate use of GMMs for the CEUS. Specifically, Section 2.3 of the SPID recommended the use of the updated GMM (EPRI, 2013)

and, as such, licensees used the NRC-endorsed updated EPRI GMM instead of the older EPRI (2004, 2006) GMM to develop PSHA base rock hazard curves. Finally, Attachment 1 requested that licensees conduct an evaluation of the local site response in order to develop site-specific hazard curves and GMRS for comparison with the plant SSE.

2.1 Screening Evaluation Results

By letter dated March 31, 2014 (Conner, 2014), DTE provided the SHSR for Fermi 2. The licensee's SHSR indicated that the GMRS exceeds the SSE for Fermi 2 over the frequency range of 1 to 10 Hertz (Hz). As such, Fermi 2 screens in for a plant seismic risk evaluation. A SFP evaluation will also be performed. The GMRS also exceeds the SSE at frequencies above 10 Hz. The licensee indicated that the seismic risk evaluation would address the high frequency exceedance.

On May 9, 2014 (NRC, 2014a), the NRC staff issued a letter providing the outcome of its 30-day screening and prioritization evaluation. As indicated in the letter, the NRC staff confirmed the licensee's screening results. The licensee's GMRS, as well as the confirmatory GMRS developed by the NRC staff, exceed the SSE for Fermi 2 over the frequency range of approximately 3 to 100 Hz. Therefore, a plant seismic risk evaluation, SFP evaluation, and a high frequency confirmation are merited for Fermi 2.

3.0 TECHNICAL EVALUATION

The NRC staff evaluated the licensee's submittal to determine if the provided information responded appropriately to Enclosure 1 of the 50.54(f) letter with respect to characterizing the reevaluated seismic hazard.

3.1 Plant Seismic Design-Basis

Enclosure 1 of the 50.54(f) letter requests the licensee provide the SSE ground motion values, as well as the specification of the control point elevation(s) for comparison to the GMRS. For operating reactors licensed before 1997, the SSE is the plant licensing basis earthquake and is characterized by (1) a peak ground acceleration (PGA) value which anchors the response spectra at high frequencies (typically at 33 Hz for the existing fleet of Nuclear Power Plant's; (2) a response spectrum shape which depicts the amplified response at all frequencies below the PGA; and (3) a control point where the SSE is defined.

In Section 3.1 of its SHSR, the licensee described its seismic design-basis. The licensee stated that the SSE response spectrum for Fermi 2 is anchored at 0.15 g (15 percent of the acceleration due to earth's gravity). The spectral shape of the SSE is based on the 1940 El Centro, California, earthquake spectrum with minor modifications to accommodate the 1935 Helena, Montana, and the 1949 Olympia, Washington, earthquakes. The licensee specified that the SSE control point is located at the base of the reactor foundation at a mean sea level (MSL) elevation 536 ft (163 m). The licensee specified the control point elevation based on the Fermi 2 updated final safety analysis report (UFSAR) (DTE, 2012) which states that the control point is located at the foundation level, corresponding to MSL elevation 563 ft (163 m) for the reactor building.

The NRC staff reviewed the licensee's description of its SSE in the SHSR. To confirm the SSE, the NRC staff reviewed the Fermi 2 UFSAR (DTE, 2012). Based on its review, the NRC staff confirmed both the SSE spectrum and control point are consistent with the UFSAR and guidance provided in the SPID.

3.2 Probabilistic Seismic Hazard Analysis

In Section 2.2 of its SHSR, the licensee stated that, in accordance with the 50.54(f) letter and the SPID, it performed a PSHA using the CEUS-SSC model (NRC, 2012b) and the updated EPRI GMM (EPRI, 2013) for the CEUS. The licensee used a minimum magnitude cutoff of **M**5.0, as specified in the 50.54(f) letter. The licensee further stated that it included the CEUS-SSC background sources out to a distance of 400 mi (640 km) around the site and included the Charleston, Commerce, Eastern Rift Margin Fault – North, Eastern Rift Margin Fault– South, New Madrid Fault System (NMFS), and Wabash Valley Repeated large Magnitude Earthquake (RLME) sources, which lie within 620 mi (1,000 km) of the site. The RLME sources are those source regions or faults for which more than one large magnitude (**M** ≥ 6.5) earthquake has occurred in the historical or paleo-earthquake (geologic evidence for prehistoric seismicity) record. The licensee used the mid-continent version of the updated EPRI GMM (EPRI, 2013) for each of the CEUS-SSC sources. Consistent with the SPID, the licensee did not provide its base rock seismic hazard curves since a site response analysis is necessary to determine the control point seismic hazard curves. The licensee provided its control point seismic hazard curves in Section 2.3.7 of its SHSR. The NRC staff's review of the licensee's control point seismic hazard curves is provided in Section 3.3 of this staff assessment.

