CHAPTER 3:
DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS
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CHAPTER 3 DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS

3.1 CONFORMANCE WITH NUCLEAR REGULATORY COMMISSION GENERAL DESIGN CRITERIA

This section of the referenced DCD is incorporated by reference with no departures or supplements.

3.2 CLASSIFICATION OF STRUCTURES, COMPONENTS, AND SYSTEMS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.2.1 SEISMIC CLASSIFICATION

Add the following text to the end of DCD Subsection 3.2.1.

STD SUP 3.2-1 There are no safety-related structures, systems, or components outside the scope of the DCD.

The nonsafety-related structures, systems, and components outside the scope of the DCD are classified as non-seismic (NS).

3.2.2 AP1000 CLASSIFICATION SYSTEM

Add the following text to the end of DCD Subsection 3.2.2.

STD SUP 3.2-1 There are no safety-related structures, systems, or components outside the scope of the DCD.

3.3 WIND AND TORNADO LOADINGS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.3.1.1 Design Wind Velocity

Add the following text to the end of DCD Subsection 3.3.1.1.

PTN DEP 2.0-1
PTN COL 3.3-1
PTN COL 3.5-1

The wind velocity characteristics for Turkey Point Units 6 & 7 are given in Subsection 2.3.1.3.1. These values exceed the design wind velocity values given in DCD Subsection 3.3.1.1 for the AP1000 plant. The higher wind velocity does not have an adverse impact on safety-related structures and components.

3.3.2.1 Applicable Design Parameters

Add the following text to the end of DCD Subsection 3.3.2.1.

PTN COL 3.3-1
PTN COL 3.5-1

The tornado characteristics for Units 6 & 7 are given in Subsection 2.3.1.3.2. These values are bounded by the tornado design parameters given in DCD Subsection 3.3.2.1 for the AP1000 plant.

3.3.2.3 Effect of Failure of Structures or Components Not Designed for Tornado Loads

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Add the following text to the end of DCD Subsection 3.3.2.3.

PTN COL 3.3-1
PTN COL 3.5-1

Consideration of the effects of wind and tornado due to failures in an adjacent AP1000 plant is bounded by the evaluation of the buildings and structures in a single unit.

3.3.3 COMBINED LICENSE INFORMATION

Add the following text to the end of DCD Subsection 3.3.3.

PTN COL 3.3-1
PTN DEP 2.0-1

The Units 6 & 7 site satisfies the site interface criteria for wind and tornado (see Subsections 3.3.2.1 and 3.3.2.3) and will not have a tornado-initiated failure of structures and components within the applicant's scope that compromises the safety of safety-related structures and components (see also Subsection 3.5.4).

The site wind velocity characteristics exceed the design wind velocity values given in DCD Subsection 3.3.1.1 for the AP1000 plant (see Subsection 3.3.1.1). The higher wind velocity will not have an adverse impact on safety-related structures and components.

Subsection 1.2.2 discusses differences between the plant specific site plan (see Figure 1.1-201) and the AP1000 typical site plan shown in DCD Figure 1.2-2.

There are no other structures adjacent to the nuclear island other than as described and evaluated in the DCD.

Missiles caused by external events separate from the tornado are addressed in Subsections 2.2 through 2.2.3, 3.5.1.5, and 3.5.1.6.

3.4 WATER LEVEL (FLOOD) DESIGN

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.4.1.3 Permanent Dewatering System

Add the following text to the end of DCD Subsection 3.4.1.3.

PTN COL 3.4-1 No permanent dewatering system is required because site groundwater levels are 2 feet or more below site grade level as described in Subsection 2.4.12.5.

3.4.3 COMBINED LICENSE INFORMATION

Replace the first paragraph of DCD Subsection 3.4.3 with the following text.

PTN COL 3.4-1 The site-specific water levels given in Section 2.4 satisfy the interface requirements identified in DCD Section 2.4.

3.5 MISSILE PROTECTION

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.5.1.3 Turbine Missiles

Add the following text to the end of the DCD Subsection 3.5.1.3.

STD SUP 3.5-1 The potential for a turbine missile from another AP1000 plant in close proximity has been considered. As noted in DCD Subsection 10.2.2, the probability of generation of a turbine missile (or P1 as identified in SRP 3.5.1.3) is less than 1 x 10^{-5} per year. This missile generation probability (P1) combined with an unfavorable orientation P2xP3 conservative product value of 10^{-2} (from SRP 3.5.1.3) results in a probability of unacceptable damage from turbine missiles (or P4 value) of less than 10^{-7} per year per plant which meets the SRP 3.5.1.3 acceptance criterion and the guidance of Regulatory Guide 1.115. Thus, neither the orientation of the side-by-side AP1000 turbines nor the separation distance is pertinent to meeting the turbine missile generation acceptance criterion. In addition, the shield building and auxiliary building walls, roofs, and floors, provide further conservative, inherent protection of the safety-related SSCs from a turbine missile.

PTN SUP 3.5-1 The five steam turbine generators associated with Units 1 through 5 are oriented along a N/S axis and are located far enough north of Units 6 & 7 that there is no turbine missile hazard from Units 1 through 5.

STD SUP 3.5-2 The turbine system maintenance and inspection program is discussed in Subsection 10.2.3.6.

3.5.1.5 Missiles Generated by Events Near the Site

Add the following text to the end of DCD Subsection 3.5.1.5.

PTN COL 3.5-1
PTN COL 3.3-1

The gatehouse, administrative building, security control building, warehouse and shops, structures related to water services, diesel-driven fire pump/enclosure, and miscellaneous structures are common structures at a nuclear power plant. They are of similar design and construction to those that are typical at nuclear power plants. Therefore, any missiles resulting from a tornado-initiated failure are not more energetic than the tornado missiles postulated for design of the AP1000.

The missiles generated by events near the site are described and evaluated in Subsection 2.2.3. With the exception of a potential barge explosion, the effects of external events on the safety-related components of the plant are insignificant. The probability of a missile generating barge explosion is determined to be less than 1E-07 events per year. Based on RG 1.91, this does not represent a design basis event. This also meets the criteria of 1E-06 occurrences per year in the DCD Section 2.2 for not requiring changes to the AP1000 design for an external accident leading to severe consequences.

3.5.1.6 Aircraft Hazards

Add the following text to the end of DCD Subsection 3.5.1.6.

PTN COL 3.5-1
PTN COL 3.3-1

RG 1.206 and NUREG-0800 state that the risks as a result of aircraft hazards should be sufficiently low. Further, aircraft accidents that could lead to radiological consequences in excess of the exposure guidelines of 10 CFR 50.34 (a)(1) with a probability of occurrence greater than an order of magnitude of 1E-07 per year should be considered in the design of the plant. In accordance with NUREG-0800, there are three acceptance criteria for the probability of aircraft accidents resulting in radiological consequences greater than the 10 CFR Part 100 exposure guidelines to be less than an order of magnitude of 1E-07 per year:

- Meeting plant-to-airport distance and projected annual operations criteria
- Plant is at least 5 statute miles from the nearest edge of military training routes

- Plant is at least 2 statute miles beyond the nearest edge of a federal airway, holding pattern, or approach pattern

The aircraft facilities and airways are described in Subsection 2.2.2.7. There exists one airport, Homestead Air Reserve Base, located approximately 4.76 miles from the Units 6 & 7 site with projected annual operations that do not meet the plant-to-airport acceptance criteria. RG 1.206 requires that the Homestead Air Reserve Base be considered regardless of the projected annual operations because the plant-to-airport distance is less than 5 miles. The Homestead Air Reserve Base has approximately 36,429 annual operations and this projection is not expected to change over the period of the license duration.

Additionally, the Units 6 & 7 site is located closer than 2 miles to the nearest edge of a federal airway, V3. The site is approximately 5.98 nautical miles from the centerline of airway V3. The width of a federal airway is typically 8 nautical miles, 4 nautical miles on each side of the centerline, placing the airway approximately 1.4 miles to the nearest edge.

Therefore, an analysis was performed in order to determine whether the accident probability rate is less than an order of magnitude of 1E-07. Details of the analysis are provided in Subsection 2.2.2.7.

The analysis results show that the rate of aircraft accidents that could lead to radiological consequences in excess of the exposure guidelines of 10 CFR 50.34(a)(1) is 4.86E-07 crashes per year. This includes the following inherent conservatisms:

- Shielding by adjacent structures, topographical features, and barriers were not credited. The skid distance would virtually be eliminated, reducing the effective area if this were credited, because the nuclear island is shielded on three sides and partially on the fourth side by other structures.

- A conservative value of the conditional core damage probability was used. General aviation aircraft were not screened out, that is, a core damage probability of zero was not applied to the general aviation class, even though studies have shown they are not considered a significant hazard to nuclear power stations because of their low weight and low penetration hazard.

- DOE methodology has conservatisms built in. One such example is in determining the effective area of the bounding building where the heading of the crashing aircraft with respect to the facility is assumed to be the worst-case perpendicular to the diagonal of the bounding rectangle regardless of direction of actual flights.

Therefore, a value of 4.86E-07 aircraft crashes per year that may lead to radiological consequences meets the guidance in NUREG-0800, Section 3.5.1.6, which states that 10 CFR 100.1, 10 CFR 100.20, 10 CFR 100.21, 10 CFR 52.17, and 10 CFR 52.79 requirements are met if the probability of aircraft accidents resulting in radiological consequences greater than the 10 CFR Part 100 exposure criteria is less than an order of magnitude of 1E-07 per year. The value of 4.86E-07 aircraft crashes per year also meets RG 1.206 guidance that states that design basis events internal and external to the nuclear plant are defined as those accidents that have a probability of occurrence on the order of magnitude of 1E-07 per year or greater, and potential consequences serious enough to affect the safety of the plant to the extent that the criteria in 10 CFR Part 100 are exceeded.

3.5.4 COMBINED LICENSE INFORMATION

Add the following text to the end of DCD Subsection 3.5.4.

PTN COL 3.5-1 The PTN site satisfies the site interface criteria for wind and tornado as discussed in Subsections 3.3.1.1, 3.3.2.1 and 3.3.2.3 and will not have a tornado-initiated failure of structures and components within the applicant's scope that compromises the safety of Units 6 & 7 safety-related structures and components (see also Subsection 3.3.3).

Subsection 1.2.2 discusses differences between the plant specific site plan (see Figure 1.1-201) and the AP1000 typical site plan shown in DCD Figure 1.2-2.

There are no other structures adjacent to the nuclear island other than as described and evaluated in the DCD.

Missiles caused by external events separate from the tornado are addressed in Subsections 2.2 through 2.2.3, 3.5.1.5, and 3.5.1.6.

3.6 PROTECTION AGAINST THE DYNAMIC EFFECTS ASSOCIATED WITH THE POSTULATED RUPTURE OF PIPING

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.6.4.1 Pipe Break Hazard Analysis

Replace the last paragraph in DCD Subsection 3.6.4.1 with the following text.

STD COL 3.6-1 The as-designed pipe rupture hazards evaluation is made available for NRC review. The completed as-designed pipe rupture hazards evaluation will be in accordance with the criteria outlined in DCD Subsections 3.6.1.3.2 and 3.6.2.5. Systems, structures, and components identified to be essential targets protected by associated mitigation features (Reference is DCD Table 3.6-3) will be confirmed as part of the evaluation, and updated information will be provided as appropriate.

A pipe rupture hazard analysis is part of the piping design. The evaluation will be performed for high and moderate energy piping to confirm the protection of systems, structures, and components which are required to be functional during and following a design basis event. The locations of the postulated ruptures and essential targets will be established and required pipe whip restraints and jet shield designs will be included. The report will address environmental and flooding effects of cracks in high and moderate energy piping. The as-designed pipe rupture hazards evaluation is prepared on a generic basis to address COL applications referencing the AP1000 design.

The pipe whip restraint and jet shield design includes the properties and characteristics of procured components connected to the piping, components, and walls at identified break and target locations. The design will be completed prior to installation of the piping and connected components.

The as-built reconciliation of the pipe rupture hazards evaluation whip restraint and jet shield design in accordance with the criteria outlined in DCD Subsections 3.6.1.3.2 and 3.6.2.5 will be completed prior to fuel load (in accordance with DCD Tier 1 Table 3.3-6, item 8).

This COL item is also addressed in Subsection 14.3.3.

3.6.4.4 Primary System Inspection Program for Leak-before-Break Piping

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Replace the first paragraph of DCD Subsection 3.6.4.4 with the following text.

STD COL 3.6-4

Alloy 690 is not used in leak-before-break piping. No additional or augmented inspections are required beyond the inservice inspection program for leak-before-break piping. An as-built verification of the leak-before-break piping is required to verify that no change was introduced that would invalidate the conclusion reached in this subsection.

3.7 SEISMIC DESIGN

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.7.1.1 Design Response Spectra

Add the following sections after DCD Subsection 3.7.1.1 as follows:

PTN SUP 3.7-1

3.7.1.1.1 Soil Profiles and Input Motions for Soil-Structure Interaction Analysis

The site-specific Ground Motion Response Spectra (GMRS) are described in Section 2.5.2. The development of the Foundation Input Response Spectra (FIRS) is described in Subsection 3.7.1.1.1.1. Strain-compatible soil properties are presented in Subsection 3.7.1.1.1.2. The development of acceleration time histories for soil-structure interaction (SSI) analysis is summarized in Subsection 3.7.1.1.1.3. A detailed discussion of each of these steps is provided in Appendix 3JJ.

The developed input is used for SSI analysis, which is provided in Appendix 3KK.

3.7.1.1.1.1 Development of FIRS

The Uniform Hazard Response Spectra (UHRS), described in Section 2.5.2.4, are defined for hard rock characterized with a shear wave velocity of Vs = 9200 feet/second (2.8 kilometers/second), which is located at about 10,000 feet (3000 meters) below the ground surface. Section 2.5.2.5 describes the development of the site amplification factors at the GMRS horizon. Section 2.5.2.6 discusses the development of the horizontal and vertical GMRS. The same procedures are followed in this section to develop FIRS at the bottom of the nuclear island foundation horizon.

The full soil columns used for computation of soil amplification factors represent the two soil conditions found at the location of Units 6 & 7. The soil column far from the nuclear island consists of in situ soil layers except for the upper 30.5 feet (9.3 meters) of structural fill. This is the fill required for the general plant area to raise the site grade elevation from the existing grade to the finished grade, and is designated as "FAR" in this Section. A second soil column, representing the site conditions near the nuclear island, where, in addition to the general fill, lean concrete, and structural fill replace the in situ soils down to a depth of 60.5 feet (18.4 meters) below finished grade. This is designated "NI" in the following discussion.

The site response analysis is conducted on a set of 60 randomized profiles, for each of the two soil profiles, to account for the variability in the dynamic soil properties. The randomization procedure is described in detail in Section 2.5.2.5.2. Using the randomized soil profiles, the soil column analyses are performed with the de-aggregated low frequency (LF) and high frequency (HF) spectra of the hard rock motion at 10^{-4} and 10^{-5} annual-frequency-of-exceedance, presented in Section 2.5.2.4, following the same methodology described in Section 2.5.2.5. Log-mean amplification functions and soil response spectra are developed for "outcrop" motions for both FAR and NI soil conditions at the FIRS horizon, located at the bottom of the nuclear island foundation at elevation –16 feet (–4.9 meters) corresponding to a depth of 41.5 feet (12.7 meters) below finished ground surface.

FIRS are computed at the elevation of –16 feet from the envelope of NI and FAR soil columns representing near and far field soil columns. The input for SSI analysis in terms of acceleration time histories were computed as in-column motion as described in Section 3JJ.5 in Appendix 3JJ. In application of the SSI input acceleration time histories, the control point was defined at elevation of –14 feet at the bottom of the NI basemat.

The change of 2 feet accounts for the thickness of the mud mat(s) and the water proofing membrane. This is considered acceptable since, in computation of the FIRS for NI soil column, 19 feet of lean concrete is already included in the soil column analysis and an additional 2 feet of concrete has negligible effects on the FIRS and associated SSI input motion.

Following the same procedure as used in Section 2.5.2.6 to obtain the GMRS, the procedure presented in RG 1.208 is implemented to develop the horizontal design response spectrum (DRS) for each of the FAR and NI soil columns. The horizontal FIRS is defined as the envelope of the FAR and NI DRS. The vertical FIRS is obtained by scaling the horizontal FIRS by the same V/H as presented in Section 2.5.2.6. The details of the site response analysis and development of FIRS are documented in Appendix 3JJ.

In addition to the FIRS, from the same set of soil amplification analyses, design spectra at the ground surface for both NI and FAR soil profiles are developed and enveloped. The surface DRS are used to check the adequacy of the SSI input motion as described in Subsection 3.7.1.1.1.3 and Appendix 3JJ.

The resulting horizontal and vertical FIRS are plotted in Figure 3.7-201 and reported in Table 3.7-201. As developed and described in Appendix 3KK, comparisons of the FIRS developed indicate they are enveloped completely by the AP1000 Certified Seismic Design Response Spectra (CSDRS) for all frequencies, as shown in Figure 3.7-202. The analysis results show that the Nuclear Island Floor Response Spectra (FRS) of AP1000 at the Turkey Point site at six key locations are enveloped by the AP1000 Certified Design Response Spectra (CSDRS).

3.7.1.1.1.2 Strain-Compatible Soil Property Profiles

From the results of soil amplification analysis of FAR and NI soil profiles, two sets of strain-compatible soil profiles are developed. Each set consists of the best estimate (BE), the lower bound (LB) and the upper bound (UB) strain-compatible shear-wave velocity, P-wave velocity and damping profiles. The development of strain-compatible soil profiles, consistent with the developed FIRS, is discussed in detail in Appendix 3JJ.

3.7.1.1.1.3 Acceleration Time Histories for SSI Input

Acceleration time histories for use in SSI analysis of the nuclear island (which includes modeling of the embedment of the nuclear island) are presented in this section. The seed acceleration time histories were selected from the database of candidate time histories given in NUREG/CR-6728 based on the low frequency de-aggregation results (i.e., magnitudes > 7 and distances > 500 km). For the analysis, the three component (i.e., two horizontal and one vertical component) strong ground motion recordings from the 1999 Chi-Chi earthquake (magnitude=7.6) recorded at the TAP024 station (closest distance=100.2 km) were selected and matched to the 5 percent damping FIRS developed earlier (see Subsection 3.7.1.1.1.1 for FIRS). These time histories were modified to be spectrum-compatible to the FIRS target spectra following the spectral matching criteria given in NUREG/CR-6728. The acceleration response spectra of the generated time histories matching FIRS are shown in Appendix 3JJ.

For SSI input motion of nuclear island with embedment, these acceleration time histories are propagated through the strain-compatible soil profiles, presented in Subsection 3.7.1.1.1.2, where they are used as input “outcrop” motions in the soil column at the FIRS horizon and the “within” acceleration time histories at the same horizon are computed. No further iterations on soil properties are performed. This analysis results in a set of 3 “within” motions for each soil profile in the two horizontal directions (H1 and H2) and vertical direction (UP), respectively. Six (6) sets are developed corresponding to the LB, BE and UB profiles for NI and FAR soil conditions. The analysis also incorporates the requirement for checking the adequacy of the SSI input motion (References 201 and 202). Checks are made with respect to the corresponding surface design response spectra (DRS) and modifications are made where necessary. The analysis steps are discussed in detail in Appendix 3JJ.

The “within” acceleration time histories are recommended for use in the SSI analysis of the nuclear island SSI model that includes embedment. The time histories are to be applied at the FIRS horizon as “within” motion and shall be used in combination with the respective SSI soil profiles discussed in Subsection 3.7.1.1.1.2.

3.7.2.12 Methods for Seismic Analysis of Dams

Add the following text to the end of DCD Subsection 3.7.2.12.

PTN COL 3.7-1

There are no existing or new dams whose failure could affect the site interface flood level specified in DCD Section 2.4.1.2, as discussed in Subsection 2.4.4.

3.7.4.1 Comparison with Regulatory Guide 1.12

STD SUP 3.7-1

Add the following text to the end of DCD Subsection 3.7.4.1.

Administrative procedures define the maintenance and repair of the seismic instrumentation to keep the maximum number of instruments in-service during plant operation and shutdown in accordance with Regulatory Guide 1.12.

3.7.4.2.1 Triaxial Acceleration Sensors

Add the following text to the end of DCD Subsection 3.7.4.2.1.

STD COL 3.7-5

A free-field sensor will be located and installed to record the ground surface motion representative of the site. It will be located such that the effects associated with surface features, buildings, and components on the recorded ground motion will be insignificant. The trigger value is initially set at 0.01 g.

3.7.4.4 Comparison of Measured and Predicted Responses

Add the following text to the end of DCD Subsection 3.7.4.4.

PTN COL 3.7-2

Post-earthquake operating procedures utilize the guidance of EPRI Reports NP-5930, TR-100082, and NP-6695, as modified and endorsed by the NRC in Regulatory Guides 1.166 and 1.167. A response spectrum check up to 10 Hz will be based on the foundation instrument. The cumulative absolute velocity will be calculated based on the recorded motions at the free field instrument. If the operating basis earthquake ground motion is exceeded or significant plant damage occurs, the plant must be shutdown in an orderly manner.

STD COL 3.7-2

In addition, the procedures address measurement of the post-seismic event gaps between the new fuel rack and walls of the new fuel storage pit, between the individual spent fuel racks, and from the spent fuel racks to the spent fuel pool walls, and provide for appropriate corrective actions to be taken if needed (such as repositioning the racks or analysis of the as-found condition).

3.7.4.5 Tests and Inspections

Add the following text to the end of DCD Subsection 3.7.4.5.

STD SUP 3.7-2

Installation and acceptance testing of the triaxial acceleration sensors described in DCD Subsection 3.7.4.2.1 is completed prior to initial startup. Installation and acceptance testing of the time-history analyzer described in DCD Subsection 3.7.4.2.2 is completed prior to initial startup

3.7.5 COMBINED LICENSE INFORMATION

3.7.5.1 Seismic Analysis of Dams

PTN COL 3.7-1

This COL Item is addressed in Subsection 3.7.2.12.

3.7.5.2 Post-Earthquake Procedures

PTN COL 3.7-2
STD COL 3.7-2

This COL Item is addressed in Subsection 3.7.4.4.

3.7.5.3 Seismic Interaction Review

Replace DCD Subsection 3.7.5.3 with the following text.

STD COL 3.7-3

The seismic interaction review will be updated for as-built information. This review is performed in parallel with the seismic margin evaluation. The review is based on as-procured data, as well as the as-constructed condition. The as-built seismic interaction review is completed prior to fuel load.

3.7.5.4 Reconciliation of Seismic Analyses of Nuclear Island Structures

Replace DCD Subsection 3.7.5.4 with the following text.

STD COL 3.7-4

The seismic analyses described in DCD Subsection 3.7.2 will be reconciled for detailed design changes, such as those due to as-procured or as-built changes in component mass, center of gravity, and support configuration based on as-procured equipment information. Deviations are acceptable based on an evaluation consistent with the methods and procedure of DCD Section 3.7

provided the amplitude of the seismic floor response spectra, including the effect due to these deviations, does not exceed the design basis floor response spectra by more than 10 percent. This reconciliation will be completed prior to fuel load.

3.7.5.5 Free Field Acceleration Sensor

STD COL 3.7-5 This COL Item is addressed in Subsection 3.7.4.2.1.

3.7.6 REFERENCES

Add the following text to the end of DCD Subsection 3.7.6:

201. NRC Letter, Nilesh C Chokshi, deputy division director, office of new reactors, NRC to Adrian P Hymer, senior director, NEI, dated January 9, 2009, Subject NEI Draft White Paper *Consistent Site-Response/Soil-Structure Interaction Analysis and Evaluation* (USNRC ADAMS Accession Number ML083580072).

202. NEI letter, Adrian P Hymer, senior director of NEI to Nilesh C Chokshi, deputy division director, office of new reactors, NRC, dated October 10, 2008, Subject *White paper in support of New Plant Applications*, (USNRC ADAMS Accession Number ML083020171).

PTN SUP 3.7-1

Table 3.7-201 (Sheet 1 of 2)
Recommended Horizontal and Vertical FIRS
(Elevation –16 foot Horizon at Bottom of Nuclear Island Foundation)

FIRS Frequency (Hz)	Horizontal Sa(g)	Vertical Sa(g)
100	5.38E-02	5.38E-02
90	5.39E-02	5.39E-02
80	5.42E-02	5.42E-02
70	5.47E-02	5.47E-02
60	5.59E-02	5.59E-02
50	5.82E-02	5.82E-02
45	6.01E-02	6.01E-02
40	6.25E-02	6.25E-02
35	6.76E-02	6.76E-02
30	7.78E-02	7.78E-02
25	9.41E-02	9.41E-02
20	9.83E-02	9.83E-02
15	8.59E-02	8.59E-02
12.5	8.07E-02	8.07E-02
10	8.17E-02	8.17E-02
9	8.34E-02	8.34E-02
8	8.47E-02	8.47E-02
7	8.34E-02	8.34E-02
6	8.04E-02	8.04E-02
5	8.71E-02	8.70E-02
4	7.97E-02	7.96E-02
3	8.77E-02	7.51E-02
2.5	9.45E-02	6.76E-02
2	7.94E-02	5.64E-02
1.5	6.92E-02	4.87E-02
1.25	7.43E-02	5.20E-02
1	8.59E-02	5.98E-02
0.9	9.94E-02	6.89E-02
0.8	1.07E-01	7.42E-02
0.7	1.01E-01	6.97E-02
0.6	9.46E-02	6.49E-02
0.5	8.04E-02	5.48E-02
0.4	5.02E-02	3.40E-02
0.3	3.21E-02	2.16E-02

PTN SUP 3.7-1

Table 3.7-201 (Sheet 2 of 2) Recommended Horizontal and Vertical FIRS (Elevation –16 foot Horizon at Bottom of Nuclear Island Foundation)

FIRS Frequency (Hz)	Horizontal Sa(g)	Vertical Sa(g)
0.2	2.09E-02	1.40E-02
0.15	1.34E-02	8.93E-03
0.125	9.69E-03	6.48E-03
0.1	5.83E-03	3.90E-03

PTN SUP 3.7-1

Figure 3.7-201 Recommended Horizontal and Vertical FIRS (Elevation –16 foot Horizon at Bottom of Nuclear Island Foundation)

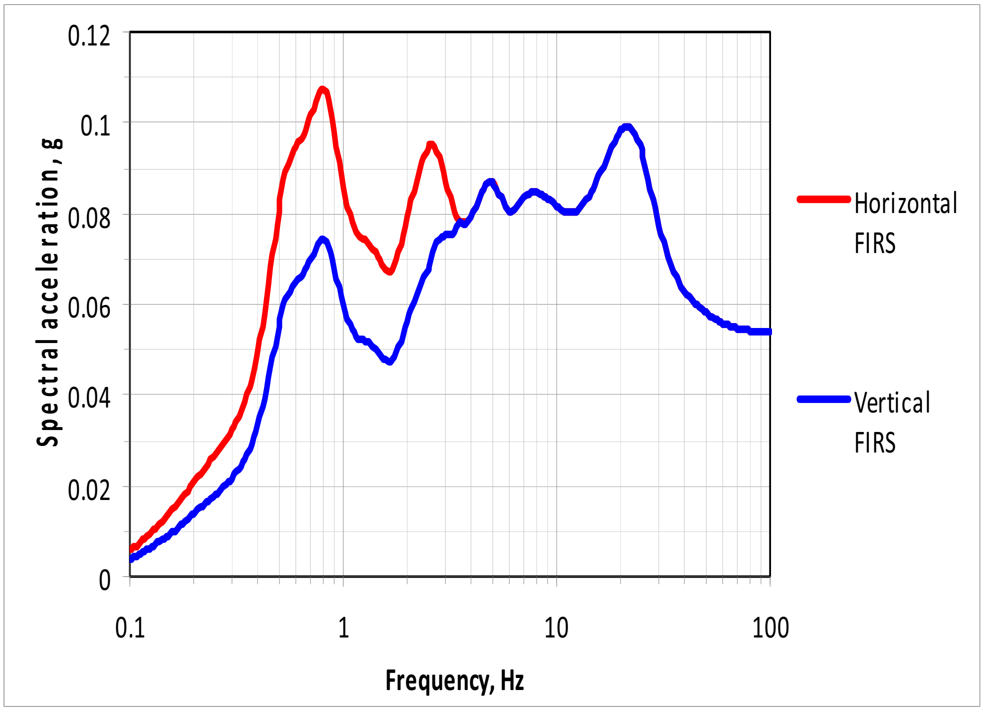
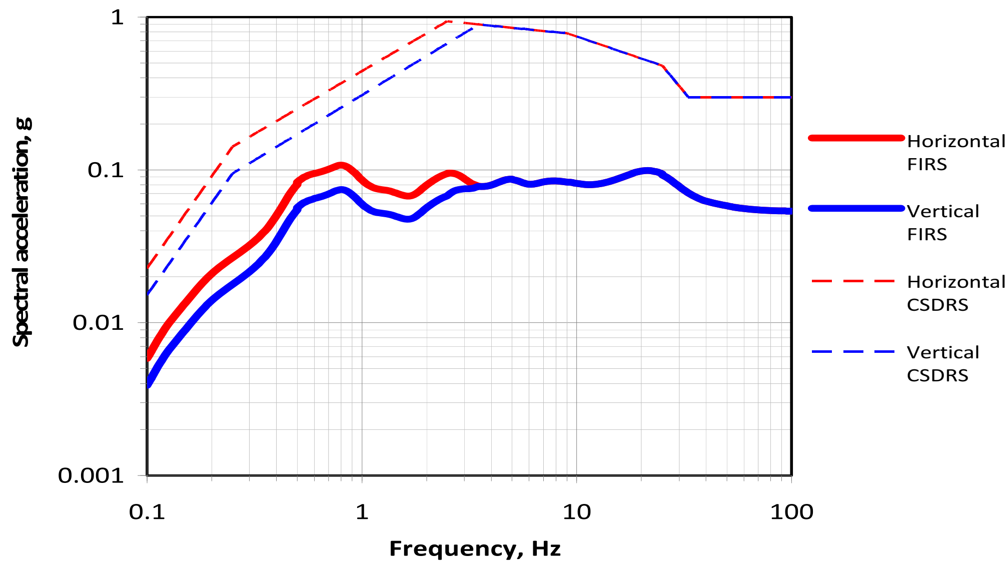
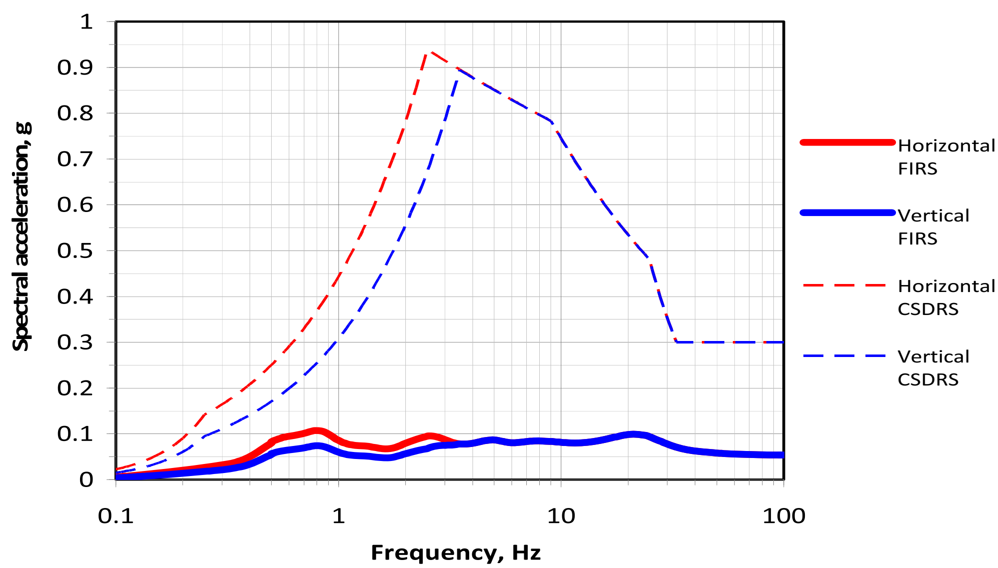


Figure 3.7-202 Comparison of Turkey Point Horizontal and Vertical FIRS with AP1000 Horizontal and Vertical CSDRS

PTN SUP 3.7-1



(Log-Log Format)



(Log-Linear Format)

3.8 DESIGN OF CATEGORY I STRUCTURES

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.8.3.7 In-Service Testing and Inspection Requirements

Replace the existing DCD statement with the following:

STD COL 3.8-5 The inspection program for structures is identified in Section 17.6. This inspection program is consistent with the requirements of 10 CFR 50.65 and the guidance in Regulatory Guide 1.160.

3.8.4.7 Testing and In-Service Inspection Requirements

Replace the existing DCD final statement of the subsection with the following:

STD COL 3.8-5 The inspection program for structures is identified in Section 17.6. This inspection program is consistent with the requirements of 10 CFR 50.65 and the guidance in Regulatory Guide 1.160.

3.8.5.1 Description of the Foundations

Add the following text after paragraph one of DCD Subsection 3.8.5.1.

PTN SUP 3.8-1 The depth of overburden and depth of embedment are given in Subsection 2.5.4.

PTN COL 2.5-17 A sheet-type high-density polyethylene (HDPE) waterproofing material will be used for both the horizontal and vertical surfaces under Seismic Category I structures. The material will be qualified by test, with commercial grade dedication and lab testing to achieve a minimum coefficient of friction (COF) of 0.55.

3.8.5.7 In-Service Testing and Inspection Requirements

Replace the existing DCD first statement with the following:

STD COL 3.8-5 The inspection program for structures is identified in Section 17.6. This inspection program is consistent with the requirements of 10 CFR 50.65 and the guidance in Regulatory Guide 1.160.

3.8.6.5 Structures Inspection Program

STD COL 3.8-5 This item is addressed in Subsections 3.8.3.7, 3.8.4.7, 3.8.5.7, and 17.6.

3.8.6.6 Construction Procedures Program

Add the following to the end of Subsection 3.8.6.6:

STD COL 3.8-6 Construction and inspection procedures for concrete filled steel plate modules address activities before and after concrete placement, use of construction mock-ups, and inspection of modules before and after concrete placement as discussed in DCD Subsection 3.8.4.8. The procedures will be made available to NRC inspectors prior to use.

3.9 MECHANICAL SYSTEMS AND COMPONENTS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.9.3.1.2 Loads for Class 1 Components, Core Support, and Component Supports

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STD COL 3.9-5 Add the following after the last paragraph under DCD subheading Request 3) and prior to DCD subheading Other Applications:

PRESSURIZER SURGE LINE MONITORING

General

The pressurizer surge line is monitored at the first AP1000 plant to record temperature distributions and thermal displacements of the surge line piping, as well as pertinent plant parameters. This monitoring occurs during the hot functional testing and first fuel cycle. The resulting monitoring data is evaluated to verify that the pressurizer surge line is within the bounds of the analytical temperature distributions and displacements.

Subsequent AP1000 plants (after the first AP1000 plant) confirm that the heatup and cooldown procedures are consistent with the pertinent attributes of the first AP1000 plant surge line monitoring. In addition, changes to the heatup and cooldown procedures consider the potential impact on stress and fatigue analyses consistent with the concerns of NRC Bulletin 88-11.

The pressurizer surge line monitoring activities include the following methodology and requirements:

Monitoring Method

The pressurizer surge line pipe wall is instrumented with outside mounted temperature and displacement sensors. The data from this instrumentation is supplemented by plant computer data from related process and control parameters.

Locations to be Monitored

In addition to the existing permanent plant temperature instrumentation, temperature and displacement monitoring will be included at critical locations on the surge line. The additional locations utilized for monitoring during the hot functional testing and the first fuel cycle (see Subsection 14.2.9.2.22) are selected based on the capability to provide effective monitoring.

Data Evaluation

Data evaluation is performed at the completion of the monitoring period (one fuel cycle). The evaluation includes a comparison of the data evaluation results with the thermal profiles and transient loadings defined for the pressurizer surge line, accounting for expected pipe outside wall temperatures. Interim evaluations of the data are performed during the hot functional testing period, up to the start of normal power operation, and again once three months worth of normal operating data has been collected, to identify any unexpected conditions in the pressurizer surge line.

3.9.3.4.4 Inspection, Testing, Repair, and/or Replacement of Snubbers

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Add the following text after the last paragraph of DCD Subsection 3.9.3.4.4:

STD SUP 3.9-3

a. Snubber Design and Testing

   1. A list of snubbers on systems which experience sufficient thermal movement to measure cold to hot position is included in Table 3.9-201.

   2. The snubbers are tested to verify they can perform as required during the seismic events, and under anticipated operational transient loads or other mechanical loads associated with the design requirements for the plant. Production and qualification test programs for both hydraulic and mechanical snubbers are carried out by the snubber vendors in accordance with the snubber installation instruction manual required to be furnished by the snubber supplier. Acceptance criteria for compliance with ASME

Section III Subsection NF, and other applicable codes, standards, and requirements, are as follows:

- Snubber production and qualification test programs are carried out by strict adherence to the manufacturer's snubber installation and instruction manual. This manual is prepared by the snubber manufacturer and subjected to review for compliance with the applicable provisions of the ASME Pressure Vessel and Piping Code of record. The test program is periodically audited during implementation for compliance.

- Snubbers are inspected and tested for compliance with the design drawings and functional requirements of the procurement specifications.

- Snubbers are inspected and qualification tested. No sampling methods are used in the qualification tests.

- Snubbers are load rated by testing in accordance with the snubber manufacturer's testing program and in compliance with the applicable sections of ASME QME-1-2007, Subsection QDR and the ASME Code for Operation and Maintenance of Nuclear Power Plants (OM Code), Subsection ISTD.

- Design compliance of the snubbers per ASME Section III Paragraph NF-3128, and Subparagraphs NF-3411.3 and NF-3412.4.

- The snubbers are tested for various abnormal environmental conditions. Upon completion of the abnormal environmental transient test, the snubber is tested dynamically at a frequency within a specified frequency range. The snubber must operate normally during the dynamic test. The functional parameters cited in Subparagraph NF-3412.4 are included in the snubber qualification and testing program. Other parameters in accordance with applicable ASME QME-1-2007 and the ASME OM Code will be incorporated.

- The codes and standards used for snubber qualification and production testing are as follows:

— ASME B&PV Code Section III (Code of Record date) and Subsection NF.

— ASME QME-1-2007, Subsection QDR and ASME OM Code, Subsection ISTD.

- Large bore hydraulic snubbers are full Service Level D load tested, including verifying bleed rates, control valve closure within the specified velocity ranges and drag forces/ breakaway forces are acceptable in accordance with ASME, QME-1-2007 and ASME OM Codes.

3. Safety-related snubbers are identified in Table 3.9-201, including the snubber identification and the associated system or component, e.g., line number. The snubbers on the list are hydraulic and constructed to ASME Section III, Subsection NF. The snubbers are used for shock loading only. None of the snubbers are dual purpose or vibration arrestor type snubbers.

b. Snubber Installation Requirements

Installation instructions contain instructions for storage, handling, erection, and adjustments (if necessary) of snubbers. Each snubber has an installation location drawing that contains the installation location of the snubber on the pipe and structure, the hot and cold settings, and additional information needed to install the particular snubber.

STD COL 3.9-3

The description of the snubber preservice and inservice testing programs in this section is based on the ASME OM Code 2001 Edition through 2003 Addenda. The initial inservice testing program incorporates the latest edition and addenda of the ASME OM Code approved in 10 CFR 50.55a(f) on the date 12 months before initial fuel load. Limitations and modifications set forth in 10 CFR 50.55a are incorporated.

c. Snubber Preservice and Inservice Examination and Testing

The preservice examination plan for applicable snubbers is prepared in accordance with the requirements of the ASME Code for Operation and Maintenance of Nuclear Power Plants (OM Code), Subsection ISTD, and the additional requirements of this Section. This examination is made after snubber installation but not more than 6 months prior to initial system preoperational testing. The preservice examination verifies the following:

1. There are no visible signs of damage or impaired operational readiness as a result of storage, handling, or installation.

2. The snubber load rating, location, orientation, position setting, and configuration (attachments, extensions, etc.) are according to design drawings and specifications.

3. Snubbers are not seized, frozen, or jammed.

4. Adequate swing clearance is provided to allow snubber movements.

5. If applicable, fluid is to the recommended level and is not to be leaking from the snubber system.

6. Structural connections such as pins, fasteners, and other connecting hardware such as lock nuts, tabs, wire, cotter pins are installed correctly.

If the period between the initial preservice examination and initial system preoperational tests exceeds 6 months, reexamination of Items 1, 4, and 5 is performed. Snubbers, which are installed incorrectly or otherwise fail to meet the above requirements, are repaired or replaced and re-examined in accordance with the above criteria.

A preservice thermal movement examination is also performed, during initial system heatup and cooldown. For systems whose design operating temperature exceeds 250°F (121°C), snubber thermal movement is verified.

Additionally, preservice operational readiness testing is performed on snubbers. The operational readiness test is performed to verify the parameters of ISTD 5120. Snubbers that fail the preservice operational readiness test are evaluated to determine the cause of failure, and are retested following completion of corrective action(s).

Snubbers that are installed incorrectly or otherwise fail preservice testing requirements are re-installed correctly, adjusted, modified, repaired or replaced, as required. Preservice examination and testing is re-performed on installation-corrected, adjusted, modified, repaired or replaced snubbers as required.

d. Snubber Inservice Examination and Testing

Inservice examination and testing of safety-related snubbers is conducted in accordance with the requirements of the ASME OM Code, Subsection ISTD. Inservice examination is initially performed not less than two months after attaining 5 percent reactor power operation and is completed within 12 calendar months after attaining 5 percent reactor power. Subsequent examinations are performed at intervals defined by ISTD-4252 and Table ISTD-4252-1. Examination intervals, subsequent to the third interval, are adjusted based on the number of unacceptable snubbers identified in the current interval.

An inservice visual examination is performed on the snubbers to identify physical damage, leakage, corrosion, degradation, indication of binding, misalignment or deformation and potential defects generic to a particular design. Snubbers that do not meet visual examination requirements are evaluated to determine the root cause of the unacceptability, and appropriate corrective actions (e.g., snubber is adjusted, repaired, modified, or replaced) are taken. Snubbers evaluated as unacceptable during visual examination may be accepted for continued service by successful completion of an operational readiness test.

Snubbers are tested inservice to determine operational readiness during each fuel cycle, beginning no sooner than 60 days before the start of the refueling outage. Snubber operational readiness tests are conducted with the snubber in the as-found condition, to the extent practical, either in-place or on a test bench, to verify the test parameters of ISTD-5210. When an in-place test or bench test cannot be performed, snubber subcomponents that control the parameters to be verified are examined and tested. Preservice examinations are performed on snubbers after reinstallation when bench testing is used (ISTD-5224), or on snubbers where individual subcomponents are reinstalled after examination (ISTD-5225).

Defined test plan groups (DTPG) are established and the snubbers of each DTPG are tested according to an established sampling plan each fuel cycle. Sample plan size and composition is determined as required for the selected sample plan, with additional sampling as may be required for that sample plan based on test failures and failure modes identified. Snubbers that do not meet test requirements are evaluated to determine root cause of the failure, and are assigned to failure mode groups (FMG) based on the evaluation, unless the failure is considered unexplained or isolated. The number of unexplained snubber failures, not assigned to a FMG, determines the additional testing sample. Isolated failures do not require additional testing. For unacceptable snubbers, additional testing is conducted for the DTPG or FMG until the appropriate sample plan completion criteria are satisfied.

Unacceptable snubbers are adjusted, repaired, modified, or replaced. Replacement snubbers meet the requirements of ISTD-1600. Post-maintenance examination and testing, and examination and testing of repaired snubbers, is done to verify as acceptable the test parameters that may have been affected by the repair or maintenance activity.

Service life for snubbers is established, monitored and adjusted as required by ISTD-6000 and the guidance of ASME OM Code Nonmandatory Appendix F.

3.9.6 INSERVICE TESTING OF PUMPS AND VALVES

Revise the third sentence of the third paragraph of DCD Subsection 3.9.6, and add information between the third and fourth sentences as follows:

STD COL 3.9-4 The edition and addenda to be used for the inservice testing program are administratively controlled; the description of the inservice testing program in this section is based on the ASME OM Code 2001 Edition through 2003 Addenda. The initial inservice testing program incorporates the latest edition and addenda of the ASME OM Code approved in 10 CFR 50.55a(f) on the date 12 months before initial fuel load. Limitations and modifications set forth in 10 CFR 50.55a are incorporated.

Revise the fifth sentence of the sixth paragraph of DCD Subsection 3.9.6 as follows:

STD COL 3.9-4 Alternate means of performing these tests and inspections that provide equivalent demonstration may be developed in the inservice test program ~~as described in subsection 3.9.8~~.

Revise the first two sentences of the final paragraph of DCD Subsection 3.9.6 to read as follows:

STD COL 3.9-4 A preservice test program, which identifies the required functional testing, is to be submitted to the NRC prior to performing the tests and following the start of construction. The inservice test program, which identifies requirements for functional testing, is to be submitted to the NRC prior to the anticipated date of commercial operation as described above.

Add the following text after the last paragraph of DCD Subsection 3.9.6:

Table 13.4-201 provides milestones for preservice and inservice test program implementation.

3.9.6.2.2 Valve Testing

Add the following prior the initial paragraph of DCD Subsection 3.9.6.2.2:

STD COL 3.9-4 Valve testing uses reference values determined from the results of preservice testing or inservice testing. These tests that establish reference and IST values are performed under conditions as near as practicable to those expected during the IST. Reference values are established only when a valve is known to be operating acceptably.

Pre-conditioning of valves or their associated actuators or controls prior to IST testing undermines the purpose of IST testing and is not allowed. Pre-conditioning includes manipulation, pre-testing, maintenance, lubrication, cleaning, exercising, stroking, operating, or disturbing the valve to be tested in any way, except as may occur in an unscheduled, unplanned, and unanticipated manner during normal operation.

Add the following sentence to the end of the fourth paragraph under the heading “Manual/Power-Operated Valve Tests”:

STD COL 3.9-4 Stroke time is measured and compared to the reference value, except for valves classified as fast-acting (e.g., solenoid-operated valves with stroke time less than 2 seconds), for which a stroke time limit of 2 seconds is assigned.

Add the following paragraph after the fifth paragraph under the heading “Manual/Power-Operated Valve Tests”:

STD COL 3.9-4 During valve exercise tests, the necessary valve obturator movement is verified while observing an appropriate direct indicator, such as indicating lights that signal the required changes of obturator position, or by observing other evidence or positive means, such as changes in system pressure, flow, level, or temperature that reflects change of obturator position.

Insert new second sentence of the paragraph containing the subheading “Power-Operated Valve Operability Tests” in DCD Subsection 3.9.6.2.2 (immediately following the first sentence of the DCD paragraph) to read:

STD COL 3.9-4 The POVs include the motor-operated valves.

Add the following sentence as the last sentence of the paragraph containing the subheading “Power-Operated Valve Operability Tests” in DCD Subsection 3.9.6.2.2:

STD COL 3.9-4 Table 13.4-201 provides milestones for the MOV program implementation.

Insert the following as the last sentence in the paragraph under the bulleted item titled "Risk Ranking" in DCD Subsection 3.9.6.2.2:

STD COL 3.9-4 Guidance for this process is outlined in the JOG MOV PV Study, MPR-2524-A.

Insert the following text after the last paragraph under the sub-heading of "Power-Operated Valve Operability Tests" and before the sub-heading "Check Valve Tests" in DCD Subsection 3.9.6.2.2:

STD COL 3.9-4 **Active MOV Test Frequency Determination** — The ability of a valve to meet its design basis functional requirements (i.e. required capability) is verified during valve qualification testing as required by procurement specifications. Valve qualification testing measures valve actuator actual output capability. The actuator output capability is compared to the valve's required capability defined in procurement specifications, establishing functional margin; that is, that increment by which the MOV's actual output capability exceeds the capability required to operate the MOV under design basis conditions. DCD Subsection 5.4.8 discusses valve functional design and qualification requirements. The initial inservice test frequency is determined as required by ASME OM Code Code Case OMN-1, Revision 1 (Reference 202). The design basis capability testing of MOVs utilizes guidance from Generic Letter 96-05 and the JOG MOV Periodic Verification PV Program. Valve functional margin is evaluated following subsequent periodic testing to address potential time-related performance degradation, accounting for applicable uncertainties in the analysis. If the evaluation shows that the functional margin will be reduced to less than established acceptance criteria within the established test interval, the test interval is decreased to less than the time for the functional margin to decrease below acceptance criteria. If there is not sufficient data to determine test frequency as described above, the test frequency is limited to not exceed two (2) refueling cycles or three (3) years, whichever is longer, until sufficient data exist to extend the test frequency. Appropriate justification is provided for any increased test interval, and the maximum test interval shall not exceed 10 years. This is to ensure that each MOV in the IST program will have adequate margin (including consideration for aging-related degradation, degraded voltage, control switch repeatability, and load-sensitive MOV behavior) to remain operable until the next scheduled test, regardless of its risk categorization or safety significance. Uncertainties associated with performance of these periodic verification tests and use of the test results (including those associated with measurement equipment and potential degradation mechanisms) are addressed appropriately. Uncertainties may be considered in the specification of acceptable valve setup parameters or in the interpretation of the test results (or a combination of both). Uncertainties affecting both valve function and structural limits are addressed.

Maximum torque and/or thrust (as applicable) achieved by the MOV (allowing sufficient margin for diagnostic equipment inaccuracies and control switch repeatability) are established so as not to exceed the allowable structural and undervoltage motor capability limits for the individual parts of the MOV.

Solenoid-operated valves (SOVs) are tested to confirm the valve moves to its energized position and is maintained in that position, and to confirm that the valve moves to the appropriate failure mode position when de-energized.

Other Power-Operated Valve Operability Tests — Power-Operated valves other than active MOVs are exercised quarterly in accordance with ASME OM ISTC, unless justification is provided in the inservice testing program for testing these valves at other than Code mandated frequencies.

Although the design basis capability of power-operated valves is verified as part of the design and qualification process, power-operated valves that perform an active safety function are tested again after installation in the plant, as required, to ensure valve setup is acceptable to perform their required functions, consistent with valve qualification. These tests, which are typically performed under static (no flow or pressure) conditions, also document the "baseline" performance of the valves to support maintenance and trending programs. During the testing, critical parameters needed to ensure proper valve setup are measured. Depending on the valve and actuator type, these parameters may include seat load, running torque or thrust, valve travel, actuator spring rate, bench set and regulator supply pressure. Uncertainties associated with performance of these tests and use of the test results (including those associated with measurement equipment and potential degradation mechanisms) are addressed appropriately. Uncertainties may be considered in the specification of acceptable valve setup parameters or in the interpretation of the test results (or a combination of both). Uncertainties affecting both valve function and structural limits are addressed.

Additional testing is performed as part of the air-operated valve (AOV) program, which includes the key elements for an AOV Program as identified in the JOG AOV program document, Joint Owners Group Air Operated Valve Program Document, Revision 1, December 13, 2000 (Reference 203 and Reference 204). The AOV program incorporates the attributes for a successful power-operated valve long-term periodic verification program, as discussed in Regulatory Issue Summary 2000-03, Resolution of Generic Safety Issue 158: Performance of Safety-Related Power-Operated Valves Under Design Basis Conditions, by incorporating lessons learned from previous nuclear power plant operations and research programs as they apply to the periodic testing of air- and other power-operated valves included in the IST program. For example, key lessons learned addressed in the AOV program include:

- Valves are categorized according to their safety significance and risk ranking.
- Setpoints for AOVs are defined based on current vendor information or valve qualification diagnostic testing, such that the valve is capable of performing its design-basis function(s).
- Periodic static testing is performed, at a minimum on high risk (high safety significance) valves, to identify potential degradation, unless those valves are periodically cycled during normal plant operation, under conditions that meet or exceed the worst case operating conditions within the licensing basis of the plant for the valve, which would provide adequate periodic demonstration of AOV capability. If required based on valve qualification or operating experience, periodic dynamic testing is performed to re-verify the capability of the valve to perform its required functions.
- Sufficient diagnostics are used to collect relevant data (e.g., valve stem thrust and torque, fluid pressure and temperature, stroke time, operating and/or control air pressure, etc.) to verify the valve meets the functional requirements of the qualification specification.
- Test frequency is specified, and is evaluated each refueling outage based on data trends as a result of testing. Frequency for periodic testing is in accordance with Reference 203 and Reference 204, with a minimum of 5 years (or 3 refueling cycles) of data collected and evaluated before extending test intervals.
- Post-maintenance procedures include appropriate instructions and criteria to ensure baseline testing is re-performed as necessary when maintenance on the valve, repair or replacement, have the potential to affect valve functional performance.
- Guidance is included to address lessons learned from other valve programs specific to the AOV program.
- Documentation from AOV testing, including maintenance records and records from the corrective action program are retained and periodically evaluated as a part of the AOV program.

Insert the following paragraph as the last paragraph under the sub-heading of “Power-Operated Valve Operability Tests” (following the previously added paragraph) and just before the sub-heading “Check Valve Tests” in DCD Subsection 3.9.6.2.2:

STD COL 3.9-4

Successful completion of the preservice and IST of MOVs, in addition to MOV testing as required by 10 CFR 50.55a, demonstrates that the following criteria are met for each valve tested: (i) valve fully opens and/or closes as required by its safety function; (ii) adequate margin exists and includes consideration of diagnostic equipment inaccuracies, degraded voltage, control switch repeatability, load-sensitive MOV behavior, and a margin for degradation; and (iii) maximum torque and/or thrust (as applicable) achieved by the MOV (allowing sufficient margin for diagnostic equipment inaccuracies and control switch repeatability) does not exceed the allowable structural and undervoltage motor capability limits for the individual parts of the MOV.

Add the paragraph below as the last paragraph of FSAR Subsection 3.9.6.2.2 prior to the subheading “Check Valve Tests”:

STD COL 3.9-4

The attributes of the AOV testing program described above, to the extent that they apply to and can be implemented on other safety-related power-operated valves, such as electro-hydraulic valves, are applied to those other power-operated valves.

Add the following new paragraph under the heading "Check Valves Tests" in DCD Subsection 3.9.6.2.2:

STD COL 3.9-4

Preoperational testing is performed during the initial test program (refer to DCD Subsection 14.2) to verify that valves are installed in a configuration that allows correct operation, testing, and maintenance. Preoperational testing verifies that piping design features accommodate check valve testing requirements. Tests also verify disk movement to and from the seat and determine, without disassembly, that the valve disk positions correctly, fully opens or fully closes as expected, and remains stable in the open position under the full spectrum of system design-basis fluid flow conditions.

Add the following new last paragraphs under the subheading "Check Valve Exercise Tests" in DCD Subsection 3.9.6.2.2:

STD COL 3.9-4 Acceptance criteria for this testing consider the specific system design and valve application. For example, a valve's safety function may require obturator movement in both open and closed directions. A mechanical exerciser may be used to operate a check valve for testing. Where a mechanical exerciser is used, acceptance criteria are provided for the force or torque required to move the check valve's obturator. Exercise tests also detect missing, sticking, or binding obturators.

When operating conditions, valve design, valve location, or other considerations prevent direct observation or measurements by use of conventional methods to determine adequate check valve function, diagnostic equipment and nonintrusive techniques are used to monitor internal conditions. Nonintrusive tests used are dependent on system and valve configuration, valve design and materials, and include methods such as ultrasonic (acoustic), magnetic, radiography, and use of accelerometers to measure system and valve operating parameters (e.g., fluid flow, disk position, disk movement, disk impact, and the presence or absence of cavitation and back-tapping). Nonintrusive techniques also detect valve degradation. Diagnostic equipment and techniques used for valve operability determinations are verified as effective and accurate under the PST program.

Testing is performed, to the extent practicable, under normal operation, cold shutdown, or refueling conditions applicable to each check valve. Testing includes effects created by sudden starting and stopping of pumps, if applicable, or other conditions, such as flow reversal. When maintenance that could affect valve performance is performed on a valve in the IST program, post-maintenance testing is conducted prior to returning the valve to service.

Add the following new paragraph under the heading “Other Valve Inservice Tests” following the Explosively Actuated Valves paragraph in DCD Subsection 3.9.6.2.2:

STD COL 3.9-4 Industry and regulatory guidance is considered in development of IST program for squib valves. In addition, the IST program for squib valves incorporates lessons learned from the design and qualification process for these valves such that surveillance activities provide reasonable assurance of the operational readiness of squib valves to perform their safety functions.

3.9.6.2.3 Valve Disassembly and Inspection

Add the following paragraph as the new second paragraph of DCD Subsection 3.9.6.2.3:

STD COL 3.9-4

During the disassembly process, the full-stroke motion of the obturator is verified. Nondestructive examination is performed on the hinge pin to assess wear, and seat contact surfaces are examined to verify adequate contact. Full-stroke motion of the obturator is re-verified immediately prior to completing reassembly. At least one valve from each group is disassembled and examined at each refueling outage, and all the valves in each group are disassembled and examined at least once every eight years. Before being returned to service, valves disassembled for examination or valves that received maintenance that could affect their performance are exercised with a full- or part-stroke. Details and bases of the sampling program are documented and recorded in the test plan.

Add Subsections 3.9.6.2.4 and 3.9.6.2.5 following the last paragraph of DCD Subsection 3.9.6.2.3:

3.9.6.2.4 Valve Preservice Tests

STD COL 3.9-4

Each valve subject to inservice testing is also tested during the preservice test period. Preservice tests are conducted under conditions as near as practicable to those expected during subsequent inservice testing. Valves (or the control system) that have undergone maintenance that could affect performance, and valves that have been repaired or replaced, are re-tested to verify performance parameters that could have been affected are within acceptable limits. Safety and relief valves and nonreclosing pressure relief devices are preservice tested in accordance with the requirements of the ASME OM Code, Mandatory Appendix I.

Preservice tests for valves are performed in accordance with ASME OM, ISTC-3100.

3.9.6.2.5 Valve Replacement, Repair, and Maintenance

Testing in accordance with ASME OM, ISTC-3310 is performed after a valve is replaced, repaired, or undergoes maintenance. When a valve or its control system has been replaced, repaired, or has undergone maintenance that could affect valve performance, a new reference value is determined, or the previous value is reconfirmed by an inservice test. This test is performed before the valve is returned to service, or immediately if the valve is not removed from service. Deviations between the previous and new reference values are identified and analyzed. Verification that the new values represent acceptable operation is documented.

3.9.6.3 Relief Requests

Insert the following text after the first paragraph in DCD Subsection 3.9.6.3:

STD COL 3.9-4 The IST Program described herein utilizes Code Case OMN-1, Revision 1, “Alternative Rules for the Preservice and Inservice Testing of Certain Electric Motor-Operated Valve Assemblies in Light Water Reactor Power Plants” (Reference 202). Code Case OMN-1 establishes alternate rules and requirements for preservice and inservice testing to assess the operational readiness of certain motor operated valves, in lieu of the requirements set forth in ASME OM Code Subsection ISTC.

OMN-1, Alternative Rules for the Preservice and Inservice Testing of Certain MOVs

Code Case OMN-1, Revision 1, "Alternative Rules for the Preservice and Inservice Testing of Certain Electric Motor Operated Valve Assemblies in Light Water Reactor Power Plants," establishes alternate rules and requirements for preservice and inservice testing to assess the operational readiness of certain motor-operated valves in lieu of the requirements set forth in OM Code Subsection ISTC. However, Regulatory Guide 1.192, "Operation and Maintenance Code Case Acceptability, ASME OM Code," June 2003, has not yet endorsed OMN-1, Revision 1.

Code Case OMN-1, Revision 0, has been determined by the NRC to provide an acceptable level of quality and safety when implemented in conjunction with the conditions imposed in Regulatory Guide 1.192. NUREG-1482, Revision 1, “Guidelines for Inservice Testing at Nuclear Power Plants,” recommends the implementation of OMN-I by all licensees. Revision 1 to OMN-1 represents an improvement over Revision 0, as published in the ASME OM-2004 Code. OMN-1

Revision 1 incorporates the guidance on risk-informed testing of MOVs from OMN-11, “Risk-Informed Testing of Motor-Operated Valves,” and provides additional guidance on design basis verification testing and functional margin, which eliminates the need for the figures on functional margin and test intervals in Code Case OMN-1.

The IST Program implements Code Case OMN-1, Revision 1, in lieu of the stroke-time provisions specified in ISTC-5120 for MOVs, consistent with the guidelines provided in NUREG-1482, Revision 1, Section 4.2.5.

Regulatory Guide 1.192 states that licensees may use Code Case OMN-1, Revision 0, in lieu of the provisions for stroke-time testing in Subsection ISTC of the 1995 Edition up to and including the 2000 Addenda of the ASME OM Code when applied in conjunction with the provisions for leakage rate testing in ISTC-3600 (1998 Edition with the 1999 and 2000 Addenda). Licensees who choose to apply OMN-1 are required to apply all of its provisions. The IST program incorporates the following provisions from Regulatory Guide 1.192:

(1) The adequacy of the diagnostic test interval for each motor-operated valve (MOV) is evaluated and adjusted as necessary, but not later than 5 years or three refueling outages (whichever is longer) from initial implementation of OMN-1.

(2) The potential increase in CDF and risk associated with extending high risk MOV test intervals beyond quarterly is determined to be small and consistent with the intent of the Commission's Safety Goal Policy Statement.

(3) Risk insights are applied using MOV risk ranking methodologies accepted by the NRC on a plant-specific or industry-wide basis, consistent with the conditions in the applicable safety evaluations.

(4) Consistent with the provisions specified for Code Case OMN-11 the potential increase in CDF and risk associated with extending high risk MOV test intervals beyond quarterly is determined to be small and consistent with the intent of the Commission's Safety Goal Policy Statement.

Compliance with the above items is addressed in Section 3.9.6.2.2. Code Case OMN-1, Revision 1, is considered acceptable for use with OM Code-2001 Edition with 2003 Addenda. Finally, consistent with Regulatory Guide 1.192, the benefits of performing any particular test are balanced against the potential adverse effects placed on the valves or systems caused by this testing.

3.9.8 COMBINED LICENSE INFORMATION

3.9.8.2 Design Specifications and Reports

Add the following text after the second paragraph in DCD Subsection 3.9.8.2:

STD COL 3.9-2 Design specifications and design reports for ASME Section III piping are made available for NRC review. Reconciliation of the as-built piping (verification of the thermal cycling and stratification loading considered in the stress analysis discussed in DCD Subsection 3.9.3.1.2) is completed by the COL holder after the construction of the piping systems and prior to fuel load (in accordance with DCD Tier 1 Section 2 ITAAC line item for the applicable systems).

3.9.8.3 Snubber Operability Testing

STD COL 3.9-3 This COL Item is addressed in Subsection 3.9.3.4.4.

3.9.8.4 Valve Inservice Testing

STD COL 3.9-4 This COL Item is addressed in Subsections 3.9.6, 3.9.6.2.2, 3.9.6.2.4, 3.9.6.2.5, and 3.9.6.3.

3.9.8.5 Surge Line Thermal Monitoring

STD COL 3.9-5 This COL item is addressed in Subsection 3.9.3.1.2, and Subsection 14.2.9.2.22.

3.9.8.7 As-Designed Piping Analysis

Add the following text to the end of DCD Subsection 3.9.8.7.

STD COL 3.9-7 The as-designed piping analysis is provided for the piping lines chosen to demonstrate all aspects of the piping design. A design report referencing the as-designed piping calculation packages, including ASME Section III piping analysis, support evaluations and piping component fatigue analysis for Class 1 piping using the methods and criteria outlined in DCD Table 3.9-19 is made available for NRC review.

This COL item is also addressed in Subsection 14.3.3.

3.9.9 REFERENCES

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201. Not used.

202. ASME Code Case OMN-1, Revision 1, “Alternative Rules for the Preservice and Inservice Testing of Certain Electric Motor-Operated Valve Assemblies in Light Water Reactor Power Plants.”

203. Joint Owners Group Air Operated Valve Program Document, Revision 1, December 13, 2000.

204. USNRC, Eugene V. Imbro, letter to Mr. David J. Modeen, Nuclear Energy Institute, Comments On Joint Owners' Group Air Operated Valve Program Document, dated October 8, 1999.

STD SUP 3.9-3

Table 3.9-201
Safety Related Snubbers

System	Snubber (Hanger) No.	Line #
CVS	APP-CVS-PH-11Y0164	L001
PXS	APP-PXS-PH-11Y0020	L021A
RCS	APP-RCS-PH-11Y0039	L215
RCS	APP-RCS-PH-11Y0067	L005B
RCS	APP-RCS-PH-11Y0080	L112
RCS	APP-RCS-PH-11Y0081	L215
RCS	APP-RCS-PH-11Y0082	L112
RCS	APP-RCS-PH-11Y0090	L118A
RCS	APP-RCS-PH-11Y0099	L022B
RCS	APP-RCS-PH-11Y0103	L003
RCS	APP-RCS-PH-11Y0105	L003
RCS	APP-RCS-PH-11Y0112	L032A
RCS	APP-RCS-PH-11Y0429	L225B
RCS	APP-RCS-PH-11Y0528	L005A
RCS	APP-RCS-PH-11Y0539	L225C
RCS	APP-RCS-PH-11Y0550	L011B
RCS	APP-RCS-PH-11Y0551	L011A
RCS	APP-RCS-PH-11Y0553	L153B
RCS	APP-RCS-PH-11Y0555	L153A
RCS	APP-RCS-PH-11Y2005	L022A
RCS	APP-RCS-PH-11Y2101	L032B
RCS	APP-RCS-PH-11Y2117	L225A

System	Snubber (Hanger) No.	Line #
RNS	APP-RNS-PH-12Y2060	L006
SGS	APP-SGS-PH-11Y0001	L003B
SGS	APP-SGS-PH-11Y0002	L003B
SGS	APP-SGS-PH-11Y0004	L003B
SGS	APP-SGS-PH-11Y0057	L003A
SGS	APP-SGS-PH-11Y0058	L004B
SGS	APP-SGS-PH-11Y0063	L003A
SGS	APP-SGS-PH-11Y0065	L005B
SGS	APP-SGS-PH-12Y0136	L015C
SGS	APP-SGS-PH-12Y0137	L015C
SGS	APP-SGS-PH-11Y0470	L006B
SGS	APP-SGS-PH-11Y2002	L006A
SGS	APP-SGS-PH-11Y2021	L006A
SGS	APP-SGS-PH-11Y3101	L006B
SGS	APP-SGS-PH-11Y3102	L006B
SGS	APP-SGS-PH-11Y3121	L006B
SGS	APP-SGS-PH-11Y0463	L006A
SGS	APP-SGS-PH-11Y0464	L006A
SGS	SG 1 Snubber A (1A)	(a)
SGS	SG 1 Snubber B (1B)	(a)
SGS	SG 2 Snubber A (2A)	(a)
SGS	SG 2 Snubber B (2B)	(a)

(a) These snubbers are on the upper lateral support assembly of the steam generators.

3.10 SEISMIC AND DYNAMIC QUALIFICATION OF SEISMIC CATEGORY I MECHANICAL AND ELECTRICAL EQUIPMENT

This section of the referenced DCD is incorporated by reference with no departures or supplements.

3.11 ENVIRONMENTAL QUALIFICATION OF MECHANICAL AND ELECTRICAL EQUIPMENT

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.11.5 COMBINED LICENSE INFORMATION ITEM FOR EQUIPMENT QUALIFICATION FILE

Add the following text to the end of DCD Subsection 3.11.5:

STD COL 3.11-1 The COL holder is responsible for the maintenance of the equipment qualification file upon receipt from the reactor vendor. The documentation necessary to support the continued qualification of the equipment installed in the plant that is within the Environmental Qualification (EQ) Program scope is available in accordance with 10 CFR Part 50 Appendix A, General Design Criterion 1.

EQ files developed by the reactor vendor are maintained as applicable for equipment and certain post-accident monitoring devices that are subject to a harsh environment. The contents of the qualification files are discussed in DCD Section 3D.7. The files are maintained for the operational life of the plant.

For equipment not located in a harsh environment, design specifications received from the reactor vendor are retained. Any plant modifications that impact the equipment use the original specifications for modification or procurement. This process is governed by applicable plant design control or configuration control procedures.

Central to the EQ Program is the EQ Master Equipment List (EQMEL). This EQMEL identifies the electrical and mechanical equipment or components that must be environmentally qualified for use in a harsh environment. The EQMEL consists of equipment that is essential to emergency reactor shutdown, containment isolation, reactor core cooling, or containment and reactor heat removal, or that is otherwise essential in preventing significant release of radioactive material to the environment. This list is developed from the equipment list provided in AP1000 DCD Table 3.11-1.The EQMEL and a summary of equipment qualification results are maintained as part of the equipment qualification file for the operational life of the plant.

Administrative programs are in place to control revision to the EQ files and the EQMEL. When adding or modifying components in the EQ Program, EQ files are generated or revised to support qualification. The EQMEL is revised to reflect these new components. To delete a component from the EQ Program, a deletion justification is prepared that demonstrates why the component can be deleted.

This justification consists of an analysis of the component, an associated circuit review if appropriate, and a safety evaluation. The justification is released and/or referenced on an appropriate change document. For changes to the EQMEL, supporting documentation is completed and approved prior to issuing the changes. This documentation includes safety reviews and new or revised EQ files. Plant modifications and design basis changes are subject to change process reviews, e.g. reviews in accordance with 10 CFR 50.59 or Section VIII of Appendix D to 10 CFR Part 52, in accordance with appropriate plant procedures. These reviews address EQ issues associated with the activity. Any changes to the EQMEL that are not the result of a modification or design basis change are subject to a separate review that is accomplished and documented in accordance with plant procedures.

Engineering change documents or maintenance documents generated to document work performed on an EQ component, which may not have an impact on the EQ file, are reviewed against the current revision of the EQ files for potential impact. Changes to EQ documentation may be due to, but not limited to, plant modifications, calculations, corrective maintenance, or other EQ concerns.

Table 13.4-201 provides milestones for EQ implementation.

APPENDIX 3A HVAC DUCTS AND DUCT SUPPORTS

This section of the referenced DCD is incorporated by reference with no departures or supplements.

APPENDIX 3B LEAK-BEFORE-BREAK EVALUATION OF THE AP1000 PIPING

This section of the referenced DCD is incorporated by reference with no departures or supplements.

APPENDIX 3C REACTOR COOLANT LOOP ANALYSIS METHODS

This section of the referenced DCD is incorporated by reference with no departures or supplements.

APPENDIX 3D METHODOLOGY FOR QUALIFYING AP1000 SAFETY-RELATED ELECTRICAL AND MECHANICAL EQUIPMENT

This section of the referenced DCD is incorporated by reference with no departures or supplements.

APPENDIX 3E HIGH-ENERGY PIPING IN THE NUCLEAR ISLAND

This section of the referenced DCD is incorporated by reference with no departures or supplements.

APPENDIX 3F CABLE TRAYS AND CABLE TRAY SUPPORTS

This section of the referenced DCD is incorporated by reference with no departures or supplements.

APPENDIX 3G NUCLEAR ISLAND SEISMIC ANALYSES

This section of the referenced DCD is incorporated by reference with no departures or supplements.

APPENDIX 3H AUXILIARY AND SHIELD BUILDING CRITICAL SECTIONS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3H3.3 LOADS

Replace the first paragraph under Wind Load with the following:

PTN DEP 2.0-1 *[The wind loads are as follows:*

- *Design wind (W)*

  For the design of the exterior walls, wind loads are applied in accordance with ASCE 7-98 with a basic wind speed of 150 mph. The importance factor is 1.15, and the exposure category is C. Wind loads are not combined with seismic loads.

APPENDIX 3I EVALUATION FOR HIGH FREQUENCY SEISMIC INPUT

This section of the referenced DCD is incorporated by reference with no departures or supplements.

PTN SUP 3 JJ-1

APPENDIX 3JJ SOIL STRUCTURE INTERACTION SOIL PROFILES AND INPUT MOTIONS

3JJ.0 INTRODUCTION

Subsection 3.7.1.1.1 summarizes the development of the Foundation Input Response Spectra (FIRS), the strain-compatible soil profiles, and the development of acceleration time histories for use as input motions in soil-structure interaction (SSI) analysis. Appendix 3JJ discusses these steps in detail.

In Subsection 3JJ.1, the site response analysis leading to the development of amplification factors at the FIRS horizon is discussed. Subsection 3JJ.2 presents the developed FIRS while Subsection 3JJ.3 presents the calculated strain-compatible soil profiles. The matching of acceleration time histories to the FIRS is discussed in Subsection 3JJ.4 and the final acceleration time histories suitable for use in SSI analysis are presented in Subsection 3JJ.5.

