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Your ref: Docket No. 52-006
Our ref: DCP/NRC2260

September 12, 2008

Subject: AP1000 Response to Request for Additional Information (SRP3.7.1)

Westinghouse is submitting a revised response to the NRC request for additional information (RAI) on SRP Section 3.7.1. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in the response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

A revised response is provided for RAI-SRP3.7.1-SEB1-02,-04,-06, and 08 through -11. This response completes all requests received to date for SRP Section 3.7.1. A response to RAI-SRP3.7.1-SEB1-02 through -14 was submitted under letter DCP/NRC2125 dated April 25, 2008. A response to RAI-SRP3.7.1-SEB1-01 was submitted under letter DCP/NRC2096 dated March 4, 2008.

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

Robert Sisk, Manager
Licensing and Customer Interface
Regulatory Affairs and Standardization

/Enclosure

1. Response to Request for Additional Information on SRP Section 3.7.1

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NRO

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	C. Pierce	-	Southern Company	1E
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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 3.7.1

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.7.1-SEB1-02
Revision: 1

Question:

Quoting the first paragraph of the TR-115 Introduction:

> "The purpose of this report is two fold: (1) to confirm that high frequency seismic input is not damaging to equipment and structures qualified by analysis for the AP 1000 Certified Seismic Design Response Spectra (CSDRS); and (2) to demonstrate that normal design practices result in an AP 1000 design that is safer and more conservative than that which would result if designed for the high frequency input."

The purpose of the report is incorrectly stated, and may lead a reader to an incorrect conclusion. (1) and (2) above apply at best to the HRHFRS that Westinghouse has defined in this report (as further revised in TR-144), which supposedly envelope the 3 currently proposed CEUS hard rock sites. As stated above, a reader may reach the conclusion that Westinghouse's two-fold purpose applies generically to "high frequency seismic input". The staff requests that Westinghouse accurately state the purpose of TR-115.

Quoting the last paragraph of the Introduction:

> "This report describes the methodology and criteria used in the evaluation to confirm that high frequency input is not damaging to equipment and structures qualified by analysis for the AP1000 CSDRS. This report also demonstrates that the AP1000 envelopes any requirements that HF would impose. Thus, HF does not need to be considered explicitly in the design. It provides supplemental criteria for selection and testing of equipment whose function might be sensitive to high frequency. This report provides a summary of the analysis and applicable test results."

This paragraph is also misleading, and may lead a reader to an incorrect conclusion. The staff requests that Westinghouse accurately state what has been specifically demonstrated in TR-115.

On August 21, 2008 the NRC has requested the following additional information be provided.

The staff requested Westinghouse to revise the TR-115 introduction and conclusion, to more accurately describe the scope of applicability of the TR-115 results. In its response, Westinghouse proposed revised wording that is generally acceptable to the staff. However, the staff noted that Westinghouse has not defined the site parameter requirements (i.e., minimum shear wave velocity of underlying medium) that must be satisfied in order to reference the results in TR-115. The staff notes that the definition of a hard rock site in the DCD is a minimum shear wave velocity equal to 8000 fps.

Therefore, the staff requests that Westinghouse specifically identify in TR-115 the site parameter requirements (i.e., minimum shear wave velocity of underlying medium) that must be satisfied in order to reference the results in TR-115, and provide the technical basis for this determination. The staff also requests Westinghouse to identify the 3 COL applicants that are currently covered by TR-115, and the minimum shear wave velocity of the underlying medium at each site.

Westinghouse Response:

Westinghouse does not believe that the purpose as defined in the first paragraph of TR-115 could be misleading applying to all high frequency input. Westinghouse will however clarify TR-115 to provide more clarity regarding its purpose. The conclusions reached in TR-115 apply only to those sites whose site GMRS are enveloped by the HRHF seismic response that was used for the evaluation as clarified in TR-144. In TR-144 under Section III, DCD Mark-UP, Tier 1, Table 5.0-1 Site Parameters, Seismic SSE it is stated: "The HRHF GMRS provide an alternate set of spectra for evaluation of site specific GMRS. A site is acceptable if its site specific GMRS fall within the AP1000 HRHF GMRS." Therefore, a site cannot be considered acceptable if it does not fall within Figures 5.0-3 and 5.0-4 as given in TR-144.

The last paragraph of the introduction is also not misleading. The high frequency input that is referred to is the one that is used in the evaluation. This high frequency input seismic response spectra envelopes the AP1000 HRHF GMRS given in TR-144 shown in Figures 5.0-3 and 5.0-4.

The only requirement that the COL applicants must demonstrate so that they are currently covered by TR-115 is to demonstrate that their site ground motion response spectra is enveloped by the HRHF spectra as defined in TR-144, and provided below under Technical Report (TR) Revisions. Sites with high shear wave velocities have higher loads due to high frequency than those with lower shear wave velocity. Sites that are enveloped by the HRHF input spectra, but have lower shear wave velocities, will have lower HRHF seismic loads than those used in the evaluation reported in TR-115 and are acceptable for AP1000.

It is not appropriate for Westinghouse to identify the COL applicants that are currently covered by TR-115 along with the minimum shear wave velocity of the underlying medium at each site. This is considered to be part of the COL application.

Design Control Document (DCD) Revision:

~~None~~Since it is not necessary to specifically state that a site must be founded on hard rock to be covered by TR-115, the following change is made to Tier 1, DCD Section 5.0, and second paragraph:

> Structures, systems, and components for the AP1000 are evaluated for generic ground motion response spectra (GMRS) with high frequency seismic input. ~~at a site where the nuclear island is founded on hard rock.~~

The second paragraph of Tier 2, Subsection 2.5.2, and second paragraph should be changed to the following:

> The AP1000 is ~~also~~ evaluated ~~at a hard rock site~~ for high frequency input using ~~a safe shutdown earthquake (SSE) defined by a peak ground acceleration (PGA) of 0.30g and~~ the ~~design~~ response spectra specified in Appendix 3I, ~~and~~ Figures 3I.1-1 and 3I.1-2. ~~These design response spectra are applicable to certain east coast rock sites.~~ The seismic response spectra given in Figures 3I.1-1 and 3I.1-2 are bounding (GMRS) with high frequency content.

Modify the first paragraph in Appendix 3I, Subsection 3.I.1, Introduction, to the following:

> The seismic analysis and design of the AP1000 plant is based on the Certified Seismic Design Response Spectra (CSDRS) shown in subsection 3.7.1.1. These spectra are based on Regulatory Guide 1.60 with an increase in the 25 hertz region. Ground Motion Response Spectra (GMRS) for some Central and Eastern United States rock sites show higher amplitude at high frequency than the CSDRS. Evaluations are described in this appendix for a GMRS with high frequency for the seismic input ~~at a site where the nuclear island is founded on hard rock~~. The resulting spectra of this site is shown in Figure 3I.1-1 and Figure 3I.1-2 and compares this hard rock high frequency (HRHF) GMRS at the foundation level against the AP1000 CSDRS for both the horizontal and vertical directions for 5% damping. The HRHF GMRS exceed the CSDRS for frequencies above about 15 Hz.

PRA Revision:

None

Technical Report (TR) Revision:

To be consistent with TR-144 the following changes will be made to TR-115.

Modify the 1st paragraph of the introduction to:

> The purpose of this report is two fold: (1) to confirm that high frequency seismic input evaluated is not damaging to equipment and structures qualified by analysis for the AP 1000 Certified Seismic Design Response Spectra (CSDRS); and (2) to demonstrate that normal design practices result in an AP 1000 design that is safer and more conservative than that which would result if designed for the high frequency input evaluated.

Modify the 5th paragraph of the introduction to:

> A Hard Rock High Frequency (HRHF) spectrum has been developed that envelopes three hard rock sites for which Combined License applications using the AP1000 as the vendor design are being prepared. Figures 1.0-1 and 1.0-2 compare the HRHF at foundation level against the AP1000 CSDRS for both the horizontal and vertical directions for 5% damping. The HRHF exceeds the CSDRS for frequencies above about 15 Hz. Evaluations in this report ~~describe the seismic input at a hard rock site where the nuclear island is founded on hard rock.~~are for Ground Motion Response Spectra (GMRS) with high frequency input.

Modify the last paragraph of the introduction to:

> This report describes the methodology and criteria used in the evaluation to confirm that high frequency input is not damaging to equipment and structures qualified by analysis for the AP1000 CSDRS. This report also demonstrates that the AP1000 envelopes any requirements that HF would impose. Thus, HF does not need to be considered explicitly in the design. It provides supplemental criteria for selection and testing of equipment whose function might be sensitive to high frequency. The HRHF GMRS provide an alternate set of spectra for evaluation of site specific GMRS. A site is acceptable if its site specific GMRS falls within the AP1000 HRHF GMRS. Therefore, a site is not considered acceptable without additional analyses if it does not fall within Figures 1.0-1 and 1.0-2. This report provides a summary of the analysis and applicable test results.

Modify Figures 1.0-1 and 1.0-2 to be consistent with Figures 5.0-3 and 5.0-4 given in TR-144.

Replace Appendix 3I, Evaluation for High Frequency Seismic Input, with the version that will appear in DCD Revision 17.

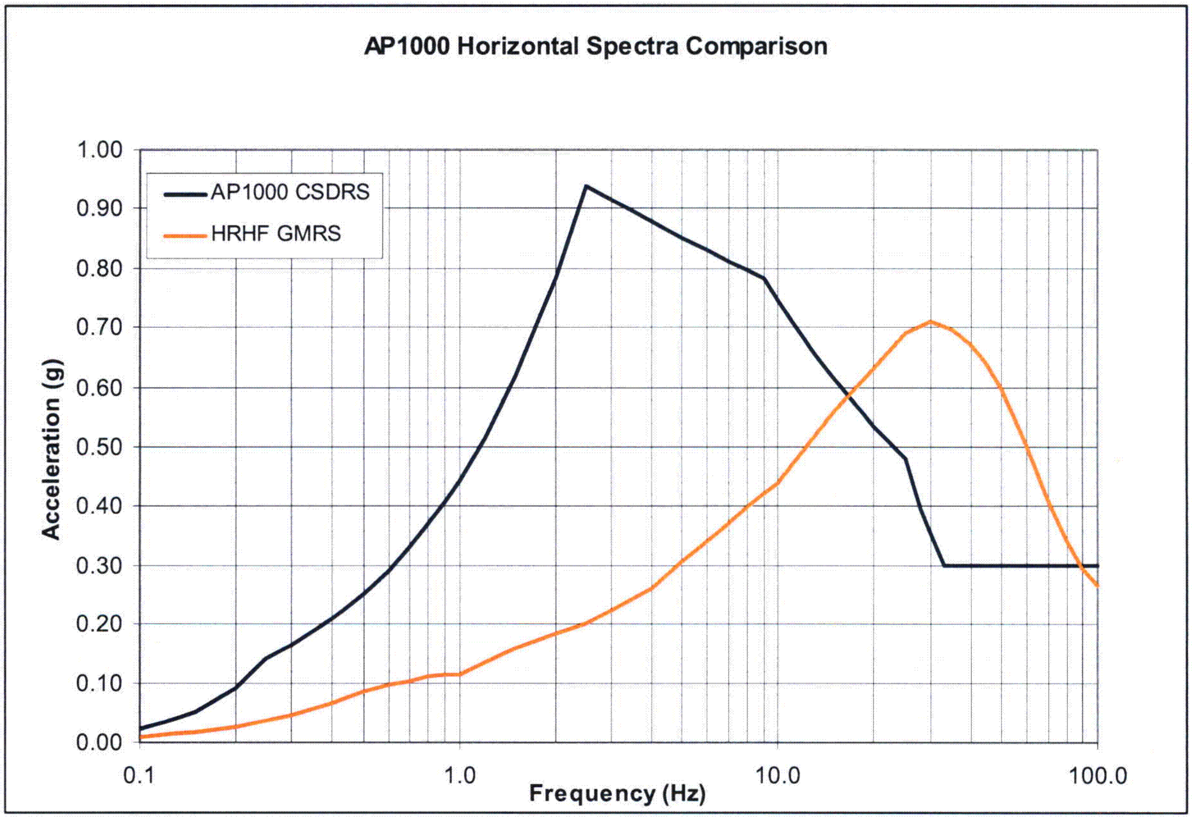


Figure 1.0-1: Comparison of the HRHF horizontal input spectra to the CSDRS

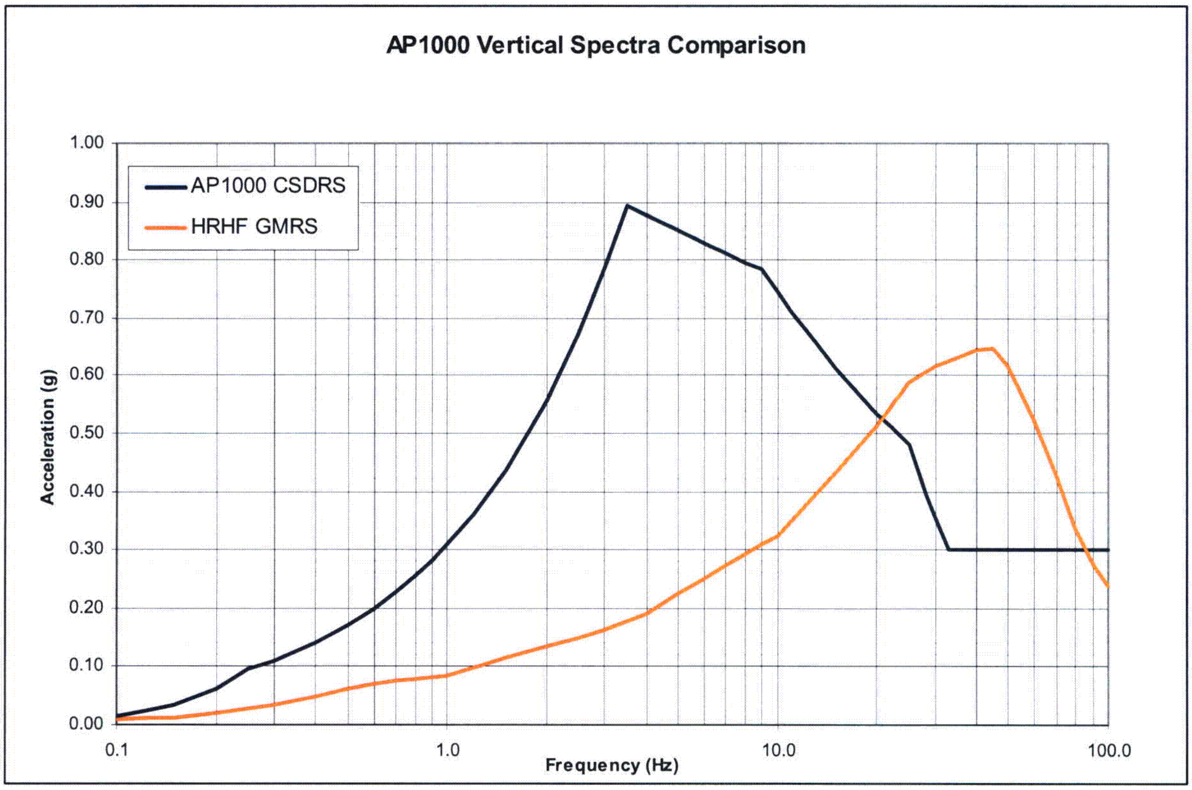


Figure 1.0-2: Comparison of the HRHF vertical input spectra to the CSDRS

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.7.1-SEB1-04
Revision: 1

Question:

In Section 4.0 of TR-115, Westinghouse lists the four (4) screening criteria used to select systems, structures, and components (SSC) for detailed evaluation:

- Select systems, structures, and components based on their importance to safety. This includes the review of component safety function for the Safe Shutdown Earthquake (SSE) event and its potential failure modes due to an SSE. Those components whose failure modes do not impact the ability to achieve safe shutdown are excluded.

- Select systems, structures, and components that are located in areas of the plant that are susceptible to large high frequency seismic inputs.

- Select systems, structures, and components that have significant modal response within the region of high frequency amplification. Significance is defined by such items as: modal mass, participation factor, stress and/or deflection.

- Select systems, structures, and components that have significant total stress as compared to allowable, when considering load combinations that include seismic.

Based on the Westinghouse screening criteria, it is not clear to the staff why the Containment Structure is not identified for detailed comparison of the CSDRS response and the HRHFRS response. The staff requests that Westinghouse either include a detailed comparison for the Containment Structure in Section 6.1, or describe in detail its technical basis for excluding the Containment Structure.

On August 21, 2008 the NRC has requested the following additional information be provided.

The staff requested Westinghouse to explain why the containment structure was not included in the HRHF evaluation sample, considering its importance in mitigating the consequences of an accident. Westinghouse responded that it was not included because it would not be significantly affected by high frequency seismic input, based on the low frequency of its fundamental response mode. The staff finds this response to be unacceptable, based on information included in DCD Rev. 16. In the discussion of the containment stick model response vs. the containment shell model response, Westinghouse identifies modes in the upper closure dome in the 20 to 30 Hz range. In addition, the modal properties of the attached water weirs and the air baffle attachments may be in the same frequency range. Westinghouse justified the adequacy of the containment stick model on the basis that these high frequency modes in the containment dome and attachments would NOT be excited by the CSDRS (modified RG 1.60 spectra), because the CSDRS has no energy in this frequency range. The staff notes that the HRHF

GMRS has significant energy in this frequency range and would be expected to excite these vibration modes.

Therefore, the staff requests that Westinghouse expand its HRHF evaluation sample to include the Containment Structure, and also to specifically evaluate these high frequency modes, which are not represented in the AP1000 containment stick model.

Westinghouse Response:

The steel containment structure was not chosen for evaluation since it does not meet the 3rd bullet of the general screening criteria:

- Select systems, structures, and components that have significant modal response within the region of high frequency amplification. Significance is defined by such items as: modal mass, participation factor, stress and/or deflection.

Shown below are the dominant frequencies with modal mass associated with the steel containment vessel with polar crane. The dominant modes for horizontal response are below 10 hertz, and the dominant mode in the vertical direction is below 20 hertz. The dominant modes are not in the region where the HRHF exceeds the AP1000 CSDRS. Further, over 75 % of the mass is participating prior to the exceedance of the AP1000 CSDRS by the HRHF. Therefore, the Steel Containment Structure was excluded from the evaluation.

Direction	Frequency (hertz)	Effective Mass Participation (kip-sec^2/ft)	Percent of Mass Participation
X (North-South)	5.090	151.499	60.578
	8.109	32.009	75.306
	17.546	31.095	88.628
Y (East-West)	3.240	31.480	12.709
	6.095	156.933	76.062
	18.947	40.003	93.161
Z (Vertical)	6.692	22.140	9.057
	16.376	166.317	77.236
	27.318	18.628	90.367

In response to the NRC August 21, 2008 request, Westinghouse offers the following.

The seismic response spectra in the vicinity of the polar crane (~224' elevation) is representative of the seismic response that the upper closure dome and the attached water weirs and air baffle attachments will experience. These floor response spectra (5% damping) are shown in Figures RAI-SRP3.7.1-SEB1-04-1 to RAI-SRP3.7.1-SEB1-04-3. As seen from these spectra comparisons, the CSDRS floor response spectra identified as SSIENV envelop the HRHF floor response spectra. Therefore, it can be stated that the items identified (upper closure dome, water weirs and the air baffle attachments) will have lower response due to HRHF response than that obtained from the CSDRS excitation.

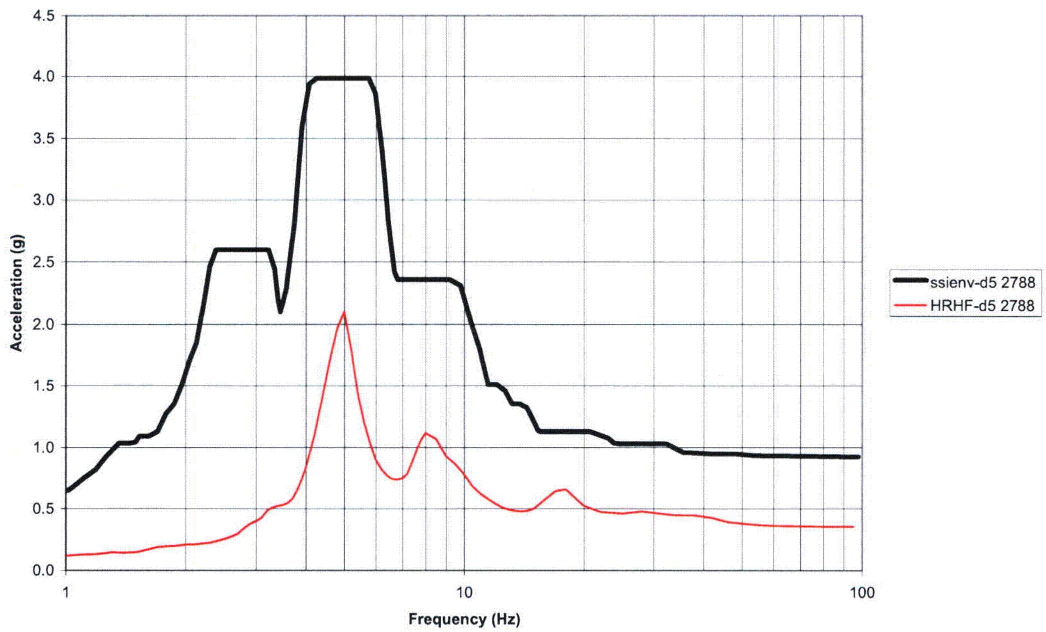


Figure RAI-SRP3.7.1-SEB1-04-1 – X Seismic Response Spectra on Steel Containment Vessel at Elevation 224'

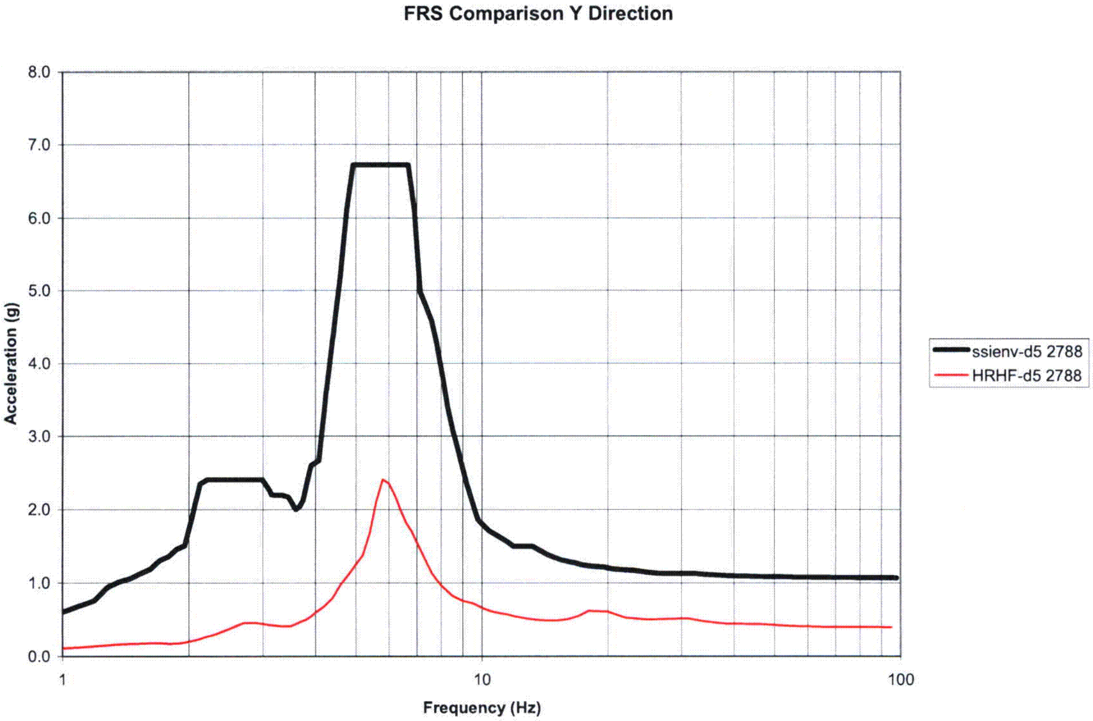


Figure RAI-SRP3.7.1-SEB1-04-2 – Y Seismic Response Spectra on Steel Containment Vessel at Elevation 224'

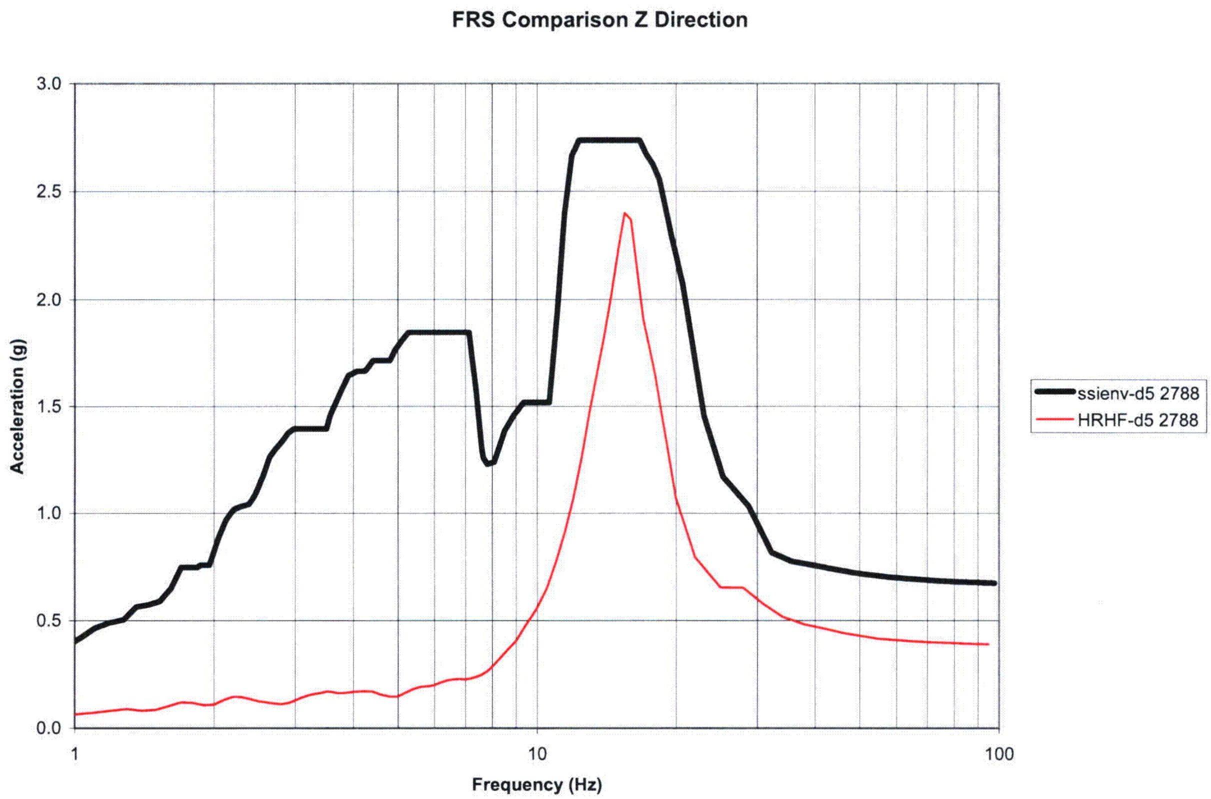


Figure RAI-SRP3.7.1-SEB1-04-3 – Z Seismic Response Spectra on Steel Containment Vessel at Elevation 224'

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.7.1-SEB1-06
Revision: 1

Question:

Westinghouse's calculation in TR-115 indicates 4 points per wavelength for 80 Hz. This is the bare minimum to represent a full cycle of sinusoidal displacement variation. The staff requests that Westinghouse include in Section 5.1 a comparison of frequencies and mode shapes between the NI10 and NI20 models, as an alternate way to demonstrate the adequacy of the NI20 model to accurately predict high frequency modes (up to 80 Hz).

