Progress Energy

Serial: NPD-NRC-2011-015 10CFR52.79
March 1, 2011

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

LEVY NUCLEAR PLANT, UNITS 1 AND 2
DOCKET NOS. 52-029 AND 52-030
SUPPLEMENT 4 TO RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 085 RELATED TO SEISMIC SYSTEM ANALYSIS

References:
1. Letter from Terri Spicher (NRC) to Garry Miller (PEF), dated March 16, 2010, "Request for Additional Information Letter No. 085 Related to SRP Section 3.7.2 for the Levy County Nuclear Plant, Units 1 and 2 Combined License Application"
2. Letter from John Elnitsky (PEF) to U.S. Nuclear Regulatory Commission, dated July 23, 2010, "Response to Request for Additional Information Letter No. 085 Related to Seismic System Analysis", Serial: NPD-NRC-2010-063
3. Letter from John Elnitsky (PEF) to U.S. Nuclear Regulatory Commission, dated November 10, 2010, "Supplement 1 to Response to Request for Additional Information Letter No. 085 Related to Seismic System Analysis", Serial: NPD-NRC-2010-086
4. Letter from John Elnitsky (PEF) to U.S. Nuclear Regulatory Commission, dated January 25, 2011, "Supplement 2 to Response to Request for Additional Information Letter No. 085 Related to Seismic System Analysis", Serial: NPD-NRC-2011-005
5. Letter from John Elnitsky (PEF) to U.S. Nuclear Regulatory Commission, dated February 14, 2011, "Supplement 3 to Response to Request for Additional Information Letter No. 085 Related to Seismic System Analysis", Serial: NPD-NRC-2011-007

Ladies and Gentlemen:

Progress Energy Florida, Inc. (PEF) hereby submits a supplemental response to the Nuclear Regulatory Commission's (NRC) request for additional information provided in Reference 1.

A revised response to one of the NRC questions (RAI 03.07.02-2) is addressed in the enclosure. The enclosure also identifies changes that will be made in a future revision of the Levy Nuclear Plant Units 1 and 2 application.

Progress Energy Florida, Inc.
P.O. Box 14042
St. Petersburg, FL 33733

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NRO

If you have any further questions, or need additional information, please contact Bob Kitchen at (919) 546-6992, or me at (727) 820-4481.

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

Executed on March 1, 2011.

Sincerely,

John Elnitsky
Vice President
New Generation Programs & Projects

Enclosure/Attachments

cc : U.S. NRC Region II, Regional Administrator
Mr. Brian C. Anderson, U.S. NRC Project Manager

Levy Nuclear Plant Units 1 and 2
Supplement 4 to Response to NRC Request for Additional Information Letter No. 085
Related to SRP Section 3.7.2 for the Combined License Application,
Dated March 16, 2010

NRC RAI #	Progress Energy RAI #	Progress Energy Response
03.07.02-1	L-0736 & L-0863	July 23, 2010; Serial: NPD-NRC-2010-063 & November 10, 2010; Serial: NPD-NRC-2010-086
03.07.02-2	L-0898	Revised response enclosed – see following pages & February 14, 2011; Serial NPD-NRC-2011-007

NRC Letter No.: LNP-RAI-LTR-085

NRC Letter Date: March 16, 2010

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 03.07.02-2

Text of NRC RAI:

AP1000 DCD (Revision 17) Section 2.5.2.3 addresses site-specific seismic evaluation that should be performed by the Combined License applicant if site-specific design response spectra exceeds the CSDRS or if site soil conditions are outside the range evaluated for AP1000 design certification.

According to the applicant's response to RAI Question 03.07.01-1 of RAI 2318 (NRC Letter # 046), the site-specific surface design response spectra exceeds the CSDRS in vertical motion at the LNP site. Although the applicant views that CSDRS-based in-structure response spectra would envelop the corresponding site-specific FIRS-based in-structure response spectra, no quantitative evaluation has been provided to justify the view. As for site soil conditions, no subsurface profile considered in the AP1000 DCD is similar to that of the LNP site which is characterized by stiff material immediately under the NI basemat with soft material to the sides. In addition, the design and analysis of AP1000 is based on subsurface conditions with uniform properties within horizontal layers, and the RAI response (cited above) does not fully justify this assumption of lateral uniformity of subsurface conditions.

The applicant is requested to provide detailed site-specific seismic evaluation of NI structures and those surrounding structures that may impact the safety function of NI structures. The evaluation should fully incorporate the effects of soil-structure interaction and meet the Acceptance Criteria 4 of SRP Section 3.7.2. If such site-specific seismic evaluation will not be done, the applicant should provide technical justification for not doing so.

PGN RAI ID #: L-0898

PGN Response to NRC RAI:

This is a revised response to NRC Letter 085 RAI 03.07.02-02 response submitted via Progress Energy Letter NPD-NRC-2011-005 dated January 25, 2011 (PGN RAI ID #: L-0737). The revised NRC Letter 085 RAI 03.07.02-02 response is as follows:

In response to NRC Letter 085 RAI 03.07.02-02, a site specific 3-D Soil Structure Interaction (SSI) analysis of the LNP Nuclear Island (NI) including the RCC Bridging Mat was performed. This SSI analysis is described in the Westinghouse proprietary report LNG-1000-S2R-804 entitled "Levy Nuclear Island and RCC Bridging Mat - 3D SASSI SSI Evaluation Report", Revision 2, dated February 2011; this proprietary report was submitted via Progress Energy Letter NPD-NRC-2011-007 dated February 14, 2011.

The SSI analysis methodology and results can be summarized as follows:

1. The upper bound (UB), best estimate (BE), lower bound (LB), and lower lower bound (LLB) soil profiles and properties were used for the SSI analysis. The UB, BE, and LB soil profiles and soil properties are presented in Tables 2.5.2-228, 229, and 230. These soil profiles and properties were developed following Standard Review Plan and section 5.2.1 of the Interim

Staff Guidance DC/COL-ISG-017 (ISG-017) as described in Subsection 2.5.2.6.7. The LLB soil profile was defined in NRC Letter 087 RAI 03.07.01-02 response Table RAI 03.07.01-02-1 to account for the degradation in the soil shear modulus due to foundation installation activities. The LLB soil profile and soil properties used for the SSI analysis are presented in Table RAI 03.07.02-02-1 (attached).

2. As described in Subsection 2.5.2.6.6, Soil Structure Interaction (SSI) analysis foundation input response spectra (FIRS) were developed at elevation -7.3 m (-24 ft.) NAVD88, the base of planned excavation beneath the nuclear island. This FIRS was scaled to ensure that the computed soil column outcropping response (SCOR) at the AP1000 foundation elevation 3.4 m (11 ft.) NAVD88 meets the 0.1g minimum ZPA requirement of 10 CFR 50 Appendix S. The SCOR FIRS developed for elevation -7 m (-24 ft.) NAVD88 is shown on Figure 3.7-201.

   Input time histories for the SSI analysis were created in two steps. First, time histories were spectrally matched to the SCOR FIRS at the base of the planned excavation. Then these time histories were input into the four (UB, BE, LB, and LLB) free field soil columns (full height to elevation 15.5 m (51 ft.)) as outcropping motions and then output as in-column motion at the base of the excavation for use in the SSI analysis. As part of this process, the surface motion was computed for each of the four soil profiles and the SCOR FIRS was enhanced at intermediate frequencies to ensure that the surface motion envelops the PBSRS. The selected seed time history was the 1992 Landers Earthquake, Villa Park Serrano Ave station, chosen from the CEUS record library provided by NUREG/CR 6728. The seed time history was selected based on the seismological properties and spectral shape of both horizontal and vertical components. The selected time history represents a distance recording of a large (M 7.3) earthquake consistent with the dominant contribution to Levy site hazard by the Charleston source. Figures RAI 03.07.02-02-1 through RAI 03.07.02-02-4 show the in-column SSI input X, Y, and Z time histories at elevation -7.3 m (-24 ft.) for the Best Estimate (BE), Upper Bound (UB), Lower Bound (LB), and the Lower Lower Bound (LLB) Soil profiles respectively.

3. The site specific LNP 3D SASSI models are embedded models. The structure portion of the LNP model is an exact representation of the WEC NI20r 3D SASSI model of the NI structure(s) above the design grade elevation 15.5 m (51 ft.) NAVD88. Additional nodes were added to the NI20r model for the below grade portion of the model to represent the LNP site specific conditions to the 75-foot depth. The site specific embedded portion of the model consists of a total of eight (8) below grade layers, to model the various material properties and layer thickness for the UB, BE, LB, and LLB soil profiles, the RCC bridging mat beneath the NI basemat, and the engineered fill and the controlled low strength material (CLSM) on the side. The average model frequency ranges from 45 Hz for UB model to 25 Hz for the LLB model.

4. The Subtraction computational method in SASSI was used for the SSI response analysis. The cut-off frequency used for the response analysis was 33 Hz. Floor response spectra (FRS) were generated for the six key AP1000 locations. These locations include: CIS at Reactor Vessel Support Elevation, ASB NE Corner at Control Room Floor, CIS at Operating Deck, ASB Corner of Fuel Building Roof at Shield Building, SCV near Polar Crane, and ASB Shield Building Roof Area. The LNP site specific broadened 5% damped FRS computed at these six locations for the X, Y and Z directions are enveloped by the AP1000 FRS envelop spectra at all of the six NI key nodes as shown in Figures RAI 03.07.02-02-5 through RAI 03.07.02-02-10. In addition the maximum LNP site specific bearing pressure (SSE plus dead load) of 20 ksf is less than the AP1000 maximum bearing pressure of 35 ksf.

5. Utilizing the NI20r embedded model and the BE soil profile and properties, a LNP 5-layer embedded benchmark model was created to address NRC questions pertaining to the SASSI Subtraction computational methods. Additional nodes were added to the NI20r model for the below grade portion of the LNP benchmark model to represent the LNP site specific subsurface conditions to the 75-foot depth. Using the LNP 5-layer benchmark model, SSI analyses were performed using the Subtraction methods and the Direct method in SASSI. The results of the benchmark SSI analysis show that the Subtraction and the Direct methods yield generally comparable responses, particularly below 15 Hz. Minor variations were observed in the FRS between the two methods across the frequency spectrum with the Subtraction method generally conservative above 15 Hz. Thus LNP SSI analysis using the Subtraction computational method in SASSI is acceptable. The comparison of the 5% damped FRS in the X, Y, and Z directions at six key AP1000 locations using the Subtraction and Direct methods are shown in report LNG-1000-S2R-804 Figures 5.2-1 through 5.2-18.
6. The Turbine Building (TB), Annex Building (AB), and Radwaste Building (RB) drilled shafts and the diaphragm wall were not modeled in the LNP 3D SSI model. The Seismic Category II/I interaction issues between the adjacent buildings and the NI have been addressed in response to NRC Letter 086 RAI 03.08.05-07 (Progress Energy Letter NPD-NRC-2011-001 dated January 25, 2011; PGN RAI ID #: L-0864). In response to NRC Letter 086 RAI 03.08.05-07, it was shown that the computed probable maximum relative displacements between the NI and the adjacent Turbine, Annex, and Radwaste Buildings' foundation mats for the performance based surface response spectra (PBSRS) and the 10^{-5} uniform hazard response spectra (UHRS) are less than the 50 mm (2.0 inch) gap between the NI and the adjacent buildings' foundation mats. In addition, the interface between the adjacent buildings' drilled shaft supported foundations and the NI is designed to avoid hard contact between the NI and the adjacent building foundations resulting from the relative displacements during the seismic event as shown in Figure RAI 03.07.02-01-1.

Associated LNP COL Application Revisions:

The following changes will be made to Subsections 2.5.2.6 and 3.7.1.1 of the FSAR in a future revision:

1) Text changes to Subsections 2.5.2.6.7, 3.7.1.1.1, and 3.7.1.1.2 as noted below;
2) New Table RAI 03.07.02-02-1 for Subsection 2.5.2.6.7 is included in Attachment 03.07.02-02 A.
3) New Figures RAI 03.07.02-02-1 through RAI 03.07.02-02-10 for Subsection 3.7.1.1.1 are included in Attachment 03.07.02-02 B.

Text changes:

a. A new paragraph will be added at the end of Subsection 2.5.2.6.7 as follows:

"A fourth profile called the Lower Lower Bound (LLB) was developed as described in Subsection 3.7.1.1.1. LLB soil profile is used to account for the degradation of soil shear modulus due to foundation installation activities in the SSI analysis. The LLB soil profile and properties are shown in Table RAI 03.07.02-02-1. The degradation of soil shear modulus for the LLB soil profile only applies to in-situ soil layers (layers 7 to 19 in Table RAI 03.07.02-02-1 which corresponds to depths 15 ft. to 75 ft.). The material properties for the engineered fill (depths 0 to 15 ft.) and rock (depths greater than 75 ft.) are the same as in the LB soil profile. The low strain shear modulus of the in-situ soil is reduced by ten percent and the new reduced shear wave velocity was calculated from the shear modulus. The compression wave velocity (V_P) for the in-situ soil was calculated as follows: For in-situ soil below the water table, if the V_P is less than that of water (i.e., 5,000 fps), the V_P of the soil is set to 5,000 fps (layers 5 to 14 in Table RAI 03.07.02-02-1). If the V_P is greater than 5,000 fps (layers 15 to 19 in Table RAI 03.07.02-02-1), the V_P is then reduced in the same ratio that the shear wave velocity is being reduced (approximately five percent)."

b. Subsection 3.7.1.1.1 text will be revised from:

"Figure 2.5.2-296 shows the comparison of the horizontal and vertical site-specific ground motion response spectra (GMRS) to the AP1000 certified design seismic design response spectra (CSDRS). The GMRS was developed as the Truncated Soil Column Surface Response (TSCSR) on the uppermost in-situ competent material (elevation 11 m [36 ft.] NAVD88) as described in Subsection 2.5.2.6.

Plant finished grade will be established at elevation 15.5 m (51 ft.) NAVD88 by placing engineered fill above in-situ material. Performance based surface horizontal and vertical response spectra (PBSRS) at the finished grade elevation were developed using the same methodology and in-situ soil properties used for developing the GMRS described in Subsection 2.5.2.6. Engineered fill properties presented in Table 2.5.4.5-201 were used from elevation 11 m (36 ft.) NAVD88 to elevation 15.5 m (51 ft.) NAVD88 in the response analysis. The vertical and the horizontal PBSRS were scaled by a factor that is required for the horizontal free-field soil column outcrop response spectra (SCOR) at the AP1000 foundation elevation 3.4 m (11 ft.) NAVD88 to meet the 0.1g zero period acceleration (ZPA) requirement of 10 CFR 50 Appendix S. The scaled horizontal and vertical SCOR FIRS at the AP1000 foundation elevation 3.4 m (11 ft.) NAVD88 are shown in Figure 3.7-205. Table 2.5.2-227 presents the digitized scaled horizontal and vertical PBSRS and Figure 2.5.2-297 presents the comparison of the AP1000 CSDRS with the scaled PBSRS for horizontal and vertical ground motions.