3JJ.1 DEVELOPMENT OF AMPLIFICATION FACTORS AT FIRS HORIZON

The Uniform Hazard Response Spectra (UHRS), described in Subsection 2.5.2.4, are defined on hard rock characterized with a shear wave velocity of V_s = 9200 feet/second (2.8 kilometers/second), which is located at about 10,000 feet (3000 meters) below the ground surface. Subsection 2.5.2.5 describes the development of the site amplification factors at the GMRS horizon that results from the transmission of the seismic waves through the thick soil column. The effect is modeled by randomized soil columns, extending from the finished ground surface (including structural fill) to randomized hard rock depths varying between 7400 feet (2256 meters) and 11,400 feet (3476 meters), and an adjustment to the soil damping within the soil column to represent the anelastic attenuation of ground motion by the entire soil column (the “kappa” value). The same procedures are followed in this section to develop amplification factors at the FIRS horizon at the bottom of the nuclear island foundation.

The full soil columns used for computation of soil amplification factors represent two site conditions. The site condition far from the nuclear island consists of in situ soil layers except for the upper 30.5 feet (9.3 meters) of structural fill. This is the fill required for the general site to raise the site grade elevation from the existing grade to the final grade, and is designated as “FAR” in this section. In addition, a second soil column represents the site conditions near the nuclear island where, in addition to the general fill, lean concrete and structural fill replace the in situ soils down to a depth of 60.5 feet (18.4 meters). This second column is designated “NI” in the following discussion.

The site response analysis is conducted on a set of 60 randomized profiles, for each of the two base soil profiles, to account for the variability in the dynamic soil properties. The randomization procedure is described in detail in Subsection 2.5.2.5.2. Figures 3JJ-201 and 3JJ-202 present the low-strain randomized shear-wave velocity profiles for NI and FAR site conditions respectively. The “input median” used as input for randomization and the median of the 60 randomized profiles (“Randomized Median”) are compared in these figures. The apparent mismatch at depths greater than 7400 feet (2256 meters) is due to the termination of certain randomized profiles at that depth. Therefore the “Randomized Median” is calculated for the remaining profiles only and shows lower values than the “Input Median”, as expected.

Using the randomized profiles, the soil column analysis is performed with the de-aggregated low frequency (LF) and high frequency (HF) spectra of hard rock motion at 10^{-4} and 10^{-5} annual-frequency-of-exceedance, presented in Subsection 2.5.2.4, following the same methodology described in Subsection 2.5.2.5. The 5 percent damping acceleration response spectra (ARS) are calculated as “outcrop” motion at the selected horizons at 301 frequencies between 0.1 and 100 Hz. Amplification factors are calculated as the ratio of the calculated ARS at the selected horizon to the input UHRS at the bottom of the soil column.

Log-mean (median) amplification factors are developed for both FAR and NI site conditions at the ground surface at elevation +25.5 feet (7.8 meters) as well as at the FIRS horizon, located at the bottom of the NI foundation at elevation –16 feet (–4.9 meters) corresponding to a depth of 41.5 feet (12.7 meters) below the finished ground surface.

Figures 3JJ-203 and 3JJ-204 present the amplification factors at the FIRS horizon from analyses of the 60 randomized profiles, for NI and FAR site conditions respectively, for different rock input motions. Figures 3JJ-205 and 3JJ-206 present the amplification factors at the ground surface. Note that LF amplification factors for the low frequency range are larger than the corresponding HF ones, and that amplification greater than 1.0 of the ARS is observed in the low frequency range, while at higher frequencies, de-amplification occurs. The amplification due to the 10^{-5} level of input motion is smaller than for the 10^{-4} level of input motion, at frequencies larger than 0.8 Hz, due to the higher strain levels and nonlinearity in the soil column.

The median of maximum strains versus depth from analyses of the 60 randomized profiles for LF and HF, 10^{-4} and 10^{-5} input motions, are presented in Figures 3JJ-207 and 3JJ-208 for NI and FAR site conditions, respectively. Note that strains are generally low and do not exceed 0.045 percent for both NI and FAR site conditions. Comparison of the profiles of median maximum strains clearly confirms that the strains due to LF motions are larger than under HF motions.

3JJ.2 DEVELOPMENT OF FIRS

The recommended horizontal and vertical FIRS are calculated for elevation –16 feet horizon. This horizon corresponds to the bottom of the nuclear island foundation horizon, refer to Subsection 3JJ.1. The same RG 1.208 methodology used for the development of the GMRS design response spectra in FSAR Subsection 2.5.2.6 is used for the recommended FIRS design response spectra. For the development of the FIRS, however, the methodology is performed twice: once to develop a design response spectrum (DRS) for the FAR soil column, and once to develop a DRS for the NI soil column. The horizontal FIRS is defined as the envelope of the FAR and NI DRS. The vertical FIRS is obtained by scaling the horizontal FIRS by the same V:H ratios as presented in Subsection 2.5.2.6. Similar to the GMRS, the recommended FIRS design response spectra are for 5 percent spectral damping.

With the site-specific amplification calculations described in the previous subsection, the site horizontal design response spectrum (DRS) for both FAR and NI soil columns were determined as follows. Figures 3JJ-209 and 3JJ-210 show the 10^{-4} and 10^{-5} horizontal HF and LF acceleration response spectra (ARS) resulting from the site response analysis, plotted on a linear spectral acceleration scale for the FAR and NI soil columns, respectively. The “LF SA(g)” and “HF SA(g)” columns in Tables 3JJ-201 and 3JJ-202 list these ARS at a 38-frequency subset of the 301 frequencies analyzed for the annual frequencies of exceedance of 10^{-4} and 10^{-5}, respectively. For each soil column the HF and LF 10^{-4} and 10^{-5} horizontal site spectra are enveloped to give a “raw” soil uniform hazard response spectrum (UHRS) and smoothed to remove small frequency-to-frequency variations, using a smoothing function that averages over spectral accelerations at adjacent frequencies. Figures 3JJ-211 and 3JJ-212 show the smoothed, UHRS calculated in this way, plotted on a linear spectral acceleration scale for the FAR and NI soil columns, respectively. Tables 3JJ-201 and 3JJ-202 tabulate the “raw” and smoothed UHRS for both FAR and NI soil columns for the annual frequencies of exceedance of 10^{-4} and 10^{-5}, respectively.

The horizontal DRS for both soil columns are calculated at each frequency using the following equations:

$A_R = SA(10^{-5})/SA(10^{-4})$ Equation 3JJ-1

$DF = 0.6 \times A_R^{0.8}$ Equation 3JJ-2

$DRS = max[SA(10^{-4}) \times max(1.0, DF), 0.45 \times SA(10^{-5})]$ Equation 3JJ-3

where $SA(10^{-4})$ is the smoothed UHRS as spectral acceleration for the 10^{-4} hazard level at each spectral frequency (and similarly for 10^{-5}), and DRS is the design response spectrum at that spectral frequency. These equations follow the procedure in RG 1.208 to determine the DRS from the 10^{-4} and 10^{-5} response spectra.

Figures 3JJ-211 and 3JJ-212 show the FAR and NI horizontal DRS, respectively, calculated with the above equations at each spectral frequency from the smoothed 10^{-4} and 10^{-5} horizontal spectra. Tables 3JJ-203 and 3JJ-204 document the smoothed 10^{-4} and 10^{-5} horizontal spectral amplitudes, the calculation of A_R and DF from Equations 3JJ-1 and 3JJ-2, and the horizontal DRS calculated according to Equation 3JJ-3 for the FAR and NI soil columns, respectively. At low spectral frequencies (about 2 Hz and below), the hazard curves are steep, so A_R in Equation 3JJ-2 above is low, and the DRS from Equation 3JJ-3 is nearly equal to the 10^{-4} UHRS.

To calculate vertical spectra, V:H ratios from RG 1.60 are adopted, as in Subsection 2.5.2.6 in development of the GMRS. The V:H ratios are applied to the smoothed 10^{-4} and 10^{-5} horizontal spectra to calculate 10^{-4} and 10^{-5} vertical UHRS, and Equations 3JJ-1 through 3JJ-3 are applied to the 10^{-4} and 10^{-5} vertical spectral accelerations to calculate a vertical DRS for both FAR and NI soil columns. The resulting vertical 10^{-4} and 10^{-5} spectra and vertical DRS are plotted in Figures 3JJ-213 and 3JJ-214 for the FAR and NI soil columns, respectively. Tables 3JJ-205 and 3JJ-206 document the V:H ratios, the 10^{-4} and 10^{-5} vertical spectral amplitudes, the calculation of A_R and DF from Equations 3JJ-1 and 3JJ-2, and the vertical DRS calculated according to Equation 3JJ-3 for the FAR and NI soil columns, respectively.

Finally, the FIRS is defined as the envelope of the DRS for FAR and NI soil columns. Figure 3JJ-215 plots the horizontal and vertical FIRS, and Table 3JJ-207 provides a tabulation of the horizontal and vertical FIRS spectra.

In addition to the FIRS, from the same set of soil amplification analysis, DRS at the ground surface for both NI and FAR soil profiles are developed and enveloped. The surface DRS are calculated using the ground surface amplification factors presented in Subsection 3JJ.1 following the same procedure for development of FIRS. Surface DRS are used to check the adequacy of the SSI input motion as described in Subsection 3JJ.5.

3JJ.3 STRAIN-COMPATIBLE SOIL PROPERTY PROFILES

Two sets of strain-compatible profiles are developed for the NI and FAR site conditions, respectively. Each set consists of best estimate (BE), lower bound (LB) and upper bound (UB) strain-compatible shear-wave velocity, P-wave velocity and damping profiles. The soil properties are developed consistent with the developed FIRS. The upper bound and the lower bound shear wave velocity profiles maintain the minimum coefficient of variation of 0.50 in terms of the best estimate soil shear modulus.

P-wave velocities are calculated using Equation 3JJ-4 where ν is the Poisson's ratio corresponding to each soil layer. In addition, below the ground water level at elevation +1 feet (0.3 meters), a minimum P-wave velocity of 5000 feet/sec (1524 meter/sec) is maintained, on the condition that ν does not exceed 0.48 to avoid numerical problems in SSI analysis.

$$V_P = V_S\sqrt{\frac{2-2\nu}{1-2\nu}} \qquad \text{Equation 3JJ-4}$$

The resulting profiles are plotted in Figures 3JJ-216, 3JJ-217, and 3JJ-218 for NI site conditions and in Figures 3JJ-219, 3JJ-220, and 3JJ-221 for FAR site conditions. Note that the lower bound SSI soil profile is composed of the lower bound shear-wave velocity profile, the lower bound P-wave velocity profile and the upper bound (larger) damping profile. Similarly, the soil property profiles are combined for the upper bound SSI soil profiles. The presented profiles are recommended for use in the SSI analysis of the nuclear island.

3JJ.4 SPECTRAL MATCHING OF ACCELERATION TIME HISTORIES

Spectrum-compatible acceleration time histories are presented in this section. The first step in the development of spectrum-compatible time histories was the selection of appropriate seed acceleration time histories. These selected input seed time histories were taken from the database of candidate time histories given in NUREG/CR-6728 based on the low frequency de-aggregation results (i.e., magnitudes > 7 and distances > 500 km). For the analysis, the three component (i.e., two horizontal and one vertical component) strong ground motion recordings from the 1999 Chi-Chi earthquake (magnitude=7.6) recorded at the TAP024 station (closest distance=100.2 km) were selected and matched to the 5 percent damping FIRS developed earlier (see Subsection 3JJ.2).

The spectral matching procedure is a time domain procedure and emphasis was placed on maintaining the phase characteristics of the initial time history in the final modified spectrum-compatible time history. In addition, emphasis was placed on maintaining the characteristic of the normalized Arias intensities (the integral of the square of the acceleration-time history, a ground motion parameter that captures the potential destructiveness of an earthquake) of the initial and final modified spectrum-compatible time histories. These time histories were modified to be spectrum-compatible to the FIRS target spectra following the spectral matching criteria given in NUREG/CR-6728. In most cases, as additional constant scale factor was applied after the spectral matching procedure to comply with the spectral matching criteria given in NUREG/CR-6728. Scale factors of 1.02, 1.022, and 1.01 were applied for the two horizontal directions (H1, H2), and vertical direction (UP) components, respectively.

The modified spectrum-compatible acceleration, velocity, and displacement time histories prior to the application of the noted constant scale factors are plotted in Figure 3JJ-222a for the H1 component. Figure 3JJ-222c shows target horizontal FIRS spectrum, 1.3*FIRS target spectrum, 0.9*FIRS target spectrum and the modified time history response spectrum including the 1.02 constant scale factor. The normalized Arias intensities for the first horizontal (H1) component initial and modified spectrum-compatible time histories are plotted in Figure 3JJ-222b. The results for the second horizontal (H2) component and the UP component are shown in Figures 3JJ-223a, 3JJ-223b, and 3JJ-223c and Figures 3JJ-224a, 3JJ-224b, and 3JJ-224c, respectively. The zero-lag cross correlation was computed for combinations between the three spectrum-compatible acceleration time histories and they all fall below the required value of 0.30.

3JJ.5 SSI ACCELERATION TIME HISTORIES

Acceleration time histories, suitable for use in SSI analysis of the nuclear island, are presented in this section. Section 3JJ.4 provides a set of two horizontal motions and one vertical motion, spectrally matched to FIRS. The acceleration time histories are propagated through the developed strain-compatible profiles, presented in Subsection 3JJ.3, where they are used as input “outcrop” motions in the soil column at the FIRS horizon and the “within” acceleration time histories at the same horizon are computed. No further iterations on soil properties are performed.

These analyses result in a set of 3 “within” motions for each soil profile in the H1 and H2 directions and the UP direction, respectively. Note that while for horizontal motions, strain-compatible shear-wave velocity profiles are used to describe the shear modulus of the soil column, in the case of vertical motions, P-wave velocity profiles are used instead. Six (6) sets of 3 orthogonal motions are developed corresponding to the LB, BE and UB profiles for NI and FAR site conditions.

From the same set of soil amplification analyses, the 5 percent damping ARS at the ground surface level are calculated. Checks are made with respect to the corresponding surface design response spectra (DRS), per applicable requirements (References 201and 202) to ensure that the envelope of LB, BE and UB surface ARS, in each direction and site condition, envelops the corresponding surface DRS. Figures 3JJ-225, 3JJ-226, and 3JJ-227 present this comparison for NI site condition in the 3 orthogonal directions. Figures 3JJ-228, 3JJ-229, and 3JJ-230 present the same plots for FAR site condition. In these figures, the surface-DRS-to-envelope-ARS ratios (DRS/ENV) are also plotted.

Note that for horizontal motions, the DRS/ENV exceed unity in most cases, but by not greater than 19 percent in all horizontal motions. Therefore, the horizontal motions can be amplified by a factor not greater than 19 percent to ensure the surface ARS envelop the surface DRS in the horizontal directions for both NI and FAR site conditions.

In the case of vertical motions, the DRS/ENV exceed unity and reach a maximum of about 1.5 but in a narrow range of frequencies, between 1 and 8 Hz, for both NI and FAR site conditions. To avoid the amplification of the “within” motions by a large constant factor, close to 1.5, it was decided to re-generate an “outcrop” vertical acceleration time history matched to an adjusted target. The adjusted target spectrum is obtained by multiplying a smoothed version of the vertical DRS/ENV by the original target vertical FIRS. Figure 3JJ-231 presents the original and adjusted targets, as well as the amplification factor applied to the original vertical FIRS. The amplification factor is shown to envelop the DRS/ENV for both NI and FAR site conditions. A new vertical acceleration time history is matched to the adjusted vertical motion target ARS following the same procedure described in Subsection 3JJ.4. The new vertical motion is used as input and the site response analysis is repeated to obtain the corresponding “within” motions at FIRS horizon.

The resulting adjusted acceleration time histories are presented in Figures 3JJ-232, 3JJ-233, and 3JJ-234 for NI site condition and in Figures 3JJ-235, 3JJ-236, and 3JJ-237 for FAR site condition. The “within” acceleration time histories are recommended for use in the SSI analysis of the nuclear island SSI model that includes embedment. The time histories are to be applied at the FIRS horizon as “within” motion and shall be used in combination with the respective SSI soil profiles discussed in Subsection 3JJ.3.

3JJ.6 REFERENCES

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201. NRC Letter, Nilesh C Chokshi, deputy division director, office of new reactors, NRC to Adrian P Hymer, senior director, NEI, dated January 9, 2009, Subject NEI Draft White Paper *Consistent Site-Response/Soil-Structure Interaction Analysis and Evaluation* (USNRC ADAMS Accession Number ML083580072).

202. NEI letter, Adrian P Hymer, senior director of NEI to Nilesh C Chokshi, deputy division director, office of new reactors, NRC, dated October 10, 2008, *Subject White paper in support of New Plant Applications*, (USNRC ADAMS Accession Number ML083020171).

Table 3JJ-201 (Sheet 1 of 2)
HF and LF Horizontal 10^{-4} Site Spectra, and Raw and Smoothed Envelope UHRS Spectra for the FAR and NI Soil Columns at FIRS Horizon

Horizontal 10^{-4} Site Spectra UHRS (g)								
Freq. Hz	FAR Soil Column FIRS Horizon UHRS		Raw Envelope	Smooth Envelope	NI Soil Column FIRS Horizon UHRS		Raw Envelope	Smooth Envelope
	LF SA(g)	HF SA(g)	SA(g)	SA(g)	LF SA(g)	HF SA(g)	SA(g)	SA(g)
100	4.84E-02	3.04E-02	4.84E-02	4.84E-02	4.73E-02	2.90E-02	4.73E-02	4.73E-02
90	4.85E-02	3.06E-02	4.85E-02	4.85E-02	4.74E-02	2.92E-02	4.74E-02	4.74E-02
80	4.88E-02	3.09E-02	4.88E-02	4.88E-02	4.76E-02	2.95E-02	4.76E-02	4.76E-02
70	4.93E-02	3.17E-02	4.93E-02	4.93E-02	4.81E-02	3.01E-02	4.81E-02	4.81E-02
60	5.03E-02	3.32E-02	5.03E-02	5.03E-02	4.91E-02	3.15E-02	4.91E-02	4.91E-02
50	5.23E-02	3.64E-02	5.23E-02	5.23E-02	5.06E-02	3.39E-02	5.06E-02	5.06E-02
45	5.36E-02	3.85E-02	5.36E-02	5.35E-02	5.14E-02	3.52E-02	5.14E-02	5.15E-02
40	5.48E-02	4.05E-02	5.48E-02	5.48E-02	5.28E-02	3.73E-02	5.28E-02	5.28E-02
35	5.64E-02	4.32E-02	5.64E-02	5.65E-02	5.50E-02	4.10E-02	5.50E-02	5.51E-02
30	6.01E-02	4.91E-02	6.01E-02	6.03E-02	5.90E-02	4.73E-02	5.90E-02	5.90E-02
25	6.67E-02	5.86E-02	6.67E-02	6.66E-02	6.35E-02	5.40E-02	6.35E-02	6.35E-02
20	6.90E-02	6.19E-02	6.90E-02	6.86E-02	6.47E-02	5.59E-02	6.47E-02	6.44E-02
15	6.47E-02	5.61E-02	6.47E-02	6.45E-02	6.24E-02	5.27E-02	6.24E-02	6.24E-02
12.5	6.35E-02	5.45E-02	6.35E-02	6.34E-02	6.15E-02	5.20E-02	6.15E-02	6.17E-02
10	6.57E-02	5.62E-02	6.57E-02	6.55E-02	6.32E-02	5.35E-02	6.32E-02	6.32E-02
9	6.73E-02	5.84E-02	6.73E-02	6.71E-02	6.41E-02	5.43E-02	6.41E-02	6.41E-02
8	6.83E-02	5.94E-02	6.83E-02	6.82E-02	6.44E-02	5.49E-02	6.44E-02	6.48E-02
7	6.77E-02	5.85E-02	6.77E-02	6.76E-02	6.64E-02	5.70E-02	6.64E-02	6.58E-02
6	6.63E-02	5.63E-02	6.63E-02	6.68E-02	6.72E-02	5.79E-02	6.72E-02	6.77E-02
5	6.97E-02	6.03E-02	6.97E-02	6.94E-02	7.21E-02	6.23E-02	7.21E-02	7.15E-02
4	6.57E-02	5.09E-02	6.57E-02	6.63E-02	6.55E-02	5.05E-02	6.55E-02	6.64E-02
3	8.08E-02	6.12E-02	8.08E-02	8.06E-02	7.97E-02	5.94E-02	7.97E-02	7.92E-02
2.5	8.98E-02	6.00E-02	8.98E-02	8.82E-02	8.34E-02	5.49E-02	8.34E-02	8.23E-02
2	7.41E-02	4.11E-02	7.41E-02	7.34E-02	6.92E-02	3.78E-02	6.92E-02	6.89E-02
1.5	6.72E-02	2.87E-02	6.72E-02	6.72E-02	6.42E-02	2.69E-02	6.42E-02	6.43E-02
1.25	7.35E-02	2.71E-02	7.35E-02	7.35E-02	7.15E-02	2.62E-02	7.15E-02	7.18E-02
1	8.45E-02	2.48E-02	8.45E-02	8.59E-02	8.34E-02	2.43E-02	8.34E-02	8.49E-02
0.9	1.00E-01	2.60E-02	1.00E-01	9.94E-02	9.86E-02	2.54E-02	9.86E-02	9.79E-02
0.8	1.10E-01	2.47E-02	1.10E-01	1.07E-01	1.09E-01	2.43E-02	1.09E-01	1.06E-01
0.7	9.93E-02	1.89E-02	9.93E-02	9.99E-02	9.97E-02	1.88E-02	9.97E-02	1.00E-01
0.6	9.19E-02	1.49E-02	9.19E-02	9.18E-02	9.31E-02	1.50E-02	9.31E-02	9.28E-02
0.5	7.97E-02	1.09E-02	7.97E-02	7.76E-02	8.02E-02	1.09E-02	8.02E-02	7.82E-02
0.4	4.72E-02	6.38E-03	4.72E-02	4.80E-02	4.80E-02	6.45E-03	4.80E-02	4.88E-02
0.3	3.09E-02	4.19E-03	3.09E-02	3.10E-02	3.12E-02	4.21E-03	3.12E-02	3.14E-02

Table 3JJ-201 (Sheet 2 of 2)
HF and LF Horizontal 10^{-4} Site Spectra, and Raw and Smoothed Envelope UHRS Spectra for the FAR and NI Soil Columns at FIRS Horizon

Horizontal 10^{-4} Site Spectra UHRS (g)								
Freq.	FAR Soil Column FIRS Horizon UHRS		Raw Envelope	Smooth Envelope	NI Soil Column FIRS Horizon UHRS		Raw Envelope	Smooth Envelope
Hz	LF SA(g)	HF SA(g)	SA(g)	SA(g)	LF SA(g)	HF SA(g)	SA(g)	SA(g)
0.2	2.05E-02	2.80E-03	2.05E-02	2.05E-02	2.03E-02	2.76E-03	2.03E-02	2.02E-02
0.15	1.30E-02	1.81E-03	1.30E-02	1.31E-02	1.28E-02	1.78E-03	1.28E-02	1.29E-02
0.125	9.55E-03	1.36E-03	9.55E-03	9.48E-03	9.45E-03	1.34E-03	9.45E-03	9.38E-03
0.1	5.71E-03	8.02E-04	5.71E-03	5.71E-03	5.67E-03	7.95E-04	5.67E-03	5.67E-03

Notes:
FIRS= Foundation input response spectrum
UHRS=Uniform hazard response spectra
LF = Low frequencies
HF = High frequencies
SA = Spectral acceleration
Amp = Amplitude

Table 3JJ-202 (Sheet 1 of 2) HF and LF Horizontal 10^{-5} Site Spectra, and Raw and Smoothed Envelope UHRS Spectra for the FAR and NI Soil Columns at FIRS Horizon

Horizontal 10^{-5} Site Spectra UHRS (g)								
Freq. Hz	FAR Soil Column FIRS Horizon UHRS		Raw Envelope	Smooth Envelope	NI Soil Column FIRS Horizon UHRS		Raw Envelope	Smooth Envelope
	LF SA(g)	HF SA(g)	SA(g)	SA(g)	LF SA(g)	HF SA(g)	SA(g)	SA(g)
100	1.05E-01	8.62E-02	1.05E-01	1.05E-01	1.02E-01	8.24E-02	1.02E-01	1.02E-01
90	1.05E-01	8.68E-02	1.05E-01	1.05E-01	1.02E-01	8.30E-02	1.02E-01	1.02E-01
80	1.05E-01	8.79E-02	1.05E-01	1.05E-01	1.03E-01	8.40E-02	1.03E-01	1.03E-01
70	1.06E-01	9.02E-02	1.06E-01	1.06E-01	1.04E-01	8.62E-02	1.04E-01	1.04E-01
60	1.09E-01	9.51E-02	1.09E-01	1.09E-01	1.06E-01	9.06E-02	1.06E-01	1.06E-01
50	1.13E-01	1.06E-01	1.13E-01	1.13E-01	1.10E-01	9.88E-02	1.10E-01	1.10E-01
45	1.17E-01	1.14E-01	1.17E-01	1.17E-01	1.12E-01	1.04E-01	1.12E-01	1.12E-01
40	1.21E-01	1.21E-01	1.21E-01	1.22E-01	1.17E-01	1.12E-01	1.17E-01	1.17E-01
35	1.28E-01	1.33E-01	1.33E-01	1.34E-01	1.25E-01	1.26E-01	1.26E-01	1.28E-01
30	1.42E-01	1.56E-01	1.56E-01	1.57E-01	1.40E-01	1.52E-01	1.52E-01	1.52E-01
25	1.68E-01	1.95E-01	1.95E-01	1.94E-01	1.58E-01	1.80E-01	1.80E-01	1.79E-01
20	1.78E-01	2.06E-01	2.06E-01	2.04E-01	1.65E-01	1.87E-01	1.87E-01	1.85E-01
15	1.62E-01	1.76E-01	1.76E-01	1.75E-01	1.56E-01	1.67E-01	1.67E-01	1.67E-01
12.5	1.54E-01	1.63E-01	1.63E-01	1.62E-01	1.50E-01	1.58E-01	1.58E-01	1.58E-01
10	1.60E-01	1.65E-01	1.65E-01	1.64E-01	1.55E-01	1.59E-01	1.59E-01	1.59E-01
9	1.63E-01	1.66E-01	1.66E-01	1.67E-01	1.58E-01	1.60E-01	1.60E-01	1.59E-01
8	1.68E-01	1.70E-01	1.70E-01	1.69E-01	1.58E-01	1.59E-01	1.59E-01	1.59E-01
7	1.67E-01	1.65E-01	1.67E-01	1.67E-01	1.61E-01	1.59E-01	1.61E-01	1.60E-01
6	1.58E-01	1.50E-01	1.58E-01	1.59E-01	1.57E-01	1.50E-01	1.57E-01	1.59E-01
5	1.63E-01	1.58E-01	1.63E-01	1.62E-01	1.75E-01	1.72E-01	1.75E-01	1.73E-01
4	1.54E-01	1.33E-01	1.54E-01	1.55E-01	1.56E-01	1.34E-01	1.56E-01	1.58E-01
3	1.70E-01	1.46E-01	1.70E-01	1.70E-01	1.70E-01	1.44E-01	1.70E-01	1.68E-01
2.5	1.84E-01	1.46E-01	1.84E-01	1.82E-01	1.73E-01	1.34E-01	1.73E-01	1.72E-01
2	1.55E-01	9.90E-02	1.55E-01	1.53E-01	1.43E-01	9.06E-02	1.43E-01	1.43E-01
1.5	1.32E-01	6.54E-02	1.32E-01	1.32E-01	1.25E-01	6.12E-02	1.25E-01	1.26E-01
1.25	1.41E-01	6.07E-02	1.41E-01	1.41E-01	1.37E-01	5.85E-02	1.37E-01	1.37E-01
1	1.53E-01	5.41E-02	1.53E-01	1.56E-01	1.51E-01	5.32E-02	1.51E-01	1.54E-01
0.9	1.81E-01	5.65E-02	1.81E-01	1.80E-01	1.78E-01	5.52E-02	1.78E-01	1.77E-01
0.8	2.05E-01	5.40E-02	2.05E-01	1.99E-01	2.03E-01	5.31E-02	2.03E-01	1.98E-01
0.7	1.91E-01	4.13E-02	1.91E-01	1.91E-01	1.92E-01	4.11E-02	1.92E-01	1.92E-01
0.6	1.78E-01	3.19E-02	1.78E-01	1.78E-01	1.80E-01	3.21E-02	1.80E-01	1.80E-01
0.5	1.56E-01	2.29E-02	1.56E-01	1.52E-01	1.57E-01	2.29E-02	1.57E-01	1.53E-01
0.4	9.26E-02	1.33E-02	9.26E-02	9.42E-02	9.43E-02	1.34E-02	9.43E-02	9.57E-02
0.3	6.01E-02	8.64E-03	6.01E-02	6.04E-02	6.08E-02	8.70E-03	6.08E-02	6.11E-02

Table 3JJ-202 (Sheet 2 of 2) HF and LF Horizontal 10^{-5} Site Spectra, and Raw and Smoothed Envelope UHRS Spectra for the FAR and NI Soil Columns at FIRS Horizon

Horizontal 10^{-5} Site Spectra UHRS (g)								
Freq.	FAR Soil Column FIRS Horizon UHRS		Raw Envelope	Smooth Envelope	NI Soil Column FIRS Horizon UHRS		Raw Envelope	Smooth Envelope
Hz	LF SA(g)	HF SA(g)	SA(g)	SA(g)	LF SA(g)	HF SA(g)	SA(g)	SA(g)
0.2	3.98E-02	5.78E-03	3.98E-02	3.98E-02	3.93E-02	5.69E-03	3.93E-02	3.93E-02
0.15	2.53E-02	3.82E-03	2.53E-02	2.54E-02	2.50E-02	3.76E-03	2.50E-02	2.51E-02
0.125	1.86E-02	2.86E-03	1.86E-02	1.85E-02	1.84E-02	2.82E-03	1.84E-02	1.83E-02
0.1	1.11E-02	1.69E-03	1.11E-02	1.11E-02	1.10E-02	1.67E-03	1.10E-02	1.10E-02

Notes:
FIRS= Foundation input response spectrum
UHRS=Uniform hazard response spectra
LF = Low frequencies
HF = High frequencies
SA = Spectral acceleration
Amp = Amplitude

Table 3JJ-203 (Sheet 1 of 2)
Horizontal 10^{-4} and 10^{-5} Smoothed Site Spectra, Values of AR and DF, and DRS for the FAR Soil Column at FIRS Horizon

Freq. Hz	Horizontal 10^{-4}	Horizontal 10^{-5}	A_R	DF	Horizontal DRS
100	4.84E-02	1.05E-01	2.16	1.11	5.38E-02
90	4.85E-02	1.05E-01	2.16	1.11	5.39E-02
80	4.88E-02	1.05E-01	2.16	1.11	5.42E-02
70	4.93E-02	1.06E-01	2.16	1.11	5.47E-02
60	5.03E-02	1.09E-01	2.16	1.11	5.59E-02
50	5.23E-02	1.13E-01	2.17	1.11	5.82E-02
45	5.35E-02	1.17E-01	2.19	1.12	6.01E-02
40	5.48E-02	1.22E-01	2.23	1.14	6.25E-02
35	5.65E-02	1.34E-01	2.37	1.20	6.76E-02
30	6.03E-02	1.57E-01	2.61	1.29	7.78E-02
25	6.66E-02	1.94E-01	2.91	1.41	9.41E-02
20	6.86E-02	2.04E-01	2.97	1.43	9.83E-02
15	6.45E-02	1.75E-01	2.71	1.33	8.59E-02
12.5	6.34E-02	1.62E-01	2.56	1.27	8.07E-02
10	6.55E-02	1.64E-01	2.50	1.25	8.17E-02
9	6.71E-02	1.67E-01	2.48	1.24	8.34E-02
8	6.82E-02	1.69E-01	2.48	1.24	8.47E-02
7	6.76E-02	1.67E-01	2.46	1.23	8.34E-02
6	6.68E-02	1.59E-01	2.38	1.20	8.03E-02
5	6.94E-02	1.62E-01	2.34	1.18	8.22E-02
4	6.63E-02	1.55E-01	2.33	1.18	7.84E-02
3	8.06E-02	1.70E-01	2.10	1.09	8.77E-02
2.5	8.82E-02	1.82E-01	2.06	1.07	9.45E-02
2	7.34E-02	1.53E-01	2.09	1.08	7.94E-02
1.5	6.72E-02	1.32E-01	1.96	1.03	6.92E-02
1.25	7.35E-02	1.41E-01	1.92	1.01	7.43E-02
1	8.59E-02	1.56E-01	1.82	1.00	8.59E-02
0.9	9.94E-02	1.80E-01	1.82	1.00	9.94E-02
0.8	1.07E-01	1.99E-01	1.86	1.00	1.07E-01
0.7	9.99E-02	1.91E-01	1.92	1.01	1.01E-01
0.6	9.18E-02	1.78E-01	1.94	1.02	9.36E-02
0.5	7.76E-02	1.52E-01	1.96	1.03	7.98E-02
0.4	4.80E-02	9.42E-02	1.96	1.03	4.94E-02
0.3	3.10E-02	6.04E-02	1.95	1.02	3.17E-02
0.2	2.05E-02	3.98E-02	1.94	1.02	2.09E-02
0.15	1.31E-02	2.54E-02	1.95	1.02	1.34E-02

Table 3JJ-203 (Sheet 2 of 2) Horizontal 10^{-4} and 10^{-5} Smoothed Site Spectra, Values of AR and DF, and DRS for the FAR Soil Column at FIRS Horizon

Freq. Hz	Horizontal 10^{-4}	Horizontal 10^{-5}	A_R	DF	Horizontal DRS
0.125	9.48E-03	1.85E-02	1.95	1.02	9.69E-03
0.1	5.71E-03	1.11E-02	1.94	1.02	5.83E-03

Notes:
FIRS= Foundation input response spectrum
AR and DF are defined in Equations 3JJ-1 and 3JJ-2, respectively.
DRS = Design response spectrum, defined in Equation 3JJ-3

Table 3JJ-204 (Sheet 1 of 2)
Horizontal 10^{-4} and 10^{-5} Smoothed Site Spectra, Values of AR and DF, and DRS for the NI Soil Column at FIRS Horizon

Freq. Hz	Horizontal 10^{-4}	Horizontal 10^{-5}	A_R	DF	Horizontal DRS
100	4.73E-02	1.02E-01	2.16	1.11	5.25E-02
90	4.74E-02	1.02E-01	2.16	1.11	5.27E-02
80	4.76E-02	1.03E-01	2.16	1.11	5.29E-02
70	4.81E-02	1.04E-01	2.16	1.11	5.34E-02
60	4.91E-02	1.06E-01	2.16	1.11	5.45E-02
50	5.06E-02	1.10E-01	2.17	1.11	5.64E-02
45	5.15E-02	1.12E-01	2.18	1.12	5.77E-02
40	5.28E-02	1.17E-01	2.22	1.13	5.99E-02
35	5.51E-02	1.28E-01	2.32	1.18	6.49E-02
30	5.90E-02	1.52E-01	2.58	1.28	7.54E-02
25	6.35E-02	1.79E-01	2.82	1.37	8.73E-02
20	6.44E-02	1.85E-01	2.87	1.40	8.99E-02
15	6.24E-02	1.67E-01	2.67	1.32	8.22E-02
12.5	6.17E-02	1.58E-01	2.57	1.28	7.87E-02
10	6.32E-02	1.59E-01	2.51	1.25	7.92E-02
9	6.41E-02	1.59E-01	2.49	1.24	7.97E-02
8	6.48E-02	1.59E-01	2.46	1.23	7.99E-02
7	6.58E-02	1.60E-01	2.43	1.22	8.03E-02
6	6.77E-02	1.59E-01	2.35	1.19	8.04E-02
5	7.15E-02	1.73E-01	2.42	1.22	8.71E-02
4	6.64E-02	1.58E-01	2.38	1.20	7.97E-02
3	7.92E-02	1.68E-01	2.13	1.10	8.69E-02
2.5	8.23E-02	1.72E-01	2.08	1.08	8.89E-02
2	6.89E-02	1.43E-01	2.07	1.08	7.41E-02
1.5	6.43E-02	1.26E-01	1.95	1.03	6.59E-02
1.25	7.18E-02	1.37E-01	1.91	1.01	7.22E-02
1	8.49E-02	1.54E-01	1.82	1.00	8.49E-02
0.9	9.79E-02	1.77E-01	1.81	1.00	9.79E-02
0.8	1.06E-01	1.98E-01	1.86	1.00	1.06E-01
0.7	1.00E-01	1.92E-01	1.92	1.01	1.01E-01
0.6	9.28E-02	1.80E-01	1.94	1.02	9.46E-02
0.5	7.82E-02	1.53E-01	1.96	1.03	8.04E-02
0.4	4.88E-02	9.57E-02	1.96	1.03	5.02E-02
0.3	3.14E-02	6.11E-02	1.95	1.02	3.21E-02
0.2	2.02E-02	3.93E-02	1.94	1.02	2.06E-02
0.15	1.29E-02	2.51E-02	1.95	1.02	1.32E-02

Table 3JJ-204 (Sheet 2 of 2)
Horizontal 10^{-4} and 10^{-5} Smoothed Site Spectra, Values of AR and DF, and DRS for the NI Soil Column at FIRS Horizon

Freq. Hz	Horizontal 10^{-4}	Horizontal 10^{-5}	A_R	DF	Horizontal DRS
0.125	9.38E-03	1.83E-02	1.95	1.02	9.59E-03
0.1	5.67E-03	1.10E-02	1.94	1.02	5.79E-03

Notes:
FIRS= Foundation input response spectrum
AR and DF are defined in Equations 3JJ-1 and 3JJ-2, respectively.
DRS = Design response spectrum, defined in Equation 3JJ-3

Table 3JJ-205 (Sheet 1 of 2)
V/H Ratios, Vertical 10^{-4} and 10^{-5} Smoothed Site Spectra, Values of AR and DF, and DRS for the FAR Soil Column at FIRS Horizon

Freq. Hz	V/H	Vertical 10^{-4}	Vertical 10^{-5}	A_R	DF	Vertical DRS
100	1.000	4.84E-02	1.05E-01	2.16	1.11	5.38E-02
90	1.000	4.85E-02	1.05E-01	2.16	1.11	5.39E-02
80	1.000	4.88E-02	1.05E-01	2.16	1.11	5.42E-02
70	1.000	4.93E-02	1.06E-01	2.16	1.11	5.47E-02
60	1.000	5.03E-02	1.09E-01	2.16	1.11	5.59E-02
50	1.000	5.23E-02	1.13E-01	2.17	1.11	5.82E-02
45	1.000	5.35E-02	1.17E-01	2.19	1.12	6.01E-02
40	1.000	5.48E-02	1.22E-01	2.23	1.14	6.25E-02
35	1.000	5.65E-02	1.34E-01	2.37	1.20	6.76E-02
30	1.000	6.03E-02	1.57E-01	2.61	1.29	7.78E-02
25	1.000	6.66E-02	1.94E-01	2.91	1.41	9.41E-02
20	1.000	6.86E-02	2.04E-01	2.97	1.43	9.83E-02
15	1.000	6.45E-02	1.75E-01	2.71	1.33	8.59E-02
12.5	1.000	6.34E-02	1.62E-01	2.56	1.27	8.07E-02
10	1.000	6.55E-02	1.64E-01	2.50	1.25	8.17E-02
9	1.000	6.71E-02	1.67E-01	2.48	1.24	8.34E-02
8	1.000	6.82E-02	1.69E-01	2.48	1.24	8.47E-02
7	1.000	6.76E-02	1.66E-01	2.46	1.23	8.34E-02
6	0.999	6.68E-02	1.59E-01	2.38	1.20	8.03E-02
5	0.999	6.93E-02	1.62E-01	2.34	1.18	8.21E-02
4	0.999	6.63E-02	1.55E-01	2.33	1.18	7.83E-02
3	0.857	6.90E-02	1.45E-01	2.10	1.09	7.51E-02
2.5	0.715	6.31E-02	1.30E-01	2.06	1.07	6.76E-02
2	0.710	5.21E-02	1.09E-01	2.09	1.08	5.64E-02
1.5	0.704	4.73E-02	9.29E-02	1.96	1.03	4.87E-02
1.25	0.701	5.15E-02	9.88E-02	1.92	1.01	5.20E-02
1	0.696	5.98E-02	1.09E-01	1.82	1.00	5.98E-02
0.9	0.694	6.89E-02	1.25E-01	1.82	1.00	6.89E-02
0.8	0.691	7.42E-02	1.38E-01	1.86	1.00	7.42E-02
0.7	0.689	6.88E-02	1.32E-01	1.92	1.01	6.95E-02
0.6	0.686	6.30E-02	1.22E-01	1.94	1.02	6.42E-02
0.5	0.682	5.29E-02	1.04E-01	1.96	1.03	5.44E-02
0.4	0.678	3.25E-02	6.38E-02	1.96	1.03	3.35E-02
0.3	0.672	2.08E-02	4.06E-02	1.95	1.02	2.13E-02
0.2	0.668	1.37E-02	2.66E-02	1.94	1.02	1.40E-02
0.15	0.668	8.73E-03	1.70E-02	1.95	1.02	8.93E-03

Table 3JJ-205 (Sheet 2 of 2) V/H Ratios, Vertical 10^{-4} and 10^{-5} Smoothed Site Spectra, Values of AR and DF, and DRS for the FAR Soil Column at FIRS Horizon

Freq. Hz	V/H	Vertical 10^{-4}	Vertical 10^{-5}	A_R	DF	Vertical DRS
0.125	0.668	6.34E-03	1.23E-02	1.95	1.02	6.48E-03
0.1	0.668	3.82E-03	7.42E-03	1.94	1.02	3.90E-03

Notes:
FIRS= Foundation input response spectrum
AR and DF are defined in Equations 3JJ-1 and 3JJ-2, respectively.
DRS = Design response spectrum, defined in Equation 3JJ-3

Table 3JJ-206 (Sheet 1 of 2)
V/H Ratios, Vertical 10^{-4} and 10^{-5} Smoothed Site Spectra, Values of AR and DF, and DRS for the NI Soil Column at FIRS Horizon

Freq. Hz	V/H	Vertical 10^{-4}	Vertical 10^{-5}	A_R	DF	Vertical DRS
100	1.000	4.73E-02	1.02E-01	2.16	1.11	5.25E-02
90	1.000	4.74E-02	1.02E-01	2.16	1.11	5.27E-02
80	1.000	4.76E-02	1.03E-01	2.16	1.11	5.29E-02
70	1.000	4.81E-02	1.04E-01	2.16	1.11	5.34E-02
60	1.000	4.91E-02	1.06E-01	2.16	1.11	5.45E-02
50	1.000	5.06E-02	1.10E-01	2.17	1.11	5.64E-02
45	1.000	5.15E-02	1.12E-01	2.18	1.12	5.77E-02
40	1.000	5.28E-02	1.17E-01	2.22	1.13	5.99E-02
35	1.000	5.51E-02	1.28E-01	2.32	1.18	6.49E-02
30	1.000	5.90E-02	1.52E-01	2.58	1.28	7.54E-02
25	1.000	6.35E-02	1.79E-01	2.82	1.37	8.73E-02
20	1.000	6.44E-02	1.85E-01	2.87	1.40	8.99E-02
15	1.000	6.24E-02	1.67E-01	2.67	1.32	8.22E-02
12.5	1.000	6.17E-02	1.58E-01	2.57	1.28	7.87E-02
10	1.000	6.32E-02	1.59E-01	2.51	1.25	7.92E-02
9	1.000	6.41E-02	1.59E-01	2.49	1.24	7.97E-02
8	1.000	6.48E-02	1.59E-01	2.46	1.23	7.99E-02
7	1.000	6.58E-02	1.60E-01	2.43	1.22	8.03E-02
6	0.999	6.76E-02	1.59E-01	2.35	1.19	8.04E-02
5	0.999	7.14E-02	1.73E-01	2.42	1.22	8.70E-02
4	0.999	6.63E-02	1.58E-01	2.38	1.20	7.96E-02
3	0.857	6.78E-02	1.44E-01	2.13	1.10	7.45E-02
2.5	0.715	5.89E-02	1.23E-01	2.08	1.08	6.36E-02
2	0.710	4.89E-02	1.01E-01	2.07	1.08	5.26E-02
1.5	0.704	4.53E-02	8.85E-02	1.95	1.03	4.64E-02
1.25	0.701	5.03E-02	9.59E-02	1.91	1.01	5.06E-02
1	0.696	5.91E-02	1.07E-01	1.82	1.00	5.91E-02
0.9	0.694	6.79E-02	1.23E-01	1.81	1.00	6.79E-02
0.8	0.691	7.36E-02	1.37E-01	1.86	1.00	7.36E-02
0.7	0.689	6.90E-02	1.32E-01	1.92	1.01	6.97E-02
0.6	0.686	6.37E-02	1.23E-01	1.94	1.02	6.49E-02
0.5	0.682	5.33E-02	1.05E-01	1.96	1.03	5.48E-02
0.4	0.678	3.31E-02	6.49E-02	1.96	1.03	3.40E-02
0.3	0.672	2.11E-02	4.11E-02	1.95	1.02	2.16E-02
0.2	0.668	1.35E-02	2.63E-02	1.94	1.02	1.38E-02
0.15	0.668	8.61E-03	1.68E-02	1.95	1.02	8.81E-03

Table 3JJ-206 (Sheet 2 of 2)
V/H Ratios, Vertical 10^{-4} and 10^{-5} Smoothed Site Spectra, Values of AR and DF, and DRS for the NI Soil Column at FIRS Horizon

Freq. Hz	V/H	Vertical 10^{-4}	Vertical 10^{-5}	A_R	DF	Vertical DRS
0.125	0.668	6.27E-03	1.22E-02	1.95	1.02	6.41E-03
0.1	0.668	3.79E-03	7.37E-03	1.94	1.02	3.87E-03

Notes:
FIRS= Foundation input response spectrum
AR and DF are defined in Equations 3JJ-1 and 3JJ-2, respectively.
DRS = Design response spectrum, defined in Equation 3JJ-3

Table 3JJ-207
Recommended Horizontal and Vertical FIRS

FIRS Frequency (Hz)	Horizontal Sa(g)	Vertical Sa(g)
100	5.38E-02	5.38E-02
90	5.39E-02	5.39E-02
80	5.42E-02	5.42E-02
70	5.47E-02	5.47E-02
60	5.59E-02	5.59E-02
50	5.82E-02	5.82E-02
45	6.01E-02	6.01E-02
40	6.25E-02	6.25E-02
35	6.76E-02	6.76E-02
30.0	7.78E-02	7.78E-02
25	9.41E-02	9.41E-02
20	9.83E-02	9.83E-02
15	8.59E-02	8.59E-02
12.5	8.07E-02	8.07E-02
10	8.17E-02	8.17E-02
9	8.34E-02	8.34E-02
8	8.47E-02	8.47E-02
7	8.34E-02	8.34E-02
6	8.04E-02	8.04E-02
5	8.71E-02	8.70E-02
4	7.97E-02	7.96E-02
3	8.77E-02	7.51E-02
2.5	9.45E-02	6.76E-02
2	7.94E-02	5.64E-02
1.5	6.92E-02	4.87E-02
1.25	7.43E-02	5.20E-02
1	8.59E-02	5.98E-02
0.9	9.94E-02	6.89E-02
0.8	1.07E-01	7.42E-02
0.7	1.01E-01	6.97E-02
0.6	9.46E-02	6.49E-02
0.5	8.04E-02	5.48E-02
0.4	5.02E-02	3.40E-02
0.3	3.21E-02	2.16E-02
0.2	2.09E-02	1.40E-02
0.15	1.34E-02	8.93E-03
0.125	9.69E-03	6.48E-03
0.1	5.83E-03	3.90E-03

Figure 3JJ-201 Randomized Shear Wave Velocity Profiles, Median Shear Wave Velocity Profile and the Input Median Profile Used for Randomization — NI Site Conditions

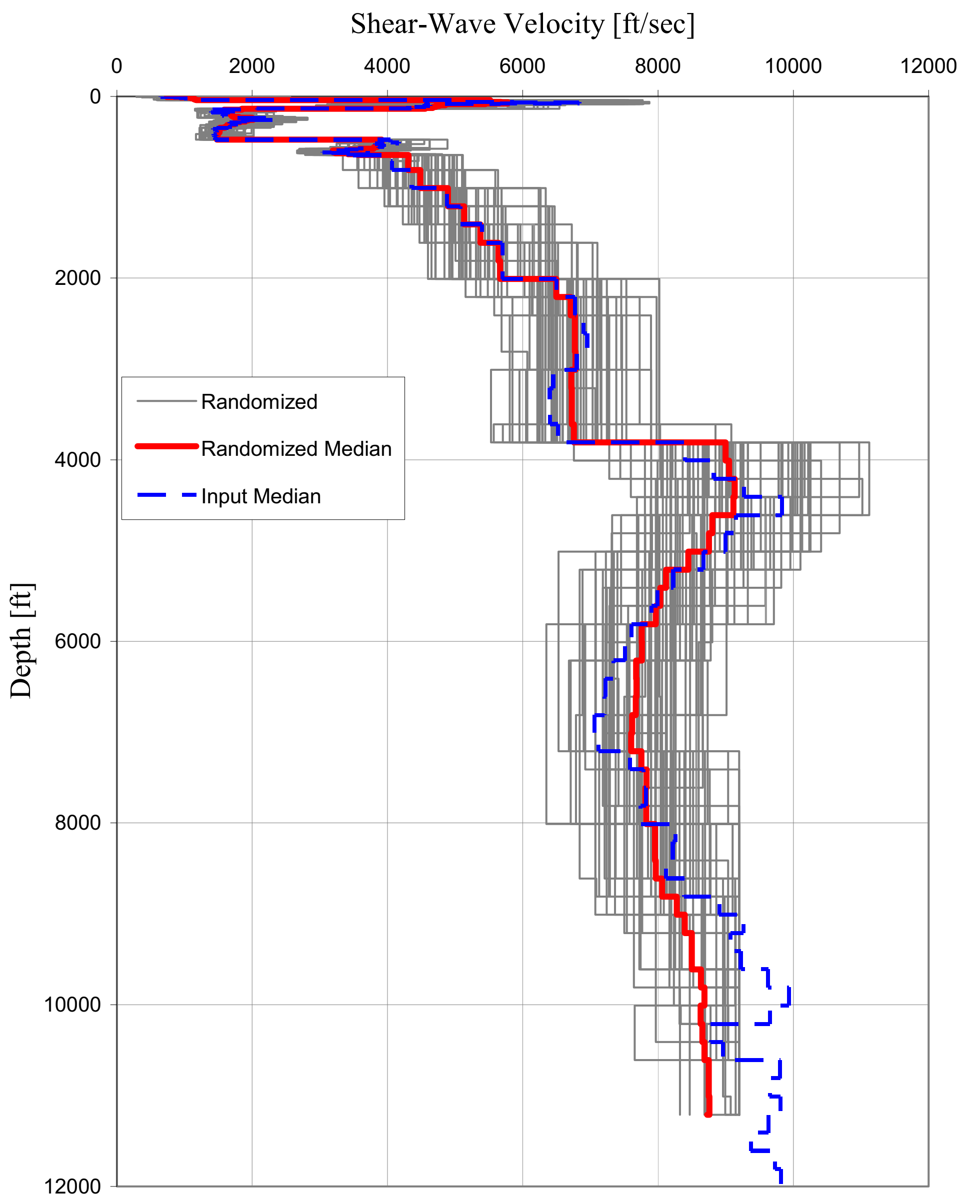


Figure 3JJ-202 Randomized Shear Wave Velocity Profiles, Median Shear Wave Velocity Profile and the Input Median Profile Used for Randomization — FAR Site Conditions

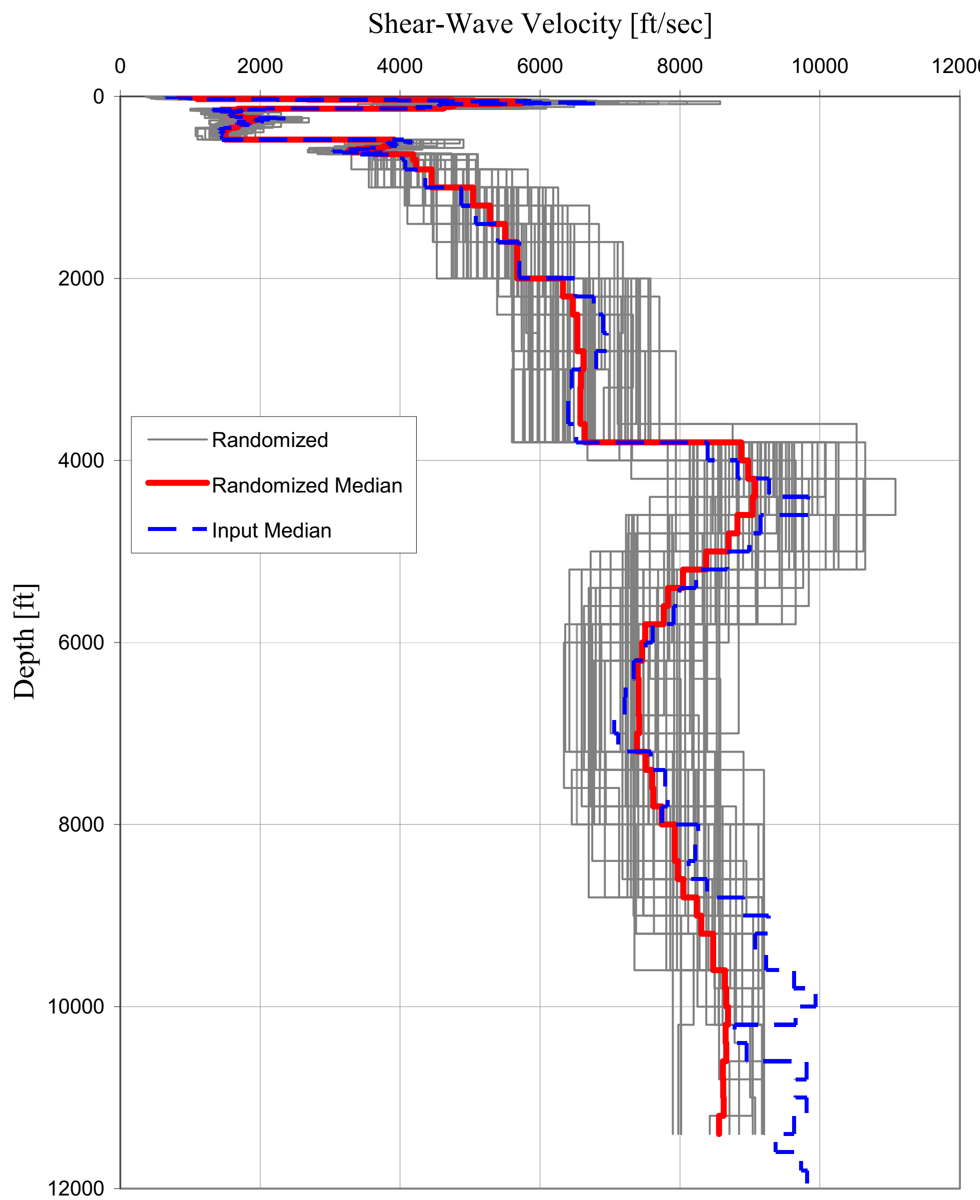


Figure 3JJ-203 ARS Amplification Factors at FIRS Horizon — NI Site Conditions

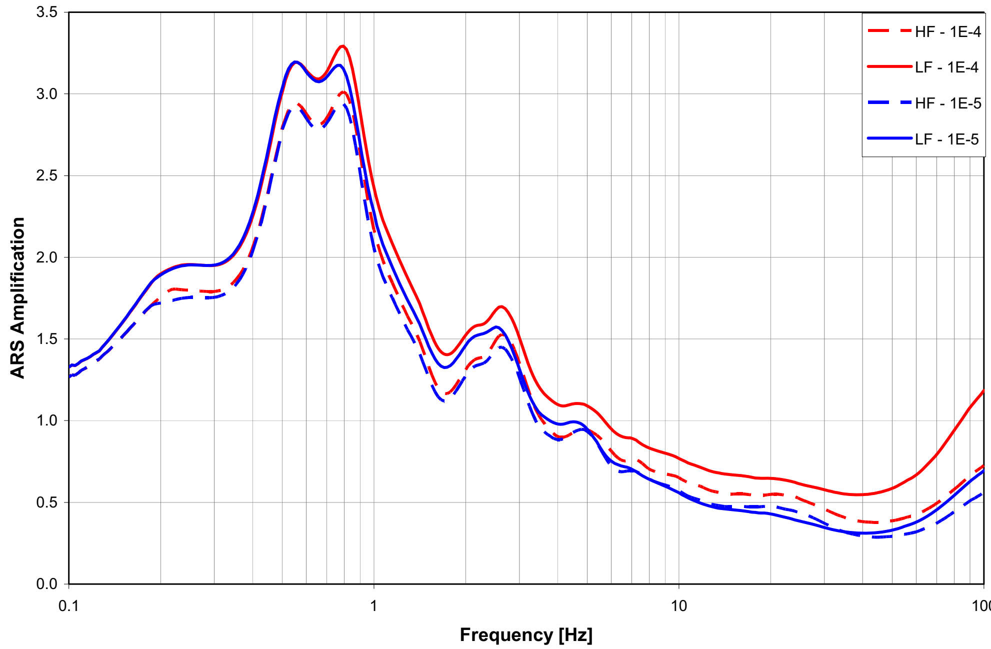


Figure 3JJ-204 ARS Amplification Factors at FIRS Horizon — FAR Site Conditions

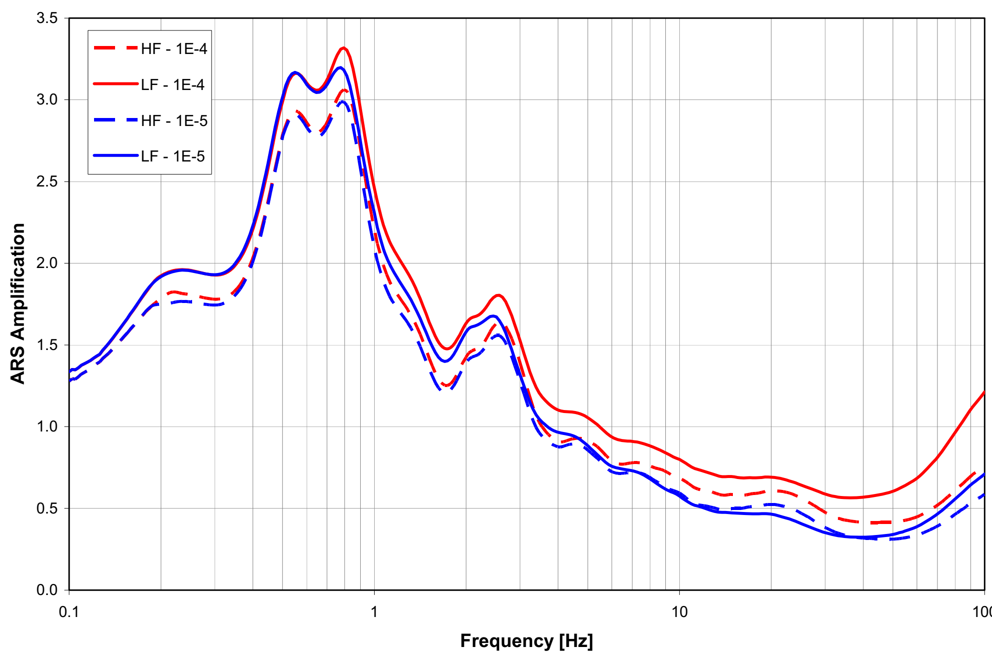


Figure 3JJ-205 ARS Amplification Factors at Ground Surface — NI Site Conditions

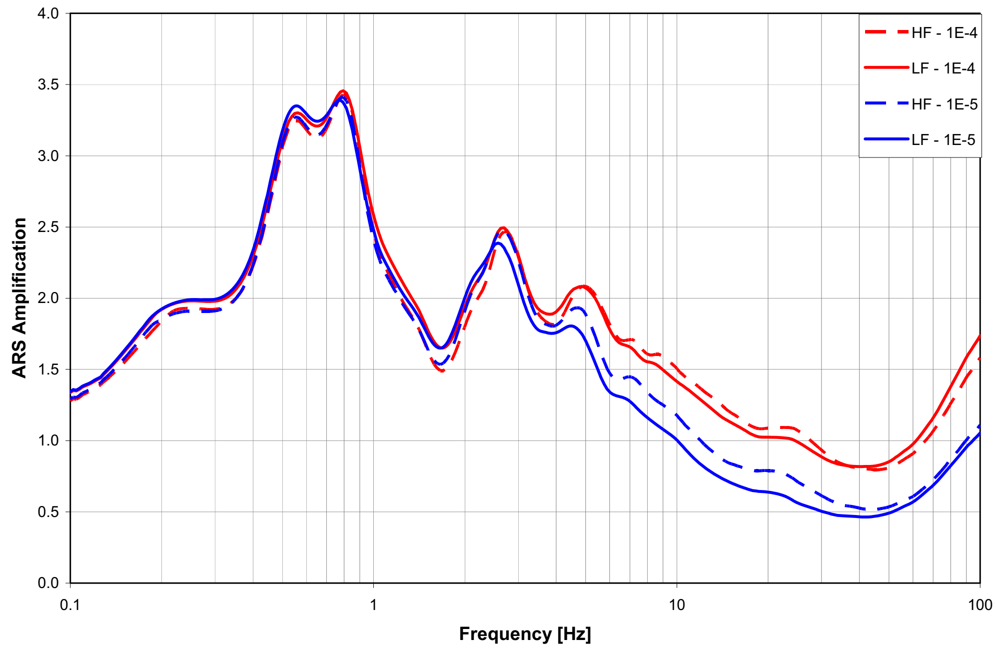


Figure 3JJ-206 ARS Amplification Factors at Ground Surface — FAR Site Conditions

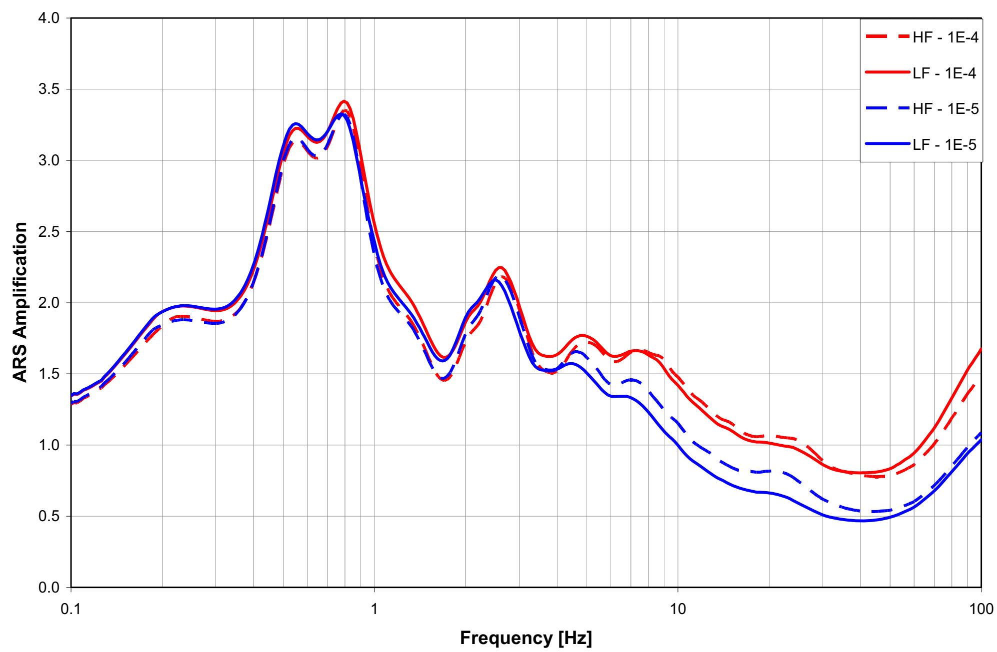


Figure 3JJ-207 Strain Profiles — NI Site Conditions

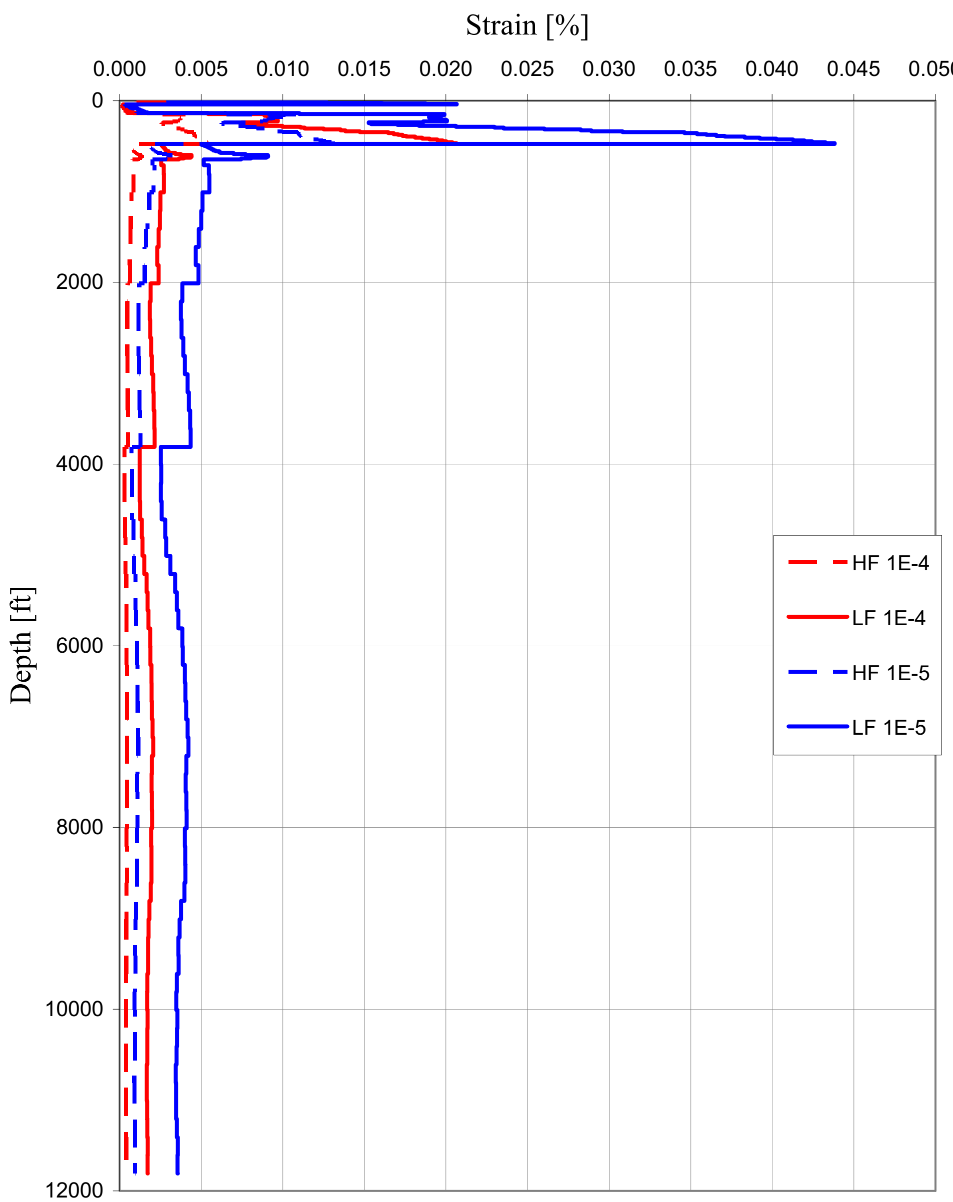


Figure 3JJ-208 Strain Profiles — FAR Site Conditions

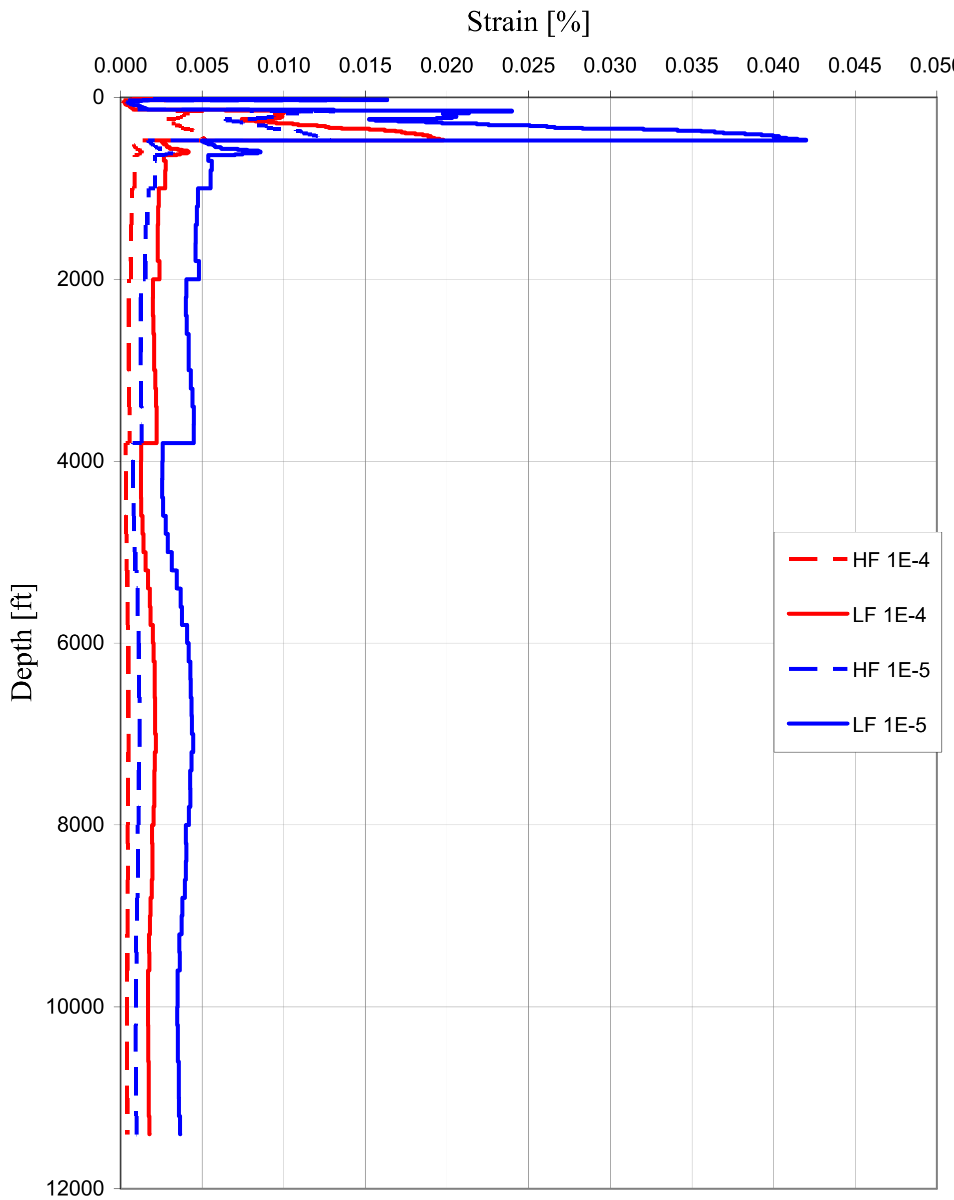


Figure 3JJ-209 HF and LF Horizontal 10^{-4} and 10^{-5} Site Spectra — FAR Soil Column

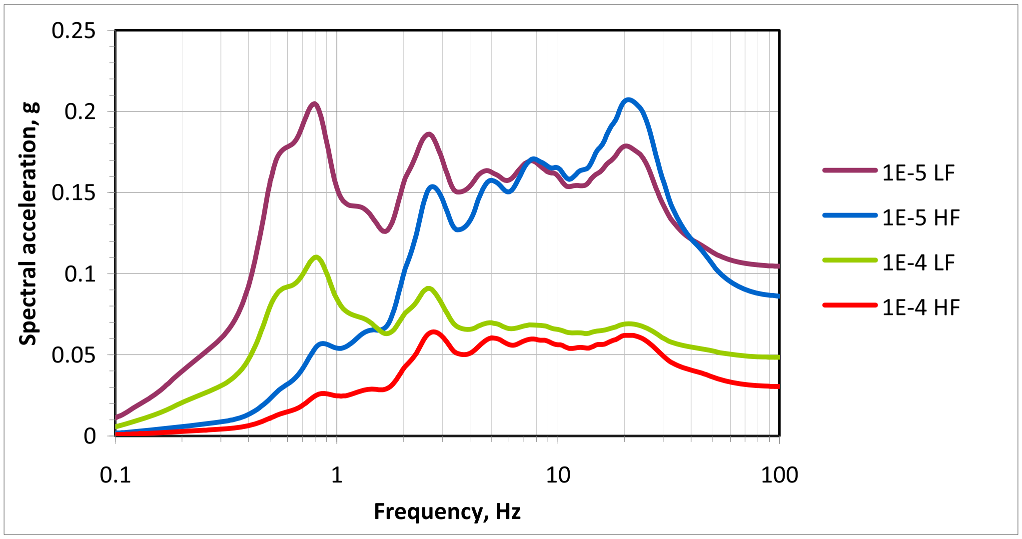


Figure 3JJ-210 HF and LF Horizontal 10^{-4} and 10^{-5} Site Spectra — NI Soil Column