Westinghouse Response:

At the December 20, 2007 meeting between the U.S. NRC staff and industry related to the high frequency seismic events, it was agreed that a maximum analysis frequency of 50 hertz would be sufficient to transmit the high frequency response through the model. Using this frequency and the formulas given in Section 5.1 the acceptable mesh size is determined.

Shortest wavelength = λ = Vs / f_{max}

Vs = 6900 ft/sec (given in Section 5.1)
f_{max} = 50 hertz

λ = 6900 / 50 = 138'

Using the NI20 model (mesh size of 20'), and the shortest wavelength of 138', then close to 7 nodes per wavelength are obtained to transmit the high frequency through the finite elements. This is sufficient accuracy in the building structure model to transmit the high frequency through the finite elements in the NI20 model. Therefore, it is not necessary to include in Section 5.1 a comparison of frequencies and mode shapes between the NI10 and NI20 models.

In addition to the above, a modal response comparison is made between the NI10 and NI20 models to demonstrate the adequacy of the NI20 model to predict high frequency response up to 50 hertz.

Table RAI-SRP3.7.1-SEB1-06-1 shows the comparison of the frequency for each model at certain modes. Due to the increased refinement of the NI10 model, the NI20 reaches higher frequencies at lower modes. This is also shown in Tables RAI-SRP3.7.1-SEB1-06-2 and RAI-SRP3.7.1-SEB1-06-3. Tables RAI-SRP3.7.1-SEB1-06-2 and RAI-SRP3.7.1-SEB1-06-3 show the highest numbered mode found in each 10 Hz frequency range and also shows how many modes are in each of the aforementioned ranges.

Figures RAI-SRP3.7.1-SEB1-06-1 to RAI-SRP3.7.1-SEB1-06-3 show a summation of the of the effective mass verses frequency for the X, Y and Z directions. The effective masses associated with the NI20 and NI10 models compare closely over the frequency range of 1 to 80 Hz.

From this comparison it can be concluded that the modal response of the NI20 model is very similar to the NI10 model, and therefore, is adequate to predict the high frequency response up to 50 hertz.

Table RAI-SRP3.7.1-SEB1-06-1: Mode Number vs. Frequency

Mode	Ni20	Ni10
50	9.29	8.29
100	14.05	12.47
150	16.81	14.83
200	20.27	16.73
250	22.61	18.69
300	24.82	21.00
350	26.97	22.37
400	28.72	23.48
450	30.59	24.49
500	32.39	25.37
550	34.23	26.13
600	35.84	26.71
650	37.52	27.48
700	39.38	28.59
750	41.15	29.87
800	42.81	30.96
850	44.34	32.19
900	45.85	33.48
950	47.41	34.48
1000	48.86	35.44
1050	50.10	36.18
1100	51.72	36.99
1150	53.10	37.78
1200	54.55	38.37
2000	N/A	58.8127

Table RAI-SRP3.7.1-SEB1-06-2: Modes Per Range (NI10)

NI10		
Frequency Range	Max Mode in Range	Modes Per Range
0-10	69	69
10-20	277	208
20-30	755	478
30-40	1303	548
40-55	1848	545

Table RAI-SRP3.7.1-SEB1-06-3: Modes Per Range (NI20)

NI20		
Frequency Range	Max Mode in Range	Modes Per Range
0-10	58	58
10-20	193	135
20-30	434	241
30-40	716	282
40-55	1200	484

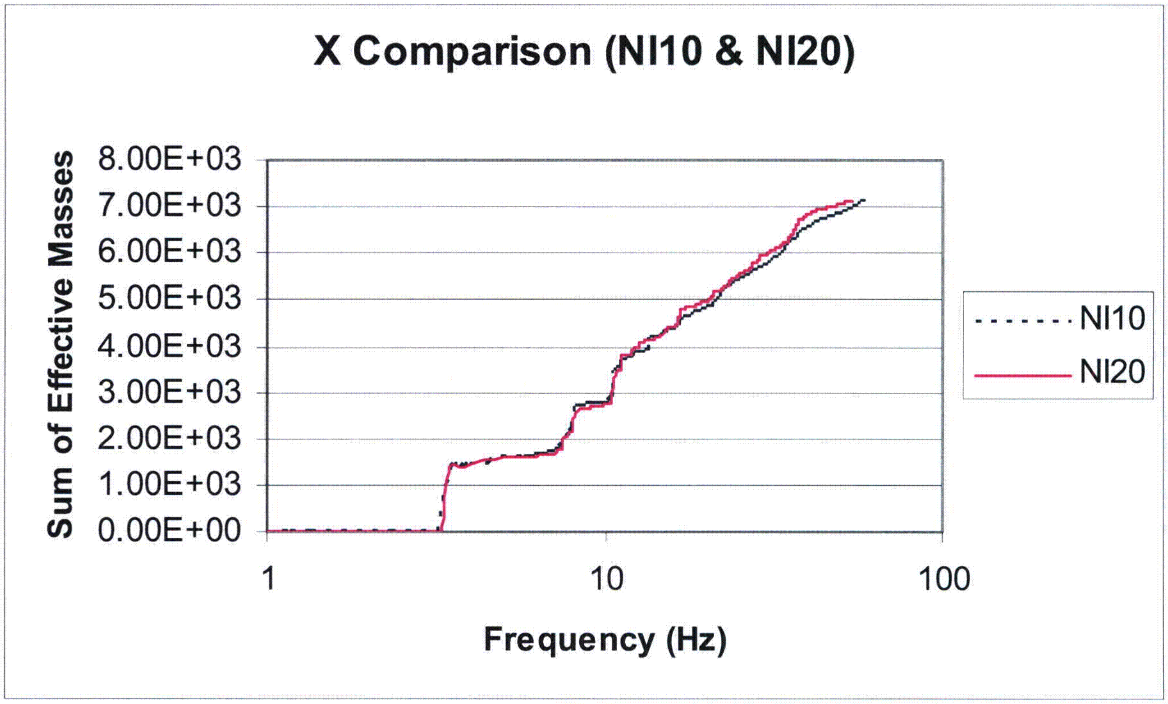


Figure RAI-SRP3.7.1-SEB1-06-1: X-Direction Comparison

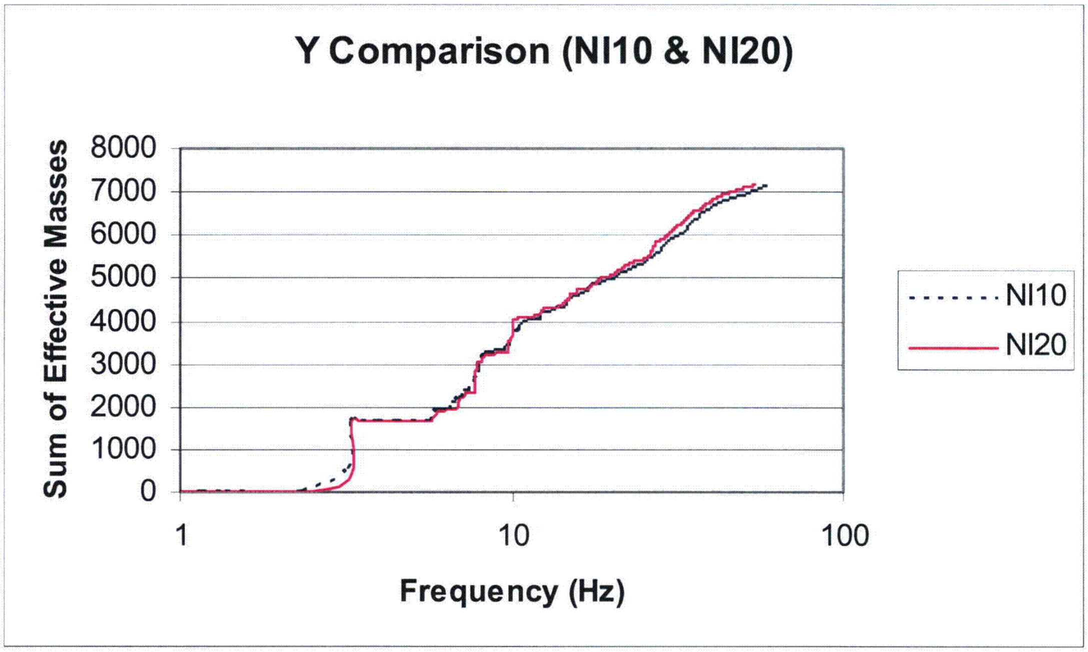


Figure RAI-SRP3.7.1-SEB1-06-2: Y-Direction Comparison

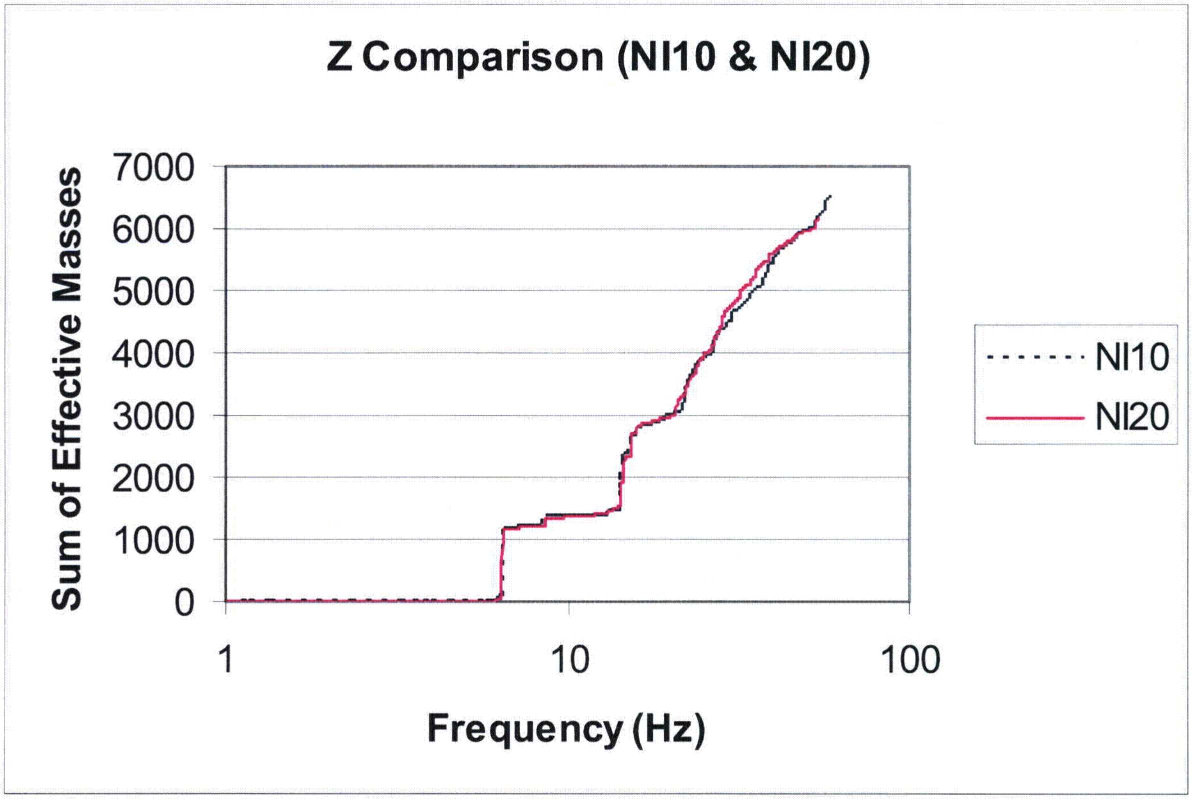


Figure RAI-SRP3.7.1-SEB1-06-3: Z-Direction Comparison

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

Section 5.1 is revised to reflect the 50 hertz requirement on the dynamic models.

5.1 Adequacy of CSDRS and HRHF Response Spectra

The adequacy of the NI20 model is demonstrated by:

1. Mesh size is adequate to transmit the high frequency through the finite elements
2. Close comparison to NI10 results

The NI20 (~20' finite element mesh size) model is used to develop the HRHF response spectra using the finite element program SASSI. For a concrete of 4000 psi with a poisson's ratio (υ) of approximately 0.17, the shear modulus of elasticity (G) is 221,846 ksf.

$$G = \frac{57400\sqrt{fc'}}{2(1+\nu)}$$ Where *fc'* is Concrete stress in psi

The shear wave velocity (V_s) is 6900 ft/sec for the concrete density of 0.15 ksf.

$$V_s = \sqrt{\frac{G}{\rho}}$$ ρ is mass density

For a maximum analysis frequency (f_{max}) of 50 Hz which must transmit through the finite elements, the shortest wavelength (λ) is 138 ft.

$$\lambda = \frac{V_s}{f_{\max}}$$

Approximately 7 (6.9) nodes per wavelength are available for a mesh size of 20', and this is adequate to transmit the high frequency through the finite elements in the NI20 model. ~~Therefore, the mesh size of 20 ft (i.e. NI20) is adequate for the Auxiliary and Shield Building (ASB). The~~ A portion of the NI20 model has an element mesh size of ~ 10' for the Containment and Internal Structure (CIS).

The discussion of the modal response as presented in the Westinghouse response is added at the end of Section 5.1.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.7.1-SEB1-08
Revision: 1

Question:

The staff also noted that there are an insufficient number of comparisons presented in TR-115 Section 5.1. The NI10 results presented show no significant amplification in the higher frequency range on any of the figures. The staff requests that Westinghouse include in Section 5.1, NI10 vs. NI20 comparisons at locations/directions where there is significant amplification at higher frequency.

Westinghouse Response:

As stated in RAI-SRP3.7.1-SEB1-06, demonstration of the adequacy of the model used to develop HRHF response is to be based on a maximum analysis frequency of 50 hertz. It was shown in the response to this RAI that the NI20 model has sufficient accuracy in the building structure model. Therefore, further comparison than that given in Section 5.1 is not necessary.

In the meeting on May 19-23, 2008, it was requested by the NRC to provide additional spectra focused on the amplification at higher frequencies in the NI10 results when compared to the NI20 model results. Figures RAI-SRP3.7.1-SEB1-08-1 to RAI-SRP3.7.1-SEB1-08-8 show the locations and response spectra of the additional nodes for which floor response spectra comparisons are provided.

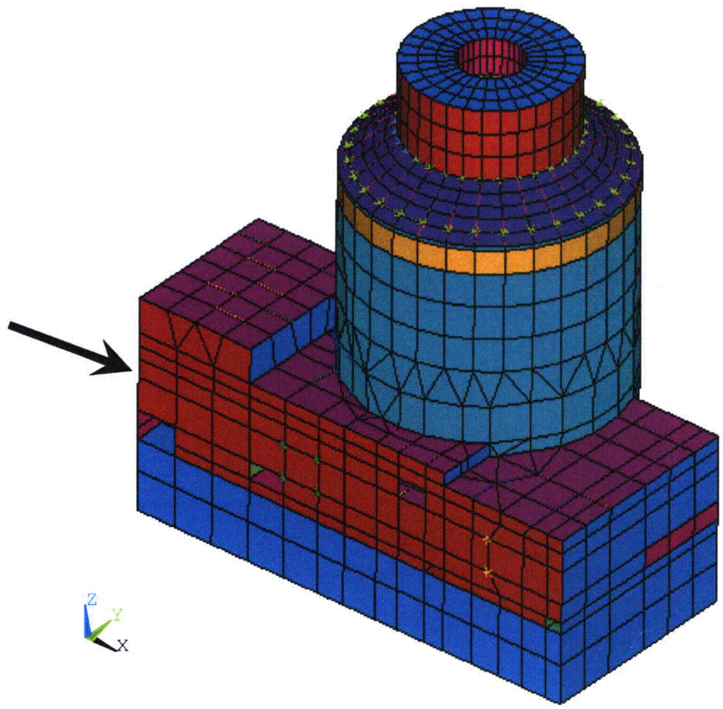


Figure RAI-SRP3.7.1-SEB1-08-1: Auxiliary building S.E. Corner Elevation 135'

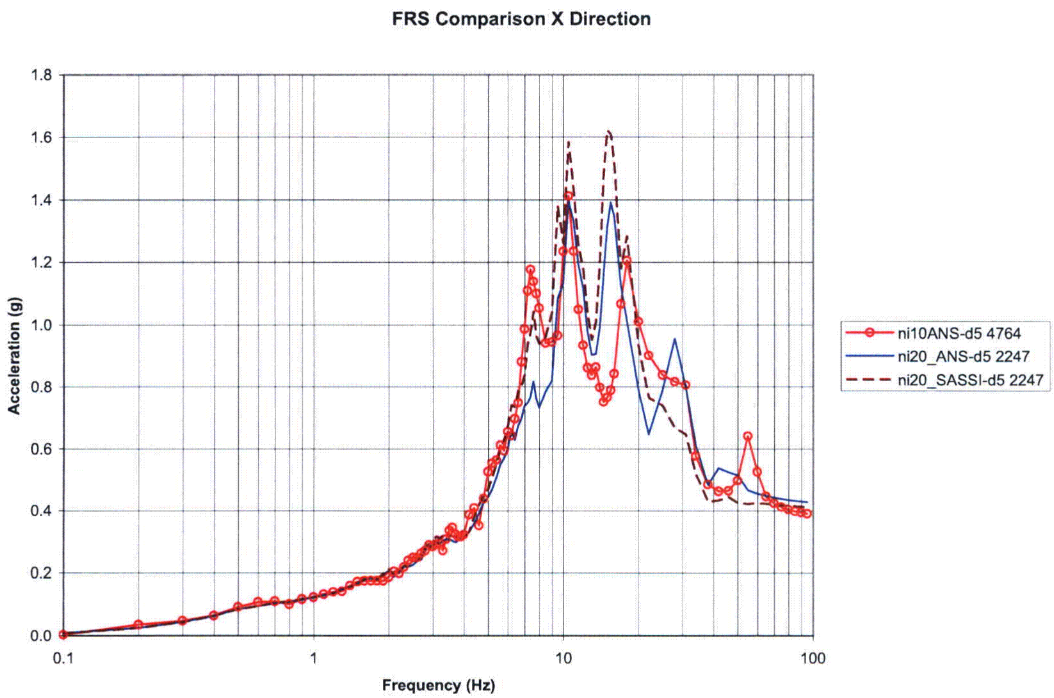


Figure RAI-SRP3.7.1-SEB1-08-2: Node NI20 2247 Direction X Elevation 135'

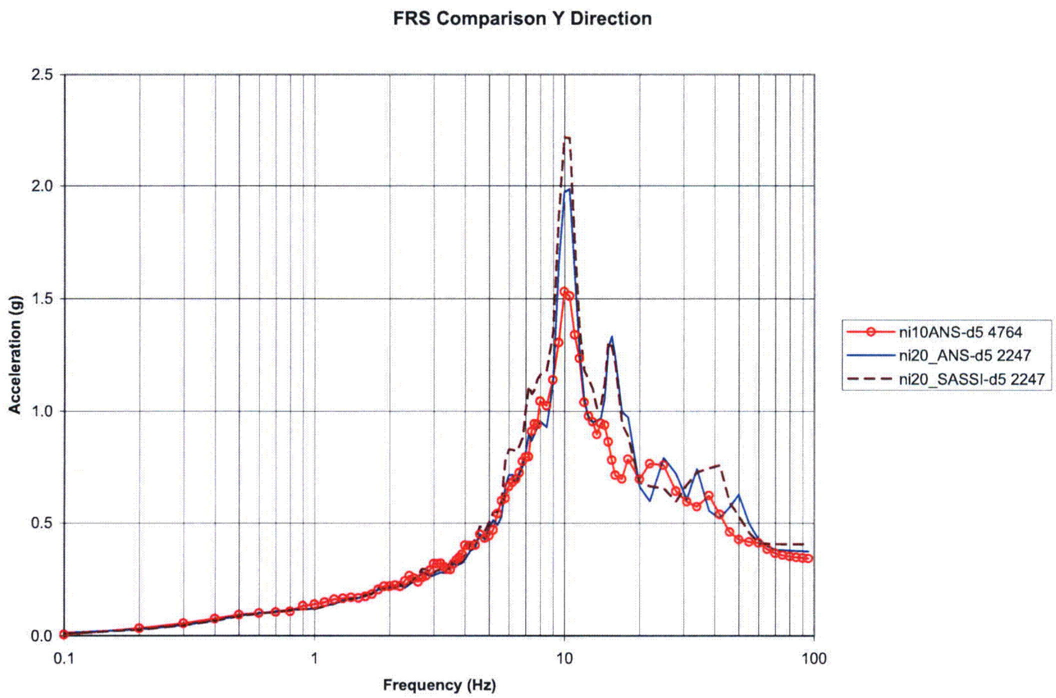


Figure RAI-SRP3.7.1-SEB1-08-3: Node NI20 2247 Direction Y Elevation 135'