As part of its confirmatory analysis of the licensee's GMRS, the NRC staff performed PSHA calculations for base rock site conditions at the Fermi 2 site. As input, the NRC staff used the CEUS-SSC model as documented in NUREG-2115 (NRC, 2012b) along with the updated EPRI GMM (EPRI, 2013). Consistent with the guidance provided in the SPID, and licensee's approach, the NRC staff included all CEUS-SSC background seismic sources within a 310 mi (500 km) radius of the Fermi 2 site. In addition, the NRC staff included the Charleston, Commerce, Eastern Rift Margin Fault – North, Eastern Rift Margin Fault – South, NMFS, and Wabash RLME sources. For each of the CEUS-SSC sources used in the PSHA, the NRC staff used the mid-continent version of the updated EPRI GMM. The NRC staff used the resulting base rock seismic hazard curves together with a confirmatory site response analysis, described in the next section, to develop control point seismic hazard curves and a GMRS for comparison with the licensee's results.

Based on its review of the SHSR, the NRC staff concludes that the licensee appropriately followed the guidance provided in the SPID for selecting the PSHA input models and parameters for the site. This includes the licensees use an appropriate implementation of the CEUS-SSC model and the updated EPRI GMM.

3.3 Site Response Evaluation

After completing PSHA calculations for reference rock site conditions, Attachment 1 to Enclosure 1 of the 50.54(f) letter requests that licensees provide a GMRS developed from the

site-specific seismic hazard curves at the control point elevation. In addition, the 50.54(f) letter specifies that the subsurface site response model, for both soil and rock sites, should extend to sufficient depth to reach the generic or base rock conditions as defined in the GMMs used in the PSHA. To develop site-specific hazard curves at the control point elevation, Attachment 1 requests that licensees perform a site response analysis. Detailed site response analyses were not typically performed for many of the older operating plants; therefore, Appendix B of the SPID provides detailed guidance on the development of site-specific amplification factors (including the treatment of uncertainty) for sites that do not have detailed, measured soil and rock parameters to extensive depths.

The purpose of the site response analysis is to determine the site amplification that would occur as a result of bedrock ground motions propagating upwards through the soil/rock column to the surface. The critical parameters that determine what frequencies of ground motion are affected by the upward propagation of bedrock motions are the layering of soil and/or soft rock, the thicknesses of these layers, the shear-wave velocities and low-strain damping of the layers, and the degree to which the shear modulus and damping change with increasing input bedrock amplitude.

3.3.1 Site Base Case Profiles

The licensee provided site profile descriptions in Sections 2.3.1 and 2.3.2 of its SHSR based on information provided in the Fermi 2 UFSAR (DTE, 2012) and the Safety Analysis Report (SAR) for proposed Fermi, Unit 3 (Fermi 3) (DTE, 2014). The licensee stated that the site is underlain by approximately 3,100 ft (945 m) of limestones, dolomites, shales and sandstones of Silurian to Cambrian age (415 – 540 Ma). Overlying this bedrock is glacial till and glaciolacustrine clay topped by a layer of variable surface soil (sands and organic material). The licensee stated that these surficial deposits were removed prior to construction, and the reactor is founded on the underlying rock.

The licensee stated that the site is well characterized due to the volume and quality of geotechnical data available at or near the site. Geophysical investigations for Fermi 2 consisted of borehole geophysical measurements (compressional wave velocities) in three deep borings, as well as two seismic refraction profiles. For the proposed Fermi 3, investigations include down-hole compressional and shear wave suspension logging, down-hole seismic testing, and spectral analysis of surface waves. Additionally, the licensee determined shear modulus values based on resonant column testing during Fermi 2 site investigations. The licensee also provided a brief description of the subsurface materials in terms of geologic units and thicknesses in its SHSR. Seismic velocities for the upper 290 ft (88 m) of subsurface beneath the control point range from 3,400 ft/s (1,036 m/s) to greater than 9,000 ft/s (2743 m/s).

To characterize the subsurface geology, the licensee developed three site base case profiles. The middle, or best estimate, profile was developed using the measured compressional velocities and layer thicknesses determined during the investigations conducted during construction of Fermi 2 and Poisson's ratios (a ratio of compressional wave to shear-wave velocity) developed during site investigations for the proposed Fermi 3 to determine shear-wave velocities. The licensee developed upper and lower base case profiles by applying a natural log standard deviation of 0.2 to the best-estimate profile.

To model the potential non-linear behavior of the soil and rock layers, the licensee used two sets of shear modulus and damping curves. In the first model, the licensee applied EPRI (1993) rock shear modulus degradation and damping curves. In the second model, the licensee assumed that the site would behave linearly under all loading levels and applied constant damping at a level corresponding to the low strain damping value of the EPRI (1993) rock curves (approximately 3 percent). The licensee weighted these alternative material behaviors equally, assigning 50-percent to each case.