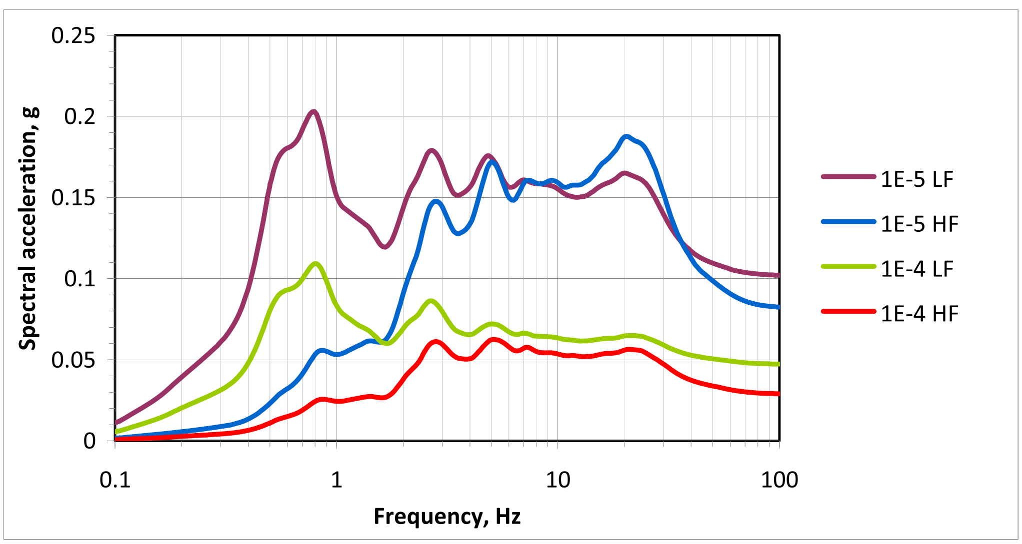


Figure 3JJ-211 Smoothed Horizontal 10^{-4} and 10^{-5} Site Spectra and DRS — FAR Soil Column

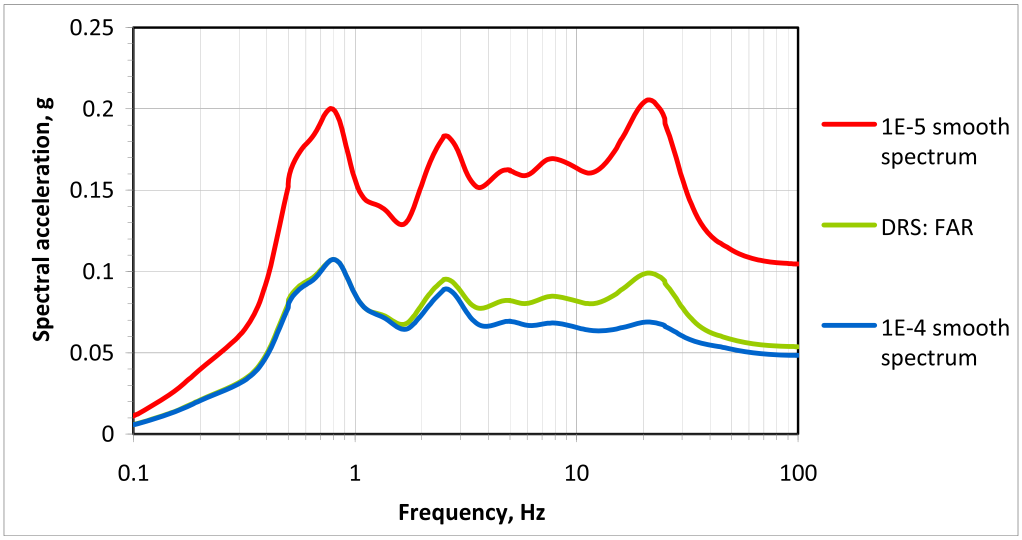


Figure 3JJ-212 Smoothed Horizontal 10^{-4} and 10^{-5} Site Spectra and DRS — NI Soil Column

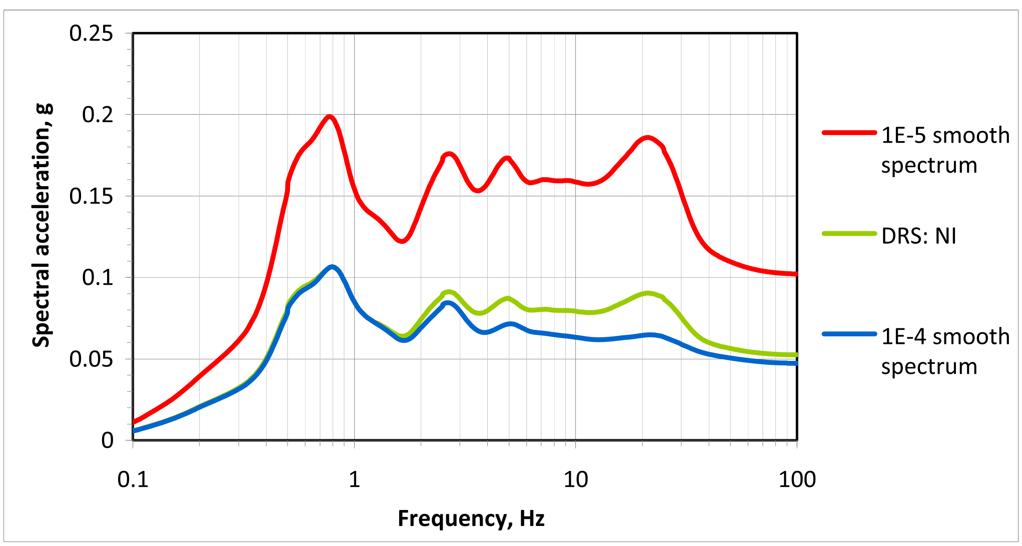


Figure 3JJ-213 Smoothed Vertical 10^{-4} and 10^{-5} Site Spectra and DRS — FAR Soil Column

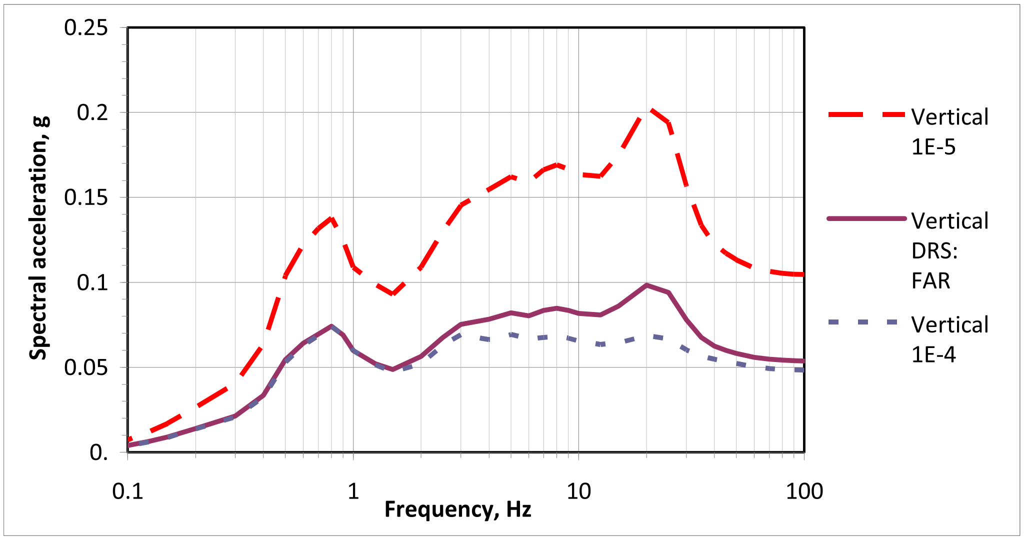


Figure 3JJ-214 Smoothed Vertical 10^{-4} and 10^{-5} Site Spectra and DRS — NI Soil Column

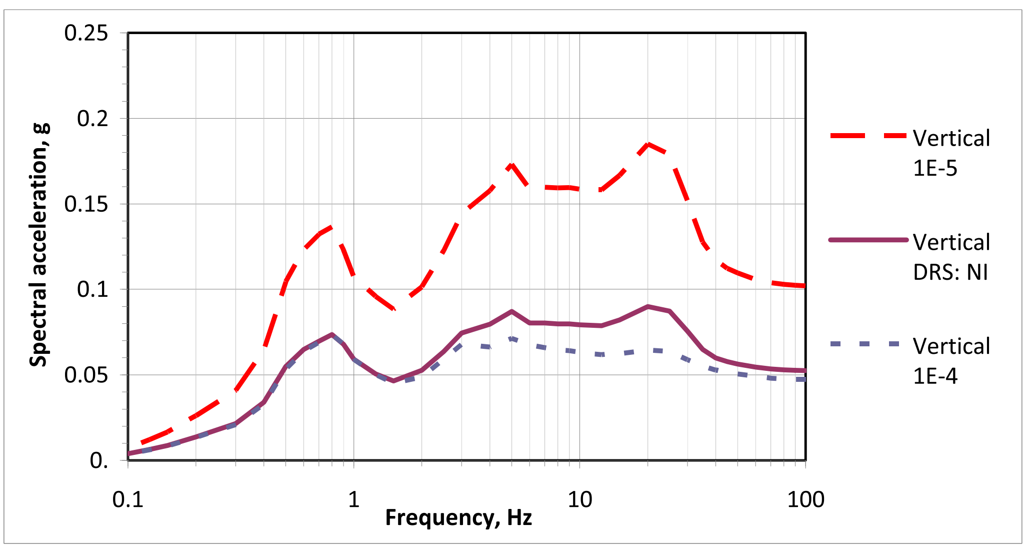


Figure 3JJ-215 Recommended Horizontal and Vertical FIRS (Elevation –16 foot Horizon at Bottom of Nuclear Island Foundation)

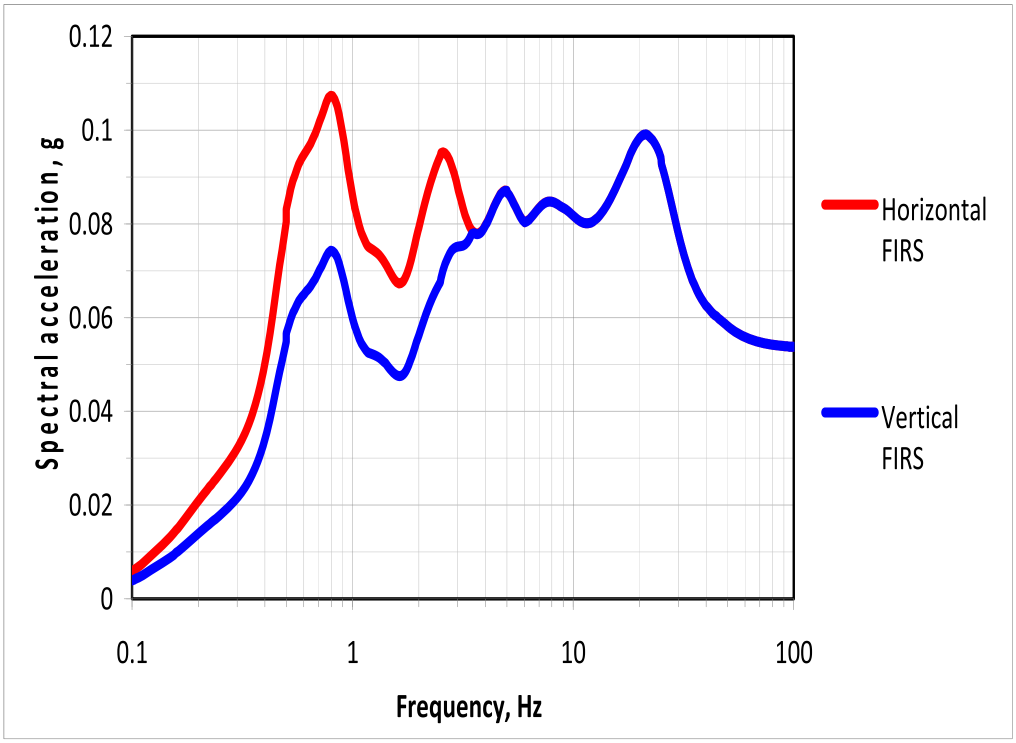


Figure 3JJ-216 Recommended SSI Shear-Wave Velocity Profiles — NI Site Conditions (Upper 1000 feet — below 1000 feet depth is not shown)

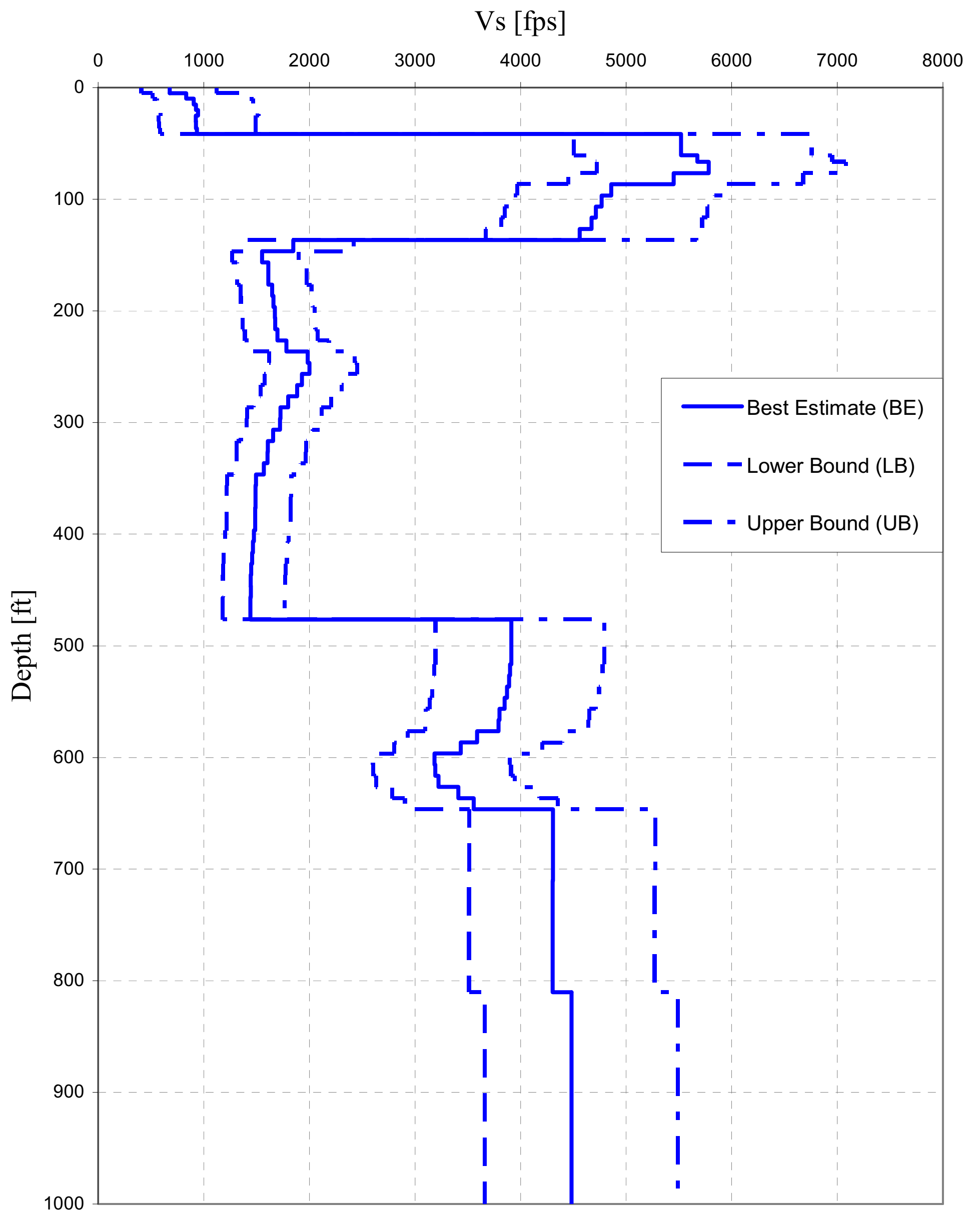


Figure 3JJ-217 Recommended SSI Damping Profiles — NI Site Conditions (Upper 1000 feet — below 1000 feet depth is not shown)

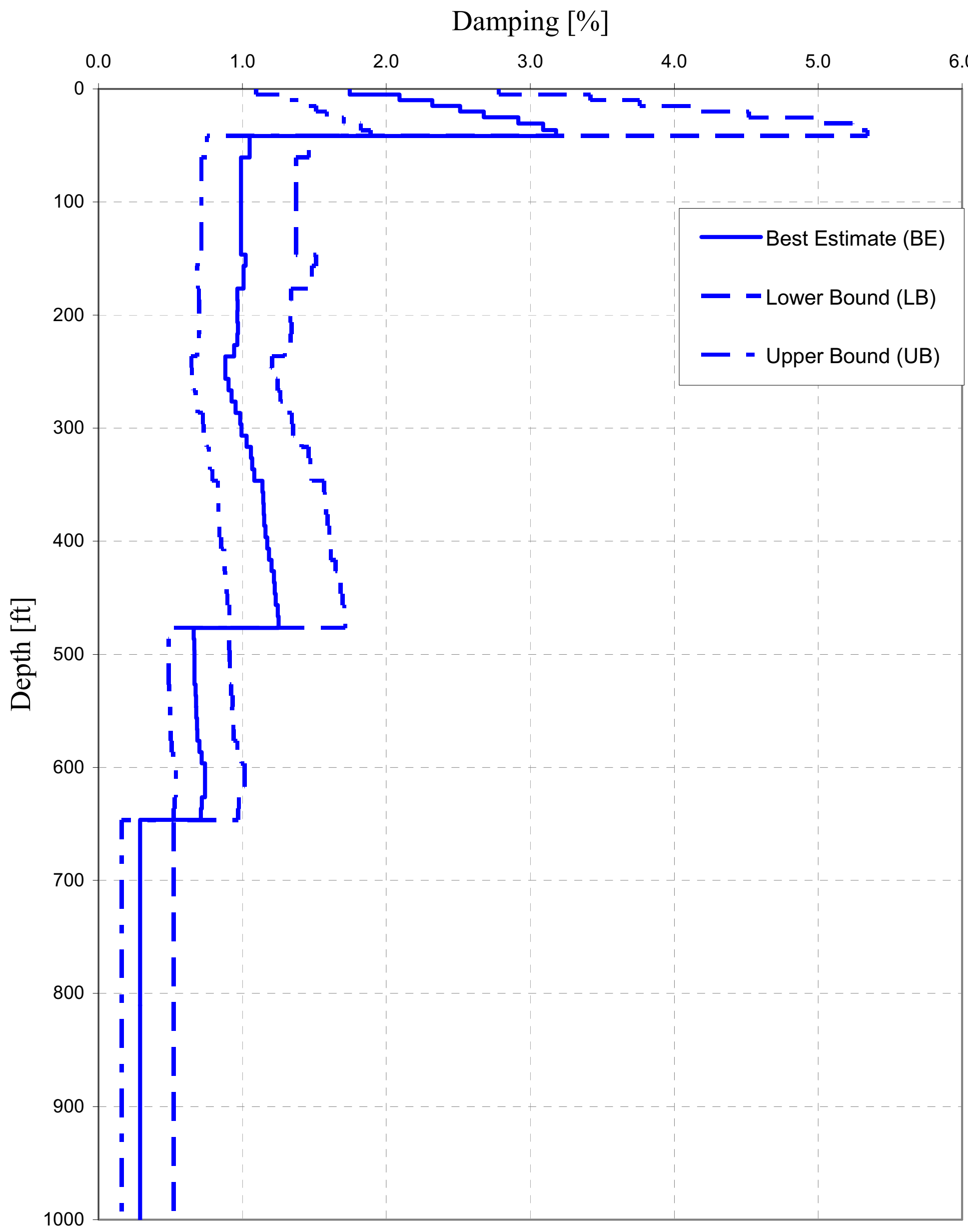


Figure 3JJ-218 Recommended P-Wave Velocity Profiles — NI Site Conditions (Upper 1000 feet — below 1000 feet depth is not shown)

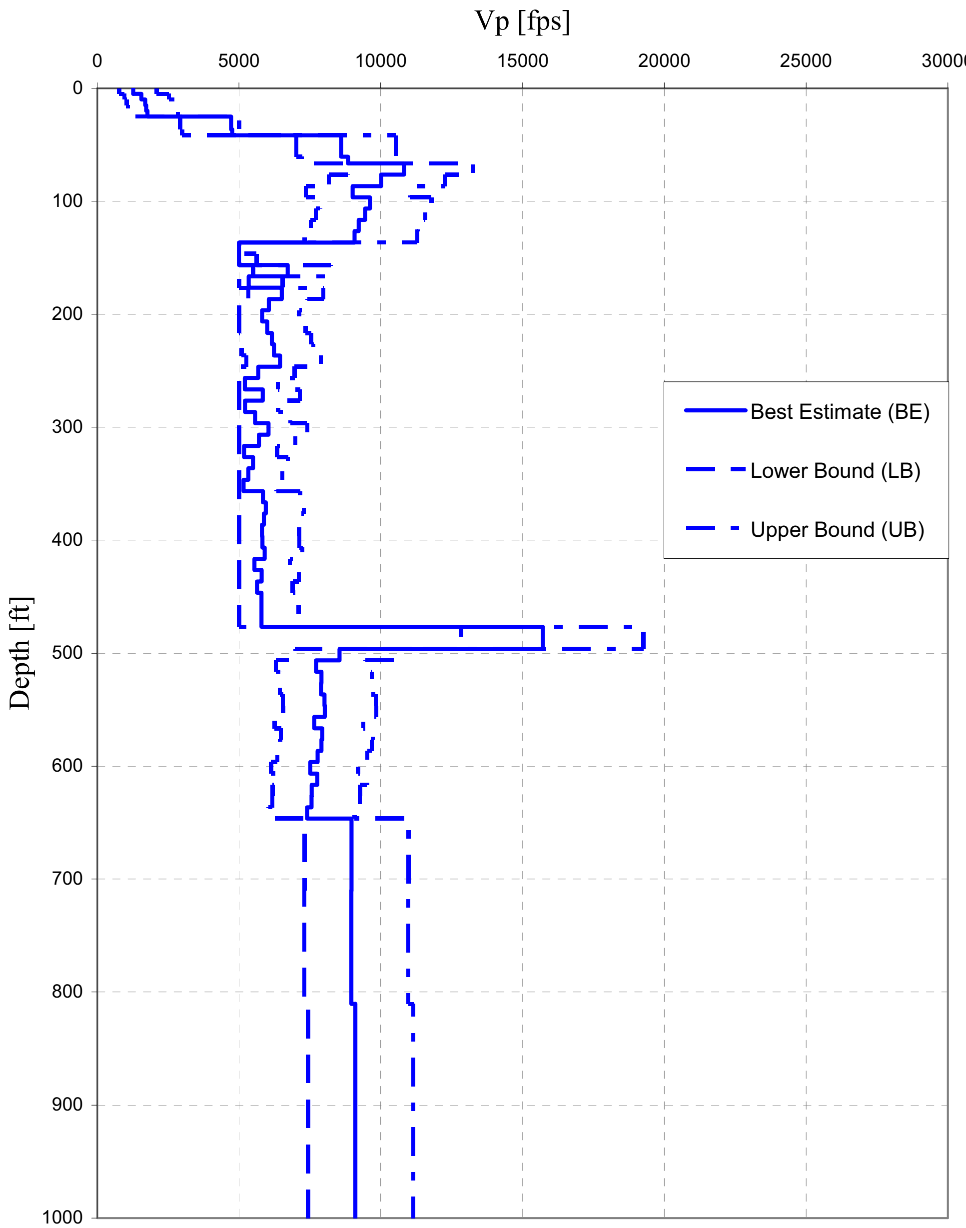


Figure 3JJ-219 Recommended SSI Shear-Wave Velocity Profiles — FAR Site Conditions (Upper 1000 feet — below 1000 feet depth is not shown)

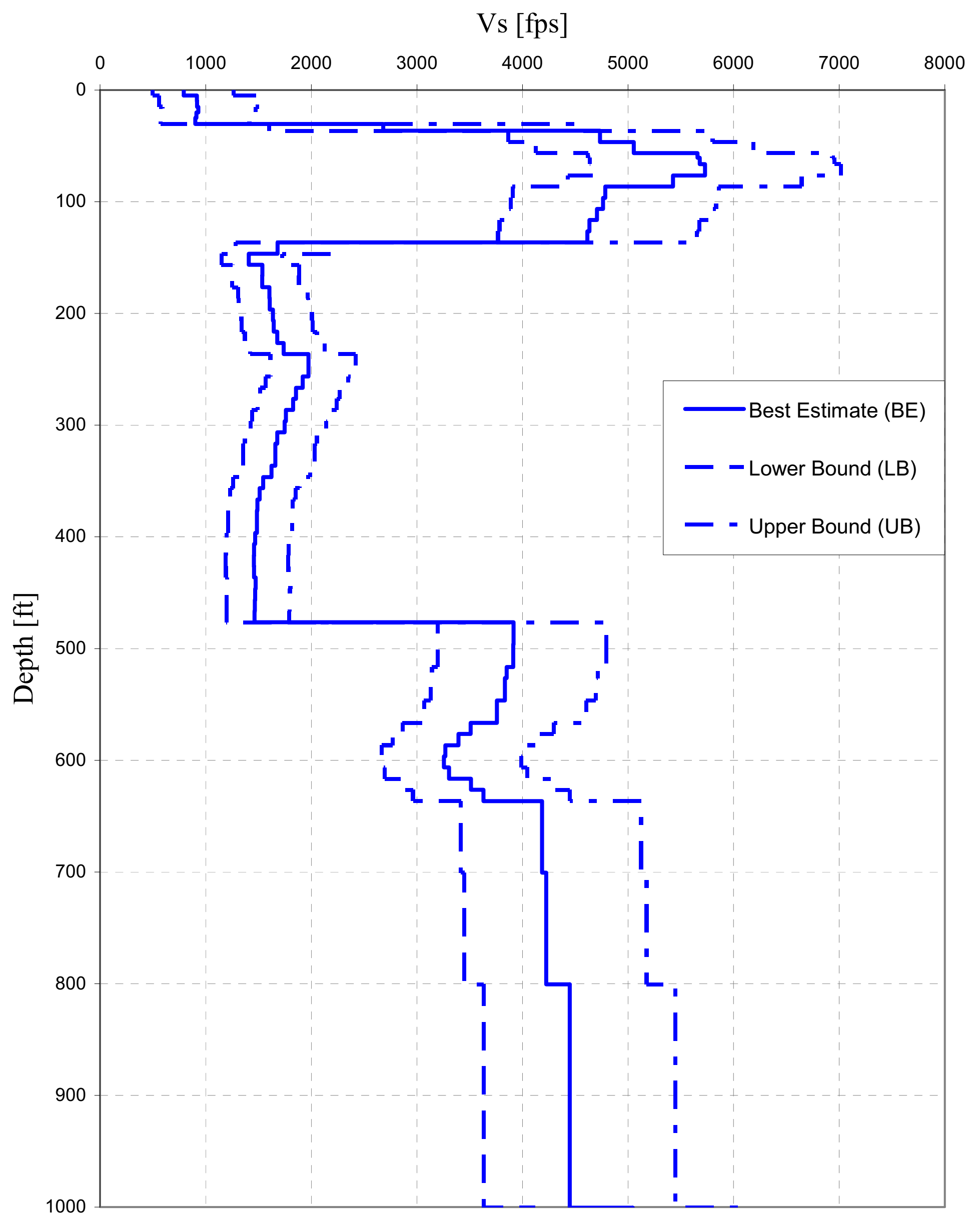


Figure 3JJ-220 Recommended SSI Damping Profiles — FAR Site Conditions (Upper 1000 feet — below 1000 feet depth is not shown)

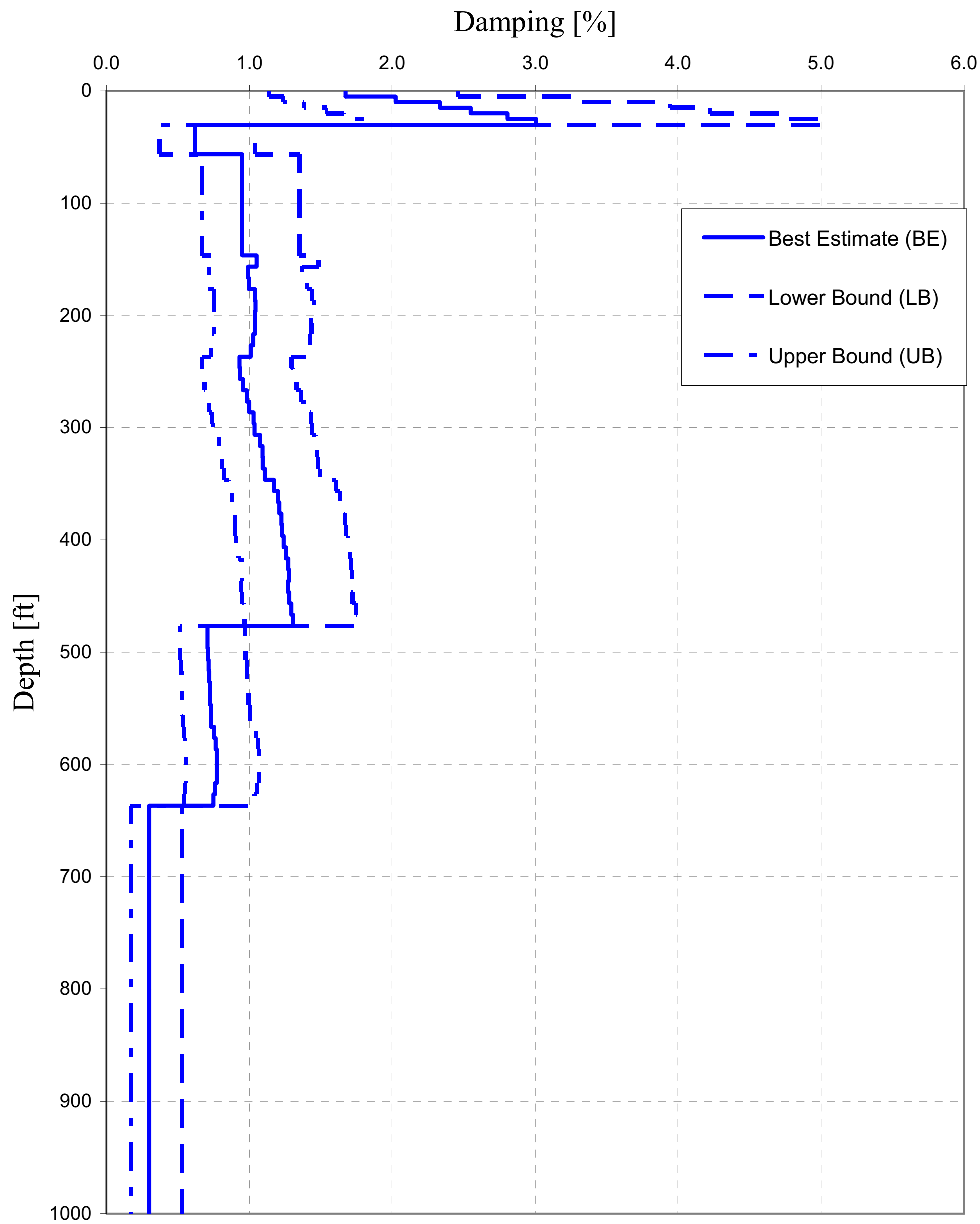


Figure 3JJ-221 Recommended P-Wave Velocity Profiles — FAR Site Conditions (Upper 1000 feet — below 1000 feet depth is not shown)

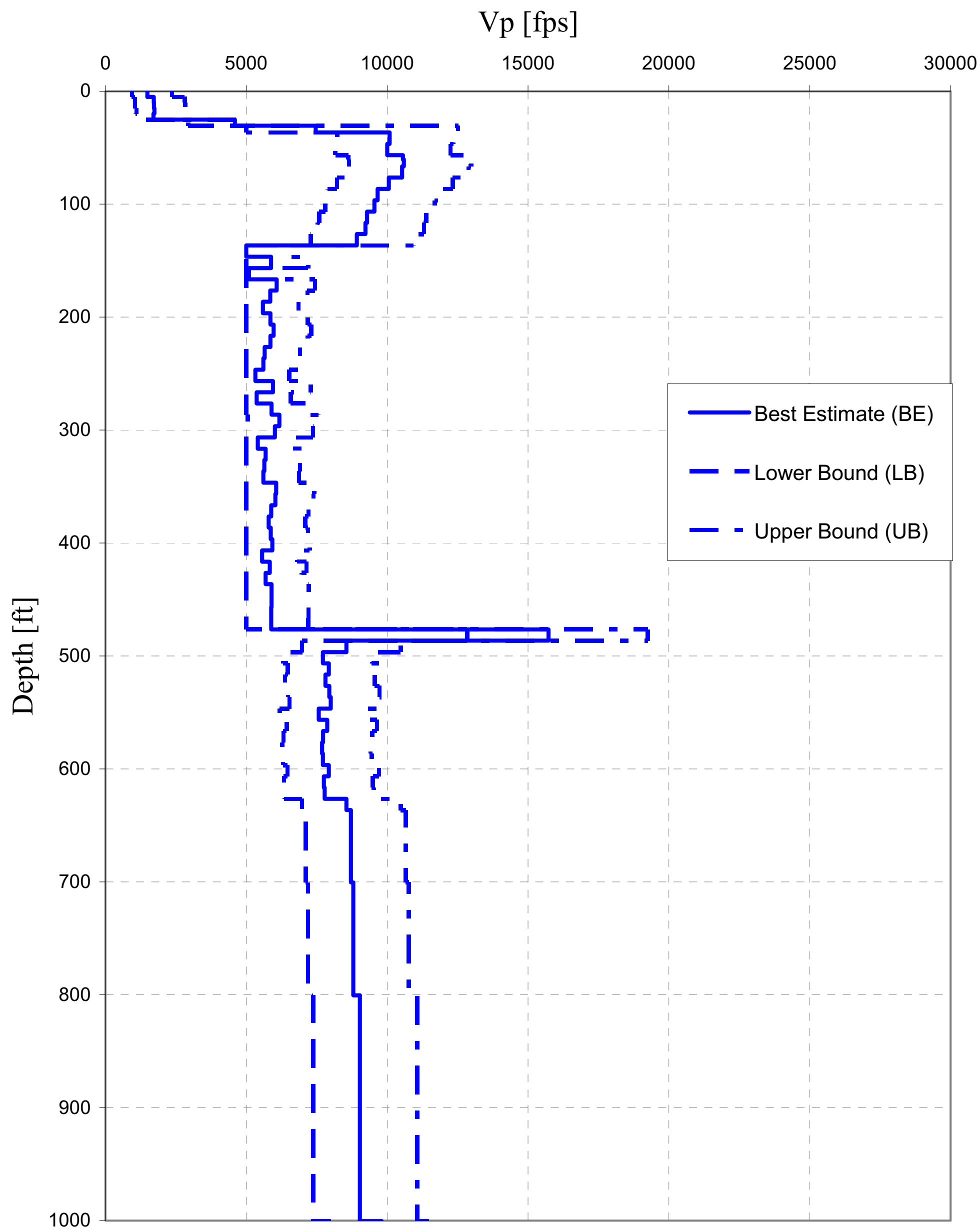


Figure 3JJ-222a Final Spectrum-Compatible Acceleration, Velocity, and Displacement Time Histories for Horizontal 1 Case Before Constant Scale Factor of 1.02 Is Applied

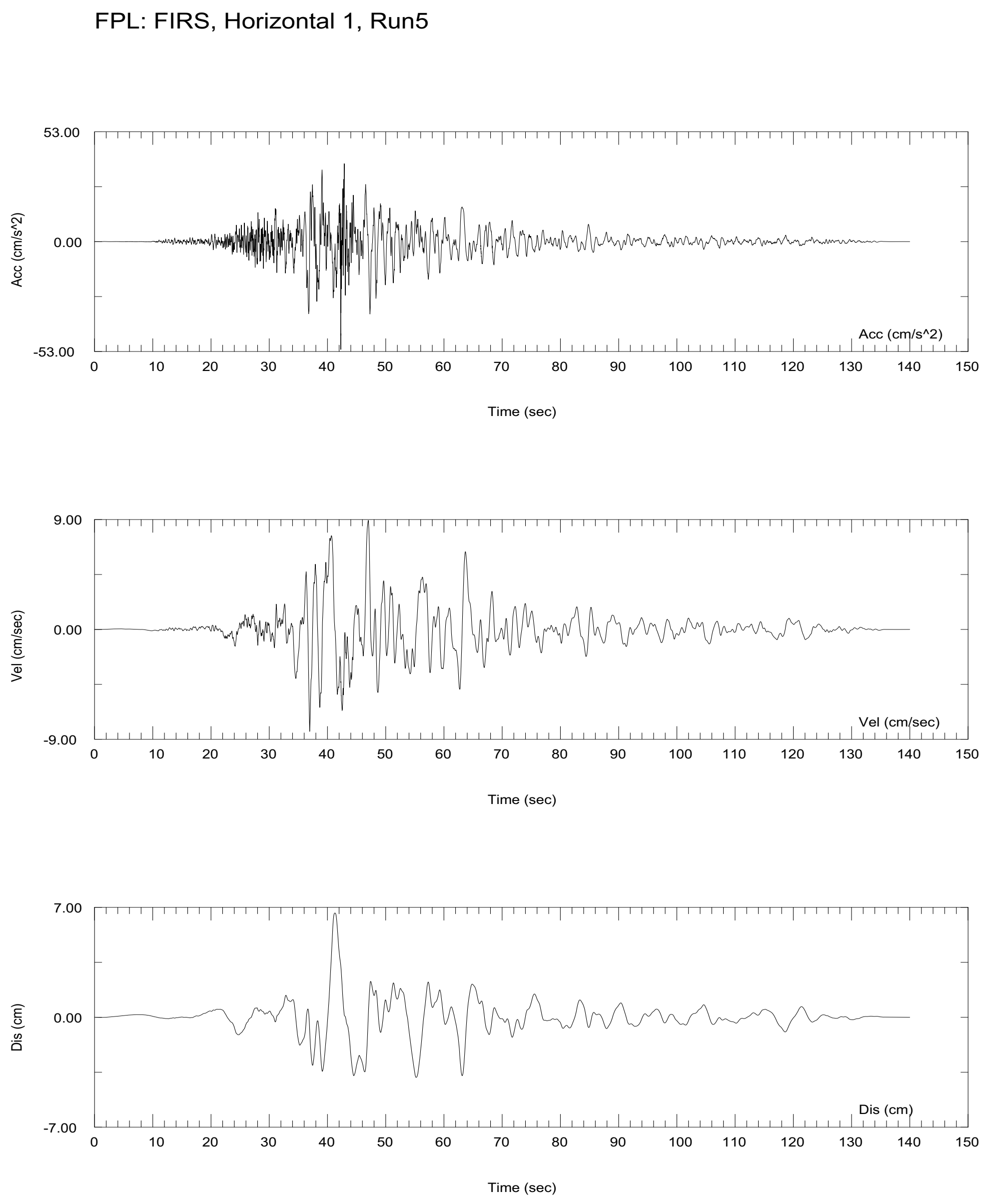


Figure 3JJ-222b Comparison of Initial Seed Acceleration Normalized Arias Intensities Plot and Final Spectrum-Compatible Acceleration Normalized Arias Intensities Plot for Horizontal 1 Cases Before Constant Scale Factor of 1.02 is Applied

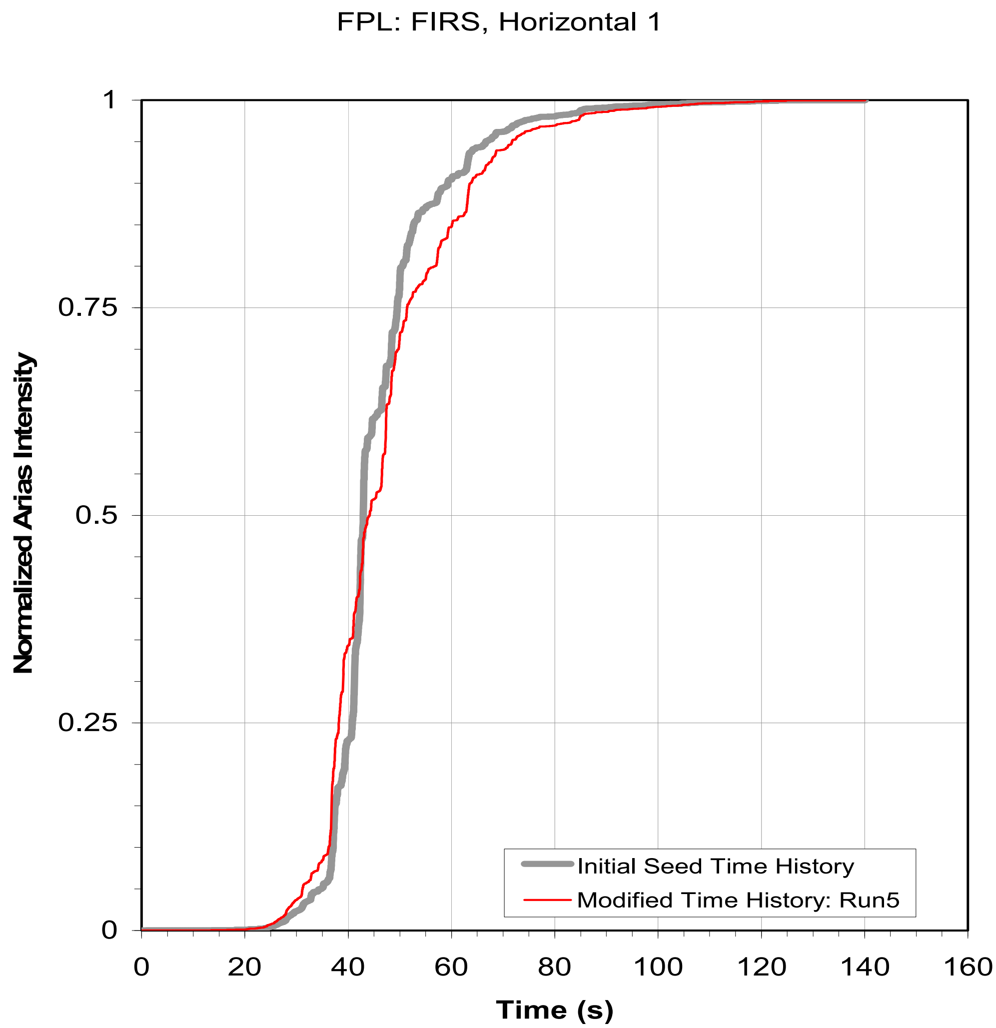


Figure 3JJ-222c Comparison Between the Final Scaled Spectrum-Compatible Response Spectrum, FIRS Horizontal Target Spectrum, and Upper and Lower Target Spectrum Bounds for Horizontal 1 Case With the Constant Scale Factor of 1.02 Applied

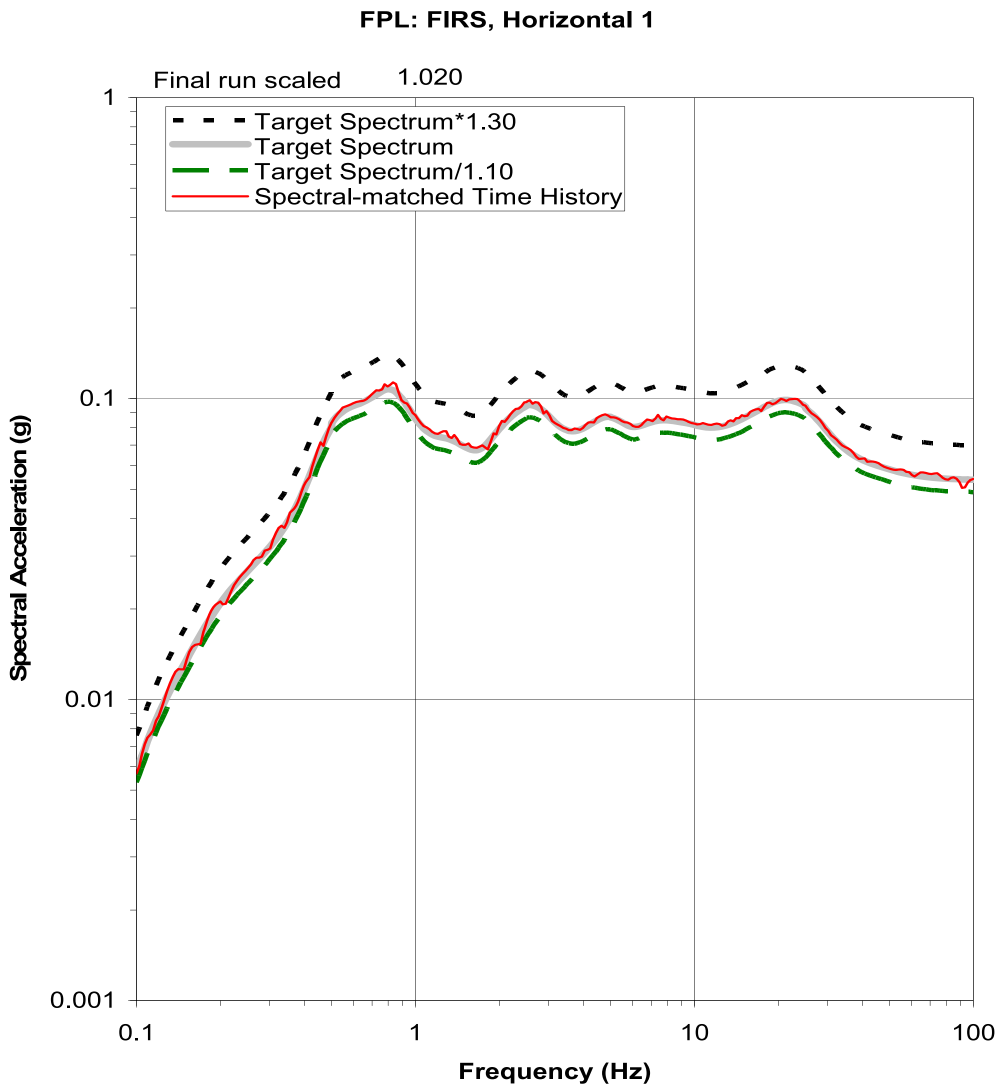


Figure 3JJ-223a Final Spectrum-Compatible Acceleration, Velocity, and Displacement Time Histories for Horizontal 2 Case Before Constant Scale Factor of 1.022 is Applied

FPL: FIRS, Horizontal 2, Run5

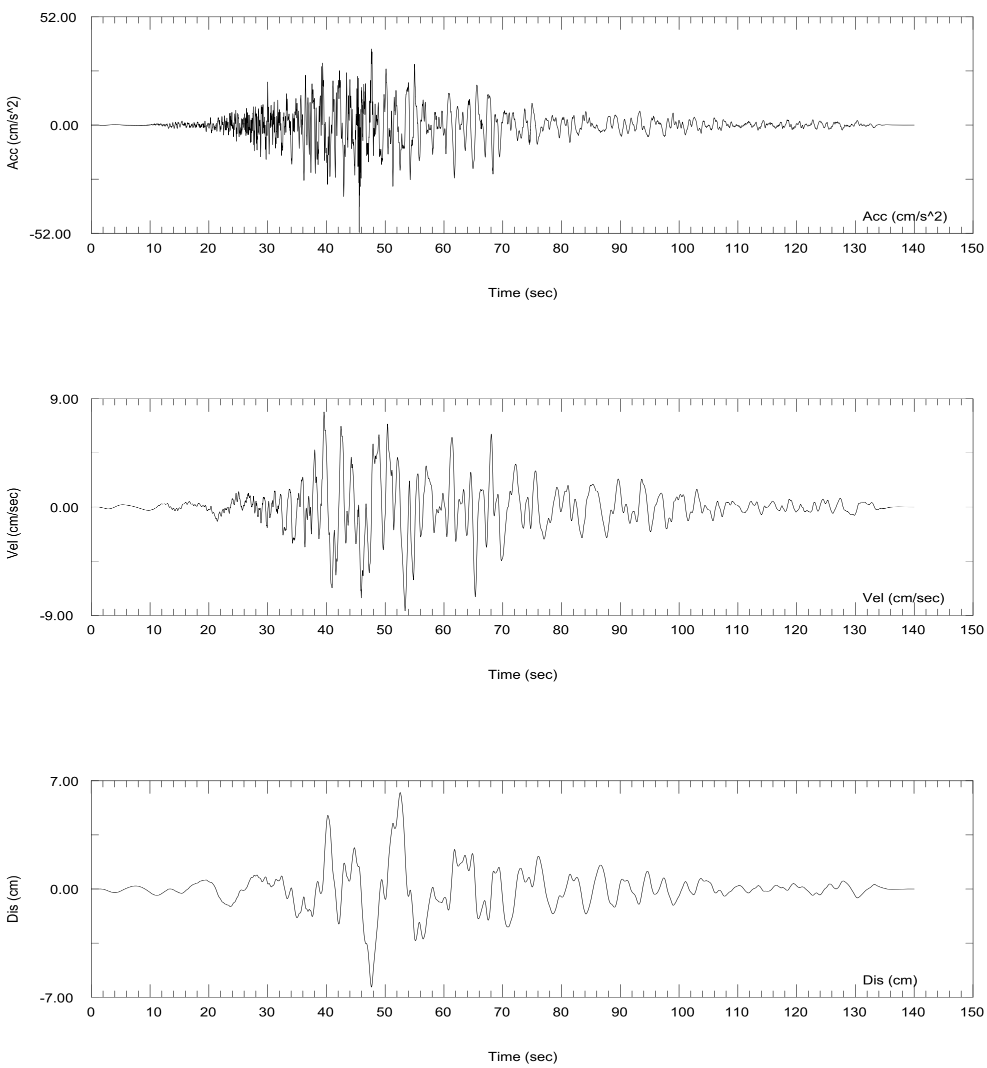


Figure 3JJ-223b Comparison of Initial Seed Acceleration Normalized Arias Intensities Plot and Final Spectrum-Compatible Acceleration Normalized Arias Intensities Plot for Horizontal 2 Cases Before Constant Scale Factor of 1.022 is Applied

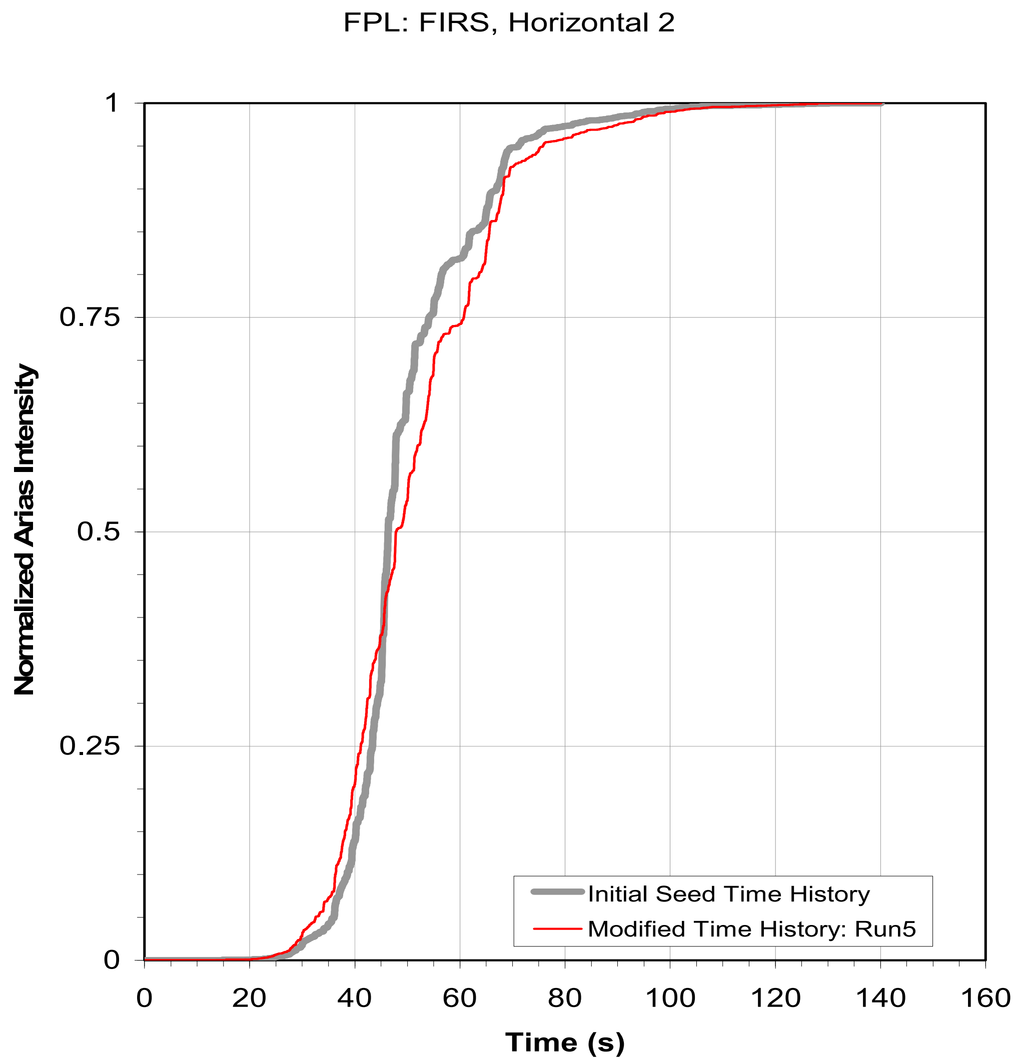


Figure 3JJ-223c Comparison Between the Final Scaled Spectrum-Compatible Response Spectrum, FIRS Horizontal Target Spectrum, and Upper and Lower Target Spectrum Bounds for Horizontal 2 Case With the Constant Scale Factor of 1.022 Applied

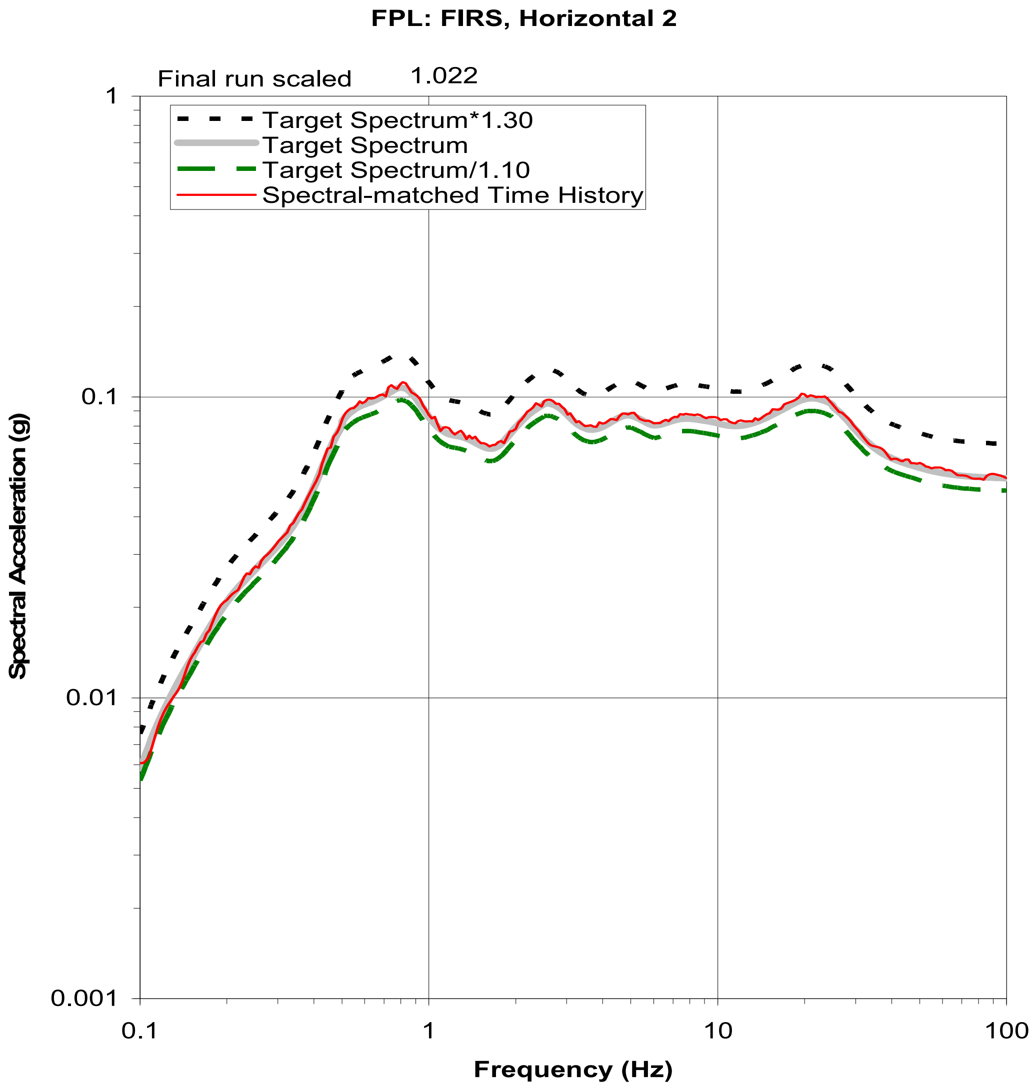


Figure 3JJ-224a Final Spectrum-Compatible Acceleration, Velocity, and Displacement Time Histories for Vertical Case Before Constant Scale Factor of 1.01 is Applied

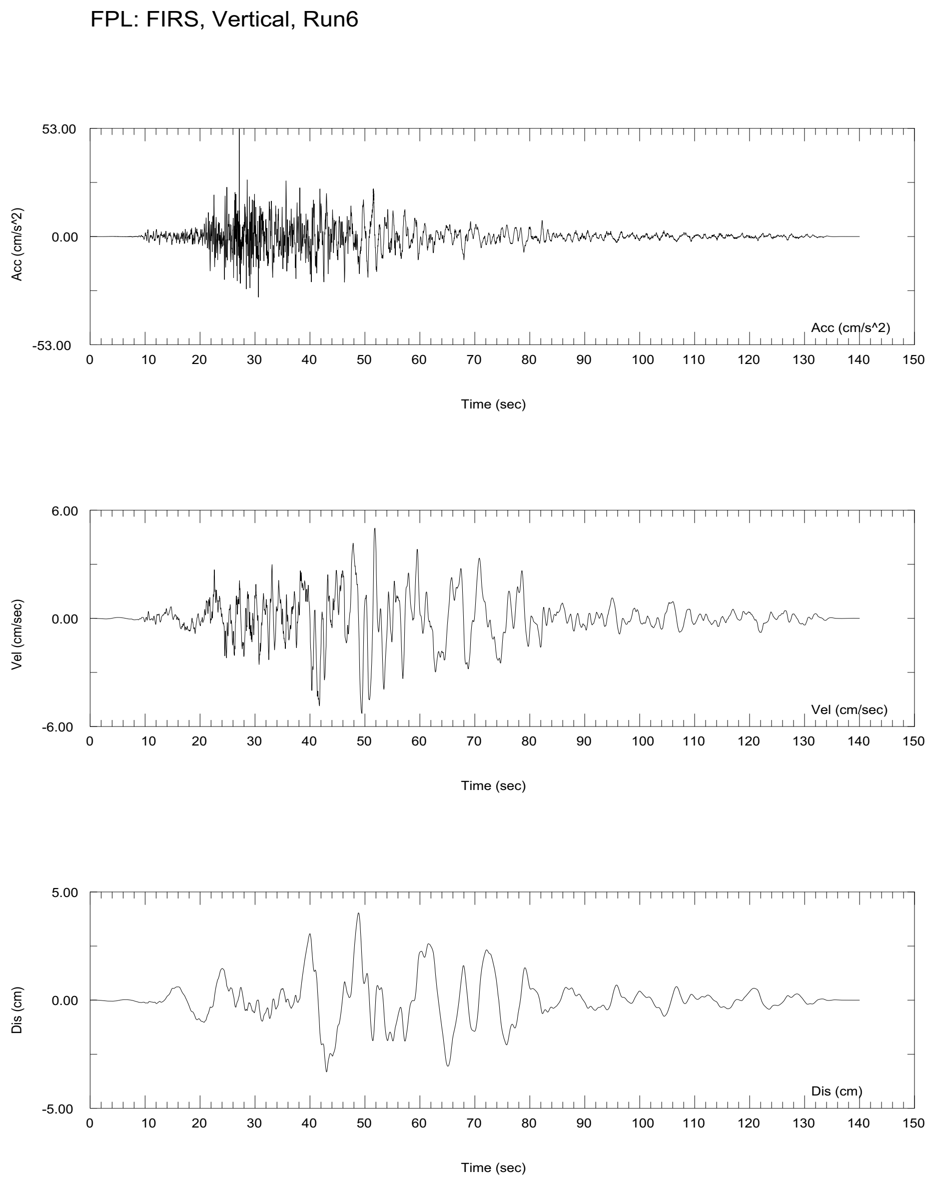


Figure 3JJ-224b Comparison of Initial Seed Acceleration Normalized Arias Intensities Plot and Final Spectrum-Compatible Acceleration Normalized Arias Intensities Plot for Vertical Cases Before Constant Scale Factor of 1.01 is Applied

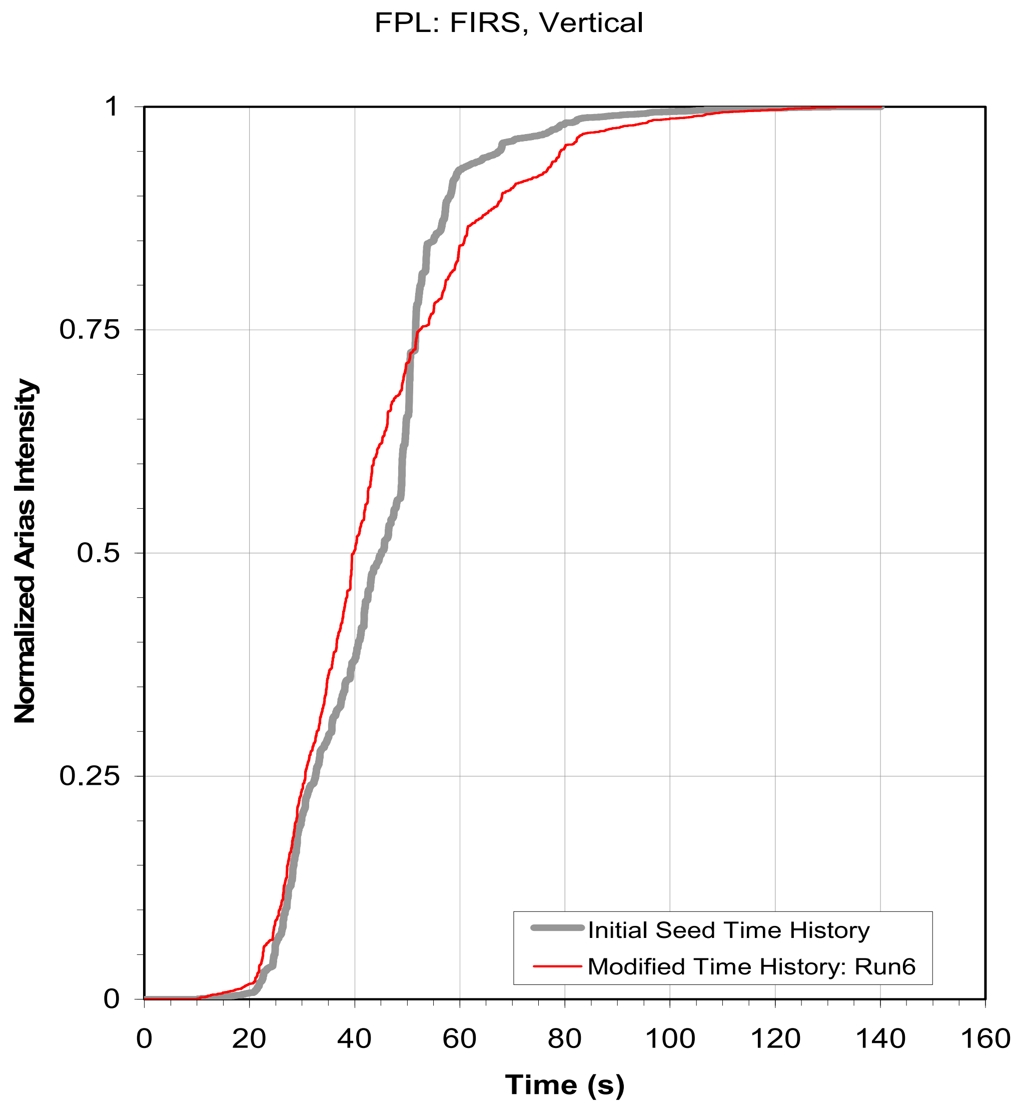


Figure 3JJ-224c Comparison Between the Final Scaled Spectrum-Compatible Response Spectrum, FIRS Vertical Target Spectrum, and Upper and Lower Target Spectrum Bounds for Vertical Case With the Constant Scale Factor of 1.01 Applied

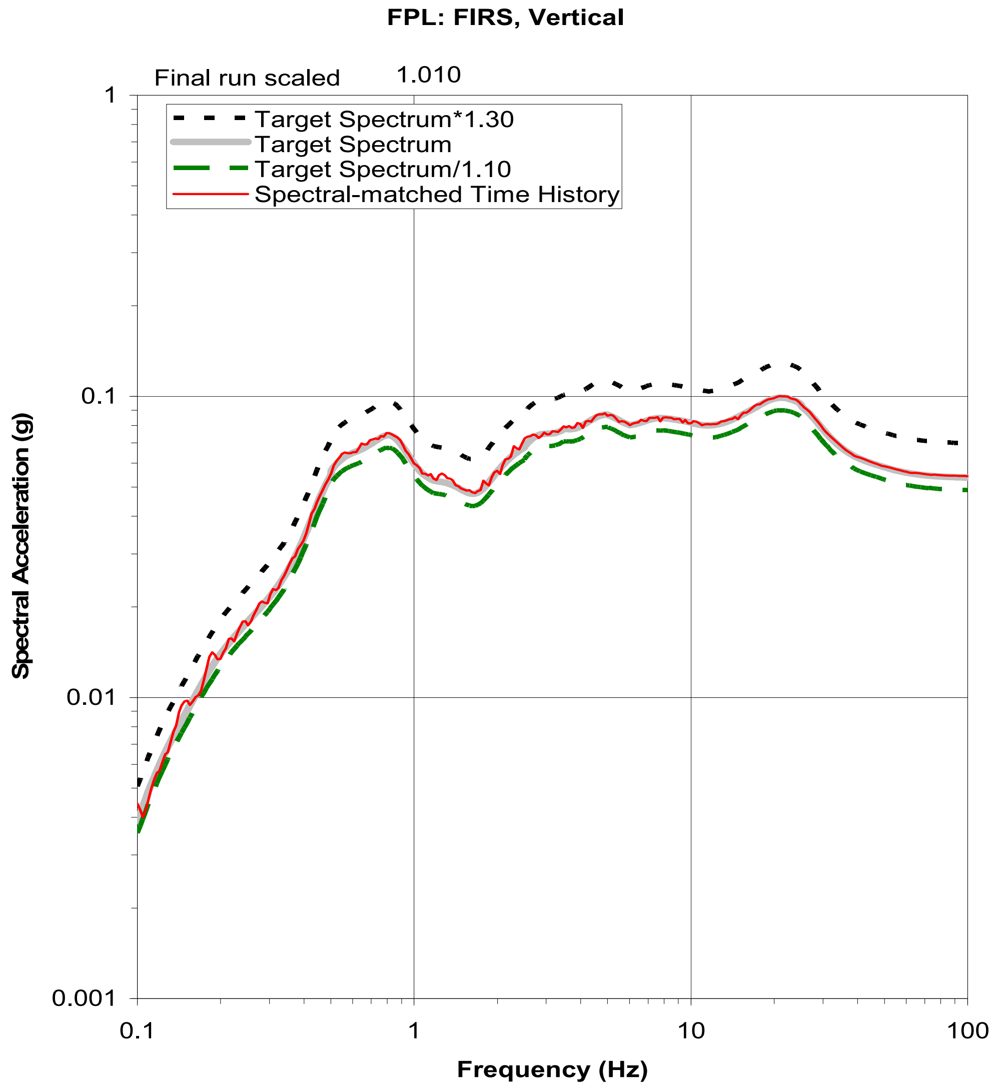


Figure 3JJ-225 5% Damping ARS at Ground Surface — Direction H1 — NI Site Condition

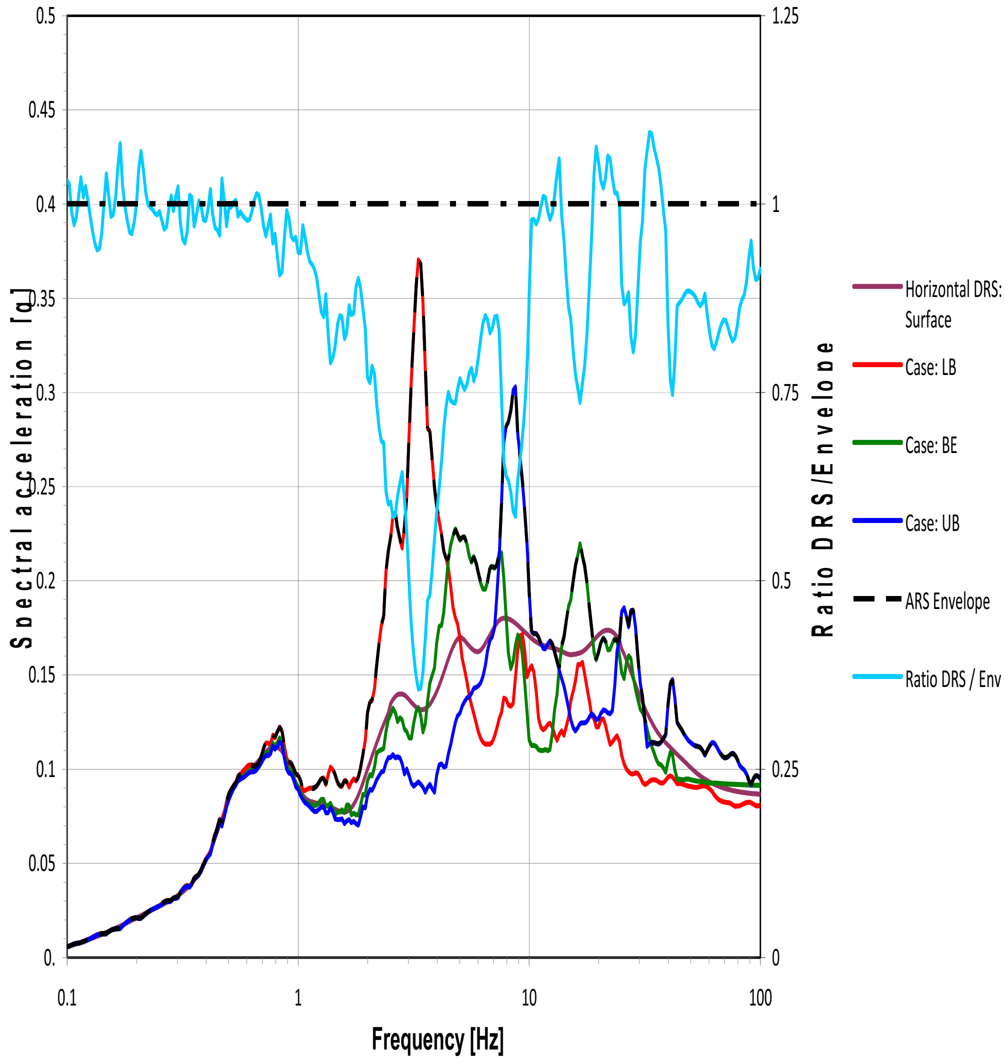


Figure 3JJ-226 5% Damping ARS at Ground Surface — Direction H2 — NI Site Condition

