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DTE Energy

June 4, 2015
NRC-15-0059

10 CFR 50.54(f)

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

References: 1) Fermi 2
NRC Docket No. 50-341
NRC License No. NPF-43

2) DTE Electric Company Letter to the NRC, "DTE Electric Company's Seismic Hazard and Screening Report, Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," NRC-14-0017, dated March 31, 2014 (Accession No. ML14090A326)

3) NRC Letter to DTE Electric Company, "Fermi, Unit 2 - Request for Additional Information Associated with Near-Term Task Force Recommendation 2.1, Seismic Hazard and Screening Report (TAC NO. MF3861)," dated November 17, 2014 (Accession No. ML14301A247)

4) DTE Electric Company Letter to the NRC, "Response to NRC Request for Additional Information Associated With Near-Term Task Force Recommendation 2.1, Seismic Hazard and Screening Report (TAC No. MF3861)," NRC-14-0080, dated December 18, 2014 (Accession No. ML14353A149)

5) NRC Letter to DTE Electric Company, "Fermi, Unit 2 - Request for Additional Information Associated with Near-Term Task Force Recommendation 2.1, Seismic Hazard and Screening Report (TAC NO. MF3861)," dated May 6, 2015 (Accession No. ML15114A369)

Subject: Response to NRC Request for Additional Information Associated With Near-Term Task Force Recommendation 2.1, Seismic Hazard and Screening Report (TAC No. MF3861)

In Reference 2, DTE Electric Company (DTE) submitted the Fermi 2 Seismic Hazard and Screening Report, in response to NRC "Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident." In Reference 3, the NRC staff requested additional information, which DTE provided to the NRC in Reference 4. The enclosure of this letter provides DTE's response to the subsequent NRC staff request (Reference 5).

This letter contains no new regulatory commitments.

Should you have any questions or require additional information, please contact Mr. Christopher Robinson, Licensing Manager at (734) 586-5076.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on June 4, 2015

Vito A. Kaminskas
Site Vice President

Enclosure: Response to Request for Additional Information

cc: NRC Project Manager
NRC Resident Office
Reactor Projects Chief, Branch 5, Region III
Regional Administrator, Region III
Michigan Public Service Commission
Regulated Energy Division (kindschl@michigan.gov)

Enclosure to NRC-15-0059

Response to Request for Additional Information

Response to Request for Additional Information

By letter dated May 6, 2015, the U.S. Nuclear Regulatory Commission (NRC) requested that DTE Electric Company (DTE) provide additional information regarding DTE's Seismic Hazard and Screening Report.

1. A table of specific damping and modulus reduction curves that correlates to geologic units or layers.
2. Clarify if any of the layers were treated as linear. If the layers were treated as linear, please provide damping value assigned to those layers.
3. Updated profile including the kappa values used in site response analysis.
4. Clarify if the depth to hard rock was randomized. If so, please describe the randomization process used.
5. Clarify if Table 2 of the request for additional information (RAI) response represents the thicknesses and velocities input into the site response analysis. If Table 2 does not include this information, please provide a table with this information.
6. Control point hazard curves at the ground motion response spectrum (GMRS) level and the GMRS itself.

RAI-1

Provide a table of specific damping and modulus reduction curves that correlates to geologic units or layers.

Response:

Table 1 below identifies the damping and modulus reduction curves used to complete the site response analysis being used in conjunction with the ongoing Fermi 2 Seismic Probabilistic Risk Assessment (SPRA). The layer designation described in Table 1 is linked to the shear wave velocity profiles in Table 2. Table 3 provides the dynamic properties associated with the Stokoe et al., Unweathered Shale model (Reference E-1).