The licensee also considered the impact of kappa, or small strain damping, on site response. Kappa is measured in units of seconds (sec), and is the damping contributed by both intrinsic hysteretic damping, as well as scattering, due to wave propagation in heterogeneous material. The licensee calculated kappa for each profile independently, resulting in three kappa estimates. The licensee used the low strain damping values from the EPRI rock curves over the profile to calculate the kappa contribution from the site profile. In addition to considering the kappa contribution from the sedimentary rocks underlying the site, the licensee added an additional 0.006 sec to account for damping in the reference rock material. The licensee's calculated kappa values for the best-estimate, upper and lower base case profiles are 0.010, 0.009, and 0.011 sec, respectively.

To account for aleatory variability in material properties across the plant site in its site response calculations, the licensee stated that it randomized its base case profiles, consistent with the SPID. The licensee also randomized the depth to reference rock ±58 ft (±18 m), which corresponds to 20-percent of the total profile thickness. The licensee stated that this randomization did not represent actual uncertainty in depth to reference rock, but was used to broaden the spectral peaks.

3.3.2 Site Response Method and Results

In Section 2.3.4 of its SHSR, the licensee stated that it followed the guidance in Appendix B of the SPID to develop input ground motions for the site response analysis, and in Section 2.3.5, the licensee described its implementation of the random vibration theory (RVT) approach to perform its site response calculations. Finally, Section 2.3.6 of the SHSR shows the resulting amplification functions and associate uncertainties for two of the eleven input loading levels for the each base case profile. The shallow base case profile is shown with EPRI cohesionless soil damping and the deep base case profile is shown with EPRI cohesionless soil and generic EPRI rock shear modulus and damping curves.

In order to develop probabilistic site-specific control point hazard curves, as requested in Requested Information Item (1) of the 50.54(f) letter, the licensee used Method 3, described in Appendix B-6.0 of the SPID. The licensee's use of Method 3 involved computing the site-specific control point elevation hazard curves for a broad range of spectral accelerations by combining the site-specific reference rock hazard curves, determined from the initial PSHA (Section 3.2 of this assessment), and the amplification function and their associated uncertainties, determined from the site response analysis.

3.3.3 Staff Confirmatory Analysis

To confirm the licensee's site response analysis, the NRC staff performed site response calculations for the Fermi 2 site. The NRC staff independently developed a shear-wave velocity profile, damping values, and modeled the potential non-linear behavior of the site using measurements and geologic information provided in the Fermi 2 UFSAR, the Fermi 3 SAR, and Appendix B of the SPID. For its site response calculations, the NRC staff employed the RVT approach and developed input ground motions in accordance with Appendix B of the SPID.

Because of the high quality of the data and the geologic consistency between Fermi 2 and proposed Fermi 3 the NRC staff's base case shear-wave velocity is based on the measured proposed Fermi 3 shear-wave velocity data. In addition, due to the consistencies between Fermi 2 and the proposed Fermi 3, the NRC staff used a single base case velocity profile rather than the three profiles developed by the licensee. Figure 3.3-1 of this assessment shows the NRC staff velocity profile compared to the base case profiles developed by the licensee.

Due to the sound nature of the rock and the relatively high velocities for the site profile, the NRC staff assumed that site response was linear under all loading levels and used kappa to account for the low strain damping in the site response analysis. Because the site contains less than 3,000 ft (914 m) of firm sedimentary rock overlying reference rock material, staff assumed an attenuation, or energy dissipation parameter (Q), of 40 to estimate kappa for each layer, consistent with the SPID. This approach to calculating kappa corresponds to a damping value of 1.25 percent, which is consistent with damping values determined during proposed Fermi 3 site investigations (0.6 – 1.8 percent). The NRC staff used a natural log standard deviation of 0.4 to estimate the epistemic uncertainty on kappa for the profile. The total profile kappa developed by the NRC staff ranges from 0.004 to 0.013 sec, with a best-estimate kappa value of 0.008 sec.

The licensee's approach to damping and kappa differed significantly than expected by the NRC staff. The licensee chose to use two different, equally weighted damping profiles: EPRI rock and linear with a damping value dictated by the low strain damping derived from the EPRI rock curves. This approach resulted in significantly higher damping across the profile and corresponds to a Q of approximately 16, which is significantly lower than the value of 40 used by the NRC staff. By letter dated November 17, 2014 (NRC, 2014b), the NRC staff issued a request for additional information (RAI) to the licensee requesting a basis for the chosen damping parameters in light of the high seismic velocities and the sound rock at the site, as determined by detailed investigations for the proposed Unit 3.