In addition to the PBSRS, finished grade Soil Structure Interaction (SSI) analysis input surface spectra were developed using Subsection 5.2.1 of the Interim Staff Guidance DC/COL-ISG-017 as described in Subsection 2.5.2.6. The finished grade surface response spectra from the three soil columns (best estimate, lower bound, and the upper bound properties) were developed using SCOR FIRS developed for elevation -7.3 m (-24 ft.) NAVD88, the base of planned excavation beneath the nuclear island. This FIRS was scaled to ensure that the computed SCOR at the AP1000 foundation elevation 3.4 m (11 ft.) NAVD88 meets the 0.1g minimum ZPA requirement of 10 CFR 50 Appendix S. Figure 3.7-201 shows the scaled SCOR FIRS for elevation -7.3 m (-24 ft.) NAVD88. The three soil property profiles were developed based on the variation in the randomized soil profiles used for developing PBSRS and complying with SRP 3.7.2.II.4 guidance on soil property variation for SSI analysis. The shear wave velocity profiles for the upper bound (UB), best estimate (BE) and lower bound (LB) soil profiles are shown in Figure 2.5.2-298. The soil column profile and soil properties are presented in Tables 2.5.2-228, 229, and 230 for BE, LB, and UB cases respectively. Both horizontal and vertical SSI input response spectra were developed. The SSI input spectra from the UB, BE, and LB soil columns (Figures 3.7-202, 203, and 204) along with the corresponding acceleration time histories and corresponding UB, BE, and LB soil column profiles (Tables 2.5.2-228, 229, and 230) would be used for nuclear island SSI analysis, if required. The envelope of the SSI input spectra from the UB, LB, and BE envelops the PBSRS as required by DC/COL-ISG-017. Figures 3.7-202 and 203 present the comparison of the AP1000 CSDRS with the SSI input response spectra from the UB, BE, and LB soil columns for the horizontal ground motions for the North-South (H1) and the East-West (H2) directions. The CSDRS envelops the SSI input response spectra from the three soil columns. Thus, site specific SSI analysis for horizontal ground motions is not required.

For the vertical ground motions, Figure 3.7-204 presents the comparison of the AP1000 CSDRS with the scaled PBSRS and the SSI input response spectra from the three soil columns. The CSDRS envelops the scaled vertical PBSRS by a similarly large margin as the horizontal. However, it does not envelop the finished grade surface SSI input response spectra from the three soil columns in the high frequency range (greater than approximately 30 Hz). For the vertical direction, the response at the top of the free field soil columns overestimates amplification that will be experienced by the AP1000. This is due to the fact that the AP1000 mat for LNP is supported vertically on the 35' RCC mat that rests on rock. Amplification of the vertical motion to the AP1000 mat will be minimal because of the high shear wave (3500 ft/sec) velocity through the RCC mat. As shown in Figure 3.7-201 the vertical CSDRS envelops the scaled vertical FIRS at the base of the excavation by a large margin. Based on this large margin and the minimal amplification expected through the RCC mat, judged to envelop the corresponding site-specific FIRS-based in-structure spectra."

To read:

"Figure 2.5.2-296 shows the comparison of the horizontal and vertical site-specific ground motion response spectra (GMRS) to the AP1000 certified design seismic design response spectra (CSDRS). The GMRS was developed as the Truncated Soil Column Surface Response (TSCSR) on the uppermost in-situ competent material (elevation 11 m (36 ft.) NAVD88) as described in Subsection 2.5.2.6.

Plant design grade will be established at elevation 15.5 m (51 ft.) NAVD88 by placing engineered fill above in-situ material. Performance based surface horizontal and vertical response spectra (PBSRS) at the design grade elevation were developed as described in Subsection 2.5.2.6. Figure 2.5.2-297 presents the comparison of the AP1000 CSDRS with the scaled PBSRS for horizontal and vertical ground motions. The CSDRS envelops the scaled horizontal and the vertical PBSRS.

The seismic Category II Annex Building and other adjacent non-seismic structures are supported on drilled shafts. The top of the basemat for the Annex Building, Radwaste Building, and the Turbine Building (except for the condenser pit area) is at design grade elevation 15.5 m (51 ft.) NAVD88. The scaled horizontal PBSRS (Figure 2.5.2-297) was used to compute the maximum relative displacements of the Annex Building, Turbine Building, and the Radwaste Building drilled shaft foundation with respect to the nuclear island to evaluate the site-specific aspect of the seismic interaction of these buildings with the nuclear island.

The nuclear island (NI) is supported on 10.7 meters (35 feet) of roller compacted concrete over rock formations at the site as described in Subsection 2.5.4.5. As described in Subsection 2.5.2.6.6, NI Soil Structure Interaction (SSI) analysis foundation input response spectra (FIRS) were developed at elevation -7.3 m (-24 ft.) NAVD88, the base of planned excavation beneath the nuclear island. This FIRS was scaled to ensure that the computed soil column outcropping response (SCOR) at the AP1000 foundation elevation 3.4 m (11 ft.) NAVD88 meets the 0.1g minimum ZPA requirement of 10 CFR 50 Appendix S. The scaled SCOR FIRS at elevation -7 m (-24 ft.) NAVD88 is shown on Figure 3.7-201.

Figures RAI 03.07.01-02-1 and RAI 03.07.01-02-2 show the conceptual grading plan and the conceptual grading section for the LNP site respectively. The plant Nuclear Island (NI) footprint (approximately 0.8 acres for each unit) is small compared to the approximately 347 acres where fill will be placed to raise the existing grade level. The existing grade in the plant footprint area is at approximate elevation 12.8 m (42 ft.) NAVD88. The finished grade in the 347 acre fill area will vary from elevation 15.2 m (50 ft.) NAVD88 to elevation 14.3 (47 ft.) NAVD88. The large extent of the fill area compared to the NI footprint and because the PBSRS is higher than the GMRS for the LNP site, inclusion of the fill to design grade for the free field response analysis and the SSI analysis is appropriate.

Design grade (elevation 15.5 m (51 ft.) NAVD88) Soil Structure Interaction (SSI) analysis input surface spectra were developed using Subsection 5.2.1 of the Interim Staff Guidance DC/COL-ISG-017 as described in Subsection 2.5.2.6. The finished grade surface response spectra from the three soil columns (best estimate, lower bound, and the upper bound properties) were developed using SCOR FIRS developed for elevation -7.3 m (-24 ft.) NAVD88, the base of planned excavation beneath the nuclear island. The three soil property profiles were developed based on the variation in the randomized soil profiles used for developing PBSRS and complying with SRP 3.7.2.II.4 guidance on soil property variation for SSI analysis. The shear wave velocity profiles for the upper bound (UB), best estimate (BE) and lower bound (LB) soil profiles are shown in Figure 2.5.2-298. The soil column profile and soil properties are presented in Tables 2.5.2-228, 229, and 230 for BE, LB, and UB cases respectively. Both horizontal and vertical SSI input response spectra were developed. The SSI input spectra from the UB, BE, and LB soil columns (Figures 3.7-202, 203, and 204) along with the corresponding acceleration time histories and corresponding UB, BE, and LB soil column profiles (Tables 2.5.2-228, 229, and 230) would be used for nuclear island SSI analysis, if required. The envelope of the SSI input spectra from the UB, LB, and BE envelops the PBSRS as required by DC/COL-ISG-017. Figures 3.7-202 and 203 present the comparison of the AP1000 CSDRS with the SSI input response spectra from the UB, BE, and LB soil columns for the horizontal ground motions for the North-South (H1) and the East-West (H2) directions. The CSDRS envelops the SSI input response spectra from the three soil columns. For the vertical ground motions, Figure 3.7-204 presents the comparison of the AP1000 CSDRS with the scaled PBSRS and the SSI input response spectra from the three soil columns. The CSDRS envelops the scaled vertical PBSRS by a similarly large margin as the horizontal. However, it does not envelop the finished grade surface SSI input response spectra from the three soil columns in the high frequency range (greater than approximately 30 Hz). Thus, a LNP site specific SSI analysis was performed.

For the SSI analysis of the nuclear island (NI) the best estimate (BE), lower bound (LB), and upper bound (UB) soil profiles presented in RAI 03.07.01-01 Table 2, RAI 03.07.01-01 Table 3, and RAI 03.07.01-01 Table 4 respectively were considered. In addition, to account for the potential degradation of soil shear modulus due to foundation installation, an additional Lower LB case (LLB) was also considered in the SSI analysis. The foundation construction activities that may affect the in-situ soil properties include installation of the drilled shafts, installation of the diaphragm wall, and installation of the rock anchors for the diaphragm wall. The construction methods and construction inspections used for installation of the drilled shafts, diaphragm wall, and the diaphragm wall anchors will minimize the extent of soil disturbance and avoid cave in. The drilled shaft construction methods and construction inspections and testing will follow guidance in ACI 336.1-01 and ACI 336.3R-93. The boreholes for the diaphragm wall anchors will be backfilled as the casing is extracted after the anchors are set in rock to avoid cave in. Alternatively, the casings will be backfilled and left in place. The volume of soil being disturbed by the drilled shaft installation, and diaphragm wall anchor installation is < 5% of the total soil volume in the vicinity of the NI. Assuming the disturbed soil around the drilled shaft and diaphragm wall anchors to have a soil shear modulus equal to ½ of the shear modulus of the corresponding soil layers, the average reduction in the soil shear modulus of the soil volume in the vicinity of the NI is < 2.5%. Thus, for the LLB soil profile, in-situ soil was conservatively assigned a shear modulus equal to 90% of the LB soil case as presented in Table RAI 03.07.01-02-1. As shown in Table 03.07.01-02-1, the fill layer shear modulus was not changed from the LB shear modulus because of the large variation from the BE case already considered i.e., the coefficient of variation for the LB fill shear modulus is in the range of 4.02 to 6.13 from the BE fill shear modulus as shown in Table 03.07.01-02-1. Rock layer shear modulus for the LLB soil profile are the same as for the LB soil profile because the construction activities do not degrade the rock layer shear modulus.

Input time histories for the SSI analysis were created in two steps. First, time histories were spectrally matched to the SCOR FIRS at the base of the planned excavation. Then these time histories were input into the four (UB, BE, LB, and LLB) free field soil columns (full height to elevation 15.5 m (51 ft.) NAVD88) as outcropping motions and then output as in-column motion at the base of the excavation (elevation -7.3 m (-24 ft.) NAVD88) for use in the SSI analysis. As part of this process, the surface motion was computed for each of the four soil profile and the SCOR FIRS was enhanced at intermediate frequencies to ensure that the surface motion envelops the PBSRS. The selected seed time history was the 1992 Landers Earthquake, Villa Park Serrano Ave station, chosen from the CEUS record library provided by NUREG/CR 6728. The seed time history was selected based on the seismological properties and spectral shape of both horizontal and vertical components. The selected time history represent a distance recording of a large (M 7.3) earthquake consistent with the dominant contribution to Levy site hazard by the Charleston source. Figures RAI 03.07.02-02-1 through RAI 03.07.02-02-4 show the in-column SSI input X, Y, and Z time histories at elevation -7.3 m (-24 ft.) for the Best Estimate (BE), Upper Bound (UB), Lower Bound (LB), and the Lower Lower Bound (LLB) Soil profiles respectively.

The site specific LNP 3D SASSI models are embedded models. The structure portion of the LNP model is an exact representation of the WEC NI20r 3D SASSI model of the NI structure(s) above the design grade elevation 15.5 m (51 ft.) NAVD88. Additional nodes were added to the NI20r model for the below grade portion of the model to represent the LNP site specific conditions to the 75-foot depth. The site specific embedded portion of the model consist of a total of eight (8) below grade layers, to model the various material properties and layer thickness for the UB, BE, LB, and LLB soil profiles, the RCC bridging mat beneath the NI basemat, and the engineered fill and the controlled low strength material (CLSM) on the side. The average model frequency ranges from 45 Hz for UB model to 25 Hz for the LLB model.

The Subtraction computational method in SASSI was used for the SSI response analysis. The cut-off frequency used for the response analysis was 33 Hz. Floor response spectra (FRS) were generated for the six key AP1000 locations. These locations include: CIS at Reactor Vessel Support Elevation, ASB NE Corner at Control Room Floor, CIS at Operating Deck, ASB Corner of Fuel Building Roof at Shield Building, SCV near Polar Crane, and ASB Shield Building Roof Area. The LNP site specific broadened 5% damped FRS computed at these six locations for the X, Y and Z directions are enveloped by the AP1000 FRS envelop spectra at all of the six NI key nodes as shown in Figures RAI 03.07.02-02-5 through RAI 03.07.02-02-10. In addition the maximum computed LNP site specific bearing pressure (SSE plus dead load) is less than the AP1000 maximum bearing pressure of 35 ksf.

Utilizing the NI20r embedded model and the BE soil profile and properties, a LNP 5-layer embedded benchmark model was created to justify the use of the SASSI Subtraction computational methods for LNP SSI analysis. Additional nodes were added to the NI20r model for the below grade portion of the LNP benchmark model to represent the LNP site specific subsurface conditions to the 75-foot depth. Using the LNP 5-layer benchmark model SSI analyses were performed using the Subtraction methods and the Direct method in SASSI. The results of the benchmark SSI analysis show that the Subtraction and the Direct methods yield generally comparable responses, particularly below 15 Hz. Minor variations were observed in the FRS between the two methods across the frequency spectrum with the Subtraction method generally conservative above 15 Hz. Thus LNP SSI analysis using the Subtraction method is justified.

The Turbine Building (TB), Annex Building (AB), and Radwaste Building (RB) drilled shafts and the diaphragm wall were not modeled in the LNP 3D SSI model. The absence of any adverse Category II/I interaction between the NI and the TB, AB, and RB for LNP is documented in Subsection 3.7.2.8."

c. Delete Subsection 3.7.1.1.2 because the information in the subsection is included in the revised Subsection 3.7.1.1.1 above.

d. Delete text added to Subsection 3.7.1.1.1 in response to NRC Letter 087 RAI 03.07.01-01 because the information in the added text is included in the revised Subsection 3.7.1.1.1 above.

