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DTE Energy

10 CFR 52.79

May 15, 2013
NRC3-13-0018

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

References: 1) Fermi 3
Docket No. 52-033
2) Letter from Tekia Govan (USNRC) to Peter W. Smith (DTE Electric), "Request for Additional Information Letter No. 85 Related to Chapters 03.07.02 for the Fermi 3 Combined License Application," dated April 15, 2013

Subject: DTE Electric Company Response to NRC Request for Additional Information Letter No. 85

In Reference 2, the NRC requested additional information to support the review of certain portions of the Fermi 3 Combined License Application (COLA). The Request for Additional Information (RAI) in Reference 2, RAI 03.07.02-11, is related to the Verification and Validation (V&V) of the SASSI2010 software that is being used in the Fermi 3 site-specific soil-structure interaction (SSI) analyses. Attachment 1 provides the response to RAI 03.07.02-11.

If you have any questions, or need additional information, please contact me at (313) 235-3341.

I state under penalty of perjury that the foregoing is true and correct. Executed on the 15th day of May 2013.

Sincerely,

Peter W. Smith, Director
Nuclear Development – Licensing and Engineering
DTE Electric Company

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NRO

Attachment: 1) Response to RAI Letter No. 85 (Question No. 03.07.02-11)

cc: Adrian Muniz, NRC Fermi 3 Project Manager
Tekia Govan, NRC Fermi 3 Project Manager
Michael Eudy, NRC Fermi 3 Project Manager (w/o attachment)
Bruce Olson, NRC Fermi 3 Environmental Project Manager (w/o attachment)
Fermi 2 Resident Inspector (w/o attachment)
NRC Region III Regional Administrator (w/o attachment)
NRC Region II Regional Administrator (w/o attachment)
Supervisor, Electric Operators, Michigan Public Service Commission (w/o attachment)
Michigan Department of Natural Resources and Environment
Radiological Protection Section (w/o attachment)

Attachment 1
NRC3-13-0018
(8 pages)

Response to RAI Letter No. 85
(eRAI Tracking No. 7077)

RAI Question No. 03.07.02-11

NRC RAI 03.07.02-11

DTE Electric Company provided verification and validation (V&V) plan (NRC3-13-0005) for SASSI2010 software to be used for seismic Soil Structure Interaction (SSI) analyses in support of the Fermi 3 Combined License application. During the Fermi 3 audit conducted on March 19 – 21, 2013, the staff reviewed the SASSI validation document entitled "Validation of SASSI2010 Version 1.0-250USER-M01," Revision 1, dated March 18, 2013, which contains the verification and validation performed for the SASSI2010 software, to verify that it is adequate for the Fermi 3 site conditions and site-specific seismic SSI analyses.

During the audit the staff determined that the test problems did not include validation for transfer functions or impedance functions, for frequencies above approximately 20 Hz up to 50 Hz for the Fermi 3 site.

In accordance with 10 CFR Part 50, Appendix S, to ensure that the seismic SSI analyses performed using SASSI2010 in support of the Fermi 3 Combined License application are adequate for the full frequency of interest at the Fermi 3 site, the applicant is requested to supplement the SASSI2010 V&V with additional test problems that address the issue identified above. This RAI also supplements RAI 03.07.02-9.

Response

The Reactor Building/Fuel Building (RB/FB) and Control Building (CB) at the Fermi 3 site are embedded structures founded on bedrock. Of these two structures, the RB/FB will require consideration of a higher range of dimensionless frequency, A_0 (where $A_0 = 2\pi f R/ V_S$, f = frequency of interest, R = foundation equivalent radius, and V_S = shear wave velocity). The shear wave velocity profiles of the rock below the RB/FB basemat are shown in Table 1. Columns 3, 6, and 9 of this table show the lower bound (LB), best estimate (BE), and upper bound (UB) shear wave velocity profiles, respectively, which are based upon the Central and Eastern United States (CEUS) Seismic Source Characterization (SSC) model. Columns 4, 7, and 10 of Table 1 show the calculated equivalent shear wave velocity profiles (equivalent shear wave velocity for the cumulative depth shown in column 2 and using equivalent shear wave travel time) for the LB, BE, and UB cases, respectively. Columns 5, 8, and 11 of Table 1 provide the calculated dimensionless frequency (A_0) values based on the equivalent shear wave velocity (V_{eq}) and frequency value of 50 Hz ($A_0 = 2*\pi*50*R/ V_{eq}$, where R = 108.4 ft is the equivalent radius of the RB/FB basemat). The largest A_0 value is 10.11, occurring for the LB case at a cumulative depth of 185.4 ft.

