PMFermiCOLPEm Resource

From: Govan, Tekia
Sent: Tuesday, November 19, 2013 9:36 AM
To: FermiCOL Resource
Subject: FW: November 18, 2013 Audit Presentation Materials
Attachments: Overview of DTE Actions Related to EF3 Seismic Analysis 20131118 FINAL.pdf; Audit Entrance 20131118 FINAL.pdf

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From: Michael K Brandon [mailto:brandonm@dteenergy.com]
Sent: Tuesday, November 19, 2013 9:00 AM
To: Govan, Tekia
Subject: Fwd: November 18, 2013 Audit Presentation Materials

Sent from my iPad

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Subject: FW: November 18, 2013 Audit Presentation Materials
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From: Govan, Tekia

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Recipients:
"FermiCOL Resource" <FermiCOL.Resource@nrc.gov>
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Files	**Size**	**Date & Time**	
MESSAGE	253	11/19/2013 9:39:28 AM	
Overview of DTE Actions Related to EF3 Seismic Analysis 20131118 FINAL.pdf	185201		
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Overview of DTE Electric Company's Actions Related to Fermi 3 Site-Specific Seismic Analysis

Fermi 3 – ESBWR

November 18, 2013

Background

- Previous site-specific seismic analyses were audited in April 2012
- RAI Letter No. 77 requesting evaluation of the impacts of the CEUS SSC model for the Fermi site was issued on May 17, 2012
- RAI Letter No. 79 requesting further information regarding seismic analysis was issued on August 7, 2012
- Based on these RAI Letters, DTE elected to re-perform the previous site-specific SSI analyses using input derived from the CEUS SSC model to address RAI Letter No. 79 questions
- The approach to addressing the impacts of the CEUS SSC model and resolving the remaining RAI questions related to site-specific SSI analyses was discussed in a Public Meeting on November 29, 2012, and confirmed in DTE Letter NRC3-12-0033 dated December 14, 2012

Summary of Resolution of Open Items

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Item	Resolution
1. CEUS SSC for Fermi 3 not bounded by current SSI Inputs	1. Replaced previous inputs with new ones based on the CEUS SSC
2. Consistency of SSI inputs used for various analyses	2. Replaced previous inputs with new ones based on the CEUS SSC model in all cases
3. Use of 7% SSE Structural Damping Ratios vs. 4% OBE Structural Damping Ratios	3. Performed new SSI analyses with OBE Structural Damping Ratios
4. Finite element mesh size/aspect ratio insufficient to capture full range of frequencies	4. Use finite element mesh size/aspect ratio capable of capturing range of frequencies up to about 50 Hz
5. Use of SASSI Subtraction Method (SM) for cases including engineered granular backfill	5. The new SSI analyses used either Direct Method (DM) or Modified Subtraction Method (MSM)
6. Comparison of out-of-plane slab and wall responses with DCD values	6. Compared results from revised analyses with DCD values
7. Reevaluate the SSSI comparative analysis results with common reference point	7. Displacements from SSSI analyses have common reference points
8. Evaluation of lateral wall pressure results from SSI analyses	8. Evaluated wall pressures from revised analyses and compared with wall capacities

SSI Inputs Update Approach

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- New site hazard using CEUS SSC model (NUREG-2115) with updates following RG 1.208 and the EPRI (2004, 2006) ground motion models for the Fermi 3 Probabilistic Seismic Hazard Analysis (PSHA)
- Developed updated site-specific Ground Motion Response Spectrum (GMRS), Performance-Based Surface Response Spectrum (PBSRS), Soil Column Outcrop Response (SCOR) FIRS for RB/FB and CB, and Truncated Soil Column Response (TSCR) FIRS for FWSC based on new Fermi 3 PSHA
- Developed SSI subsurface profiles with and without engineered granular backfill based on statistics of iterated properties for the randomized subsurface profile with engineered granular backfill used for the SCOR FIRS and PBSRS
- Developed SSI time histories matched to enhanced SCOR FIRS for use with and without engineered granular backfill