Attachments/Enclosures:

Attachment 03.07.02-02 A: New Table RAI 03.07.02-02-1

Attachment 03.07.02-02 B: New Figures RAI 03.07.02-02-1 through RAI 03.07.02-02-10

Attachment 03.07.02-02 A

New Table RAI 03.07.02-02-1

[1 page attached]

LNP COL 2.5-3 Table RAI 03.07.02-02-1: Lower Lower Bound Properties for SSI Analyses of the LNP Site

Layer	Thickness (ft.)	Total Depth (ft.)	Unit Weight (pcf)	Shear Wave Velocity (ft/sec)	Damping Ratio (%)	Compression Wave Velocity (ft/sec)	Elevation of Layer Base (ft.)
1	2.5	2.5	110	373	2.6	935	48.5
2	2.5	5	110	342	4.4	935	46
3	2.5	7.5	110	315	5.8	935	43.5
4	3.5	11	110	300	6.8	935	40
5	2	13	110	301	7.3	5000	38
6	2	15	110	294	7.9	5000	36
7	3.5	18.5	120	1066	5.4	5000	32.5
8	2.5	21	120	1058	5.5	5000	30
9	1	22	120	1058	5.5	5000	29
10	3.5	25.5	120	1019	5.3	5000	25.5
11	3.5	29	120	1015	5.5	5000	22
12	6.7	35.7	120	1054	5.6	5000	15.3
13	4.3	40	120	1043	5.9	5000	11
14	2.4	42.4	120	1043	4.8	5000	8.6
15	8.3	50.7	130	1756	4.9	5848	0.3
16	8.3	59	130	1755	5.0	5848	-8
17	7.2	66.2	130	1746	5.1	5848	-15.2
18	7.2	73.4	130	1744	2.4	5848	-22.4
19	1.6	75	138	2147	2.4	6661	-24
20	24.2	99.2	138	2264	2.4	7022	-48.2
21	46.8	146	138	2199	2.4	6532	-95
22	61.5	207.5	138	2755	2.4	7634	-156.5
23	17.9	225.4	138	2707	2.4	6654	-174.4
24	23.9	249.3	120	2145	4.7	5920	-198.3
25	24.6	273.9	120	2148	4.7	5920	-222.9
26	40	313.9	120	2890	1.9	6450	-262.9
27	42.1	356	120	2742	1.9	6450	-305
28	38.3	394.3	140	3384	1.3	7267	-343.3
29	59.8	454.1	140	2750	1.3	6614	-403.1
30	61.1	515.2	140	3038	1.3	7348	-464.2
31	242.7	757.9	140	3708	1.3	8981	-706.9
32	354.8	1112.7	140	4845	1.3	11758	-1061.7
33	246.6	1359.3	150	5956	1.0	14574	-1308.3
34	255.7	1615	150	4165	1.0	10084	-1564
35	150.7	1765.7	150	5943	1.0	14207	-1714.7
36	100.8	1866.5	150	5111	1.0	12166	-1815.5
37	199.6	2066.1	150	5853	1.0	14289	-2015.1
38	600.3	2666.4	150	4432	1.2	10614	-2615.4
39	149.6	2816	150	4863	1.2	11594	-2765
40	199.2	3015.2	150	5062	1.2	12207	-2964.2
41	650.5	3665.7	150	4220	1.2	10288	-3614.7
42	597	4262.7	150	4535	1.2	10982	-4211.7
43	104.1	4366.8	150	3919	1.2	9390	-4315.8
44	Halfspace		169	7672	0.1	13146	

Notes:

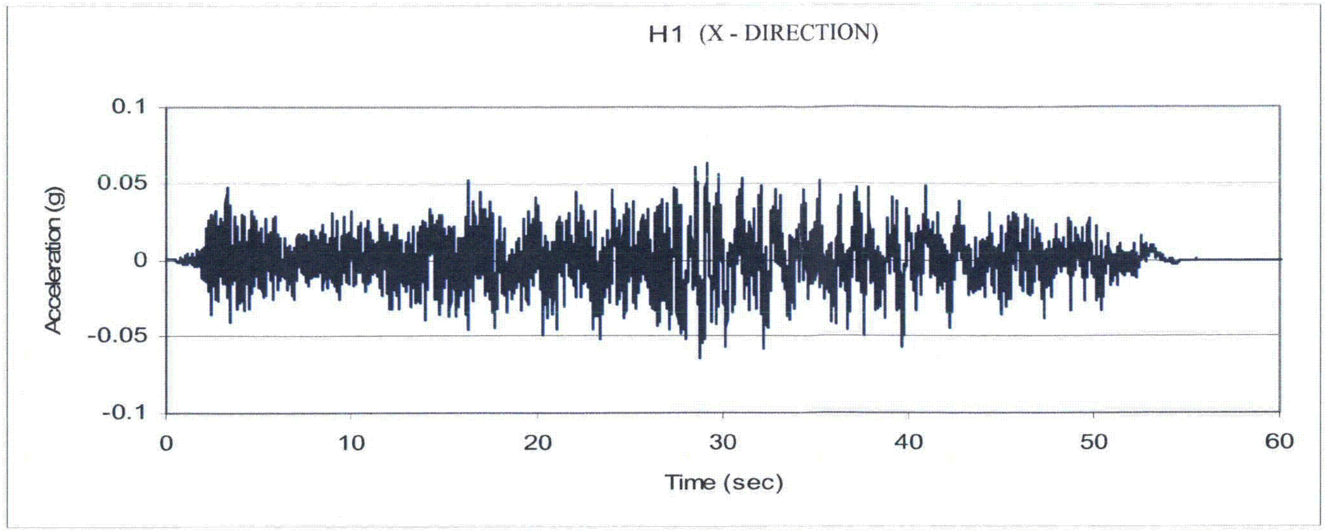
% = percent; ft. = feet; ft/sec = feet per second; pcf = pound per cubic foot; SSI = soil structure interaction

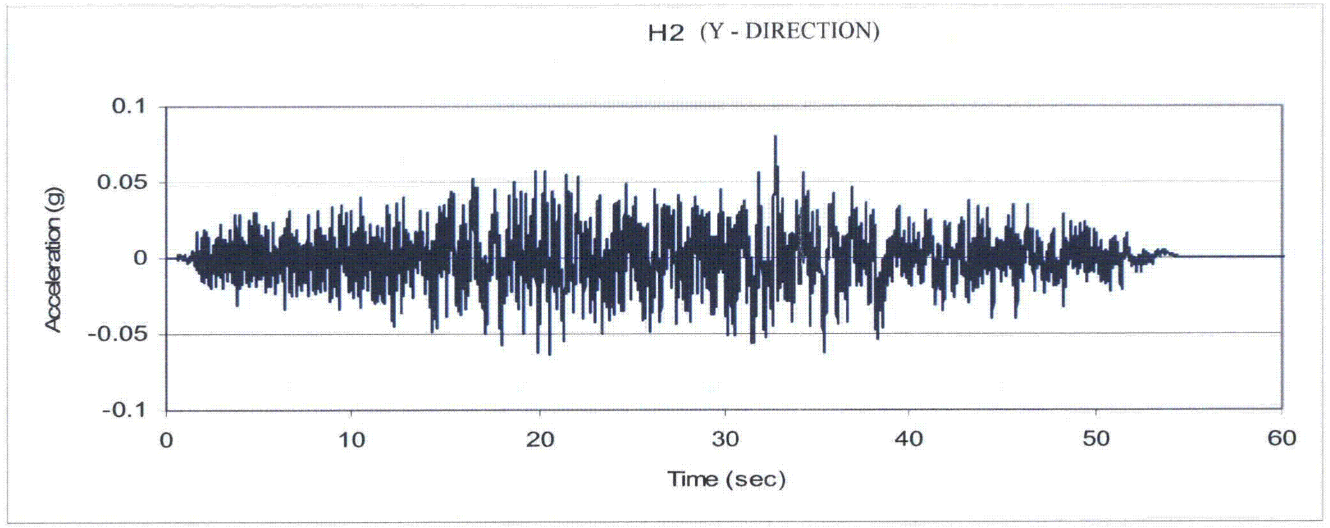
Attachment 03.07.02-02 B

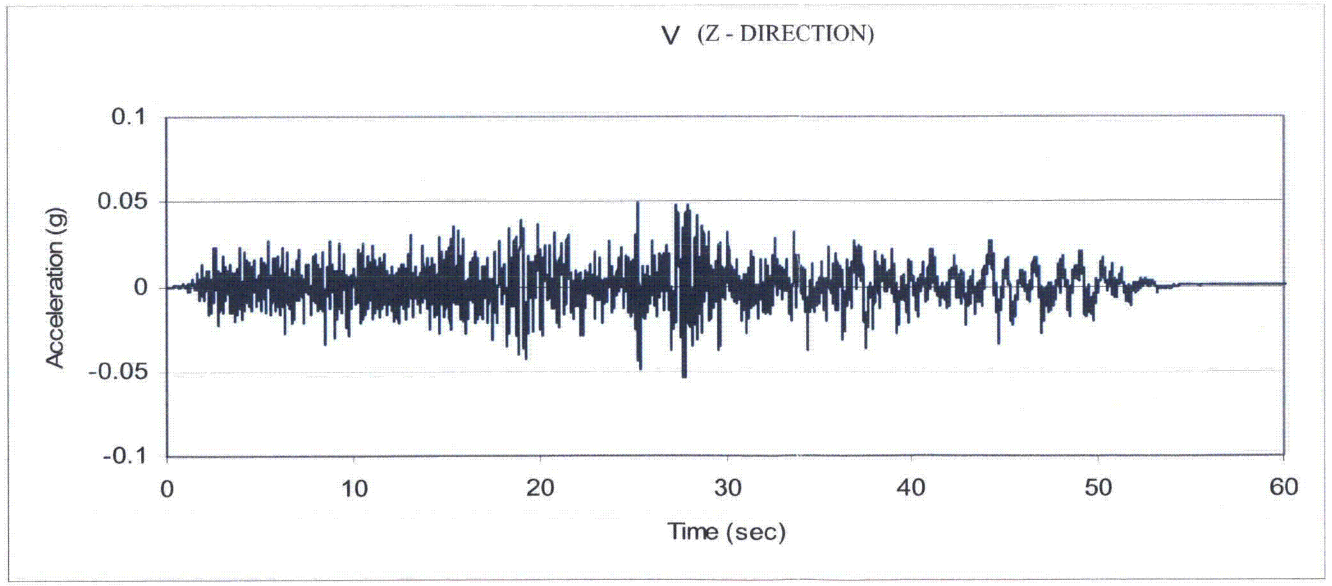
New Figures RAI 03.07.02-02-1

through RAI 03.07.02-02-10

[10 pages attached]







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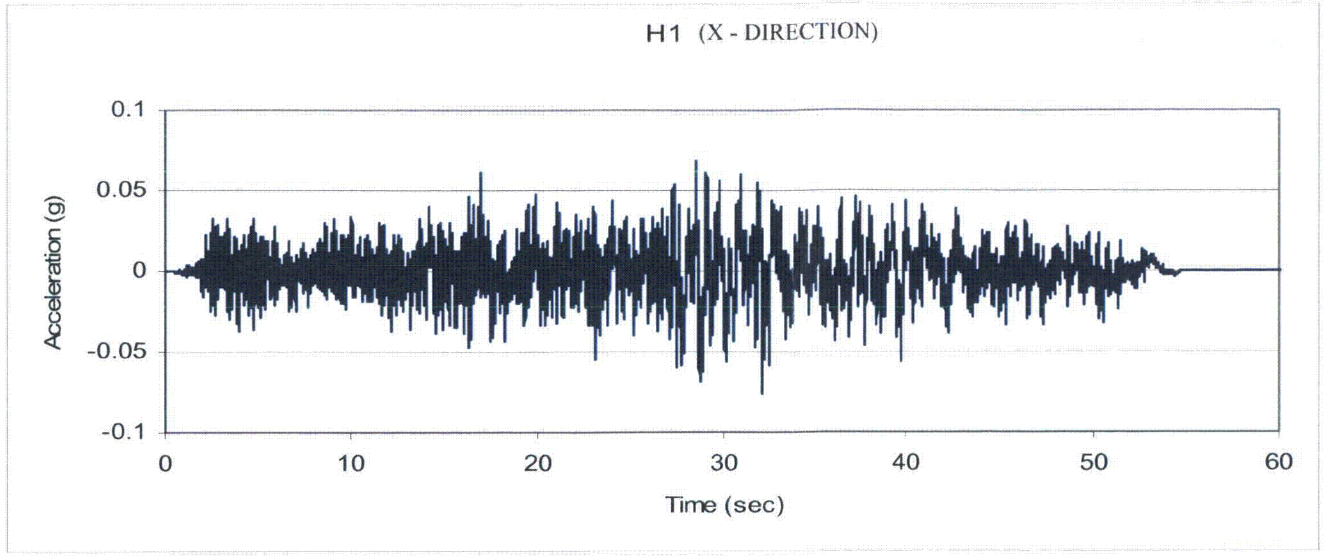
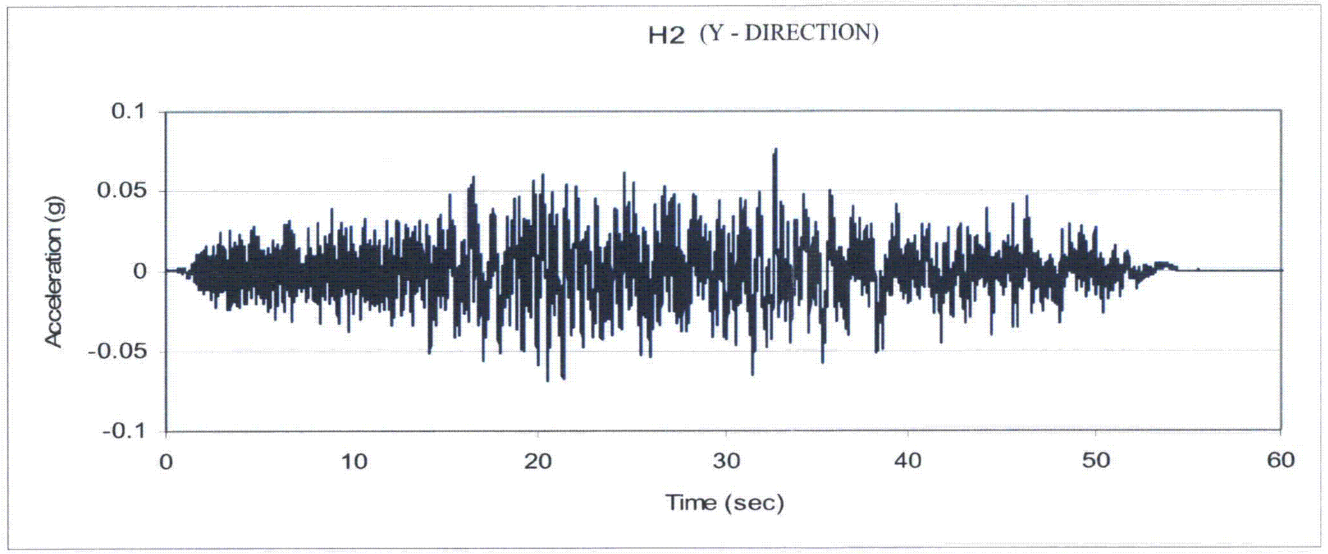
Levy Nuclear Plant
Units 1 and 2
Part 2, Final Safety Analysis Report

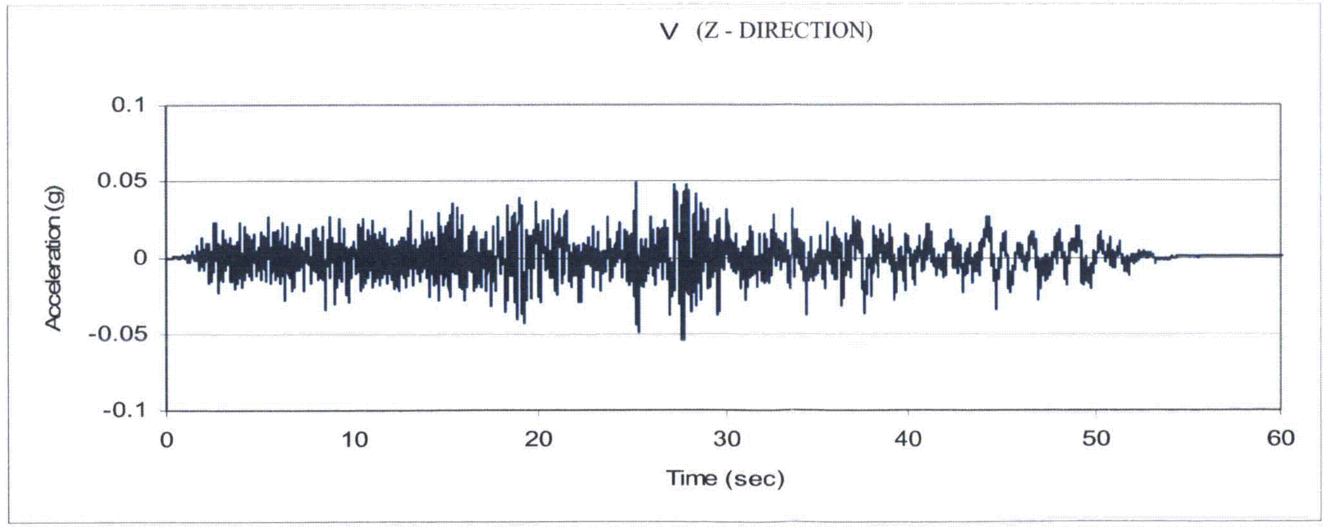
LNP BE Soil Profile Seismic Input
Time History - El. -24 ft.