To address RAI 03.07.02-11, an additional test problem is included in the SASSI2010 validation document. This problem is identified as problem number 46 within the validation document. This test problem examines the transfer functions for frequencies up to 50 Hz. The test problem is for embedded structures, representative of Fermi 3 RB/FB and CB, which are also embedded structures. The following provides detailed description of the test problem and the solution results.

Problem No. 46

This test problem examines scattering response motions of a rigid, massless cylindrical foundation embedded in a homogeneous, elastic, isotropic half-space, and subjected to vertically propagating SV-waves for frequencies up to 50 Hz. The problem is analyzed using SASSI2010 and the translational and rocking transfer functions obtained from SASSI2010 are compared with the results reported by Day (Reference 1).

Model

The geometry of the model is shown in Figure 1 and the isometric view of the finite element model of the rigid, massless structure is shown in Figure 2. Figure 2 also shows the excavated volume. The excavated soil and the rigid, massless structure are attached to independent internal node sets. On the perimeter of the excavation, the excavated soil and the rigid, massless structure are attached to the same nodes. As shown in Figure 2, only half of the foundation is modeled. Symmetry about the XZ plane is used to reduce the size of the problem. The foundation radius, R, is equal to 65 ft, and the embedment depth is 32.5 ft. This results in an embedment depth to foundation radius ratio of 0.5 (dimensionless parameter H). The parameter H = 0.5 is selected because Day's solution is provided for H = 0.5, H = 1.0, and H = 2.0. For the Fermi 3 RB/FB, the H value is 0.6 (embedment depth of about 65.6 ft and equivalent radius of about 108.4 ft.), which is close to Day's reported value of H = 0.5.

The soil properties in the model are:

Shear wave velocity, V_S = 2,000 ft/sec

Material damping = 0.01

Weight density = 128.68 pcf

Poisson's ratio = 0.25

Compression wave velocity, V_P = 3,464.1 ft/sec

The SASSI2010 soil layer model consists of four top layers and a half-space below. The thickness of each top layer is 8.125 ft. The cylindrical excavated volume and the foundation are modeled using solid elements. There are 512 solid elements in the excavated volume and 512 solid elements in the cylindrical foundation. There are 570 interaction nodes. The element sizes of the excavated volume are such that none exceed 8.125 ft. Per the SASSI2010 User's Manual, the passing frequency of the model is:

$f = V_S / (5*h) = 49.22$ Hz (about 50 Hz)

This gives a dimensionless frequency of

$A_0 = 2 \pi f R / V_S = 10$

SASSI2010 Analysis

The direct (flexible volume) method is used for the analysis and the control motion is specified at the ground surface.

Comparison of SASSI2010 Results with Day's Solution

Figure 3 shows the comparison of translational responses (transfer functions) from SASSI2010 and Day's solution. Figure 4 shows the comparison of rocking responses (transfer functions) from SASSI2010 and Day's solution. The results are plotted for A_0 values up to 10 (about 50 Hz).

Based on these comparisons, it is concluded that the results from SASSI2010 and the results reported by Day (Reference 1) are in good agreement, except at an A_0 value of about 6.8, where the SASSI2010 response value is about 30% higher. This is an isolated deviation and its impact on the total response from SASSI2010 analysis is negligible.

Conclusion:

Test problem 46 described above is representative of the Fermi 3 embedded RB/FB and CB structures. The above comparisons show that the results from SASSI2010 are in good agreement with the results reported by Day (Reference 1) for A_0 values up to 10 (frequency of about 50 Hz). Based on these results, it is concluded that the SASSI2010 transfer functions are adequate for the full frequency range of interest (i.e., up to 50 Hz) at the Fermi 3 site.

References:

1. Day, S. M. 1977, "Finite Element Analysis of Seismic Scattering Problem", Doctoral dissertation, University of California, San Diego

Proposed COLA Markup

None.

Table 1: Fermi 3 Soil (Rock) Profile Shear Wave Velocity Characteristics for Rock Below RB/FB Basemat