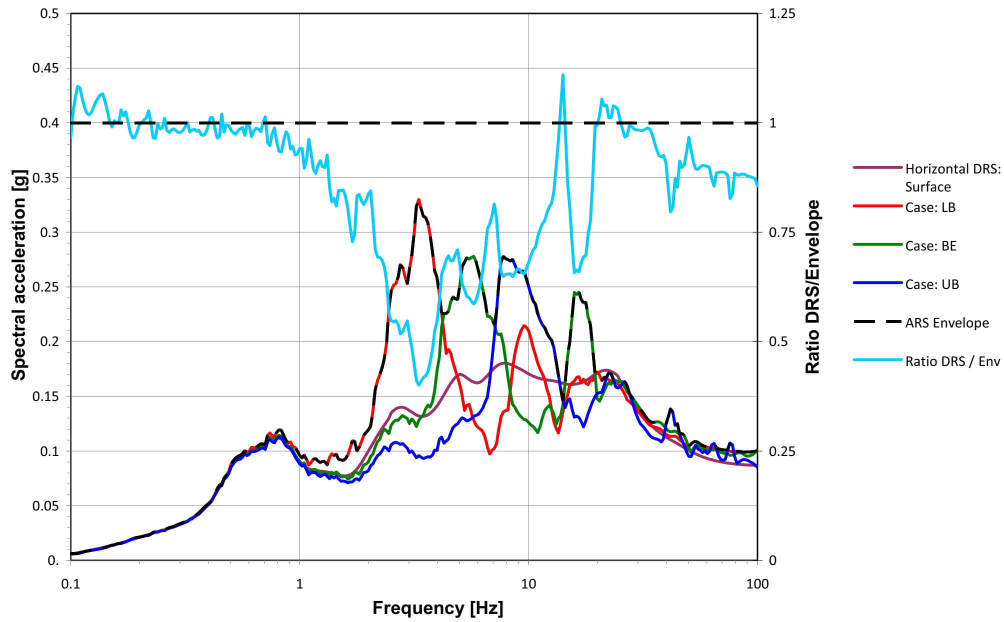


Figure 3JJ-227 5% Damping ARS at Ground Surface — Direction UP — NI Site Condition

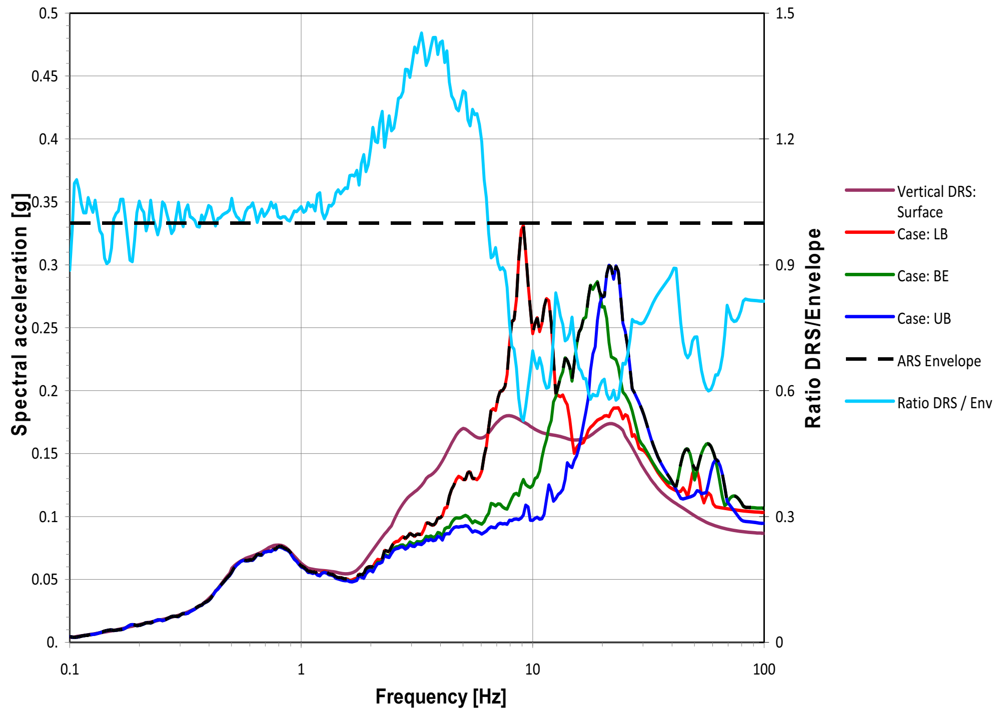


Figure 3JJ-228 5% Damping ARS at Ground Surface — Direction H1 — FAR Site Condition

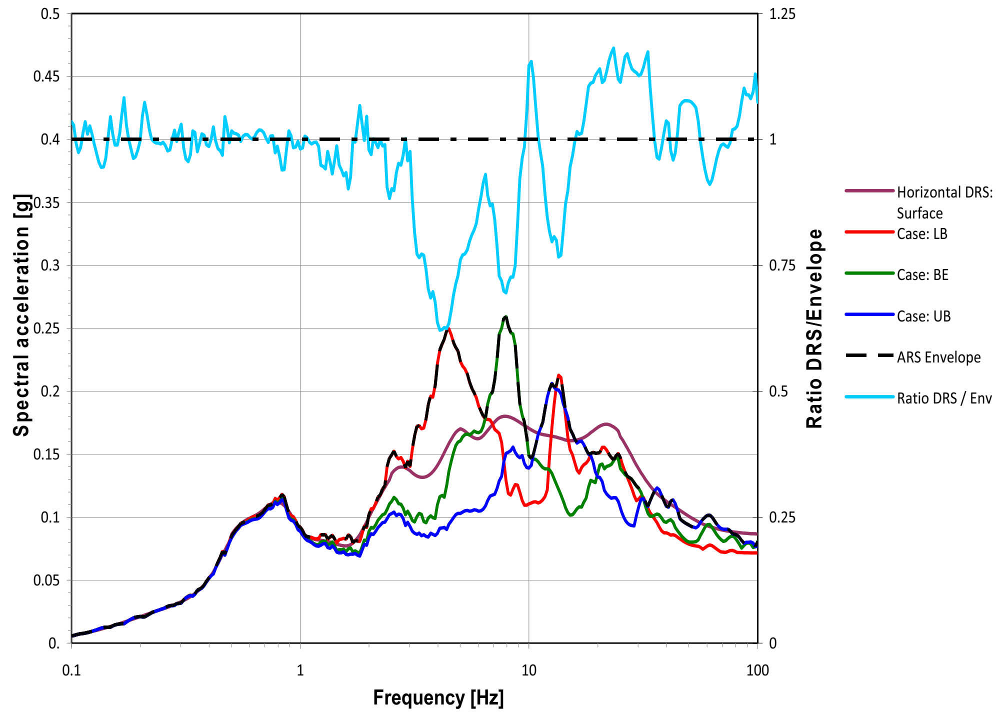


Figure 3JJ-229 5% Damping ARS at Ground Surface — Direction H2 — FAR Site Condition

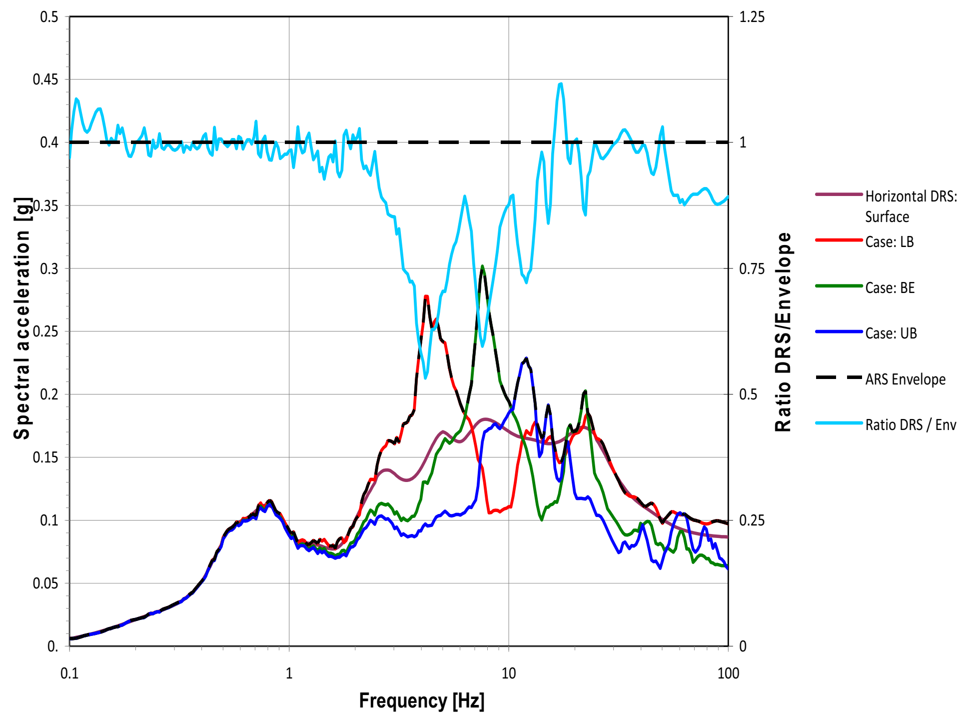


Figure 3JJ-230 5% Damping ARS at Ground Surface — Direction UP — FAR Site Condition

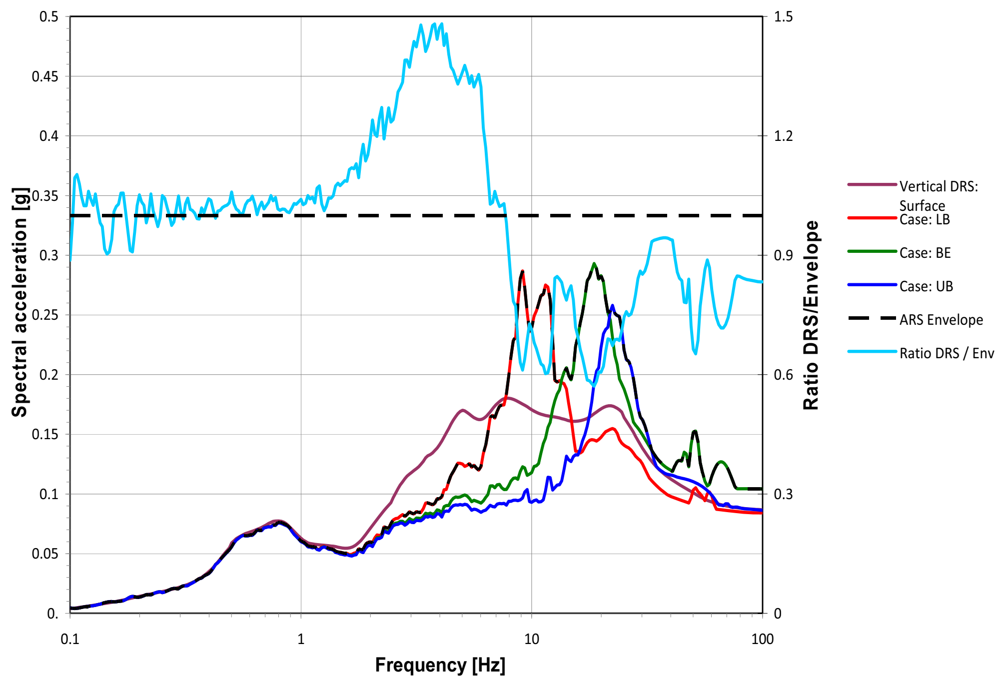


Figure 3JJ-231 Adjusted Vertical Target ARS at FIRS Horizon (5% Damping) Time [sec]

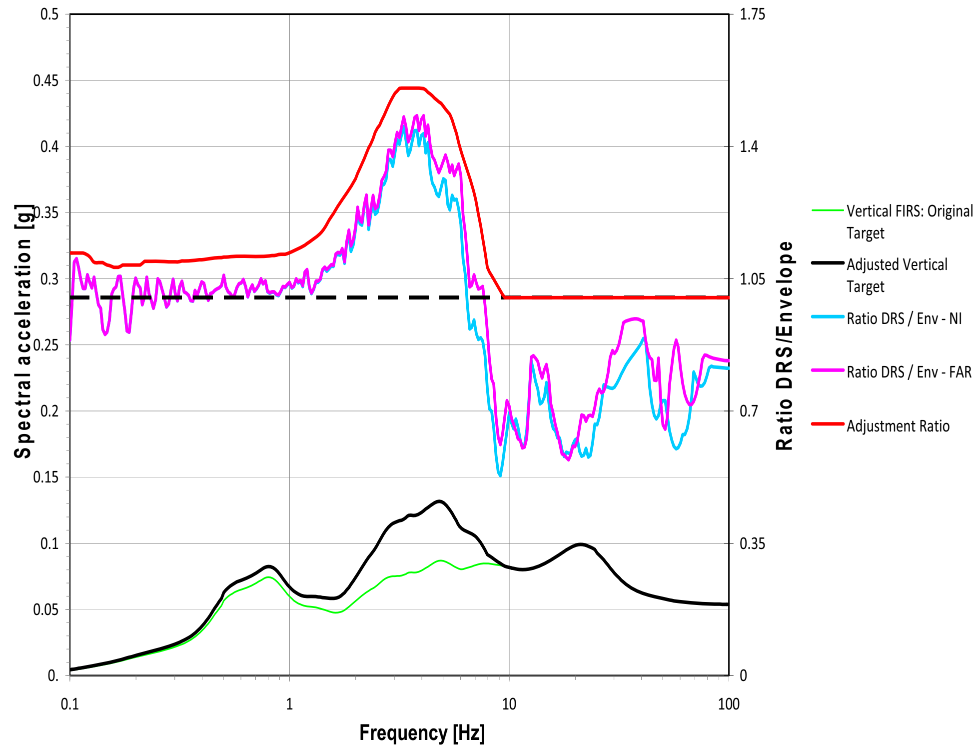


Figure 3JJ-232 SSI Input "Within" Acceleration Time History — Direction H1 — NI Site Condition Time [sec]

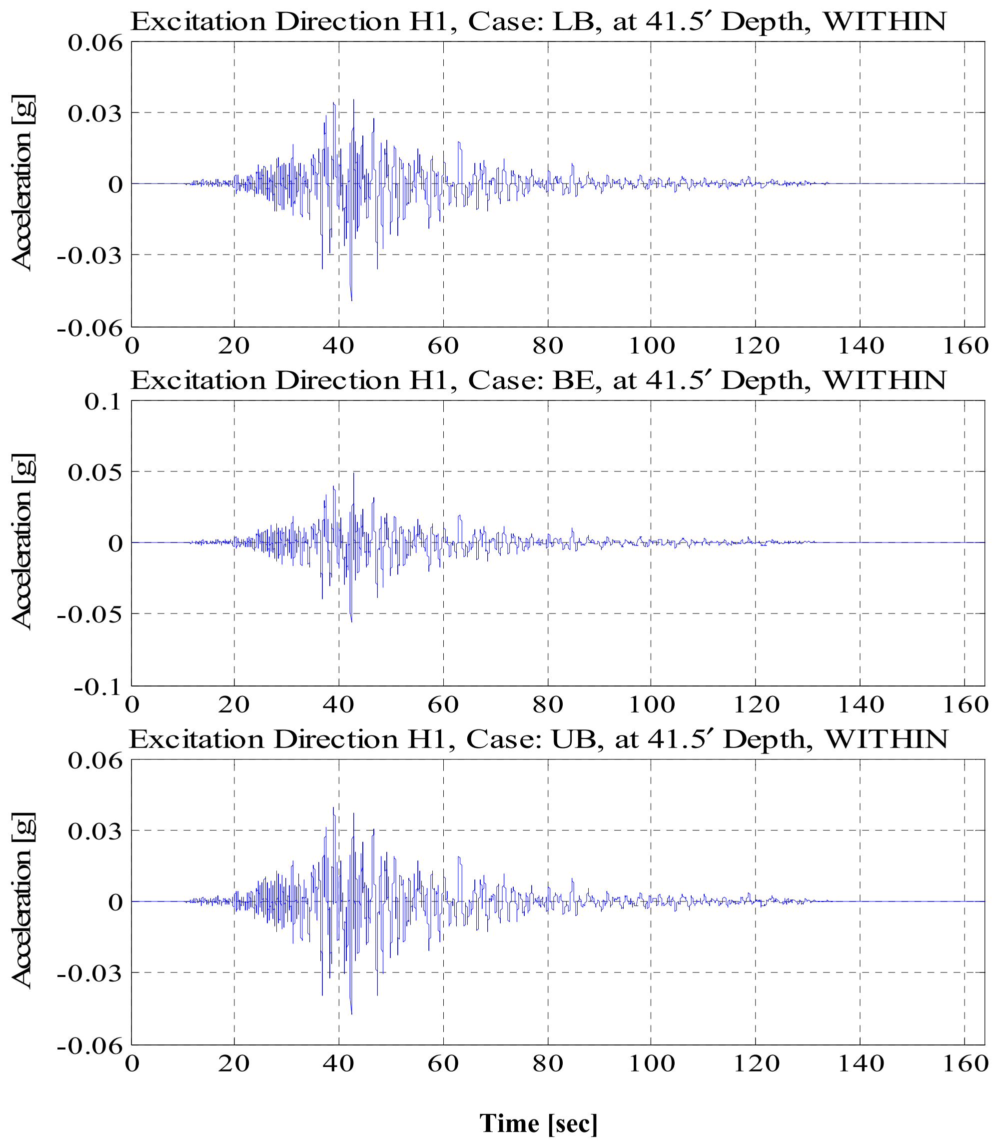


Figure 3JJ-233 SSI Input "Within" Acceleration Time History — Direction H2 — NI Site Condition Time [sec]

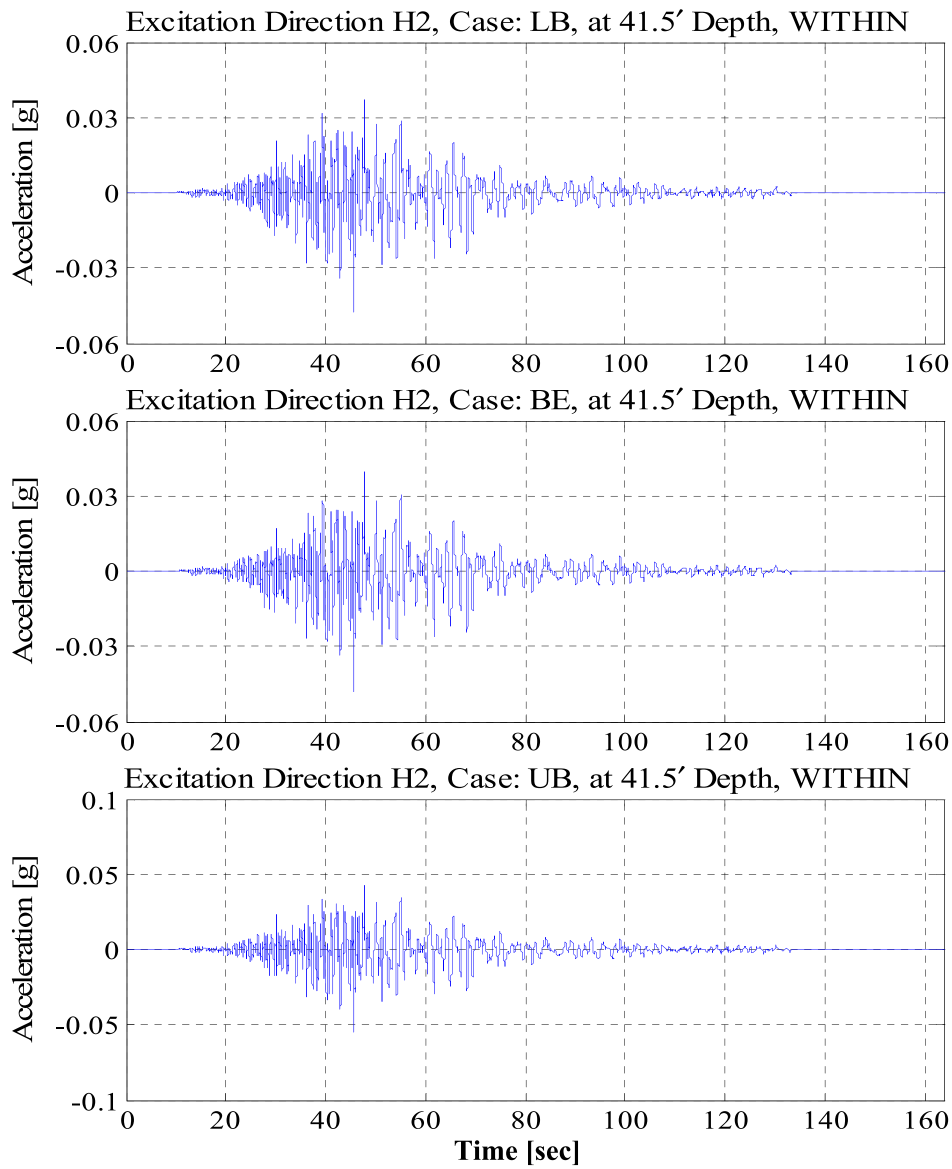


Figure 3JJ-234 SSI Input "Within" Acceleration Time History — Direction UP — NI Site Condition Time [sec]

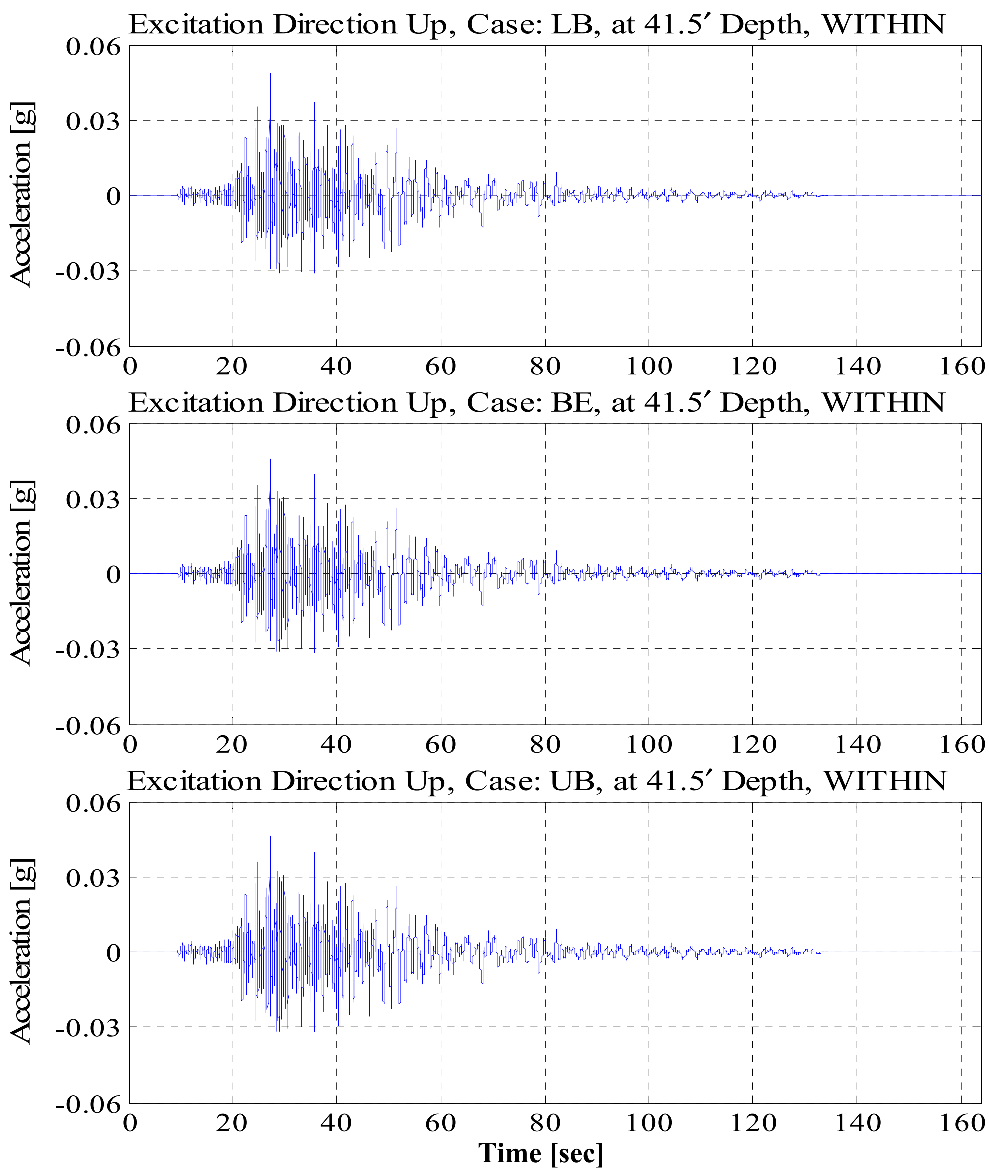


Figure 3JJ-235 SSI Input "Within" Acceleration Time History — Direction H1 — FAR Site Condition Time [sec]

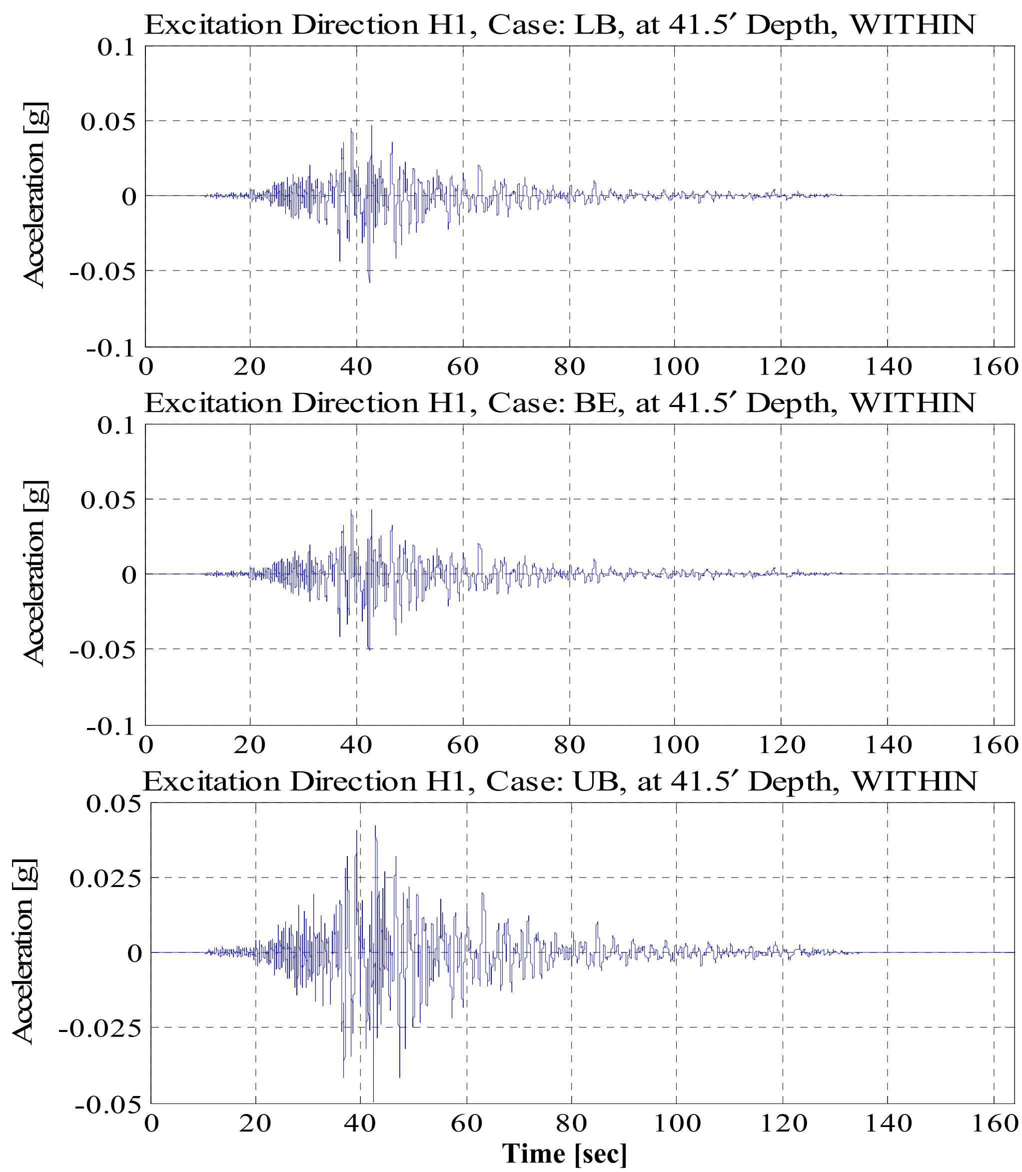


Figure 3JJ-236 SSI Input "Within" Acceleration Time History — Direction H2 — FAR Site Condition Time [sec]

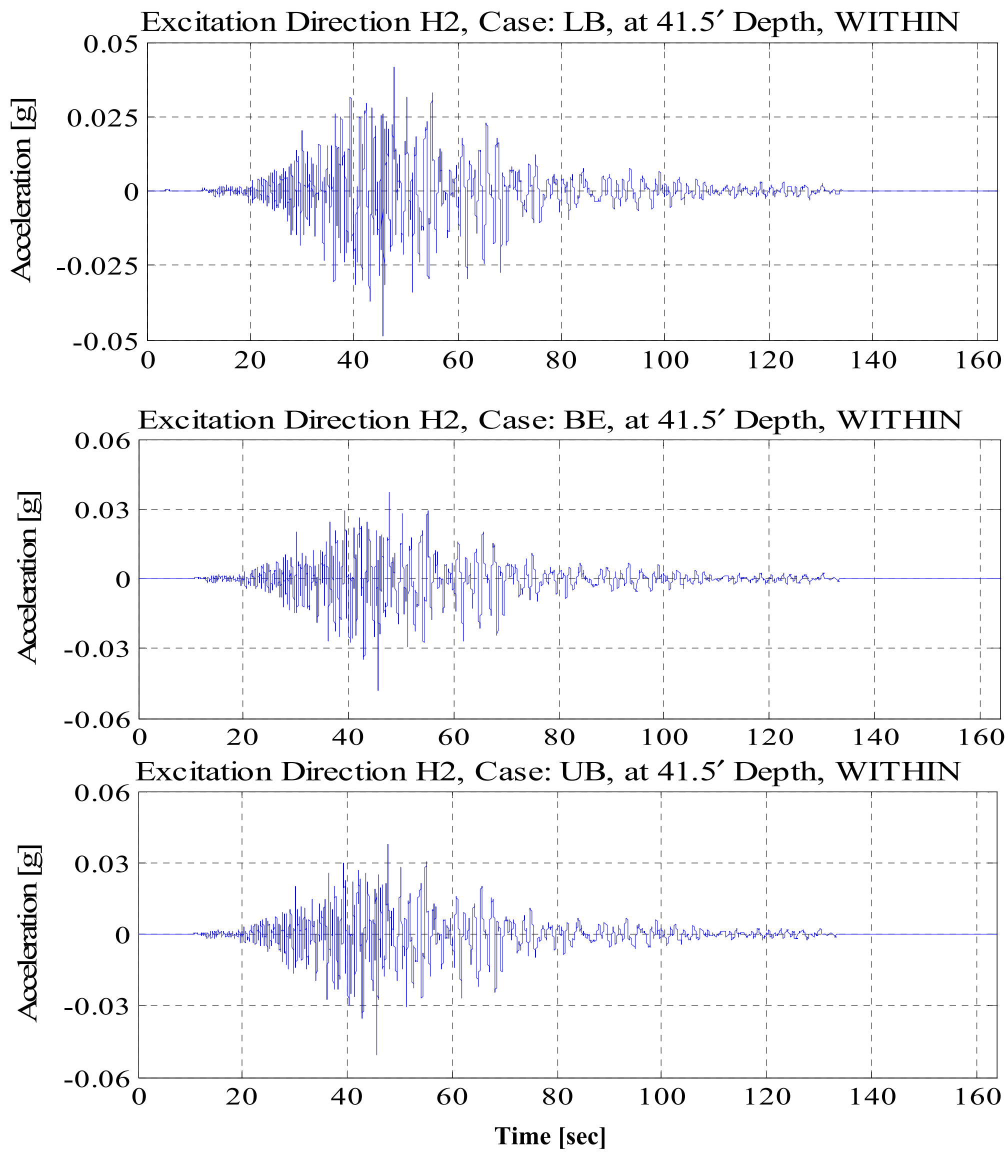
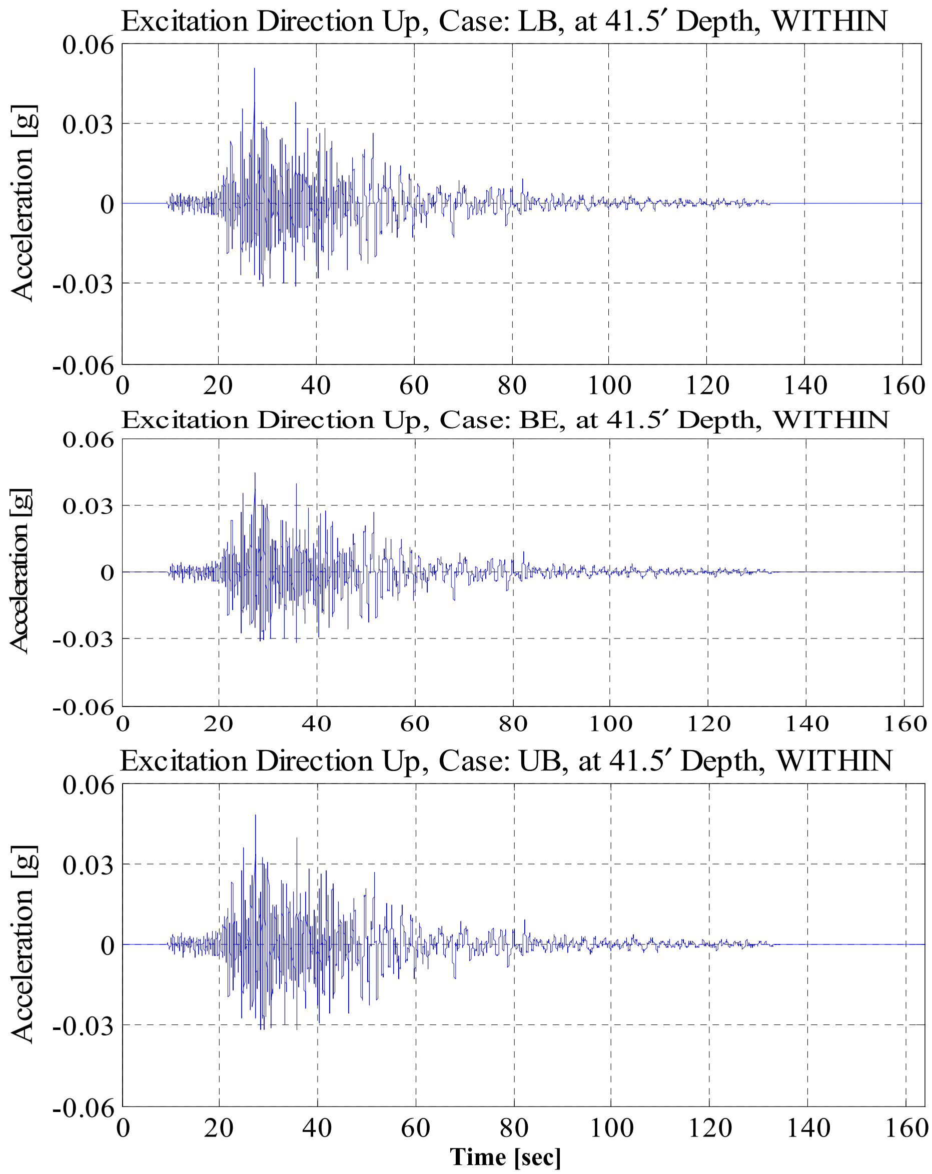


Figure 3JJ-237 SSI Input "Within" Acceleration Time History — Direction UP — FAR Site Condition



PTN SUP 3KK-1

APPENDIX 3KK SITE SPECIFIC SEISMIC EVALUATION REPORT

Appendix 3KK is comprised of the AP1000 Turkey Point Site Specific Seismic Evaluation Report, Westinghouse Document Number TPG-1000-S2R-802, Revision 3. This is a Westinghouse proprietary document and is withheld under 10 CFR 2.390(b). Refer to Part 9 of this COL Application for this document.

The non-proprietary AP1000 Turkey Point Site Specific Seismic Evaluation Report, Westinghouse Document Number TPG-1000-S2R-807, Revision 0, is provided here. This is a redacted version of the proprietary AP1000 Turkey Point Site Specific Seismic Evaluation Report.

TPG-1000-S2R-807
Revision 0

November 2011

AP1000

Turkey Point Site Specific Seismic Evaluation Report

Westinghouse Electric Company LLC
Nuclear Power Plants
1000 Westinghouse Drive
Cranberry Township, PA 16066

Record of Revisions

Rev	Date	Revision Description[1]
0	See EDMS	Original Issue

Note (1) Significant changes are briefly described in this table. In the rest of the report, each row that has changed is marked using a revision bar in the margin of the page. This approach satisfies the change identification requirements in WP 4.5 Section 7.4.

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1.0 Purpose

Two AP1000 units are to be constructed at the Florida Power & Light (FPL) Turkey Point site. Since shear wave velocity profiles at the Turkey Point Units 6 & 7 site are different from the generic soil shear wave velocity profiles used for the AP1000 design, a site-specific Soil Structure Interaction (SSI) analysis was performed.

Westinghouse Electric Company (WEC) has completed a revised site-specific SSI analysis of the Seismic Category (SC) I Turkey Point Nuclear Plant (TPNP) Nuclear Island (NI) with Lean Concrete (LC) bridging mat and SCII adjacent structures including the Turbine Building (TB) First Bay and Annex Building (AB). This report describes the results of the revised site-specific SSI analyses that have been performed to demonstrate the acceptability of the AP1000 plant at the Turkey Point site. The analysis was revised to address the following:

1. Incorporate in the TPNP SSI model and SSI analysis using the current AP1000 NI20r three-dimensional (3D) Model and site-specific conditions including the LC mat, engineered fill, and TPNP best estimate (BE), lower bound (LB) and upper bound (UB) site soil profiles;
2. Incorporate lessons learned pertaining to justification of the NI20r 3D model and analysis results;
3. Compare the TPNP in-structure floor response spectra (FRS) to the AP1000 3D Certified Seismic Design Response Spectra (CSDRS) FRS envelope at six (6) key AP1000 NI locations.
4. Establish the TPNP two-dimensional (2D) north-south (NS) model, which represents the AP1000 NI with the Turbine Building (TB) First Bay and TPNP BE, LB and UB site soil profiles, and perform the corresponding SSI analysis;
5. Establish the TPNP 2D east-west (EW) model, which represents the AP1000 NI with the Annex Building (AB) and TPNP BE, LB and UB site soil profiles, and perform the corresponding SSI analysis;
6. Compare the TPNP TB First Bay and AB FRS to the AP1000 2D FRS envelope at the TB First Bay and AB 2D stick model base and six (6) key AP1000 NI locations; and
7. Assess the relative displacements between the AP1000 NI and the TB First Bay and AB at elevations associated with the ground surface and near the top of each adjacent structure.

The 3D SSI analysis results show that the Floor Response Spectra (FRS) of an AP1000 plant at the Turkey Point Units 6 & 7 site is enveloped by the AP1000 Certified Seismic Design Response Spectra (CSDRS) FRS at the key AP1000 NI locations.

2.0 Background

This section summarizes the free field response analyses and SSI analyses that have been performed for the TPNP site to demonstrate that the AP1000 generic seismic response envelops the TPNP site specific seismic response.

2.1 Summary of TPNP Free Field Response Analyses

The overall site elevation will be raised by approximately 25.5 feet with compacted crushed limestone. Adjacent to the NI (as shown in Figure 3.1-1), a slurry wall will be constructed to facilitate dewatering of the NI excavation. Inside the slurry wall area and as shown in Figure 3.1-2, the Miami Limestone will be excavated to competent rock, a surface elevation estimated to be approximately 35 feet below the ground surface (i.e., El. – 35’). On this surface, approximately 19 feet of mass (lean) concrete will be placed to bring the surface to El. -16’ for construction of the mud mat and foundation of the NI. Adjacent to the NI, Class 1 compacted limestone backfill will be placed to bring the ground surface to El. +25.5’. Finally, below the Miami Limestone, the Key Largo Limestone is grouted from El. -35 to El. -60.

Horizontal and vertical acceleration response spectra (ARS) at the design grade elevation were developed using the same methodology and in-situ soil properties used for developing the site specific ground motion response spectra (GMRS). Free field site response analyses results, response spectra, SSI input time histories, and strain compatible soil properties were provided by FPL in Bechtel letters 25409-000-TCM-GEG-00424 (Reference 1) and 25409-000-TCM-GEG-00581 (Reference 2) and 25409-000-TCM-GEG-00404 (Reference 3).

Figure 2.1-1 (FSAR Figure 2.5.2-253) and Figure 2.1-2 (FSAR Figure 2.5.2-254) show the horizontal and vertical site-specific GMRS, respectively. The GMRS was developed as the Truncated Soil Column Surface Response (TSCSR) on the uppermost in-situ competent material (El. -16’).

The horizontal and vertical foundation input response spectra (FIRS) at the TPNP foundation El. -16’ are shown in Figures 2.1-3 through 2.1-5 for the NI (near) site conditions, and Figures 2.1-6 through 2.1-8 for the FAR site conditions.

Design grade deterministic surface spectra were developed following the Interim Staff Guidance DC/COL-ISG-017. The design grade surface response spectra from the three soil columns, best estimate (BE), lower bound (LB), and the upper bound (UB) soil properties were developed at the base NI foundation El. -16’. Figures 2.1-9 through 2.1-14 present the comparison of the computed surface motions to the respective DRS for each directional component (H1, H2, V), each soil case (BE, LB and UB) and each site condition (NI and FAR).

The in-column time histories at El. -16’ for the BE, LB and UB soil profiles were used as input to the SSI analysis and were provided by FPL in Bechtel Letter 25409-000-TCM-GEG-00424 (Reference 1). The time histories were input into the three (BE, LB and UB) soil columns as outcropping motions at El. -16’, and then output as in-column motions at El. -16 ft for use in the SSI analysis. These in-column time histories at El.-16’ are shown in Figures 3.5-1 through 3.5-3 for the NI site conditions and in Figures 3.5-4 through 3.5-6 for the FAR site conditions.

Similarly, surface founded FIRS for the SCII TB First Bay and AB adjacent structures and corresponding time histories were provided by FPL in Bechtel Letter 25409-000-TCM-GEG-00404 (Reference 3), and the horizontal and vertical FIRS are presented in Figures 2.1-15 and 2.1-16, respectively. Corresponding TB First Bay and AB time histories are presented in Figures 3.5-7 through 3.5-9 for the TB First Bay and Figures 3.5-10 through 3.5-12 for the AB.

The BE, LB and UB soil property profiles were developed based on the variation in the randomized soil profiles used for developing the DRS and complying with SRP 3.7.2.II.4 guidance on soil property variation for SSI analysis, i.e., the coefficient of variation used was the larger of that calculated from the randomized soil profiles or 1.5 on the shear modulus as described in FSAR Subsection 2.5.2.6.7. The soil column profile and soil properties are presented in FSAR Tables 3.2-1, 3.2-2 and 3.2-3 for BE, LB, and UB cases, respectively.

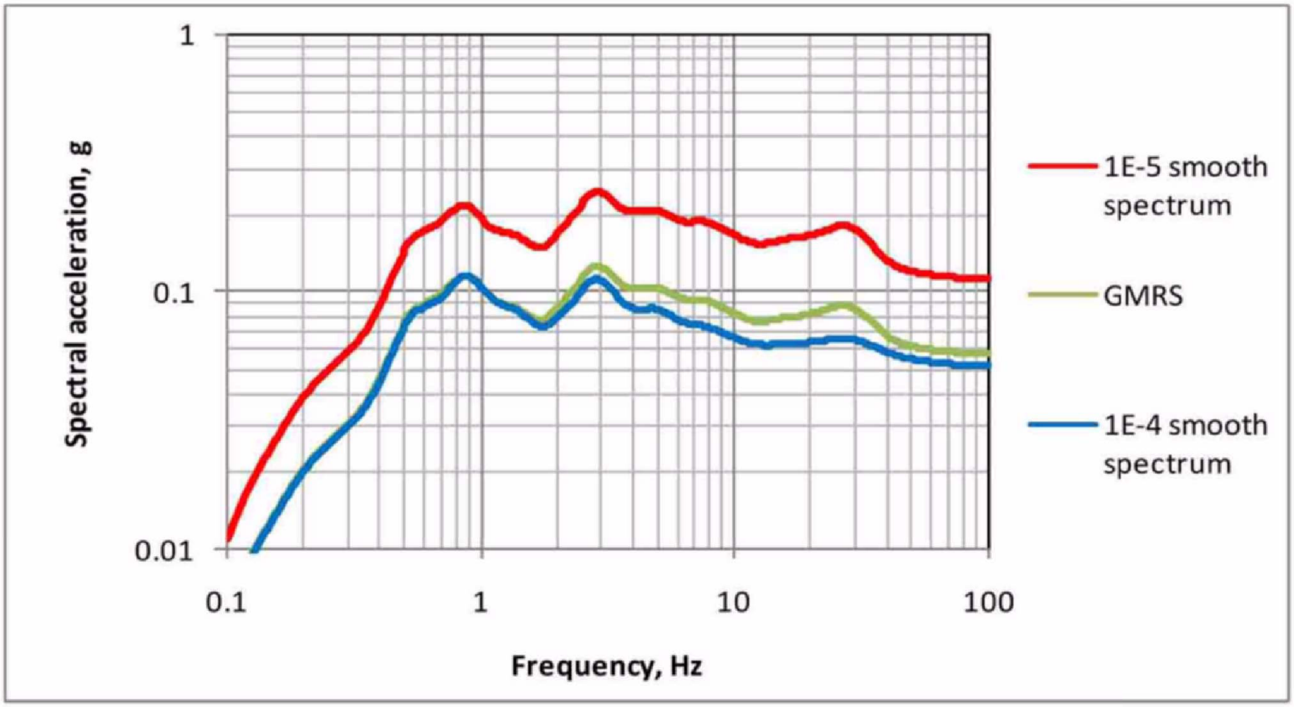

Figure 2.1-1: Horizontal GMRS for the TPNP Site (FPL FSAR Figure 2.5.2-253)

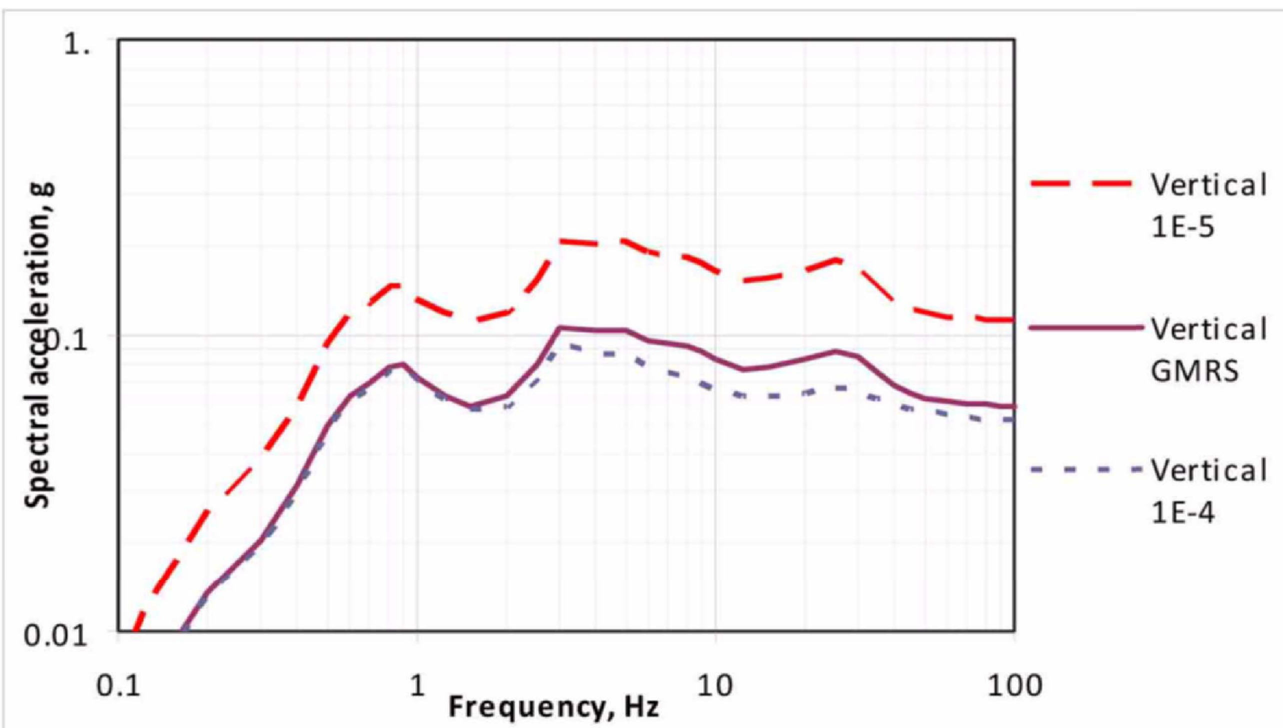

Figure 2.1-2: Vertical GMRS for the TPNP Site (FPL FSAR Figure 2.5.2-254)

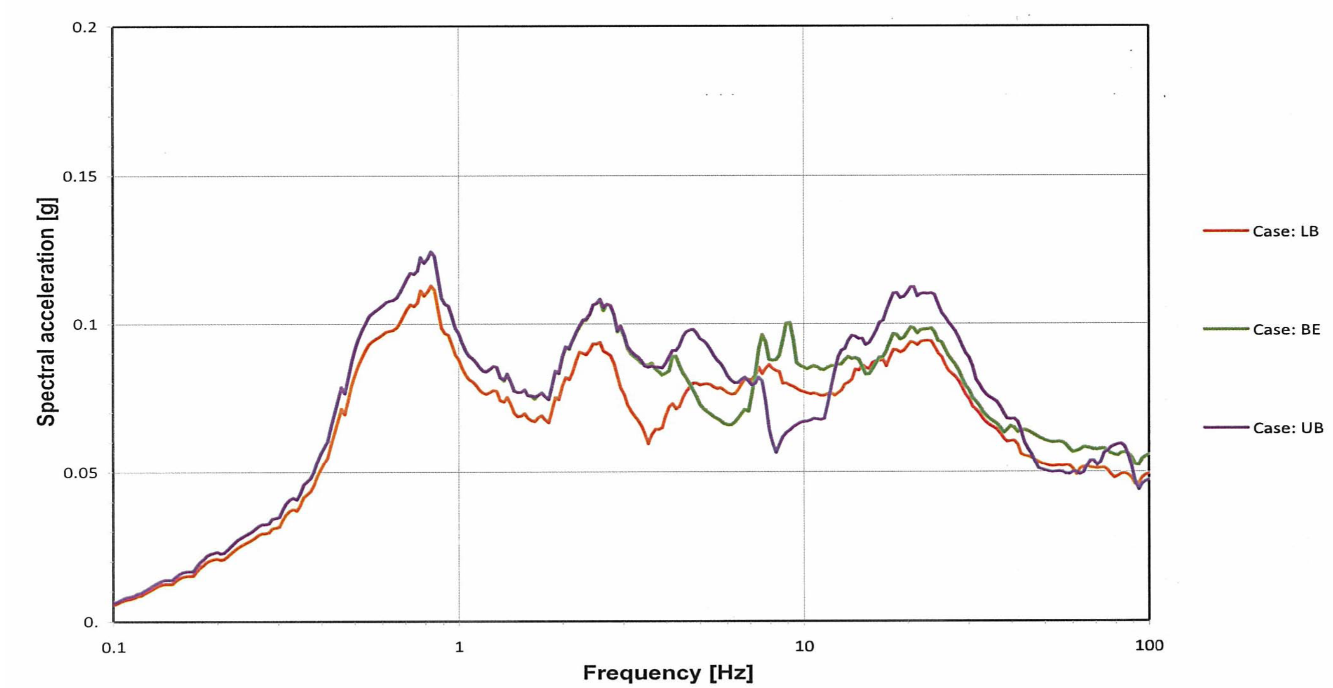

Figure 2.1-3: NI H1 Horizontal Response Spectra at AP1000 Foundation Elevation -16'

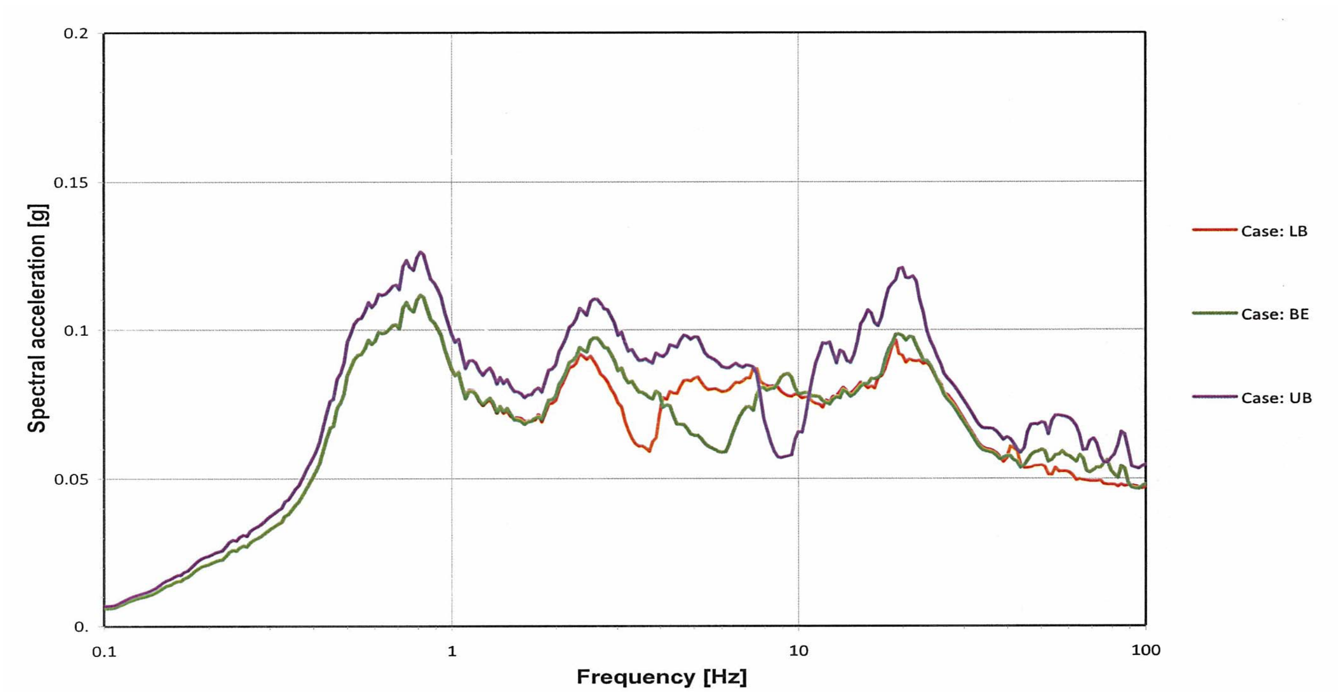

Figure 2.1-4: NI H2 Horizontal Response Spectra at AP1000 Foundation Elevation -16'

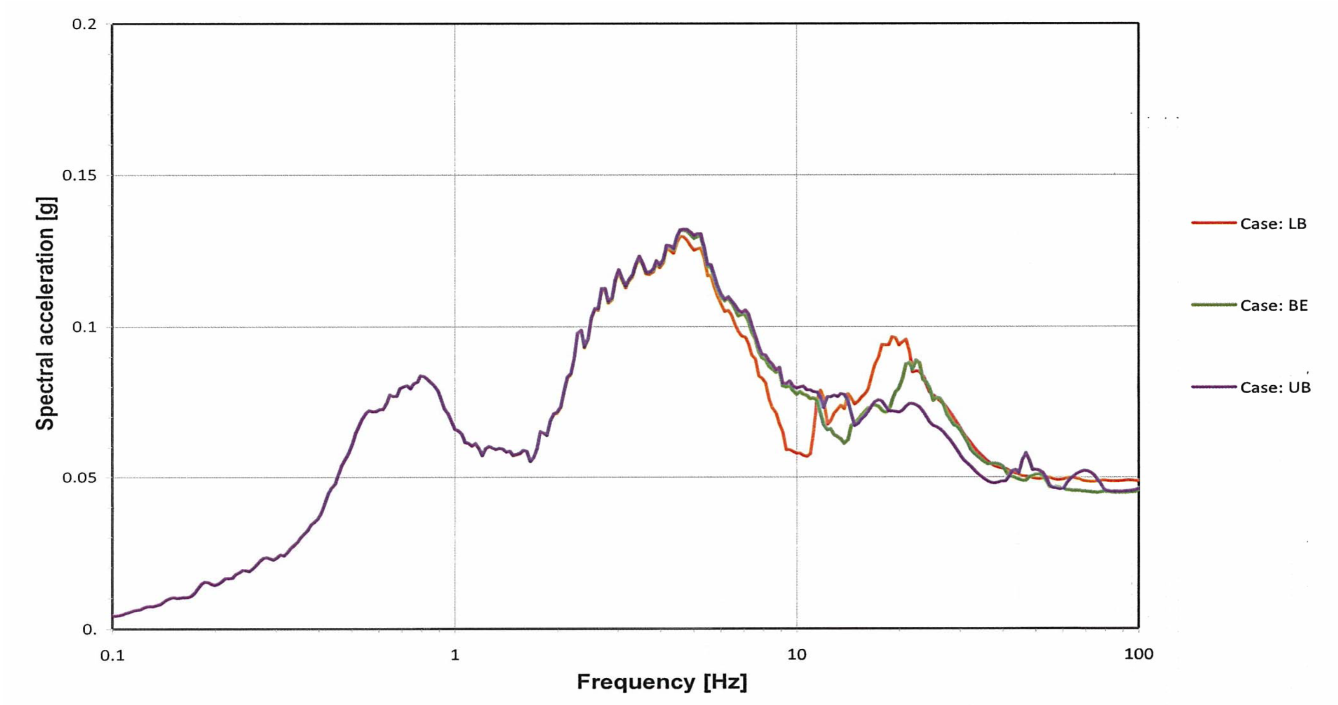

Figure 2.1-5: NI UP Vertical Response Spectra at AP1000 Foundation Elevation -16'

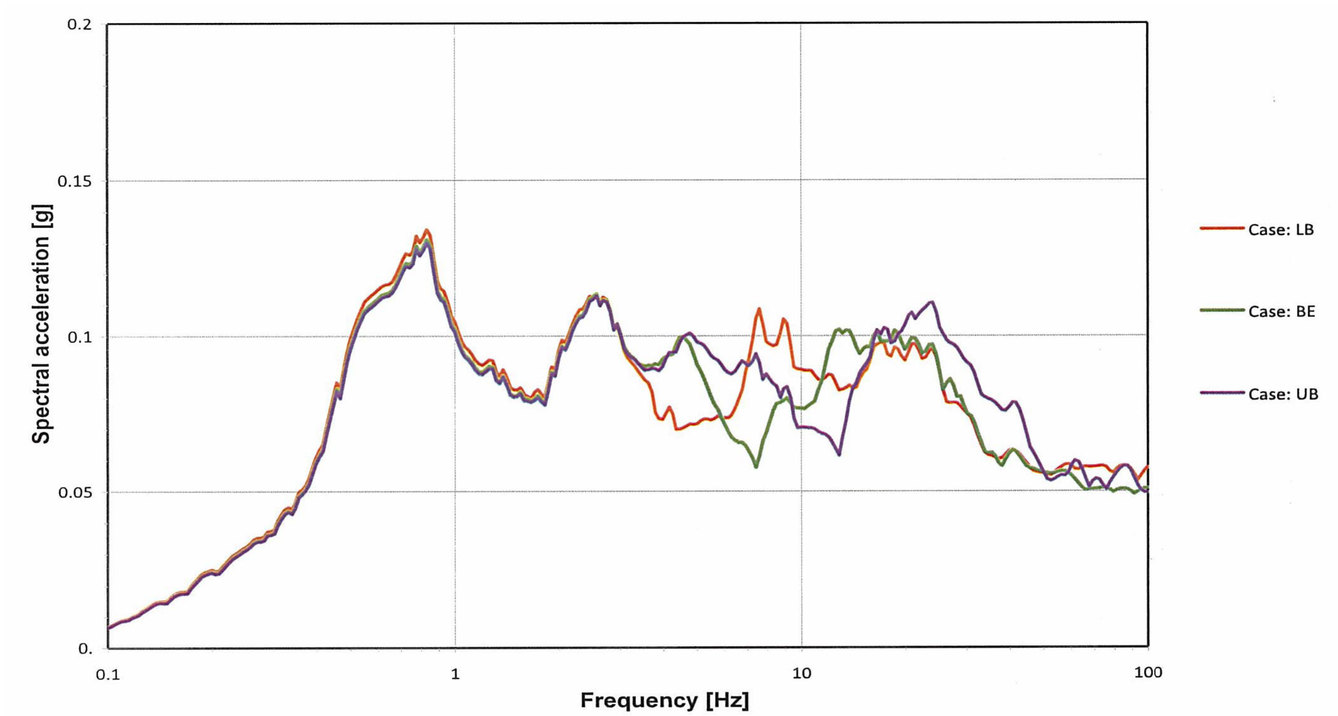

Figure 2.1-6: FAR H1 Horizontal Response Spectra at AP1000 Foundation Elevation -16'

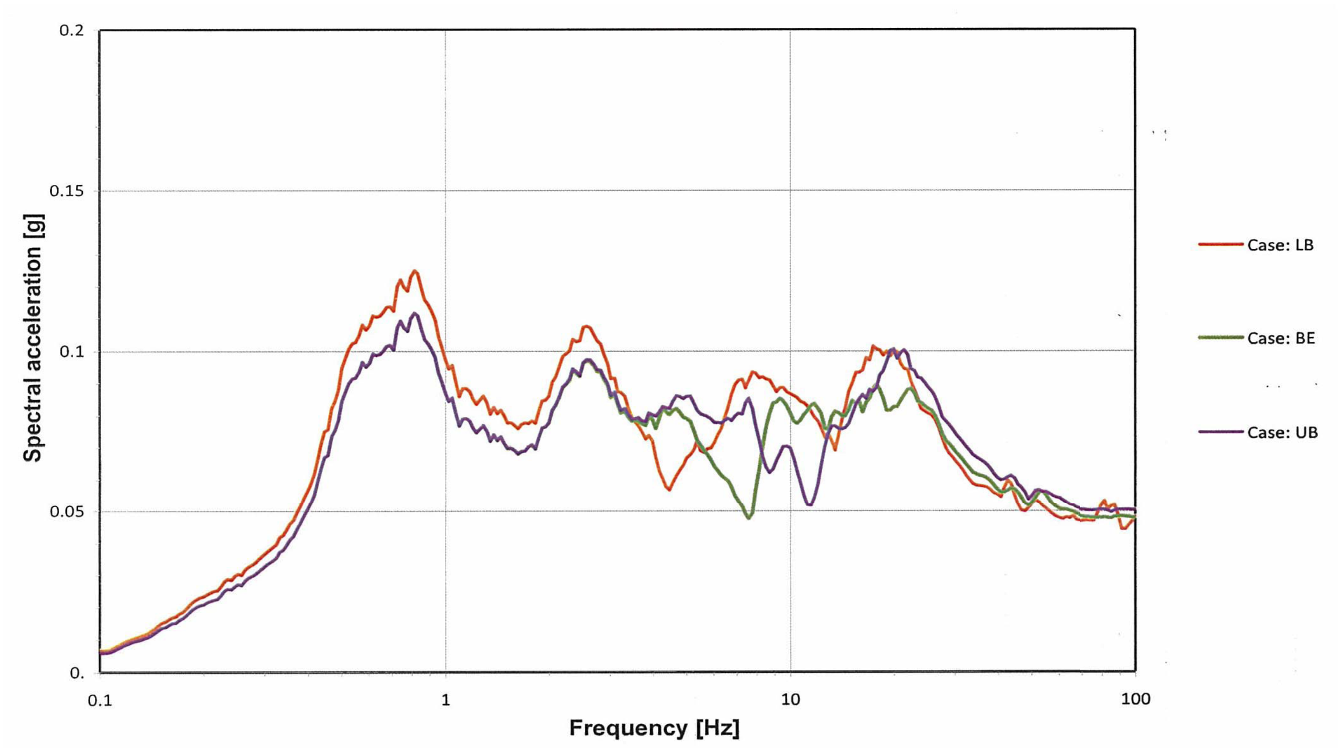

Figure 2.1-7: FAR H2 Horizontal Response Spectra at AP1000 Foundation Elevation -16'

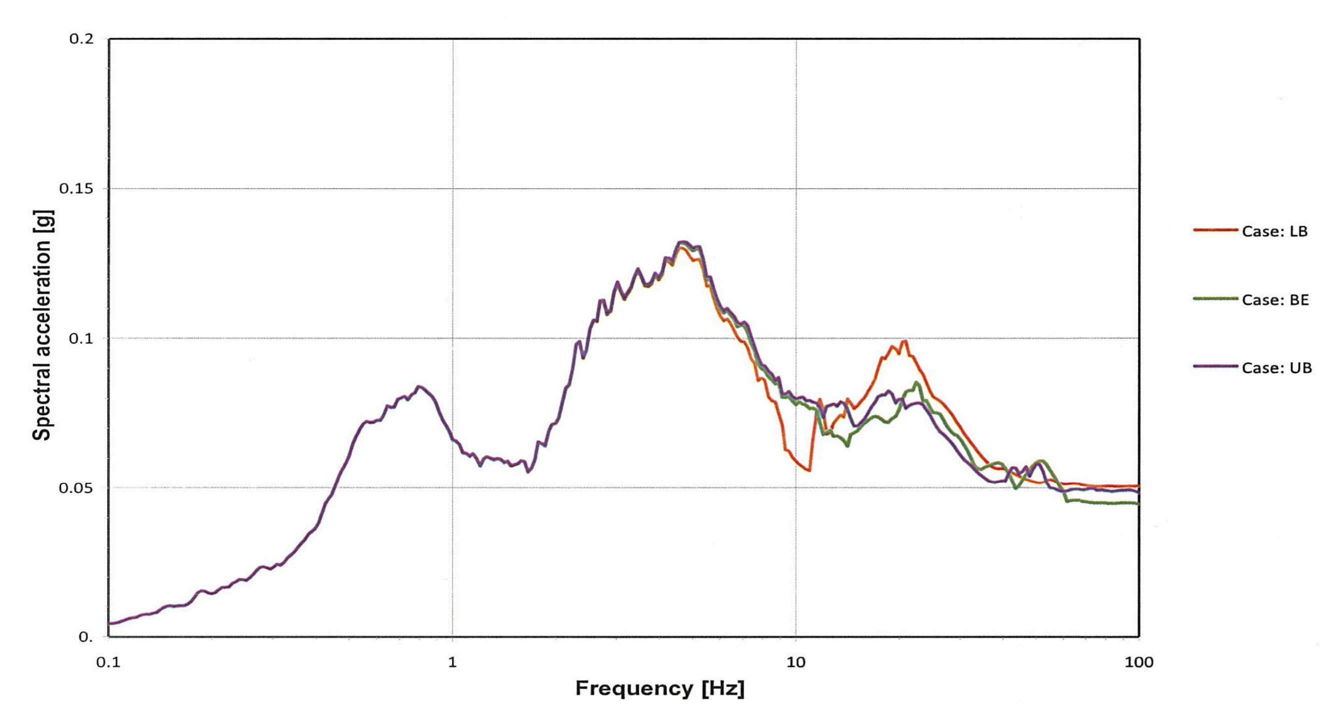

Figure 2.1-8: FAR UP Vertical Response Spectra at AP1000 Foundation Elevation -16'

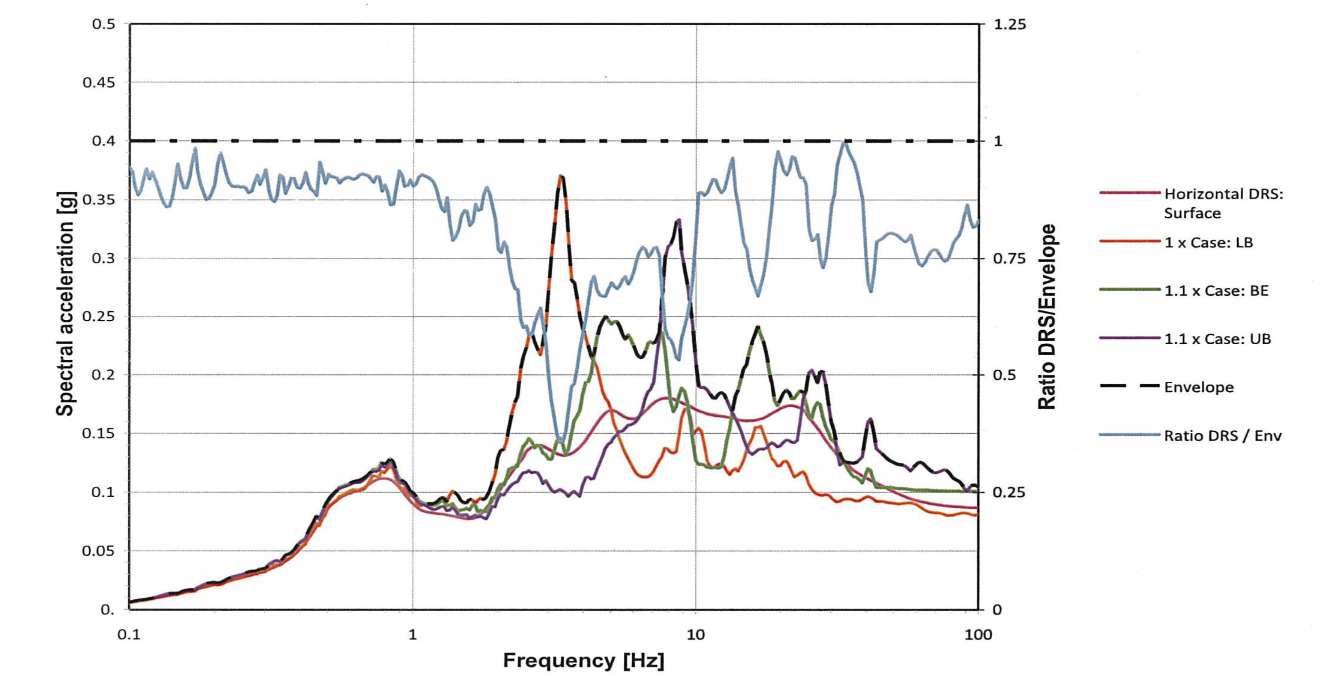

Figure 2.1-9: Comparison of Spectra of Computed H1 Component Surface Motions for NI SSI Profiles with Horizontal DRS