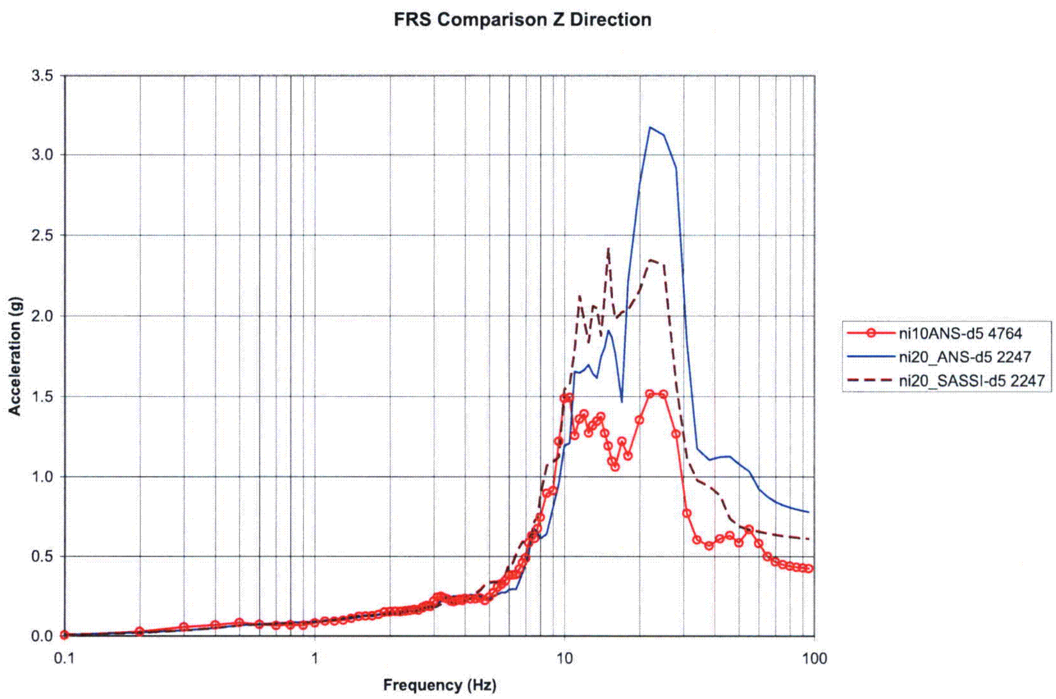


Figure RAI-SRP3.7.1-SEB1-08-4: Node NI20 2247 Direction Z Elevation 135

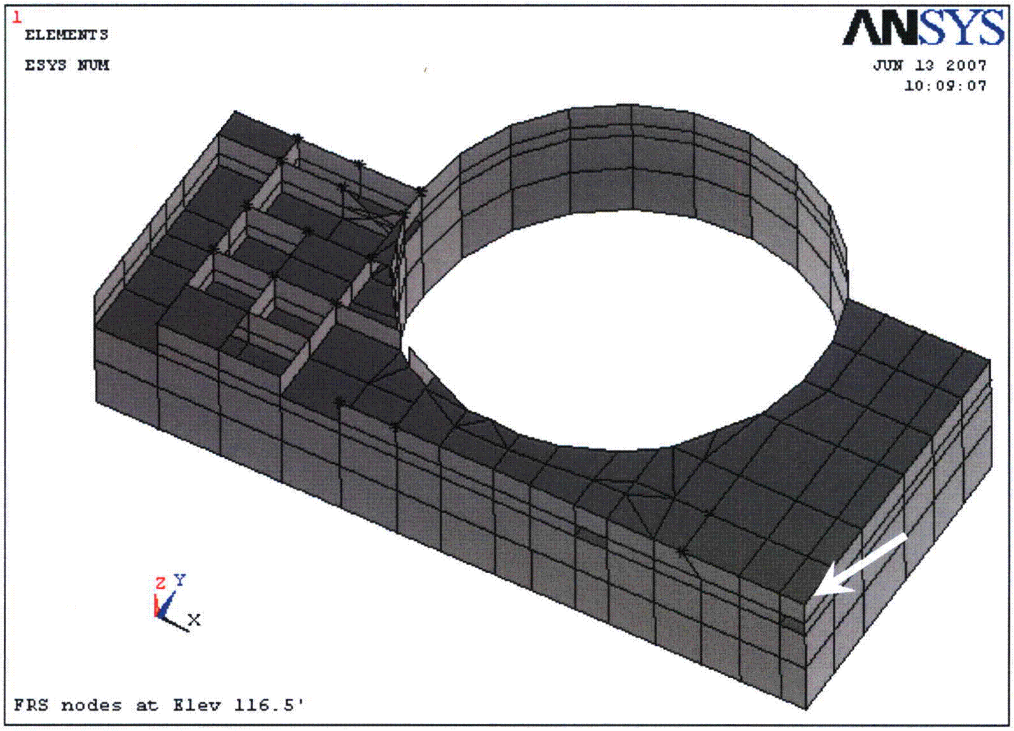


Figure RAI-SRP3.7.1-SEB1-08-5: Auxiliary Building Northeast Corner Elevation 116.5'

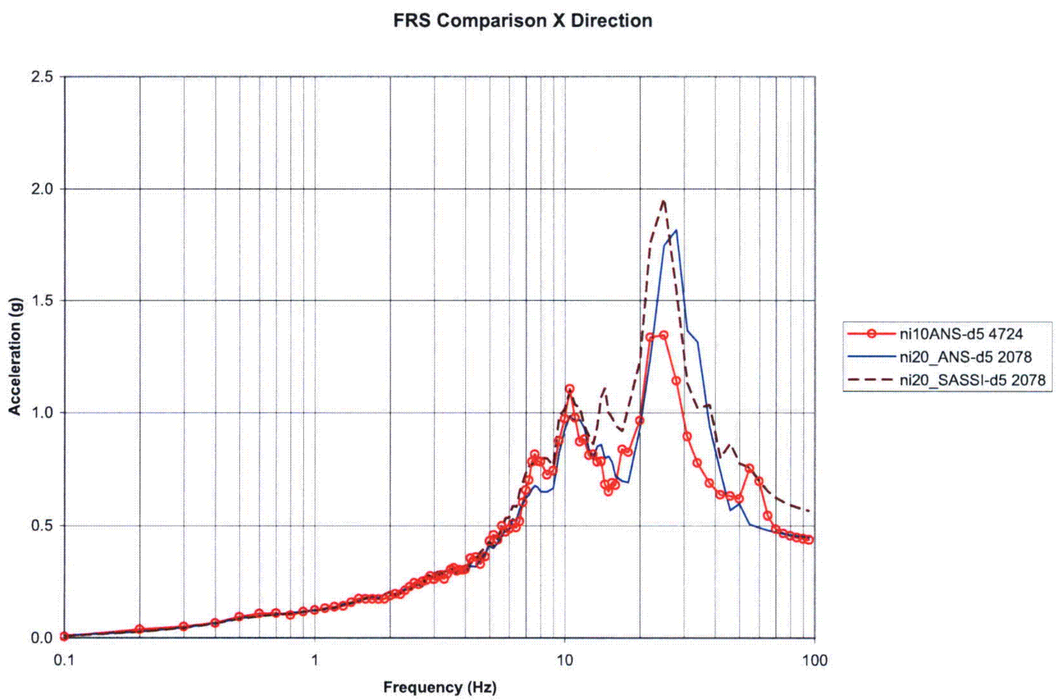


Figure RAI-SRP3.7.1-SEB1-08-6: Node NI20 2078 Direction X Elevation 116.5'

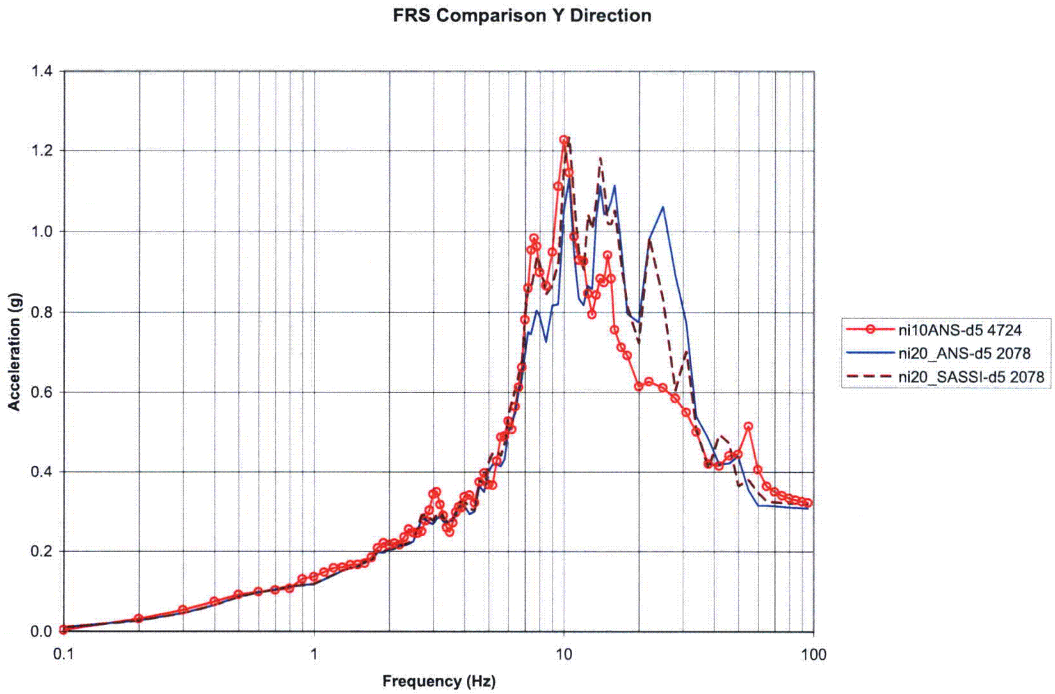


Figure RAI-SRP3.7.1-SEB1-08-7: Node NI20 2078 Direction Y Elevation 116.5'

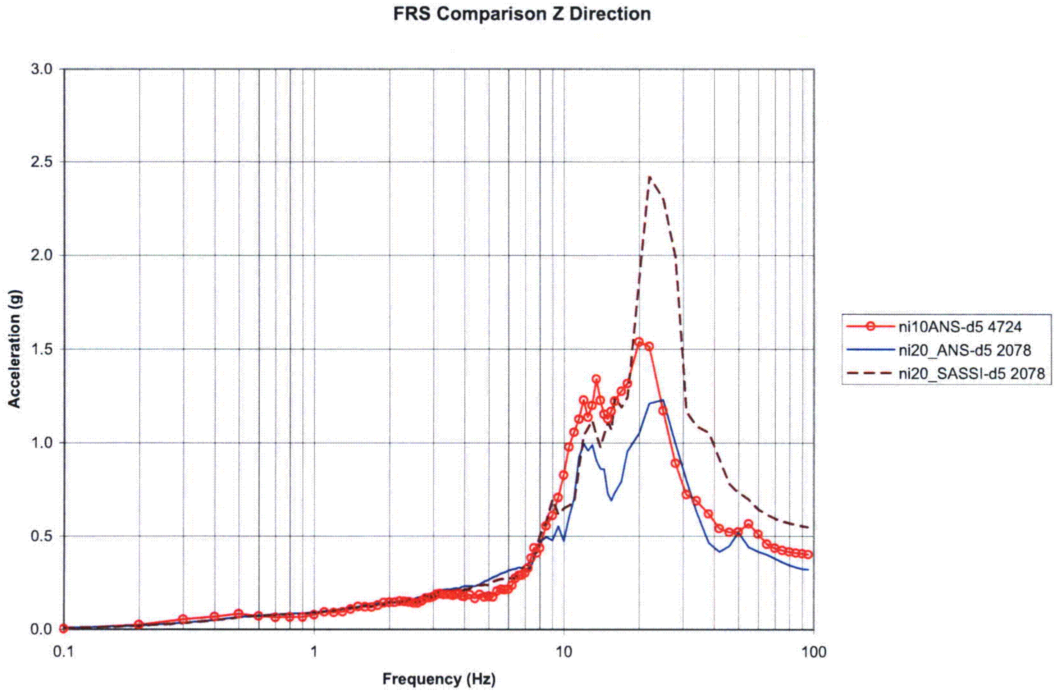


Figure RAI-SRP3.7.1-SEB1-08-8: Node NI20 2078 Direction Z Elevation 116.5'

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

~~None~~The figures provided, RAI-SRP3.7.1-SEB1-08-1 to RAI-SRP3.7.1-SEB1-08-8, will be added to Section 5.1 of the TR-115 as Figures 5.1-4 and 5.1-5. Note that each figure will show the node location and the floor response spectra for the X, Y and Z locations.

(TR-115 Section 5.1 Last Paragraph)

A comparison between the fine mesh (NI10) model used for design and the NI20 model shows the adequacy of the NI20 model to represent building responses. This comparison is shown in Figures 5.1-1 to 5.1-~~3~~5 (5% damping). The response spectra from the two models compare closely, with the response spectra from the NI20~~,~~ being slightly more conservative in most cases. Figures 5.1-1 to 5.1-3 compare results from ANSYS. Figures 5.1-4 and 5.1-5 compare results from ANSYS and SASSI.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

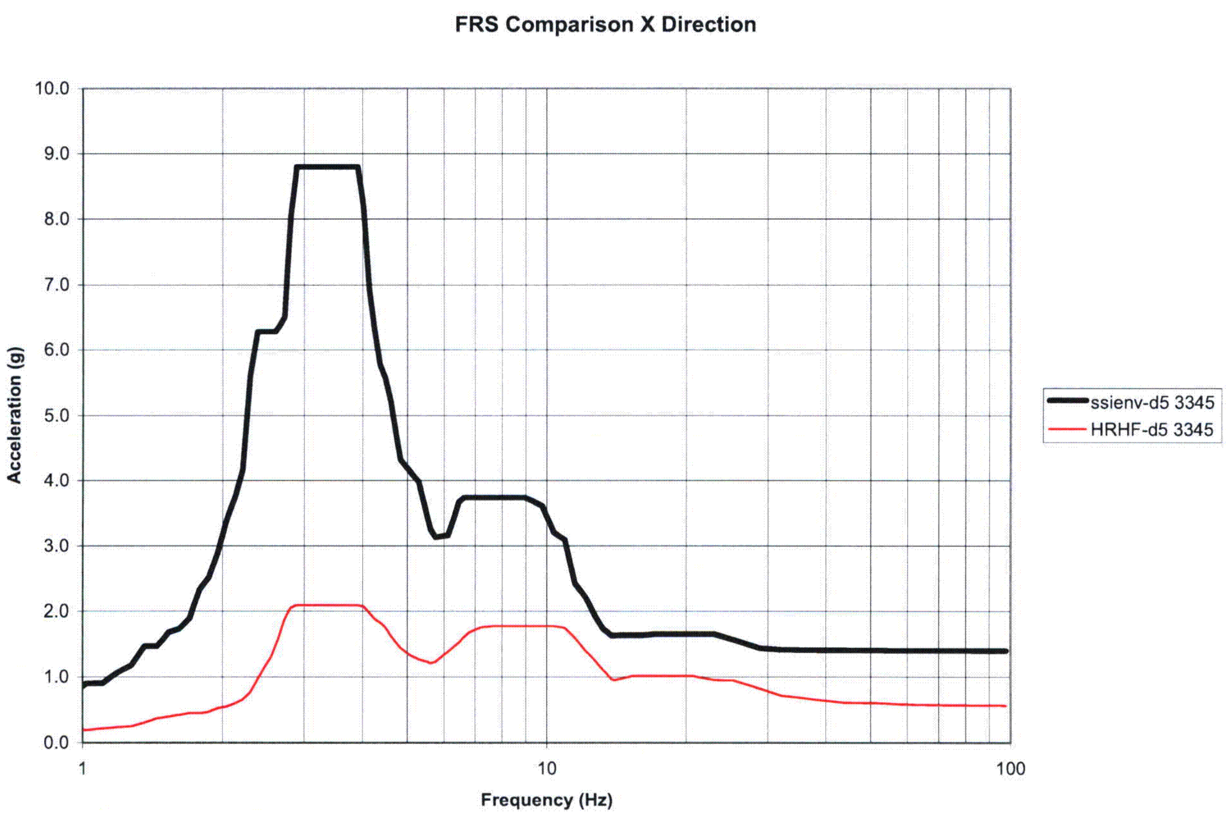
RAI Response Number: RAI-SRP3.7.1-SEB1-09
Revision: 1

Question:

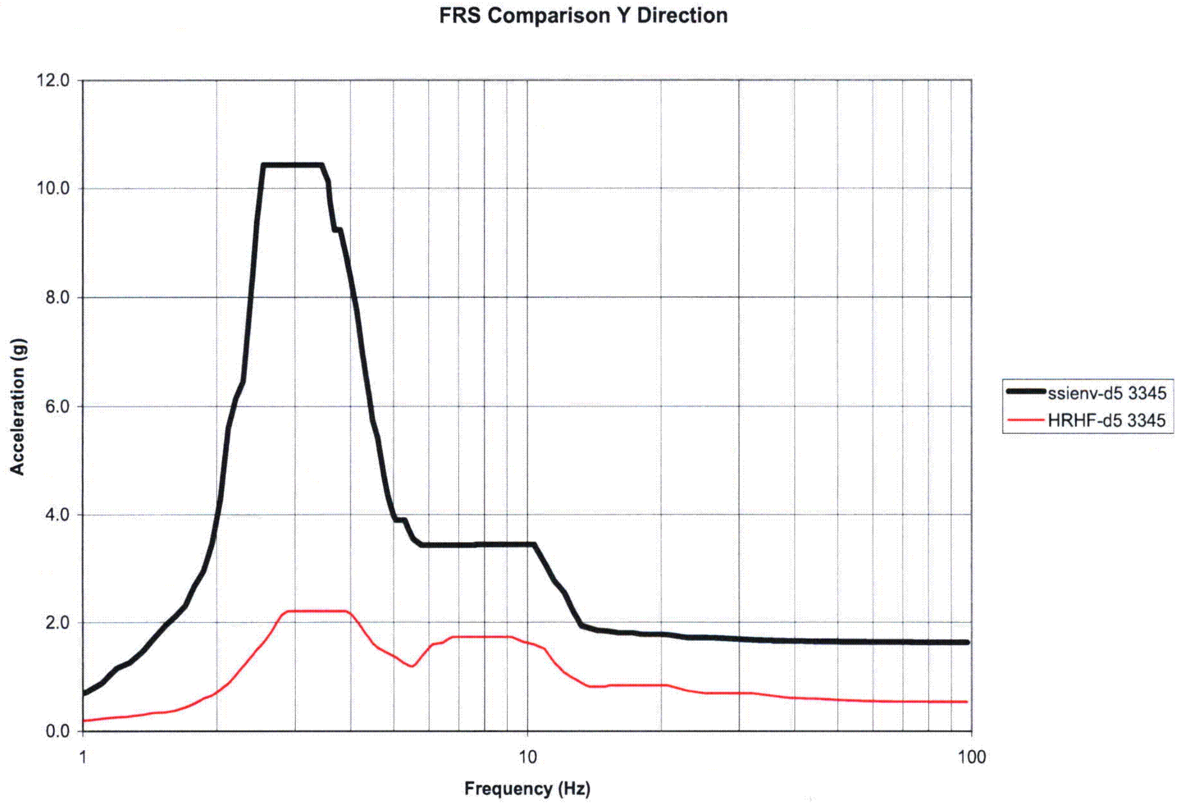
The staff noted that improved, more readable Figures 5.2-1 through 5.2-6 in TR-115 are needed. The ordinate scale and the legend cannot be read even by zooming in the electronic file. High resolution printing makes them barely readable. The staff requests that Westinghouse submit larger, readable copies of Figures 5.2-1 through 5.2-6, to facilitate the staff's evaluation of the information.

Westinghouse Response:

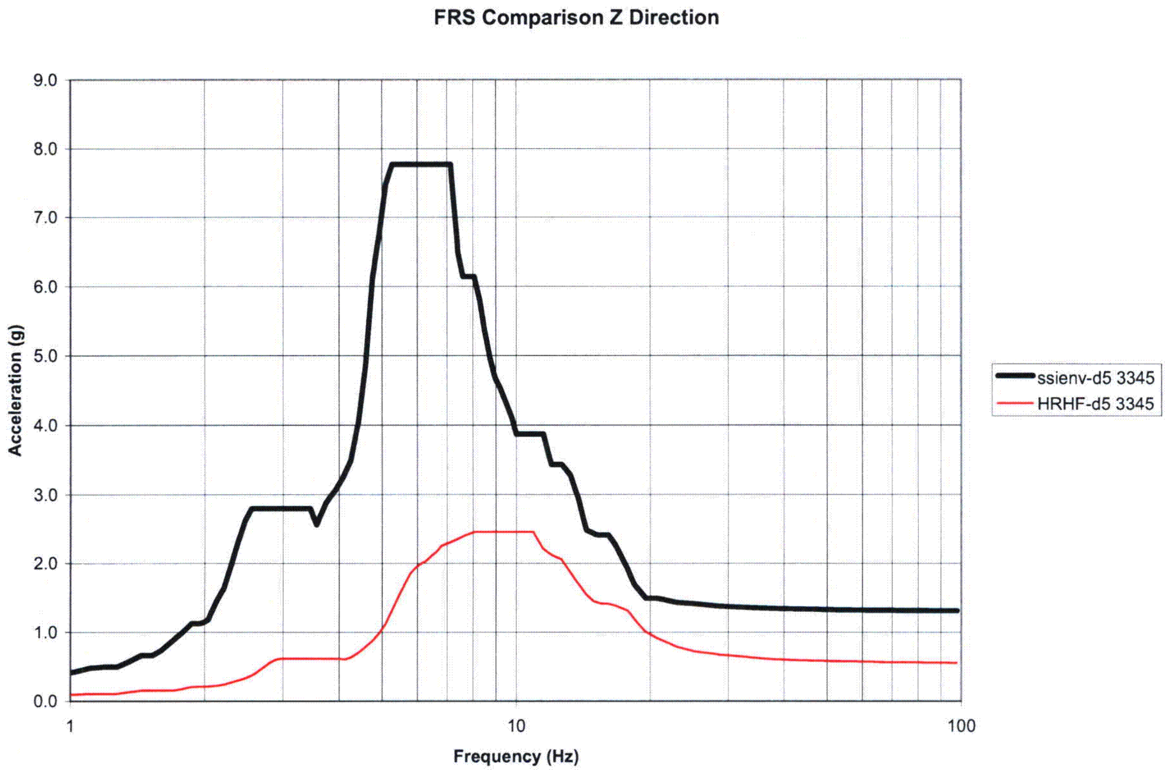
The requested figures are found in Figures RAI-SRP3.7.1-SEB1-09-01a to RAI-SRP3.7.1-SEB1-09-06c. These figures will replace the Figures 5.2-1 through 5.2-6 in the next revision to TR-115. See also RAI-SRP-3.7.1-SEB1-10 and RAI-SRP-3.7.1-SEB1-11.