FIGURE RAI 03.07.02-02-1

Rev. 0







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LNP UB Soil Profile Seismic Input
Time History - El. -24 ft.

FIGURE RAI 03.07.02-02-2

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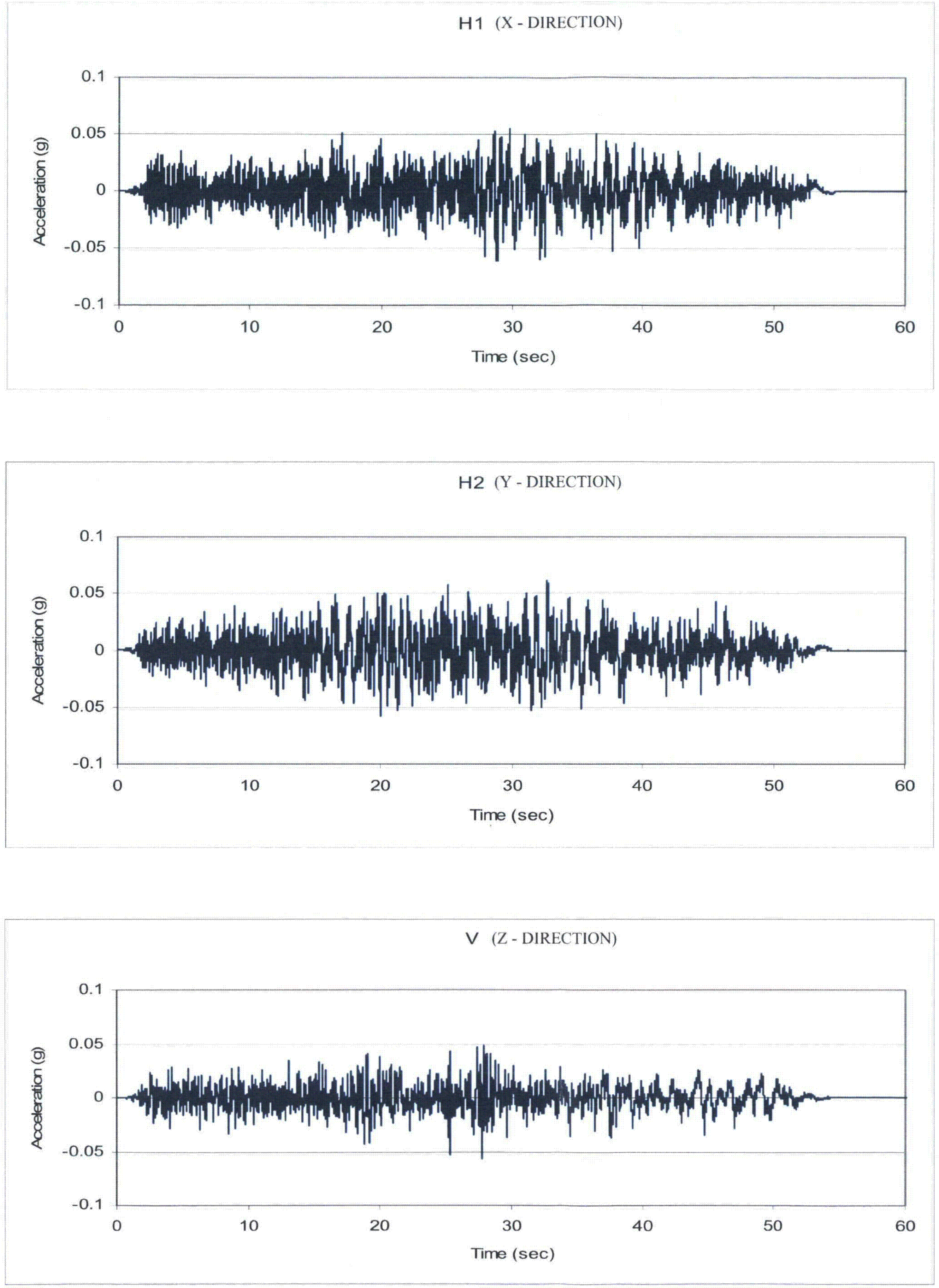

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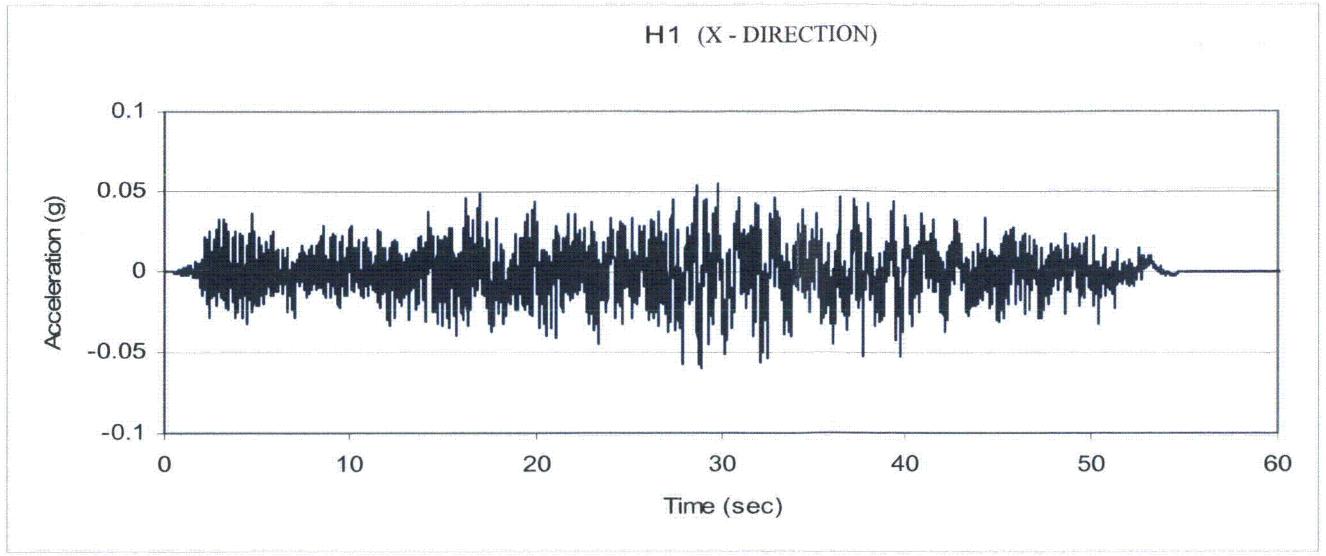
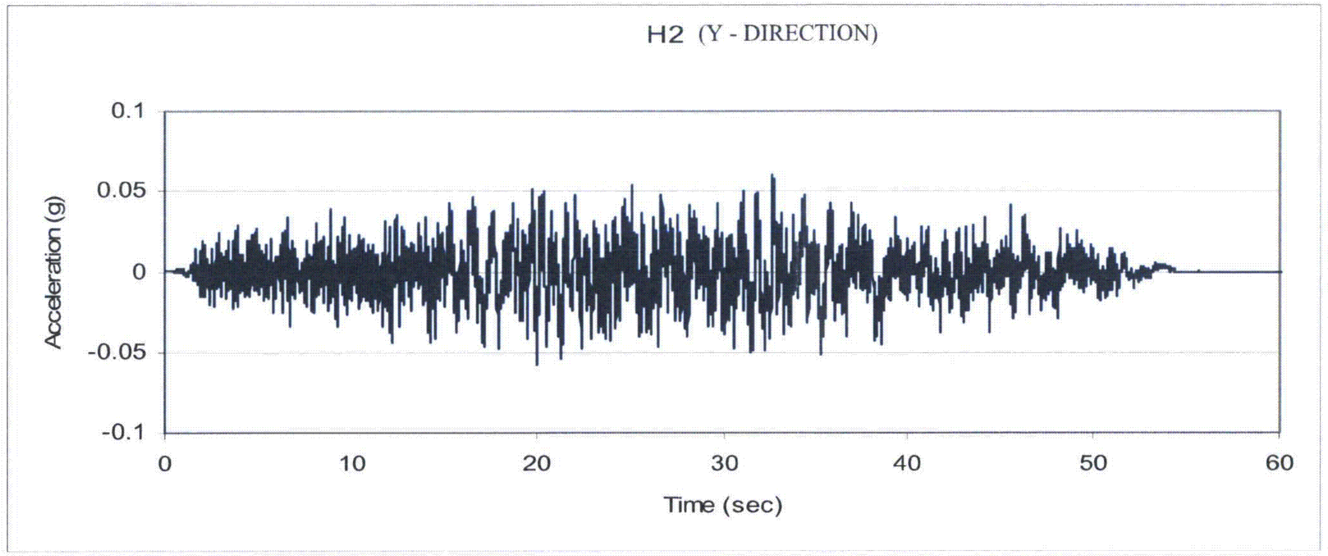
Levy Nuclear Plant
Units 1 and 2
Part 2, Final Safety Analysis Report

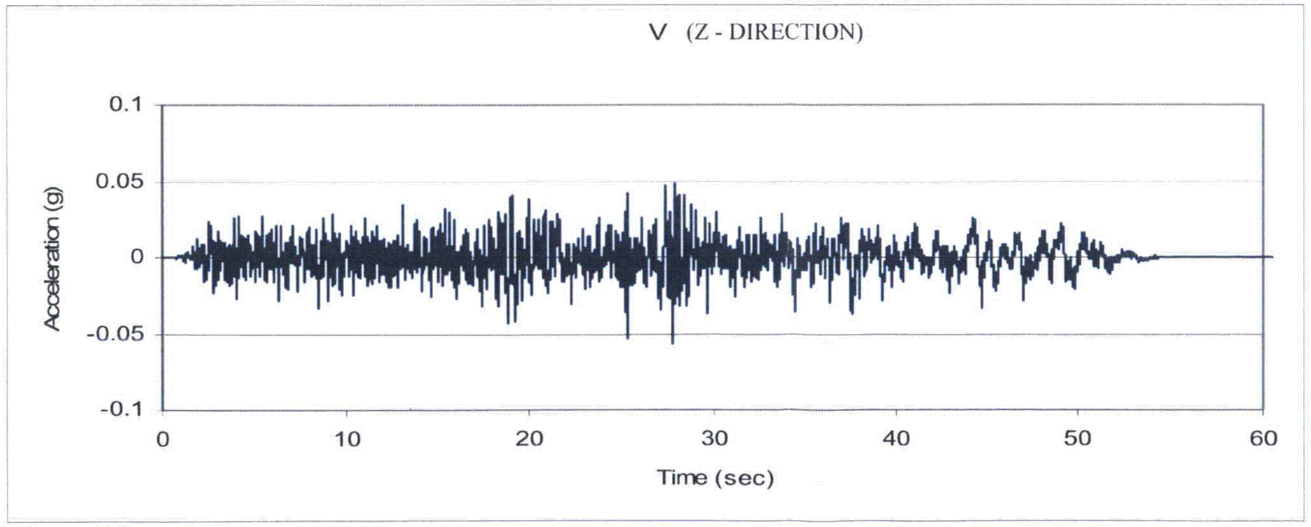
LNP LB Soil Profile Seismic Input
Time History - El. -24 ft.