By letter dated December 18, 2014 (Kaminskas, 2014), the licensee responded to the NRC staff's RAI stating that it revised its site response approach to be more consistent with the approach used for the proposed Fermi Unit 3. This revision includes reducing the amount of damping in the profiles and adding an additional profile that accommodated additional uncertainty in the depth to reference rock. The licensee stated that this approach, and the resulting Foundation Input Response Spectrum (FIRS), would be used for subsequent evaluations and confirmations, as needed for the response to the 50.54(f) letter. The NRC staff reviewed the information provided in the licensee's response. The reduced damping values provided in the response are consistent with the damping values in the Fermi 3 SAR and those

expected by the NRC staff. Further, the additional profile accounts for epistemic uncertainty in the depth to reference rock. The NRC staff reviewed the information provided in the licensee's RAI response and by letter dated May 6, 2015 (NRC, 2015), the NRC staff asked the licensee to provide additional information regarding the revised inputs into the site response analysis. Specifically, the NRC staff asked the licensee to provide detailed velocity profiles, shear modulus degredation and damping curves, and updated site kappas. The NRC staff also requested that the licensee provide updated control point seismic hazard curves and an updated control point GMRS.

By letter dated June 4, 2015 (Kaminskas, 2015), the licensee responded to the NRC staff's RAI with updated site velocity profiles, shear modulus degredation and damping curves, and updated site kappas for the revised inputs. The licensee stated that the FIRS submitted as part of the licensee's December 18, 2014, letter includes the effect of 17 ft of glacial till that overlies the rock. The licensee infers that this relatively thin layer of till will have little effect on the overall site response; consequently, the FIRS is comparable to the GMRS.

In order to assure that the updated site profiles and the FIRS developed by the licensee are comparable to the control point GMRS, the NRC staff used the information provided in the licensee's RAI response to calculate a confirmatory GMRS at the control point elevation.

Figure 3.3-2 of this assessment shows a comparison of the NRC staff's and licensee's median site amplification functions and uncertainties (±1 standard deviation) for two of the eleven input loading levels for profiles used in the licensee's SHSR submittal. The licensee's site amplification functions shown in Figure 3.3-2 of this assessment are for its original site response analysis and not the updated functions. Peaks in amplification functions occur between 3 and 5 Hz in both staff and licensee curves. The peak amplification factors between 3 and 5 Hz calculated by the NRC staff are approximately 1.4 times that calculated by the licensee. These differences are due to the higher damping values used by the licensee for its original site response analysis.

Figure 3.3-3 of this assessment compares the control point hazard curves at 1 Hz, 10 Hz, and PGA developed by the NRC staff with those developed by the licensee in the SHSR. Again the licensee's control point hazard curves are from its original analysis and not the updated results developed by the licensee in response to the NRC staff's RAI.

As described in the June 4, 2015 (Kaminskas, 2015), letter, the licensee updated its damping parameters and added epistemic uncertainty to the depth of hard rock in response to the NRC staff's RAI. These modifications to the site response analysis impact both the control point seismic hazard curves and the GMRS. The NRC staff performed a confirmatory analysis using the licensee's updated inputs and achieved results consistent with those developed as part of the staff's independent analysis. Therefore, the staff concludes that the licensee's updated site profiles results in a hazard characterization that is consistent with interpretations resulting from the extensive subsurface investigations for the Fermi Unit 3 COL.

In summary, the NRC staff concludes that the licensee's site response was conducted using present-day guidance and methodology, including the NRC-endorsed SPID which the licensee used for its site response calculations using a range of input parameters. The staff's

independent calculations confirm that the licensee adequately characterized the site response, including the uncertainty associated with the subsurface material properties, for the Fermi site.

3.4 Ground Motion Response Spectra

In Section 2.4 of its SHSR, the licensee stated that it used the control point hazard curves, described in SHSR Section 2.3.7, to develop the 10^{-4} and 10^{-5} (mean annual frequency of exceedance) uniform hazard response spectra (UHRS) and then computed the GMRS using the criteria in RG 1.208.

The NRC staff independently calculated the 10^{-4} and 10^{-5} UHRS using the results of its confirmatory PSHA and site response analysis, as described in Sections 3.2 and 3.3 of this staff assessment, respectively. Figure 3.4-1 of this assessment shows a comparison of the GMRS determined by the licensee to that determined by the NRC staff. Also, in Figure 3.4-1 is the supplemental FIRS developed by the licensee after updating the damping profile and adding a velocity profile to its analysis and the updated GMRS developed by the NRC staff using the licensee's updated profile.

As shown in Figure 3.4-1 below, the licensee's original GMRS shape is similar to that calculated by the NRC staff with differences in the overall amplitude. These differences are the result of differences in the site response analysis performed by the licensee and discussed by the NRC staff in Section 3.3 above. The supplemental FIRS developed by the licensee for use in risk evaluation activities is more consistent with the NRC staff's confirmatory GMRS.