Soil (Rock) Shear Wave Velocity Below Building Foundation – Reactor Building / Fuel Building										
Layer Thickness (ft)	Cumul-ative Depth (ft)	Lower Bound Soil			Best Estimate Soil			Upper Bound Soil		
		Shear Wave Velocity (ft/sec)	Equiv. Shear Wave Velocity (ft/sec)	Dimension-less Frequency Ao	Shear Wave Velocity (ft/sec)	Equiv. Shear Wave Velocity (ft/sec)	Dimensionl-ess Frequency Ao	Shear Wave Velocity (ft/sec)	Equiv. Shear Wave Velocity (ft/sec)	Dimensio-nless Frequency Ao
2.1	2.1	5460	5460	6.23	6687	6687	5.09	8189	8,189	4.16
9.7	11.8	5436	5440	6.26	6658	6663	5.11	8154	8,160	4.17
11.1	22.9	5383	5412	6.29	6593	6629	5.13	8074	8,118	4.19
12	34.9	5356	5393	6.31	6560	6605	5.15	8035	8,089	4.21
12.1	47	5389	5392	6.31	6600	6604	5.15	8083	8,088	4.21
15	62	3734	4869	6.99	4573	5963	5.71	5601	7,303	4.66
20.3	82.3	2779	4107	8.29	3403	5030	6.77	4187	6,170	5.52
20	102.3	2793	3761	9.05	3455	4618	7.37	4231	5,663	6.01
20	122.3	2768	3553	9.58	3390	4360	7.81	4151	5,345	6.37
21	143.3	2718	3400	10.01	3328	4170	8.16	4370	5,175	6.58
21	164.3	3254	3380	10.07	4091	4160	8.18	5190	5,177	6.57
21.1	185.4	3273	3368	10.11	4166	4161	8.18	5260	5,187	6.56
10.1	195.5	4532	3413	9.97	5551	4215	8.07	6798	5,251	6.48
20.2	215.7	7726	3601	9.45	9462	4446	7.66	11589	5,534	6.15
21	236.7	7701	3780	9.01	9432	4665	7.30	11552	5,803	5.87
21	257.7	7763	3945	8.63	9507	4867	6.99	11644	6,050	5.63
20.3	278	7614	4089	8.32	9325	5043	6.75	11421	6,265	5.43
45	323	7312	4356	7.81	8956	5370	6.34	10968	6,663	5.11
45.2	368.2	7331	4585	7.42	8978	5649	6.03	10996	7,002	4.86