FIGURE RAI 03.07.02-02-3

Rev. 0







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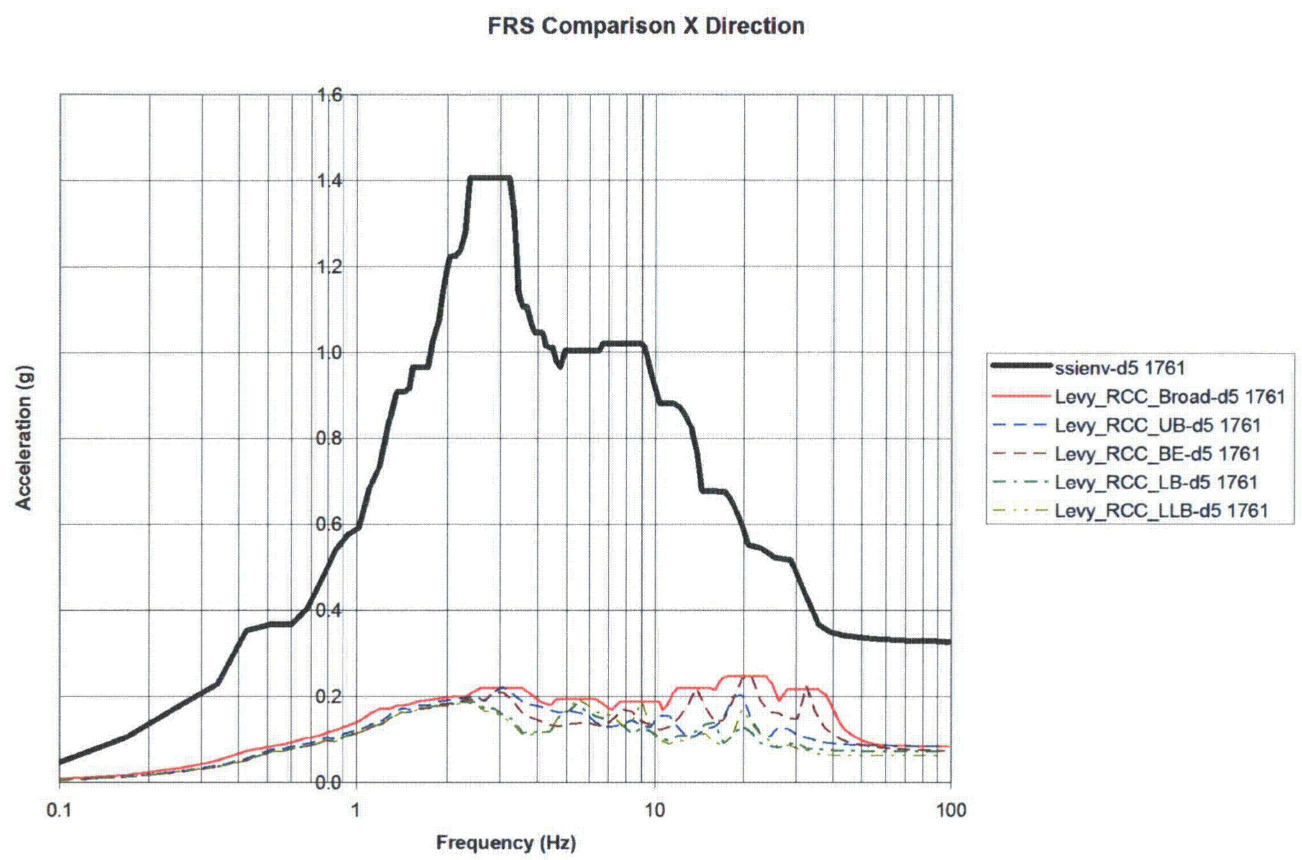
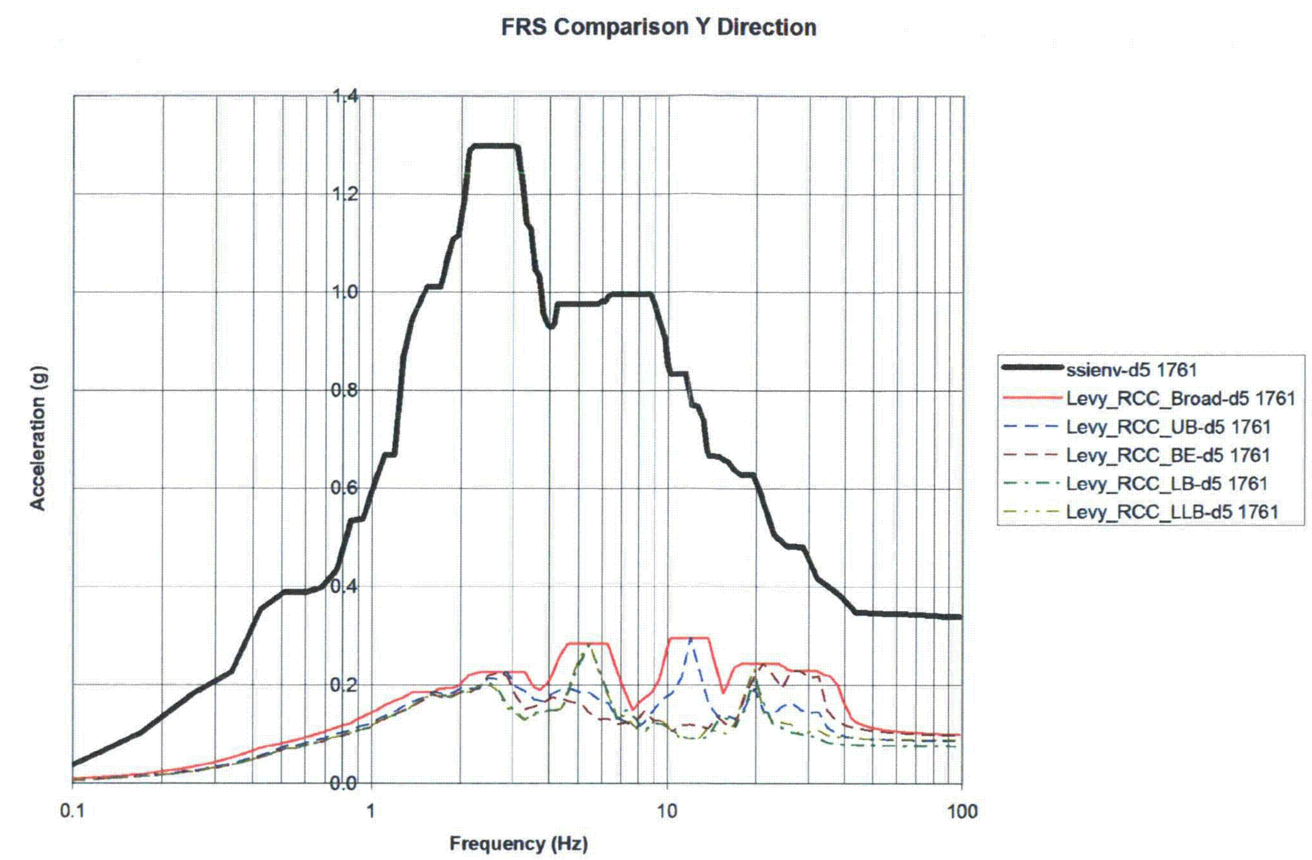
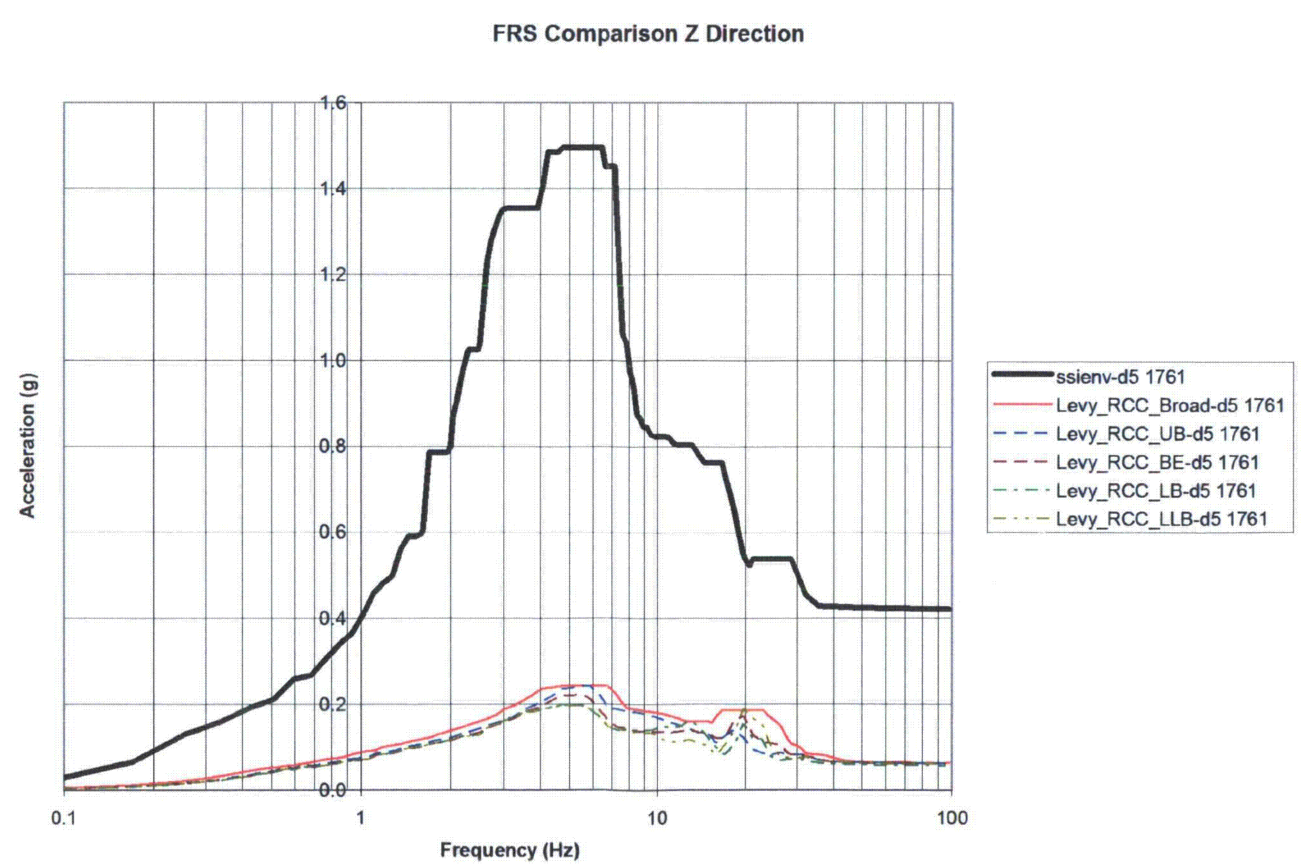
LNP LLB Soil Profile Seismic Input
Time History - El. -24 ft.

FIGURE RAI 03.07.02-02-4

Rev. 0







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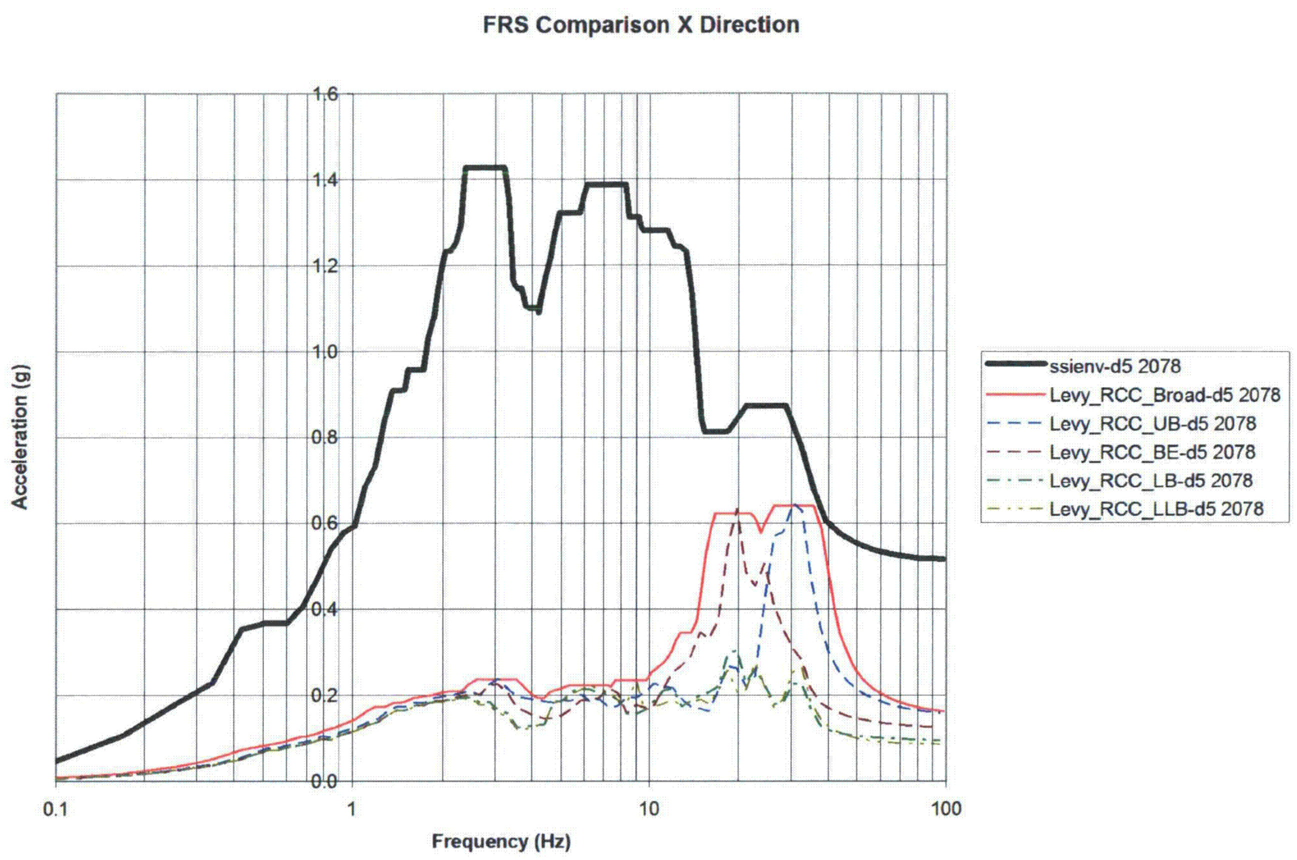
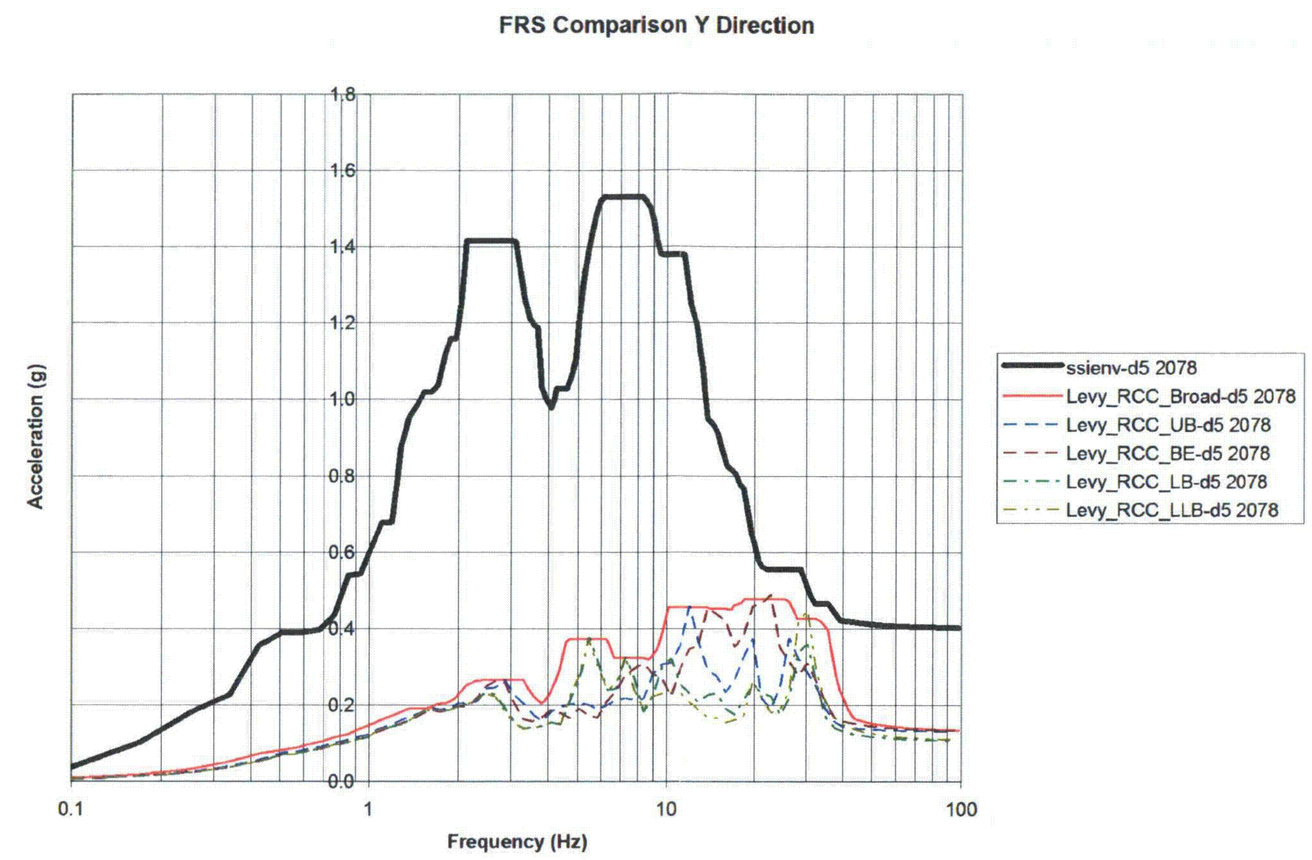
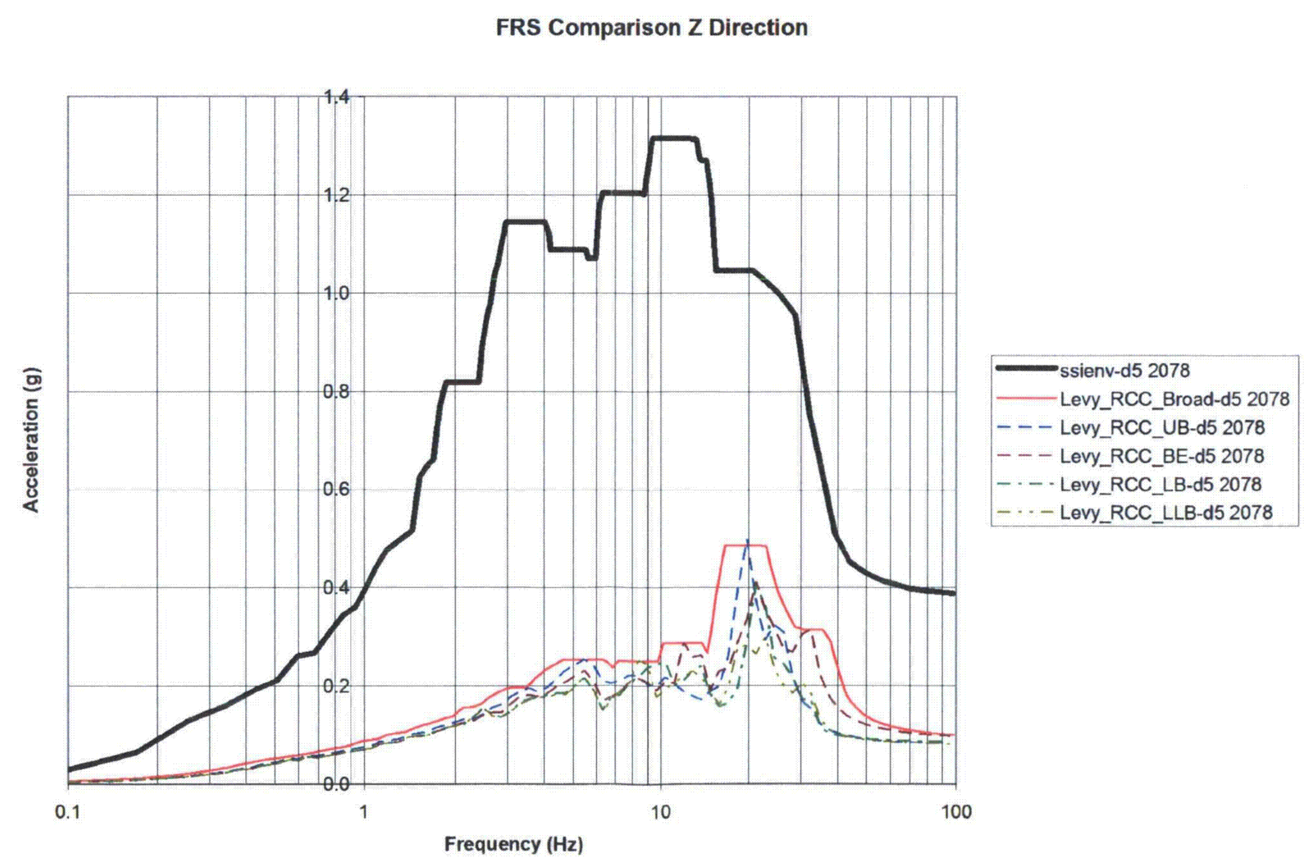
Comparison of LNP BE, UB, LB and LLB SSI FRS and AP1000 FRS Envelop - Node 1761