The NRC staff confirms that the licensee used the present-day guidance and methodology outlined in RG 1.208 and the SPID to calculate the horizontal GMRS, as requested in the 50.54(f) letter. The NRC staff performed both a PSHA and site response confirmatory analysis and achieved results consistent with the licensee's updated FIRS and was able to confirm that the GMRS determined from the licensee's updated inputs would be consistent with both the FIRS and the NRC staff's GMRS. As such, the NRC staff concludes that the licensee has adequately characterized the reevalutated seismic hazard at the Fermi 2 site. Therefore, the FIRS is suitable for use in subsequent evaluations and confirmations, as needed, for the response to the 50.54(f) letter.

4.0 CONCLUSION

The NRC staff reviewed the information provided by the licensee for the reevaluated seismic hazard for the Fermi 2 site. Based on its review, the NRC staff concludes that the licensee conducted the seismic hazard reevaluation using present-day methodologies and regulatory guidance, appropriately characterized the site given the information available, and met the intent of the guidance for determining the reevaluated seismic hazard. In response to the NRC staff's RAI, the licensee updated its damping parameters and added epistemic uncertainty to the depth of base or reference rock. The staff concludes that these changes result in an improved characterization of the subsurface properties and are consistent with the interpretations resulting from the extensive subsurface investigations for the Fermi Unit 3 COL. Therefore, based on the preceding analysis, described in detail in the sections above, the NRC staff concludes that the licensee provided an acceptable response to Requested Information

items (1) – (3), (5), and (7), and comparison portion of Item (4), identified in Enclosure 1 of the 50.54(f) letter. Further, the staff concludes that the licensee's reevaluated seismic hazard is suitable for other actions associated with Near-Term Task Force Recommendation 2.1, "Seismic".

In reaching this determination, the NRC staff confirmed the licensee's conclusion that the GMRS exceeds the SSE for the Fermi 2 site in the frequency range of approximately 3 to 100 Hz. As such, a plant seismic risk evaluation, SFP evaluation, and high frequency confirmation are merited for Fermi 2. The licensee indicated that the HF confirmation can be addressed in the seismic risk evaluation. The NRC review and acceptance of DTE's plant seismic risk evaluation, SFP evaluation, and HF confirmation (i.e., Items (4), (8), and (9)) for Fermi 2 will complete the Seismic Hazard Evaluation identified in Enclosure 1 of the 50.54(f) letter.

REFERENCES

Note: ADAMS Accession Nos. refers to documents available through NRC's Agencywide Documents Access and Management System (ADAMS). Publicly-available ADAMS documents may be accessed through http://www.nrc.gov/reading-rm/adams.html.

U.S. Nuclear Regulatory Commission Documents and Publications

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Figure 3.3-1 Plot of Staff's and Licensee's Base Case Shear-Wave Velocity Profiles Used in SHSR for the Fermi 2 Site