Table 1 – Damping and Modulus Reduction Curves

Input Parameter		Value							
Seismic Source Input		M = 6.5 with distances and depths resulting in 11 peak ground acceleration values from 0.01 g to 1.5 g at the Site							
		Single-corner Table B-4 EPRI (2013b)	Double-corner Table B-6 EPRI (2013b)	Single-corner Table B-4 EPRI (2013b)	Double-corner Table B-6 EPRI (2013b)	Single-corner Table B-4 EPRI (2013b)	Double-corner Table B-6 EPRI (2013b)	Single-corner Table B-4 EPRI (2013b)	Double-corner Table B-6 EPRI (2013b)
Seismic Source Model		Additional parameters used in the point source model found below Table B-4 EPRI (2013b)							
Profile		Best Estimate (P1)		Lower Ranger (P2)		Upper Range (P3)		Lower Range Alternative (P4)	
Profile Weight		W = 0.4		W = 0.18		W = 0.3		W = 0.12	
Shear Modulus and Damping Case 1	Till	EPRI Soil (0 to 20 ft)	Peninsular Range (0-50 ft)	EPRI Soil (0 to 20 ft)	Peninsular Range (0-50 ft)	EPRI Soil (0 to 20 ft)	Peninsular Range (0-50 ft)	EPRI Soil (0 to 20 ft)	Peninsular Range (0-50 ft)
	All Rock layers	Stokoe et al., (2003) Unweathered Shale	1.0 % Linear damping	Stokoe et al., (2003) Unweathered Shale	1.0 % Linear damping	Stokoe et al., (2003) Unweathered Shale	1.0 % Linear damping	Stokoe et al., (2003) Unweathered Shale	1.0 % Linear damping
	Weight	W=0.5	W=0.5	W=0.5	W=0.5	W=0.5	W=0.5	W=0.5	W=0.5
	Kappa	0.00742	0.00730	0.00767	0.00753	0.0072	0.00711	0.00789	0.00775
Shear Modulus and Damping Case 2	Till	EPRI Soil (0 to 20 ft)	Peninsular Range (0-50 ft)	EPRI Soil (0 to 20 ft)	Peninsular Range (0-50 ft)	EPRI Soil (0 to 20 ft)	Peninsular Range (0-50 ft)	EPRI Soil (0 to 20 ft)	Peninsular Range (0-50 ft)
	Layers 4&5 (P1-P3) Layers 3&4 (P4)	EPRI Rock	3.2% Linear damping	EPRI Rock	3.2% Linear damping	EPRI Rock	3.2% Linear damping	EPRI Rock	3.2% Linear damping
	All Other layers	Stokoe et al., (2003) Unweathered Shale	1.0 % Linear damping	Stokoe et al., (2003) Unweathered Shale	1.0 % Linear damping	Stokoe et al., (2003) Unweathered Shale	1.0 % Linear damping	Stokoe et al., (2003) Unweathered Shale	1.0 % Linear damping
	Weight	W=0.5	W=0.5	W=0.5	W=0.5	W=0.5	W=0.5	W=0.5	W=0.5
	Kappa	0.00877	0.00870	0.00923	0.00913	0.00838	0.00829	0.00889	0.00875

Table 2 - Base Case Shear Wave Velocity Profiles Fermi-2

Top of Layer Elevation [ft]	Profile P1		Profile P2		Profile P3		Profile P4	
	V_S [ft/s]	Depth [ft]	V_S [ft/s]	Depth [ft]	V_S [ft/s]	Depth [ft]	V_S [ft/s]	Depth [ft]
566	1000	0	800	0	1250	0	800	0
552	1000	14	800	14	1250	14	800	14
552	6500	14	5652	14	7475	14	5696	14
482	6500	84	5652	84	7475	84		
482	4500	84	3913	84	5175	84		
472							5696	94
472							2957	94
452	4500	114	3913	114	5175	114		
452	3400	114	2957	114	3910	114		
412							2957	154
412							3304	154
382	3400	184	2957	184	3910	184		
382	3900	184	3391	184	4485	184		
352							3304	214
352							6435	214
342	3900	224	3391	224	4485	224		
342	5000	224	4348	224	5750	224		
332	5000	234	4348	234	5750	234		
332	9280	234	9280	234	9280	234		
246							6435	320
246							9280	320

Table 3 - Dynamic Properties from Stokoe et al. (2003)

STRAIN (%)	G/GMAX	DAMPING (%)
.00001	1.00	1.00
.00010	1.00	1.01
.00100	1.00	1.06
.00300	0.99	1.19
.00500	0.98	1.31
.01000	0.95	1.61
.02000	0.91	2.19
.03000	0.87	2.73
.04000	0.83	3.25
.05000	0.80	3.74
.06000	0.77	4.21
.07000	0.74	4.66
.08000	0.71	5.08
.08500	0.70	5.29
.10000	0.67	5.88
.15000	0.57	7.59
.20000	0.50	9.02

RAI-2

Clarify if any of the layers were treated as linear. If the layers were treated as linear, please provide damping value assigned to those layers.

Response:

Table 1 above identifies the layers that are treated as linear and the damping value assigned to those layers. Linear damping assumptions were used for the rock layers when the dynamic properties for the till layer were modeled with the Peninsular Range values. As shown in Table 1, the damping value assigned to the rock layers for the linear case was linked to the low-strain damping values for the respective rock layer dynamic properties used for the alternative case of equivalent linear behavior.

RAI-3

Provide an updated profile including the kappa values used in site response analysis.

Response:

While the kappa values were quantified, they are not used in the site response analysis to avoid double-counting the effect of damping. For the Fermi 2 site, the derivation of kappa for each profile is based on the layer thickness, shear wave velocity (V_s), and damping. Given two alternative damping interpretations representing epistemic uncertainty for both the Glacial Till and the Paleozoic rock layers, there are four values of kappa for each site profile. Given the limited thickness of the site profiles to hard rock (234 ft to 320 ft), the uncertainty in kappa due to epistemic uncertainty in damping properties is expected to be small. As such, there is no need to derive a secondary kappa value. Effectively, the two damping alternatives for the Glacial Till and the Paleozoic rock layers with a best estimate V_s below 4,000 feet per second (fps) represent the epistemic uncertainty in kappa.