FIGURE RAI 03.07.02-02-5

Rev. 0







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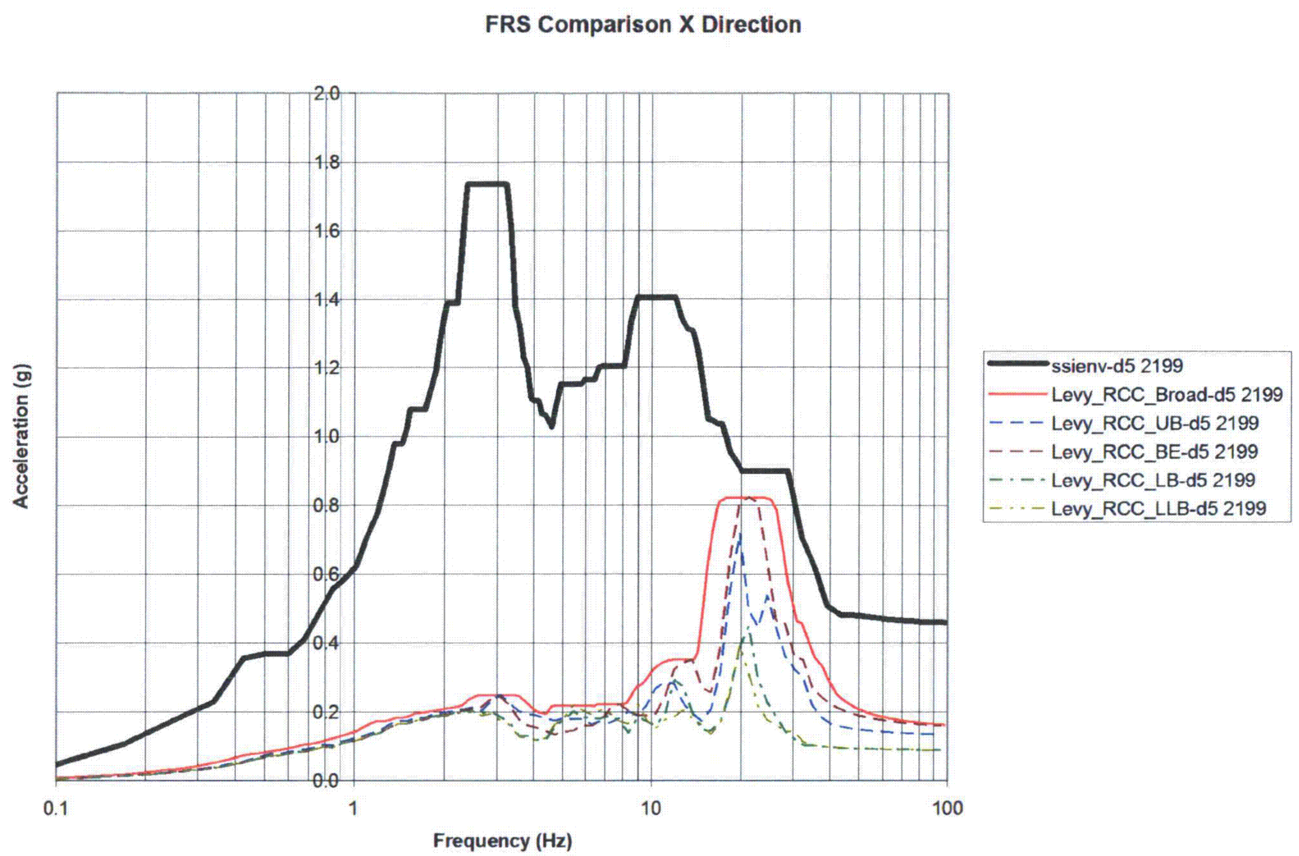
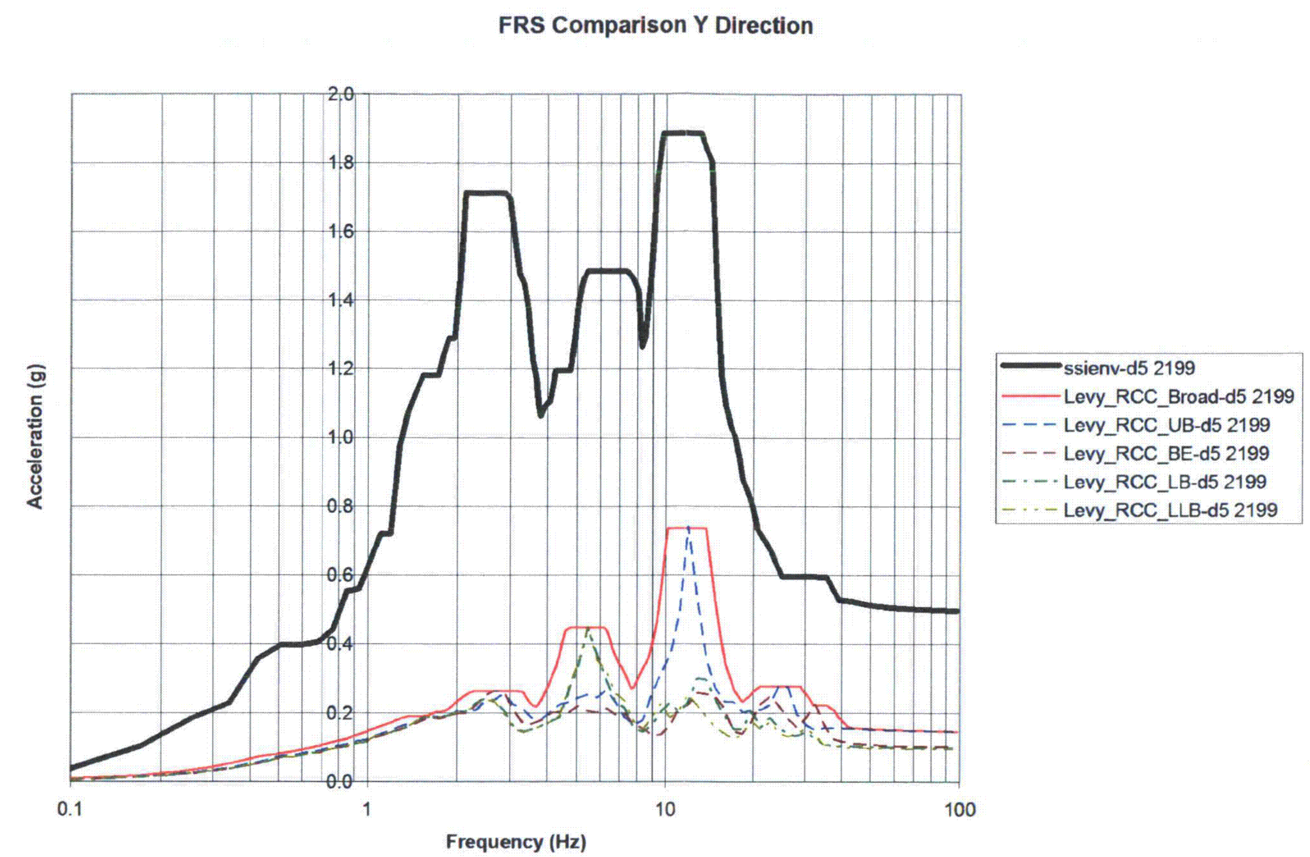
Levy Nuclear Plant
Units 1 and 2
Part 2, Final Safety Analysis Report

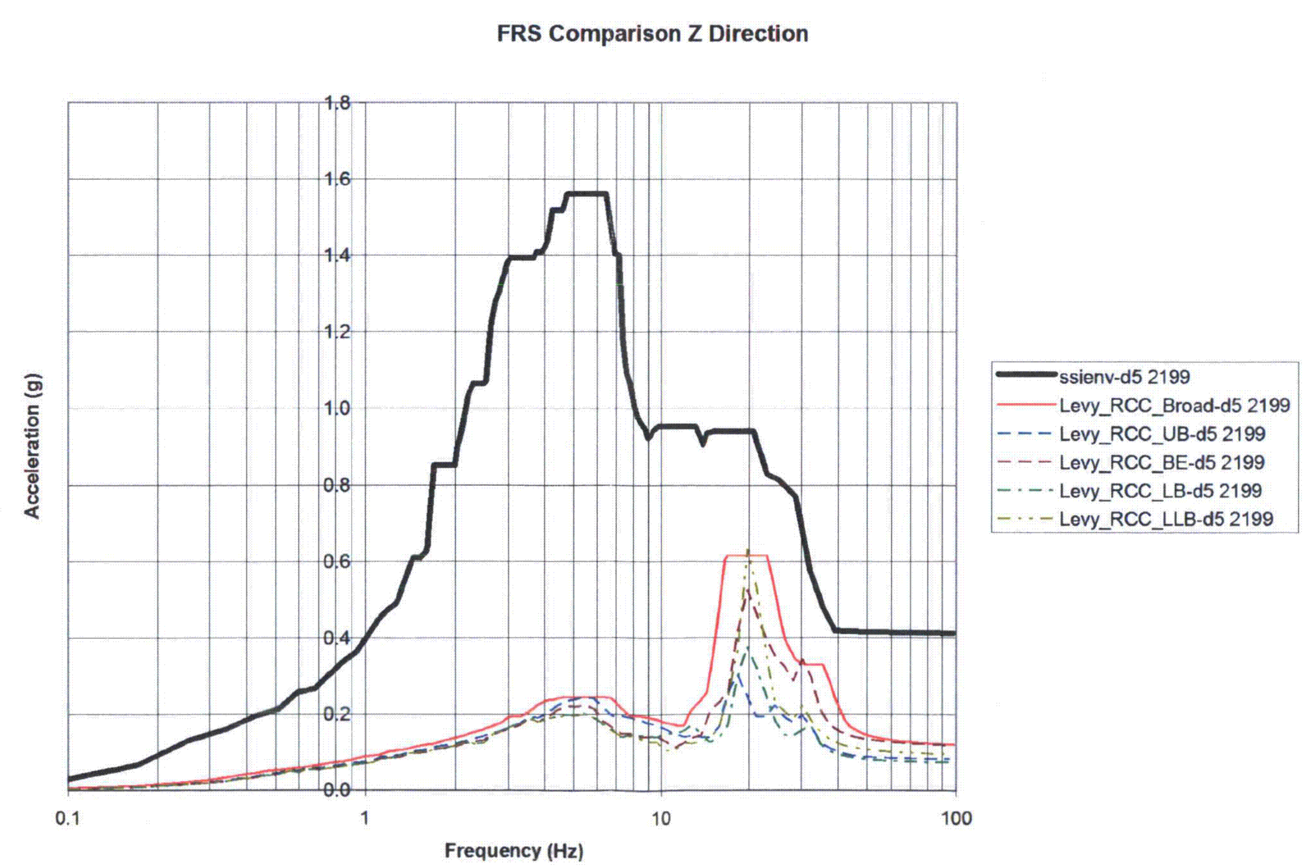
Comparison of LNP BE, UB, LB and LLB SSI FRS and AP1000 FRS Envelop - Node 2078