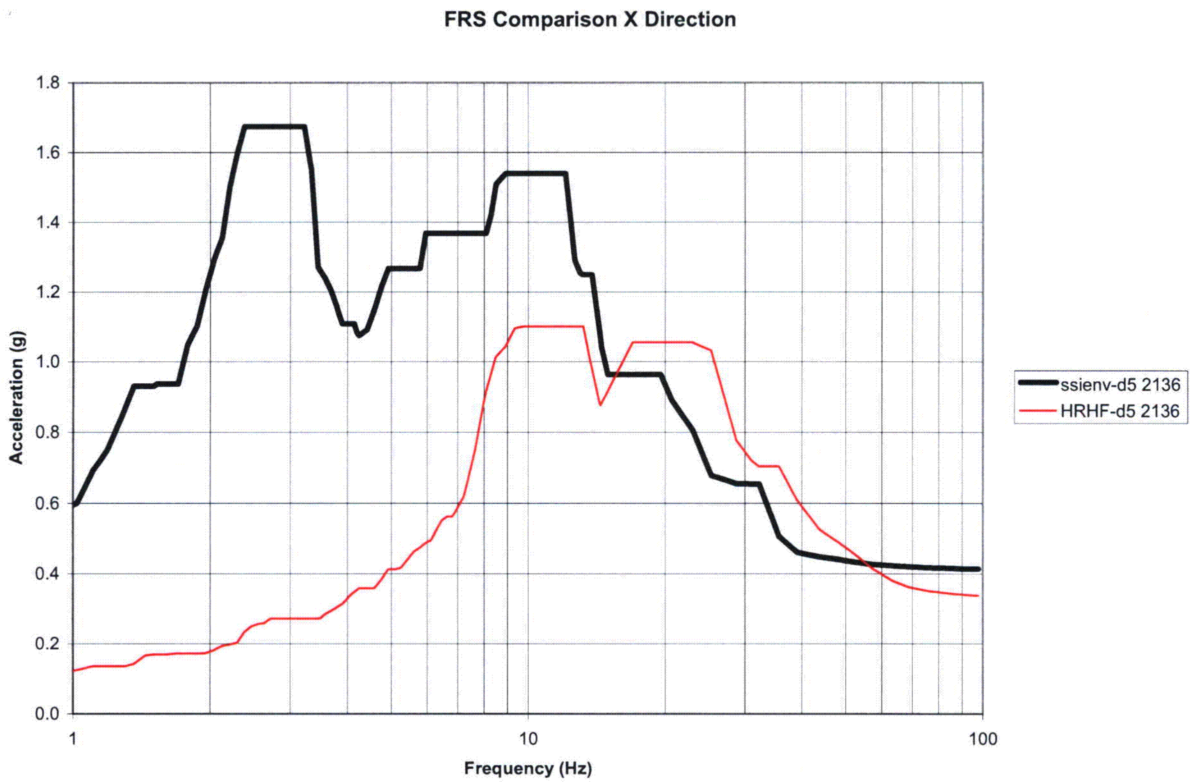
RAI-SRP3.7.1-SEB1-09-01a: ASB at Elevation 327.4' X Direction



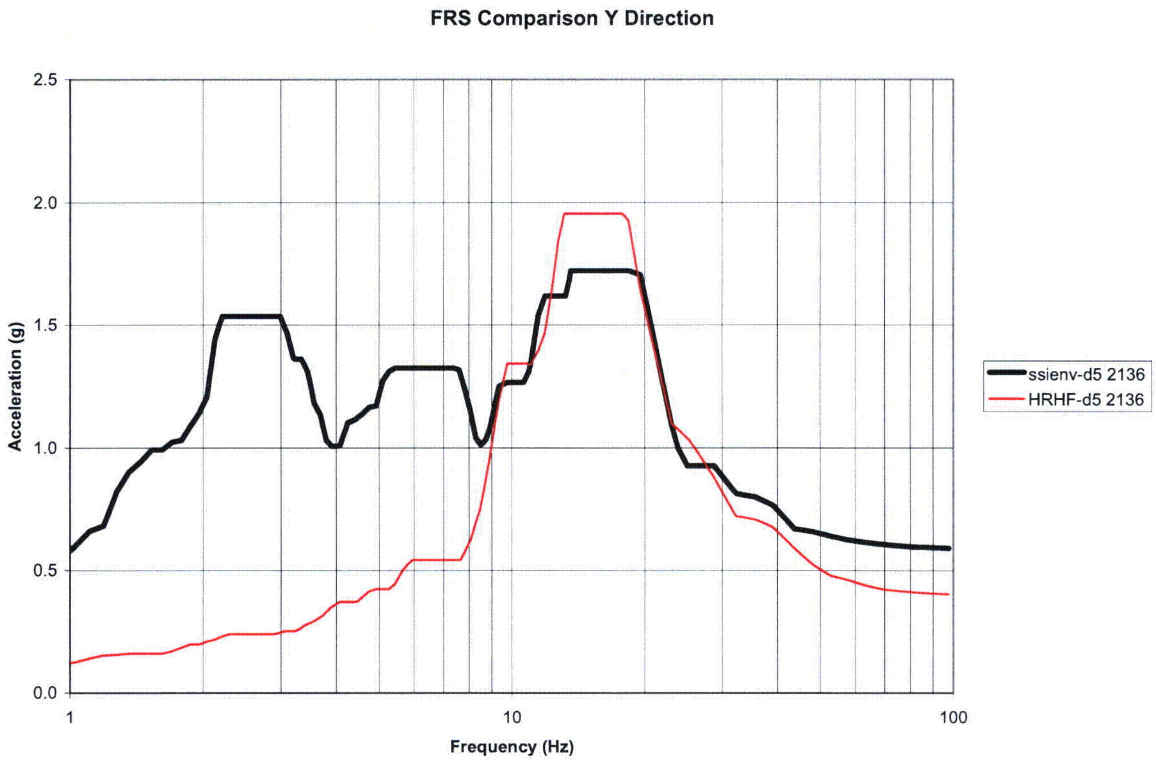
RAI-SRP3.7.1-SEB1-09-01b: ASB at Elevation 327.4' Y Direction



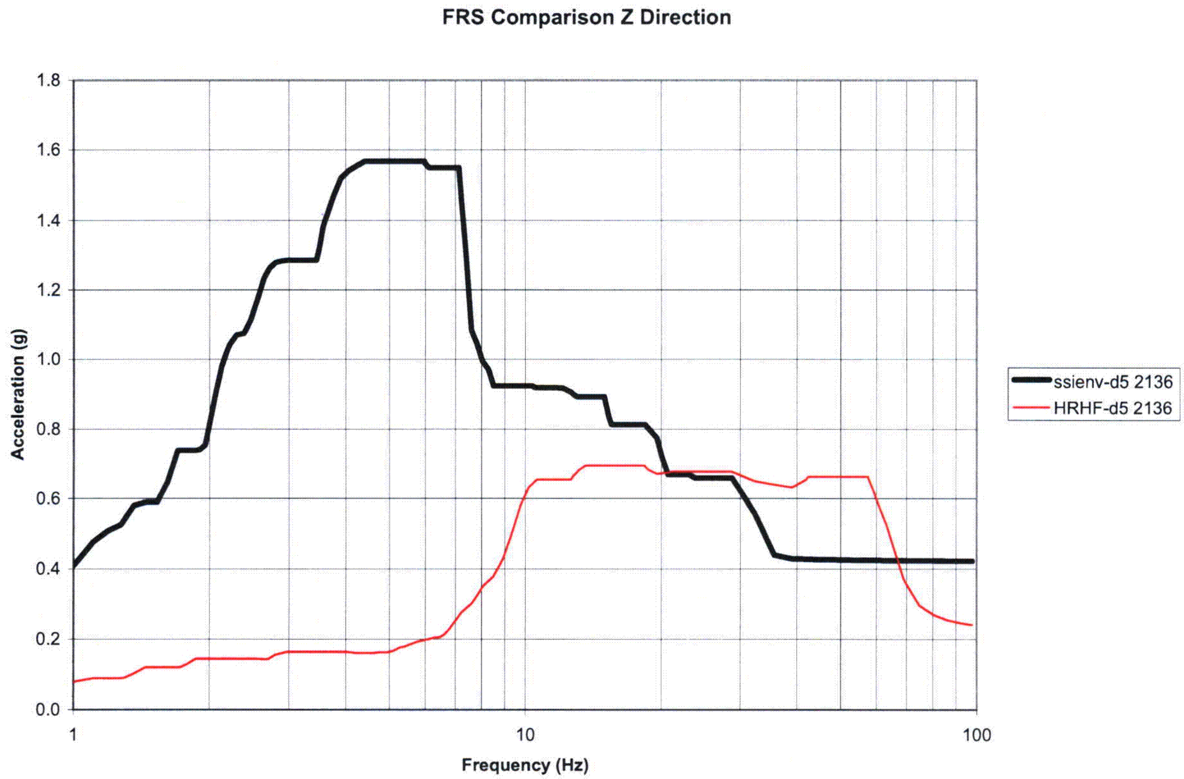
RAI-SRP3.7.1-SEB1-09-01c: ASB at Elevation 327.4' Z Direction



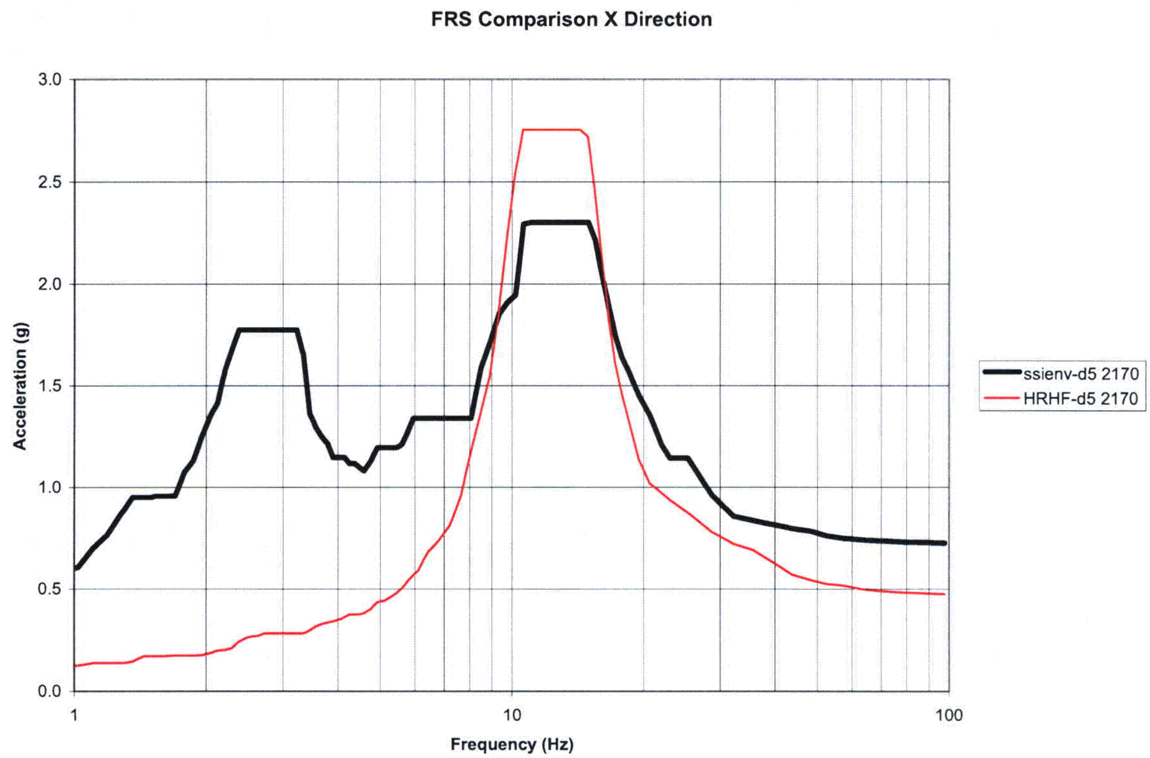
RAI-SRP3.7.1-SEB1-09-02 Ea: Containment Operating Floor (Elevation 134.25')
East Side X Direction



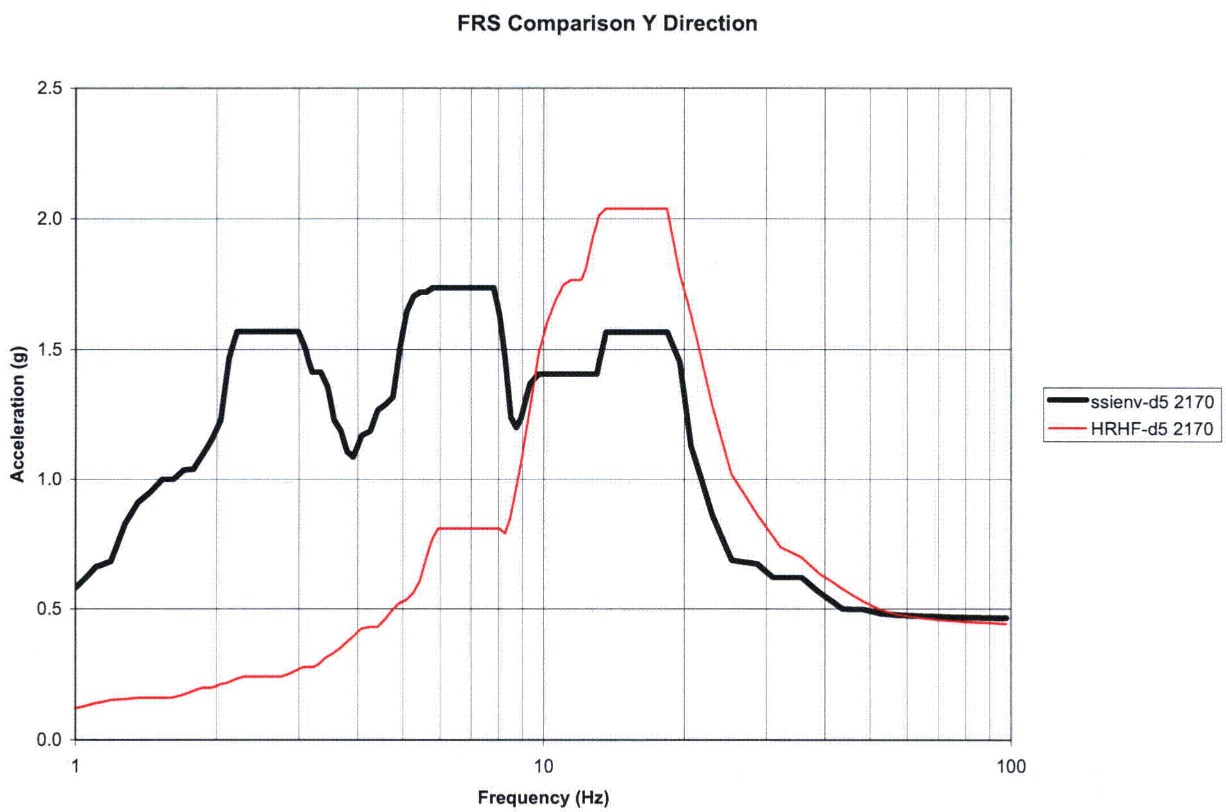
RAI-SRP3.7.1-SEB1-09-02 Eb: Containment Operating Floor (Elevation 134.25')
East Side Y Direction



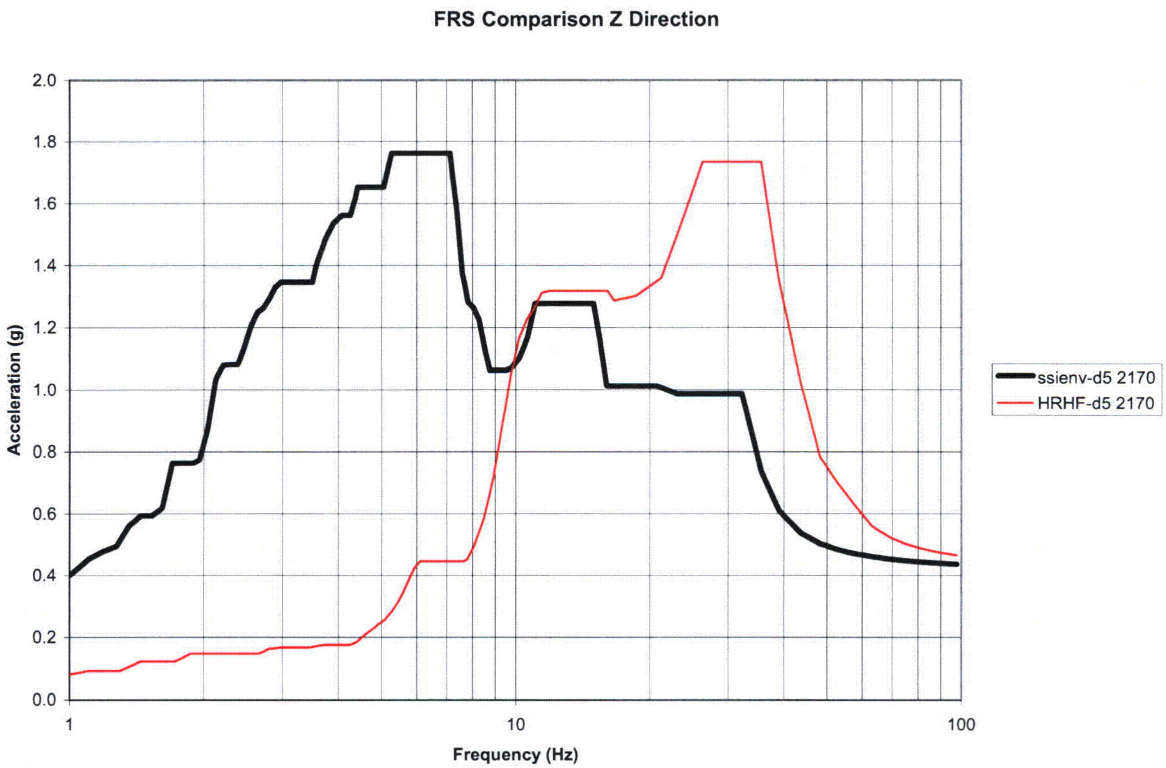
**RAI-SRP3.7.1-SEB1-09-02 Ec: Containment Operating Floor (Elevation 134.25')
East Side Z Direction**



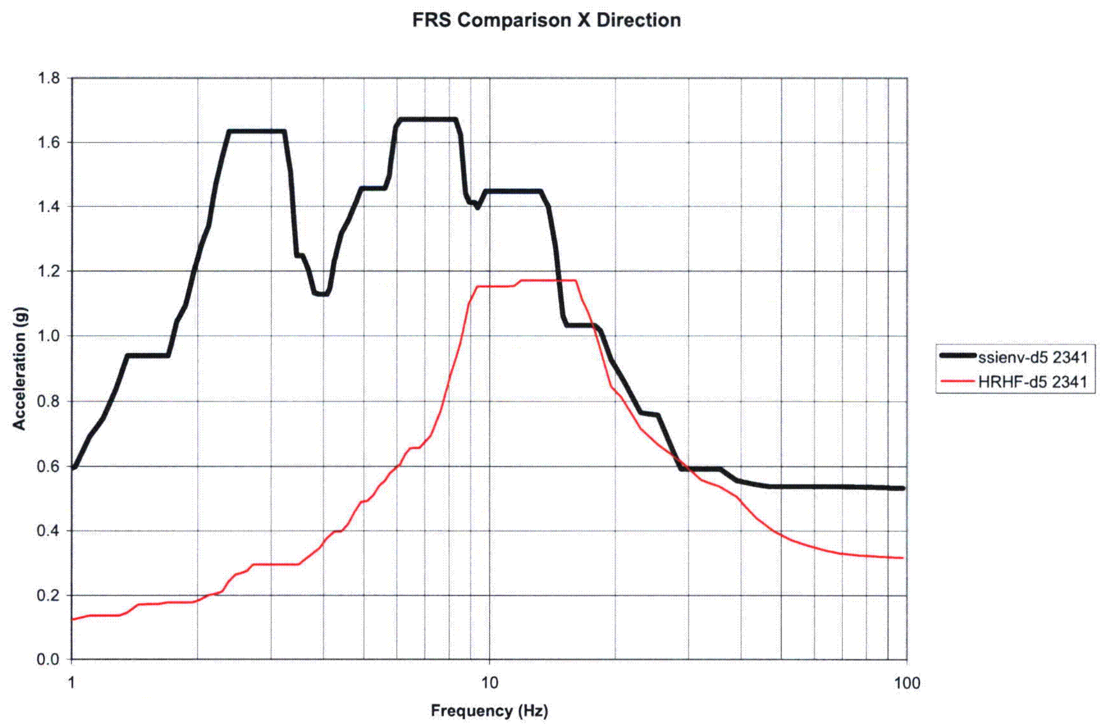
RAI-SRP3.7.1-SEB1-09-02 Wa: Containment Operating Floor (Elevation 134.25') West Side X Direction



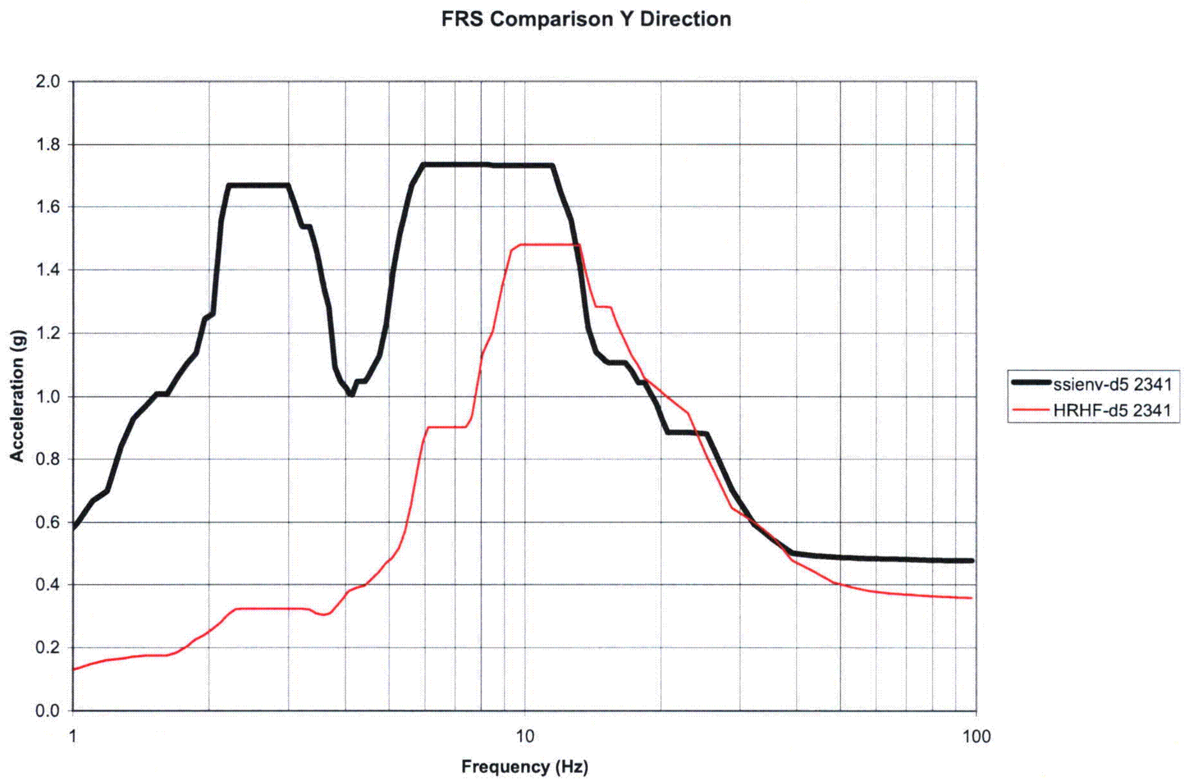
**RAI-SRP3.7.1-SEB1-09-02 Wb: Containment Operating Floor (Elevation 134.25')
West Side Y Direction**



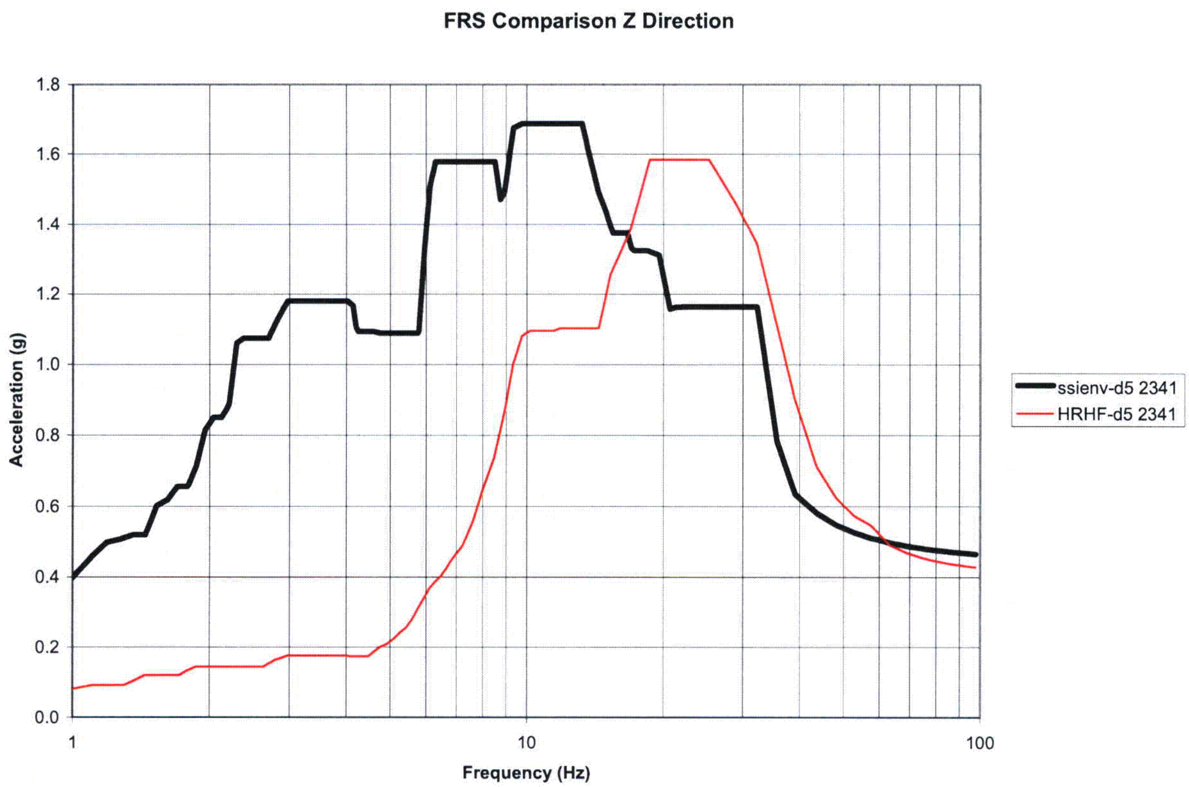
RAI-SRP3.7.1-SEB1-09-02 Wc: Containment Operating Floor (Elevation 134.25') West Side Z Direction