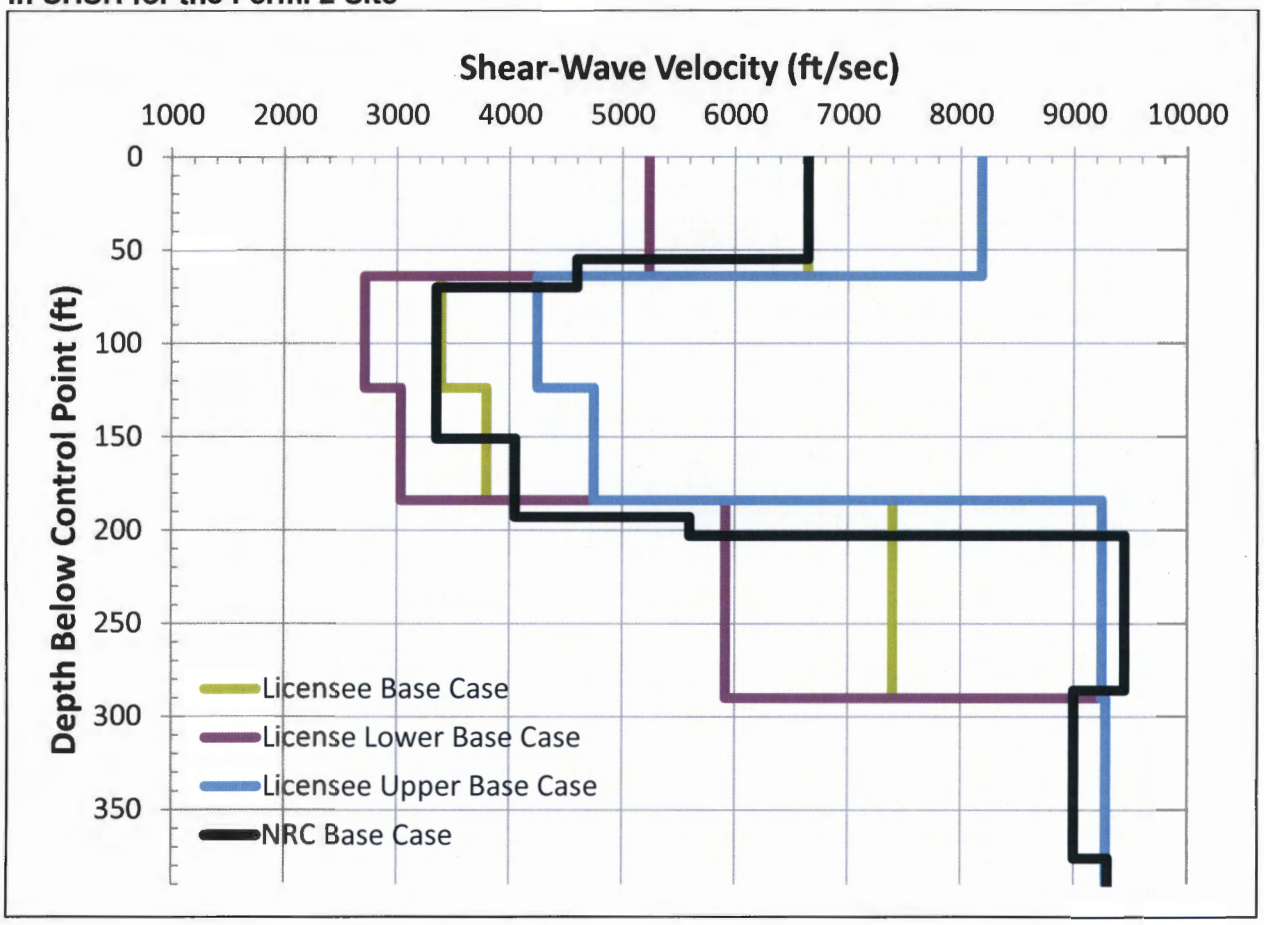


Figure 3.3- 2 Plot Comparing the Staff's and the Licensee's Median Amplification Functions and Uncertainties Presented in the SHSR for the Fermi 2 Site