Using the kappa values obtained for the four velocity profiles and including a kappa of 0.006 seconds (s) for the underlying hard rock, the total site kappa is estimated to range from a low of 0.00711 s for profile P3 to a high of 0.00923 s for profile P2. The suite of kappa estimates and associated weights is summarized Table 4.

Table 4: Summary of Kappa Estimates and Associated Weights

VELOCITY PROFILE	PROFILE WEIGHT	KAPPA (S)
P1 Base-Case	0.4	0.00742
		0.00730
		0.00877
		0.00870
P2 Lower Range	0.18	0.00767
		0.00753
		0.00923
		0.00913
P3 Upper Range	0.3	0.00720
		0.00711
		0.00838
		0.00829
P4 Lower Range Profile Alternative	0.12	0.00789
		0.00775
		0.00889
		0.00875

RAI-4

Clarify if the depth to hard rock was randomized. If so, please describe the randomization process used.

Response:

The depth to hard rock is indirectly randomized as a result of randomizing the thickness of each layer the site profiles. The variation in thickness is modeled assuming a lognormal distribution with 0.1 used for the standard deviation of the natural logarithm of the thickness. This allows for a range in the depth to hard rock for each randomized profile.

RAI-5

Clarify if Table 2 of the request for additional information (RAI) response represents the thicknesses and velocities input into the site response analysis. If Table 2 does not include this information, please provide a table with this information.

Response:

Table 2 of the December 18, 2014, RAI response (Reference E-2) represents the total thickness and velocities input into the site response analysis. That same table is provided above (Table 2) as part of the response to RAI-1. Each layer is subdivided into sub-layers (for thickness) as shown in Table 5 below.

Given that the total thickness for each profile varies as a result of randomizing the layer thickness, the exact thickness of each sub-layer changes as the profile changes.

Table 5: Sub-Division of Layers for Profiles

	Profile			
	P1	P2	P3	P4
	Number of Sub-Divisions per Layer			
Layer 1	21	21	21	21
Layer 2	10	10	10	14
Layer 3	4	4	4	18
Layer 4	18	18	18	21
Layer 5	21	21	21	15
Layer 6	2	2	2	N/A

RAI-6

Provide the control point hazard curves at the ground motion response spectrum (GMRS) level and the GMRS itself.

Response:

The GMRS in Reference E-3 is developed at the outcropping rock at the reactor building (RB) foundation level. The reference foundation input response spectrum (FIRS) at the RB foundation level used in the SPRA and the Expedited Seismic Evaluation Process (ESEP) accounts for the effects of the 17 feet of till overlying the bedrock in accordance with the NRC Interim Staff Guidance (ISG) 17 (Reference E-4) requirements for building soil structure interaction (SSI) analyses. The hazard curves are defined in the same manner so that the seismic fragilities, tied to the peak ground acceleration (PGA) associated with the FIRS, are consistently convolved to obtain seismic risk.

The SPRA project has not revised the SPID GMRS at outcropping bedrock. Therefore, it is not available at this time.

The RB foundation elevation (EL) is 536 ft. At the plant site, the top of rock is at approximate EL 552, and the plant grade is at EL 583. However, the soil column used in developing the RB level FIRS and the hazard curves extends from hard rock up to EL 566, which is the top of the till. Thus, the soil column includes the effects of the 17 feet layer of till overlying site rock. Because of the sharp velocity contrast between the site bedrock (V_s = 6000 fps) and the overlying till (V_s = 1500 fps), much of the upward travelling wave gets reflected at the rock/till interface. Therefore, it is expected that the overlying till layer has a relatively small (in the range of about 5%) effect on the top of rock ground motion. Accordingly, the FIRS at the RB foundation level can be taken as a reasonable representation of the GMRS in the free field outcrop at the control point elevation, which is the RB foundation level.

REFERENCES

E-1. Stokoe, K. H., W. K. Choi, and F-Y Menq, 2003, "Summary Report: Dynamic Laboratory Tests: Unweathered and Weathered Shale Proposed Site of Building 9720-82 Y-12 National Security Complex, Oak Ridge, Tennessee," Department of Civil Engineering, The University of Texas at Austin, Austin, Texas, 2003.

E-2. DTE Electric Company Letter to the NRC, "Response to NRC Request for Additional Information Associated With Near-Term Task Force Recommendation 2.1, Seismic Hazard and Screening Report (TAC No. MF3861)," NRC-14-0080, dated December 18, 2014 (Accession No. ML14353A149)

E-3. DTE Electric Company Letter to the NRC, "DTE Electric Company's Seismic Hazard and Screening Report, Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," NRC-14-0017, dated March 31, 2014 (Accession No. ML14090A326)

E-4. U.S. Nuclear Regulatory Commission, "Interim Staff Guidance on Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses," DC/COL-ISG-017, March 24, 2010 (Accession No. ML100570203)