FIGURE RAI 03.07.02-02-6

Rev. 0







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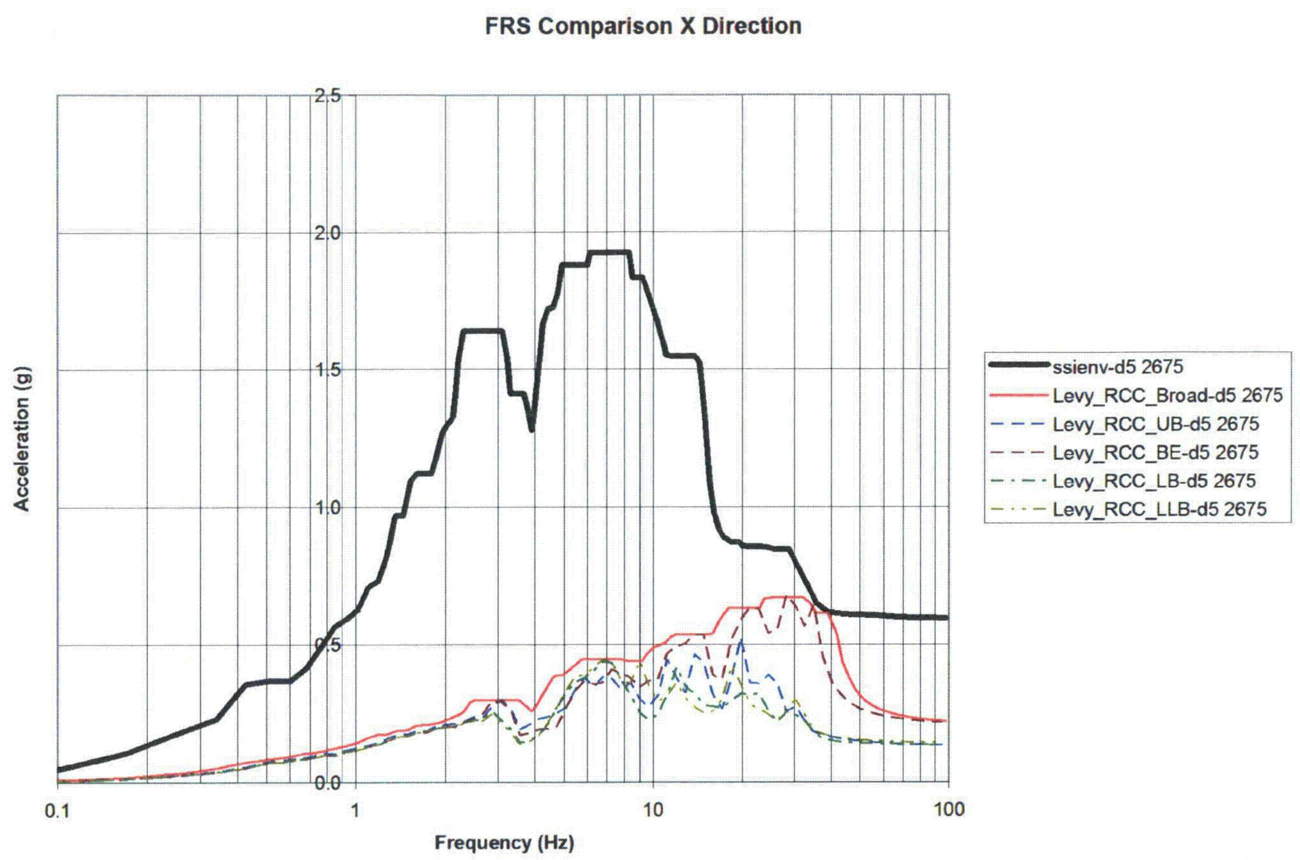
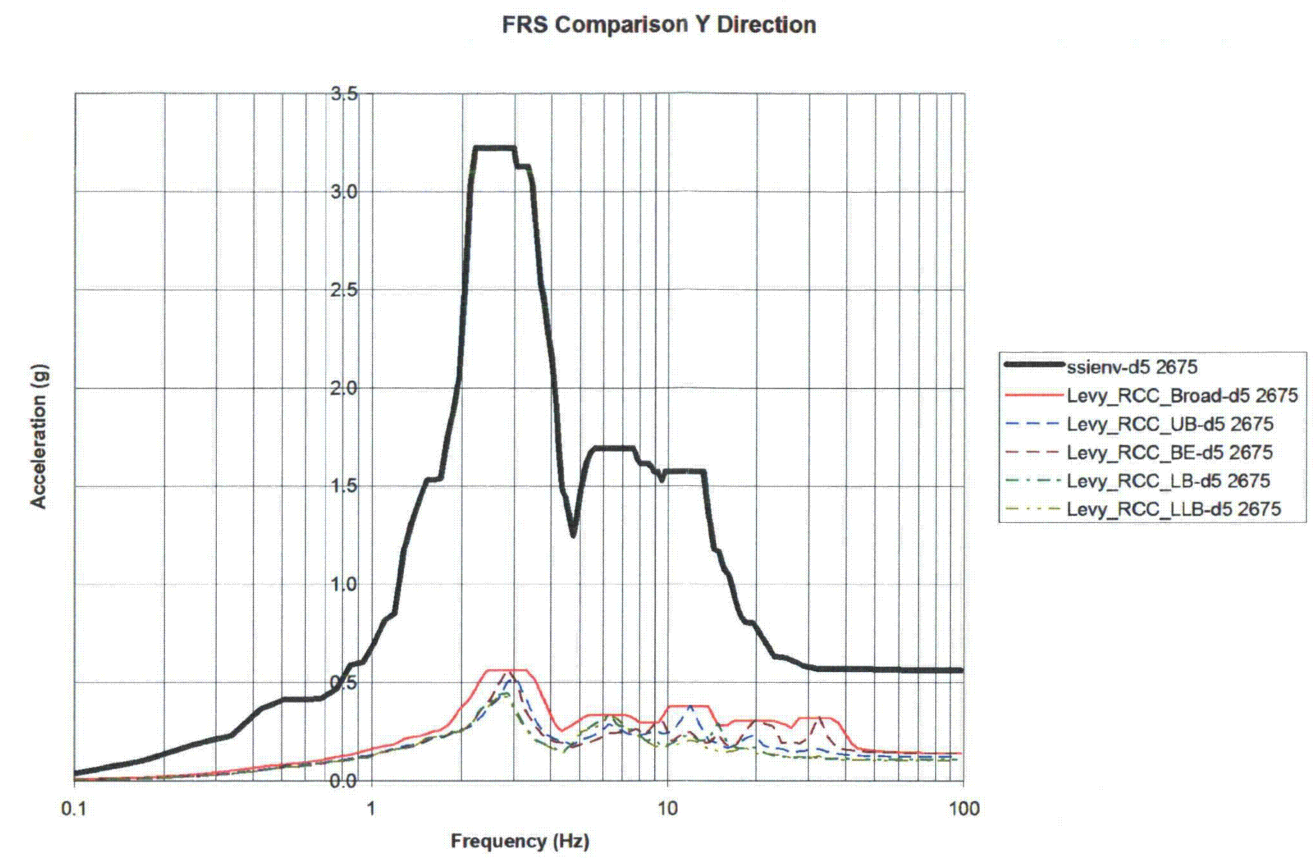
Levy Nuclear Plant
Units 1 and 2
Part 2, Final Safety Analysis Report

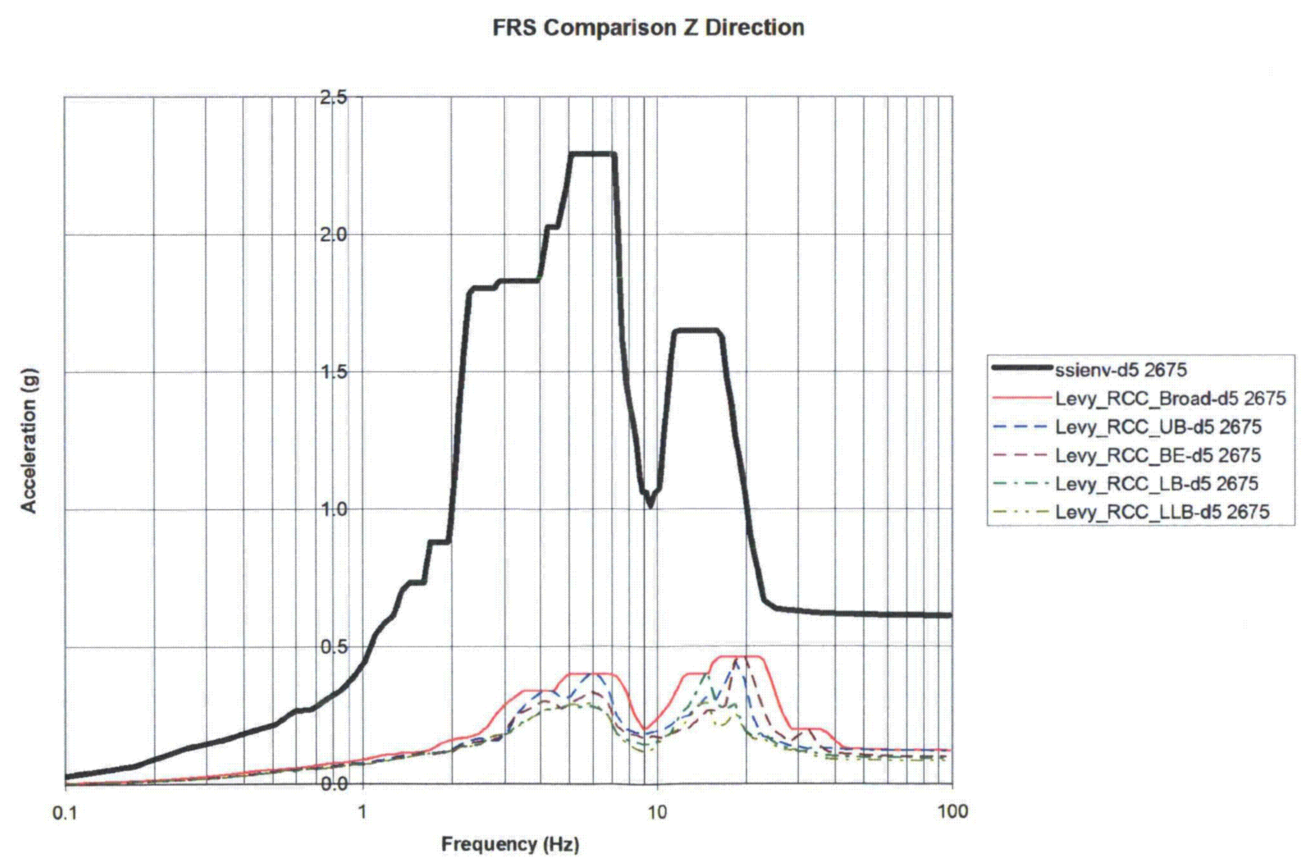
Comparison of LNP BE, UB, LB and LLB SSI FRS and AP1000 FRS Envelop - Node 2199

FIGURE RAI 03.07.02-02-7

Rev. 0







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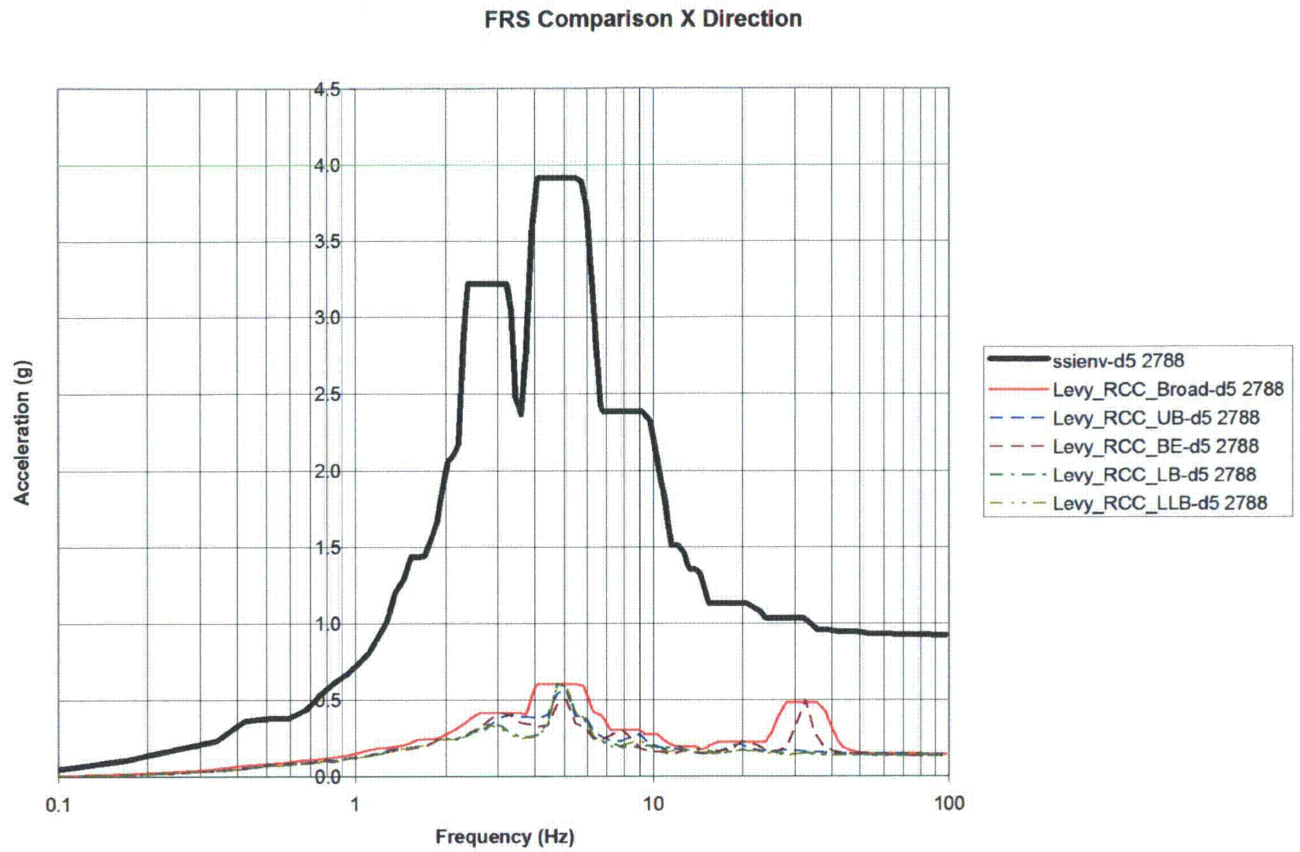
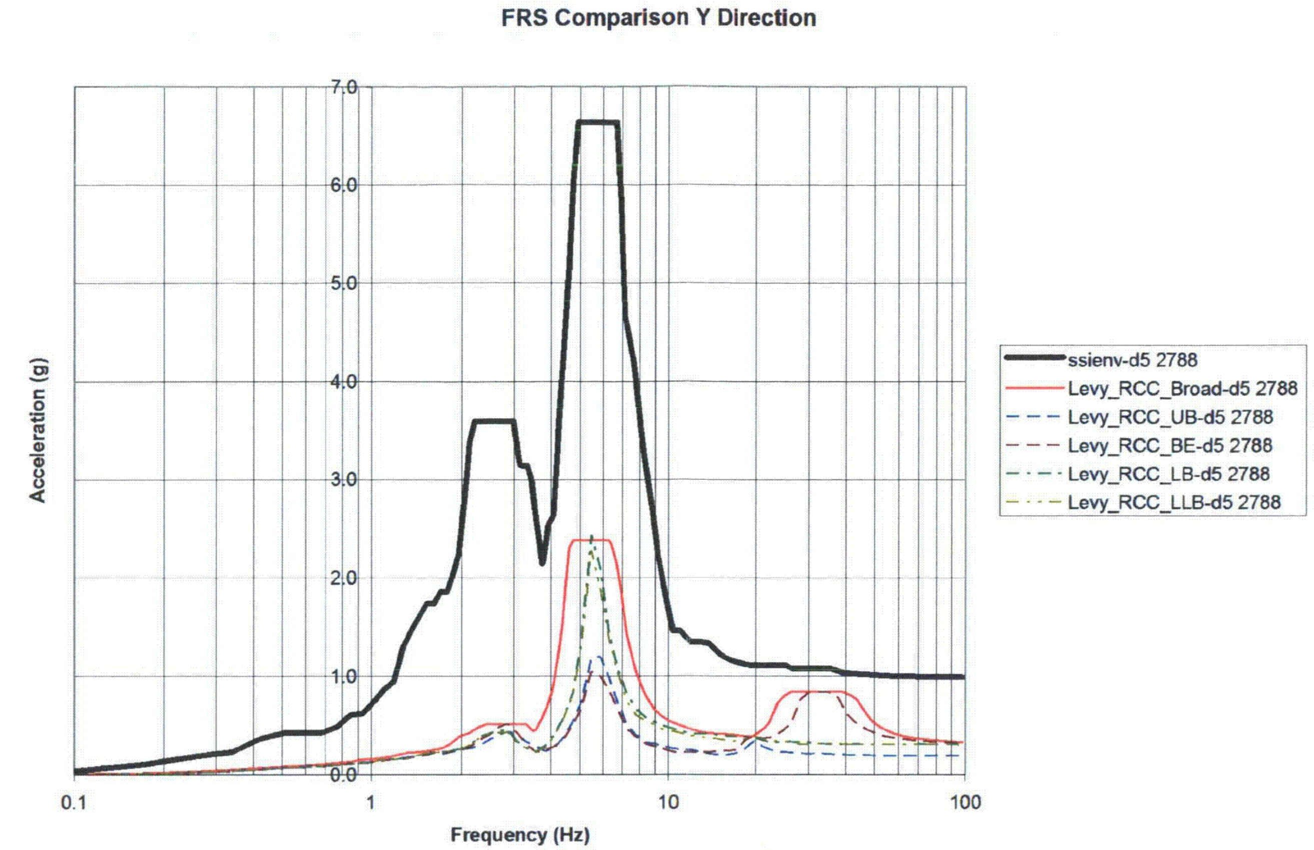
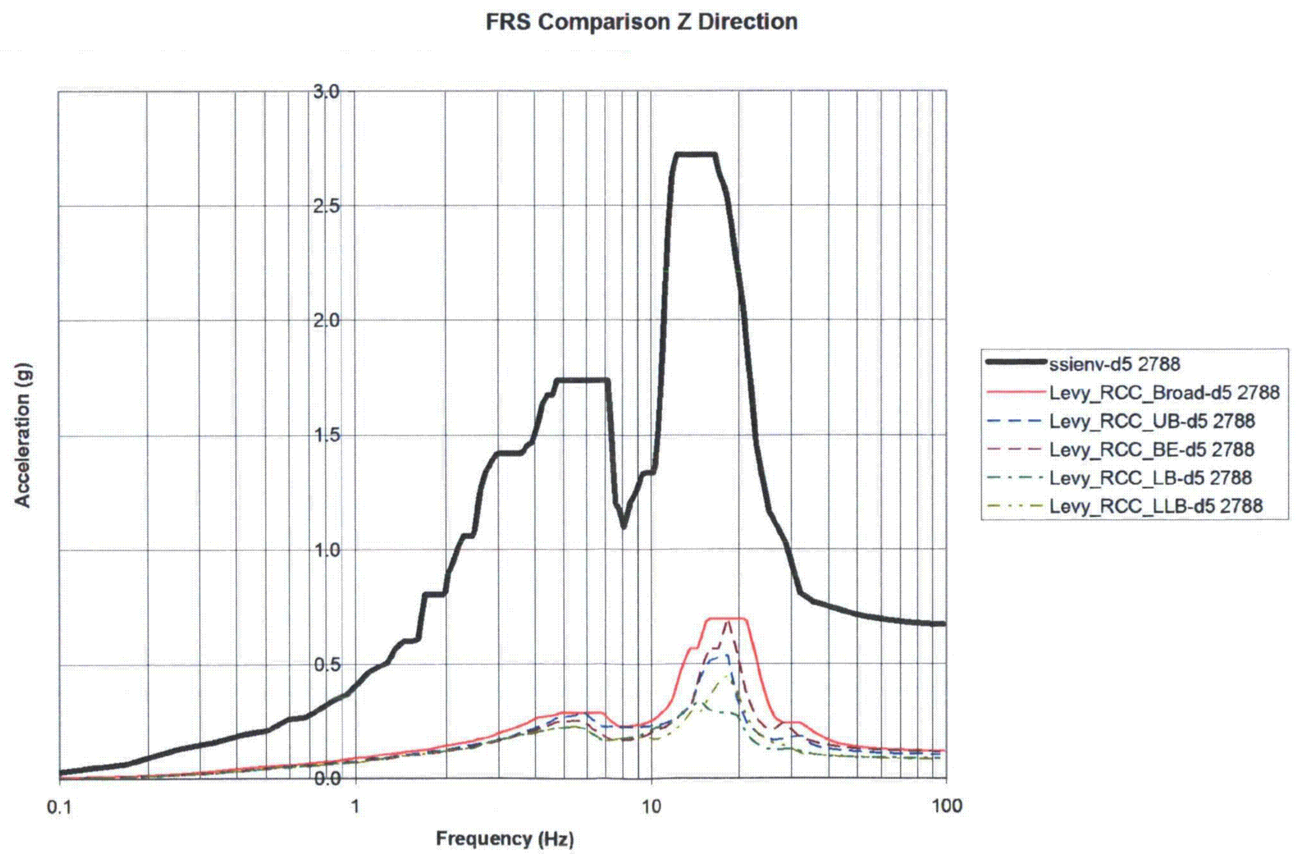
Comparison of LNP BE, UB, LB and LLB SSI FRS and AP1000 FRS Envelop - Node 2675