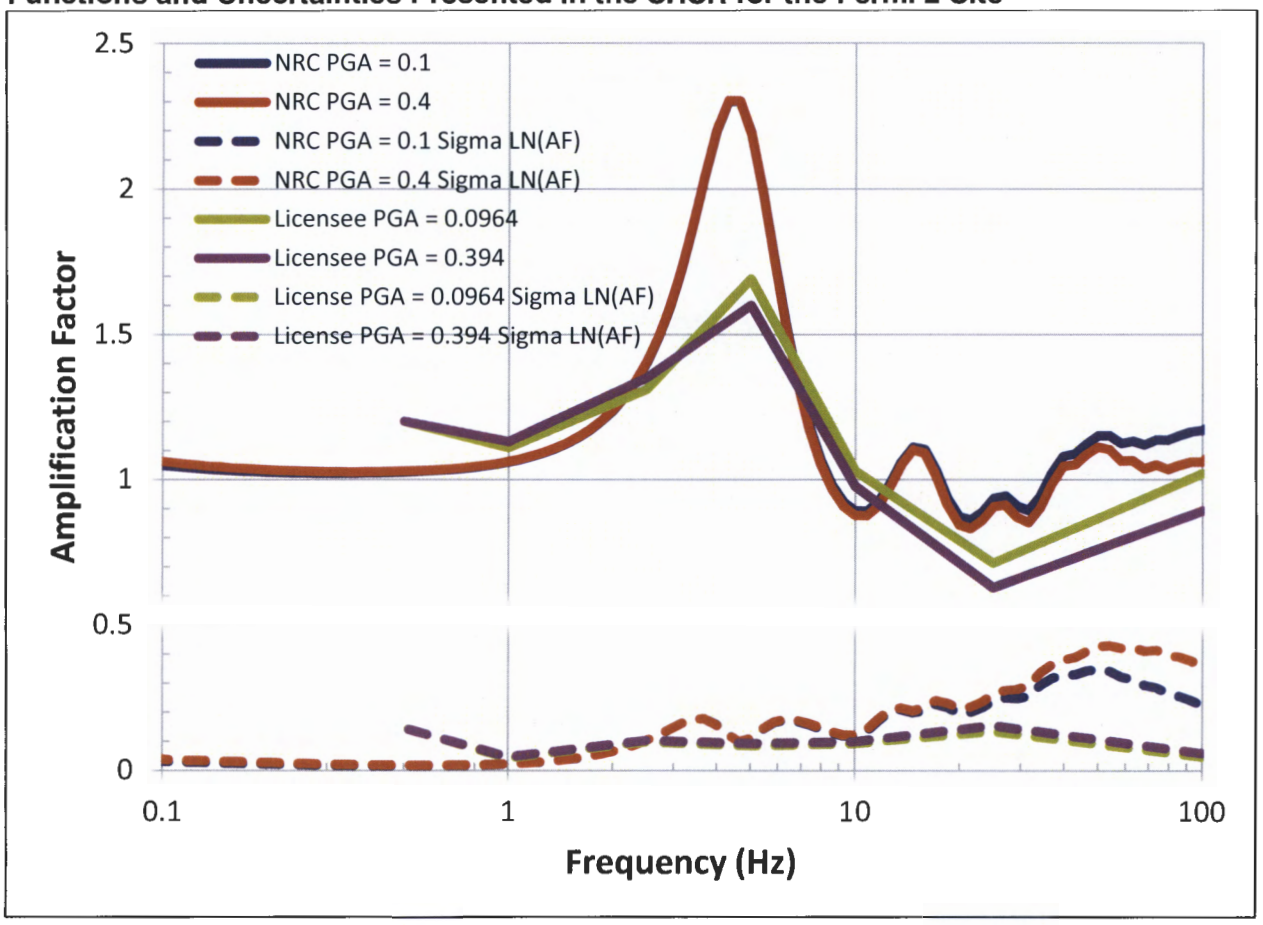


Figure 3.3-3 Plot Comparing the Staff's and the Licensee's Mean Control Point Hazard Curves in the SHSR at a Variety of Frequencies for the Fermi 2 Site