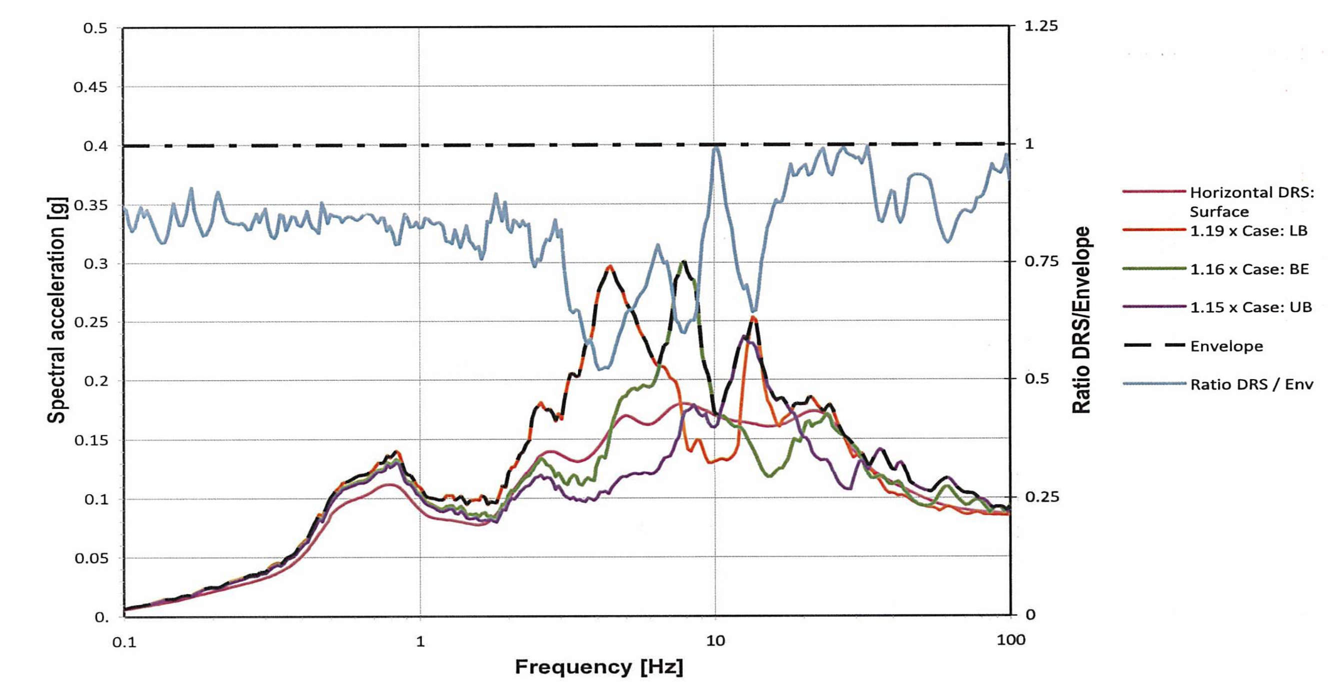

Figure 2.1-10: Comparison of Spectra of Computed H1 Component Surface Motions for FAR SSI Profiles with Horizontal DRS

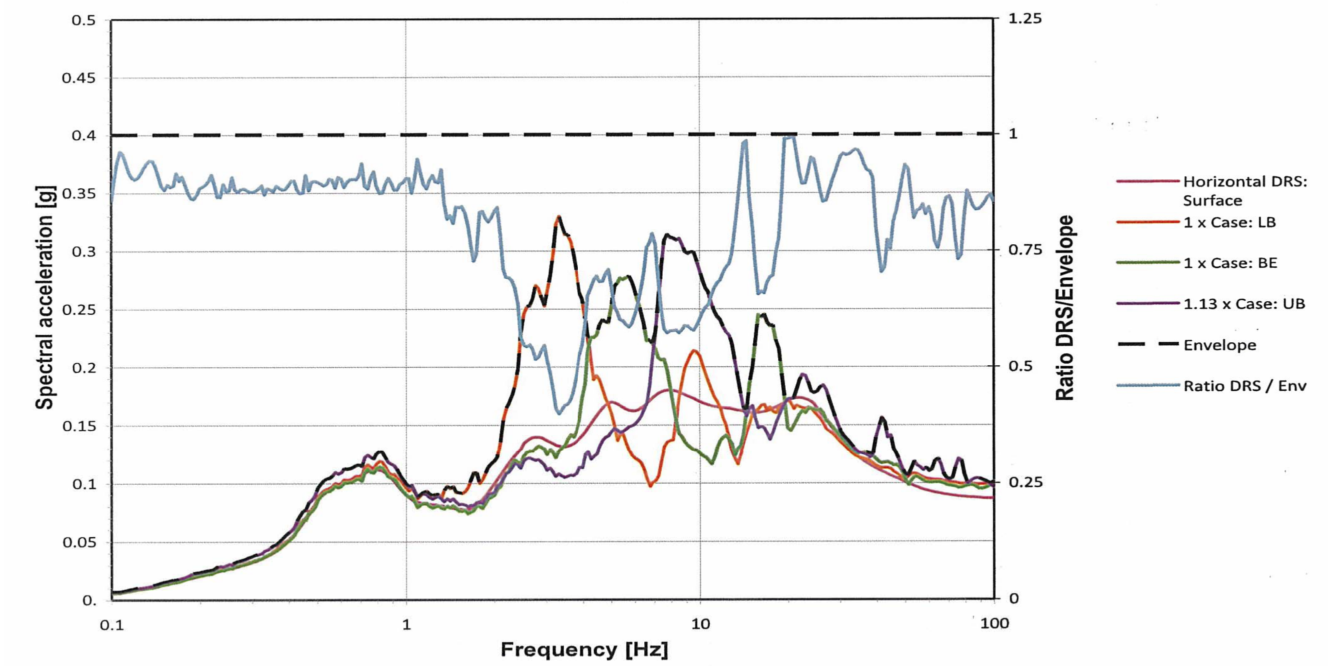

Figure 2.1-11: Comparison of Spectra of Computed H2 Component Surface Motions for NI SSI Profiles with Horizontal DRS

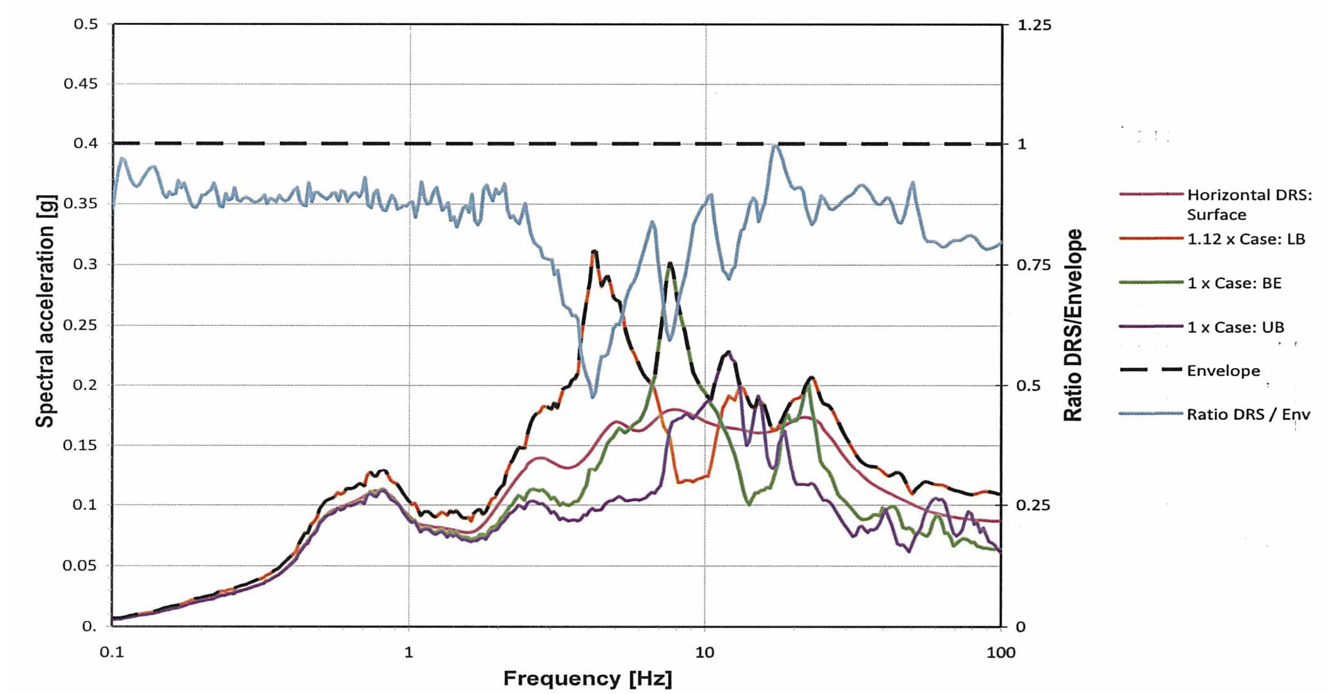

Figure 2.1-12: Comparison of Spectra of Computed H2 Component Surface Motions for FAR SSI Profiles with Horizontal DRS

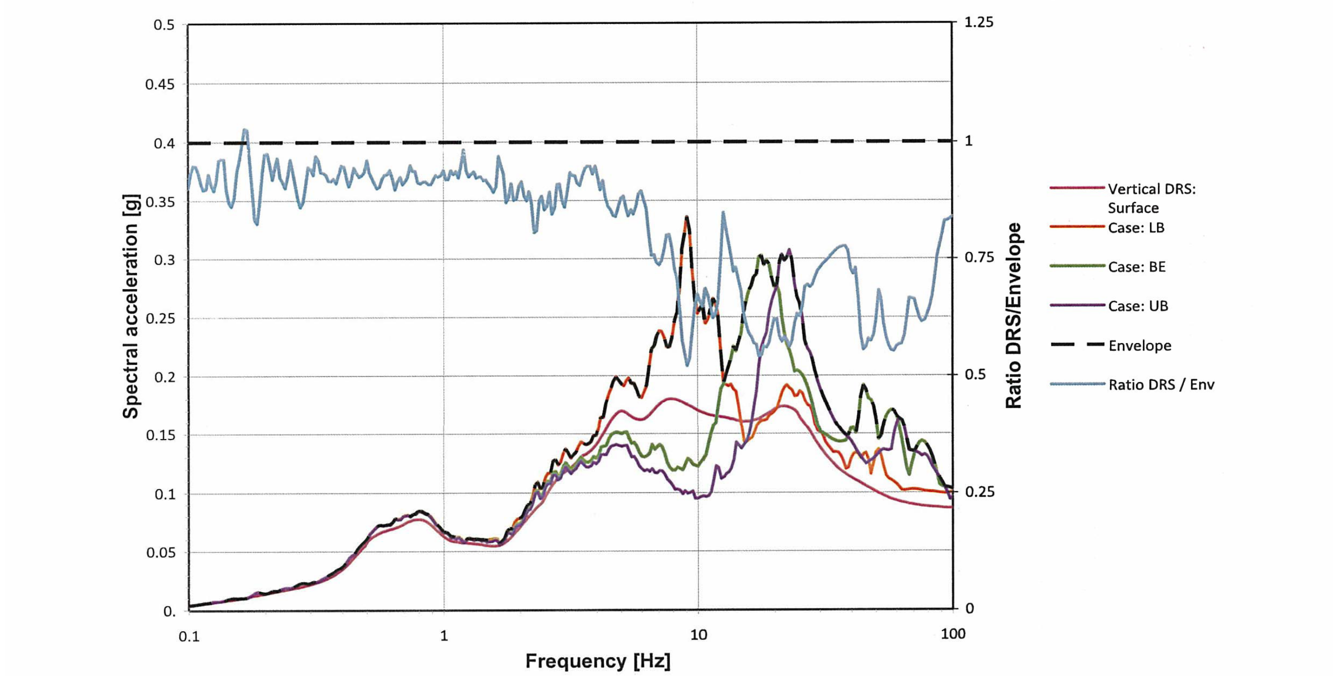

Figure 2.1-13: Comparison of Spectra of Computed V Component Surface Motions for NI SSI Profiles with Vertical DRS

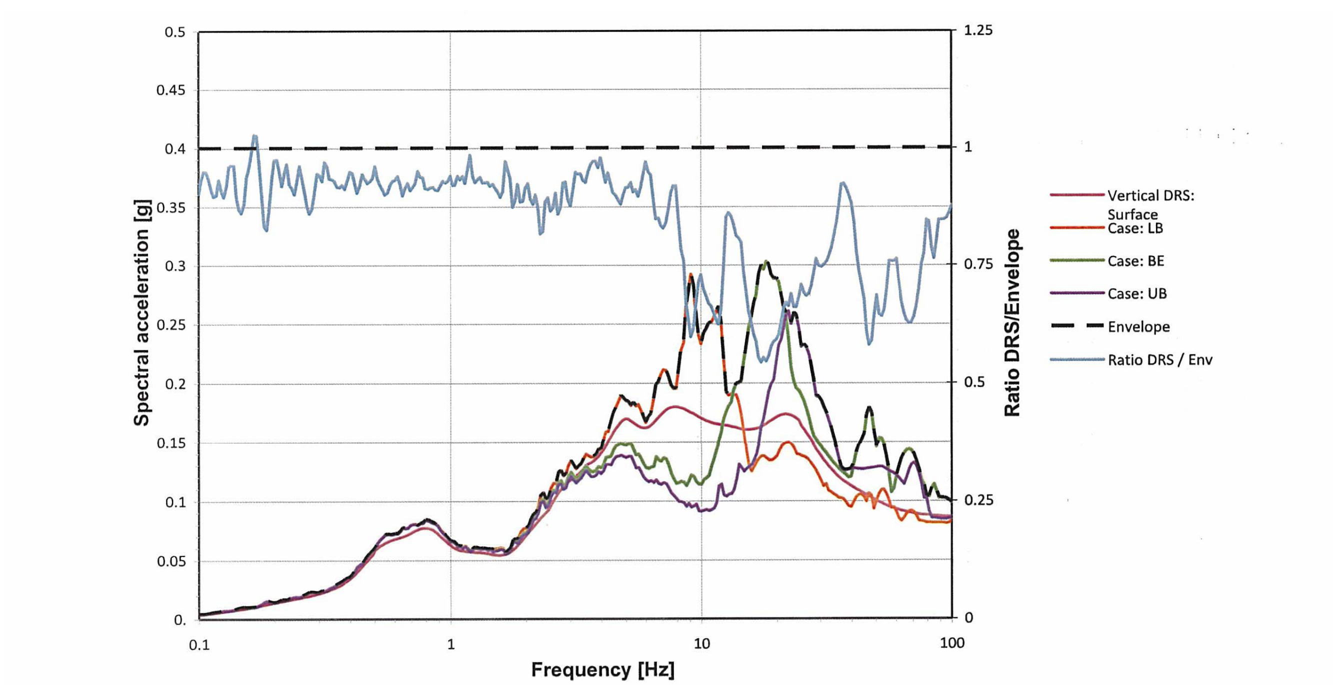

Figure 2.1-14: Comparison of Spectra of Computed V Component Surface Motions for FAR SSI Profiles with Vertical DRS

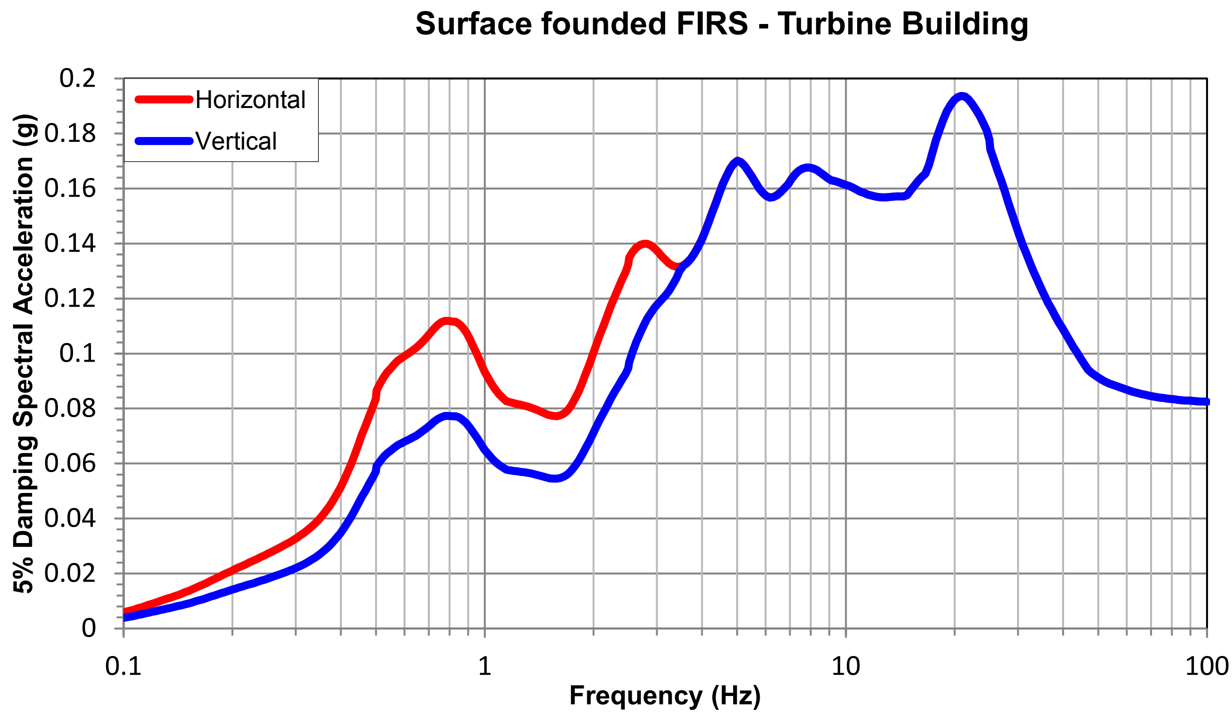

Figure 2.1-15: FIRS for the TPNP Turbine Building (FPL FSAR Figure 2.5.2-253)

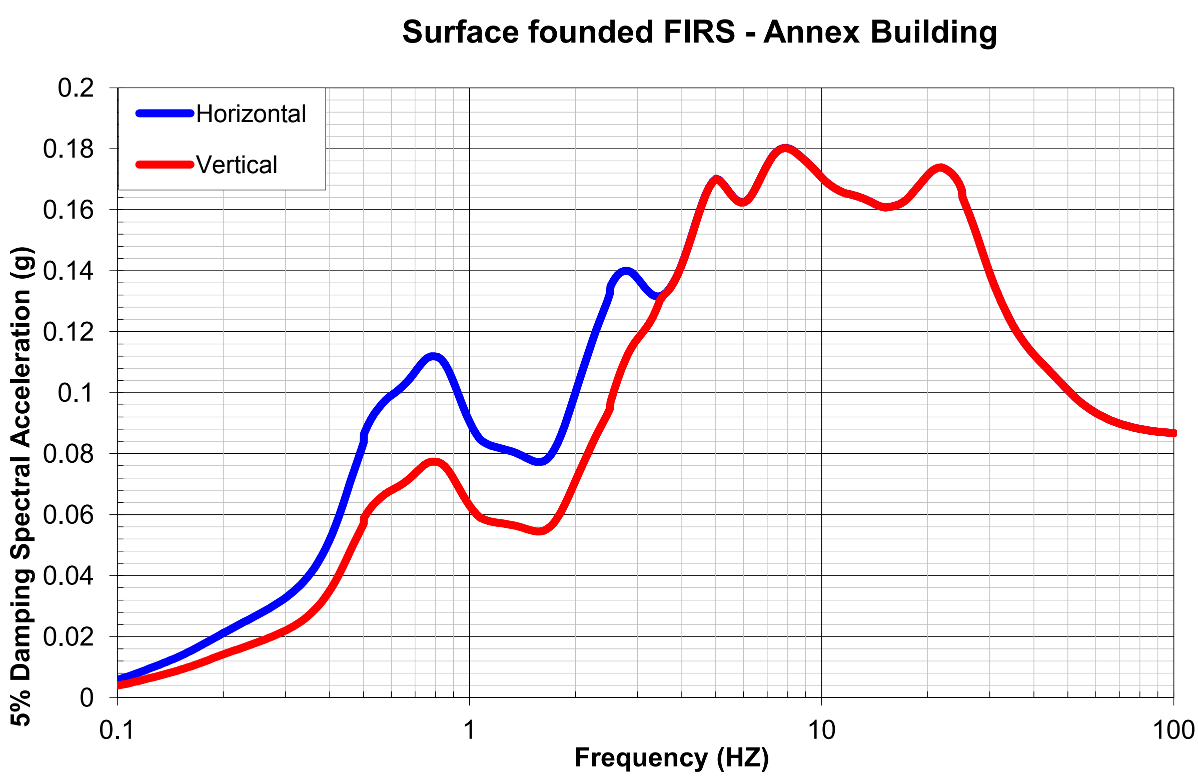

Figure 2.1-16: FIRS for the TPNP Annex Building (FPL FSAR Figure 2.5.2-254)

2.2 TPNP Soil-Structure Interaction (SSI) Analyses

TPNP site specific SSI analyses were performed and are summarized as follows:

- The TPNP specific SSI analyses utilized three-dimensional (3D) and two-dimensional (2D) parametric SSI analyses.
- For the TPNP 3D SSI analyses, the AP1000 NI20r 3D embedded finite element model (FEM) was modified to incorporate the TPNP site conditions including a 19-foot thick lean concrete (LC) mat constructed beneath the NI basemat, and engineered fill adjacent to the NI.
- The in-column ground motions at the top of the LC mat (elevation -16 ft.) for the BE, UB and LB soil profiles were the input motions for the SSI models. These in-column input motions were developed as part of the design grade deterministic surface spectra following Subsection 5.2.1 of the Interim Staff Guidance DC/COL-ISG-017.
- For the TPNP Turbine Building (TB) First Bay and Annex Building (AB) and Radwaste Building (RB), 2D embedded models were used incorporating the Seismic Category II adjacent structures and engineered fill in the TPNP 2D SSI analyses. The Seismic Category I/II interaction issues between the adjacent buildings and the NI are addressed herein.
- Supplemental TPNP 2D parametric SSI analyses were performed to demonstrate the adequacy of the 3D mesh size, the soil layer modeling used and passing frequency in the TPNP 3D models.
- TPNP 2D Coarse and Fine models were created and parametric SSI analyses performed for evaluation of TPNP 3D model frequency filtering, model mesh size limitations, and influence of the lower boundary SITE profile depth. The 2D Coarse model layer frequencies range from about 10 to 474 Hz and represent the embedded portion of the TPNP 3D model. The Fine model layer frequencies range from about 49 to 474 Hz. The 2D SSI response forms the basis for the Fine-to-Coarse response spectra ratios (Bump Factors) to account for the lower 3D model passing frequencies.
- 2D parametric SSI analysis results were used to calculate horizontal and vertical frequency-dependent Fine-to-Coarse SSI response spectra ratios (Bump Factors) at each of the six key locations.
- Factored FRS at the six key locations were calculated using the TPNP 3D Design-Basis BE, LB and UB models and the SASSI Direct method SSI analyses results. The 3D Direct FRS results are amplified by the Bump Factors and compared to the AP1000 generic FRS at the six key locations to show that the AP1000 FRS envelops the factored TPNP site specific SSI analyses FRS.

3.0 SSI Analysis Design Inputs

The following sections summarize design input information provided by FPL in Bechtel letters 25409-000-TCM-GEG-00424 (Reference 1) and 25409-000-TCM-GEG-00581 (Reference 2) pertaining to the TPNP site soil profiles, Foundation elevation (El.) -16 input time histories, and proposed LC mat and engineered fill material properties. Design inputs also include the WEC generic AP1000 3D FRS envelope, and hard rock high frequency (HRHF) FRS envelope, which the TPNP SSI analyses results are compared for the structure (low frequency) and equipment (high frequency) qualification, respectively.

3.1 Foundation Concept Description

Two AP1000 units, designated Units 6 and 7 are planned at the FPL TPNP site located in south Miami-Dade County, Florida. Plan and cross-section views of the TPNP Unit 7 excavation limits are presented in Figures 3.1-1 and 3.1-2, respectively. Note that the TPNP Unit 7 plan and cross-section information are similar to that of Unit 6, thus only TPNP Unit 7 is graphically presented.

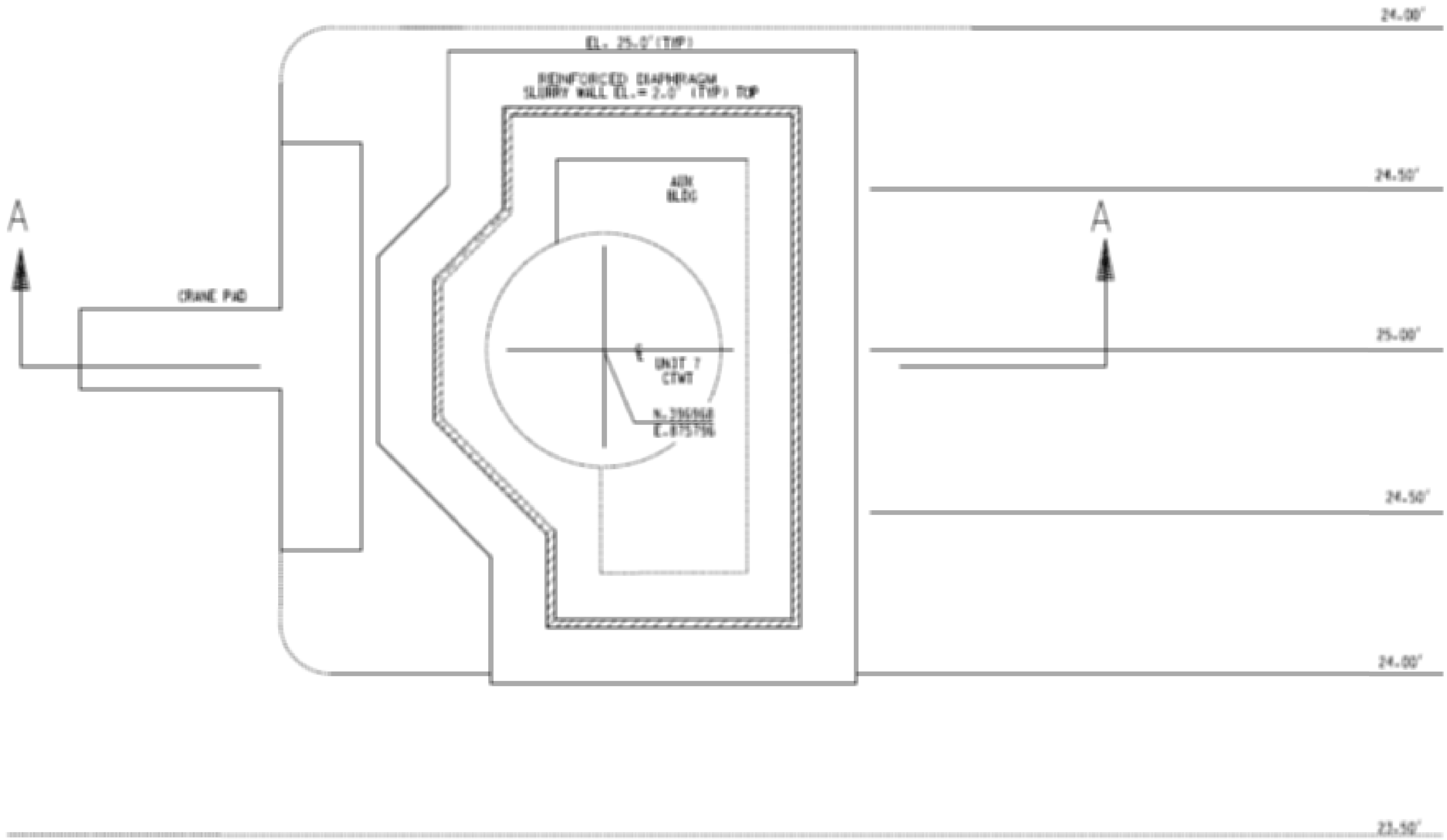

Figure 3.1-1: TPNP Unit 7 Excavation Limits Plan View (Reference 4)

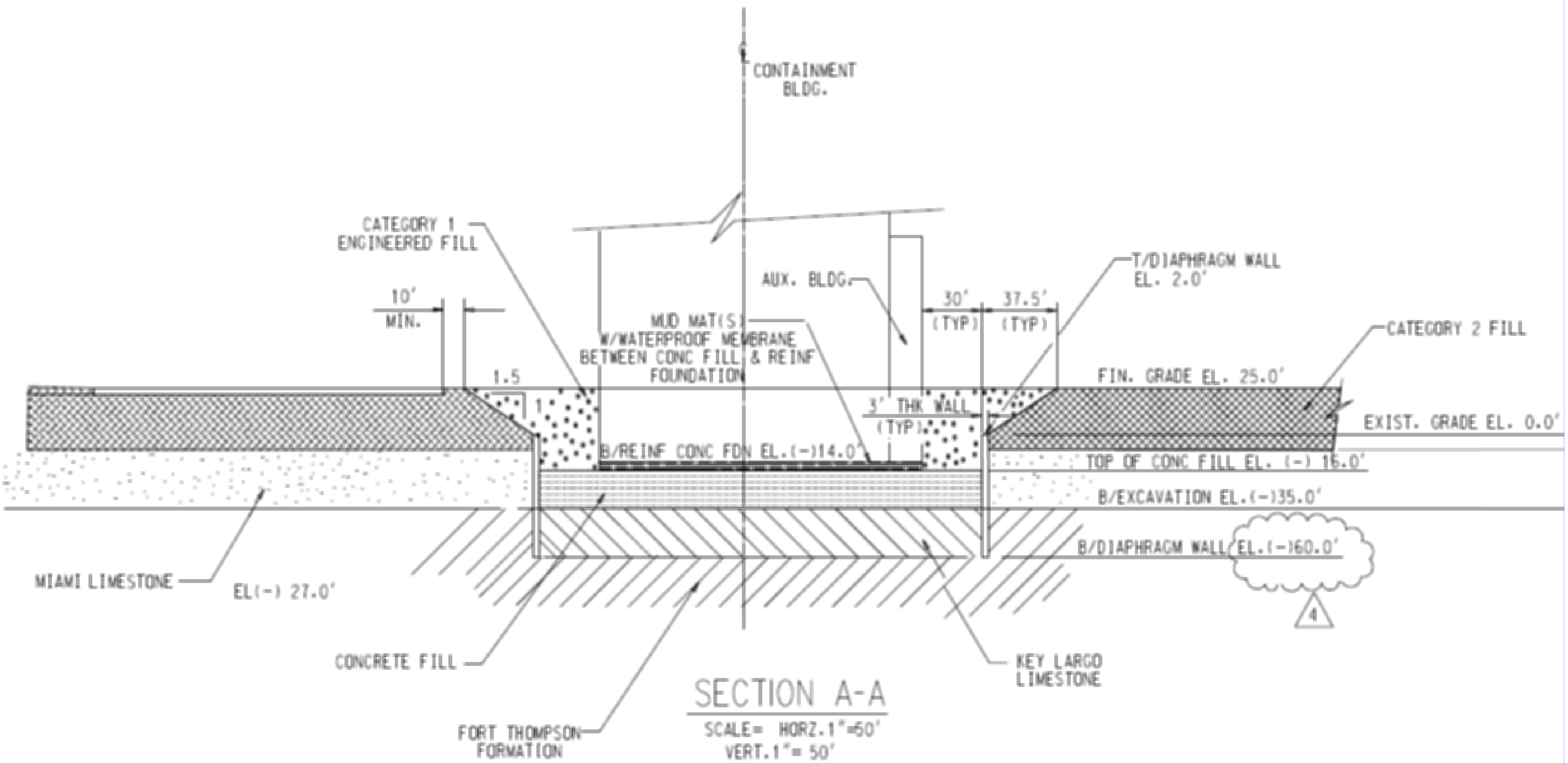

Figure 3.1-2: TPNP Unit 7 Excavation Cross-Section (Reference 4)

3.2 TPNP Best Estimate, Lower Bound and Upper Bound Soil Profiles

TPNP site soil profiles including the BE, LB and UB soil cases were provided in Bechtel letters 25409-000-TCM-GEG-00424 (Reference 1) and 25409-000-TCM-GEG-00581 (Reference 2). The layer thickness, unit weight, shear wave velocity (Vs), compression wave velocity (Vp), and damping ratio from the ground surface to the simulated halfspace are presented in Tables 3.2-1 to 3.2-3. Figure 3.2-1 graphically presents the TPNP Vs profiles within the approximately 4,300-foot TPNP site soil profile depth.

Table 3.2-1: TPNP Best Estimate Soil Column Profile and Soil Properties

Layer No.	Thickness [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
1	5.00	0.130	679.1	1270.5	1.7451
2	5.00	0.130	832.9	1558.3	2.0917
3	5.00	0.130	904.4	1691.9	2.3193
4	5.00	0.130	925.9	1732.2	2.5126
5	5.00	0.130	946.3	1770.3	2.6773
6	5.50	0.130	924.8	4715.4	2.9160
7	6.00	0.130	926.2	4722.9	3.0885
8	5.00	0.130	935.2	4768.7	3.1783
9	6.33	0.150	5518.5	8600.0	1.0500
10	6.33	0.150	5518.5	8600.0	1.0500
11	6.33	0.150	5518.5	8600.0	1.0500
12	6.00	0.155	5674.2	8842.7	0.9900
13	10.00	0.155	5781.3	10815.9	0.9900
14	10.00	0.155	5449.9	10015.8	0.9900
15	10.00	0.136	4858.1	9006.7	0.9900
16	10.00	0.136	4768.7	9622.9	0.9900
17	10.00	0.136	4712.1	9446.3	0.9900
18	10.00	0.136	4670.9	9223.8	0.9900
19	10.00	0.136	4559.3	9080.0	0.9900
20	10.00	0.136	1847.0	5000.0	0.9900
21	10.00	0.120	1552.6	5000.0	1.0212
22	10.00	0.120	1612.0	6723.2	1.0076
23	10.00	0.120	1611.4	5341.1	1.0073
24	10.00	0.120	1648.1	6514.9	0.9659
25	10.00	0.120	1658.5	6049.1	0.9669
26	10.00	0.120	1673.0	5817.4	0.9658
27	10.00	0.120	1676.8	6001.6	0.9689
28	10.00	0.120	1697.5	6164.6	0.9653
29	10.00	0.120	1783.4	6229.6	0.9423
30	10.00	0.120	1984.7	6444.8	0.8814
31	10.00	0.120	2001.3	5685.0	0.8819
32	10.00	0.120	1929.8	5203.4	0.9033
33	10.00	0.120	1883.5	5836.6	0.9239
34	10.00	0.120	1800.3	5215.9	0.9521
35	10.00	0.120	1726.5	5563.4	0.9853
36	10.00	0.120	1722.1	6045.7	0.9935
37	10.00	0.120	1657.3	5699.9	1.0289
38	10.00	0.120	1607.8	5179.7	1.0583
39	10.00	0.120	1603.5	5494.8	1.0674
40	10.00	0.120	1567.8	5332.1	1.0821
41	10.00	0.120	1495.6	5161.7	1.1395
42	10.00	0.120	1490.7	5848.2	1.1442
43	10.00	0.120	1489.8	5945.5	1.1484

Table 3.2-1: TPNP Best Estimate Soil Column Profile and Soil Properties (cont'd)

Layer No.	Thickness [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
44	10.00	0.120	1488.1	5879.4	1.1522
45	10.00	0.120	1487.6	5810.1	1.1606
46	10.00	0.120	1474.5	5827.1	1.1735
47	10.00	0.120	1466.2	5908.8	1.1852
48	10.00	0.120	1457.6	5551.0	1.2029
49	10.00	0.120	1448.9	5800.0	1.2188
50	10.00	0.120	1445.4	5635.2	1.2241
51	10.00	0.120	1446.1	5790.2	1.2311
52	10.00	0.120	1441.6	5793.2	1.2458
53	10.00	0.120	1441.0	5788.1	1.2507
54	10.00	0.130	3913.6	15720.1	0.6610
55	10.00	0.130	3913.4	15719.5	0.6655
56	10.00	0.130	3913.3	8549.2	0.6663
57	10.00	0.130	3913.2	7719.9	0.6669
58	10.00	0.130	3901.3	7903.4	0.6677
59	10.00	0.130	3891.0	7891.1	0.6738
60	10.00	0.130	3873.0	8018.8	0.6783
61	10.00	0.130	3847.3	8027.7	0.6791
62	10.00	0.130	3800.1	7658.9	0.6851
63	10.00	0.130	3790.9	7938.7	0.6857
64	10.00	0.130	3588.0	7903.1	0.7011
65	10.00	0.130	3432.3	7776.0	0.7169
66	10.00	0.130	3184.0	7513.6	0.7390
67	10.00	0.130	3191.8	7763.7	0.7395
68	10.00	0.130	3222.5	7564.4	0.7390
69	10.00	0.130	3410.8	7557.8	0.7188
70	10.00	0.130	3556.1	7402.6	0.7118
71	64.00	0.130	4308.0	8967.7	0.2900
72	100.00	0.130	4304.4	8960.4	0.2900
73	200.00	0.130	4483.1	9105.3	0.2900
74	200.00	0.130	4895.2	9514.6	0.2900
75	200.00	0.130	5131.4	9600.0	0.2900
76	200.00	0.130	5375.9	10057.4	0.2900
77	200.00	0.130	5640.4	10552.3	0.2900
78	200.00	0.130	5665.1	10598.5	0.2900
79	200.00	0.130	6496.8	12154.4	0.2900
80	200.00	0.130	6705.9	12545.6	0.2900
81	200.00	0.130	6771.8	12668.9	0.2900
82	200.00	0.130	6771.8	12668.9	0.2900
83	200.00	0.130	6779.1	12682.6	0.2900
84	200.00	0.130	6717.1	12566.6	0.2900
85	200.00	0.130	6724.7	12580.8	0.2900
86	200.00	0.130	6724.7	12580.8	0.2900

Table 3.2-1: TPNP Best Estimate Soil Column Profile and Soil Properties (cont'd)

Layer No.	Thickness [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
87	200.00	0.130	6756.6	12640.4	0.2900
88	200.00	0.130	8996.6	16831.0	0.2900
89	200.00	0.130	9050.7	16932.3	0.2900
90	200.00	0.130	9132.9	17086.1	0.2900
91	200.00	0.130	9113.1	17049.0	0.2900
92	200.00	0.130	8800.1	16463.4	0.2900
93	200.00	0.130	8750.5	16370.7	0.2900
94	200.00	0.130	8444.8	15798.7	0.2900
95	200.00	0.130	8119.4	15190.0	0.2900
96	200.00	0.130	8034.9	15032.0	0.2900
97	200.00	0.130	7967.0	14904.9	0.2900
98	200.00	0.130	7755.8	14509.8	0.2900
99	200.00	0.130	7761.2	14519.8	0.2900
100	200.00	0.130	7676.3	14361.0	0.2900
101	200.00	0.130	7678.0	14364.3	0.2900
102	200.00	0.130	7673.1	14355.0	0.2900
103	200.00	0.130	7616.5	14249.2	0.2900
104	200.00	0.130	7601.7	14221.5	0.2900
105	200.00	0.130	7755.0	14508.2	0.2900
106	200.00	0.130	7827.7	14644.2	0.2900
107	200.00	0.130	7812.5	14615.9	0.2900
108	200.00	0.130	7823.1	14635.6	0.2900
109	200.00	0.130	7953.1	14878.8	0.2700
110	200.00	0.130	7953.1	14878.8	0.2700
111	200.00	0.130	7967.0	14904.9	0.2700
112	200.00	0.130	8059.6	15078.2	0.2600
113	200.00	0.130	8276.7	15484.3	0.2500
114	200.00	0.130	8394.8	15705.3	0.2600
115	200.00	0.130	8499.1	15900.4	0.2500
116	200.00	0.130	8499.1	15900.4	0.2500
117	200.00	0.130	8632.8	16150.6	0.2400
118	200.00	0.130	8683.6	16245.5	0.2400
119	200.00	0.130	8629.9	16145.1	0.2400
120	200.00	0.130	8655.0	16191.9	0.2500
121	200.00	0.130	8684.4	16247.0	0.2500
122	200.00	0.130	8749.0	16367.9	0.2500
123	200.00	0.130	8749.0	16367.9	0.2500
124	200.00	0.130	8760.9	16390.2	0.2500
125	200.00	0.130	8726.0	16324.9	0.2200
126	0.00	0.170	9200.0	17211.6	1.0000

Table 3.2-2: TPNP Lower Bound Soil Column Profile and Soil Properties

Layer No.	Thickness [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
1	5.00	0.130	411.8	770.4	2.7815
2	5.00	0.130	512.9	959.5	3.4161
3	5.00	0.130	557.2	1042.4	3.7591
4	5.00	0.130	575.6	1076.8	4.1745
5	5.00	0.130	589.1	1102.2	4.5194
6	5.50	0.130	573.4	2923.7	4.9857
7	6.00	0.130	574.8	2930.9	5.2373
8	5.00	0.130	586.4	2990.0	5.3438
9	6.33	0.150	4505.9	7021.9	1.4613
10	6.33	0.150	4505.9	7021.9	1.4613
11	6.33	0.150	4505.9	7021.9	1.4613
12	6.00	0.155	4633.0	7220.0	1.3712
13	10.00	0.155	4720.4	8831.1	1.3712
14	10.00	0.155	4449.8	8177.8	1.3712
15	10.00	0.136	3966.7	7353.9	1.3712
16	10.00	0.136	3893.6	7857.1	1.3712
17	10.00	0.136	3847.4	7712.9	1.3712
18	10.00	0.136	3813.8	7531.2	1.3712
19	10.00	0.136	3669.2	7307.4	1.3712
20	10.00	0.136	1409.7	5000.0	1.3712
21	10.00	0.120	1267.7	5000.0	1.5110
22	10.00	0.120	1316.2	5489.4	1.4836
23	10.00	0.120	1315.7	5000.0	1.4649
24	10.00	0.120	1345.7	5319.4	1.3383
25	10.00	0.120	1354.2	5000.0	1.3388
26	10.00	0.120	1366.0	5000.0	1.3339
27	10.00	0.120	1369.1	5000.0	1.3413
28	10.00	0.120	1386.0	5033.3	1.3363
29	10.00	0.120	1456.1	5086.4	1.2946
30	10.00	0.120	1620.5	5262.2	1.2046
31	10.00	0.120	1634.0	5000.0	1.1999
32	10.00	0.120	1575.7	5000.0	1.2432
33	10.00	0.120	1537.9	5000.0	1.2631
34	10.00	0.120	1469.9	5000.0	1.3140
35	10.00	0.120	1409.7	5000.0	1.3423
36	10.00	0.120	1406.1	5000.0	1.3532
37	10.00	0.120	1353.2	5000.0	1.4099
38	10.00	0.120	1312.8	5000.0	1.4601
39	10.00	0.120	1309.2	5000.0	1.4705
40	10.00	0.120	1280.1	5000.0	1.4820
41	10.00	0.120	1221.1	5000.0	1.5664

Table 3.2-2: TPNP Lower Bound Soil Column Profile and Soil Properties (cont'd)

Layer No.	Thickness [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
42	10.00	0.120	1217.2	5000.0	1.5725
43	10.00	0.120	1216.4	5000.0	1.5825
44	10.00	0.120	1215.0	5000.0	1.5918
45	10.00	0.120	1214.7	5000.0	1.6033
46	10.00	0.120	1203.9	5000.0	1.6149
47	10.00	0.120	1197.2	5000.0	1.6122
48	10.00	0.120	1190.1	5000.0	1.6474
49	10.00	0.120	1183.1	5000.0	1.6871
50	10.00	0.120	1180.2	5000.0	1.6842
51	10.00	0.120	1180.8	5000.0	1.6948
52	10.00	0.120	1177.1	5000.0	1.7093
53	10.00	0.120	1176.6	5000.0	1.7129
54	10.00	0.130	3195.4	12835.4	0.9001
55	10.00	0.130	3195.3	12834.9	0.9070
56	10.00	0.130	3195.2	6980.4	0.9109
57	10.00	0.130	3195.1	6303.3	0.9121
58	10.00	0.130	3185.4	6453.1	0.9140
59	10.00	0.130	3177.0	6443.1	0.9226
60	10.00	0.130	3162.3	6547.3	0.9307
61	10.00	0.130	3141.3	6554.6	0.9280
62	10.00	0.130	3102.7	6253.5	0.9389
63	10.00	0.130	3095.3	6482.0	0.9394
64	10.00	0.130	2929.6	6452.9	0.9658
65	10.00	0.130	2802.5	6349.1	0.9910
66	10.00	0.130	2599.8	6134.8	1.0152
67	10.00	0.130	2606.1	6339.0	1.0162
68	10.00	0.130	2631.2	6176.3	1.0150
69	10.00	0.130	2784.9	6170.9	0.9741
70	10.00	0.130	2903.6	6044.2	0.9705
71	64.00	0.130	3517.4	7322.1	0.5235
72	100.00	0.130	3514.5	7316.1	0.5235
73	200.00	0.130	3660.4	7434.4	0.5235
74	200.00	0.130	3996.9	7768.6	0.5235
75	200.00	0.130	4189.8	7838.4	0.5235
76	200.00	0.130	4389.4	8211.8	0.5235
77	200.00	0.130	4605.4	8615.9	0.5235
78	200.00	0.130	4625.6	8653.7	0.5235
79	200.00	0.130	5304.6	9924.0	0.5235
80	200.00	0.130	5475.4	10243.5	0.5235
81	200.00	0.130	5529.2	10344.1	0.5235
82	200.00	0.130	5529.2	10344.1	0.5235
83	200.00	0.130	5535.1	10355.3	0.5235
84	200.00	0.130	5484.5	10260.6	0.5235

Table 3.2-2: TPNP Lower Bound Soil Column Profile and Soil Properties (cont'd)

Layer No.	Thickness [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
85	200.00	0.130	5490.7	10272.2	0.5235
86	200.00	0.130	5490.7	10272.2	0.5235
87	200.00	0.130	5516.7	10320.8	0.5235
88	200.00	0.130	7345.7	13742.5	0.5235
89	200.00	0.130	7389.9	13825.2	0.5235
90	200.00	0.130	7457.0	13950.8	0.5235
91	200.00	0.130	7440.8	13920.4	0.5235
92	200.00	0.130	7185.2	13442.3	0.5235
93	200.00	0.130	7144.8	13366.6	0.5235
94	200.00	0.130	6895.1	12899.6	0.5235
95	200.00	0.130	6629.4	12402.6	0.5235
96	200.00	0.130	6560.5	12273.5	0.5235
97	200.00	0.130	6505.0	12169.8	0.5235
98	200.00	0.130	6332.6	11847.2	0.5235
99	200.00	0.130	6337.0	11855.4	0.5235
100	200.00	0.130	6267.7	11725.7	0.5235
101	200.00	0.130	6269.1	11728.4	0.5235
102	200.00	0.130	6265.0	11720.8	0.5235
103	200.00	0.130	6218.9	11634.5	0.5235
104	200.00	0.130	6206.8	11611.8	0.5235
105	200.00	0.130	6331.9	11845.9	0.5203
106	200.00	0.130	6391.3	11956.9	0.5229
107	200.00	0.130	6378.9	11933.8	0.5229
108	200.00	0.130	6387.5	11949.9	0.5248
109	200.00	0.130	6493.7	12148.5	0.4643
110	200.00	0.130	6493.7	12148.5	0.4643
111	200.00	0.130	6505.1	12169.8	0.4643
112	200.00	0.130	6580.7	12311.3	0.4429
113	200.00	0.130	6757.9	12642.9	0.4206
114	200.00	0.130	6854.4	12823.3	0.4423
115	200.00	0.130	6939.5	12982.6	0.4324
116	200.00	0.130	6939.5	12982.6	0.4324
117	200.00	0.130	7048.7	13186.9	0.4125
118	200.00	0.130	7090.1	13264.4	0.4360
119	200.00	0.130	7046.3	13182.4	0.4360
120	200.00	0.130	7066.7	13220.7	0.4147
121	200.00	0.130	7090.8	13265.6	0.4305
122	200.00	0.130	7143.5	13364.3	0.4073
123	200.00	0.130	7143.5	13364.3	0.4073
124	200.00	0.130	7153.3	13382.5	0.4073
125	200.00	0.130	7124.8	13329.2	0.2856
126	0.00	0.170	9200.0	17211.6	1.0000

Table 3.2-3: TPNP Upper Bound Soil Column Profile and Soil Properties

Layer No.	Thickness [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
1	5.00	0.130	1119.9	2095.1	1.0949
2	5.00	0.130	1352.8	2530.8	1.2808
3	5.00	0.130	1467.9	2746.1	1.4309
4	5.00	0.130	1489.5	2786.5	1.5123
5	5.00	0.130	1519.8	2843.3	1.5860
6	5.50	0.130	1491.5	5000.0	1.7055
7	6.00	0.130	1492.6	5000.0	1.8214
8	5.00	0.130	1491.6	5000.0	1.8903
9	6.33	0.150	6758.8	10532.8	0.7545
10	6.33	0.150	6758.8	10532.8	0.7545
11	6.33	0.150	6758.8	10532.8	0.7545
12	6.00	0.155	6949.5	10830.0	0.7148
13	10.00	0.155	7080.6	13246.7	0.7148
14	10.00	0.155	6674.7	12266.8	0.7148
15	10.00	0.136	5950.0	11030.9	0.7148
16	10.00	0.136	5840.4	11785.6	0.7148
17	10.00	0.136	5771.1	11569.3	0.7148
18	10.00	0.136	5720.7	11296.8	0.7148
19	10.00	0.136	5665.2	11282.6	0.7148
20	10.00	0.136	2419.9	5000.0	0.7148
21	10.00	0.120	1901.5	5621.6	0.6902
22	10.00	0.120	1974.3	8234.1	0.6843
23	10.00	0.120	1973.6	6541.5	0.6927
24	10.00	0.120	2018.5	7979.1	0.6972
25	10.00	0.120	2031.3	7408.6	0.6983
26	10.00	0.120	2049.0	7124.8	0.6993
27	10.00	0.120	2053.7	7350.5	0.6998
28	10.00	0.120	2079.0	7550.0	0.6974
29	10.00	0.120	2184.2	7629.7	0.6858
30	10.00	0.120	2430.7	7893.2	0.6449
31	10.00	0.120	2451.0	6962.7	0.6481
32	10.00	0.120	2363.6	6372.9	0.6564
33	10.00	0.120	2306.8	7148.4	0.6758
34	10.00	0.120	2204.9	6388.1	0.6899
35	10.00	0.120	2114.5	6813.7	0.7232
36	10.00	0.120	2109.1	7404.5	0.7294
37	10.00	0.120	2029.7	6980.9	0.7509
38	10.00	0.120	1969.2	6343.8	0.7670
39	10.00	0.120	1963.9	6729.7	0.7748
40	10.00	0.120	1920.2	6530.4	0.7900

Table 3.2-3: TPNP Upper Bound Soil Column Profile and Soil Properties (cont'd)

Layer No.	Thickness [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
41	10.00	0.120	1805.8	7136.8	0.9000
42	10.00	0.120	1825.8	7162.6	0.8325
43	10.00	0.120	1824.6	7281.7	0.8334
44	10.00	0.120	1822.5	7200.7	0.8340
45	10.00	0.120	1822.0	7115.9	0.8402
46	10.00	0.120	1805.8	7136.8	0.8528
47	10.00	0.120	1795.7	7236.7	0.8713
48	10.00	0.120	1785.1	6798.5	0.8784
49	10.00	0.120	1774.6	7103.5	0.8804
50	10.00	0.120	1770.2	6901.7	0.8897
51	10.00	0.120	1771.1	7091.6	0.8943
52	10.00	0.120	1765.6	7095.2	0.9080
53	10.00	0.120	1764.8	7089.0	0.9132
54	10.00	0.130	4793.1	19253.1	0.4854
55	10.00	0.130	4792.9	19252.4	0.4883
56	10.00	0.130	4792.8	10470.6	0.4874
57	10.00	0.130	4792.6	9455.0	0.4876
58	10.00	0.130	4778.1	9679.7	0.4877
59	10.00	0.130	4765.5	9664.6	0.4921
60	10.00	0.130	4743.4	9821.0	0.4944
61	10.00	0.130	4712.0	9831.9	0.4969
62	10.00	0.130	4654.1	9380.2	0.4999
63	10.00	0.130	4642.9	9722.9	0.5005
64	10.00	0.130	4394.3	9679.3	0.5090
65	10.00	0.130	4203.7	9523.6	0.5187
66	10.00	0.130	3899.6	9202.3	0.5379
67	10.00	0.130	3909.1	9508.5	0.5381
68	10.00	0.130	3946.7	9264.5	0.5380
69	10.00	0.130	4177.4	9256.4	0.5304
70	10.00	0.130	4355.3	9066.3	0.5221
71	64.00	0.130	5276.2	10983.2	0.1606
72	100.00	0.130	5271.8	10974.2	0.1606
73	200.00	0.130	5490.7	11151.6	0.1606
74	200.00	0.130	5995.4	11652.9	0.1606
75	200.00	0.130	6284.7	11757.6	0.1606
76	200.00	0.130	6584.1	12317.7	0.1606
77	200.00	0.130	6908.1	12923.9	0.1606
78	200.00	0.130	6938.4	12980.5	0.1606
79	200.00	0.130	7956.9	14886.1	0.1606
80	200.00	0.130	8213.1	15365.2	0.1606
81	200.00	0.130	8293.8	15516.2	0.1606
82	200.00	0.130	8293.8	15516.2	0.1606
83	200.00	0.130	8302.7	15532.9	0.1606
84	200.00	0.130	8226.8	15390.9	0.1606
85	200.00	0.130	8236.1	15408.3	0.1606

Table 3.2-3: TPNP Upper Bound Soil Column Profile and Soil Properties (cont'd)

Layer No.	Thickness [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
86	200.00	0.130	8236.1	15408.3	0.1606
87	200.00	0.130	8275.1	15481.2	0.1606
88	200.00	0.130	11018.5	20613.7	0.1606
89	200.00	0.130	11084.8	20737.8	0.1606
90	200.00	0.130	11185.5	20926.1	0.1606
91	200.00	0.130	11161.2	20880.7	0.1606
92	200.00	0.130	10777.8	20163.5	0.1606
93	200.00	0.130	10717.1	20049.9	0.1606
94	200.00	0.130	10342.7	19349.4	0.1606
95	200.00	0.130	9944.2	18603.8	0.1606
96	200.00	0.130	9840.7	18410.3	0.1606
97	200.00	0.130	9757.6	18254.7	0.1606
98	200.00	0.130	9498.9	17770.8	0.1606
99	200.00	0.130	9505.5	17783.1	0.1606
100	200.00	0.130	9401.5	17588.6	0.1606
101	200.00	0.130	9403.6	17592.5	0.1606
102	200.00	0.130	9397.5	17581.2	0.1606
103	200.00	0.130	9328.3	17451.7	0.1606
104	200.00	0.130	9310.1	17417.7	0.1606
105	200.00	0.130	9497.9	17768.9	0.1617
106	200.00	0.130	9586.9	17935.4	0.1608
107	200.00	0.130	9568.4	17900.8	0.1608
108	200.00	0.130	9581.3	17924.9	0.1603
109	200.00	0.130	9740.5	18222.8	0.1570
110	200.00	0.130	9740.5	18222.8	0.1570
111	200.00	0.130	9757.6	18254.8	0.1570
112	200.00	0.130	9871.0	18467.0	0.1526
113	200.00	0.130	10136.9	18964.3	0.1486
114	200.00	0.130	10281.5	19235.0	0.1528
115	200.00	0.130	10409.2	19473.9	0.1445
116	200.00	0.130	10409.2	19473.9	0.1445
117	200.00	0.130	10573.0	19780.3	0.1396
118	200.00	0.130	10635.2	19896.6	0.1321
119	200.00	0.130	10569.4	19773.6	0.1321
120	200.00	0.130	10600.1	19831.0	0.1507
121	200.00	0.130	10636.2	19898.4	0.1452
122	200.00	0.130	10715.3	20046.5	0.1535
123	200.00	0.130	10715.3	20046.5	0.1535
124	200.00	0.130	10729.9	20073.8	0.1535
125	200.00	0.130	10687.2	19993.8	0.1695
126	0.00	0.170	9200.0	17211.6	1.0000

Note: % = percent; ft. = feet; ft/sec = feet per second; kcf = kips per cubic foot; SSI = soil structure interaction

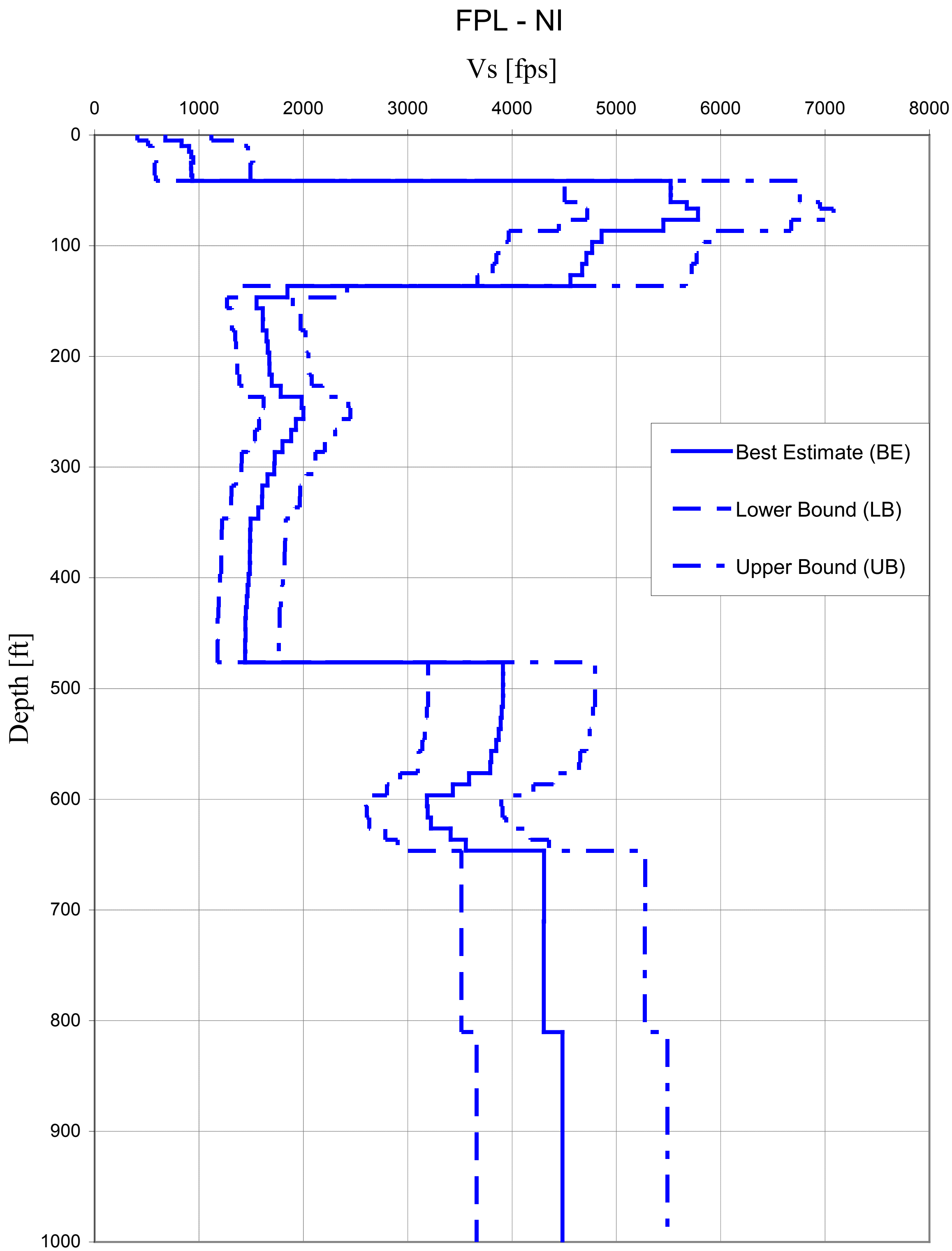

Figure 3.2-1: Turkey Point Site (FPL) - NI V_S

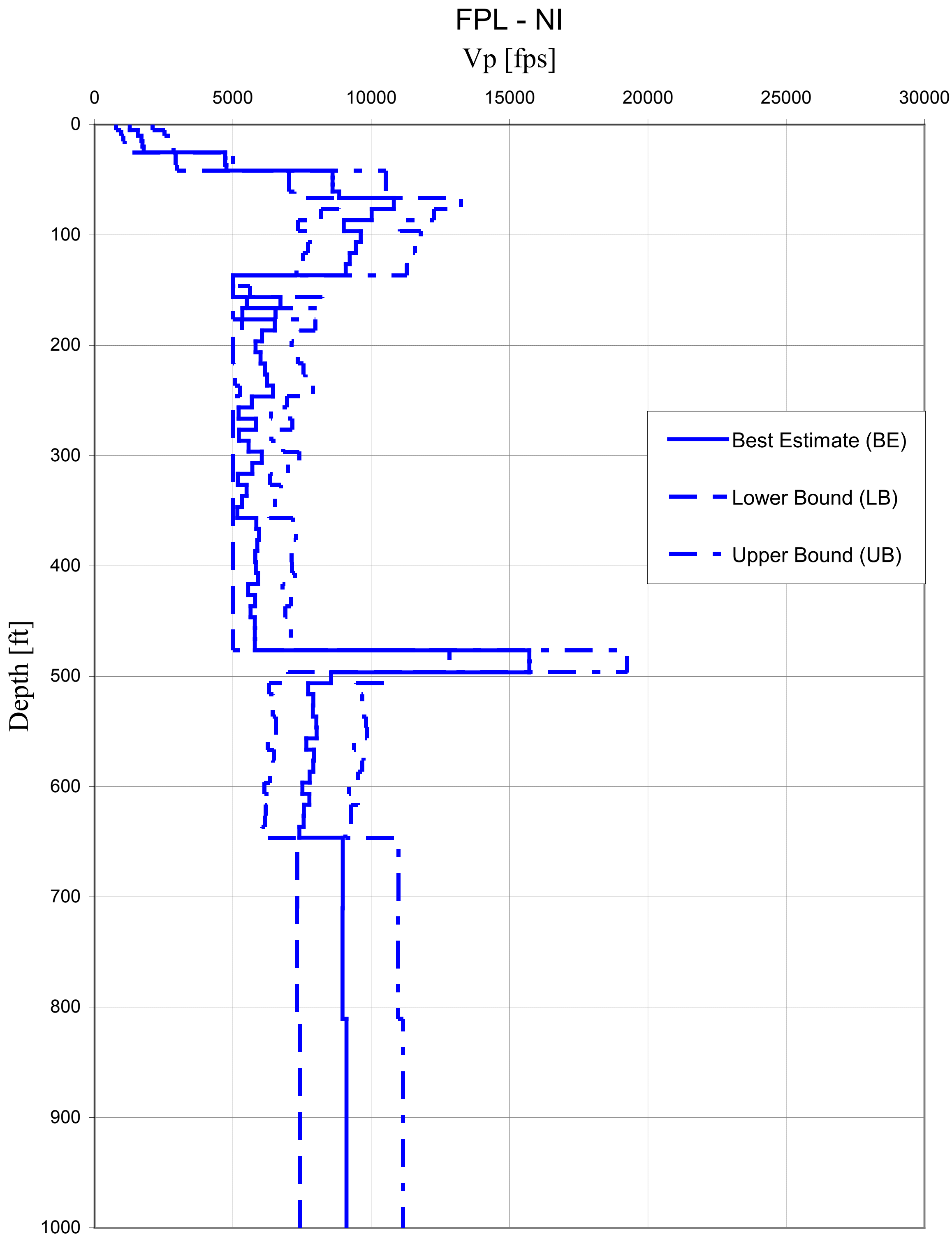

Figure 3.2-2: Turkey Point Site (FPL) - NI V_P

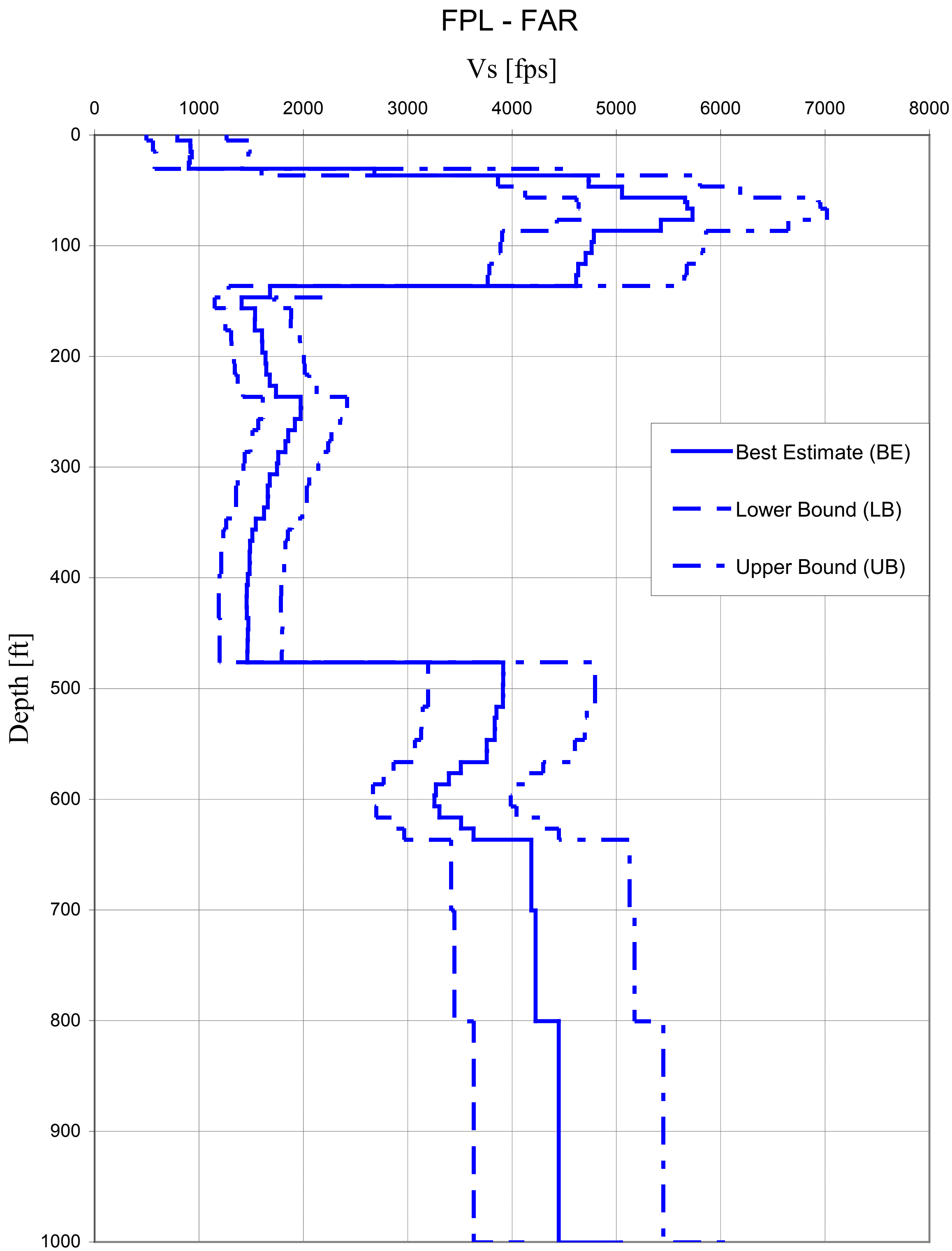

Figure 3.2-3: Turkey Point Site (FPL) - FAR V_S

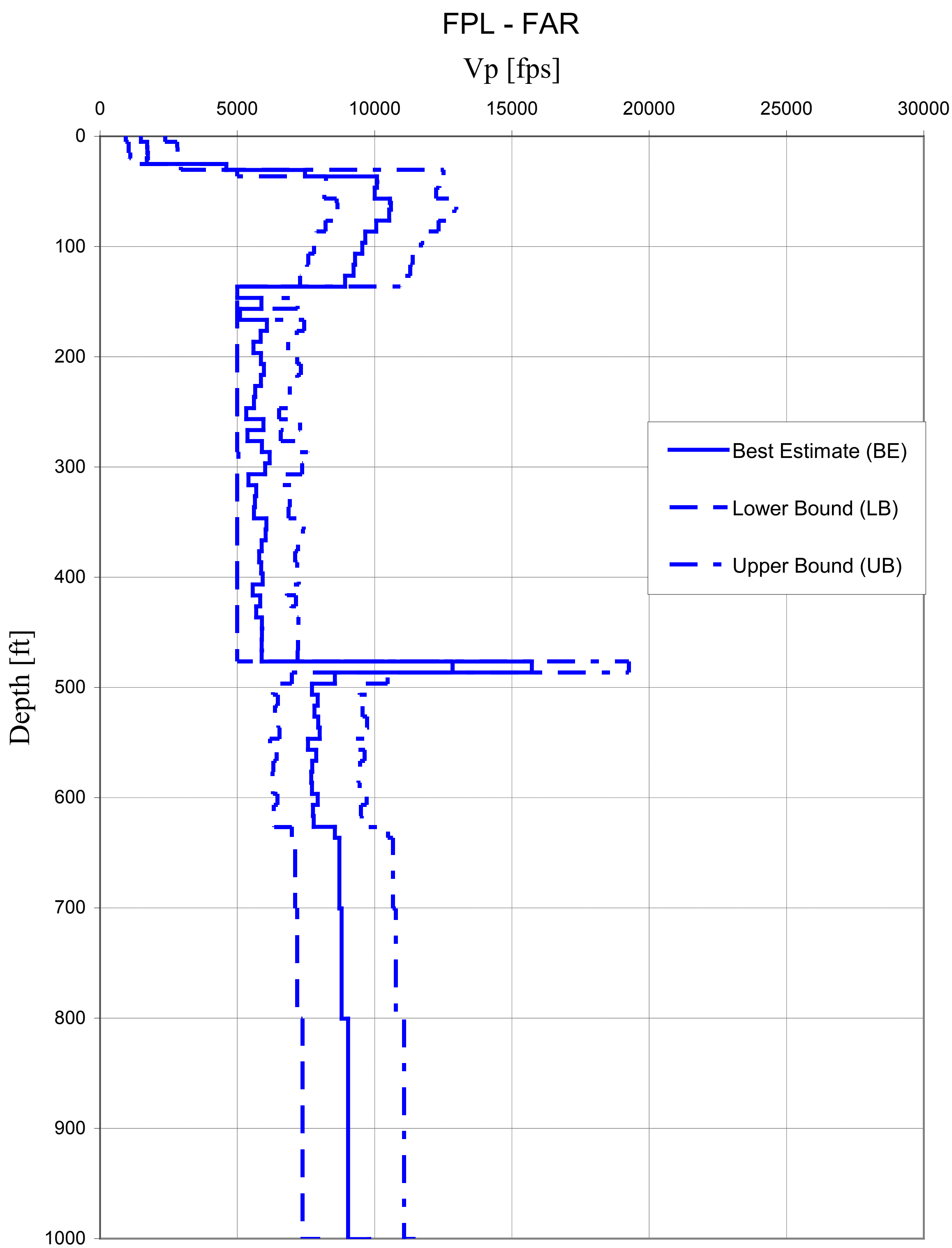

Figure 3.2-4: Turkey Point Site (FPL) - FAR V_P

3.3 TPNP Engineered Fill and Lean Concrete Properties for SSI Analyses

Tables 3.3-1, 3.3-2 and 3.3-3 present the dynamic material properties for the LC and engineered fill for the BE, LB and UB soil cases, which were provided by FPL in Bechtel letter 25409-000-TCM-GEG-00424 (Reference 1):

Table 3.3-1: TPNP Backfill Soil and Fill Concrete Profile – BE

Material	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping
Engineered Fill	0.130	679.1	1270.5	0.017
Engineered Fill	0.130	832.9	1558.3	0.021
Engineered Fill	0.130	904.4	1691.9	0.023
Engineered Fill	0.130	925.9	1732.2	0.025
Engineered Fill	0.130	946.3	1770.3	0.027
Engineered Fill	0.130	924.8	4715.4	0.029
Engineered Fill	0.130	926.2	4722.9	0.031
Engineered Fill	0.130	935.2	4768.7	0.032
Lean Concrete	0.150	5518.5	8600.0	0.011
Lean Concrete	0.150	5518.5	8600.0	0.011
Lean Concrete	0.150	5518.5	8600.0	0.011

Table 3.3-2: TPNP Backfill Soil and Fill Concrete Profile – LB

Material	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping
Engineered Fill	0.130	411.8	770.4	0.028
Engineered Fill	0.130	512.9	959.5	0.034
Engineered Fill	0.130	557.2	1042.4	0.038
Engineered Fill	0.130	575.6	1076.8	0.042
Engineered Fill	0.130	589.1	1102.2	0.045
Engineered Fill	0.130	573.4	2923.7	0.050
Engineered Fill	0.130	574.8	2930.9	0.050
Engineered Fill	0.130	586.4	2990.0	0.050
Lean Concrete	0.150	4505.9	7021.9	0.015
Lean Concrete	0.150	4505.9	7021.9	0.015
Lean Concrete	0.150	4505.9	7021.9	0.015

Table 3.3-3: TPNP Backfill Soil and Fill Concrete Profile – UB

Material	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping
Engineered Fill	0.130	1119.9	2095.1	0.011
Engineered Fill	0.130	1352.8	2530.8	0.012
Engineered Fill	0.130	1467.9	2746.1	0.014
Engineered Fill	0.130	1489.5	2786.5	0.015
Engineered Fill	0.130	1519.8	2843.3	0.016
Engineered Fill	0.130	1491.5	5000.0	0.017
Engineered Fill	0.130	1492.6	5000.0	0.018
Engineered Fill	0.130	1491.6	5000.0	0.019
Lean Concrete	0.150	6758.8	10532.8	0.008
Lean Concrete	0.150	6758.8	10532.8	0.008
Lean Concrete	0.150	6758.8	10532.8	0.008

3.4 Key Nodes Selected

The six (6) key 2D and 3D NI nodes selected to obtain floor response spectra (FRS) are shown below in Table 3.4-1.