SSI Input Update Results

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- SCOR FIRS for RB/FB and CB are enveloped by ESBWR CSDRS at all frequencies between 0.1 and 100 Hz
- TSCR FIRS for FWSC incorporating 2-D effects are enveloped by 1.35 times the ESBWR CSDRS at all frequencies between 0.1 and 100 Hz
- The updated SCOR FIRS for the RB/FB and CB and the TSCR FIRS for the FWSC incorporate the CEUS SSC impacts and previous NRC RAIs

SSI Software

- Software
  - All of the revised SSI analyses for Fermi 3 have been performed using SASSI2010 Version 1.0
  - Staff reviewed the SASSI2010 V&V documentation during the Fermi 3 SASSI2010 V&V Audit conducted in Sargent & Lundy's Chicago offices from March 19 to March 21, 2013
  - Following the Audit, Staff issued RAI 03.07.02-11 related to V&V for transfer and/or impedance functions > 20 Hz, < 50 Hz
  - DTE responded with letter NRC3-13-0018 and provided further clarification with letter NRC3-13-0023

RAI 03.07.02-9 – SSI Modeling

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In order to respond to the questions raised in the individual items within RAI 03.07.02-9, DTE performed new analyses with SASSI2010:

1. Used CEUS SSC model inputs for Fermi 3
2. Used consistent input time history motions
3. Used OBE Damping Values for structural elements
4. Used sufficiently fine mesh size for the excavated volume to capture frequencies up to about 50 Hz., as defined in DC/COL-ISG-1
5. Used the DM wherever possible and the MSM where the number of Interaction Nodes exceeded the capacity of SASSI2010 using DM (MSM was benchmarked for each structure)

Analyses were performed with the DCD "Base" structural model for the RB/FB and for the CB so that all comparisons to DCD values and envelopes are made on a consistent basis

SSI Analyses without Engineered Granular Backfill

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- To confirm that the Referenced DCD design is applicable under Fermi 3 site-specific conditions, analyses for RB/FB and CB were performed without taking credit for engineered granular backfill above the top of bedrock considering partial embedment in the Bass Islands Group bedrock
- Results from these analyses demonstrate:
  - Response spectra, accelerations, forces and moments, and soil pressures on walls at key locations are bounded by the Referenced DCD design
  - Stability (Sliding factors of safety) shows margin

SSI Analyses without Engineered Granular Backfill (continued)

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SSI Analyses without Engineered Granular Backfill

Building	Case ID No.	Model (DCD)	Model	SASSI2010 Method of Analysis	Input Motion	Subsurface Profile		
						UB	BE	LB
RB/FB	RBFB1UB-DM	Base	SSI Without Engineered Granular Backfill	DM	FIRS	✓	--	--
	RBFB1BE-DM					--	✓	--
	RBFB1LB-DM					--	--	✓
CB	CB1UB-DM					✓	--	--
	CB1BE-DM					--	✓	--
	CB1LB-DM					--	--	✓

BE = Best estimate; LB = Lower bound; UB = Upper bound

- The CB and the RB/FB were analyzed using the DM, capturing frequencies up to about 50 Hz

SSI Analyses with Engineered Granular Backfill

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- DTE performed analyses taking into account the engineered granular backfill surrounding the structures to demonstrate that the backfill above bedrock does not adversely impact Seismic Category I structures
- Results from these analyses demonstrate:
  - Response spectra, accelerations, forces and moments, and soil pressures on walls at key locations are bounded by the Referenced DCD design
  - Stability (Sliding factors of safety) shows margin

SSI Analyses with Engineered Granular Backfill (continued)

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SSI Analyses with Engineered Granular Backfill

Building	Case ID No.	Model (DCD)	Model	SASSI2010 Method of Analysis	Input Motion	Subsurface Profile UB	Subsurface Profile BE	Subsurface Profile LB
RB/FB	RBFB2UB-MSM	Base	SSI With Engineered Granular Backfill	MSM	FIRS	✓	--	--
	RBFB2LB-MSM*					--	--	✓
CB	CB2UB-DM			DM		✓	--	--
	CB2LB-DM*					--	--	✓
CB	CB3UB-DM			DM		✓	--	--
	CB3LB-DM*		SSSI With Engineered Granular Backfill			--	--	✓
CB	CB4-FWSC1UB-MSM			MSM		✓	--	--
	CB4-FWSC1LB-MSM*					--	--	✓