RAI-SRP3.7.1-SEB1-09-03a: ASB at Northeast Corner (Elevation 134.5') X Direction

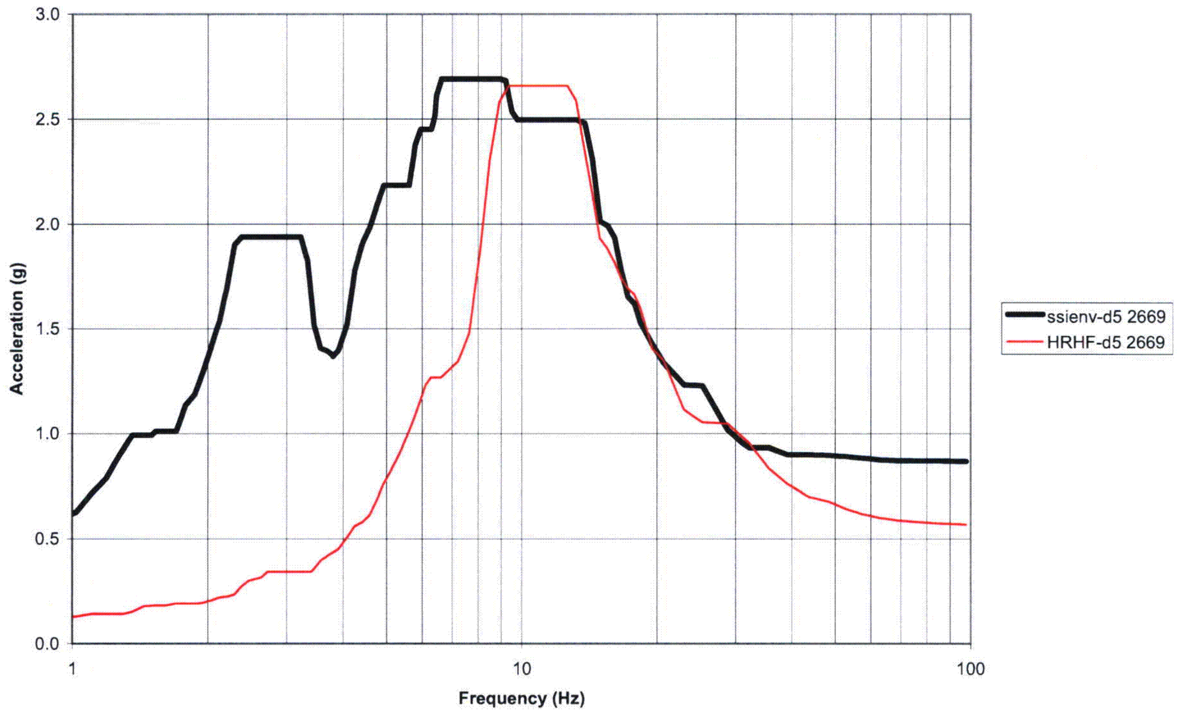


RAI-SRP3.7.1-SEB1-09-03b: ASB at Northeast Corner (Elevation 134.5') Y Direction

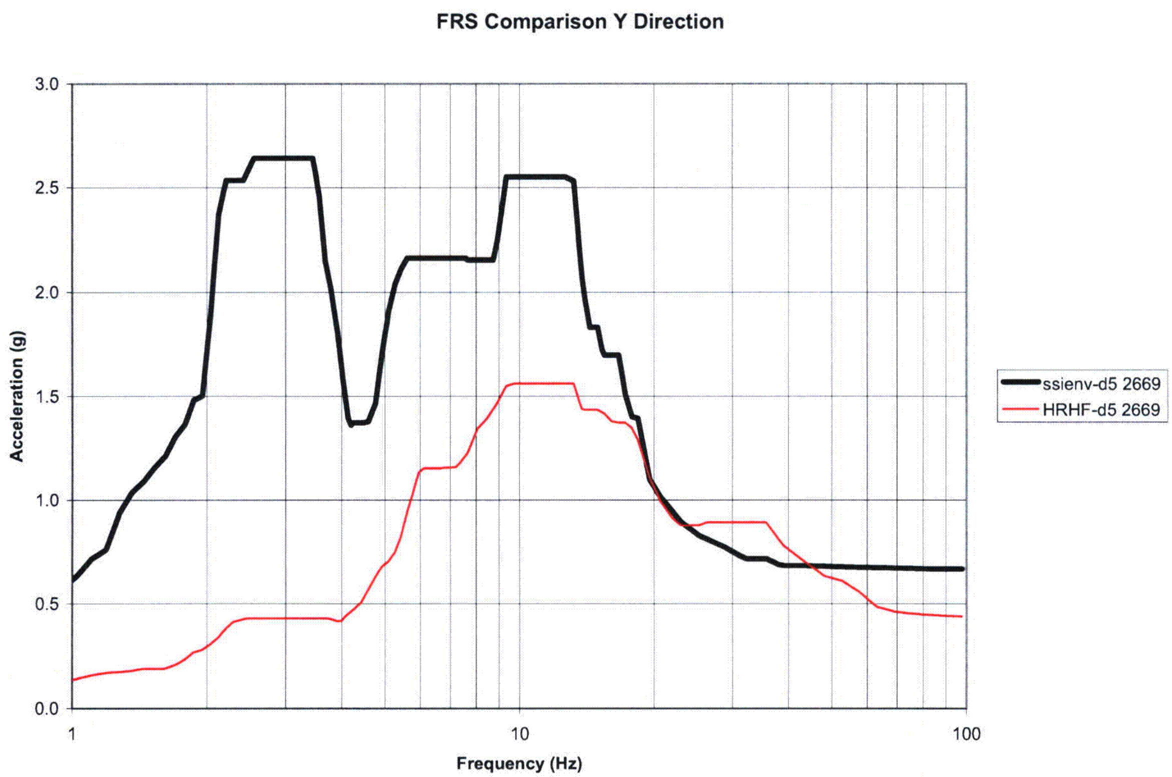


RAI-SRP3.7.1-SEB1-09-03c: ASB at Northeast Corner (Elevation 134.5') Z Direction

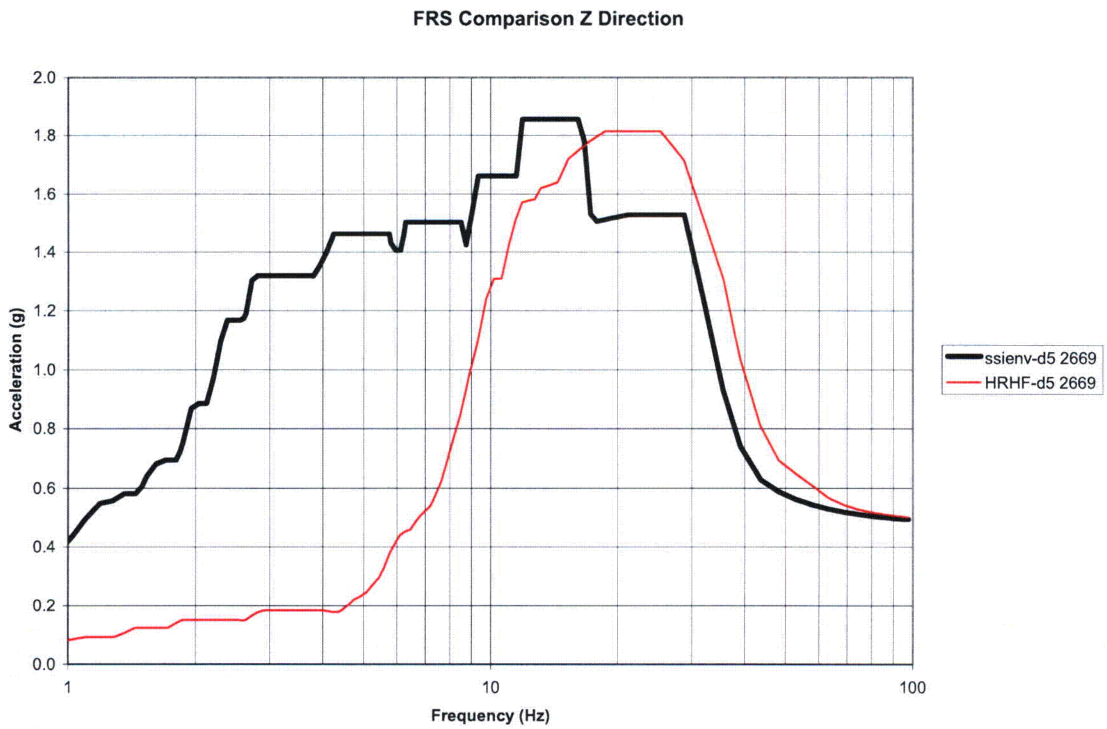
FRS Comparison X Direction



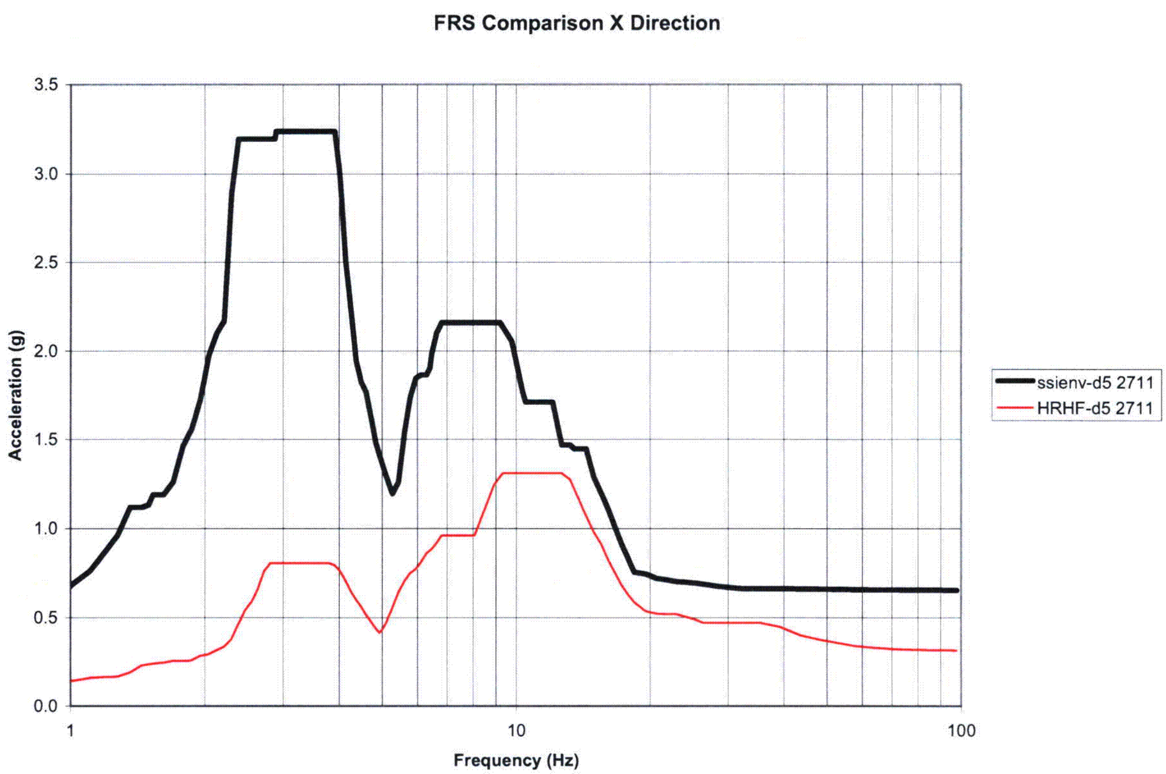
RAI-SRP3.7.1-SEB1-09-04a: ASB at Fuel Building Roof (Elevation 179.56') X Direction



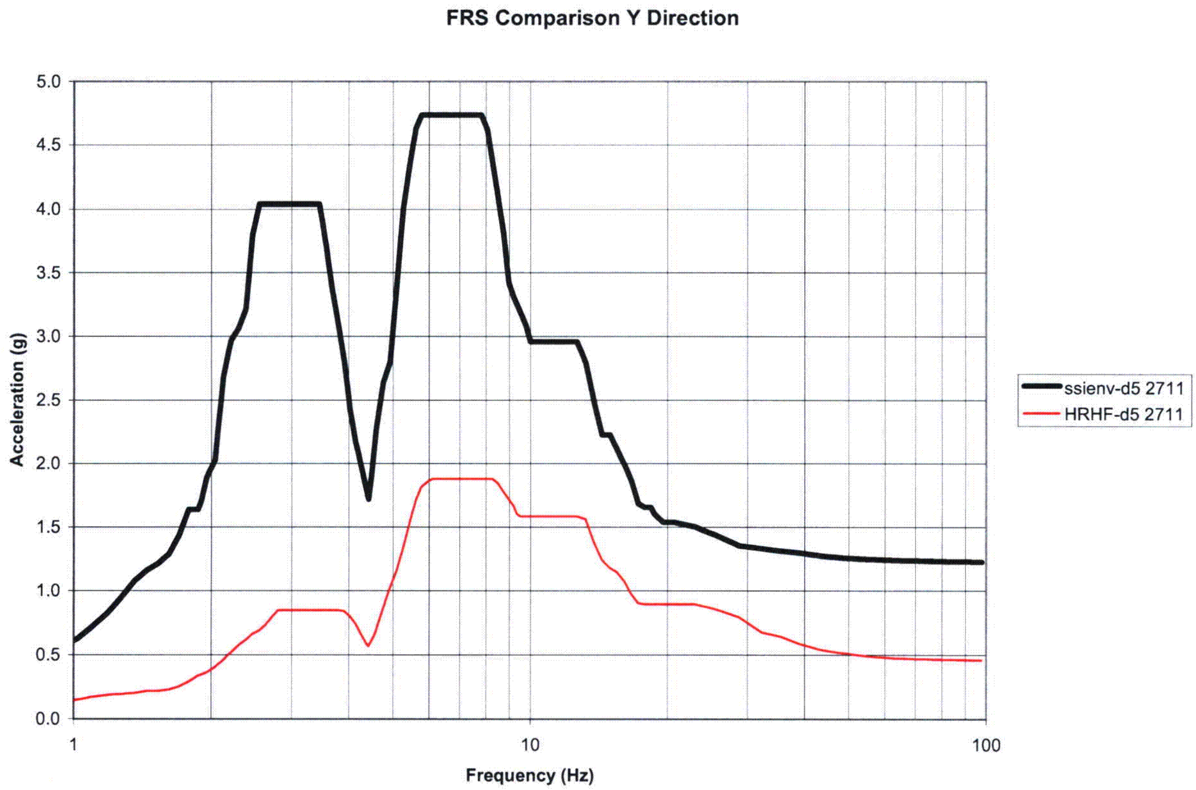
RAI-SRP3.7.1-SEB1-09-04b: ASB at Fuel Building Roof (Elevation 179.56') Y Direction



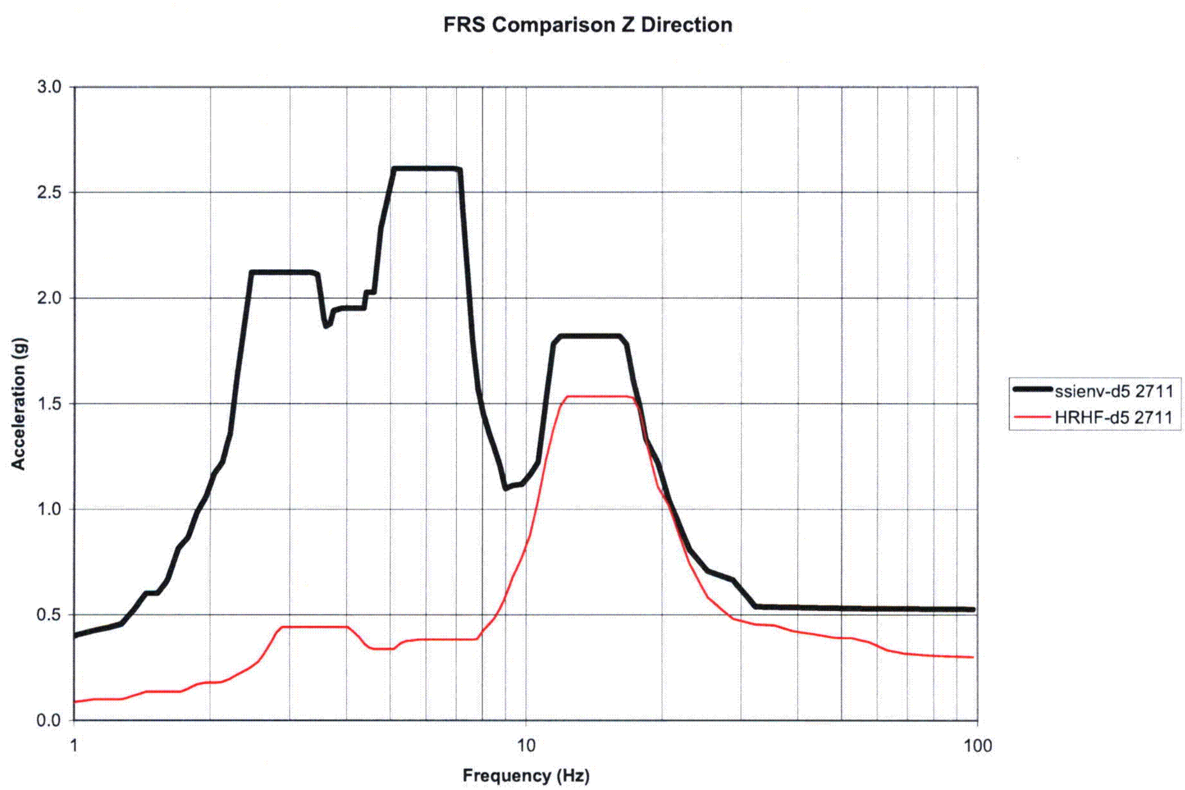
RAI-SRP3.7.1-SEB1-09-04c: ASB at Fuel Building Roof (Elevation 179.56') Z Direction



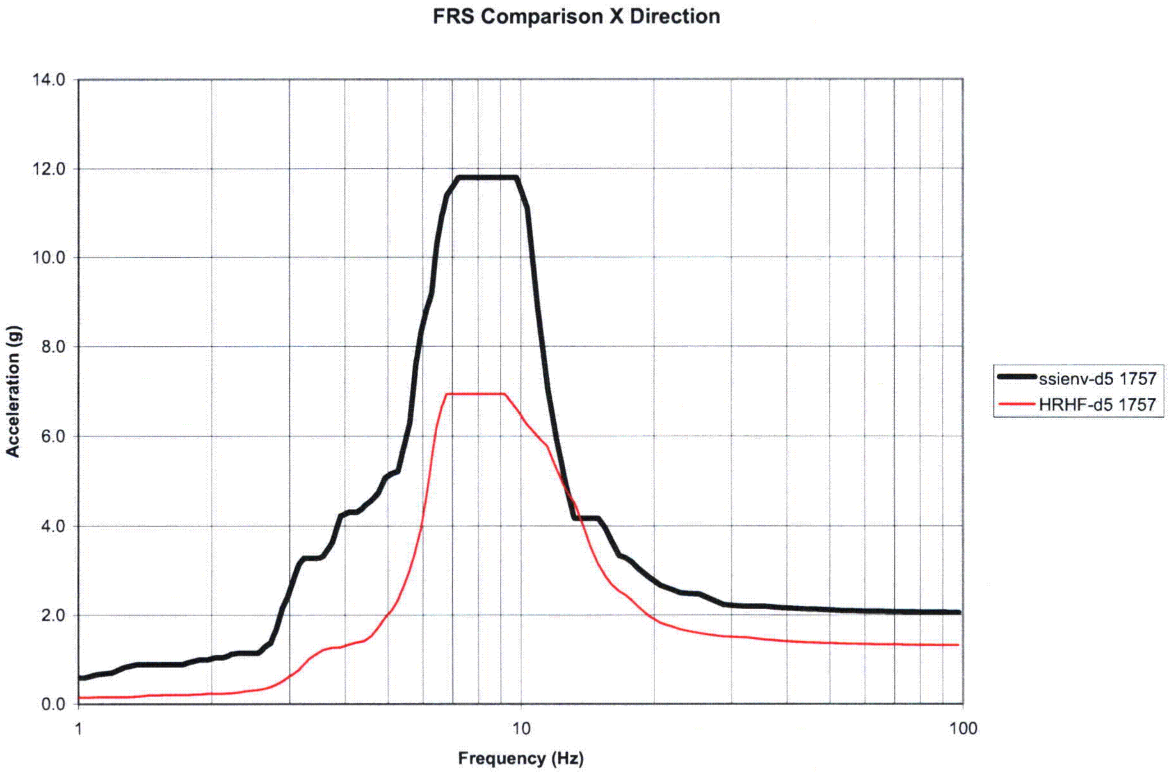
RAI-SRP3.7.1-SEB1-09-05a: ASB Shield Building (Elevation 180') X Direction



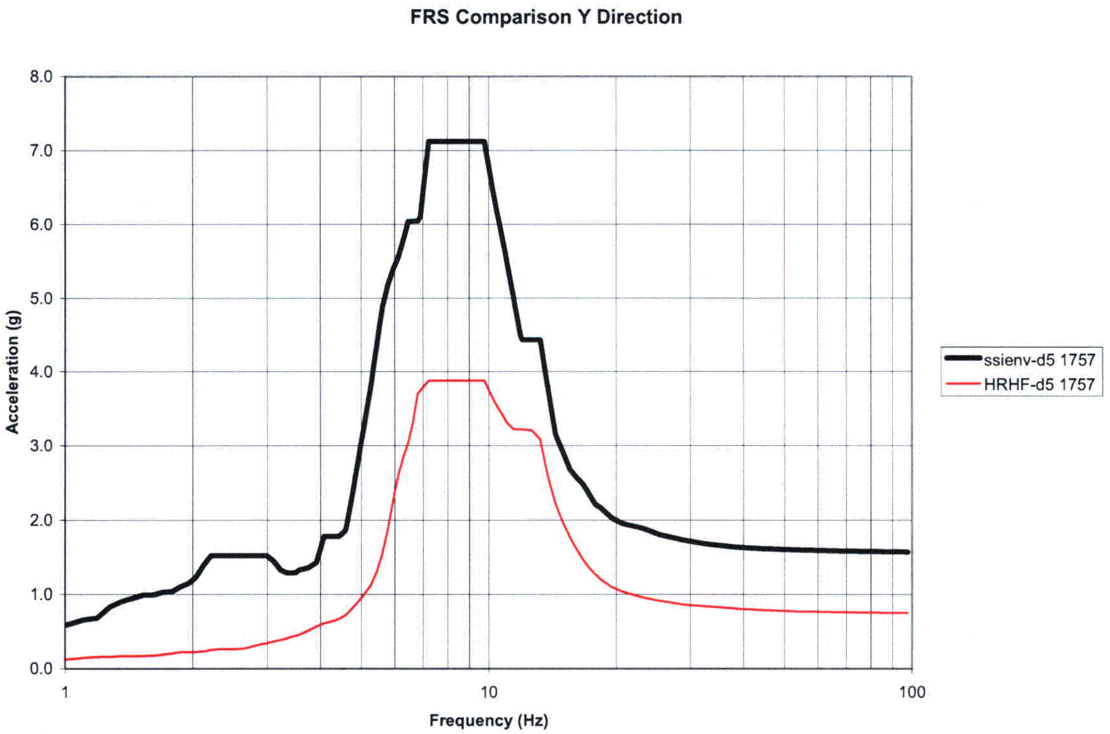
RAI-SRP3.7.1-SEB1-09-05b: ASB Shield Building (Elevation 180') Y Direction