Table 3.4-1: NI Key Nodes at Location

TPNP/NI20r (3D) Node	TPNP (2D) Node	3D-X (feet)	3D-Y (feet)	3D-Z (feet)	Location
1761	4041	1000	1000	100	CIS at Reactor Vessel Support Elevation
2078	4061	1116.5	948.5	116.5	ASB NE Corner at Control Room Floor
2199	4535	1008	1014	134.25	CIS at Operating Deck
2675	4120	929	1000	179.19	ASB Corner of Fuel Building Roof at Shield Building
2788	4412	1000	1000	224	SCV Near Polar Crane
3329	4310	956.5	1000	327.41	ASB Shield Building Roof Area

3.5 TPNP Time History Inputs – El. -16' (Foundation/Top of Lean Concrete)

The TPNP input acceleration time histories were provided by FPL in Bechtel Letter 25409-000-TCM-GEG-00424 (Reference 1) and are graphically presented herein as Figures 3.5-1 through 3.5-6 for the TPNP BE, LB and UB soil cases. The input time histories are used as seismic input in three orthogonal directions at the foundation/ top of the TPNP lean concrete mat (El. -16') in the TPNP SSI analyses.

Reference 1 provides two horizontal and one vertical time history (El. -16') for 32768 BE, LB and UB discrete values of acceleration with a time step of 0.005 seconds in files FPL-NI-BE-H1.ath, FPL-NI-BE-H2.ath, and FPL-NI-BE-UP.ath, FPL-NI-LB-H1.ath, FPL-NI-LB-H2.ath, and FPL-NI-LB-UP.ath,, FPL-NI-UB-H1.ath,, FPL-NI-UB-H2.ath, and FPL-NI-UB-UP.ath for the (near) NI conditions. FAR conditions time histories were provided in files FPL-FAR-BE-H1.ath, FPL-FAR-BE-H2.ath, and FPL-FAR-BE-UP.ath, FPL-FAR-LB-H1.ath, FPL-FAR-LB-H2.ath, and FPL-FAR-LB-UP.ath, FPL-FAR-UB-H1.ath, FPL-FAR-UB-H2.ath, and FPL-FAR-UB-UP.ath. The seismic analysis was executed for each excitation direction separately.

3.5.1 TPNP Time History Inputs – El. +25.5' Surface Founded Adjacent Structures

The TPNP input acceleration time histories for the adjacent structures including the TB First Bay and AB were provided by FPL in Bechtel Letter 25409-000-TCM-GEG-00404 (Reference 3) and are presented in Figures 3.5-7 through 3.5-9 for the TPNP TB First Bay, and Figures 3.5-10 through 3.5-12 for the AB. The input time histories are used as seismic input in two orthogonal directions at the ground surface (El. +25.5) in the TPNP SSI analyses (X and Z for the TB First Bay, and Y and Z for the AB).

Reference 3 provides two horizontal and one vertical time history (El. +25.5') for 28000 discrete values of acceleration with a time step of 0.005 seconds in files SURTB-H1.acc, SURTB-H2.acc, and SURTB-UP.acc for the TB First Bay, and SURDRS-H1.acc, SURDRS-H2.acc and SURDRS-UP.acc for the AB.

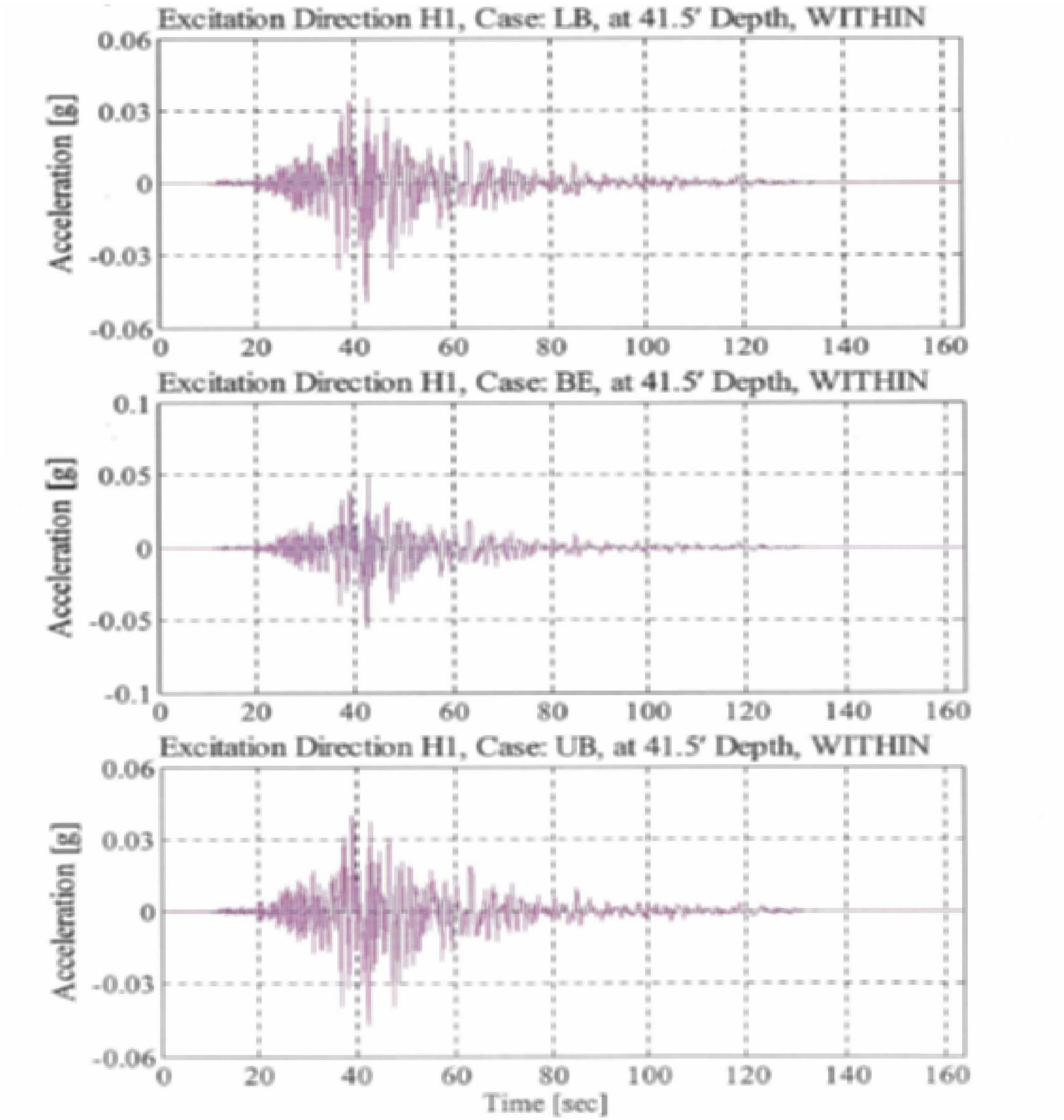

Figure 3.5-1: TPNP NI BE, LB and UB Seismic Input in H1 (X-Direction) – El. -16'

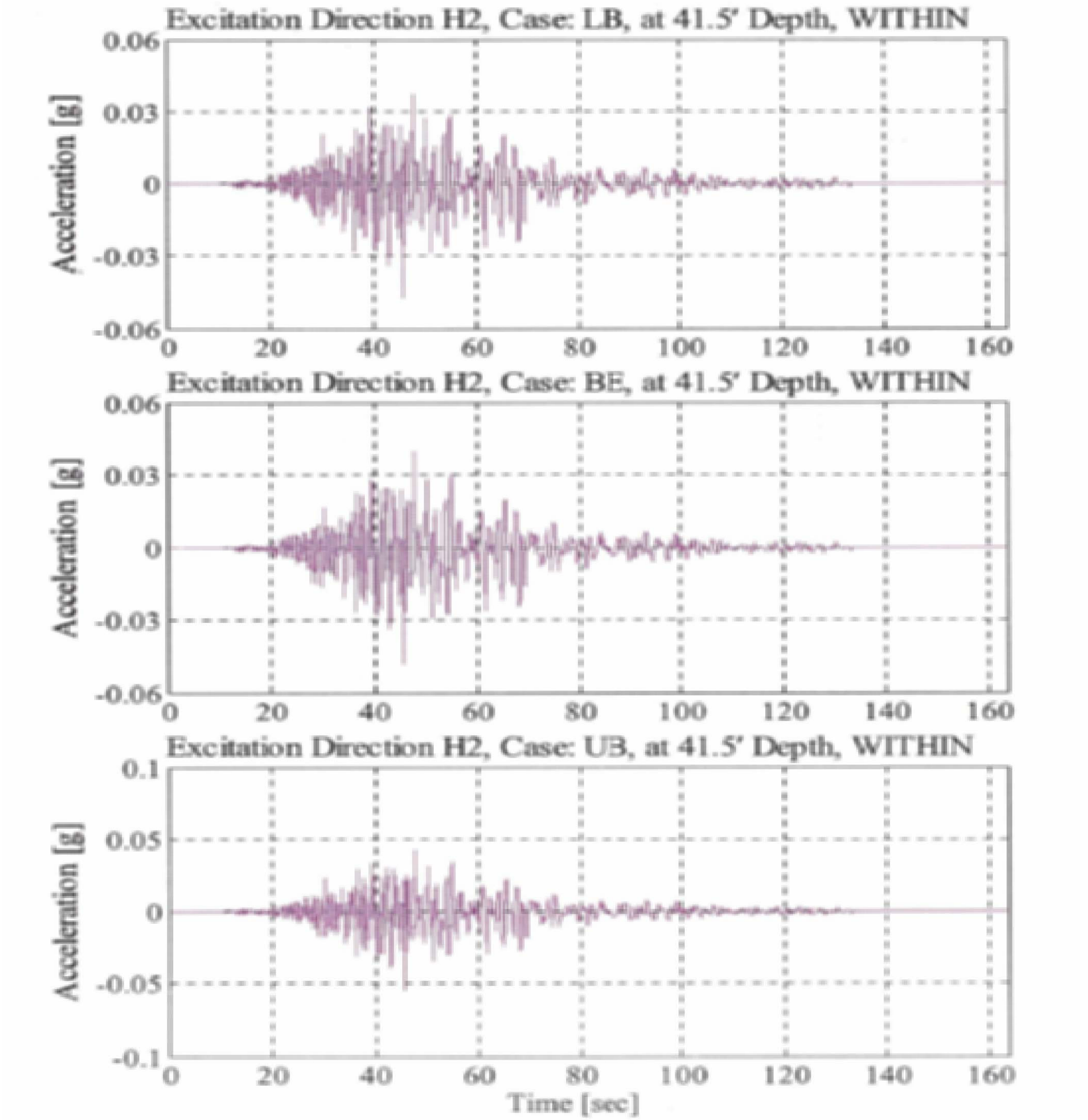

Figure 3.5-2: TPNP NI BE, LB and UB Seismic Input in H2 (Y-Direction) – El. -16'

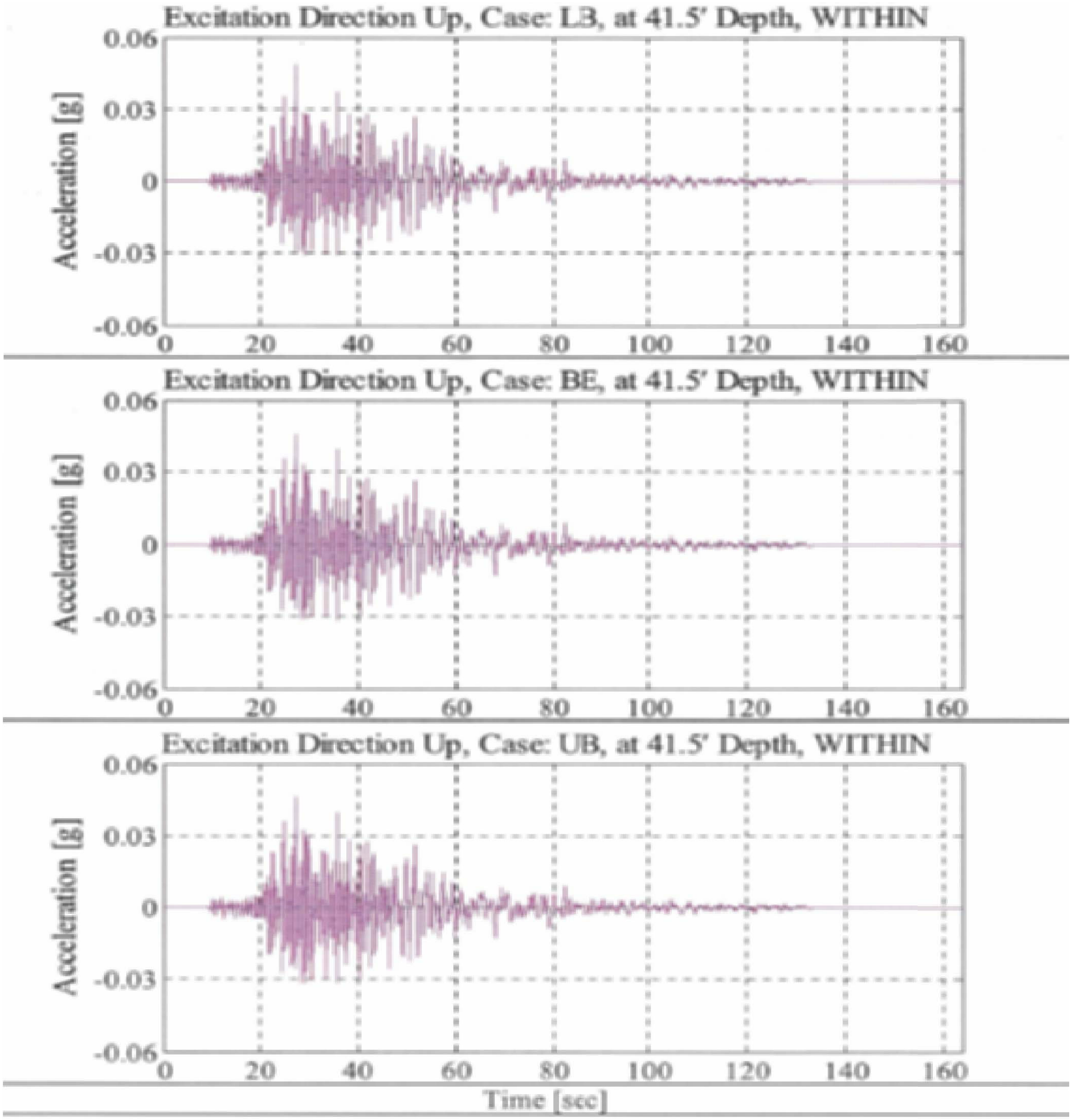

Figure 3.5-3: TPNP NI BE, LB and UB Seismic Input in UP (Z-Direction) – El. -16'

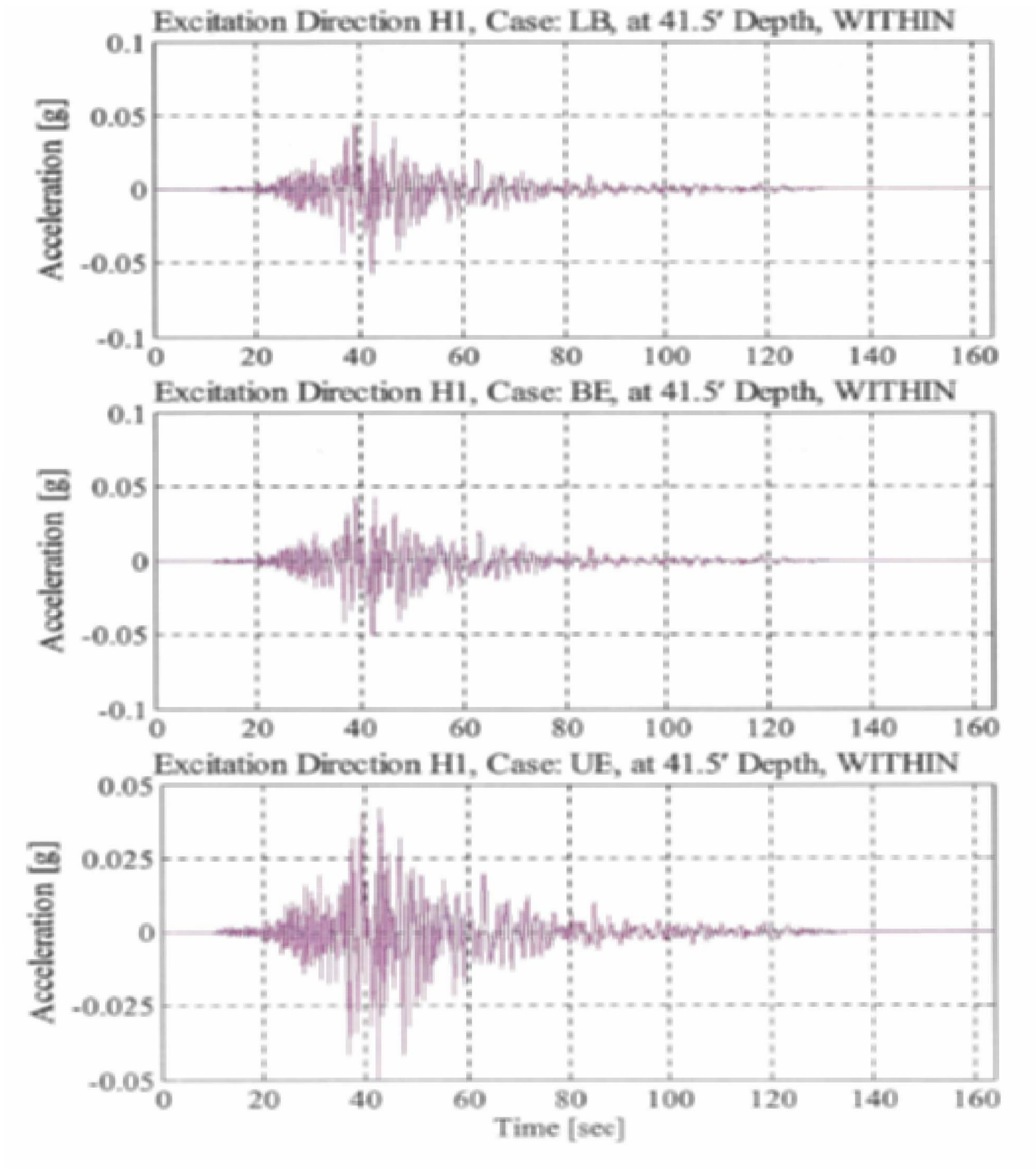

Figure 3.5-4: TPNP FAR BE, LB and UB Seismic Input in H1 (X-Direction) – El. -16’

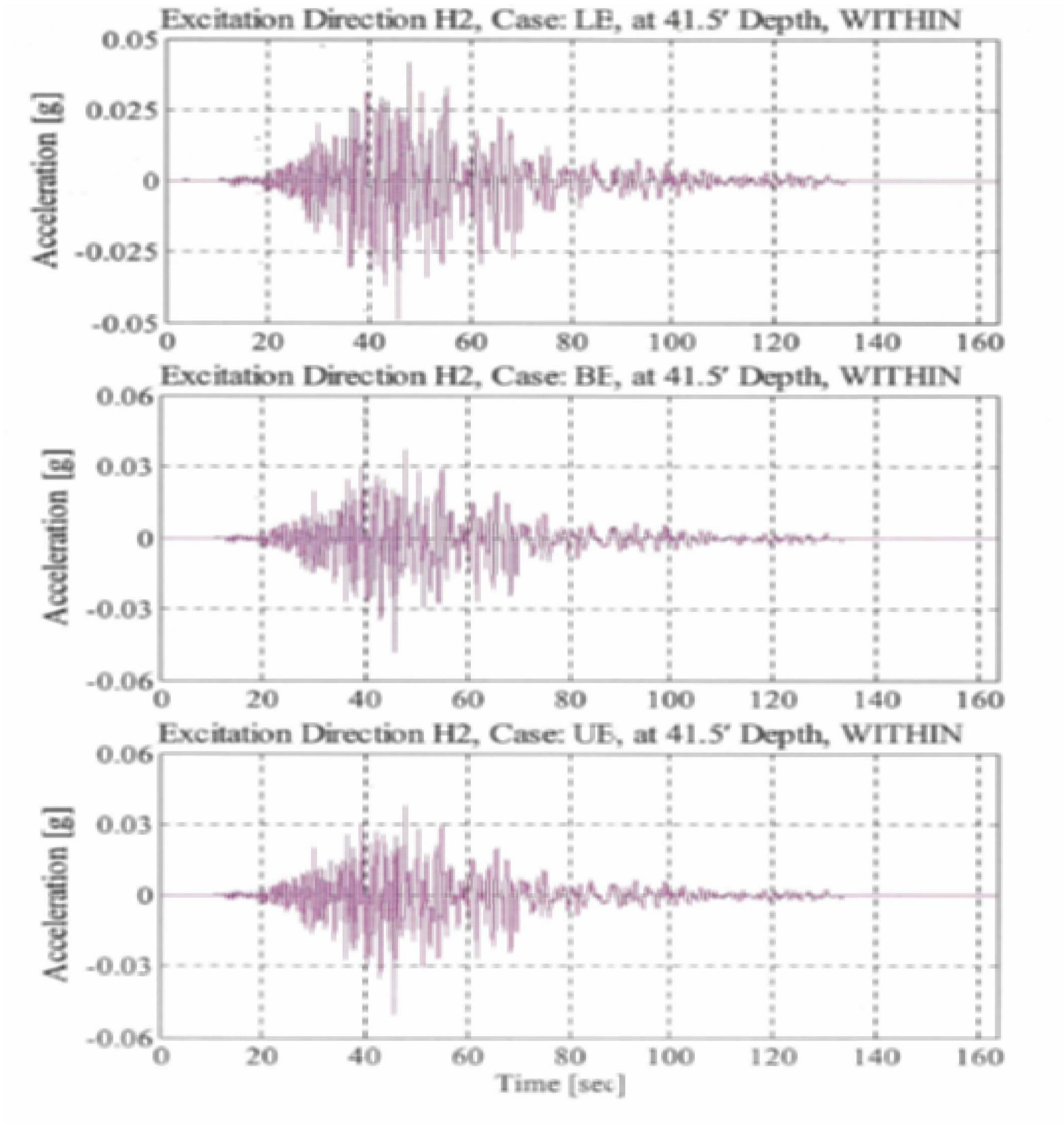

Figure 3.5-5: TPNP FAR BE, LB and UB Seismic Input in H2 (Y-Direction) – El. -16’

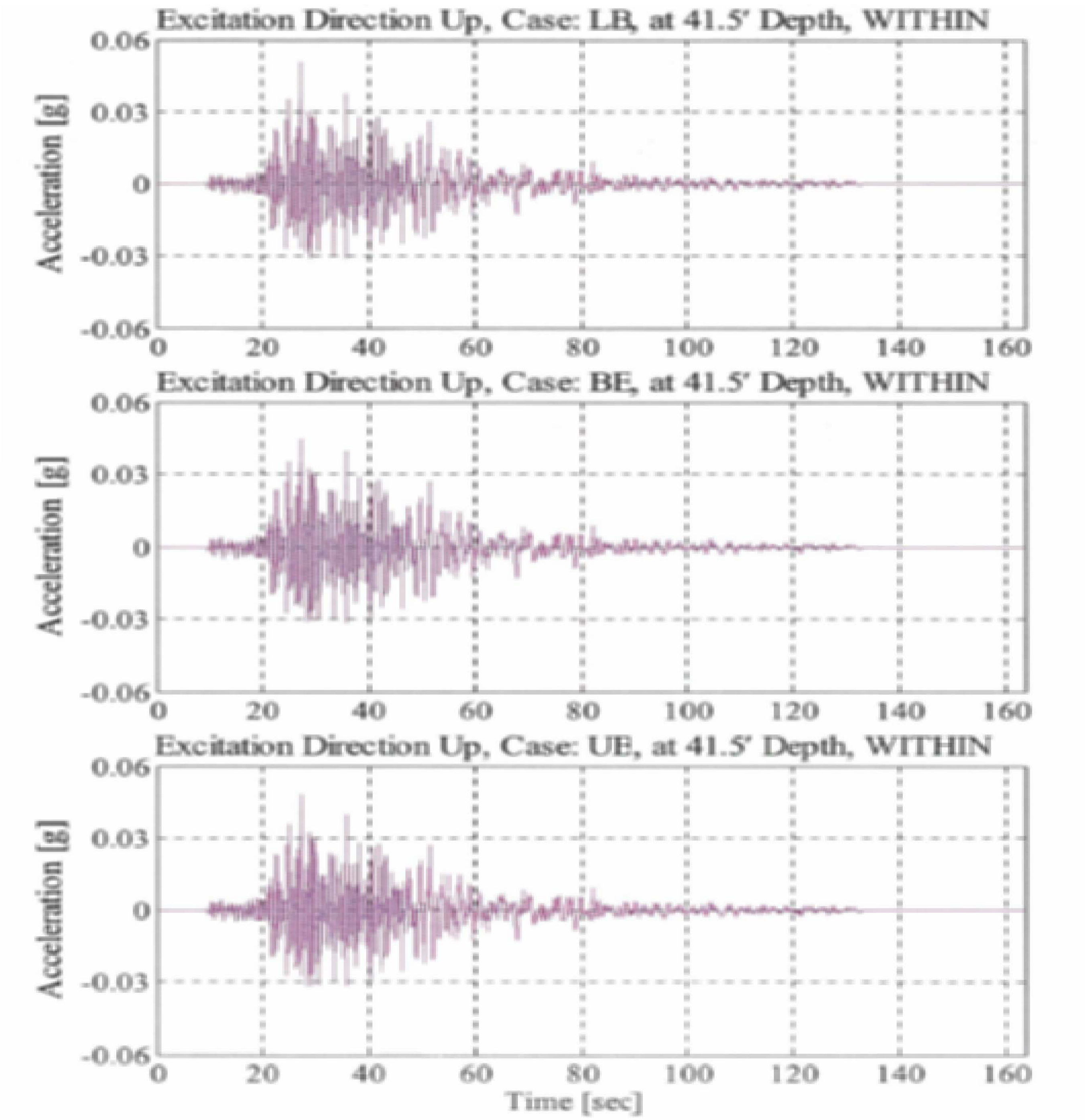

Figure 3.5-6: TPNP FAR BE, LB and UB Seismic Input in UP (Z-Direction) – El. -16'

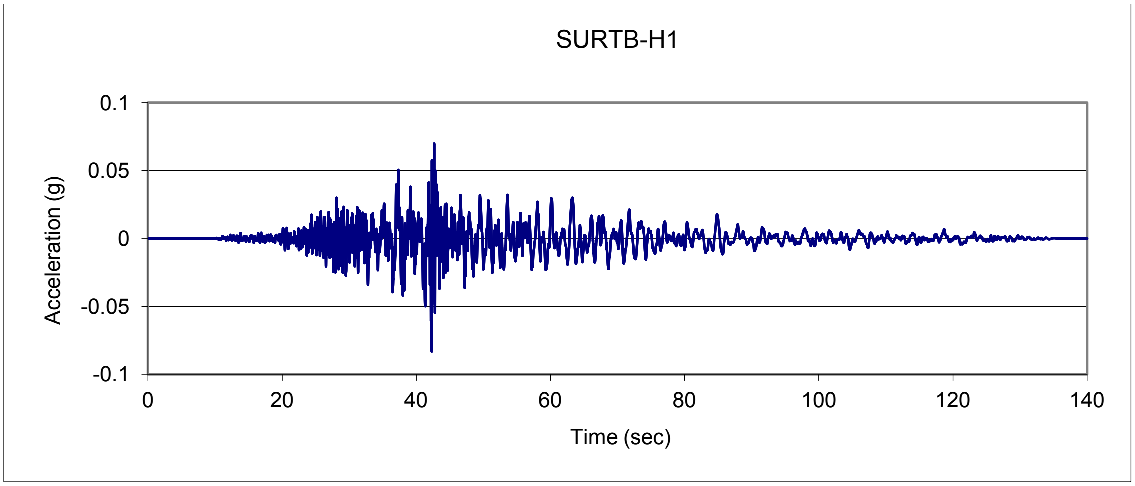

Figure 3.5-7: TPNP Turbine Building First Bay Seismic Input H1 in X-Direction – El. +25.5’

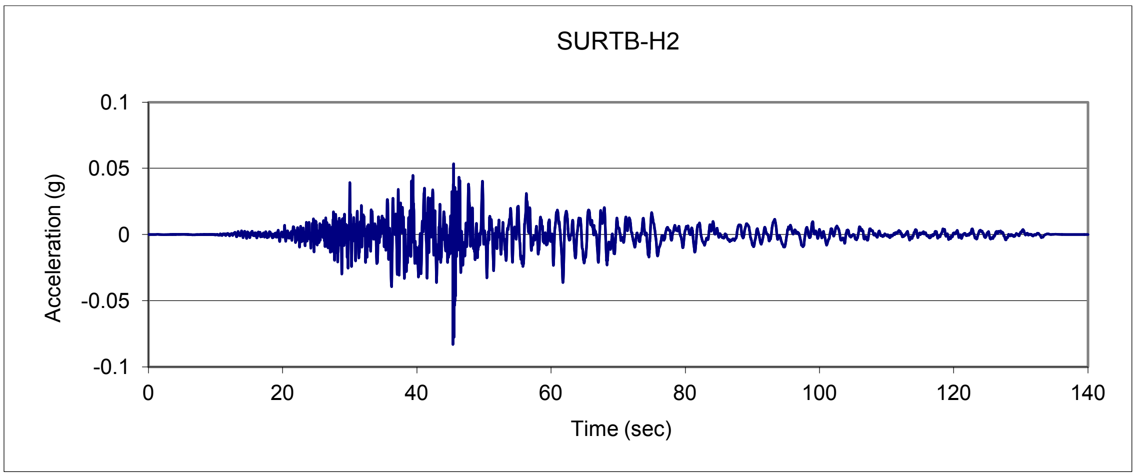

Figure 3.5-8: TPNP Turbine Building First Bay Seismic Input H2 in Y-Direction – El. +25.5’

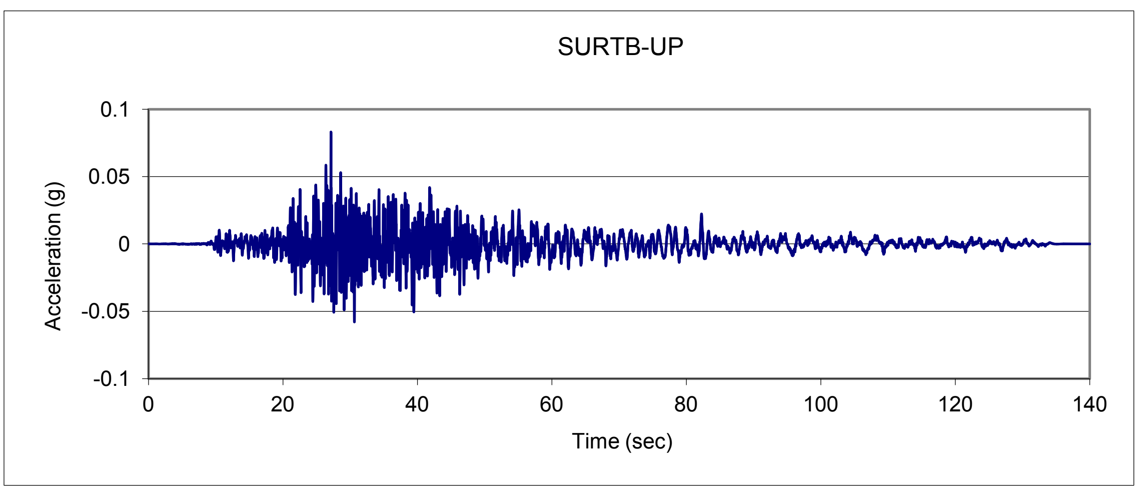

Figure 3.5-9: TPNP Turbine Building First Bay Seismic Input UP in Z-Direction – El. +25.5’

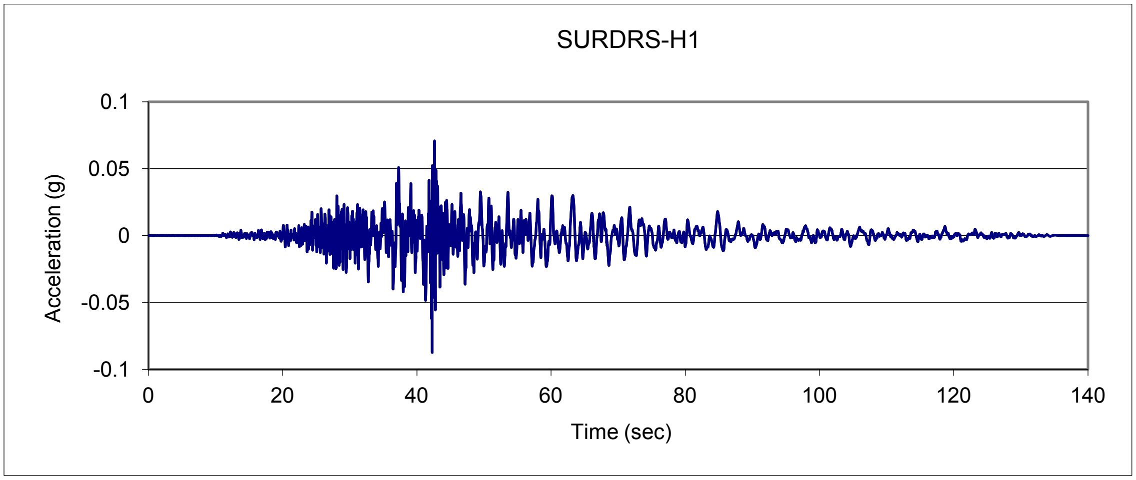

Figure 3.5-10: TPNP Annex Building Seismic Input H1 in X-Direction – El. +25.5'

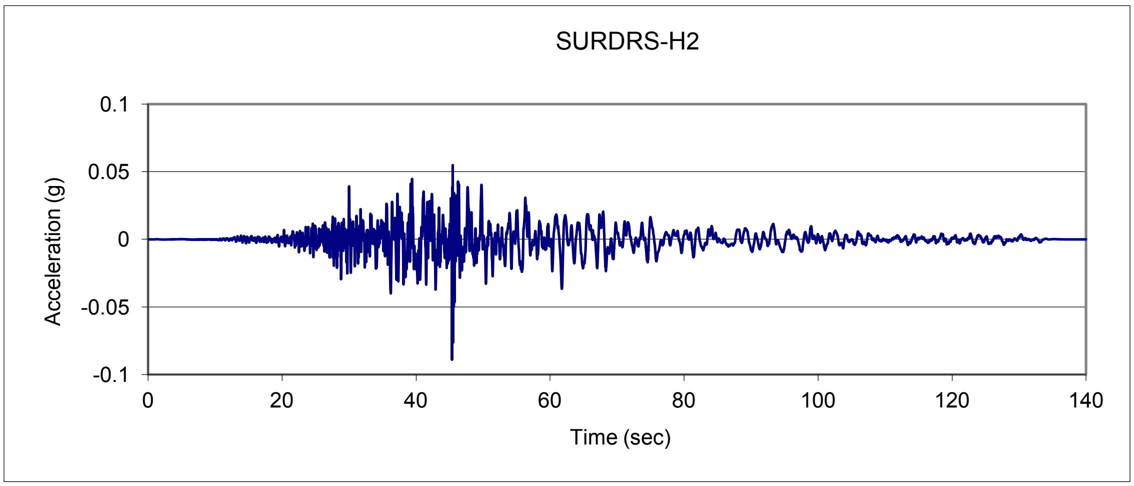

Figure 3.5-11: TPNP Annex Building Seismic Input H2 in Y-Direction – El. +25.5'

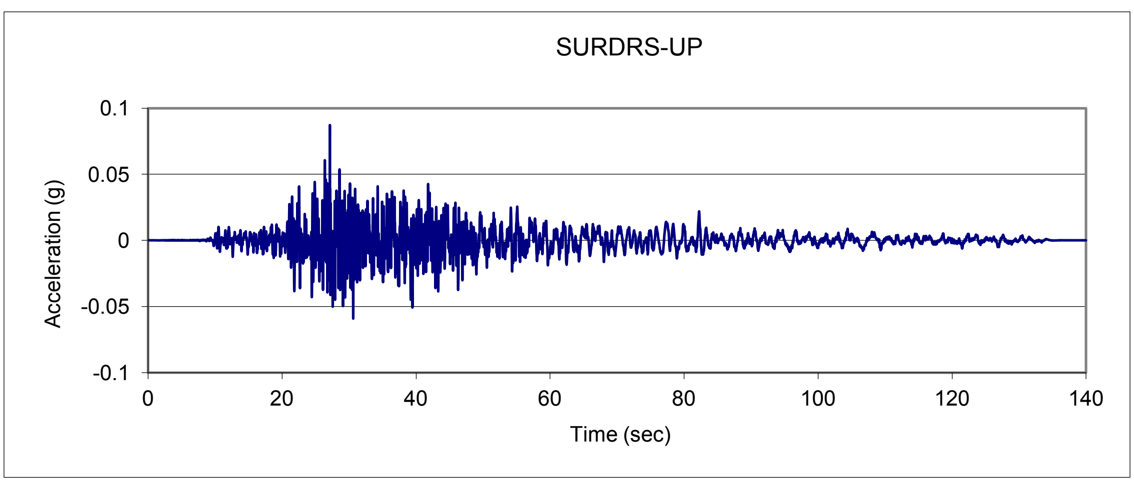

Figure 3.5-12: TPNP Annex Building Seismic Input UP in Z-Direction – El. +25.5'

3.6 AP1000 Envelope Response Spectra

The AP1000 3D FRS envelope is provided in Reference 8, and the HRHF FRS envelope (for high frequency equipment qualification) is provided in Reference 9. The TPNP 3D SSI FRS are compared to the AP1000 3D and HRHF FRS envelops at the six key locations identified in Table 3.4-1. Similarly, the AP1000 2D FRS envelops for the TB First Bay and AB are provided in Reference 10. The TPNP adjacent structures FRS are compared to the AP1000 2D FRS envelops at the six key nodes identified in Table 3.4-1. Section 6.0 presents the comparison of TPNP site specific FRS to the AP1000 and HRHF FRS envelopes.

4.0 [ ]a,c

[

]a,c

4.1 [ ]a,c

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]a,c

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]a,c

4.1.1 [ ]a,c

[

]a,c

Table 4.1-1: [ ]a,c

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a,c

Figure 4.1-1: [ ]a,c

4.2 [ ]a,c

[

]a,c

Table 4.2-1: [ ][a,c]

a,c

a,c

a,c

Table 4.2-2: [ ]a,c

a,c

a,c

a,c

Table 4.2-3: [ ]a,c

a,c

a,c

a,c

4.3 [ ]a,c

[

]a,c

4.3.1 [ ]a,c

[

]a,c

a,c

Figure 4.3-1: [ ]a,c

a,c

Figure 4.3-2: [ ]a,c

4.3.2 [ ]a,c

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]a,c

Table 4.3-1: [ ]a,c

a,c

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4.3.3 [ ]a,c

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]a,c

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Figure 4.3-3: [ ]a,c

4.3.4 [ ]a,c

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]a,c

Table 4.3-2: [ ]a,c

a,c

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a,c

4.4 [ ]a,c

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]a,c

a,c

Figure 4.4-1: [ ]a,c

a,c

Figure 4.4-2: [ ]a,c

5.0 [ ]a,c

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]a,c

5.1 [ ]a,c

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]a,c

5.2 [ ]a,c

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]a,c

5.3 [ ]a,c

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]a,c

.

6.0 TPNP Site Specific SSI Analyses Results

6.1 TPNP 2D SSI Analysis Results and Frequency-Dependent Bump Factor

Figures 6.1-1 and 6.1-2 present the TPNP 2D horizontal and vertical Bump Factors calculated from the ratio of the TPNP 2D BE Fine and Coarse FRS for each of the six (6) key locations. As shown, the frequency-dependent TPNP 2D Bump Factors range from 1.0 to about 2.1 horizontally and 1.0 to about 1.7 vertically.

The TPNP 2D Coarse and Fine SSI acceleration response spectra for 5% damping at the six (6) key NI locations are presented in Figures 6.1-3 through 6.1-14. The results of the TPNP 2D BE SSI Y (horizontal) and Z (vertical) analysis are compared to the AP1000 3D, 2D and HRHF FRS envelopes. As shown, the TPNP 2D BE FRS are enveloped by the AP1000 and HRHF FRS envelopes.

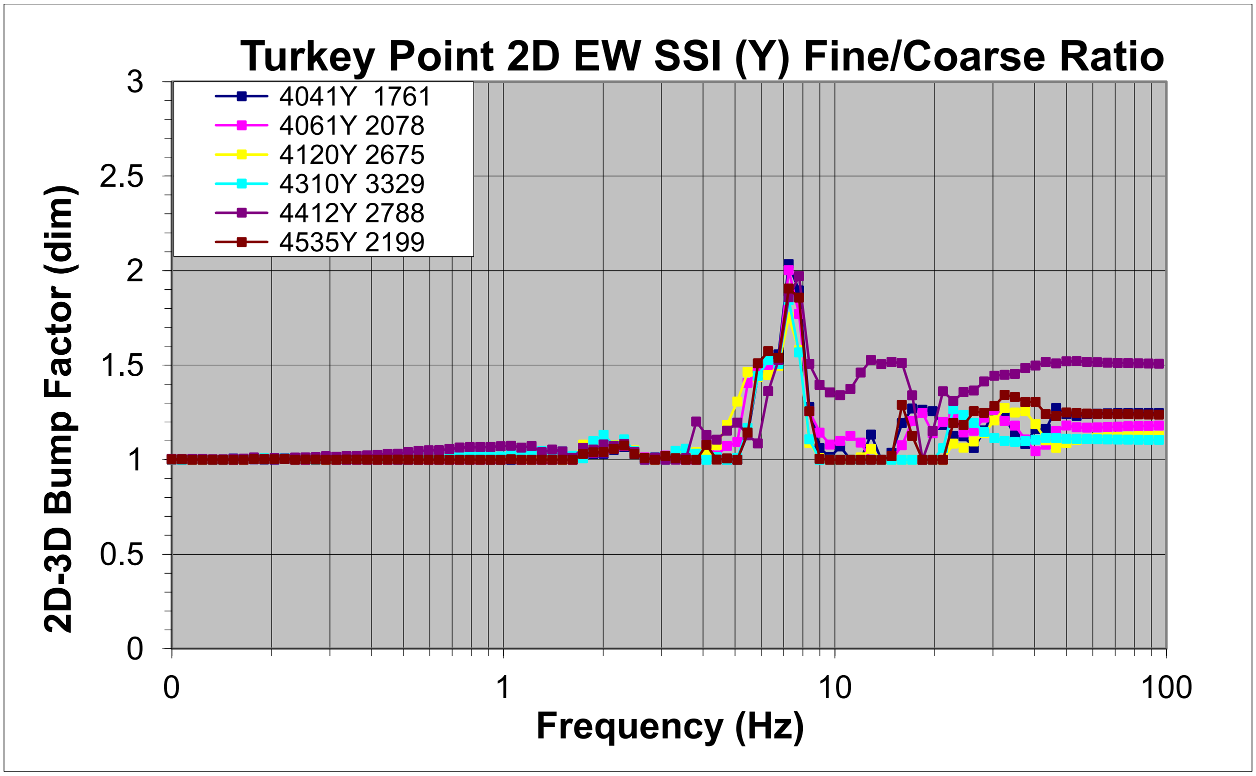

Figure 6.1-1: TPNP 2D-3D Horizontal Bump Factors – All Nodes

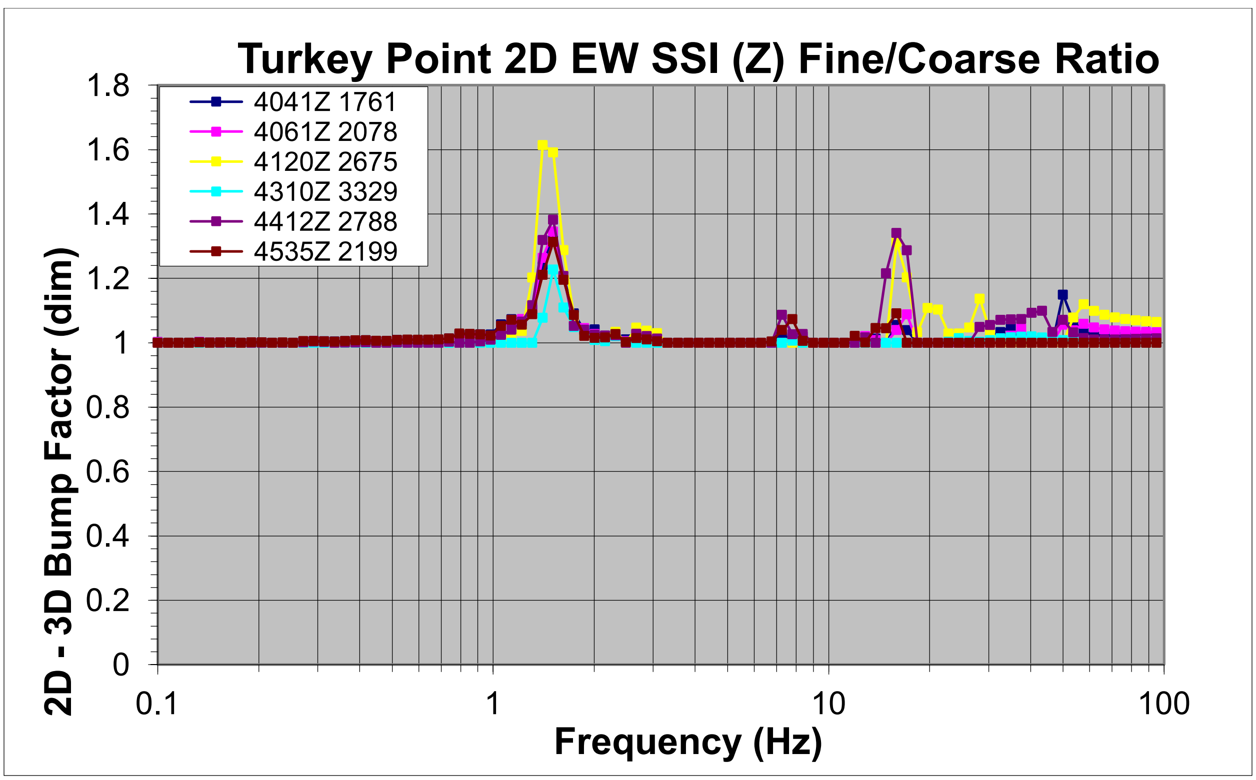

Figure 6.1-2: TPNP 2D-3D Vertical Bump Factors – All Nodes

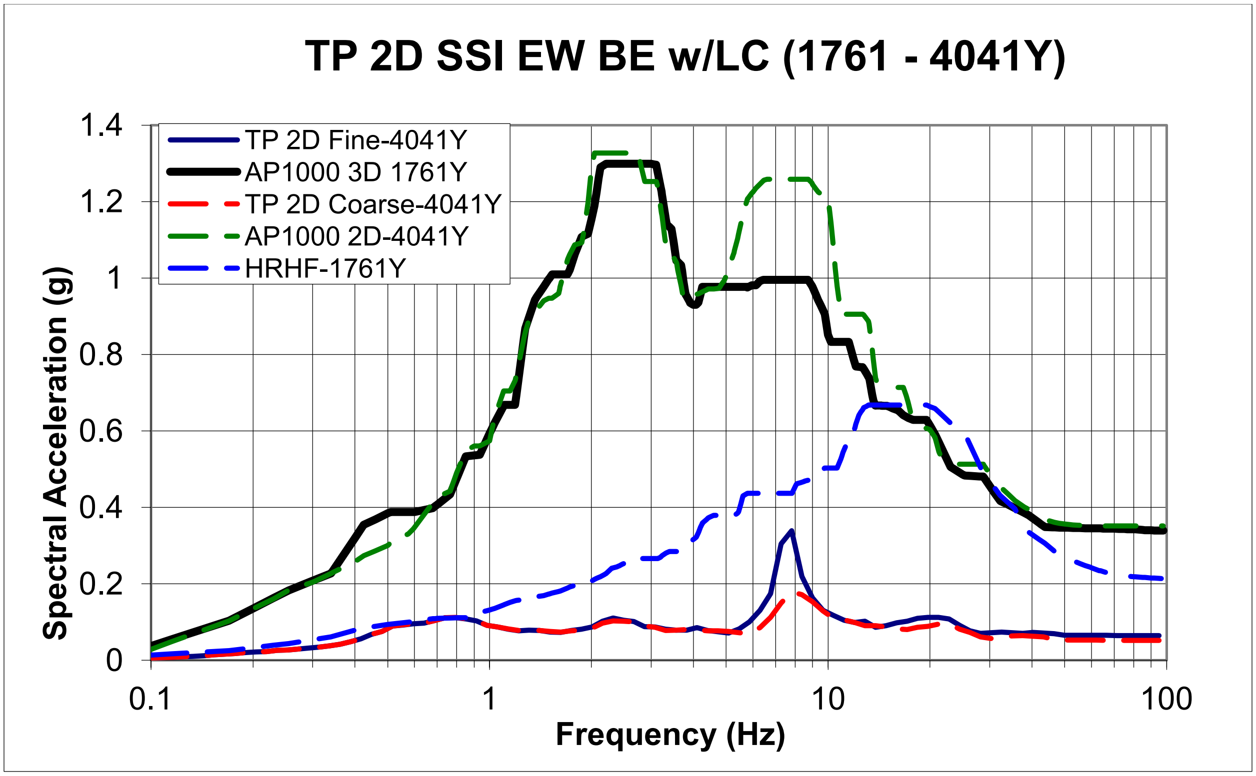

Figure 6.1-3: TPNP 2D Fine and Coarse FRS and AP1000 FRS Envelope in Y-Direction – Node 4041

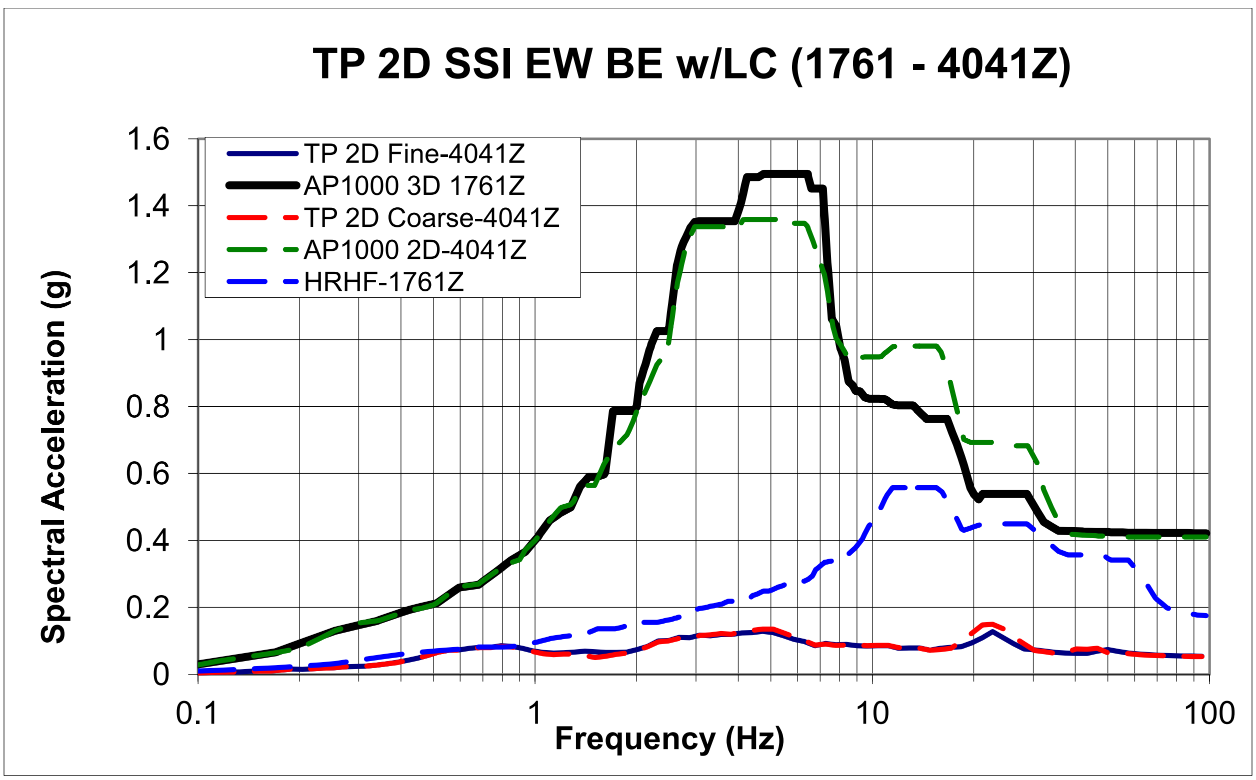

Figure 6.1-4: TPNP 2D Fine and Coarse FRS and AP1000 FRS Envelope in Z-Direction – Node 4041

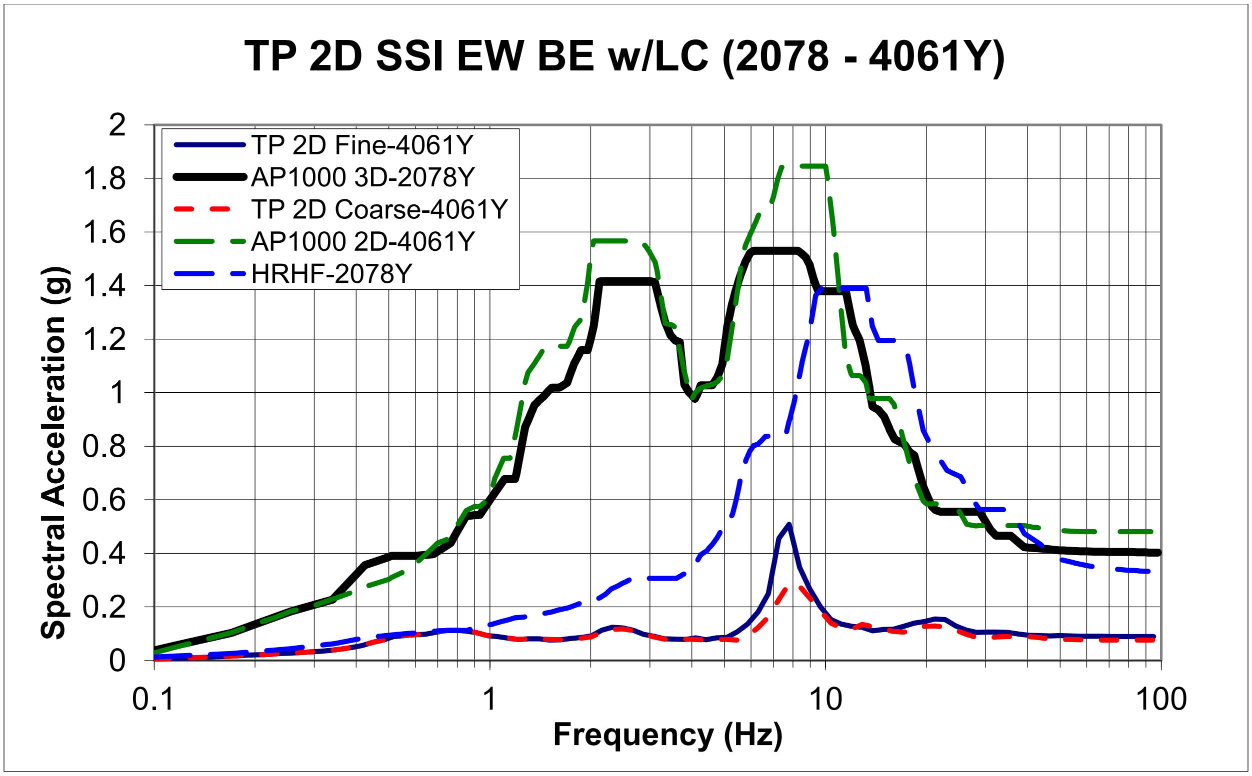

Figure 6.1-5: TPNP 2D Fine and Coarse FRS and AP1000 FRS Envelope in Y-Direction – Node 4061

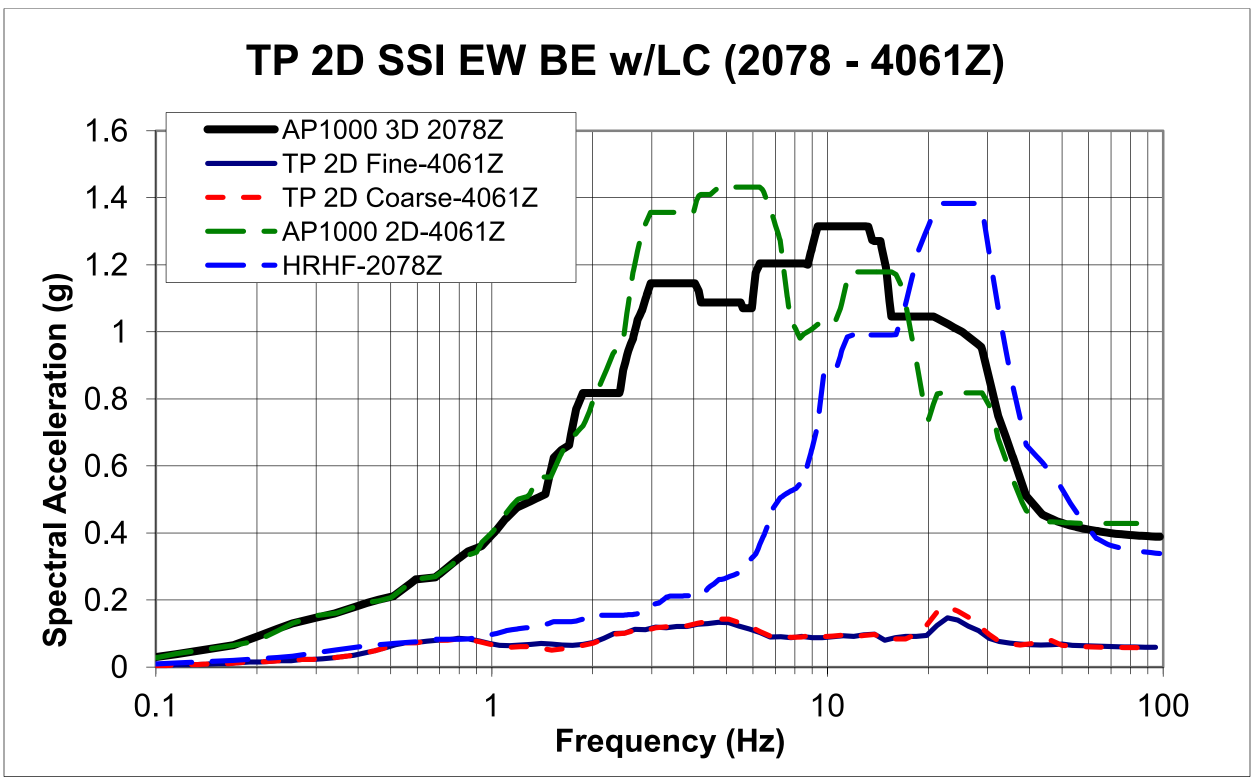

Figure 6.1-6: TPNP 2D Fine and Coarse FRS and AP1000 FRS Envelope in Z-Direction – Node 4061

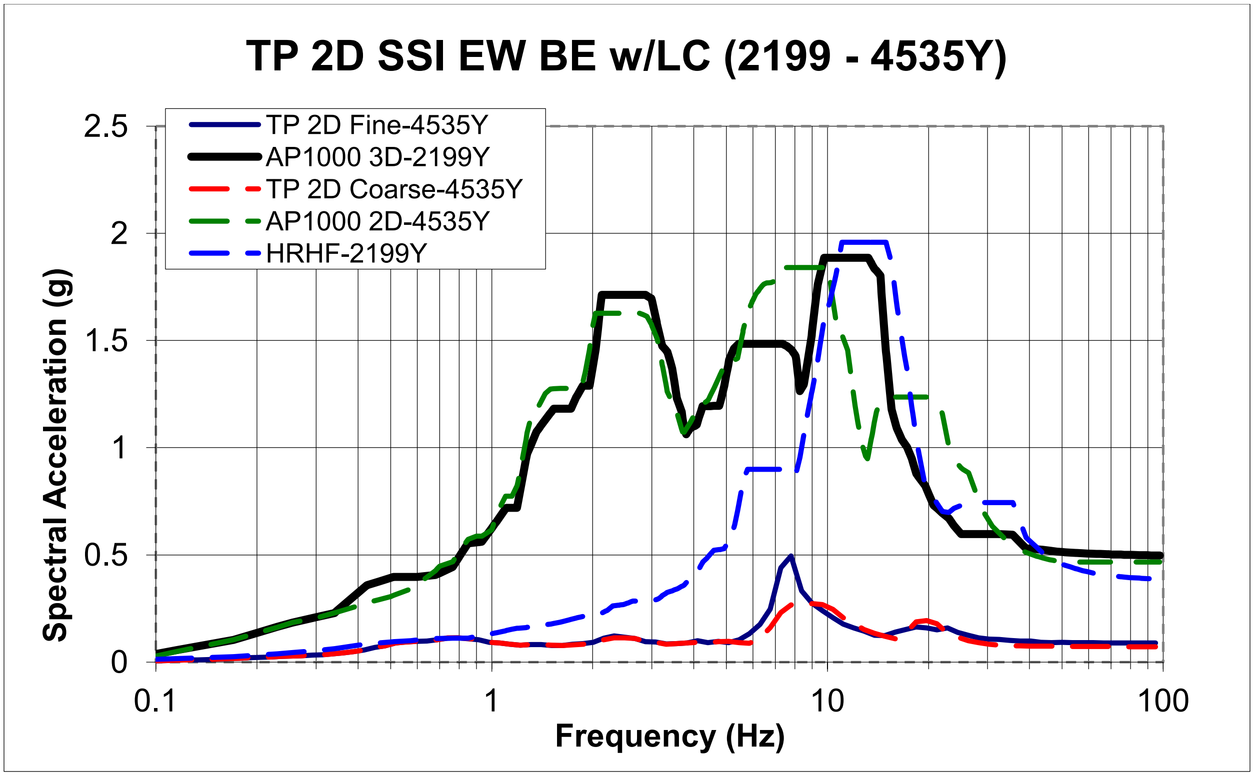

Figure 6.1-7: TPNP 2D Fine and Coarse FRS and AP1000 FRS Envelope in Y-Direction – Node 4535

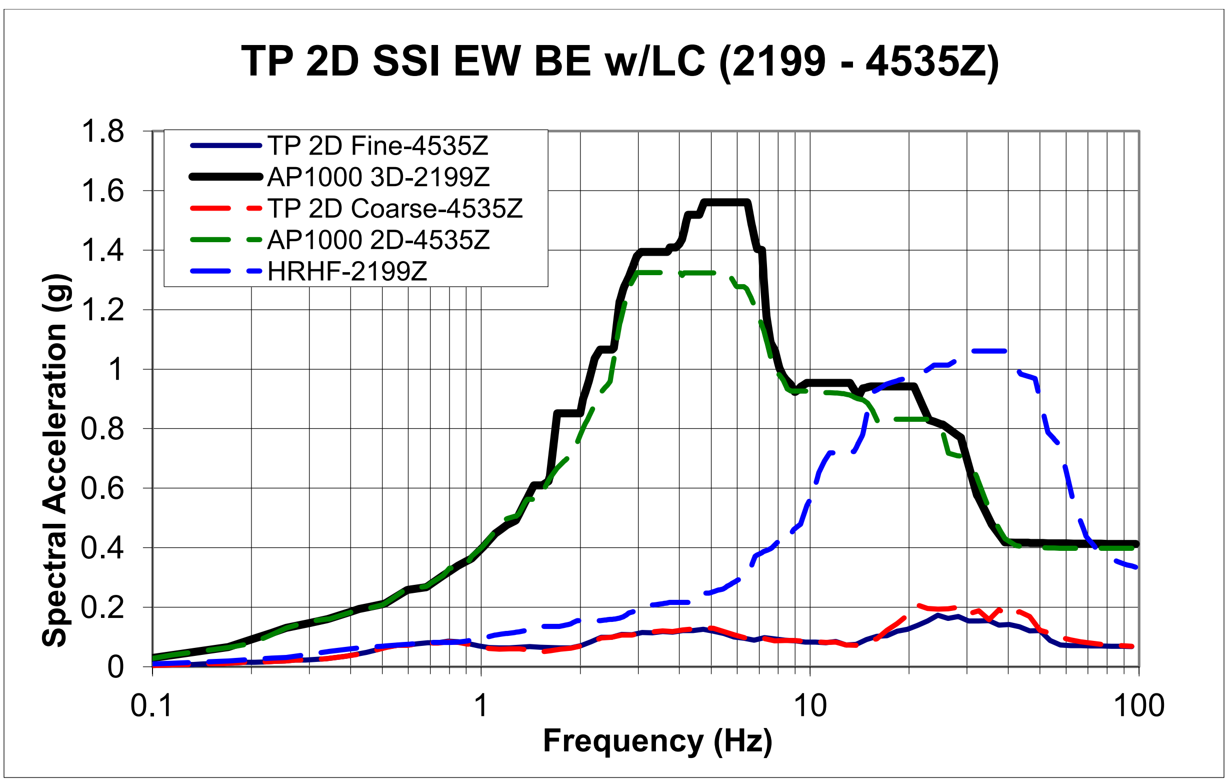

Figure 6.1-8: TPNP 2D Fine and Coarse FRS and AP1000 FRS Envelope in Z-Direction – Node 4535

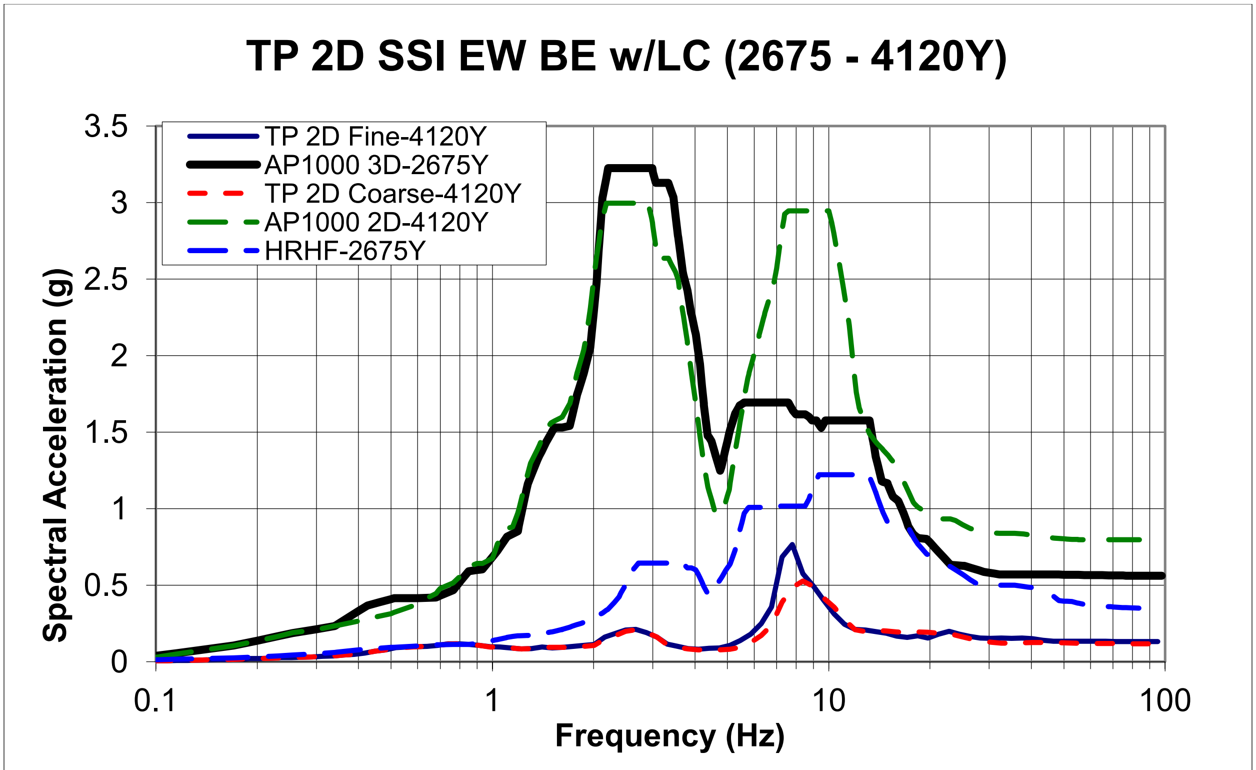

Figure 6.1-9: TPNP 2D Fine and Coarse FRS and AP1000 FRS Envelope in Y-Direction – Node 4120

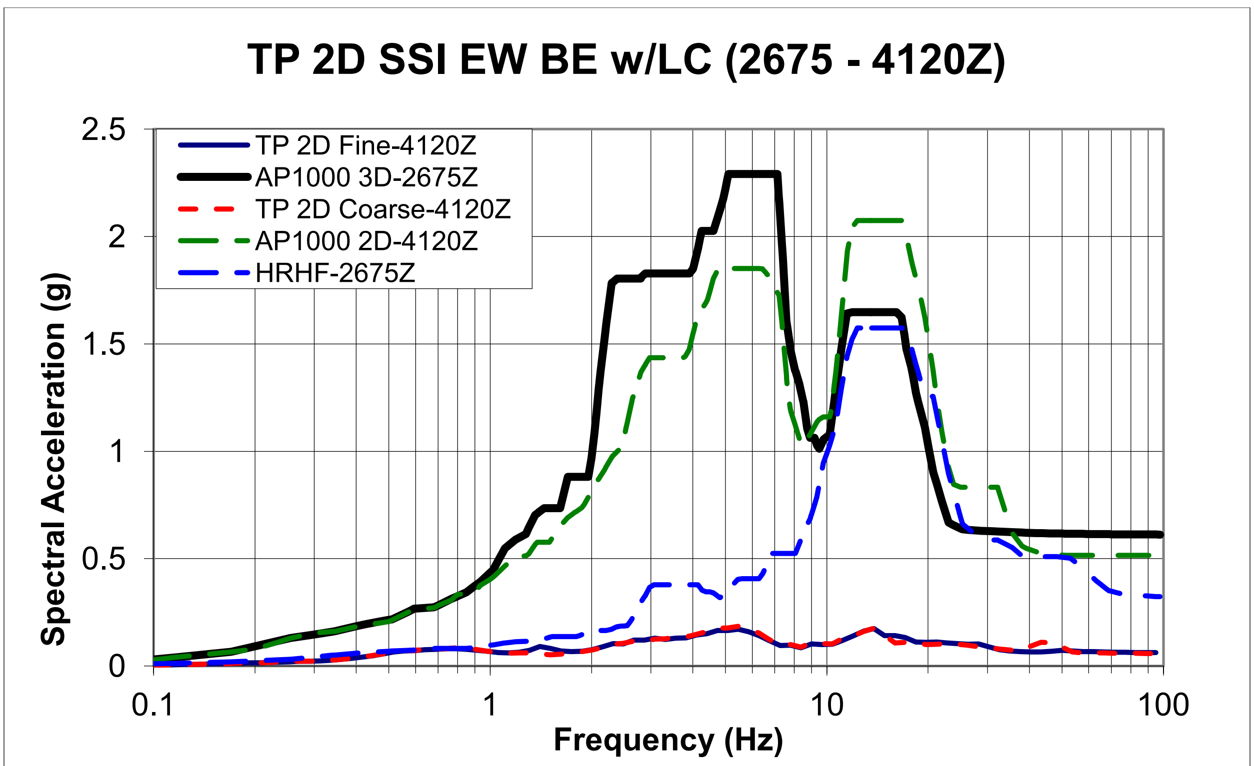

Figure 6.1-10: TPNP 2D Fine and Coarse FRS and AP1000 FRS Envelope in Z-Direction – Node 4120