Note: *** To keep the LB model within SASSI2010 computer code capability, the LB model layer thicknesses and mesh dimensions are kept the same as those for the corresponding UB model.**

BE = Best estimate; LB = Lower bound; UB = Upper bound

- CB and RB/FB analyses with UB soil profiles captured frequencies up to ~50 Hz.
- DM was used wherever possible, MSM used where SASSI2010 code capability was exceeded

RAI 03.07.02-9 Remaining Items

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Results from the revised analyses were used to address:

6. Out-of-Plane Responses
   - Where RB/FB and CB floors have out-of-plane frequencies lower than 50 Hz, the SSI models include oscillators to represent these lower out-of plane frequencies
   - The maximum vertical accelerations and response spectra at the oscillators are bounded by the corresponding ESBWR standard plant design maximum vertical accelerations and response spectra
7. Evaluation of SSSI Effects
   - SSSI effects were shown to be negligible

RAI 03.07.02-9 Remaining Items (Continued)

DTE Energy

Results from the revised analyses were used to address (Continued):

8. Lateral Wall Pressures from the Applicable SSI and SSSI Analyses
   - Soil pressures at elevations close to the backfill-to-bedrock transition, including the sharp increase in lateral soil pressures at elevations close to the backfill-to-bedrock transition were evaluated
   - A quantitative assessment of the sidewall design (out-of-plane bending moments and shears due to lateral soil pressure) at the locations where the DCD design pressures are exceeded has been provided
   - The Fermi 3 wall pressures are within the capacity of ESBWR DCD wall designs

Summary of SSI & SSSI Results

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- Results from the Fermi 3 site-specific SSI and SSSI analyses show that the seismic forces in members, floor response spectra, and accelerations are bounded by values presented in the Referenced DCD for both the RB/FB and CB
- Results from the Fermi 3 site-specific foundation stability evaluations demonstrated that the minimum Fermi 3 site-specific factors of safety for sliding, overturning, and flotation are met for both the RB/FB and CB
- The Fermi 3 site-specific soil dynamic bearing demands for the RB/FB and CB are greater than the Referenced DCD maximum dynamic bearing demands, but are considerably below the allowable dynamic bearing capacities of the Bass Islands Group bedrock

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Audit of SSI Analyses and SSI Input Development

Entrance Meeting

Sargent & Lundy, L.L.C.
55 East Monroe
Chicago, Illinois

Fermi 3 – ESBWR

November 18, 2013

Entrance Meeting

DTE Energy

- Safety Topic
- Introductions
- Audit Scope
- Materials Available for Review
- Agenda Review

USNRC Introductions

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USNRC:

Tekia Govan	Senior Project Manager, BWR Projects Branch
Manas Chakravorty	Structural Engineering Branch 2, Technical Reviewer
Carl Costantino	NRC Consultant (BNL)
Manuel Miranda	NRC Consultant (BNL)

DTE Introductions

DTE Electric Company	Peter Smith Mike Brandon John Price	
AMEC E&I	Bob Youngs	
Black & Veatch	Brandon Gomer Ed Meyer	
GE Hitachi	Taylor Blake	
Sargent & Lundy	Farid Berry Bob Hooks Javad Moslemian Joe Petrich Surendra Singh Eric Weyhrich Ming Yang	Delfo Bianchini Randy Kurtz Jim McIntyre Brian Renwick

Audit Scope

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- The scope of the audit is to review the site-specific SSI analyses performed in support of the Fermi 3 Combine License application, and in response to the NRC staff's RAI Letter Nos. 70, 79, 82, and 85
- Specifically, the staff will review selected portions of the calculations that were prepared in support of the documentation provided to the staff in letters:

NRC3-13-0005	NRC3-13-0024
NRC3-13-0007	NRC3-13-0026
NRC3-13-0015	NRC3-13-0027
NRC3-13-0017	NRC3-13-0028
NRC3-13-0018	NRC3-13-0031
NRC3-13-0019	NRC3-13-0032
NRC3-13-0021	Markups to FSAR Tier 2, Sections 3.7 and 3.8
NRC3-13-0023	

B&V Materials Available for Audit

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Letter	RAI	Subject	Calculation No.	Calculation Title	Rev.
NRC3-13-0007	RAI 3.7.2-10 RAI 2.5.2-20	COV = 1 in backfill Menq	147483.51.9041	Estimated Shear Wave Velocity of Backfill Surrounding Seismic Category I Structures for SSI Analysis	1
			147483.51.9064	Fermi 3 CEUS SSC Site Response and Determination of FIRS, PBSRS, and GMRS	1
			147483.51.9066	Fermi 3 CEUS SSC SSI Inputs	1
NRC3-13-0015	RAI 3.7.2-10 RAI 2.5.2-20	FSAR 3.7.1 Markup	147483.51.9041	Estimated Shear Wave Velocity of Backfill Surrounding Seismic Category I Structures for SSI Analysis	1
			147483.51.9042	Estimated Compression Wave Velocity of Backfill Surrounding Seismic Category I Structures for SSI Analysis	1
			147483.51.9047	Shear Wave Velocity Profile Weighting for the Backfill Surrounding Seismic Category I Structures	0
			147483.51.9056	Two Dimensional Scaling Ratios for FWSC FIRS	2
			147483.51.9059	Fill Concrete Parameters Under FWSC and Surrounding RB/FB and CB	1
			147483.51.9061	Calculations in Support of Response to RAI 03.07.01-04	1
			147483.51.9064	Fermi 3 CEUS SSC Site Response and Determination of FIRS, PBSRS, and GMRS	1
			147483.51.9066	Fermi 3 CEUS SSC SSI Inputs	1
			147483.51.9067	Power Spectral Density of SSI Time Histories	0
			147483.51.9068	Fermi 3 CEUS SSC Site Response and Determination of FIRS for FWSC	0
NRC3-13-0027	RAI 2.5.2-21	UR & LR profiles, sigma, Menq, weights	147483.51.9041	Estimated Shear Wave Velocity of Backfill Surrounding Seismic Category I Structures for SSI Analysis	1
			147483.51.9047	Shear Wave Velocity Profile Weighting for the Backfill Surrounding Seismic Category I Structures	0
			147483.51.9064	Fermi 3 CEUS SSC Site Response and Determination of FIRS, PBSRS, and GMRS	1
NRC3-13-0031	RAI 2.5.2-21	Additional Information	147483.51.9041	Estimated Shear Wave Velocity of Backfill Surrounding Seismic Category I Structures for SSI Analysis	1
			147483.51.9047	Shear Wave Velocity Profile Weighting for the Backfill Surrounding Seismic Category I Structures	0
			147483.51.9064	Fermi 3 CEUS SSC Site Response and Determination of FIRS, PBSRS, and GMRS	1
			147483.51.9070	Shear Wave Velocity Profile Weighting for the Backfill Surrounding Seismic Category I Structures – Comparison of Menq and Richart et al. Methods	0