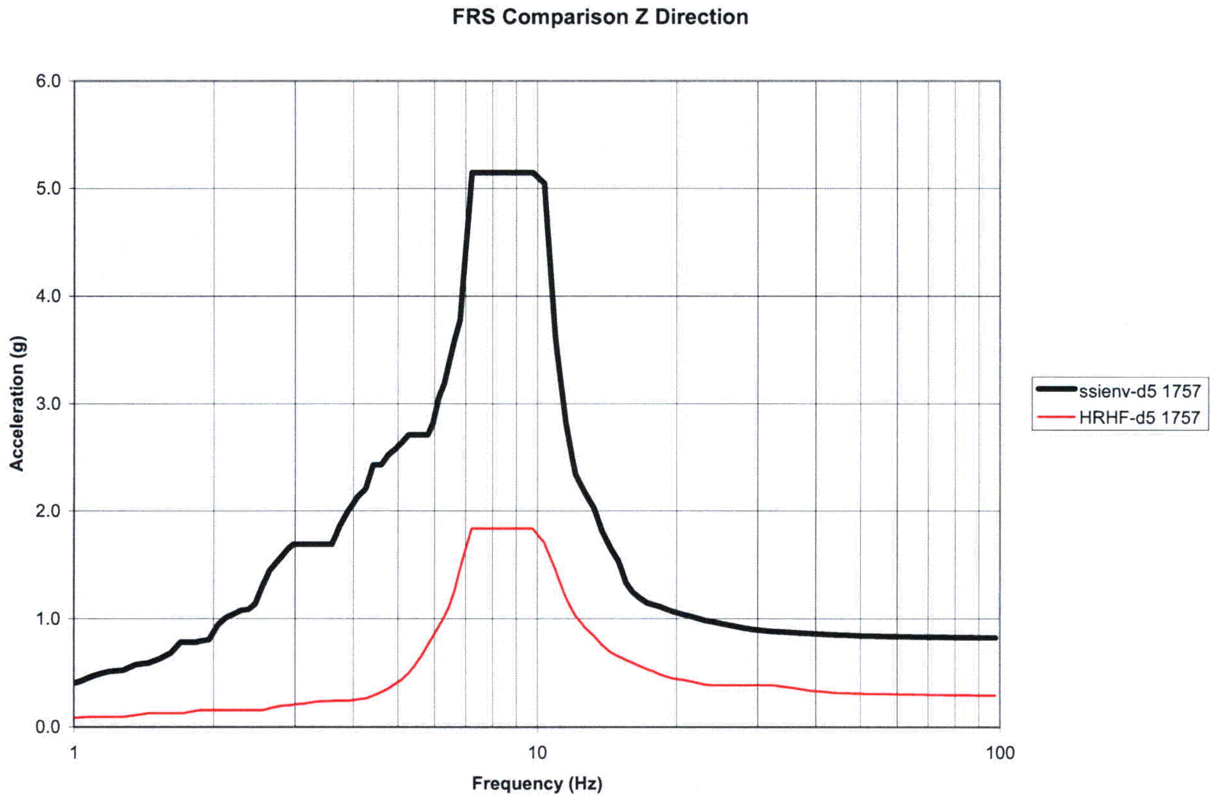
RAI-SRP3.7.1-SEB1-09-05c: ASB Shield Building (Elevation 180') Z Direction



RAI-SRP3.7.1-SEB1-09-06a: Reactor Coolant Pump X Direction



RAI-SRP3.7.1-SEB1-09-06b: Reactor Coolant Pump Y Direction



RAI-SRP3.7.1-SEB1-09-06c: Reactor Coolant Pump Z Direction

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

Figures RAI-SRP3.7.1-SEB1-09-01a to RAI-SRP3.7.1-SEB1-09-06c will replace Figures 5.2-1 through 5.2-6 in the next revision to TR-115.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.7.1-SEB1-10
Revision: 1

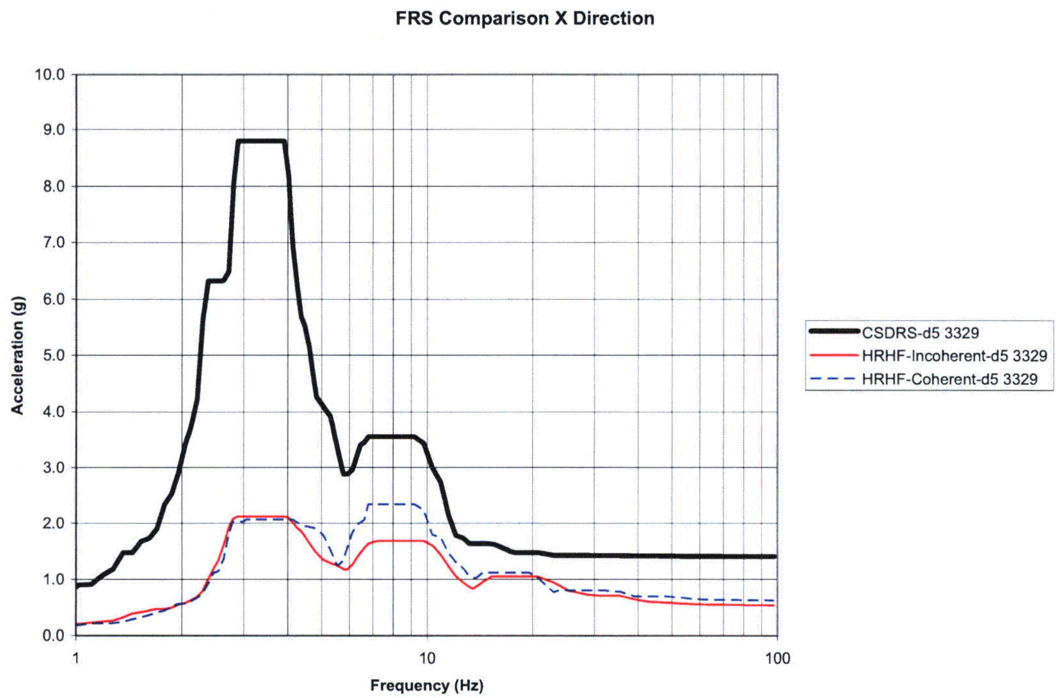
Question:

The staff requests that Westinghouse augment Figures 5.2-1 through 5.2-6 in TR-115, by adding the HRHF broadened spectra from the NI20 fixed base analysis, without any reduction for incoherency or other considerations. This will provide the staff with results needed to conduct an evaluation of the effect of incoherency.

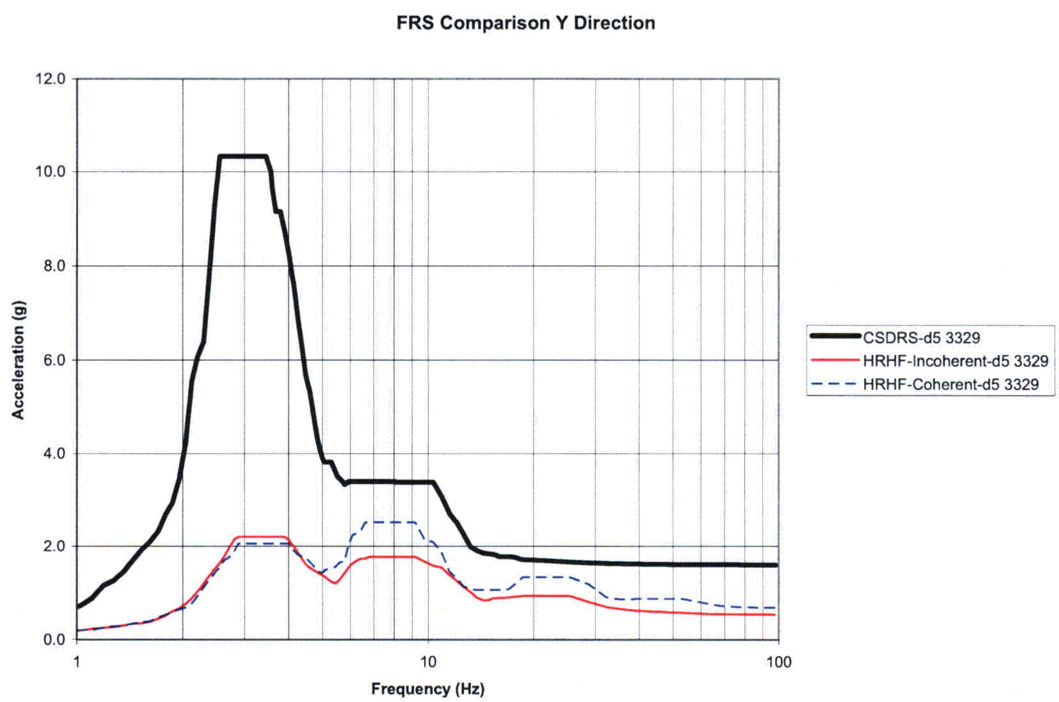
Westinghouse Response:

It iIs noted that Westinghouse uses the NEI recommended coherency function that reduces high frequency ground motions by accounting for special seismic wave incoherency. The rock-based coherency function that is being used was developed by Dr. Norman A. Abrahamson. This function is consistent with the requirements of the "Common Understanding" developed by the NRC staff and industry representatives during the December 20-21, 2006 public meeting. Since Westinghouse is using the coherency function that is consistent with the "Common Understanding" between the NRC and industry, it is not considered necessary to provide this information. There is nothing unique in the Westinghouse application of the coherency function.

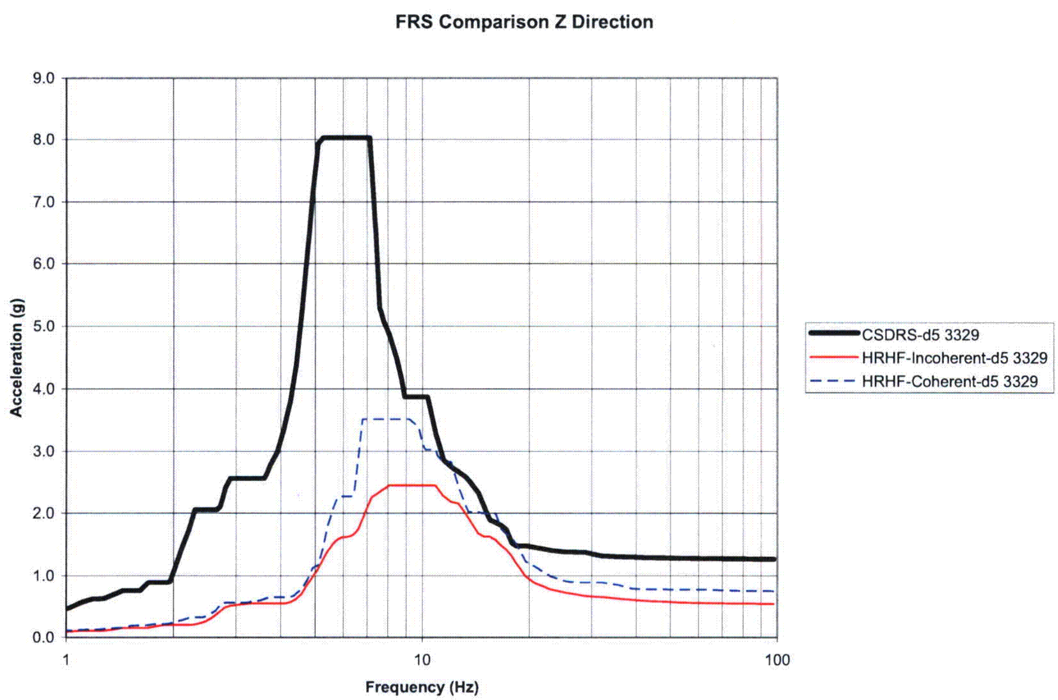
In response to the question raised by the NRC during May 19-23, 2008, Westinghouse has provided the response spectra for the HRHF broadened NI20 model with coherent and incoherent considerations in Figure RAI-SRP3.7.1-SEB1-10-1 to RAI-SRP3.7.1-SEB1-10-21 (5% damping).



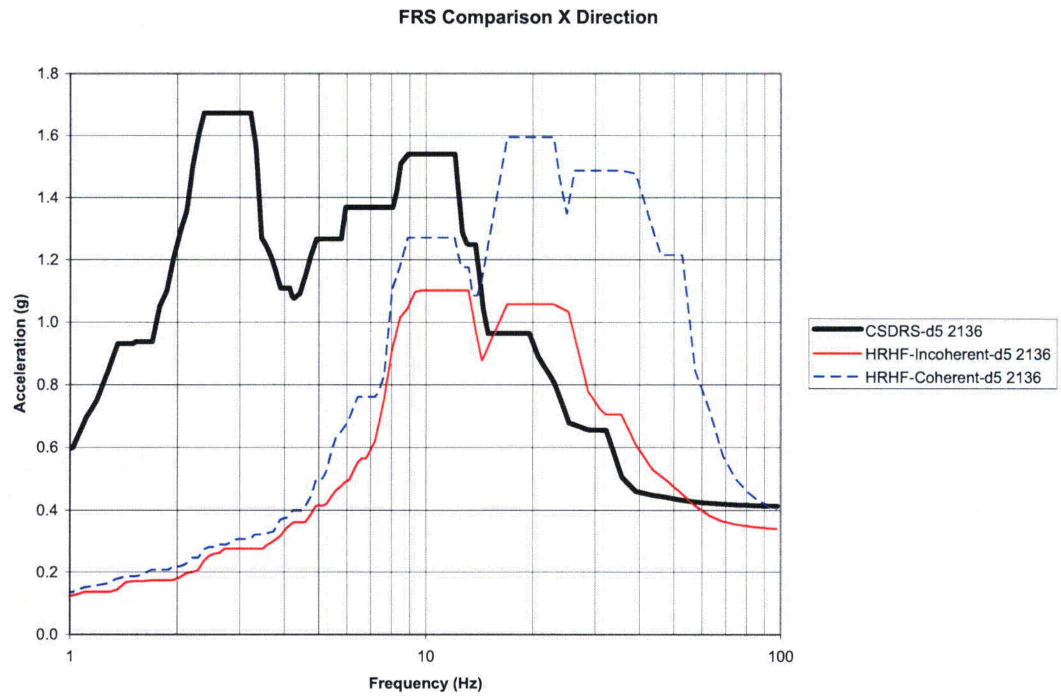
RAI-SRP3.7.1-SEB1-10-1: ASB at Elevation 327.4' X-Direction



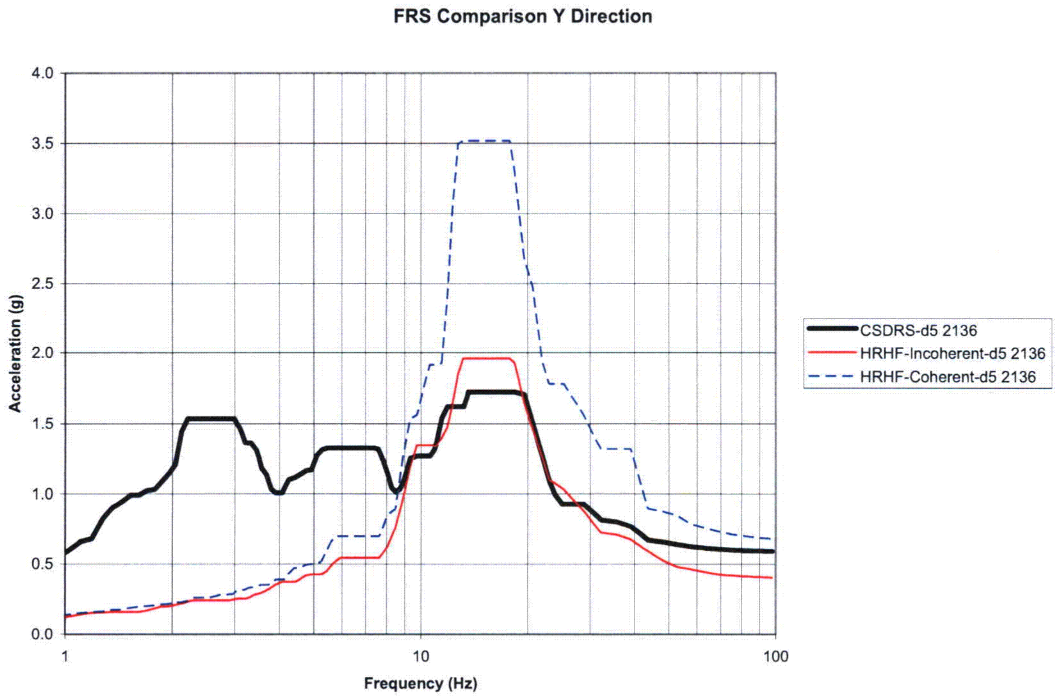
RAI-SRP3.7.1-SEB1-10-2: ASB at Elevation 327.4' Y-Direction



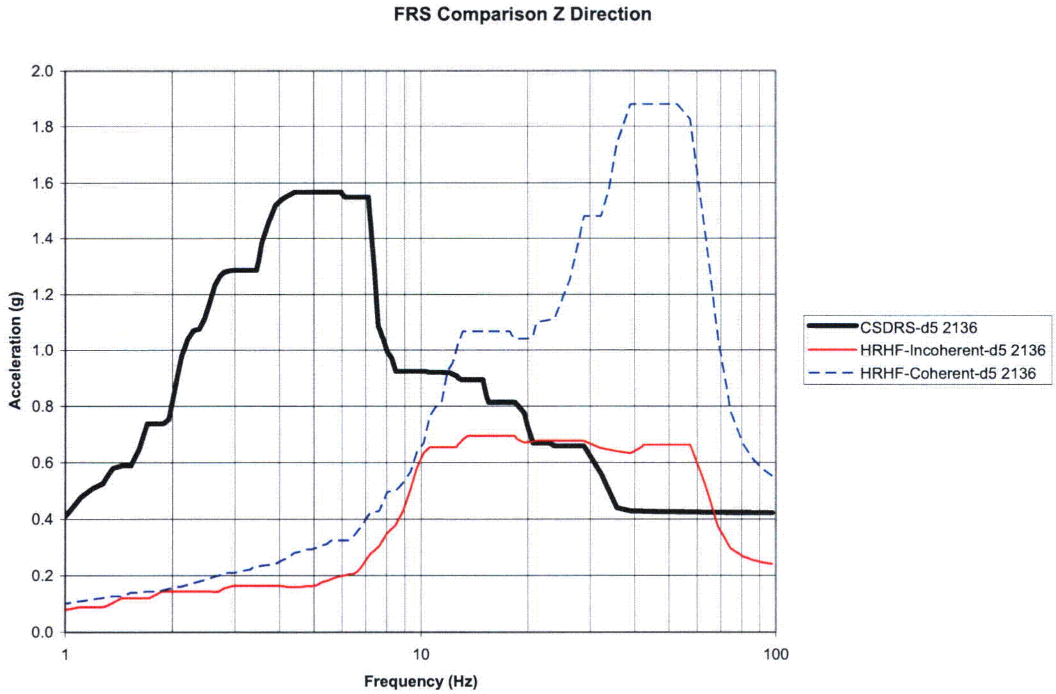
RAI-SRP3.7.1-SEB1-10-3: ASB at Elevation 327.4' Z-Directions



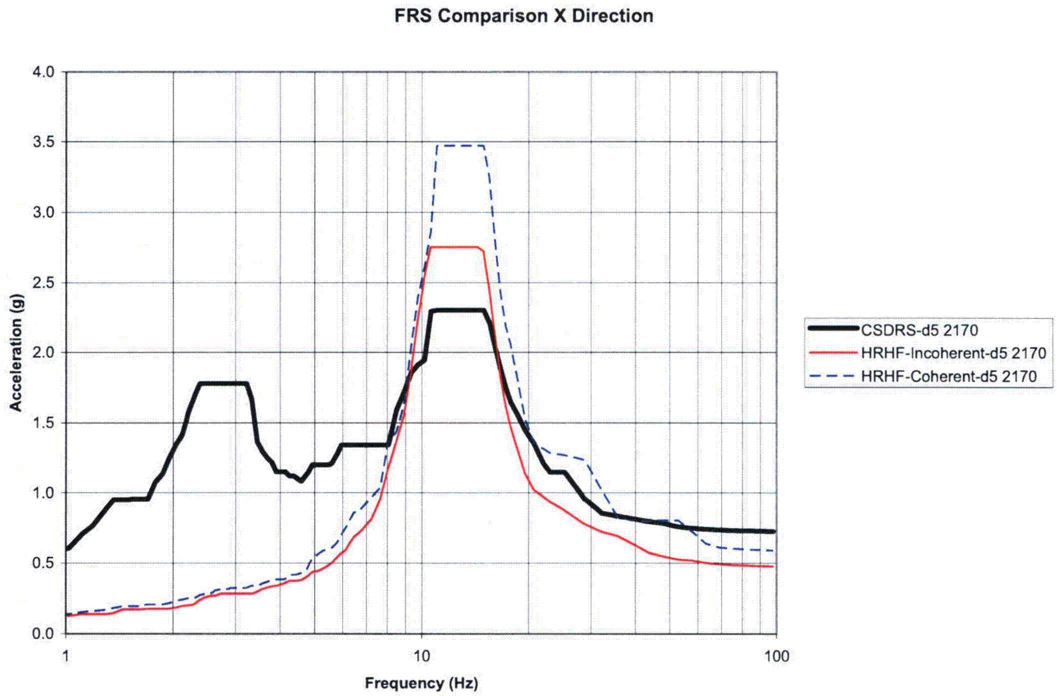
RAI-SRP3.7.1-SEB1-10-4: East Side Containment Operating Floor (Elevation 134.25') X-Direction



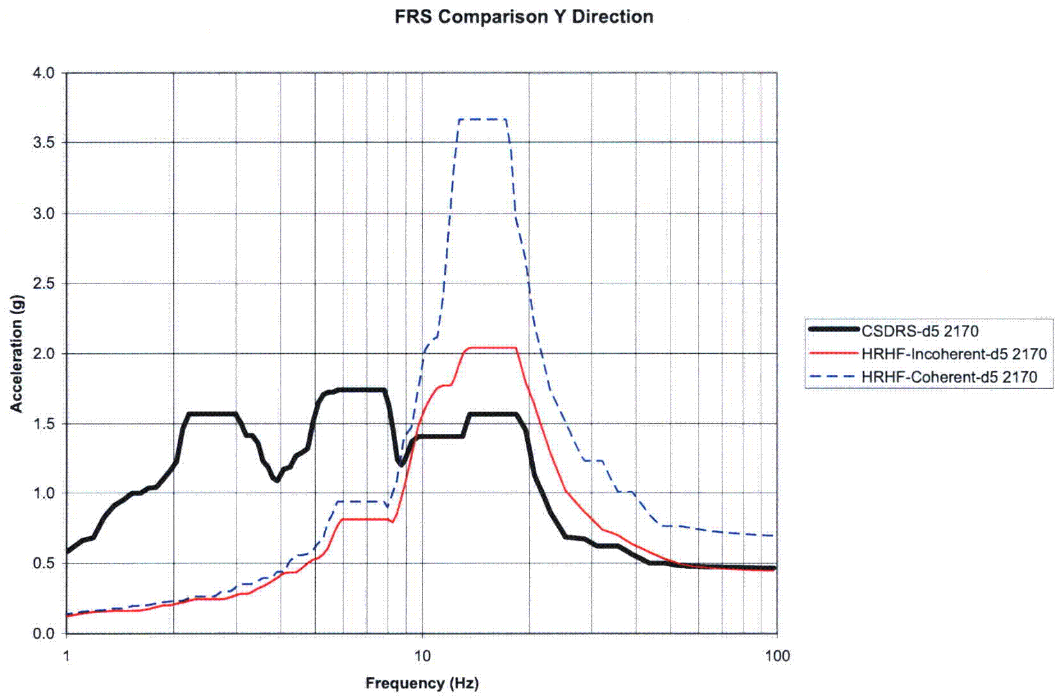
RAI-SRP3.7.1-SEB1-10-5: East Side Containment Operating Floor (Elevation 134.25') Y-Direction