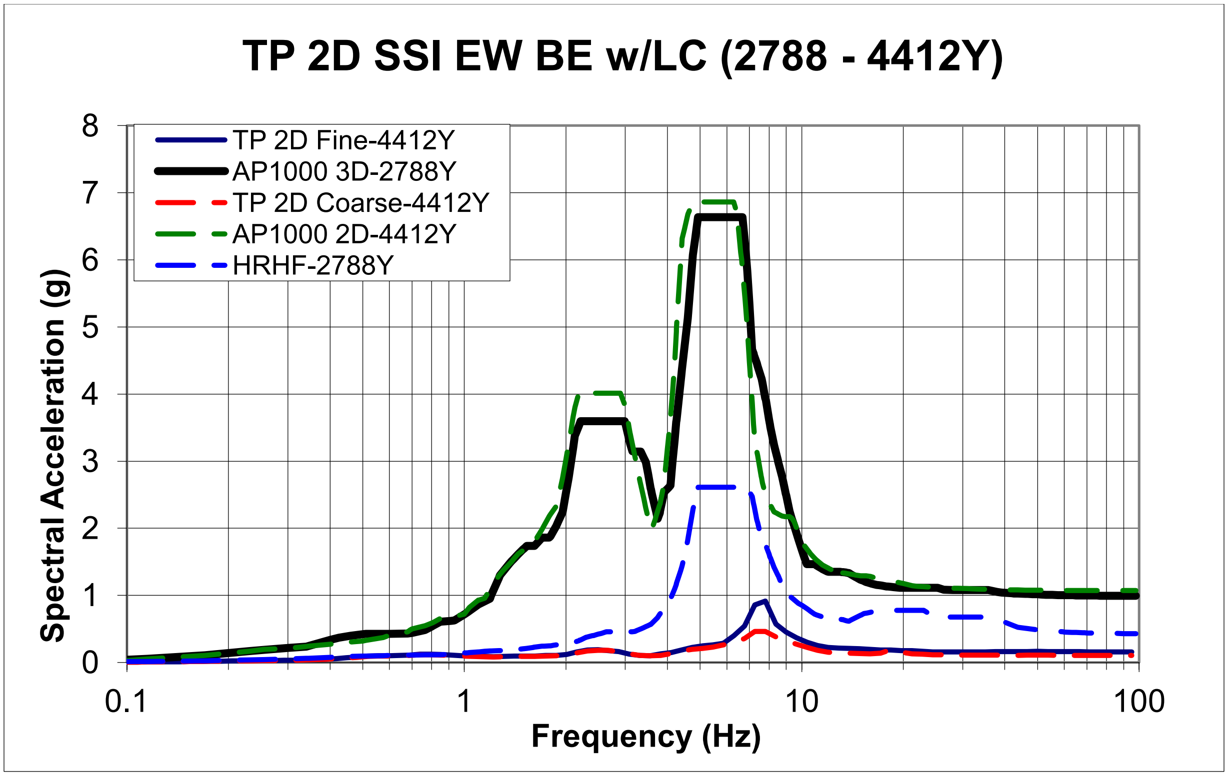

Figure 6.1-11: TPNP 2D Fine and Coarse FRS and AP1000 FRS Envelope in Y-Direction – Node 4412

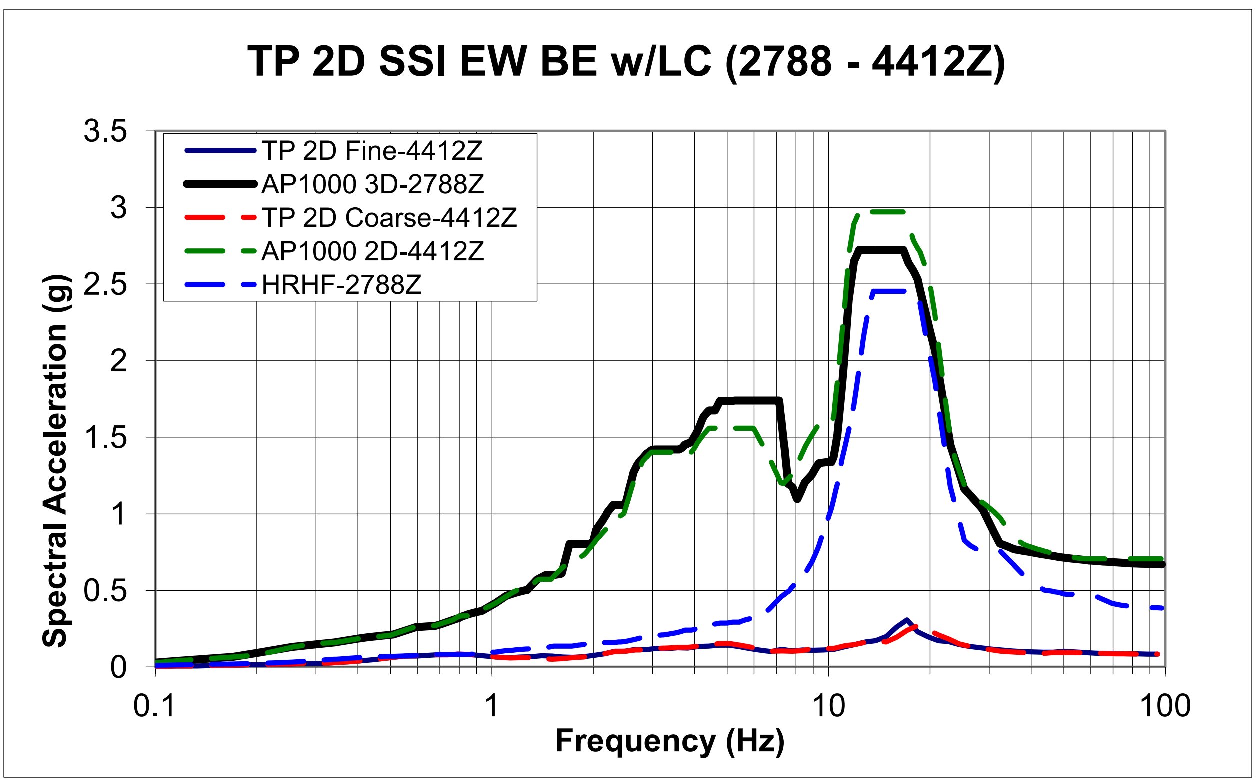

Figure 6.1-12: TPNP 2D Fine and Coarse FRS and AP1000 FRS Envelope in Z-Direction – Node 4412

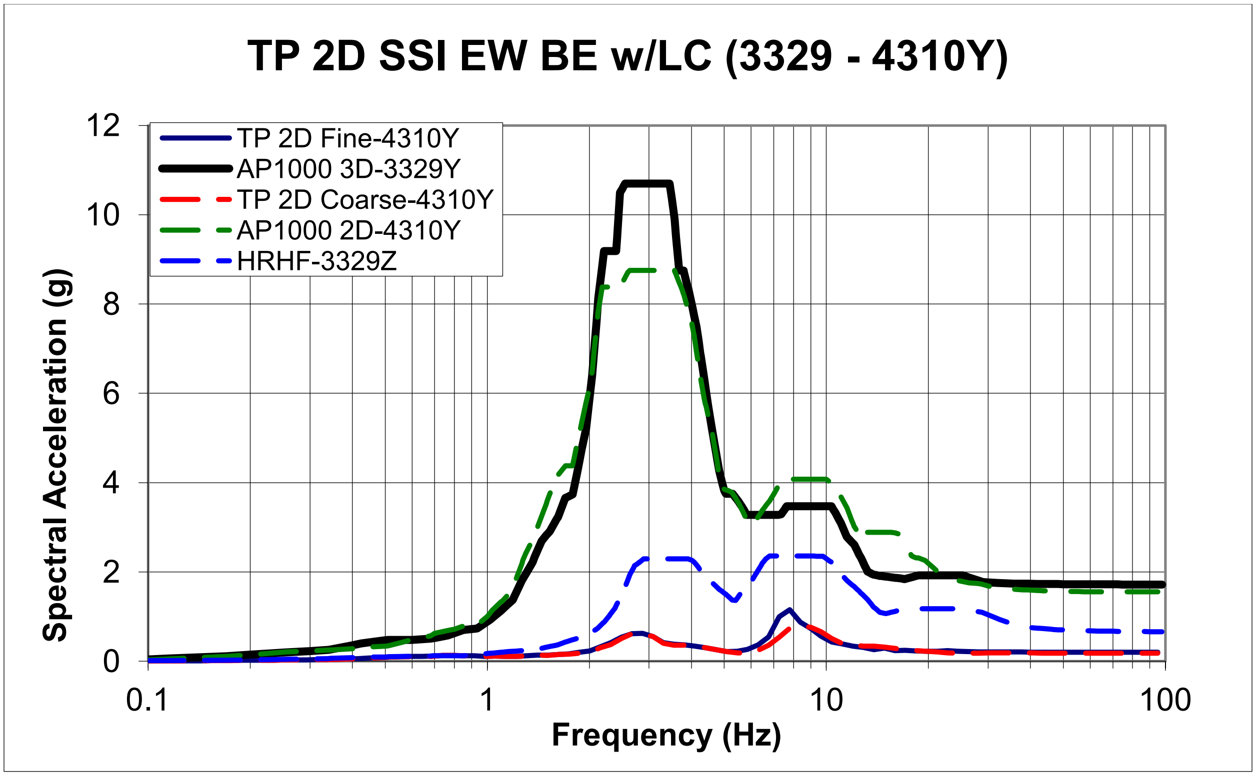

Figure 6.1-13: TPNP 2D Fine and Coarse FRS and AP1000 FRS Envelope in Y-Direction – Node 4310

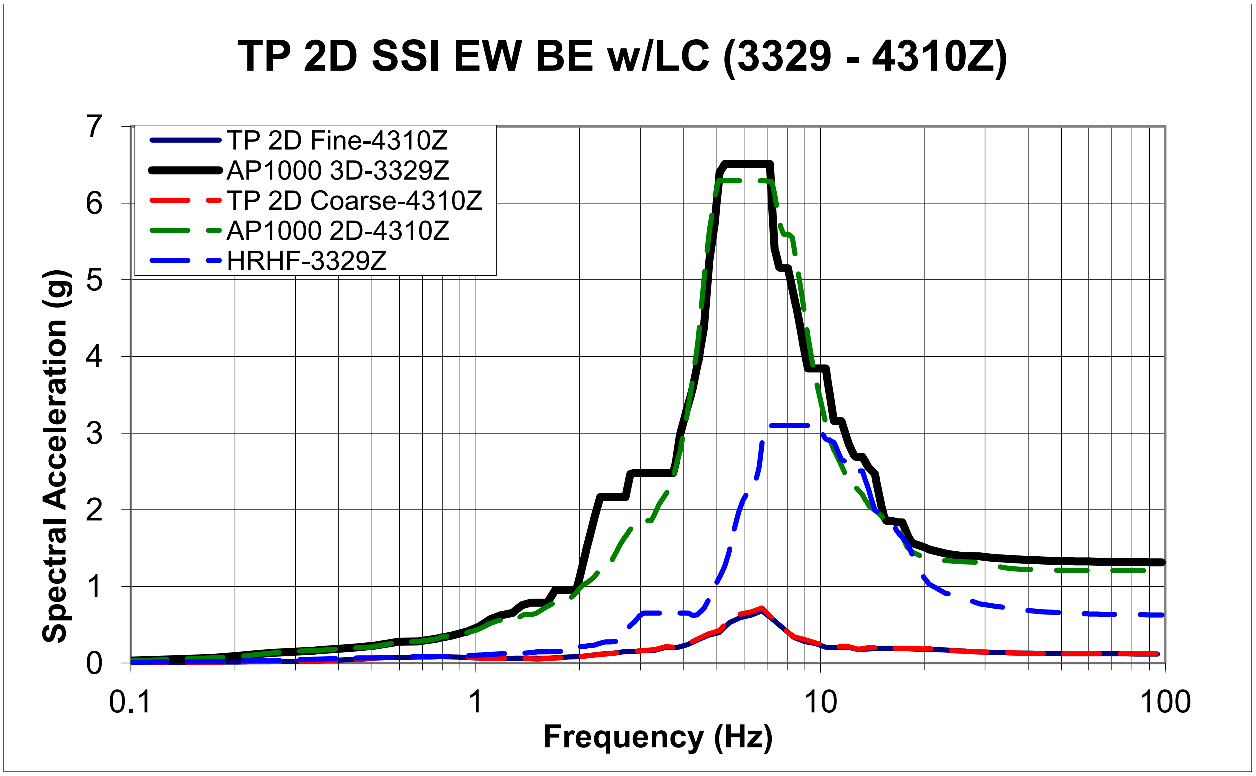

Figure 6.1-14: TPNP 2D Fine and Coarse FRS and AP1000 FRS Envelope in Z-Direction – Node 4310

6.2 TPNP 3D BE, LB and UB Factored Design-Basis SSI Analysis Results

Time history seismic analyses for the TPNP 3D Design-Basis model and the TPNP BE, LB and UB cases were performed in two horizontal and one vertical direction. The TPNP top of LC (El. -16) input time histories were used in SASSI with the SASSI Direct method of analysis. FRS for 5 percent damping were obtained at the six key NI locations shown in Table 3.4-1. The horizontal and vertical Bump Factors are applied along the frequency spectrum to amplify the TPNP 3D BE, LB and UB Design-Basis FRS based on the horizontal and vertical Bump Factors presented in Figures 6.1-1 and 6.1-2, respectively.

Figures 6.2-1 through 6.2-18 present the horizontal and vertical TPNP Factored 3D Design-Basis FRS, which includes the BE, LB and UB FRS and TPNP FRS envelope compared to the 3D AP1000 CSDRS and HRHF FRS envelopes at the six (6) key NI locations. The HRHF FRS envelope is presented to demonstrate that additional and margin exists at the key nodes in the high frequency range (20-50 Hz). As shown, the TPNP site specific FRS are enveloped by the AP1000 CSDRS and HRHF FRS envelopes at each of the six key NI locations.

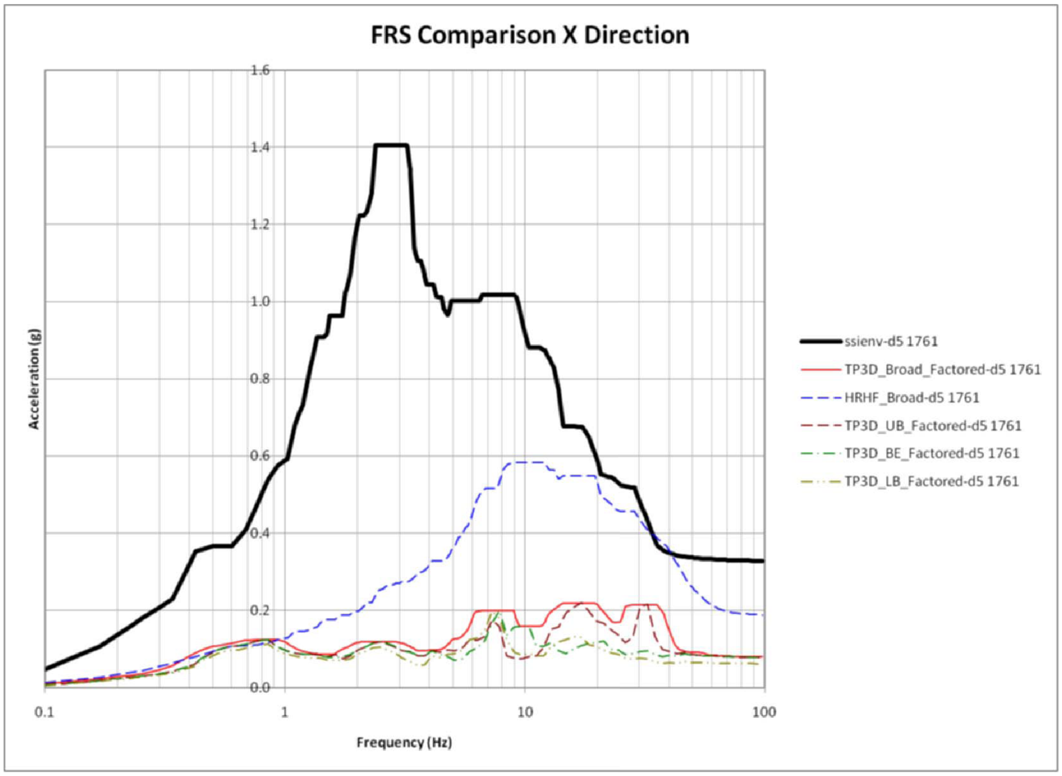

Figure 6.2-1: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in X-Direction – Node 1761

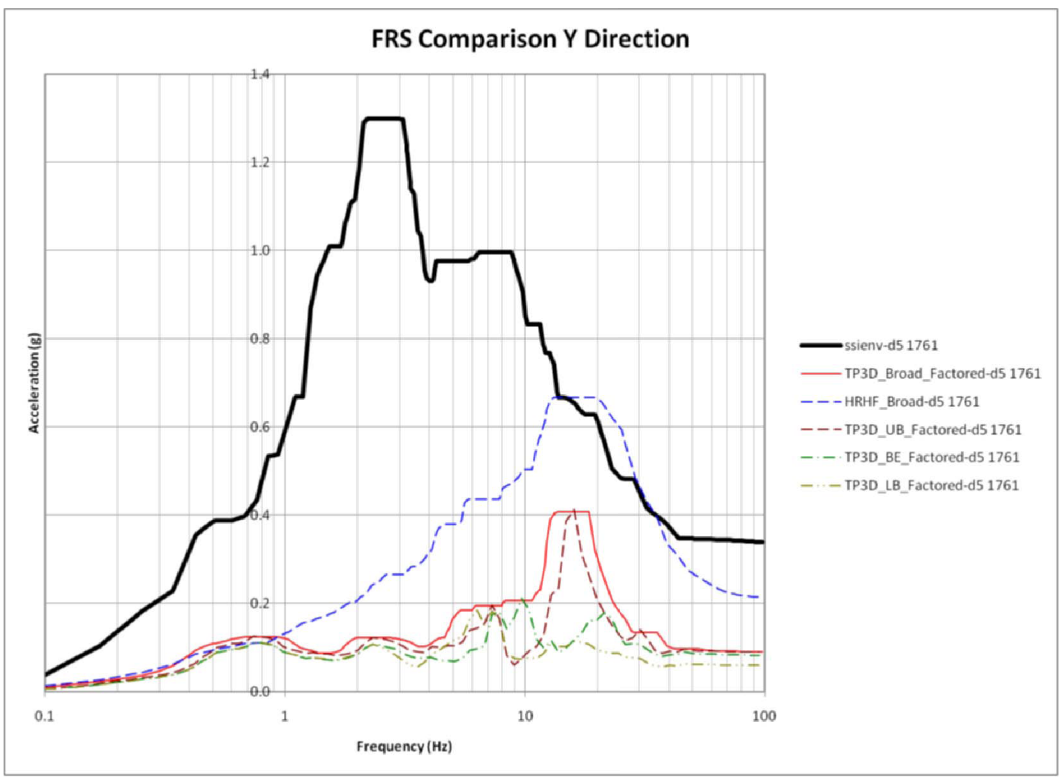

Figure 6.2-2: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in Y-Direction – Node 1761

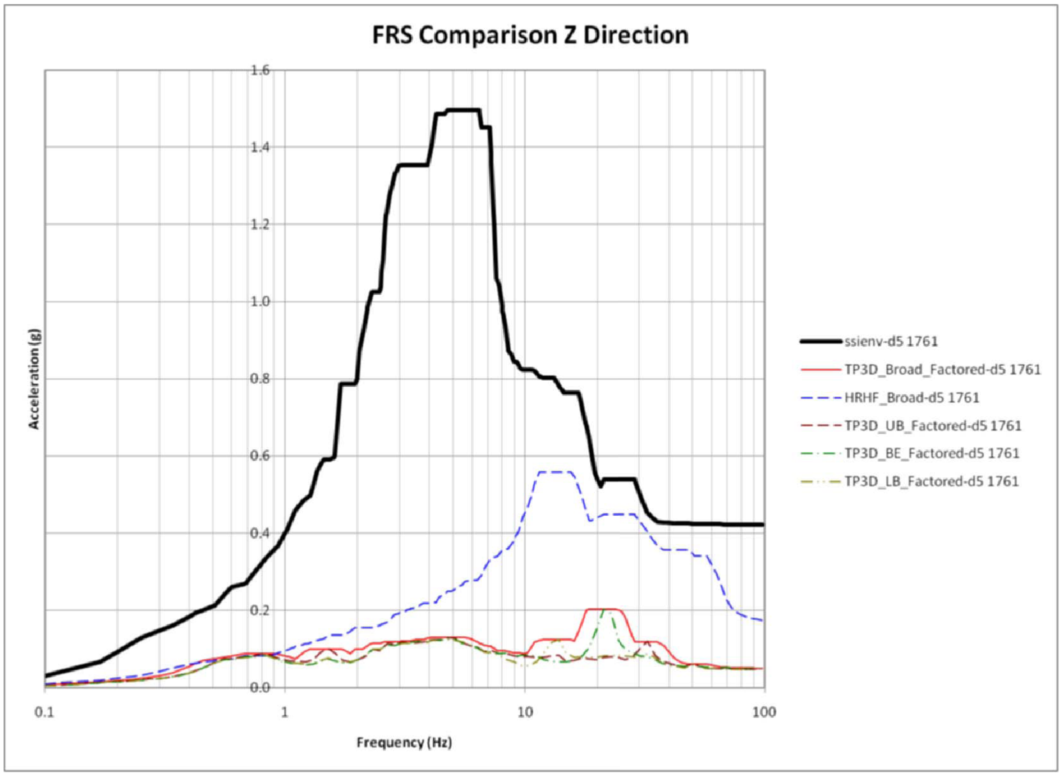

Figure 6.2-3: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in Z-Direction – Node 1761

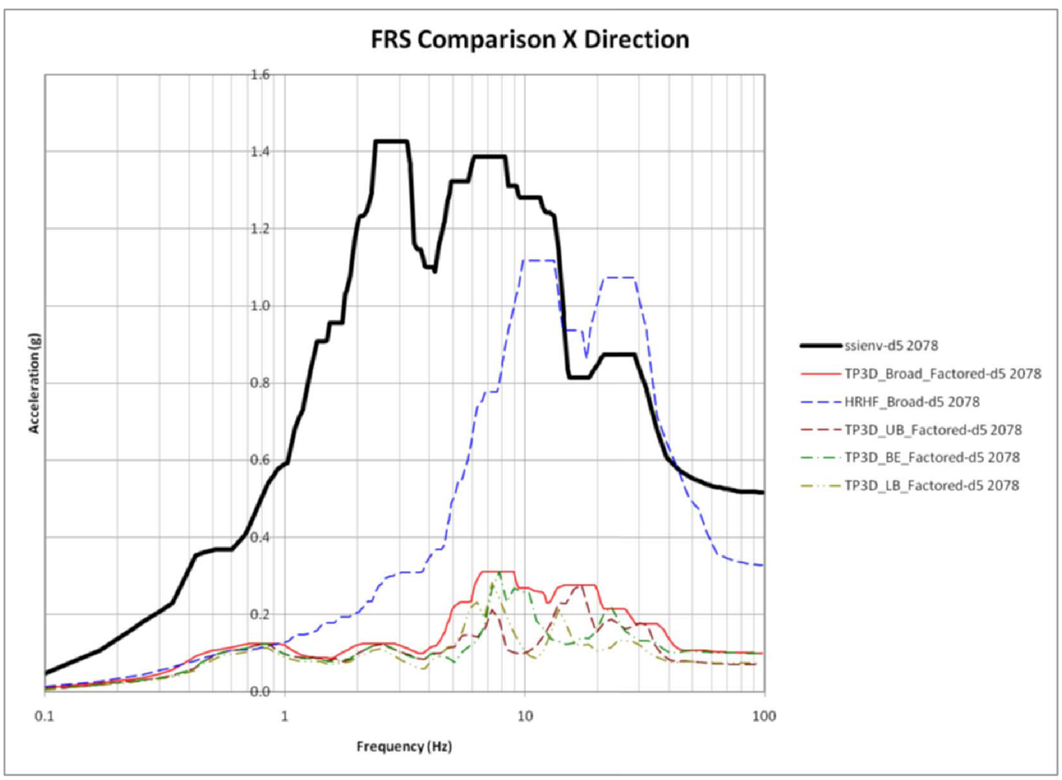

Figure 6.2-4: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in X-Direction – Node 2078

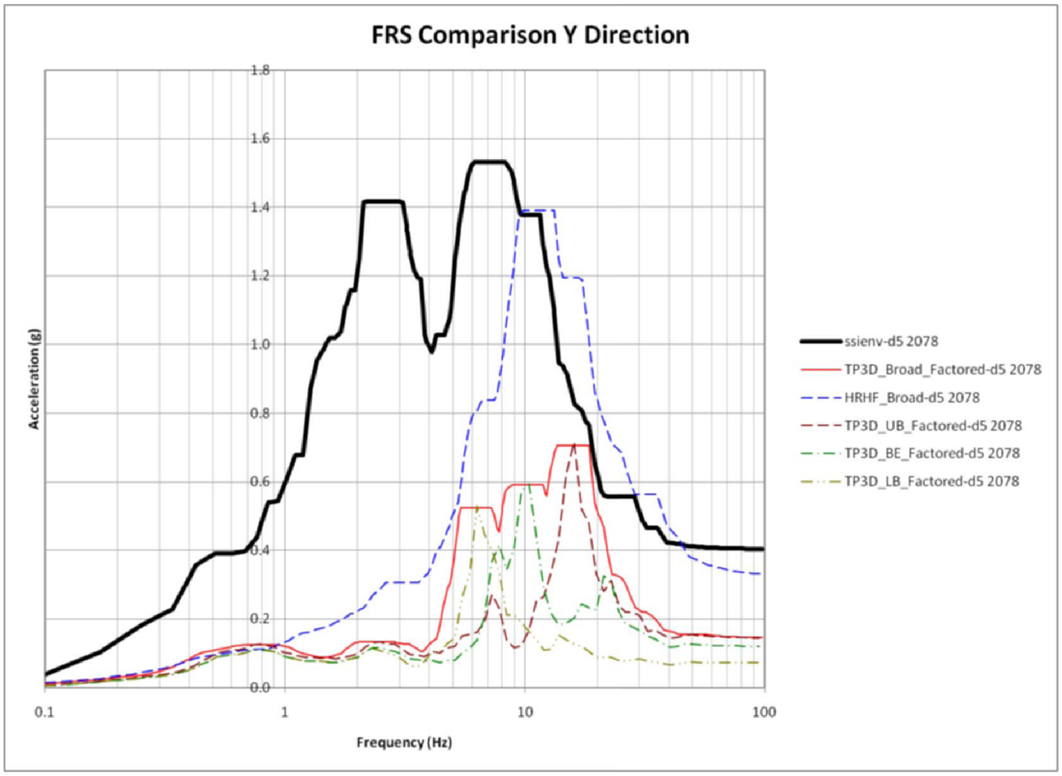

Figure 6.2-5: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in Y-Direction – Node 2078

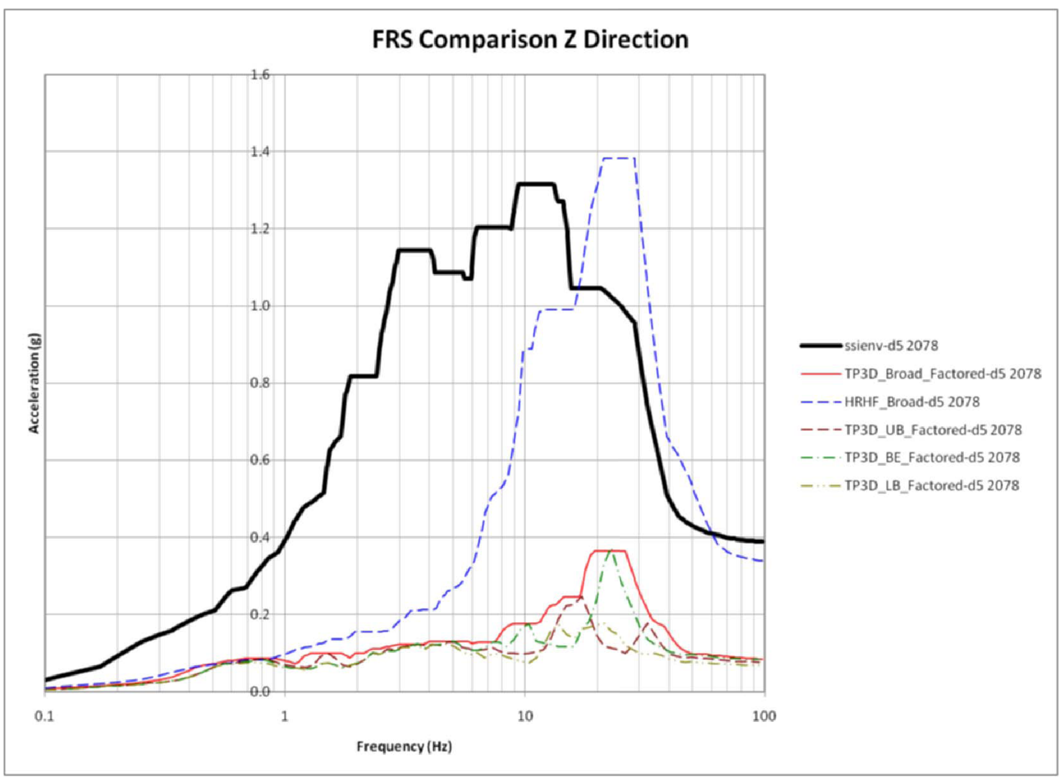

Figure 6.2-6: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in Z-Direction – Node 2078

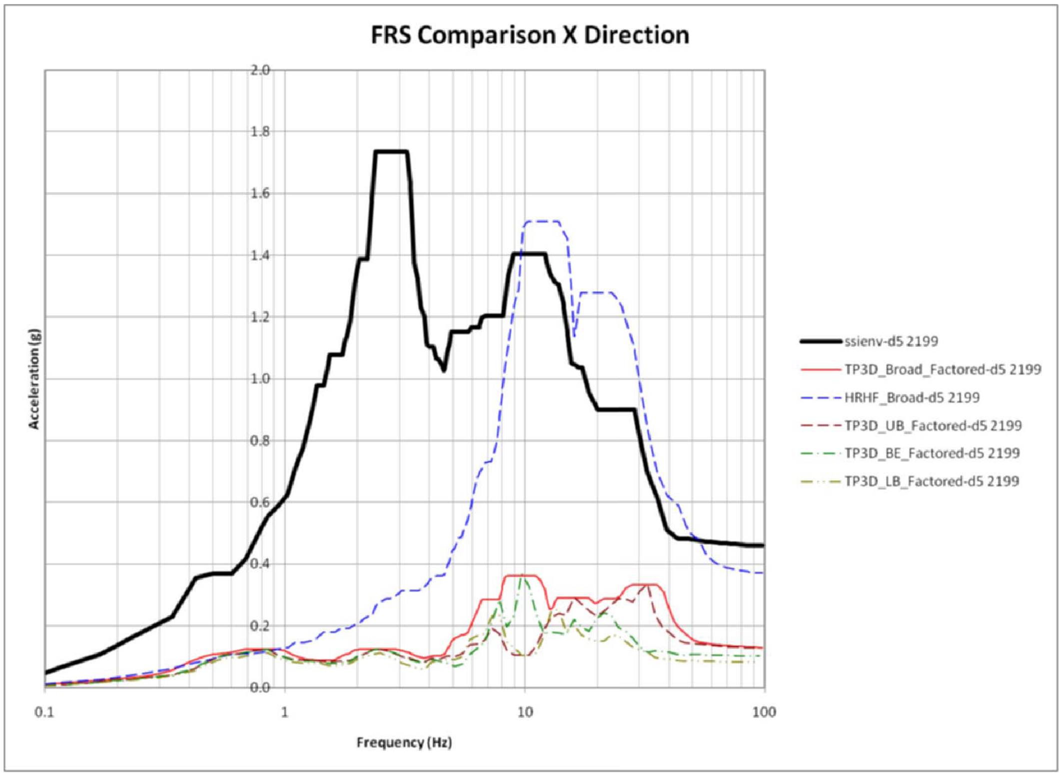

Figure 6.2-7: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in X-Direction – Node 2199

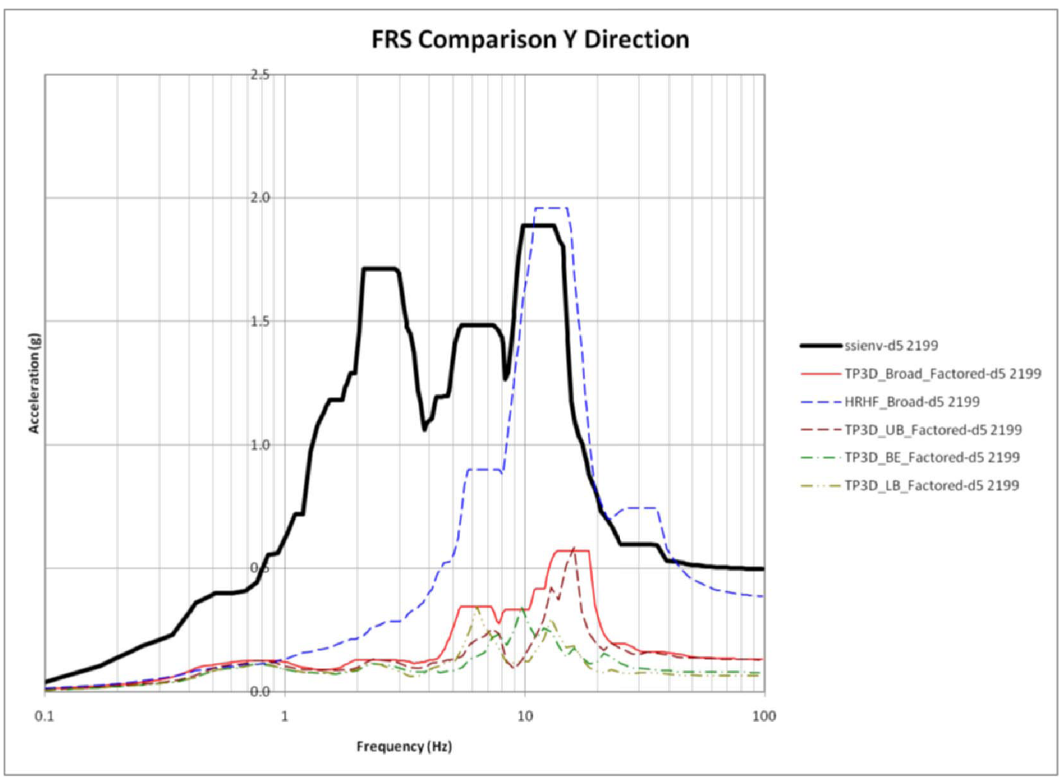

Figure 6.2-8: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in Y-Direction – Node 2199

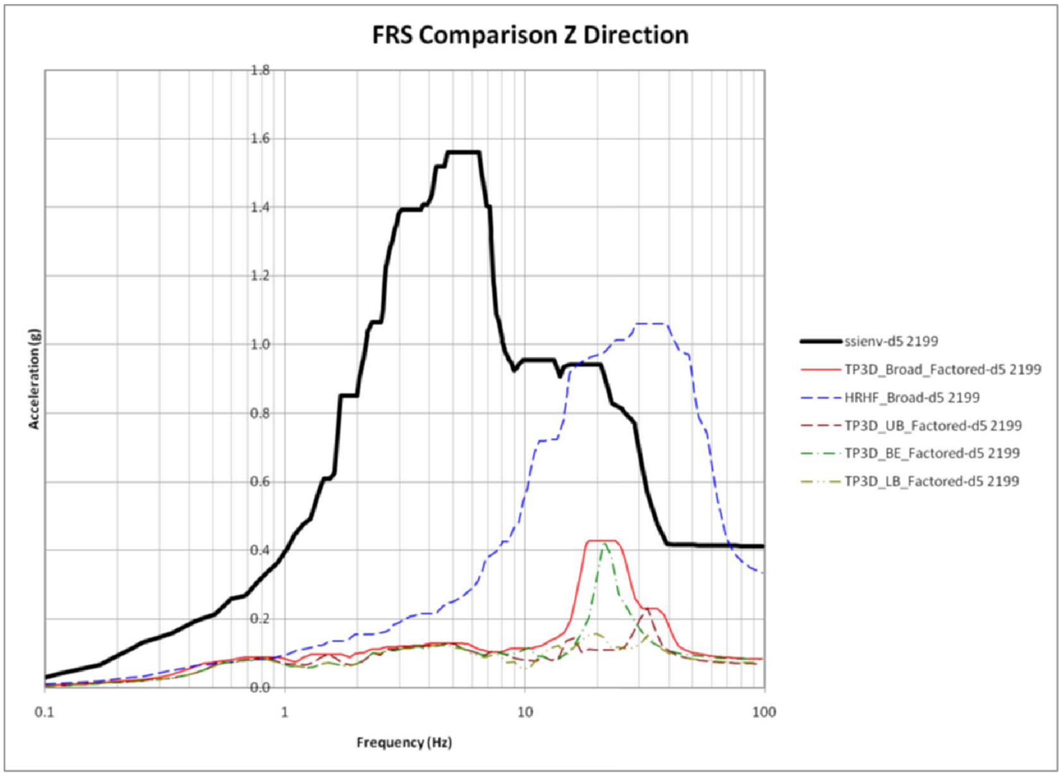

Figure 6.2-9: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in Z-Direction – Node 2199

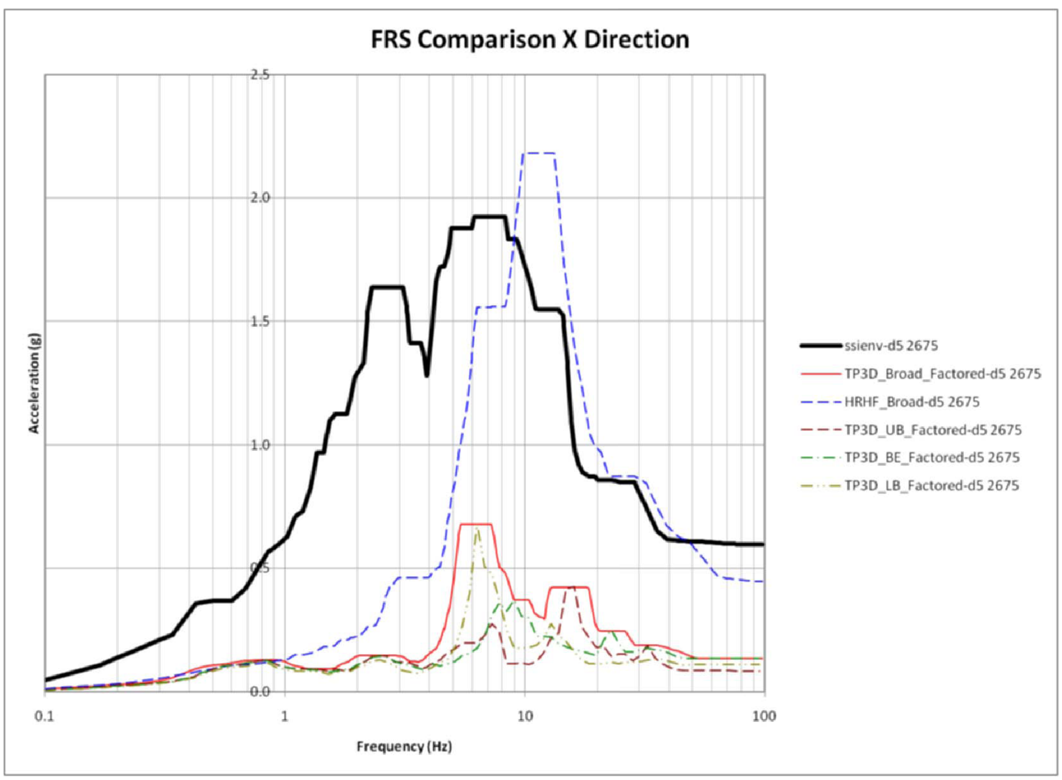

Figure 6.2-10: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in X-Direction – Node 2675

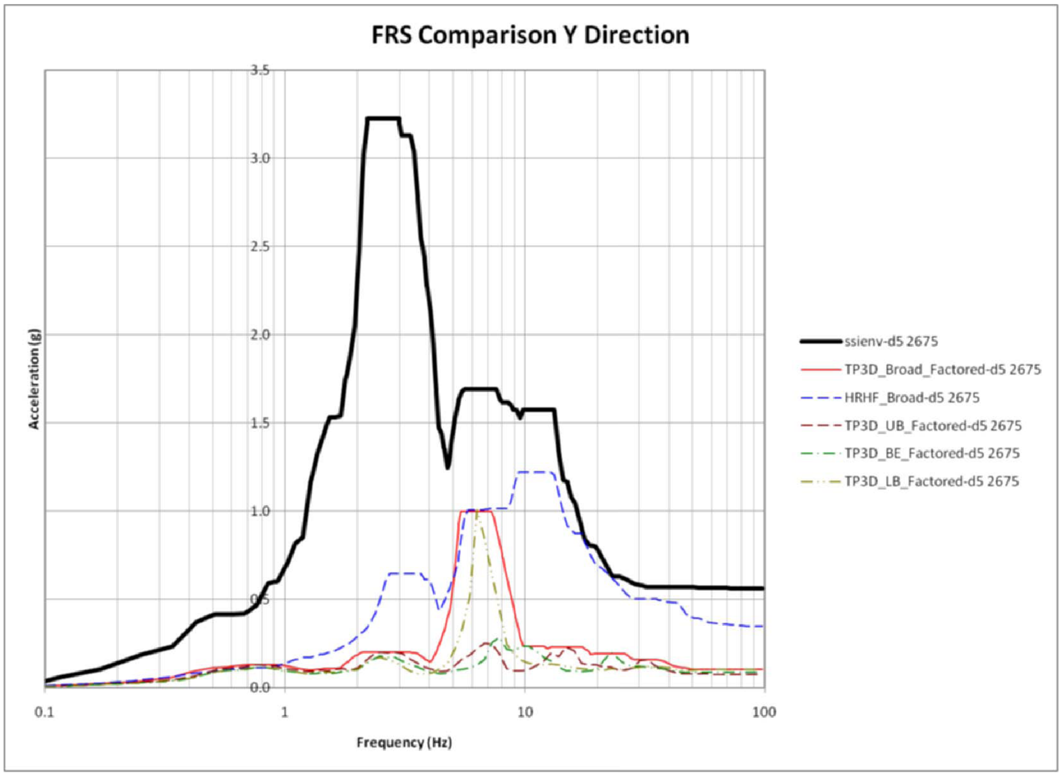

Figure 6.2-11: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in Y-Direction – Node 2675

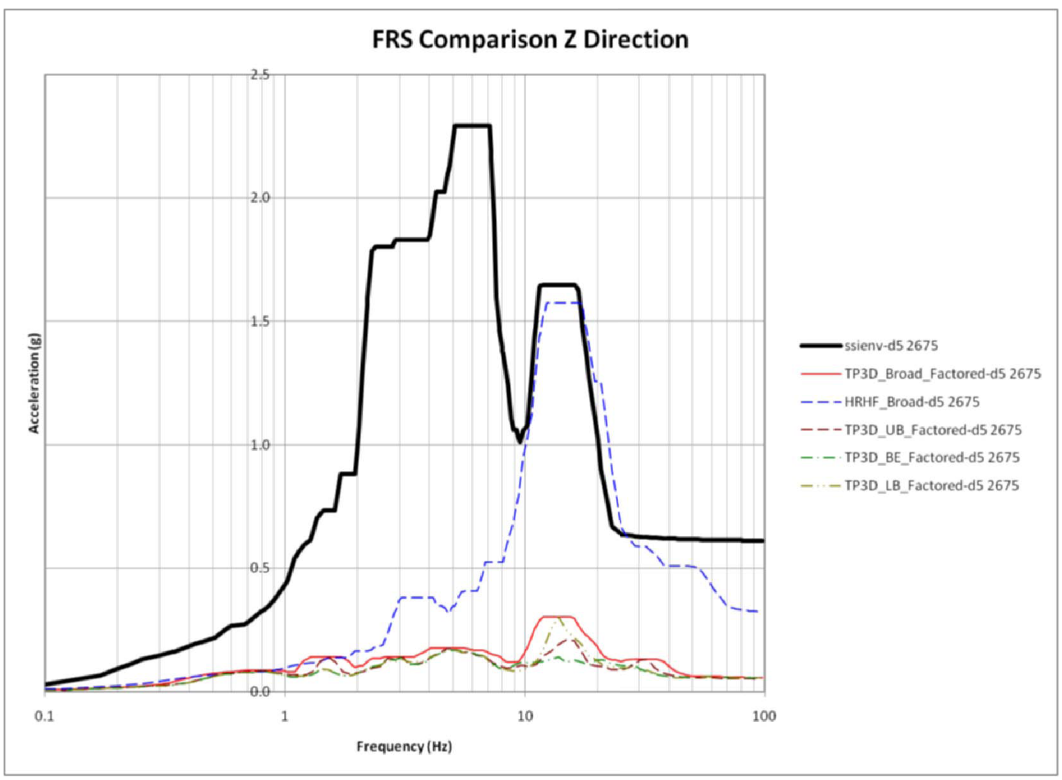

Figure 6.2-12: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in Z-Direction – Node 2675

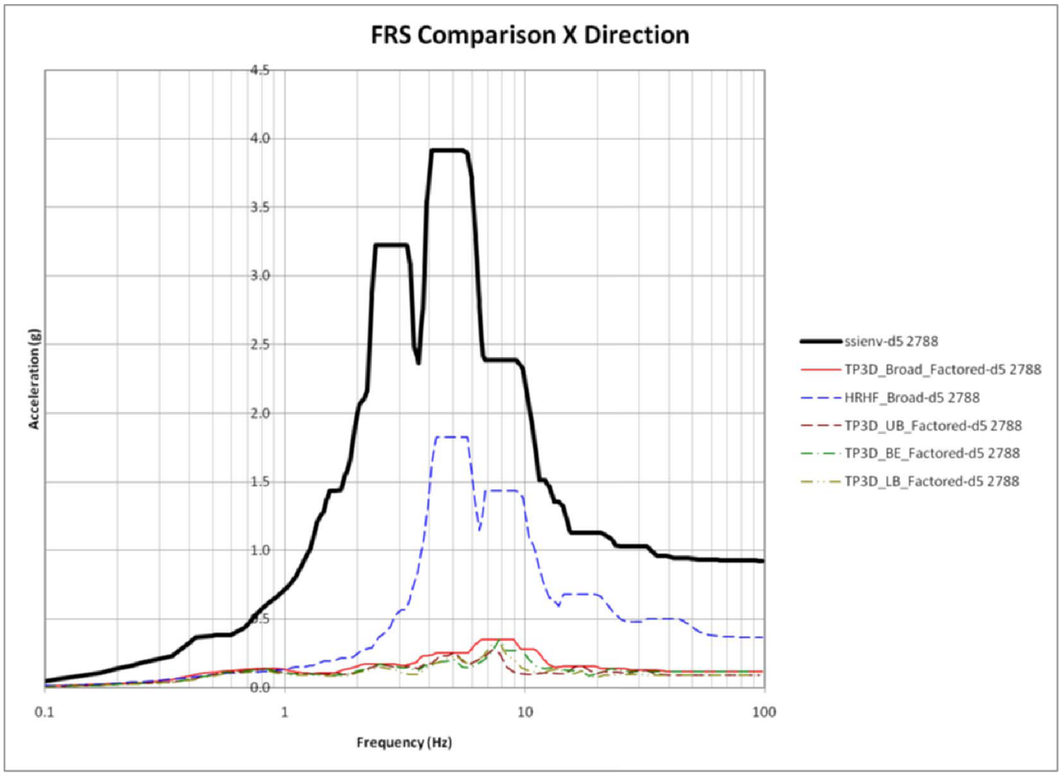

Figure 6.2-13: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in X-Direction – Node 2788

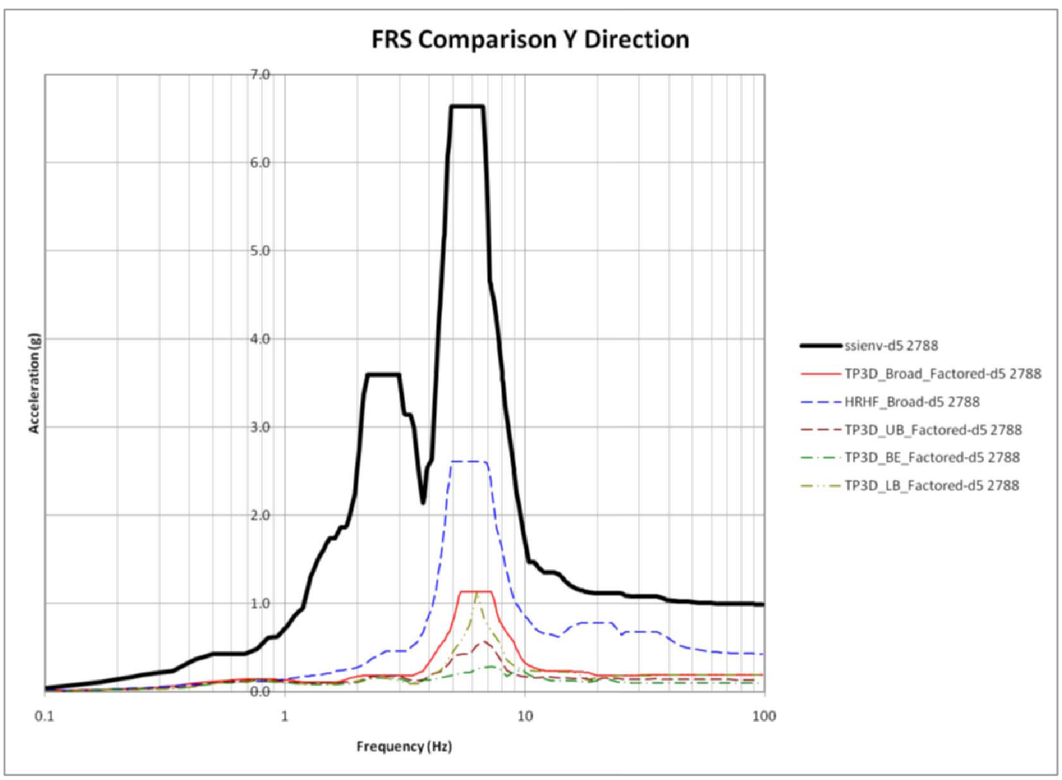

Figure 6.2-14: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in Y-Direction – Node 2788

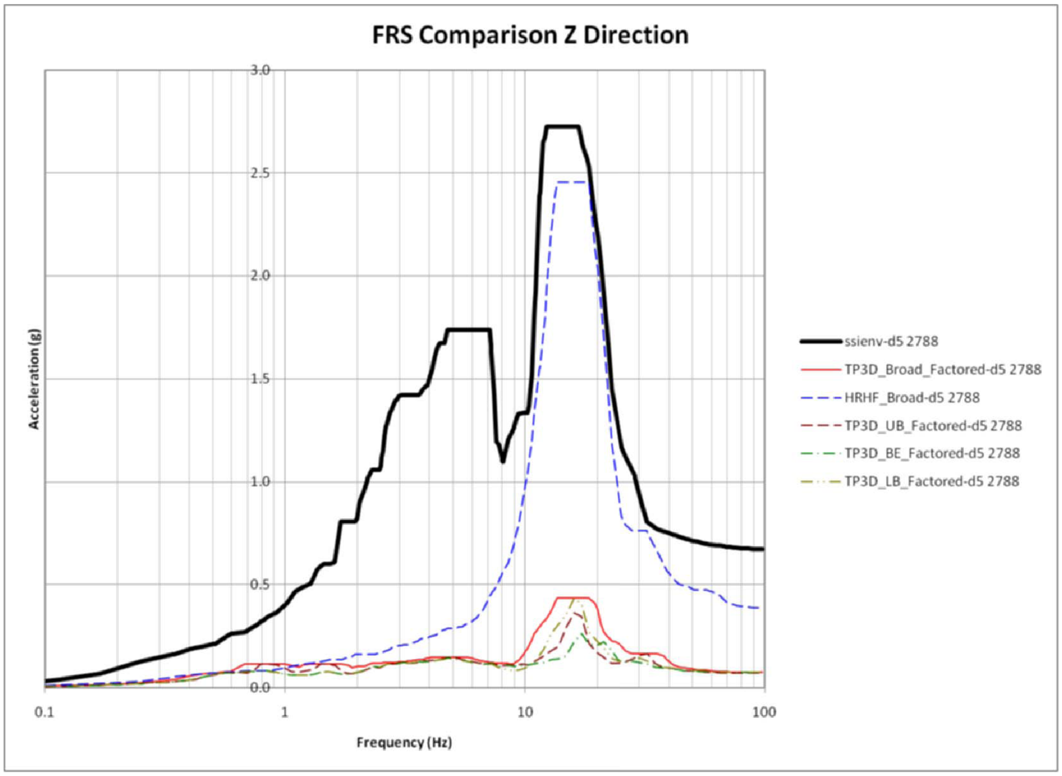

Figure 6.2-15: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in Z-Direction – Node 2788

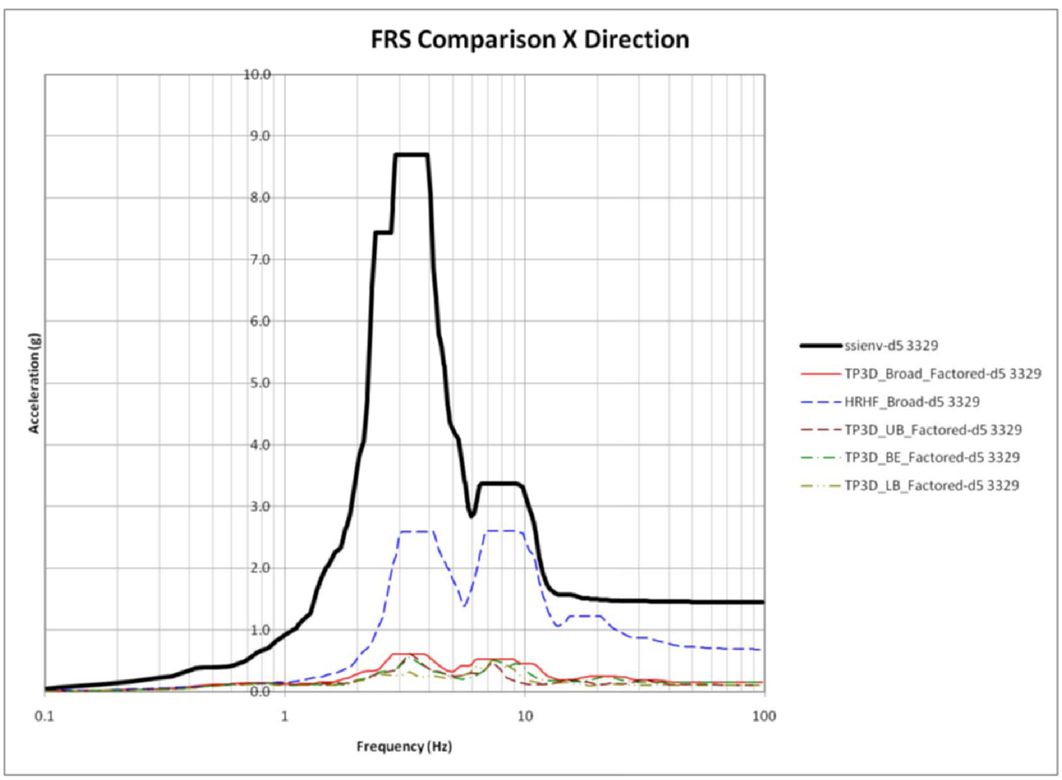

Figure 6.2-16: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in X-Direction – Node 3329

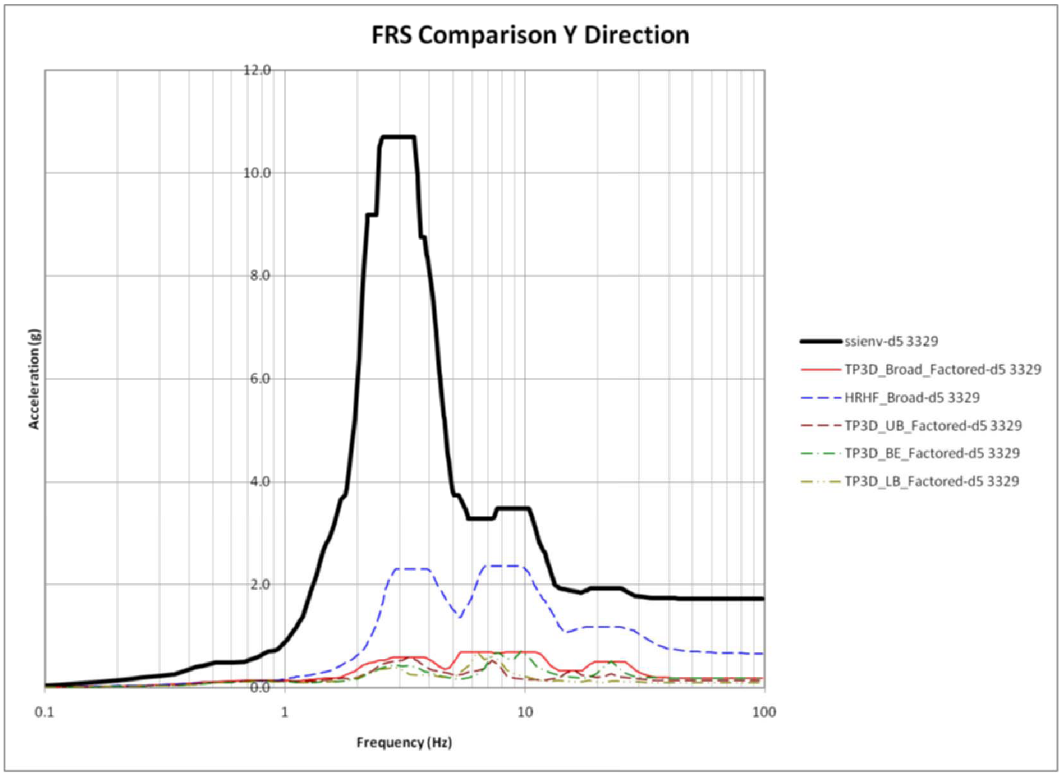

Figure 6.2-17: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in Y-Direction – Node 3329

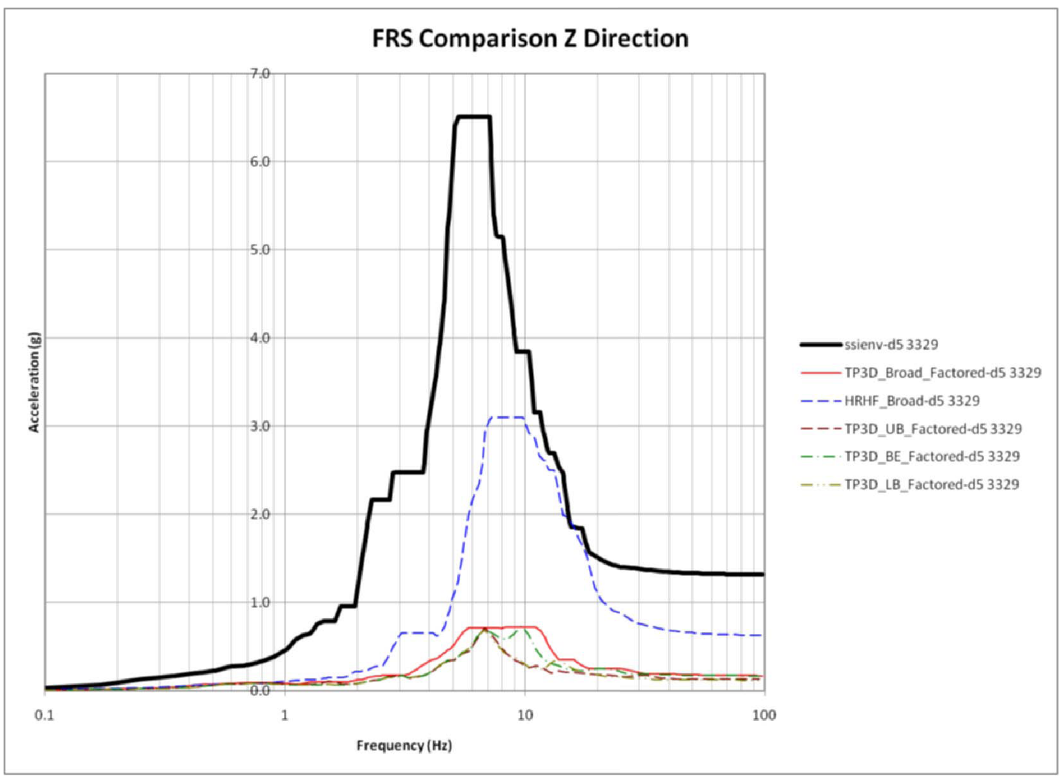

Figure 6.2-18: TPNP 3D BE, LB, UB FRS and AP1000 FRS Envelope in Z-Direction – Node 3329

6.3 TPNP 2D BE, LB and UB SSI Adjacent Building Analysis Results

TPNP adjacent building SSI analyses were performed to present FRS at the ground surface of the Turbine Building (TB) First Bay and Annex Building (AB) for the TPNP BE, LB and UB soil cases. Also, relative displacements are determined to assess the interaction between the adjacent structures and the NI. Section 6.4 presents the results of the relative displacement interaction evaluation.

Time history seismic analyses using the TPNP 2D TB First Bay (NS) model, TPNP 2D AB (EW) model, and the TPNP BE, LB and UB soil cases were performed in one horizontal and one vertical direction (X and Z for the TB First Bay model, and Y and Z for the AB model). The TPNP ground surface input time histories were provided in Reference 3 for the TB First Bay and AB, and were used in SASSI in conjunction with the Direct method. FRS for 5 percent damping were obtained at the ground surface for the TB First Bay (node 2951) and AB (node 2942). FRS for 5 percent damping were also obtained at the six (6) key nodes of the NI to assess any influence of the adjacent structures on the key NI nodes.

Figures 6.3-1 through 6.3-2 present the TB First Bay horizontal and vertical TPNP FRS envelopes and the individual TB First Bay FRS for the TPNP BE, LB and UB soil cases compared to the AP1000 TB FRS envelope at the ground surface (AP1000 El. 100.0' and TPNP El. +25.5'). As shown, the AP1000 TB FRS envelop the TPNP site specific FRS and broadened TPNP TB FRS at the TB First Bay surface node 2951.

Similarly, Figures 6.3-3 through 6.3-4 present the AB horizontal and vertical TPNP FRS envelopes and the individual AB FRS for the TPNP BE, LB and UB soil cases compared to the AP1000 AB FRS envelope at the ground surface (AP1000 El. 100.0' and TPNP El. +25.5'). As shown, the AP1000 AB FRS envelop the TPNP site specific FRS and broadened TPNP AB FRS at the AB surface node 2942. TB First Bay and AB FRS envelopes are from Reference 10.

Appendix A presents the FRS at the six (6) key nodes of the NI due to the TB First Bay (North-South) and AB (East-West) response for each of the TPNP BE, LB and UB soil cases.

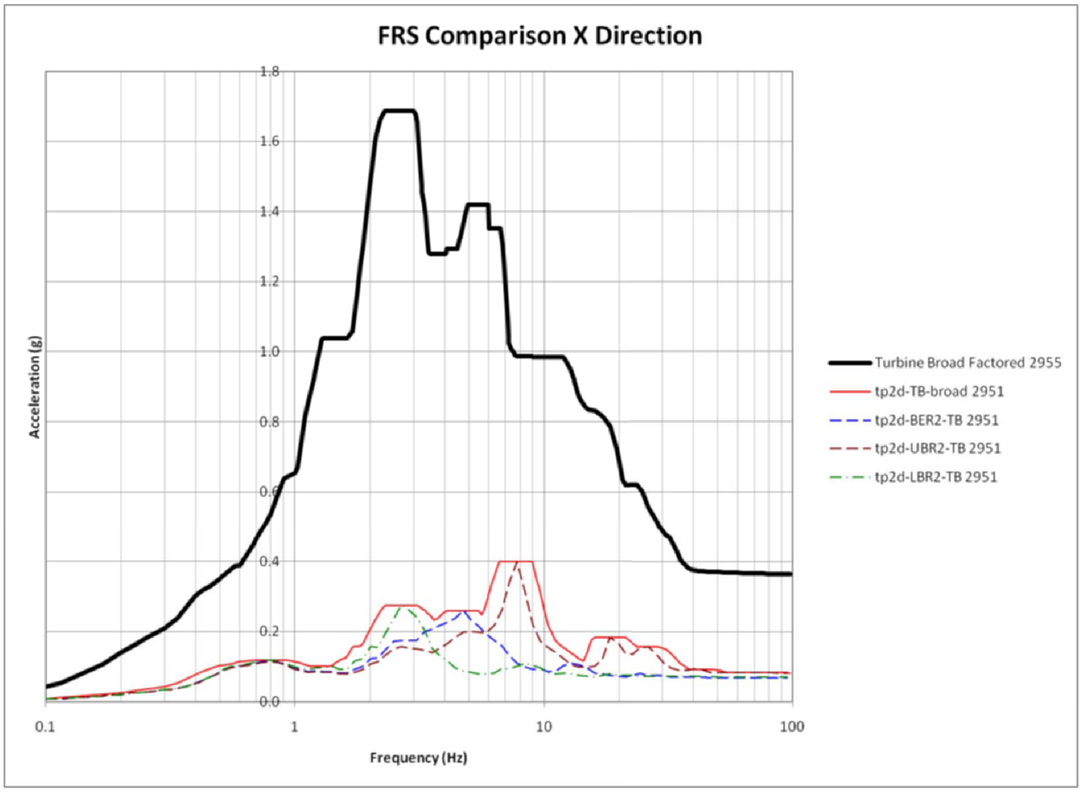

Figure 6.3-1: TPNP TB First Bay BE, UB, LB FRS and AP1000 FRS Envelope in X-Direction – Node 2951

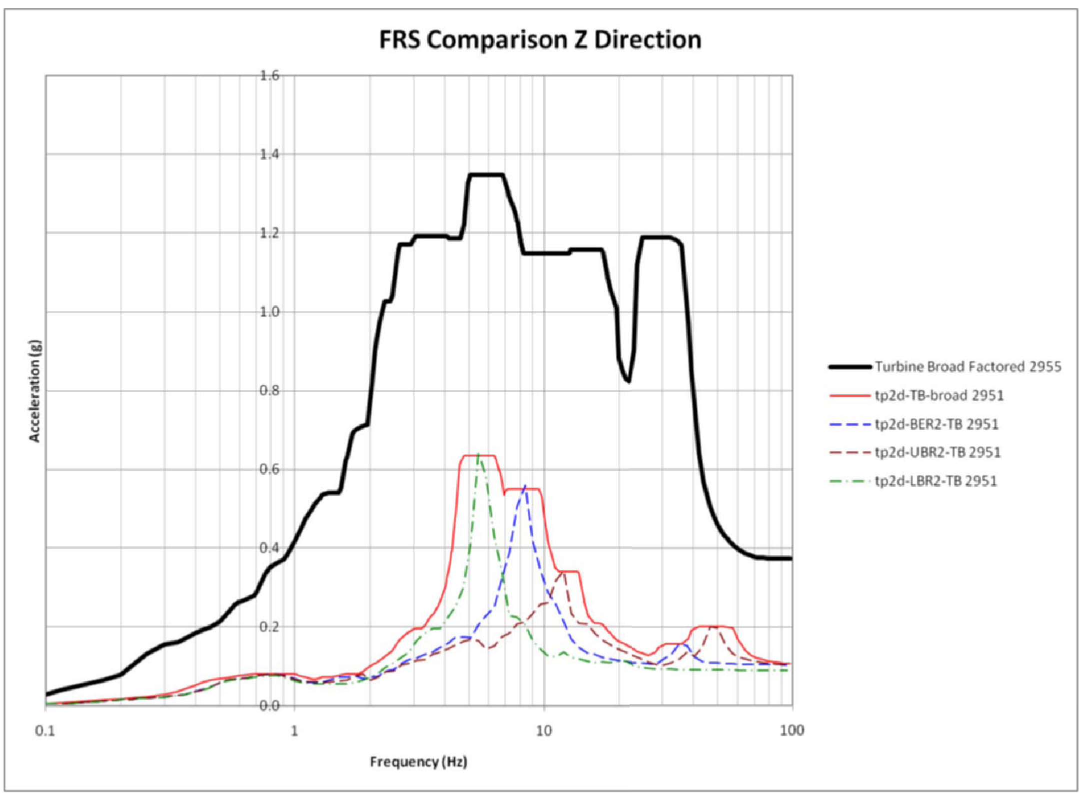

Figure 6.3-2: TPNP TB First Bay BE, UB, LB FRS and AP1000 FRS Envelope in Z-Direction – Node 2951

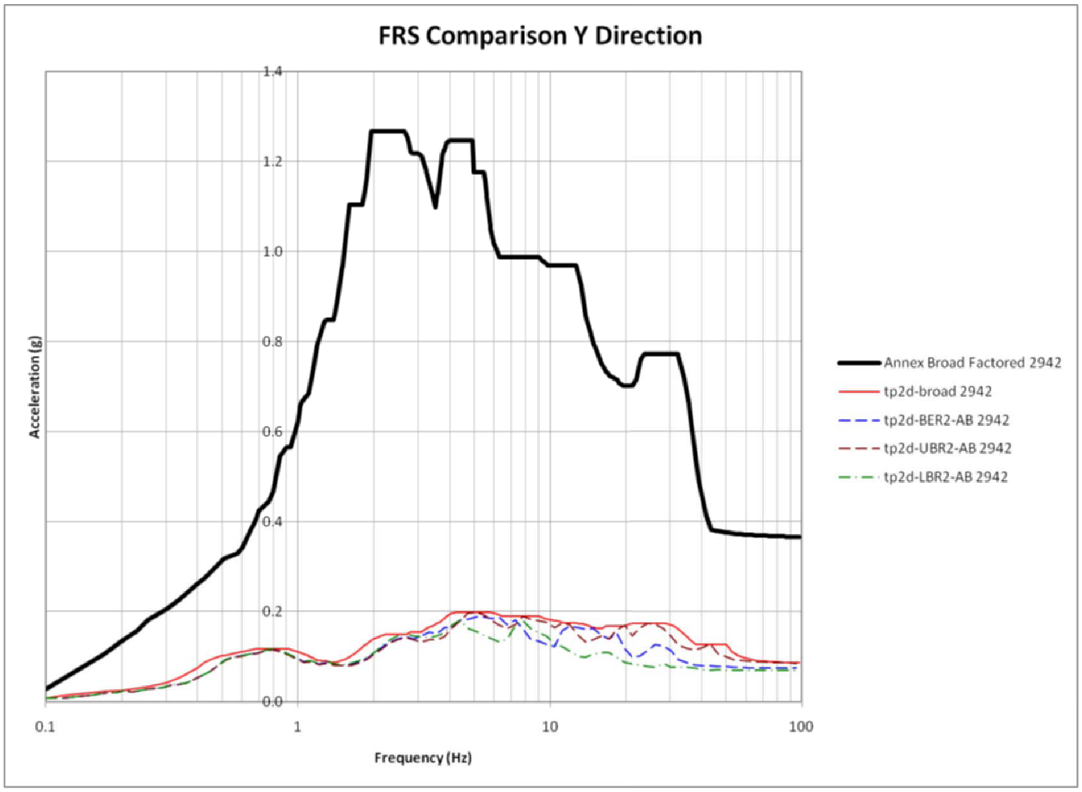

Figure 6.3-3: TPNP Annex Building BE, UB, LB FRS and AP1000 FRS Envelope in Y-Direction – Node 2942

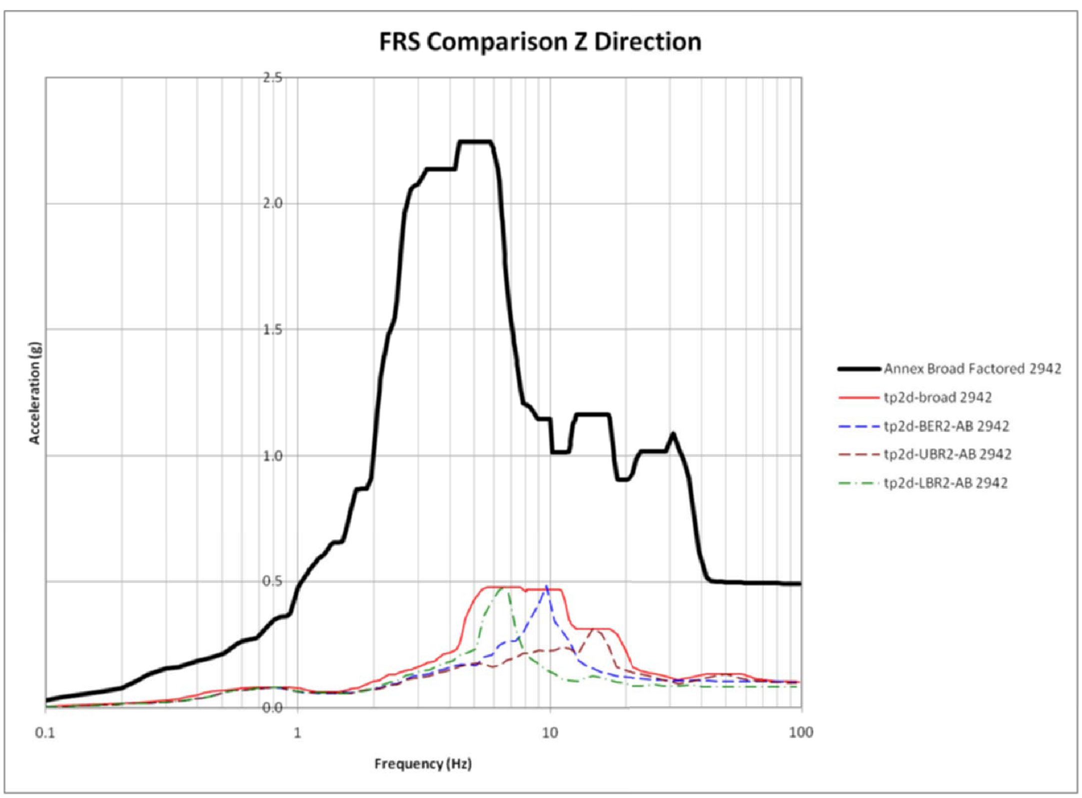

Figure 6.3-4: TPNP Annex Building BE, UB, LB FRS and AP1000 FRS Envelope in Z-Direction – Node 2942

6.4 TPNP Adjacent Structure Relative Displacements

The TPNP 2D NS and EW models were used to obtain the relative displacements at the locations listed below:

- Turbine Building Foundation to Nuclear Island
- Top of Turbine Building to Nuclear Island (El.170)
- Annex Building Foundation to Nuclear Island
- Top of Annex Building to Nuclear Island (El.180)

The relative displacements were calculated to ensure that there is no contact between the structures at the foundations or at the superstructure. To prevent contact, the relative displacements between the NI and the foundations of the adjacent buildings must be less than 2 inches. To avoid contact between the NI and the Top of the Turbine Building (elevation 170’) and Top of the Annex Building (elevation 180’), the relative displacement between the superstructures must be less than 4 inches. The relative displacements, shown in Table 6.4-1, are less than the space allocated; therefore there is no contact between the NI and the adjacent structures.