Figure 1: Geometry of Cylindrical Foundation Cross Section

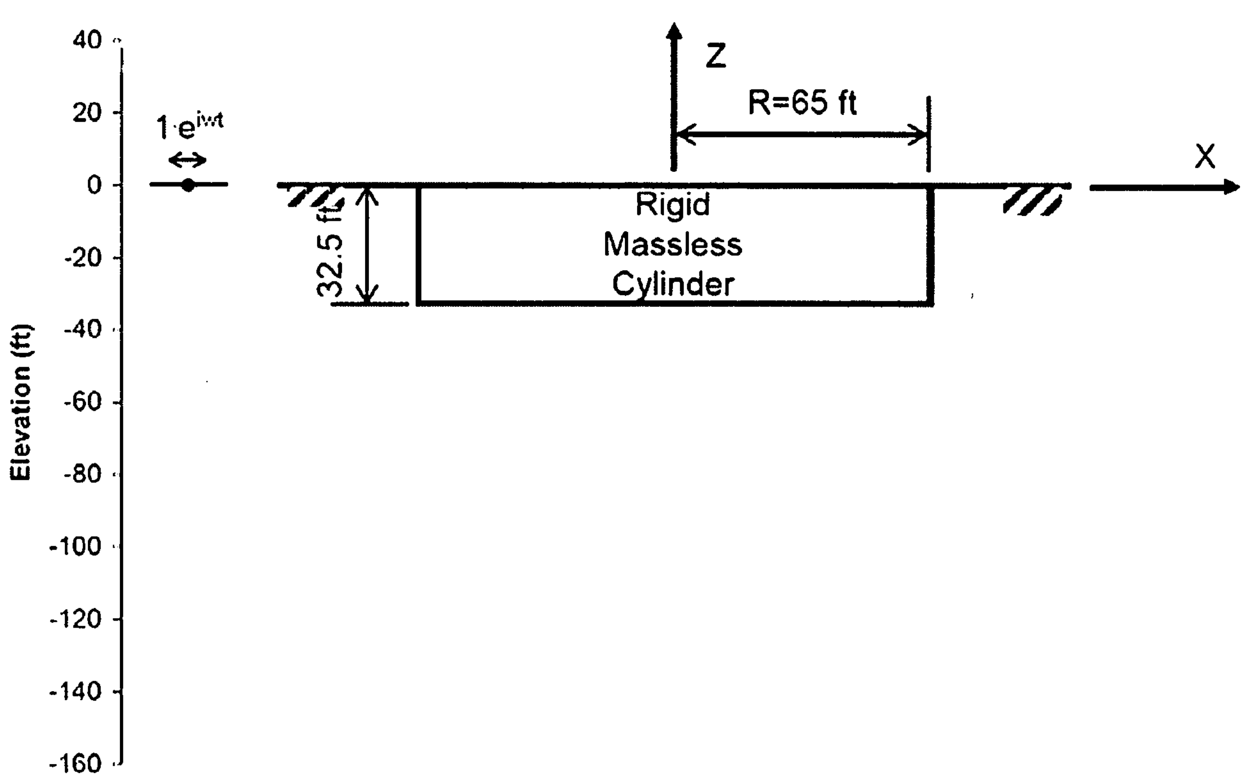

Figure 2: Isometric View of Finite Element Model

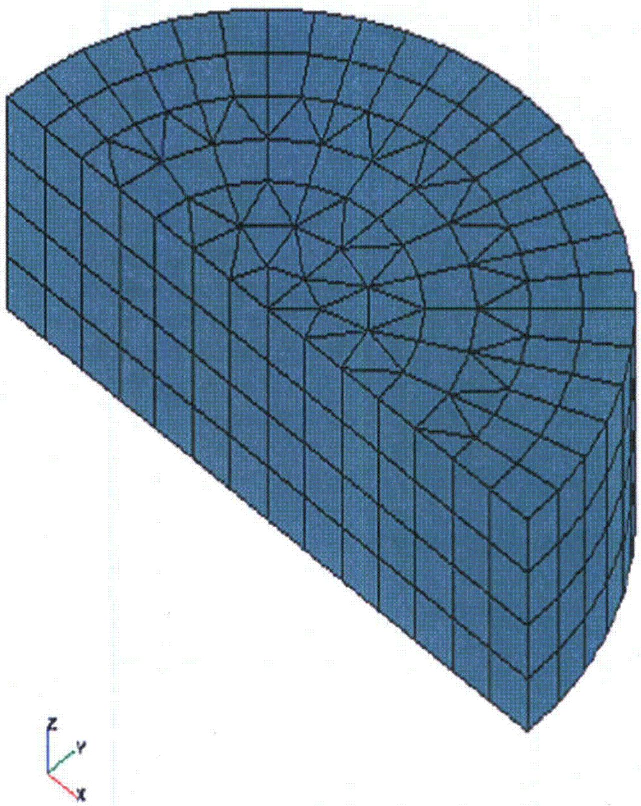

Figure 3: Translational Response due to Vertically Propagating SV-Wave, H = 0.5

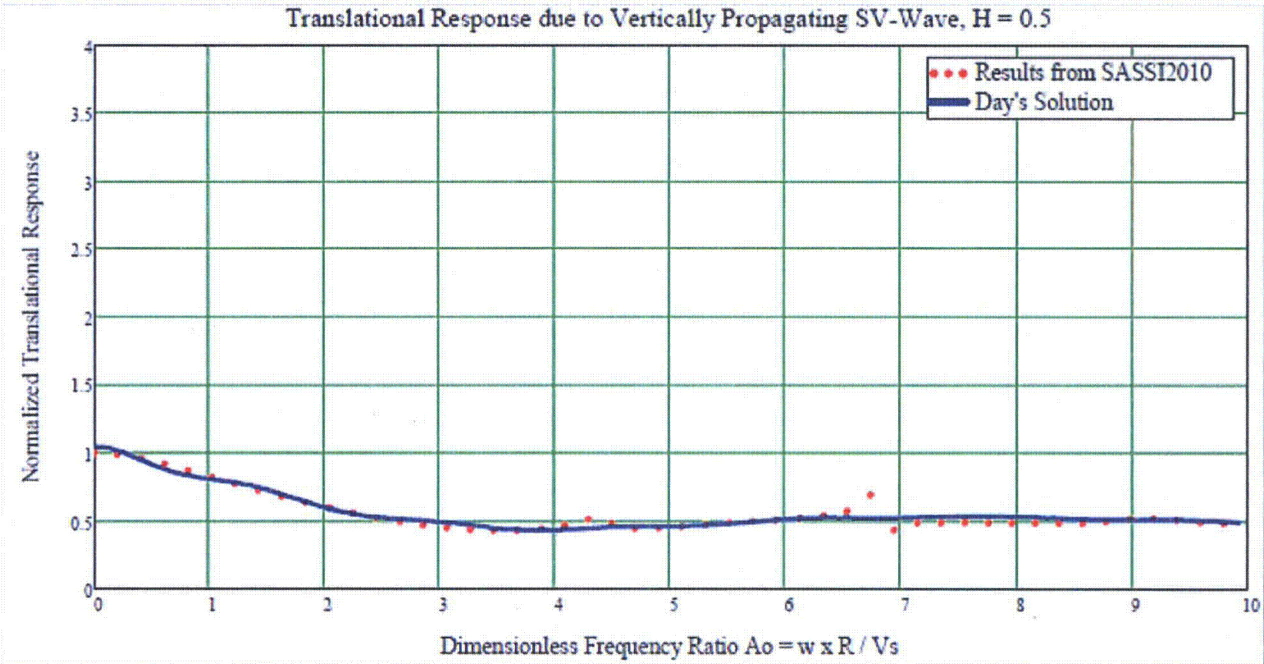

Figure 4: Rocking Response due to Vertically Propagating SV-Waves, H = 0.5