S&L Materials Available for Audit

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Volume (Note 1.)	Letter	Report or RAI	Validation Package	Rev.	Calculation No. (Note 2.)	Calculation Title	Rev.
Note 3.	N/A	SL-011668	Verification / Validation Plan for SASSI2010 Version 1.O-250USER-MO1	0	N/A	N/A	N/A
	NRC3-13-0005	SL-011674	Verification / Validation Plan for SASSI2010 Version 1.O-250USER-MO1	0	N/A	N/A	N/A
	N/A	SL-011705	SASSI2010 Version 1.O-2S0USER-MO1 Verification / Validation Summary Report	0	SWR03.7.316-1.0-2S0USER*	Validation of SASSI2010 Version 1.0-2S0USER-M01	1
					UM_SASSI2010_TOCver1-0	SASSI2010 Version 1.0 – User Manual	N/A
I	N/A	N/A	N/A	N/A	2013-01132	Fermi 3 Seismic Analysis Criteria	1
II	NRC3-13-0017	SL-011814	Modified Subtraction Method (MSM) Reactor Building/Fuel Building Benchmark Summary Report	0	2013-03371	Benchmark of MSM SSI Analysis of Reactor Building/Fuel Building (Quarter Model)	1
	NRC3-13-0021	SL-011863	Modified Subtraction Method (MSM) Firewater Service Complex Benchmark Summary Report	0	2013-03373	Fermi 3 ESBWR - Benchmarking of MSM SSI Analysis of Firewater Service Complex (Half Model)	0
	NRC3-13-0021	SL-011874	Modified Subtraction Method (MSM) Control Building Benchmark Summary Report	0	2013-05804	Fermi 3 ESBWR - Benchmarking of MSM SSI Analysis of Control Building	0
III	NRC3-13-0019 NRC3-13-0026	SL-011864	Licensing Basis SSI Analyses of Reactor Building/Fuel Building and Control Building Summary Report	1	2013-03369	Fermi 3 ESBWR - Licensing Basis SSI Analysis of the Reactor Building/Fuel Building	0
					2013-03370	Fermi 3 ESBWR - Licensing Basis SSI Analysis of the Control Building	0
IV	NRC3-13-0024	SL-011956	SSI Analyses of Reactor Building/Fuel Building and Control Building with Engineered Backfill Summary Report	0	2013-03375	Fermi 3 ESBWR - SSI Analysis with Engineered Backfill (UB and LB) of Reactor Building/Fuel Building (MSM)	3
					2013-03376	Fermi 3 ESBWR - SSI Analysis with Engineered Backfill (UB and LB) of the Control Building	0
V	NRC3-13-0028	SL-011960	SSSI Sensitivity Studies of CB and FWSC with Engineered Backfill Summary Report	0	2013-07463	Fermi 3 ESBWR - SSSI Analysis of CB (Effect of RB/FB) with Engineered Backfill	1
					2013-07464	Fermi 3 ESBWR - SSSI Analysis of CB-FWSC with Engineered Backfill	0
VI	NRC3-13-0032	SL-012018	Evaluation of Reactor Building/Fuel Building and Control Building Dynamic Bearing Capacity, Foundation Stability, and Wall Seismic Soil Pressures Summary Report	0	2013-07635	Evaluation of Adequacy of Wall Designs for Rock-Soil Pressures	0
					2013-07638	Fermi 3 ESBWR - Evaluation of RB/FB and CB Foundation Stability	0
VII	NRC3-13-0032	RAI 03.07.02-9	Combined Response (Includes Markups to FSAR Tier 2, Sections 3.7 and 3.8)	0	2013-07634	Evaluation of Oscillator's Acceleration and response Spectra	0
					2013-09240	Fermi 3 ESBWR - Comparisons of Envelope of SSI and SSSI Responses with DCD Responses	0
VIII	NRC3-13-0018 NRC3-13-0023	RAI 03.07.02-11	V&V for transfer and/or impedance functions > 20 Hz, < 50 Hz	1	SWR03.7.316-1.0-2S0USER (Note 3.)	Validation of SASSI2010 Version 1.0-2S0USER-M01	3

Audited in March 2013
Materials in separate binder

NOTES:

1. Each Volume contains the Report or RAI Response followed by the calculation(s) that back up the Report or RAI Response.
2. Hard copies of the calculations contain the body of the calculation, including all attachments. Computer input and output files are available on a dedicated hard drive.
3. S&L Proprietary Materials. These are available for the Audit.

Audit Plan and Schedule Review

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AGENDA FOR
FERMI 3: REVIEW OF SOIL STRUCTURE INTERACTION CALCULATIONS RELATED TO FSAR SECTIONS 3.7 AND 3.8

November 18 through November 21, 2013