Table 6.4-1: Relative Displacements

TPNP Soil Case	North South Model		East West Model	
	Turbine Building Foundation to Nuclear Island (inches)	Top of Turbine Building to Nuclear Island (El.170±) (inches)	Annex Building Foundation to Nuclear Island (inches)	Top of Annex Building to Nuclear Island (El.180±) (inches)
BE	0.029	0.177	0.014	0.072
LB	0.065	0.253	0.027	0.077
UB	0.016	0.115	0.007	0.058

7.0 Conclusions

Based on the information presented in this report, the following conclusions are presented:

- The TPNP 3D BE, LB and UB Factored Design-Basis FRS and the corresponding TPNP broadened envelope are enveloped by the AP1000 3D CSDRS and HRHF (high frequency) FRS envelope with margin;
- The SCII TPNP 2D BE, LB and UB Turbine Building First Bay and Annex Building FRS are enveloped by the corresponding adjacent structure AP1000 2D-3D FRS envelope (Reference 10) with margin;
- The TPNP Turbine Building First Bay relative displacements of 0.065 inches and 0.253 inches at the bottom and top of the structure, respectively are less than the 2-inch and 4-inch top and bottom NI gaps; and
- The TPNP Annex Building relative displacements of 0.027 inches and 0.077 inches at the bottom and top of the structure, respectively are less than the 2-inch and 4-inch top and bottom NI gaps.

8.0 References

1. Bechtel Letter No. 25409-000-TCM-GEG-00424,"Re-submittal of Calculation 25409-000-K0C-0000-00032, Revision 0, SSI Input Soil Properties and Time Histories for Turkey Point Units 6 & 7 COLA," dated April 28, 2010.
2. Bechtel Letter No. 25409-000-TCM-GEG-00581,"Turkey Point Units 6 & 7, Effect of Grouted Rock on Seismic Site Response," dated July 20, 2011.
3. Bechtel Letter No. 25409-000-TCM-GEG-00404,"Release of Extracted Data from Calculations 25409-000-K0C-0000-00036 Rev. 0 and 00037 Rev. 0 for Turkey Point Units 6 & 7," dated February 26, 2010.
4. Bechtel Drawing 25409-000-CE-0010-00001, Rev. 4, "Nuclear Island Power Block Excavation Plan and Sections."
5. SASSI2000, User's Manual, A System for Analysis of Soil-Structure-Interaction, Rev. 1, November 1999, Geotechnical Engineering Division Civil Engineering Department, University of California, Berkeley, CA 94720.
6. ACS SASSI NQA Version 2.3.0 Verification & Quality Assurance Plan.
7. FPL Turkey Point Units 6 & 7 COLA (Final Safety Analysis Report), Rev. 2, Chapter 2.0, Section 2.5, Geology, Seismology and Geotechnical Engineering.
8. APP-GW-S2R-010, Rev. 5, TR03, "Extension of Nuclear Island Seismic Analyses to Soil Sites."
9. APP-GW-GLR-115, Rev. 3, TR115, "Effect of High Frequency Seismic Content on SSC's."
10. DCP_NRC_002981, Rev. 3, Enclosure 2, "AP1000 Response to Request for Additional Information (SRP3)," dated July 28, 2010.

Appendix A: TPNP Adjacent Structure SSI Analysis Results – NI Key Nodes

Floor response spectra (FRS) for the TB First Bay (TP2DNS) and AB (TP2DEW) models and the TPNP BE, LB and UB soil cases were obtained and compared. Note that for the TP2DNS analysis, X and Z due to X (North-South), and TP2DEW analysis, Y and Z due to Y (East-West) directions are presented on the figures below. For X-direction comparisons, the Y is zero and for Y-direction comparisons, the X is zero. For vertical, Z comparisons, Z due to X (North –South) and Z due to Y (East-West) are presented.

FRS for 5% damping and the TP2DNS model FRS at the six (6) key NI nodes are provided in Figures A-1 through A-12. FRS for 5% damping and the TP2DEW model FRS at the six (6) key NI nodes are provided in Figures A-13 through A-24.

Based on the adjacent structure SSI analyses results, the TP3DNS and TP2DEW FRS obtained are similar for the BE, LB and UB soil cases, and all nodes are enveloped by the AP1000 2D FRS envelope. Therefore, the TPNP TB First Bay and AB adjacent structures do not affect the NI structure responses.

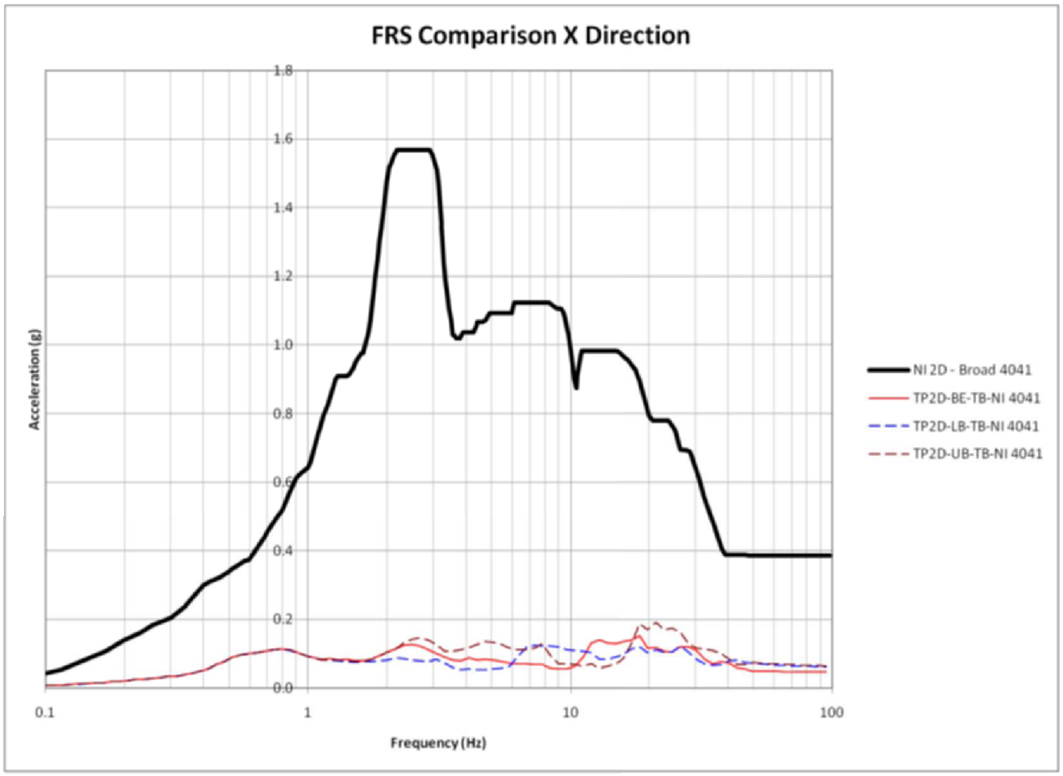

Figure A-1: TPNP Turbine Building First Bay BE, LB and UB in X-Direction – Node 4041

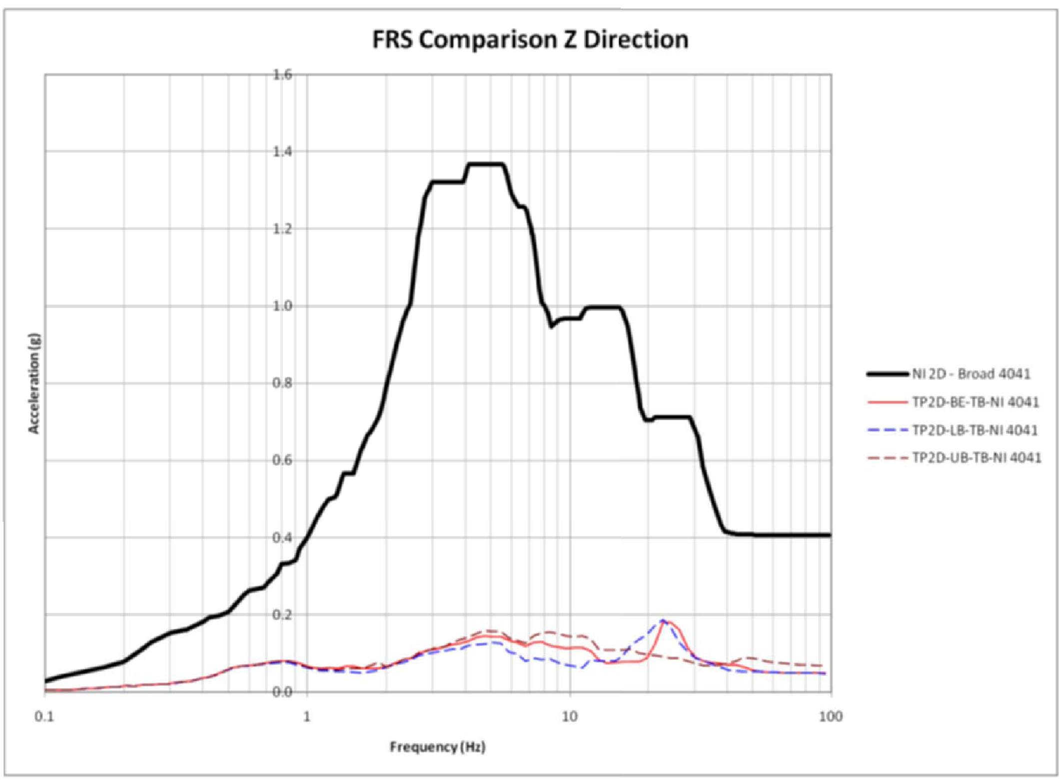

Figure A-2: TPNP Turbine Building First Bay BE, LB and UB in Z-Direction – Node 4041

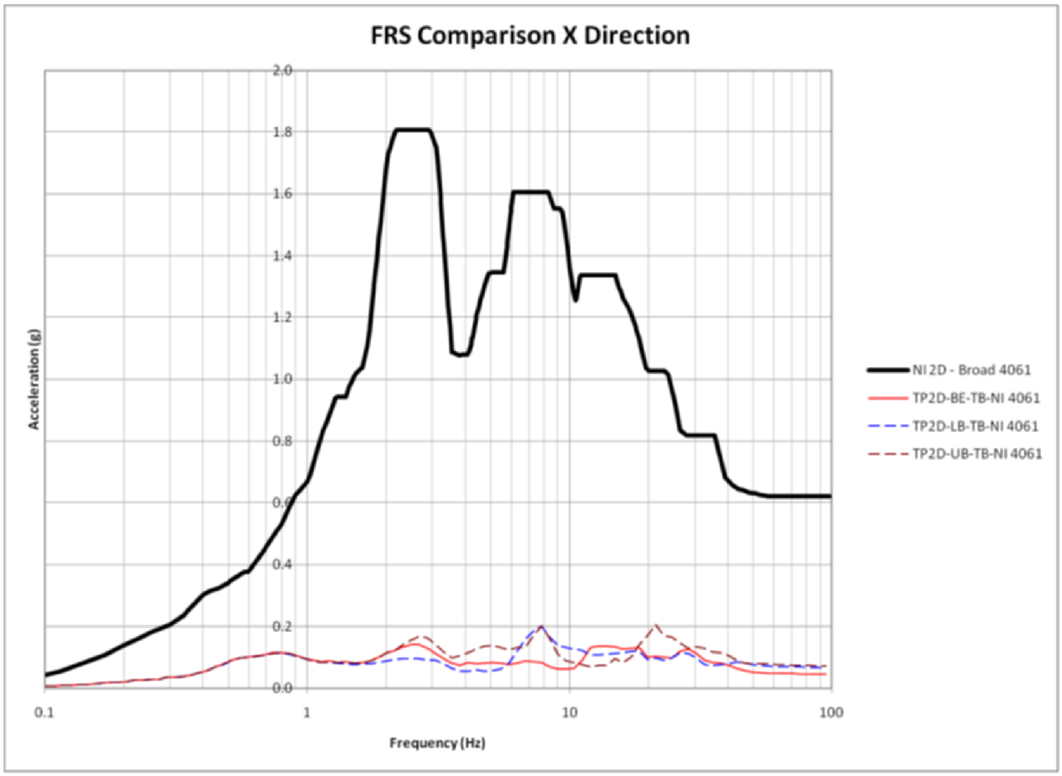

Figure A-3: TPNP Turbine Building First Bay BE, LB and UB in X-Direction – Node 4061

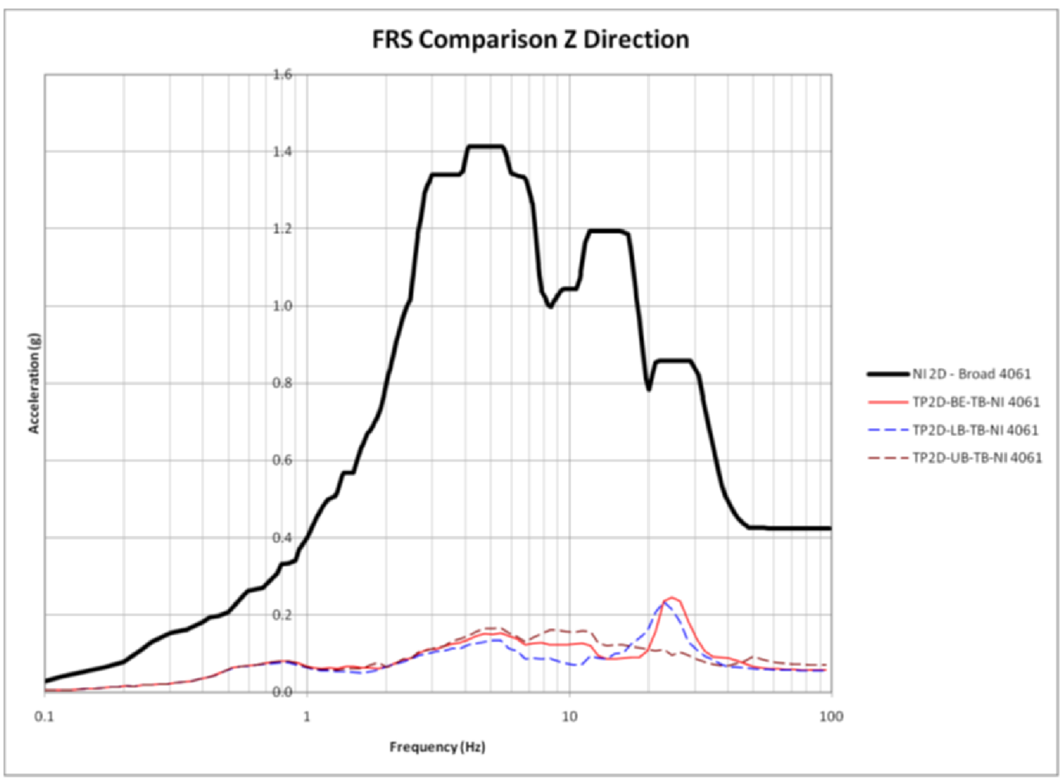

Figure A-4: TPNP Turbine Building First Bay BE, LB and UB in Z-Direction – Node 4061

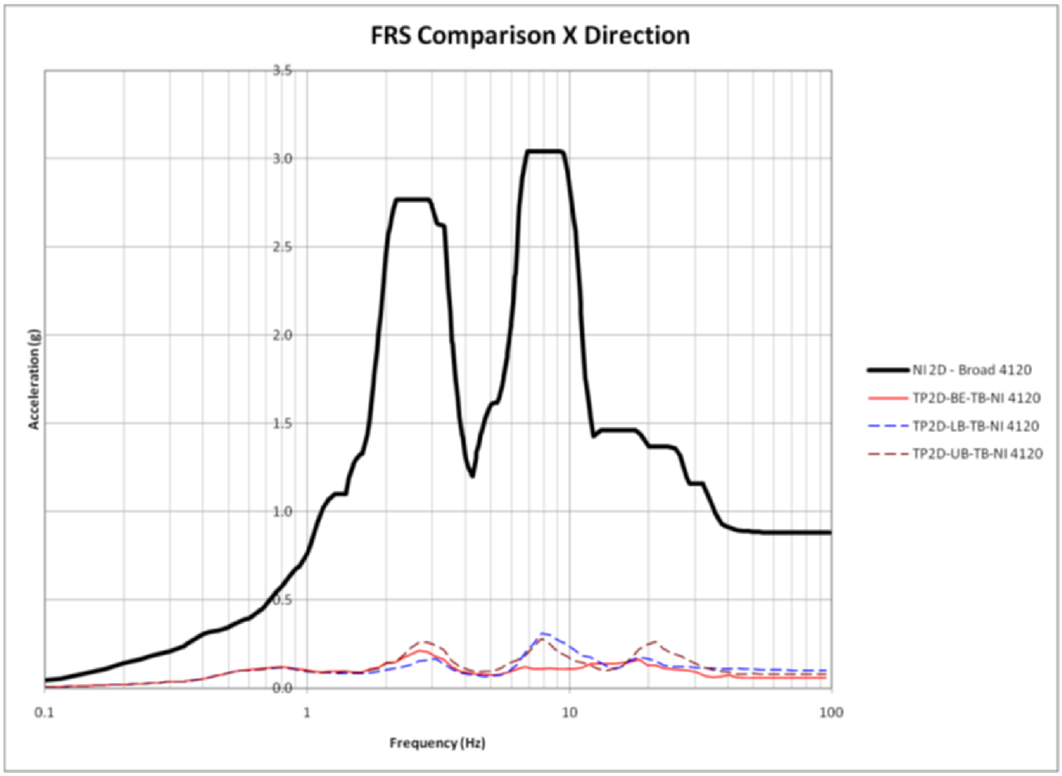

Figure A-5: TPNP Turbine Building First Bay BE, LB and UB in X-Direction – Node 4120

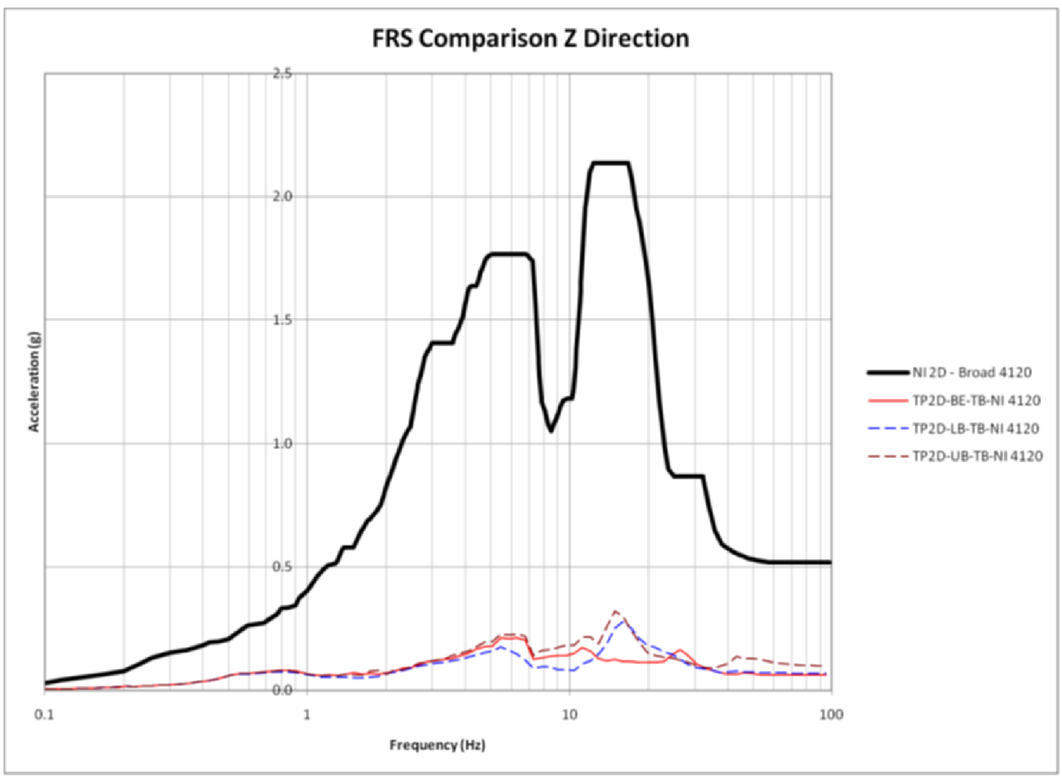

Figure A-6: TPNP Turbine Building First Bay BE, LB and UB in Z-Direction – Node 4120

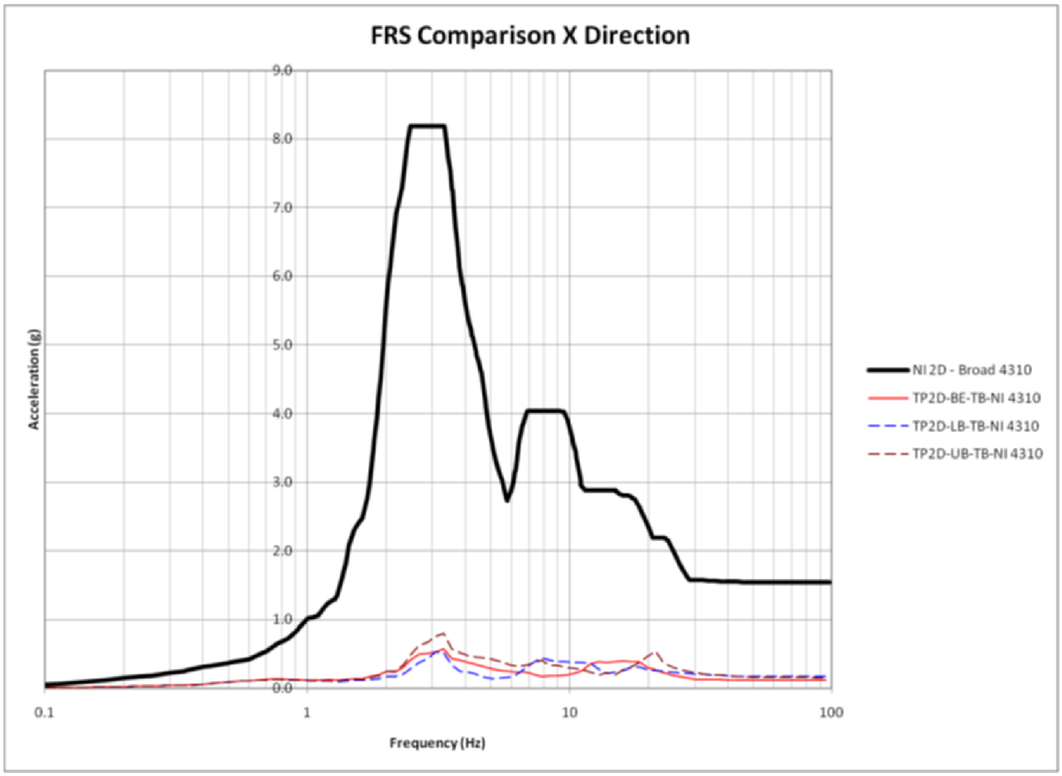

Figure A-7: TPNP Turbine Building First Bay BE, LB and UB in X-Direction – Node 4310

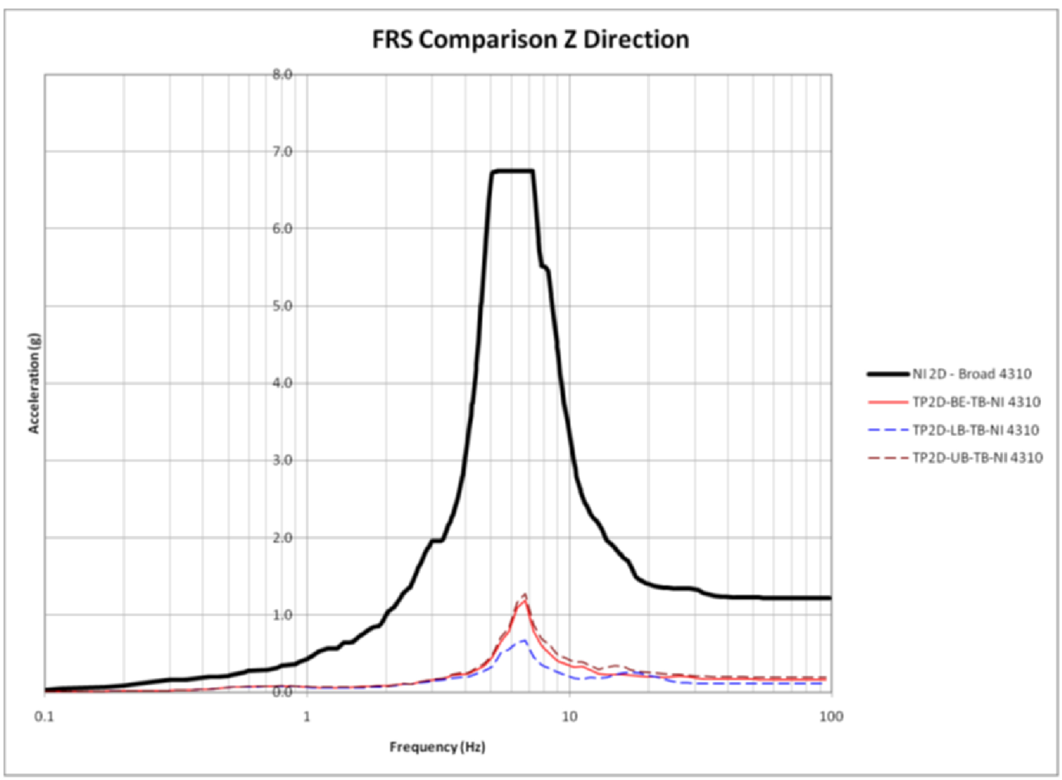

Figure A-8: TPNP Turbine Building First Bay BE, LB and UB in Z-Direction – Node 4310

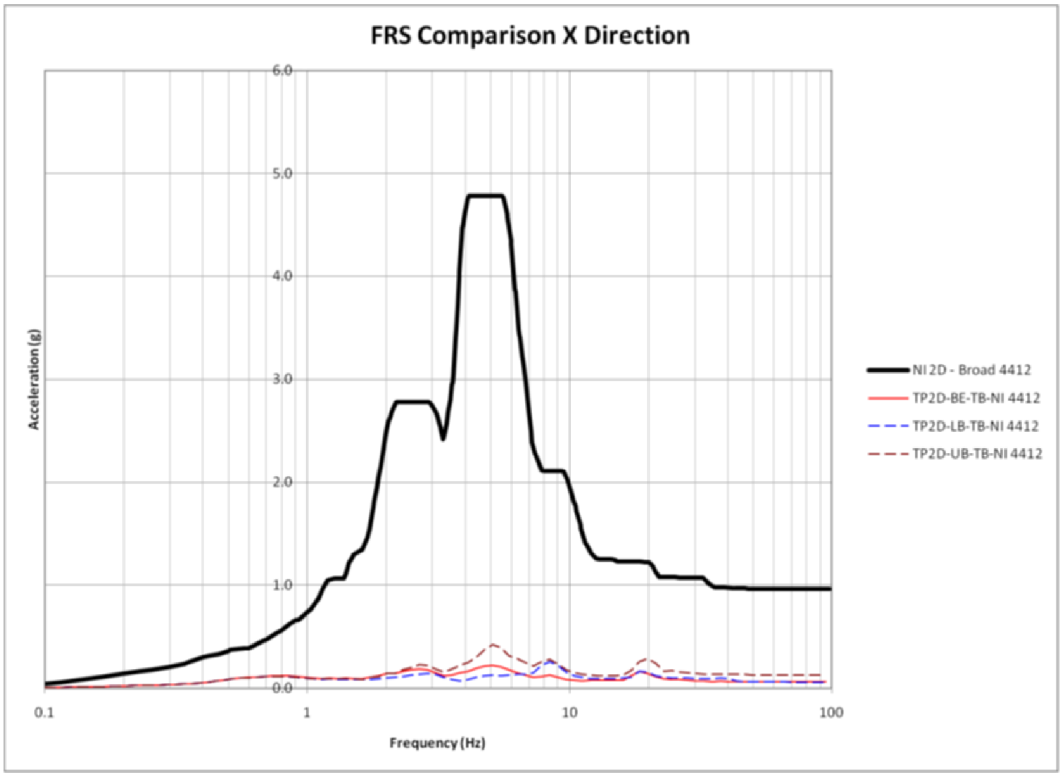

Figure A-9: TPNP Turbine Building First Bay BE, LB and UB in X-Direction – Node 4412

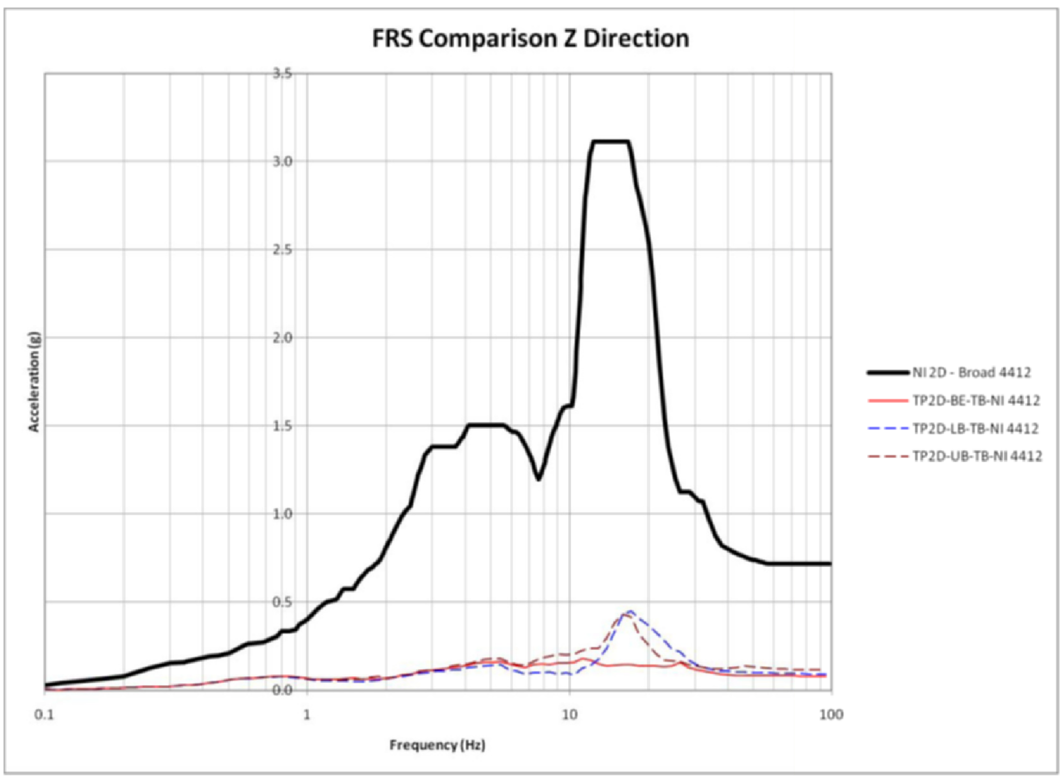

Figure A-10: TPNP Turbine Building First Bay BE, LB and UB in Z-Direction – Node 4412

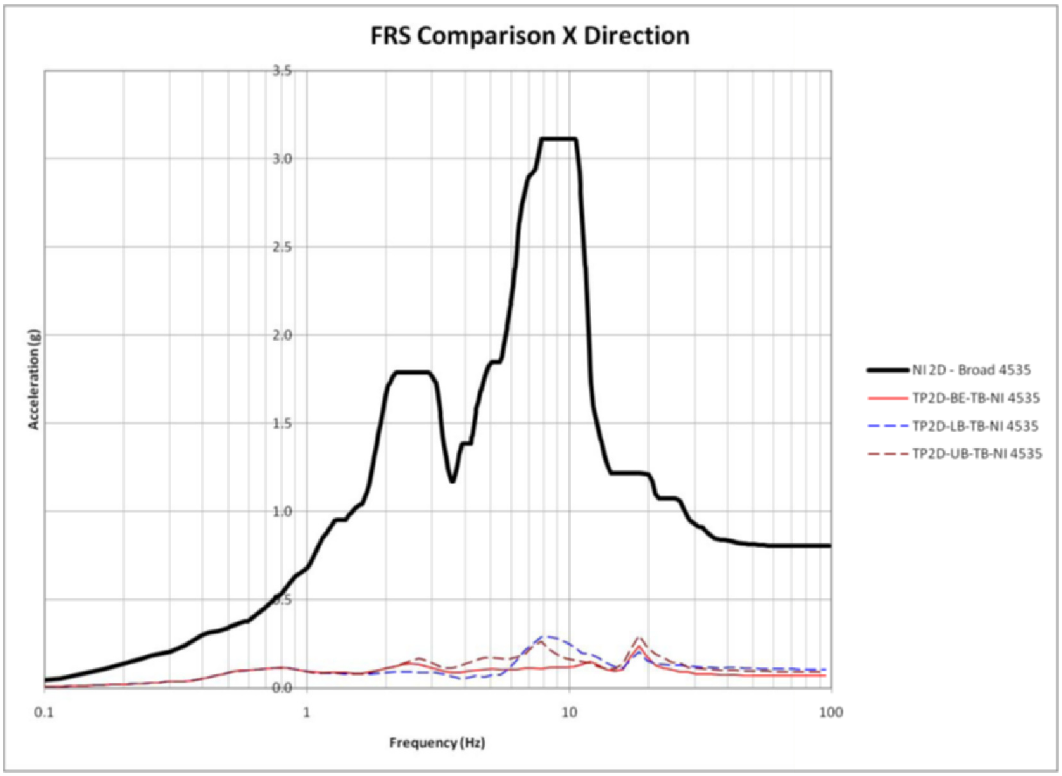

Figure A-11: TPNP Turbine Building First Bay BE, LB and UB in X-Direction – Node 4535

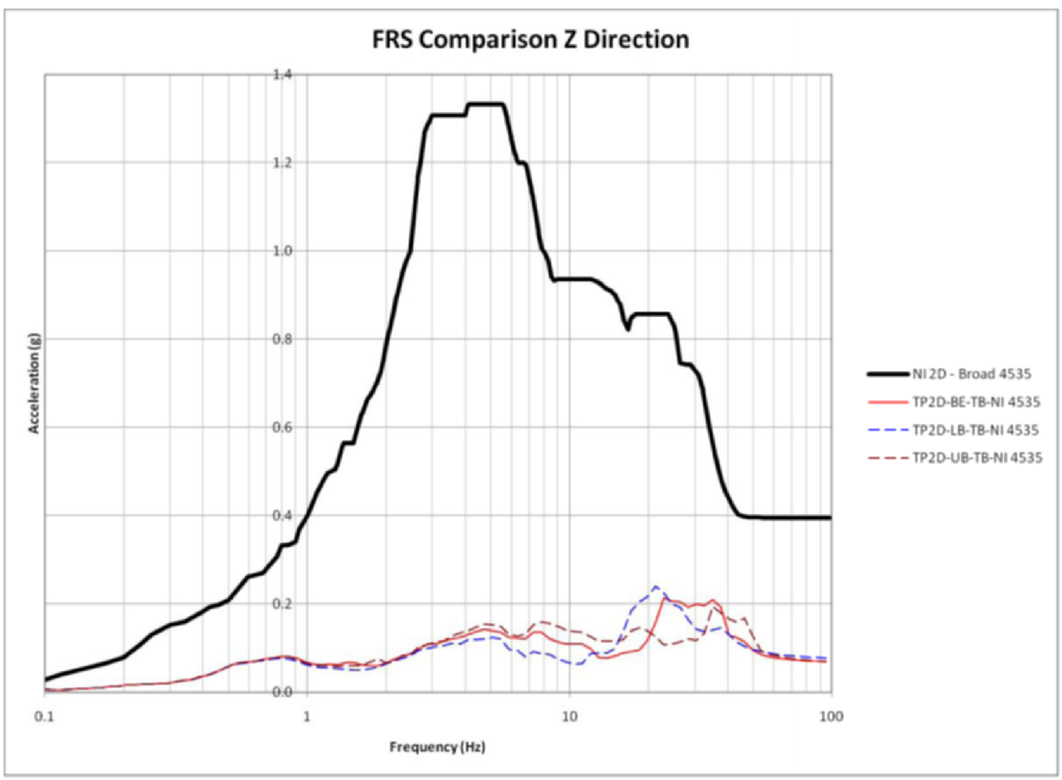

Figure A-12: TPNP Turbine Building First Bay BE, LB and UB in Z-Direction – Node 4535

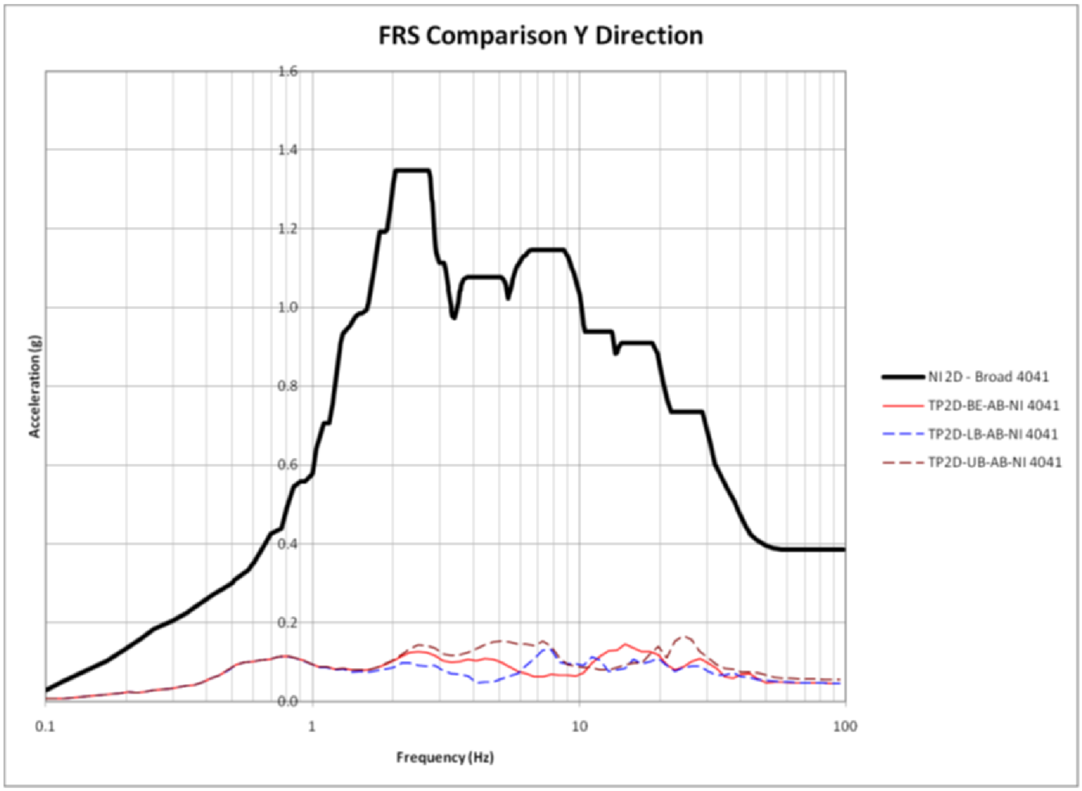

Figure A-13: TPNP Annex Building BE, LB and UB in Y-Direction – Node 4041

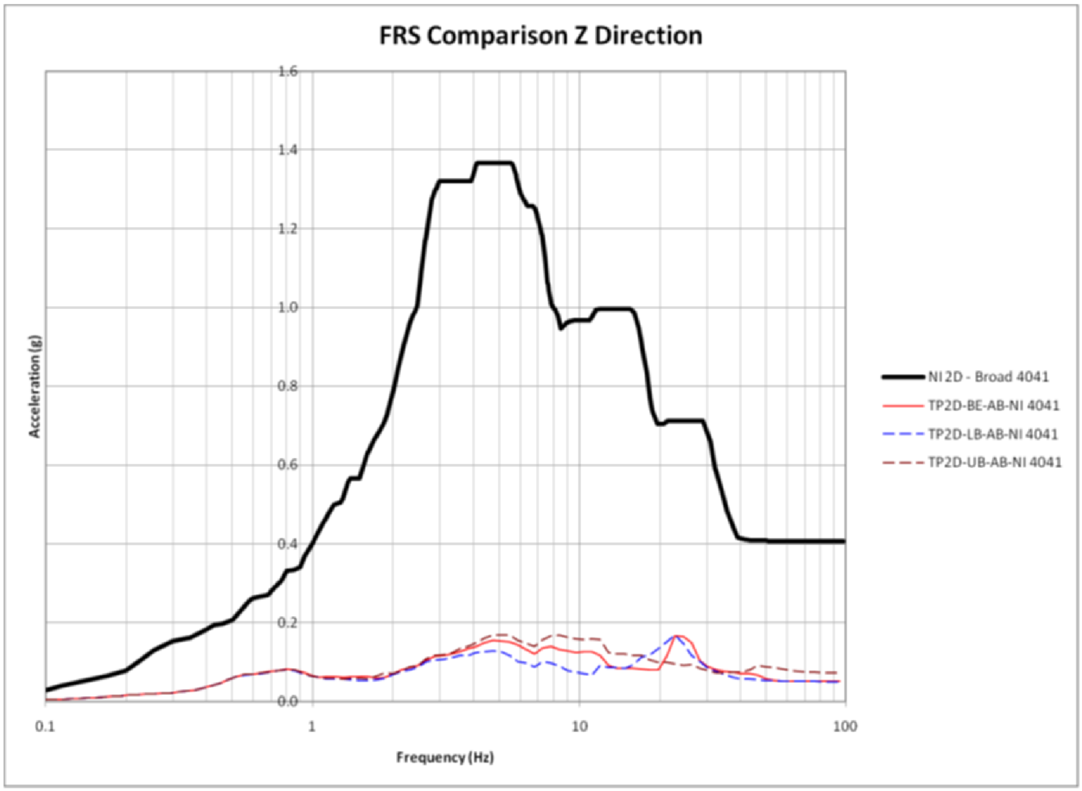

Figure A-14: TPNP Annex Building BE, LB and UB in Z-Direction – Node 4041

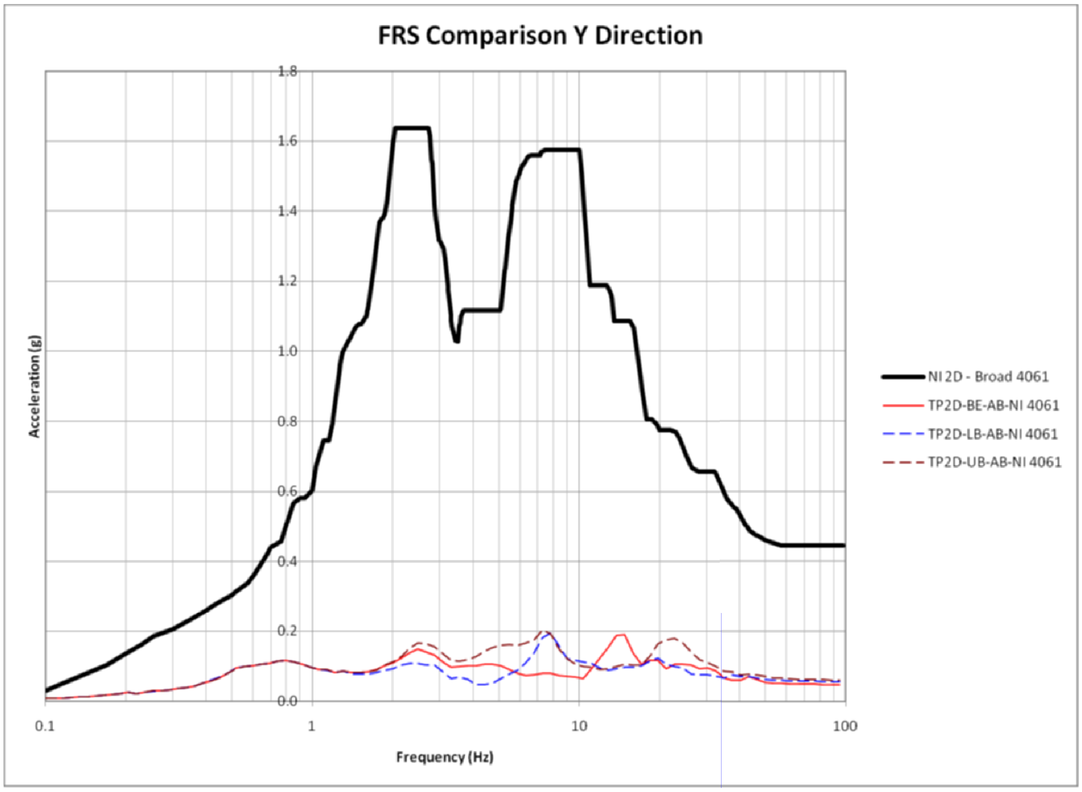

Figure A-15: TPNP Annex Building BE, LB and UB in Y-Direction – Node 4061

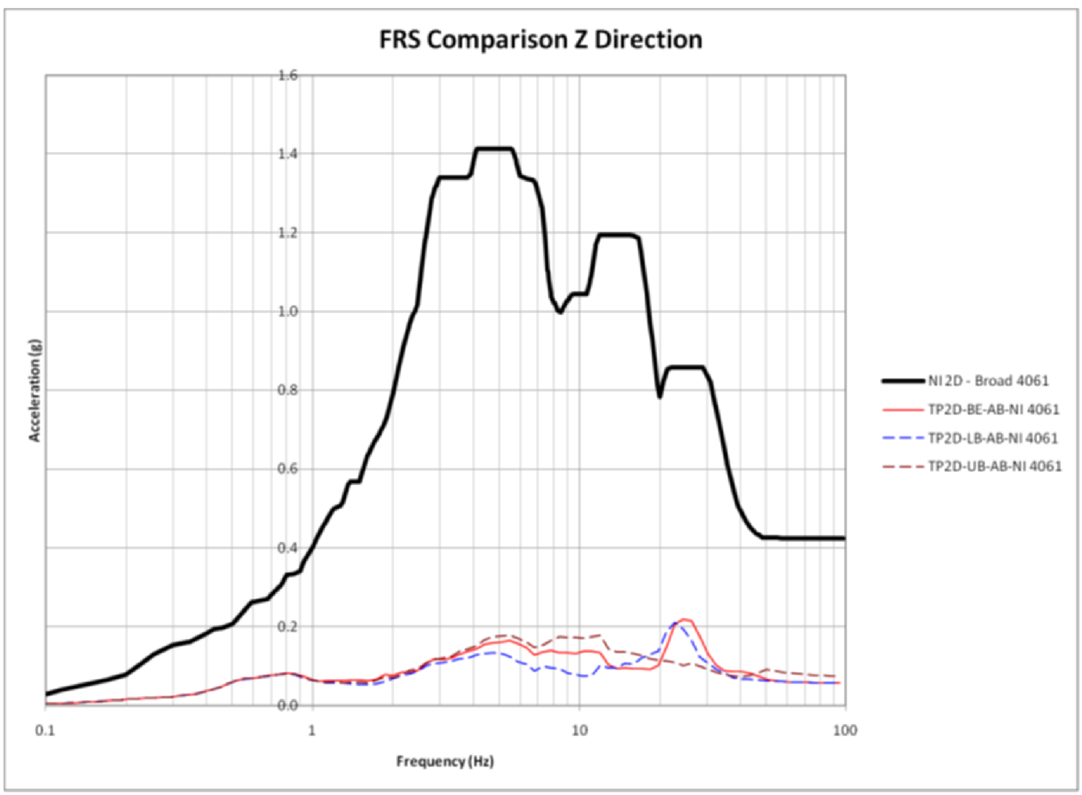

Figure A-16: TPNP Annex Building BE, LB and UB in Z-Direction – Node 4061

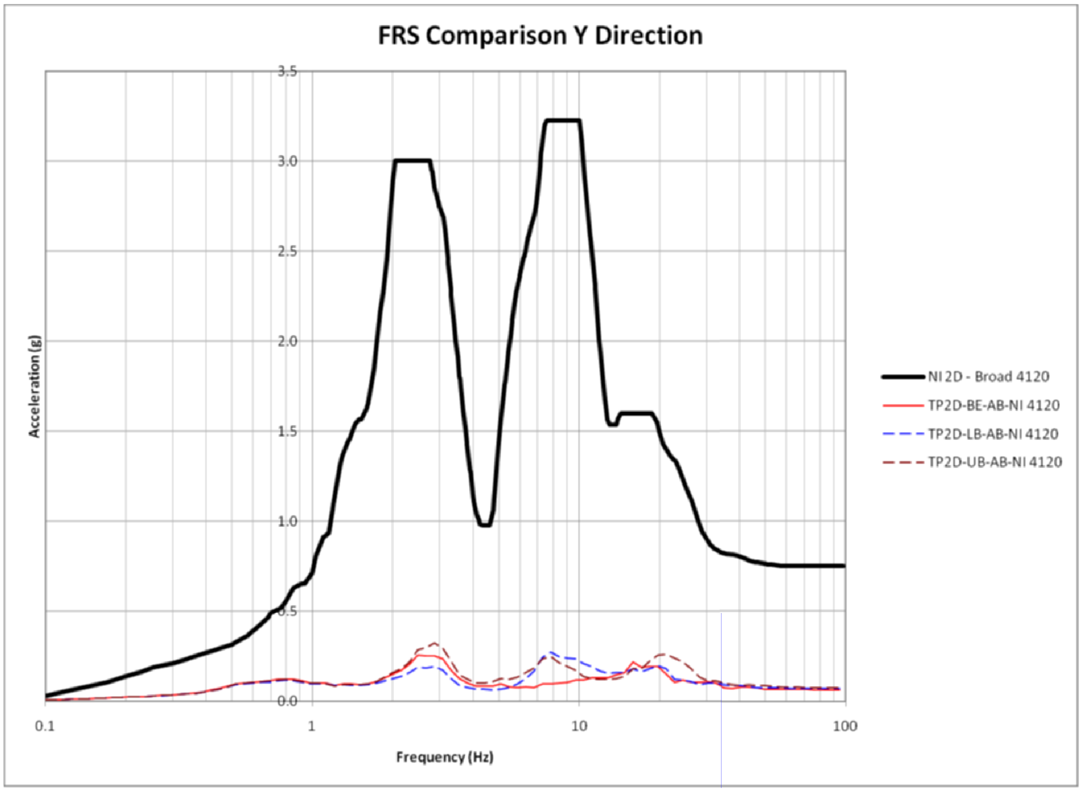

Figure A-17: TPNP Annex Building BE, LB and UB in Y-Direction – Node 4120

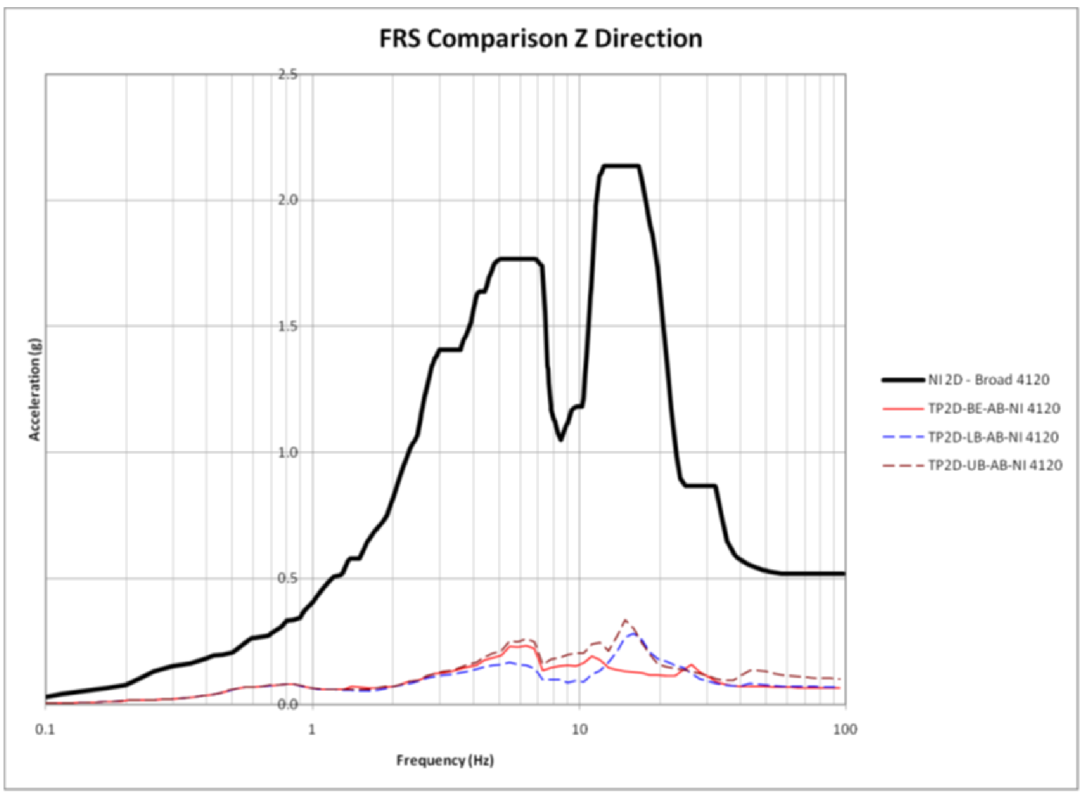

Figure A-18: TPNP Annex Building BE, LB and UB in Z-Direction – Node 4120

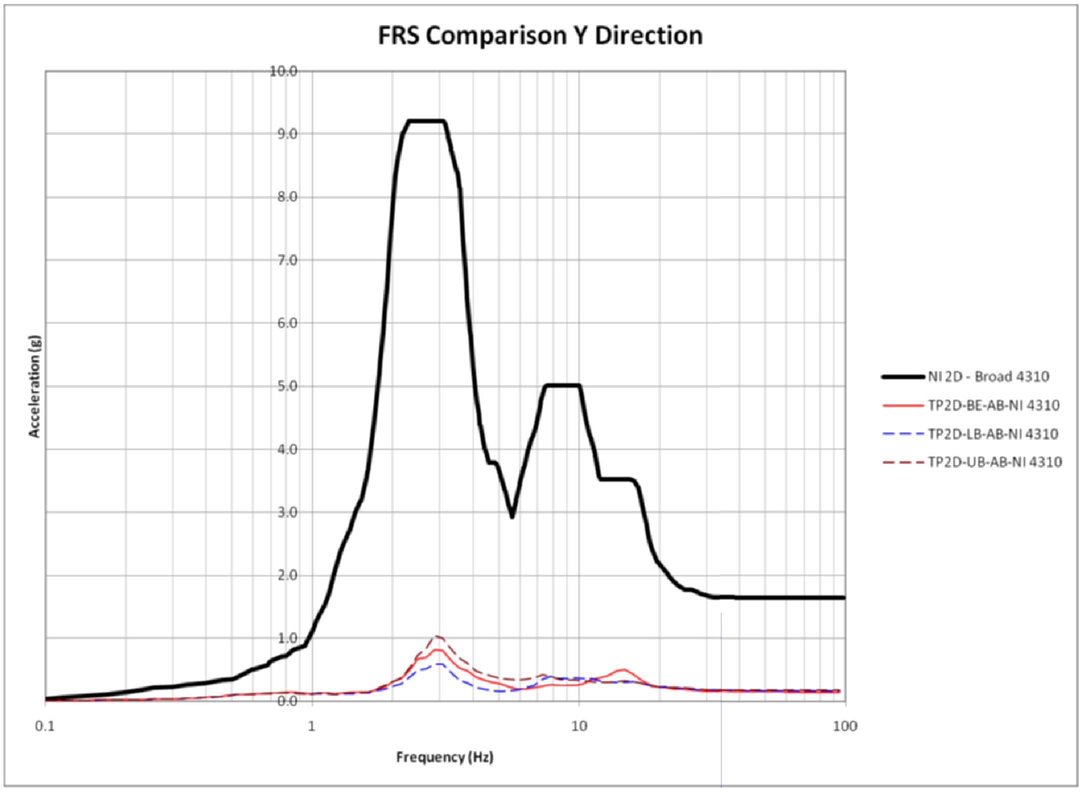

Figure A-19: TPNP Annex Building BE, LB and UB in Y-Direction – Node 4310

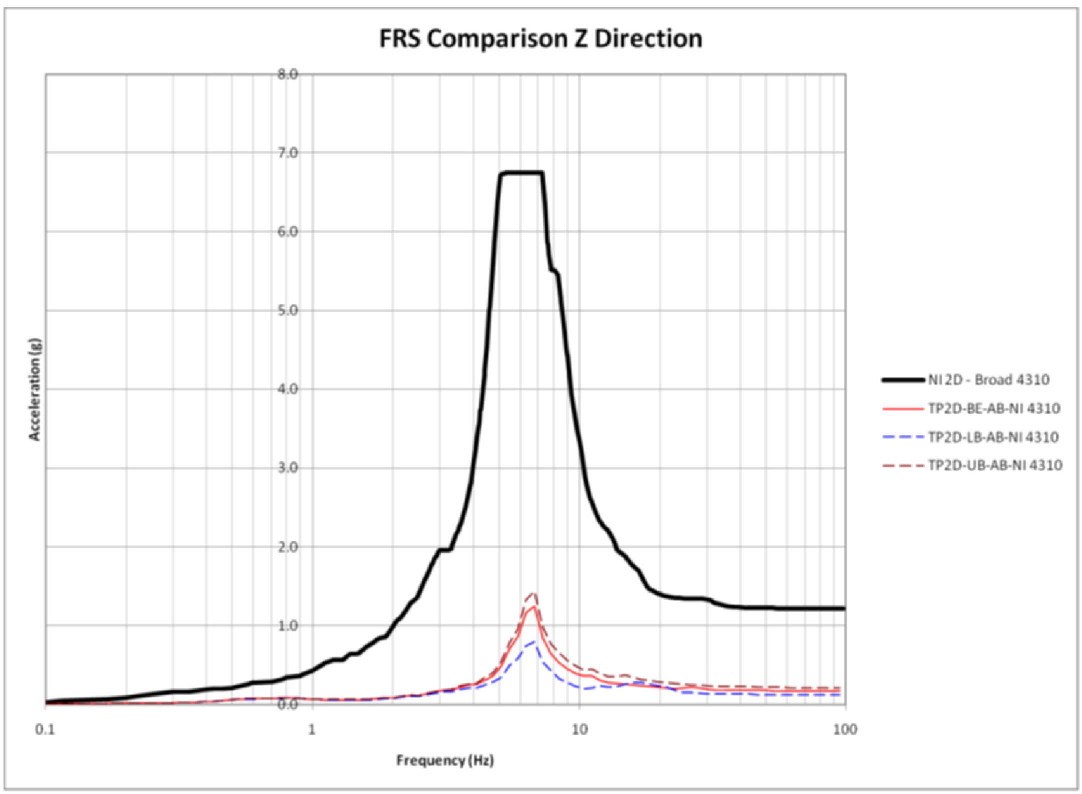

Figure A-20: TPNP Annex Building BE, LB and UB in Z-Direction – Node 4310

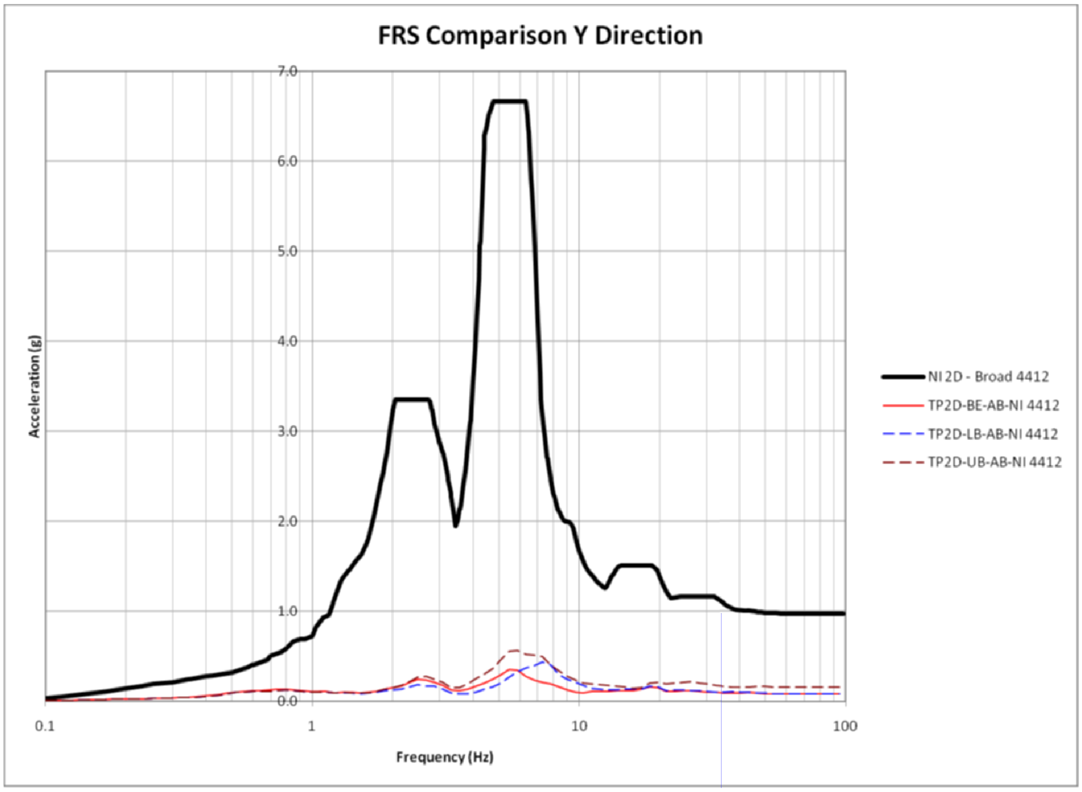

Figure A-21: TPNP Annex Building BE, LB and UB in Y-Direction – Node 4412

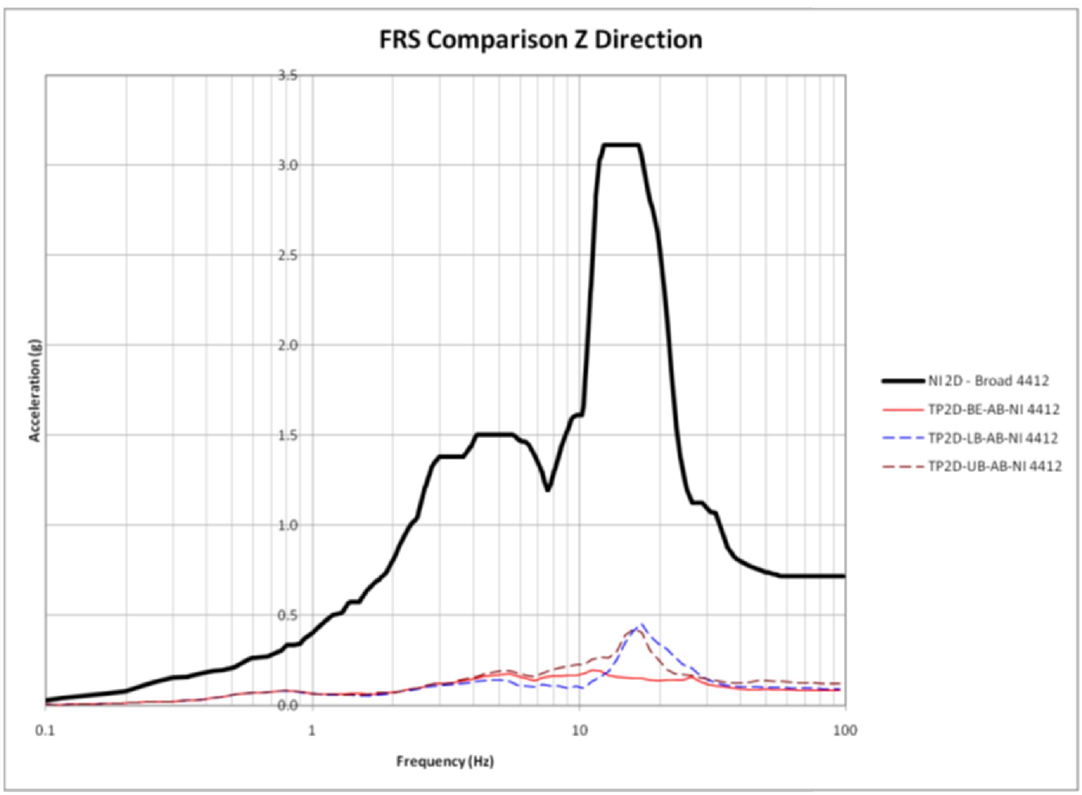

Figure A-22: TPNP Annex Building BE, LB and UB in Z-Direction – Node 4412

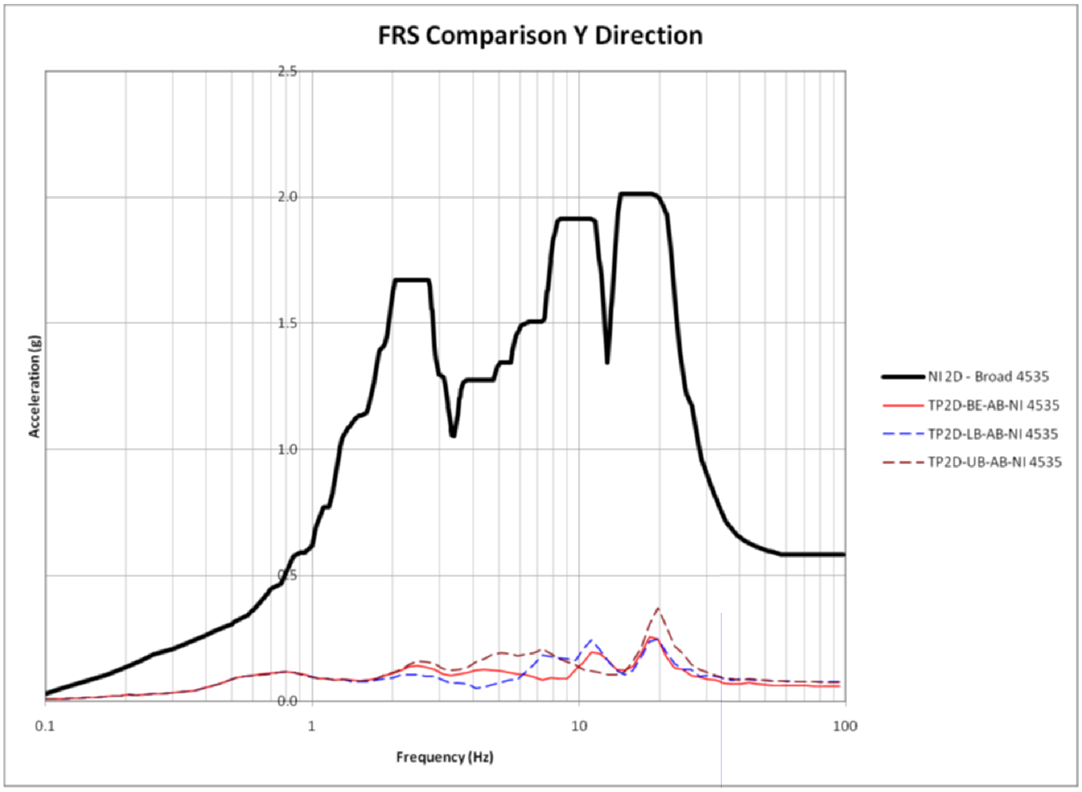

Figure A-23: TPNP Annex Building BE, LB and UB in Y-Direction – Node 4535

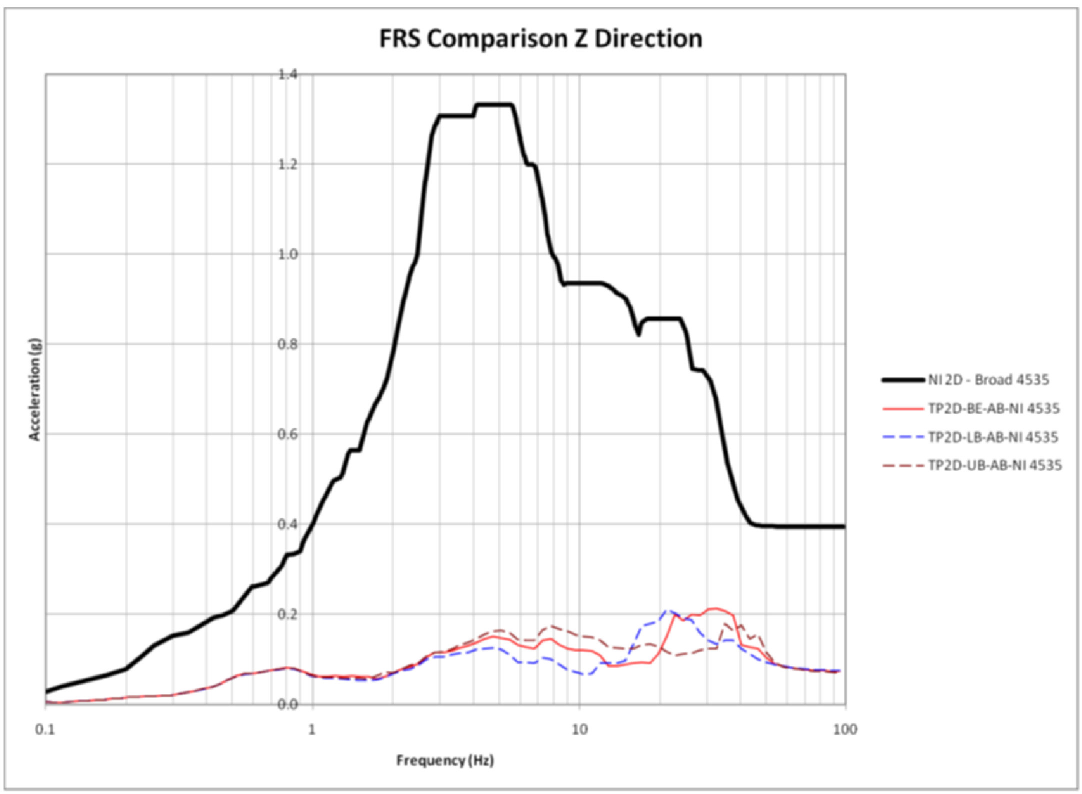

Figure A-24: TPNP Annex Building BE, LB and UB in Z-Direction – Node 4535