FIGURE RAI 03.07.02-02-8

Rev. 0







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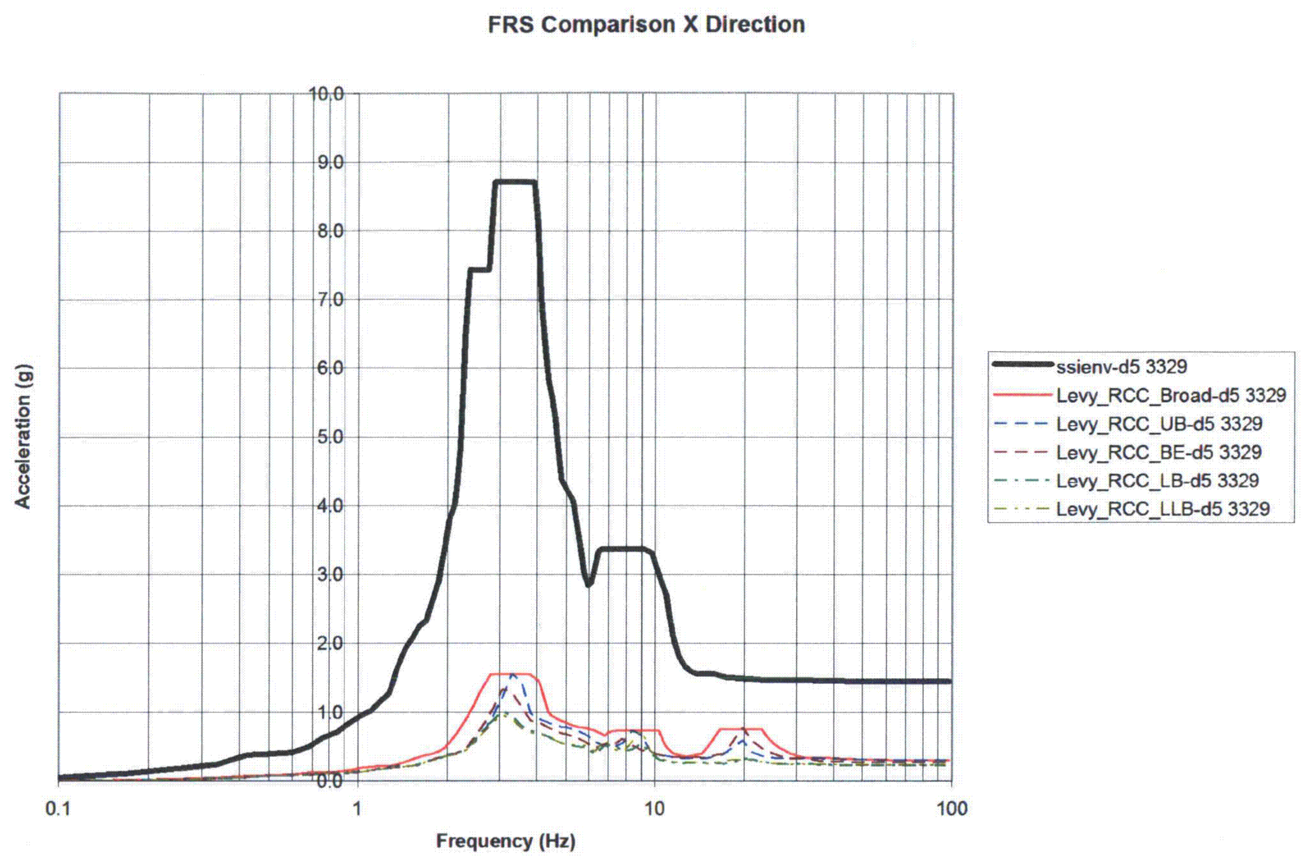
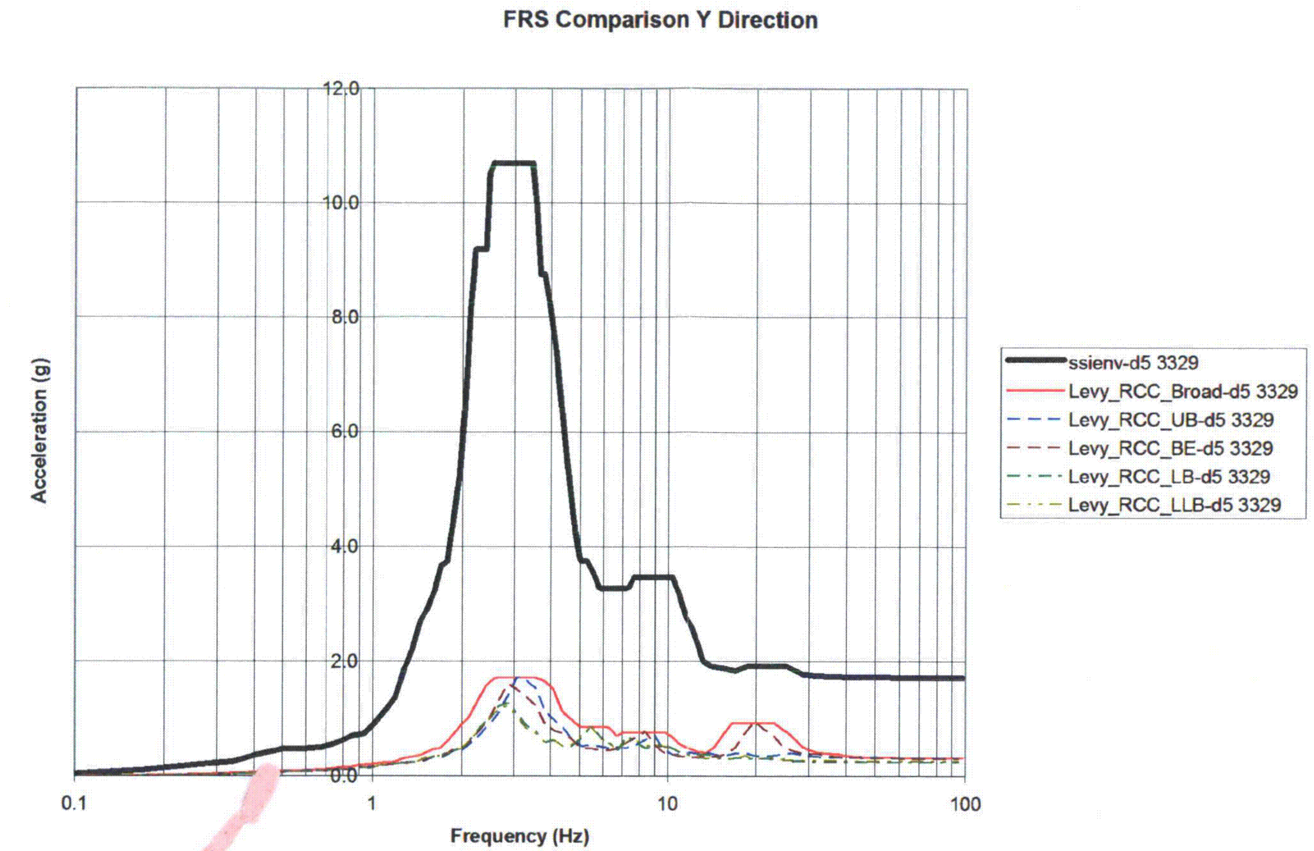
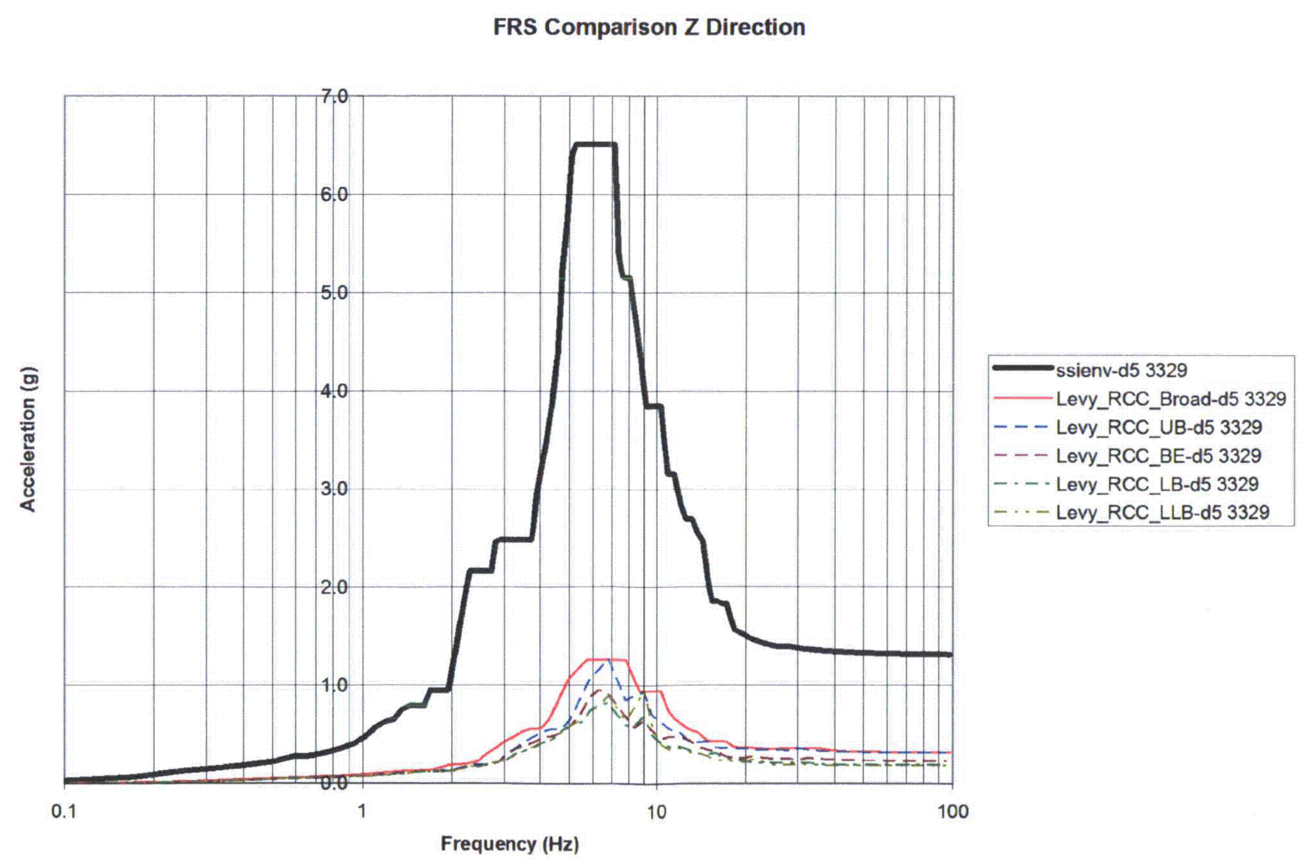
Comparison of LNP BE, UB, LB and LLB SSI FRS and AP1000 FRS Envelop - Node 2788

FIGURE RAI 03.07.02-02-9

Rev. 0







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Units 1 and 2
Part 2, Final Safety Analysis Report

Comparison of LNP BE, UB, LB and LLB SSI FRS and AP1000 FRS Envelop - Node 3329

FIGURE RAI 03.07.02-02-10

Rev. 0