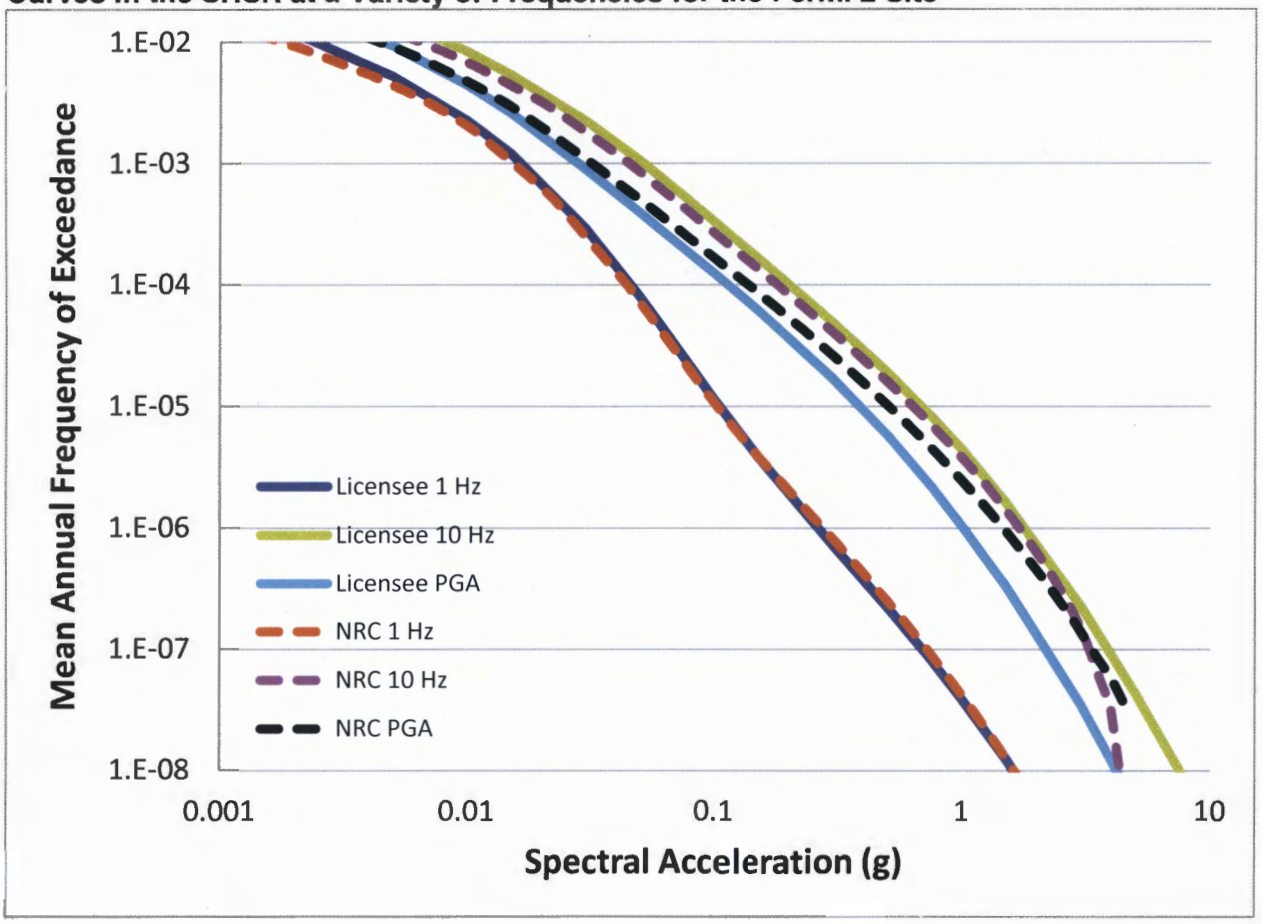
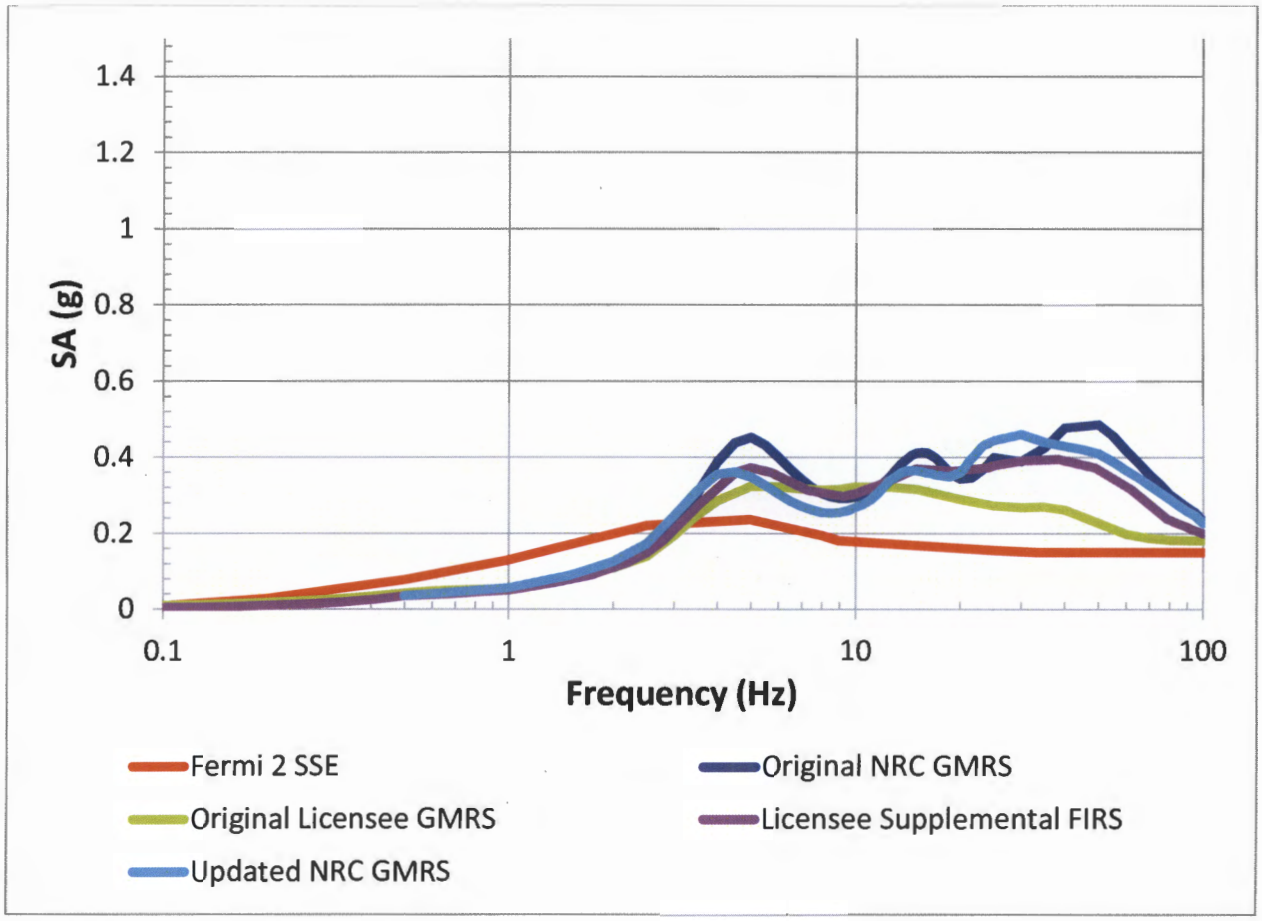


Figure 3.4-1 Comparison of the Staff's GMRS with the Licensee's GMRS, Licensee's Supplemental FIRS, NRC's Updated GMRS using Licensee's Updated Profile and SSE for the Fermi 2 Site



If you have any questions, please contact me at (301) 415-1617 or at Frankie.Vega@nrc.gov.

Sincerely,

/RA/

Frankie Vega, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No. 50-341

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