DTE Energy

Fermi 3 Soil-Structure Interaction Analysis Experience

A Retrospective View of the Guidance Enhancements

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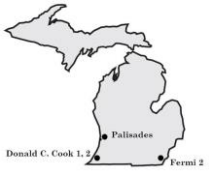
Introduction

- Fermi 3 Background
- Fermi 3 SSI journey and current status
- View of four of the guidance enhancements and how they might have impacted Fermi 3
  - Issue 2: Seismic Stability Evaluation
  - Issue 10: SASSI Subtraction Method
  - Issue 8: Artificial TH Development
  - Issue 4: Seismic Soil Pressures

Fermi 3 COLA Background



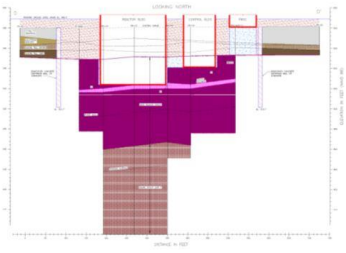
- DTE Energy submitted the Fermi 3 COLA was submitted in September 2008 for a potential new nuclear unit at the company's Fermi site in Monroe County Michigan on the western shore of Lake Erie

- The COLA references the GE-Hitachi ESBWR DCD
- No site specific Soil Structure Interaction (SSI) analyses were originally performed
- Site parameters were enveloped by the DCD
- ESBWR DCD originally did not credit side backfill adjacent to SCI structures – No requirements specified

Fermi 3 SSI Journey

- SC I Reactor and Control Bldgs partially embedded in bedrock
- In 2010, ESBWR DCD Rev 7 credited side backfill for stability – specified V_s>1000 ft/s uniform to surface
- Fermi 3 engineered granular backfill cannot satisfy this requirement
- Performed site specific SSI analyses
- Initial Fermi 3 SSI performed SASSI 2000 using subtraction method ignoring the presence of side backfill

Fermi 3 Site Cross Section



Fermi 3 SSI Journey (continued)

- Subsequent SSI analyses were performed to evaluate:
  - Impacts of the non-Seismic Category I backfill above the top of bedrock on the RB/FB and CB
  - Structure- Soil-Structure Interaction (SSSI)
- Subtraction method used for initial analyses with backfill and SSSI cases
- Inclusion of the low V_s side backfill, addressing the subtraction method issue, and covering the full frequency range challenge software capabilities due to the size of finite element models and large number of interaction nodes.

Fermi 3 SSI Journey Current Status

- Re-performing all previous SSI analyses to address:
  - Central and Eastern U.S. (CEUS) Seismic Source Characterization (SSC) impacts for the Fermi site.
  - Previous modeling issues and differences between analyses performed at different times
- Use of SASSI2010 permits approximately double the number of interaction nodes.
- Use of the modified subtraction method (MSM) – allows for model size reduction.
  - Addresses subtraction method issues
  - Requires validation against direct method – quarter models.

Guidance Enhancements

Four Aspects of Guidance Enhancements that might have changed the course of the Fermi 3 SSI journey

- Issue 2: Seismic Stability Evaluation
- Issue 10: SASSI Subtraction Method
- Issue 8: Artificial TH Development
- Issue 4: Seismic Soil Pressures

SRP 3.7/3.8 Enhancement
Issue 2: Seismic Stability Evaluation

- **Challenge** – difficulties meeting current criteria because of bounding site conditions and conservative assumptions for capacity analysis in generic designs.
- **Fermi 3 impact** – ESBWR used a minimum V_s of 1,000 ft/s in order to address the stability evaluation.
- **Result** – site-specific SSI analyses to be performed for Fermi 3. All other seismic DCD parameters were met.
- **Benefit** – proposed enhancements could allow for fewer bounding conditions, resulting in less site-specific (COLA) analyses. Perhaps would have permitted site specific resolution of stability without SSI

SRP 3.7/3.8 Enhancement
Issue 10: SASSI Subtraction Method

- **Challenge** – address SASSI issues identified by DNFSB in 2011; SSI analysis of embedded structures using SM could result in erroneous and non-conservative seismic response.
- **Fermi 3 impact** – DM analysis of rock condition was possible DM analysis of site configuration with side backfill required significant compromises.
- **Result** – Sought SSI software with more capability. Combination of SASSI2010, MSM, and quarter models allows model simplification to within the software's limits.
- **Benefit** – specific guidance for FE mesh and implementation of MSM will allow for simpler review and acceptance.

SRP 3.7/3.8 Enhancement
Issue 8: Artificial TH Development

- **Challenge** – selection of appropriate seed, perform spectral matching, nonlinear analysis.
- **Fermi 3 impact** – Option 1; however, TH for initial analyses did not meet SRP 3.7.1 criterion of 0.16 minimum correlation coefficient (H1/H2 < 0.16).
- **Result** – chose new seed TH that met all criteria. Performed 1.3* and 0.9* FIRS checks, as well as power spectral density (PSD) check.
- **Benefit** – avoided analyses using multiple TH

SRP 3.7/3.8 Enhancement
Issue 4: Seismic Soil Pressures

- **Challenge** – seismic soil pressures can vary substantially depending on many factors. Uncertainties need to be addressed.
- **Fermi 3 impact** –Sharp increase in the lateral soil pressures at the backfill-to-bedrock transition. Iterative assessment approach progressively reducing conservatisms.
- **Result** – High confidence in conclusion; but, need to justify approach on site specific basis.
- **Benefit** – specific guidance endorsing alternate approaches will result in simpler analyses and reviews.

Conclusions

- Appears to be a straightforward path for conclusion of Fermi 3 Analyses.
- Guidance enhancements and lessons learned will improve efficiency of future analyses efforts and reviews
- Hindsight is 20/20