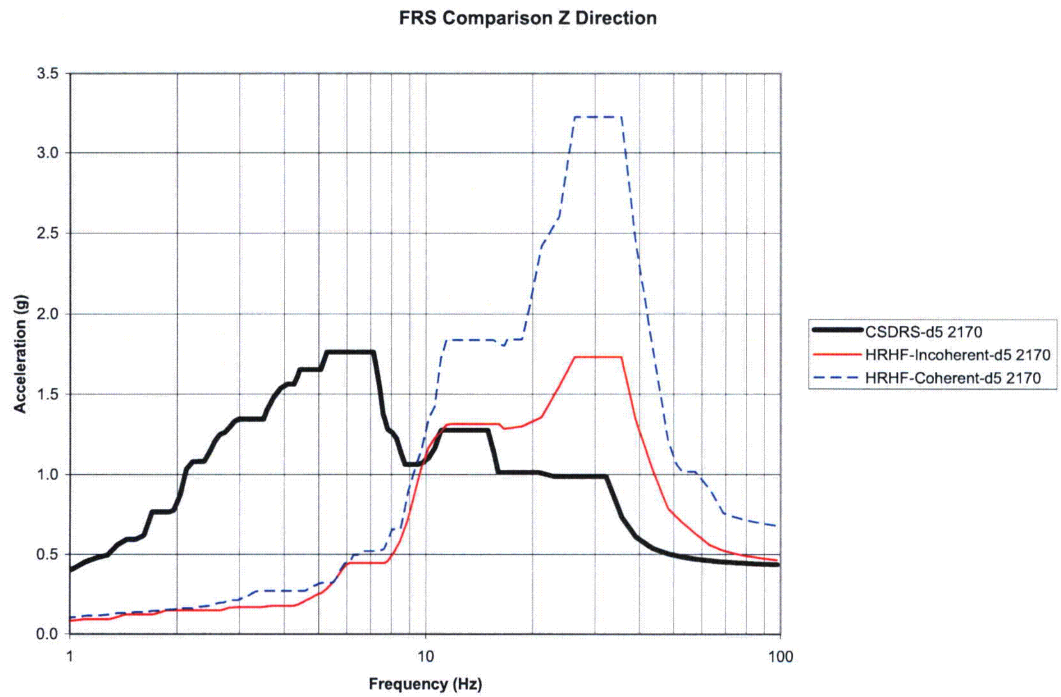
RAI-SRP3.7.1-SEB1-10-6: East Side Containment Operating Floor (Elevation 134.25') Z-Direction



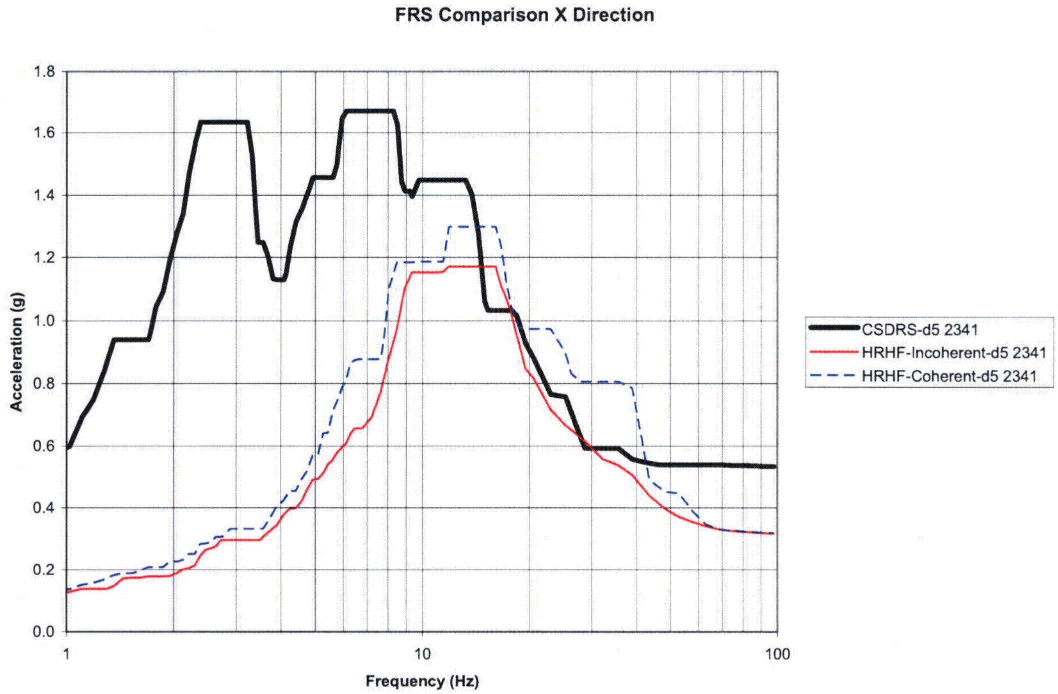
RAI-SRP3.7.1-SEB1-10-7: West Side Containment Operating Floor (Elevation 134.25') X-Direction



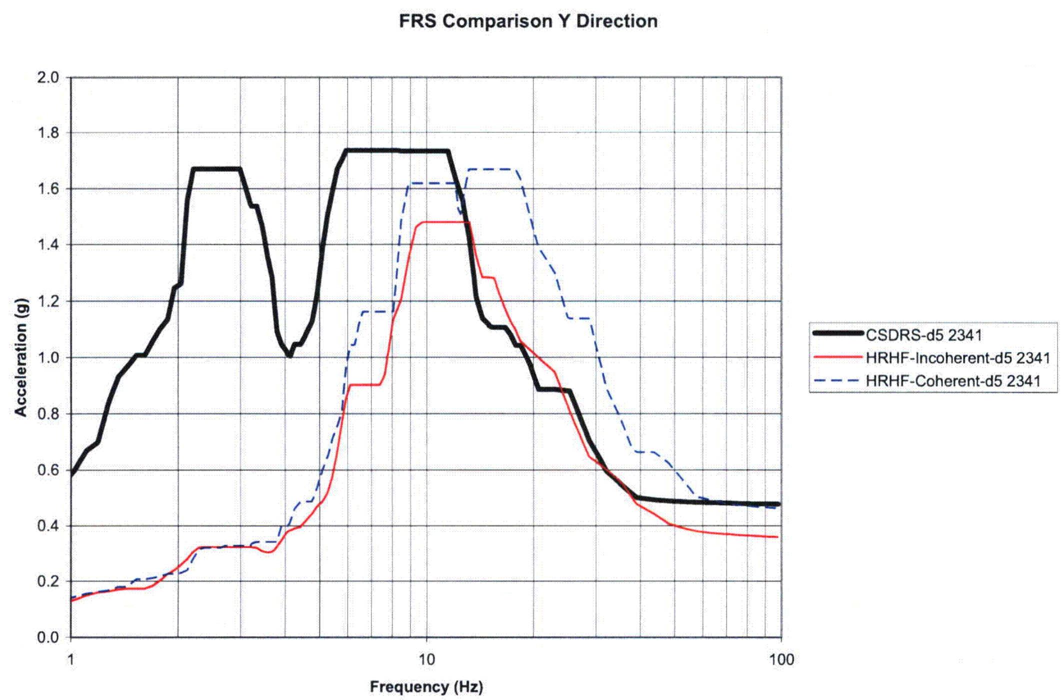
RAI-SRP3.7.1-SEB1-10-8: West Side Containment Operating Floor (Elevation 134.25') Y-Direction



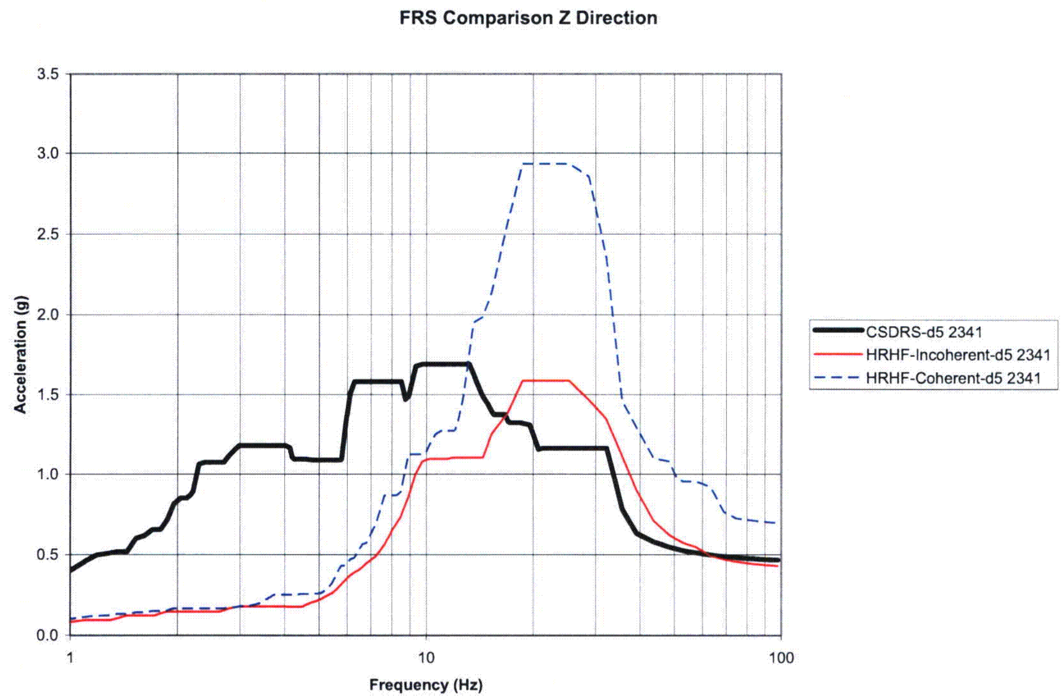
RAI-SRP3.7.1-SEB1-10-9: West Side Containment Operating Floor (Elevation 134.25') Z-Direction



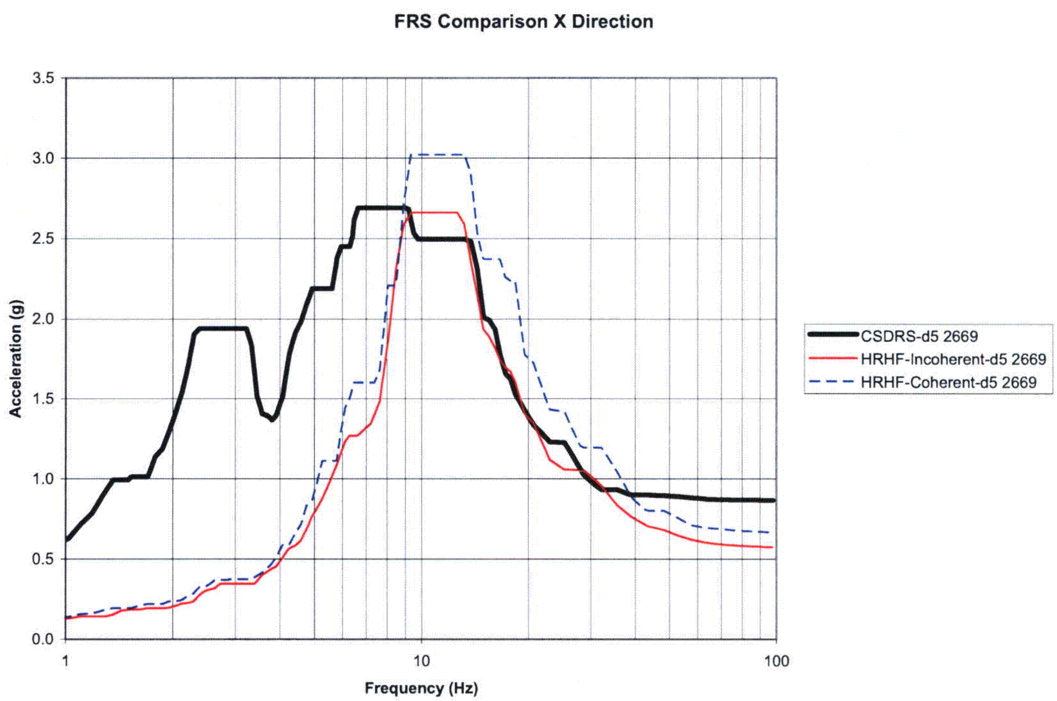
RAI-SRP3.7.1-SEB1-10-10: ASB at Northeast Corner (Elevation 134.5') X-Direction



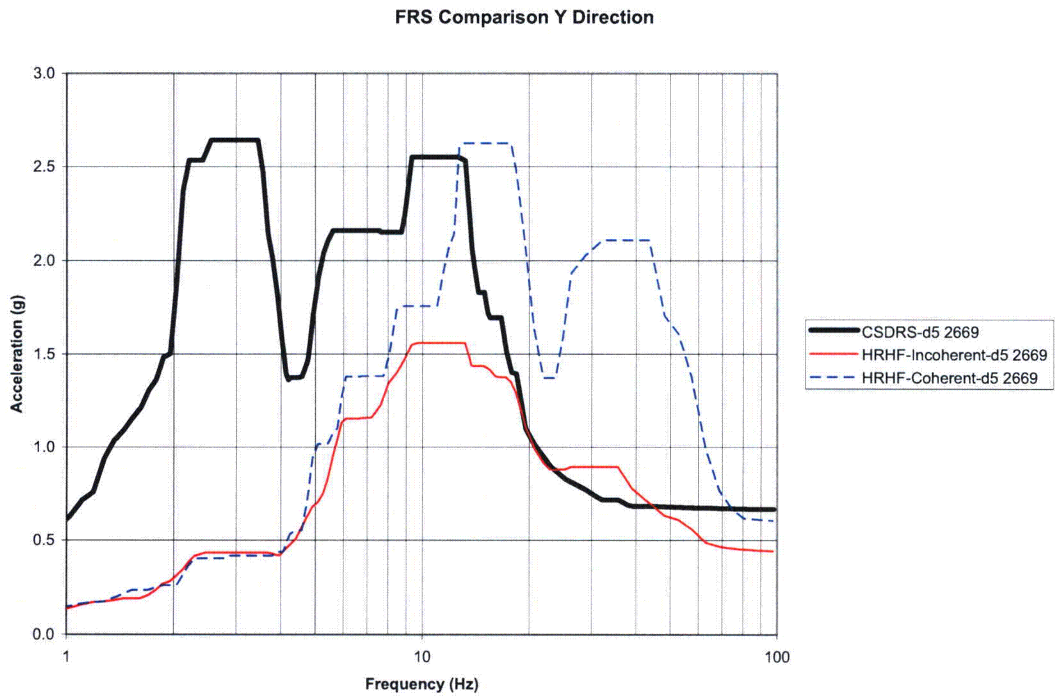
RAI-SRP3.7.1-SEB1-10-11: ASB at Northeast Corner (Elevation 134.5') Y-Direction



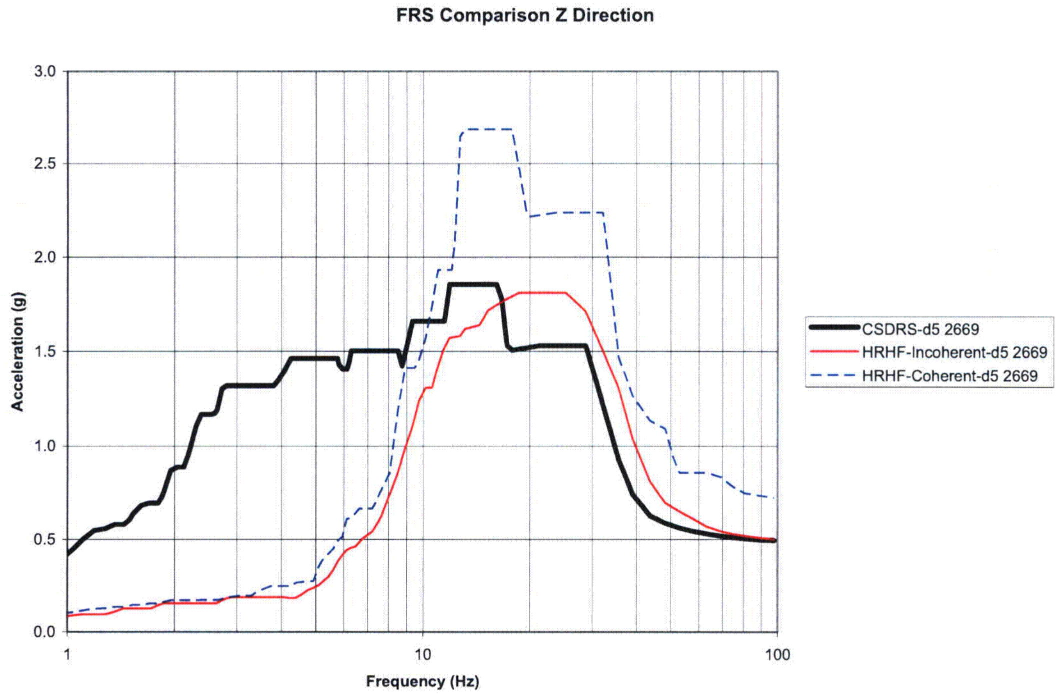
RAI-SRP3.7.1-SEB1-10-12: ASB at Northeast Corner (Elevation 134.5') Z-Direction



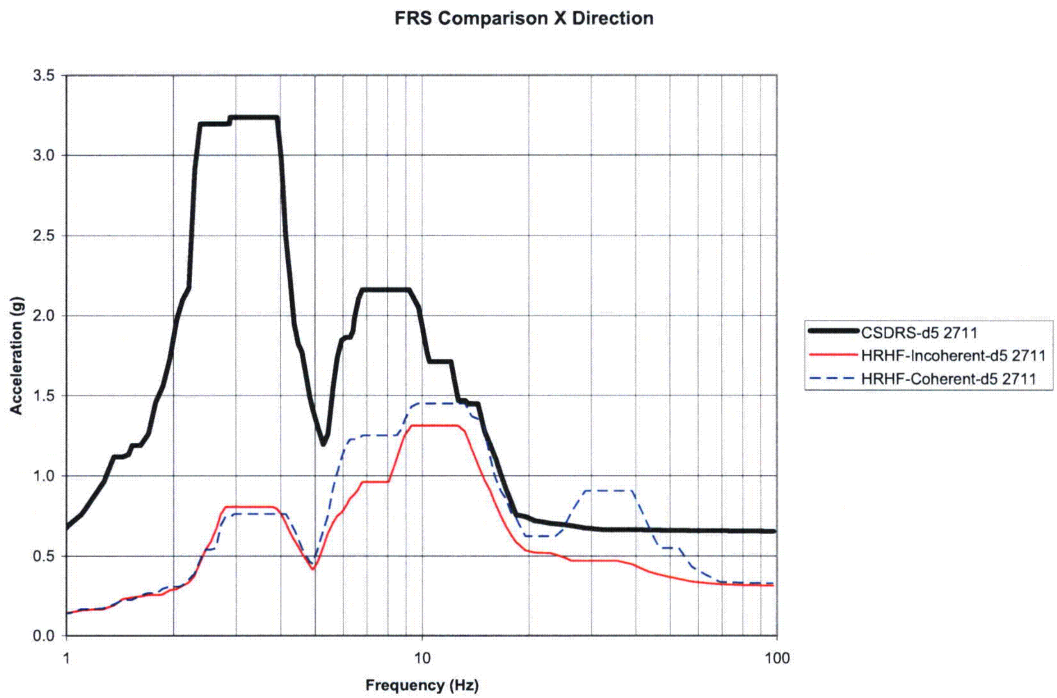
RAI-SRP3.7.1-SEB1-10-13: ASB at Fuel Building Roof (Elevation 179.56') X-Direction



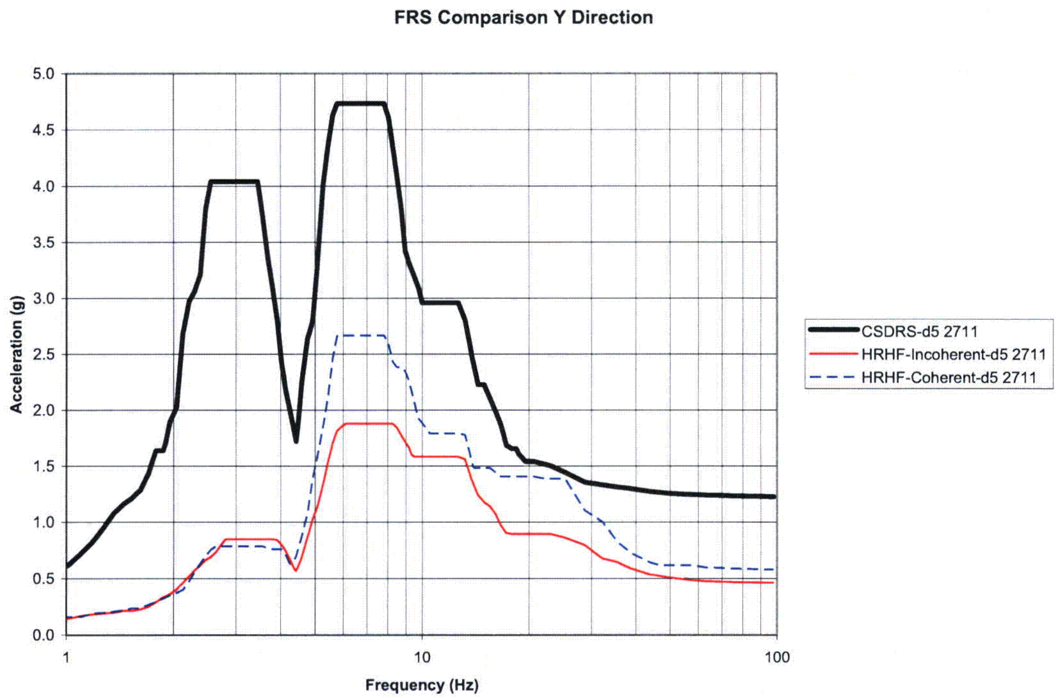
RAI-SRP3.7.1-SEB1-10-14: ASB at Fuel Building Roof (Elevation 179.56') Y-Direction



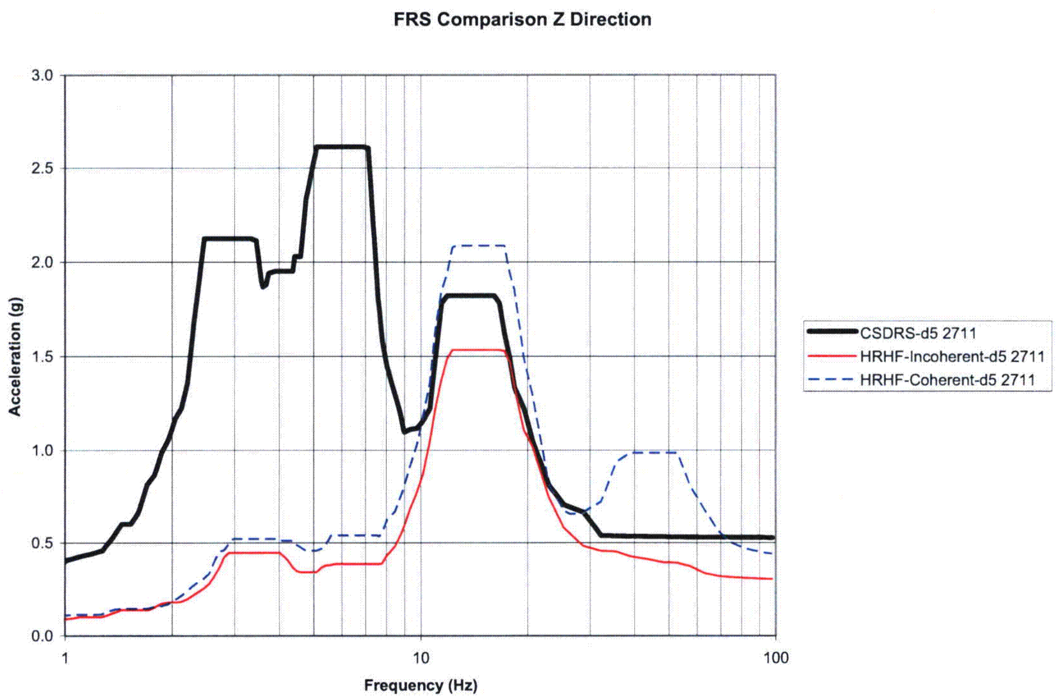
RAI-SRP3.7.1-SEB1-10-15: ASB at Fuel Building Roof (Elevation 179.56') Z-Direction



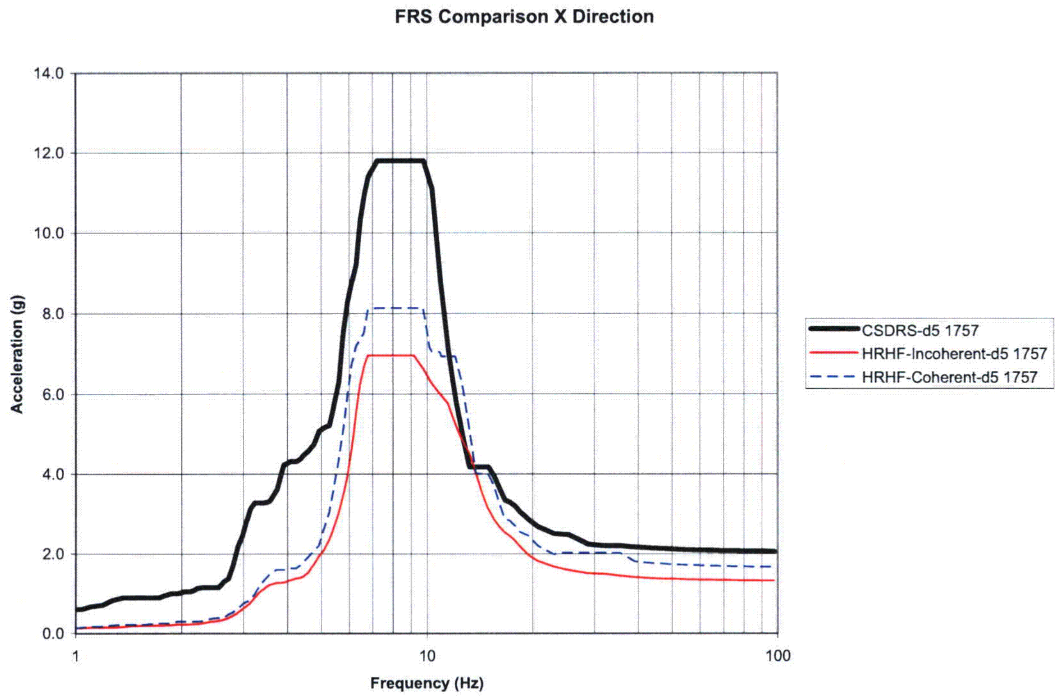
RAI-SRP3.7.1-SEB1-10-16: FRS Nodes – Elevation 180' X-Direction



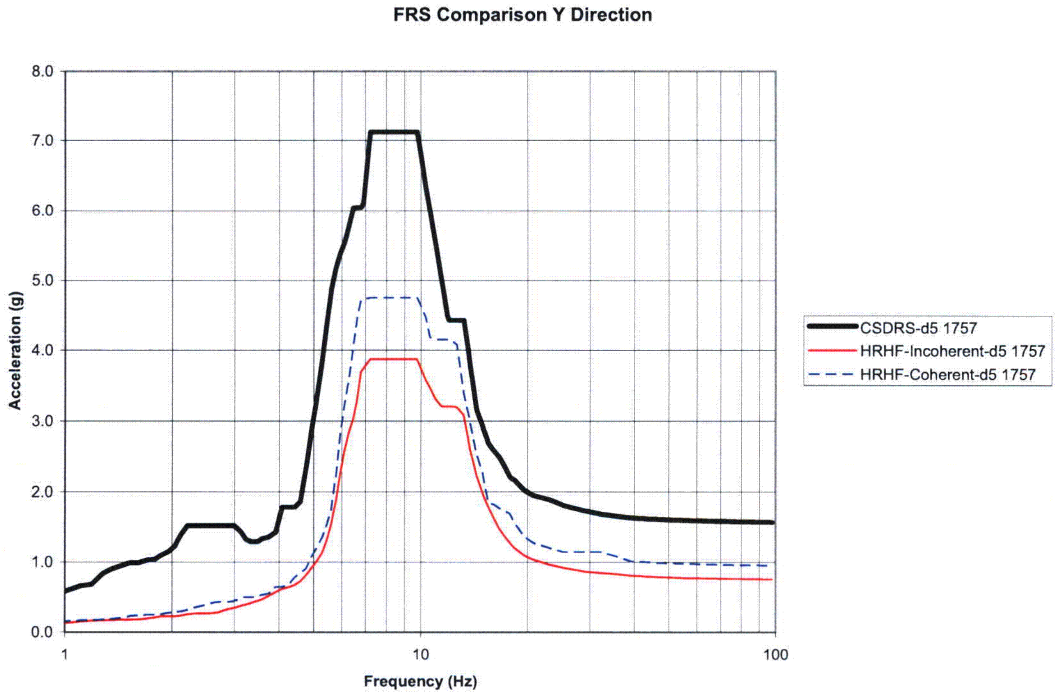
RAI-SRP3.7.1-SEB1-10-17: FRS Nodes – Elevation 180' Y-Direction



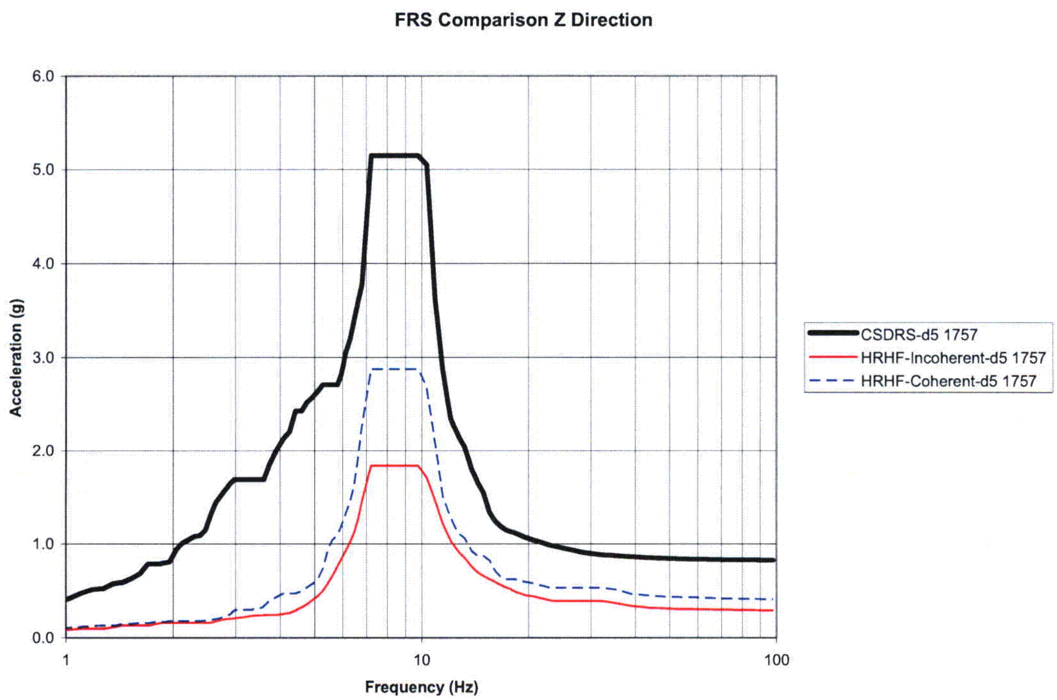
RAI-SRP3.7.1-SEB1-10-18: FRS Nodes – Elevation 180' Z-Direction



RAI-SRP3.7.1-SEB1-10-19: Reactor Coolant Pump – Elevation 99' X-Direction



RAI-SRP3.7.1-SEB1-10-20: Reactor Coolant Pump – Elevation 99' Y-Direction



RAI-SRP3.7.1-SEB1-10-21: Reactor Coolant Pump – Elevation 99' Z-Direction

Reference(s): None

Design Control Document (DCD) Revision: None

PRA Revision: None

Technical Report (TR) Revision: ~~None~~The Figure RAI-SRP3.7.1-SEB1-10-1 to RAI-SRP3.7.1-SEB1-10-21 will replace Figure 5.2-1 through 5.2-6 in TR-115. See also RAI-SRP3.7.1-SEB1-11 for changes to Section 5.2.

5.2 Comparison of CSDRS and HRHF Response Spectra

To show the significance of the HRHF response spectra, the CSDRS and HRHF seismic responses are compared. Figures 5.2-1 through 5.2-6 (5% damping) compare the response spectra with coherent and incoherent considerations at a number of locations in the nuclear island. There are some exceedances, mostly above the 15 Hz region. These curves are typical of the plant comparative responses found throughout the plant.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.7.1-SEB1-11
Revision: 1

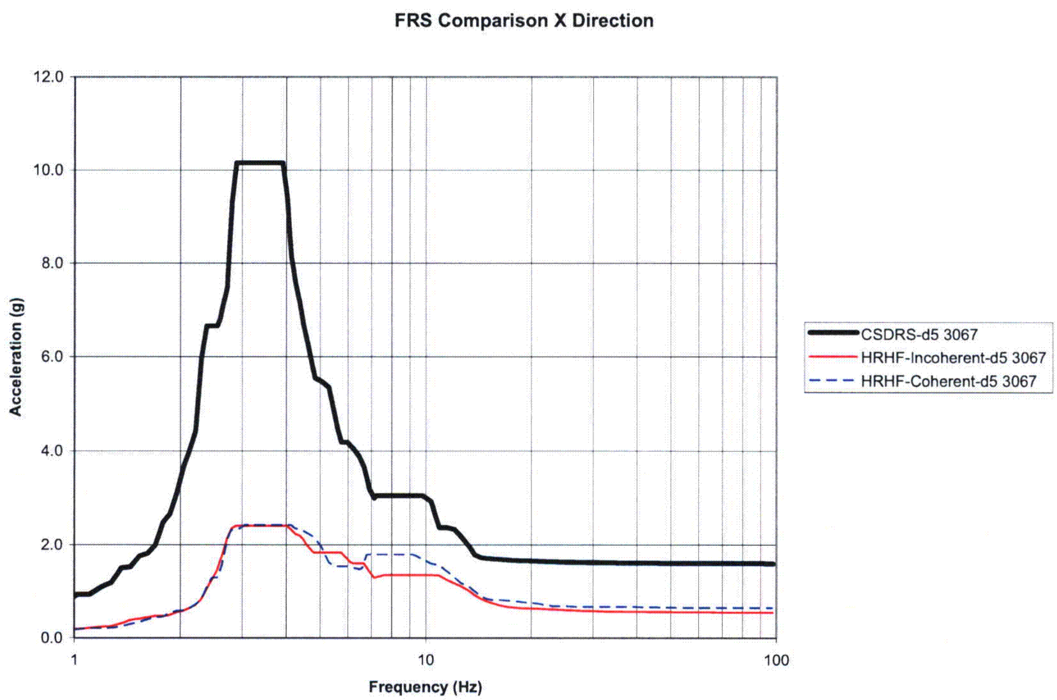
Question:

The staff requests that Westinghouse provide additional figures in Section 5.2 TR-115, to include all location/direction combinations presented in the Section 5.1 figures, and to provide a cross-reference between the corresponding 5.1 and 5.2 figures.

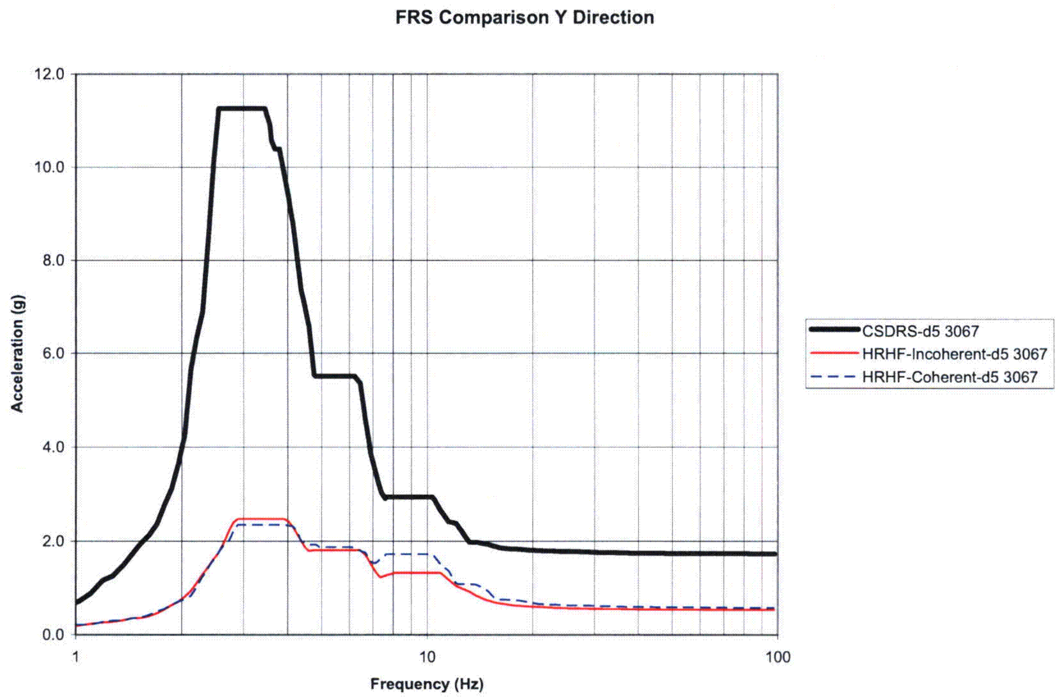
Westinghouse Response:

The figures provided in Section 5.1 are for comparison of NI10 and NI20 models. The time histories are different from that used in the HRHF evaluation documented in TR-115 as discussed in the Westinghouse response to RAI-SRP3.7.1-SEB01-07. No reduction for incoherency was considered. A representative group of HRHF floor response spectra were developed at locations considered susceptible to the high frequency response for comparison to the CSDRS floor response spectra. Some of these locations are the same or close to those given in Section 5.1. It would not be useful to add additional figures in Section 5.2 since the locations chosen are considered sufficient for comparison. A cross-reference between corresponding 5.1 and 5.2 figures cannot be given since different time histories are used.

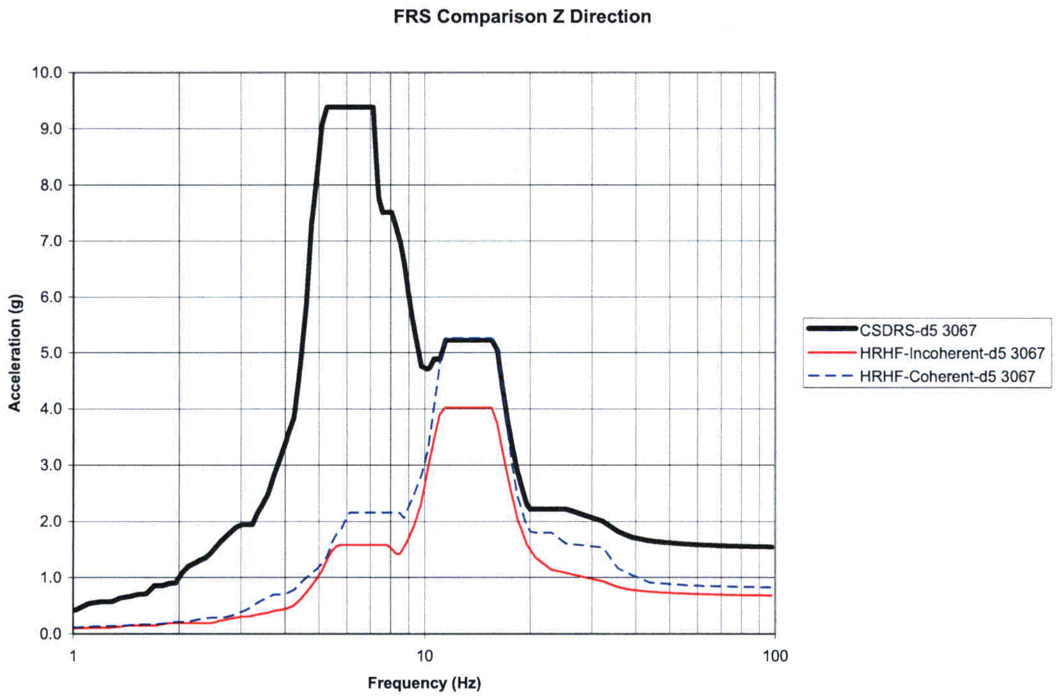
In response to the NRC's request to supplement Section 5.2 in the TR-115 during May 19-23, 2008, Westinghouse has provided incoherent and coherent comparison response spectrum for the nodal locations presented in TR-115 Section 5.1. These spectra are presented below in Figure RAI-SRP3.7.1-SEB1-11-1 to RAI-SRP3.7.1-SEB1-11-9 (5% damping).



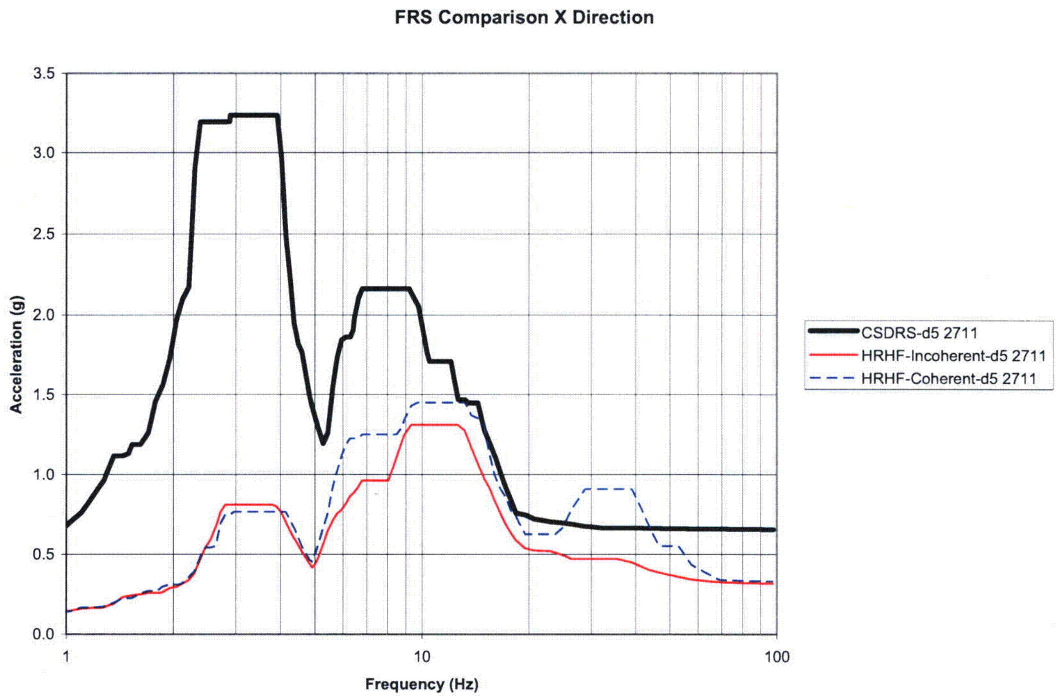
RAI-SRP3.7.1-SEB1-11-1: Seismic Response Spectra on roof of Shield Building X-Direction



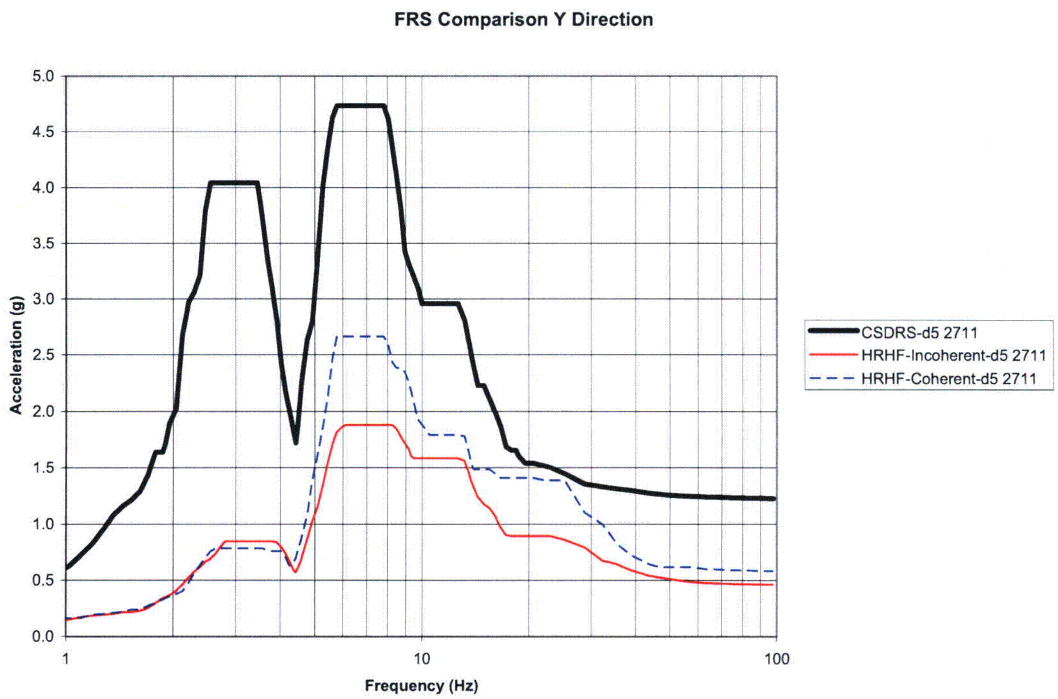
RAI-SRP3.7.1-SEB1-11-2: Seismic Response Spectra on roof of Shield Building Y-Direction



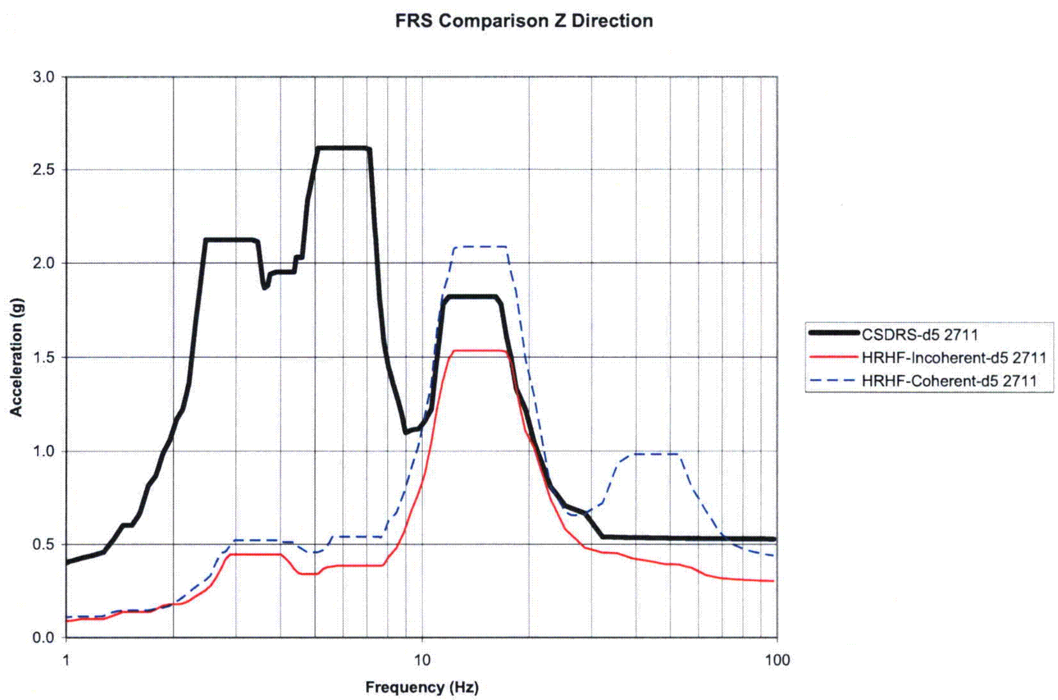
RAI-SRP3.7.1-SEB1-11-3: Seismic Response Spectra on roof of Shield Building Z-Direction



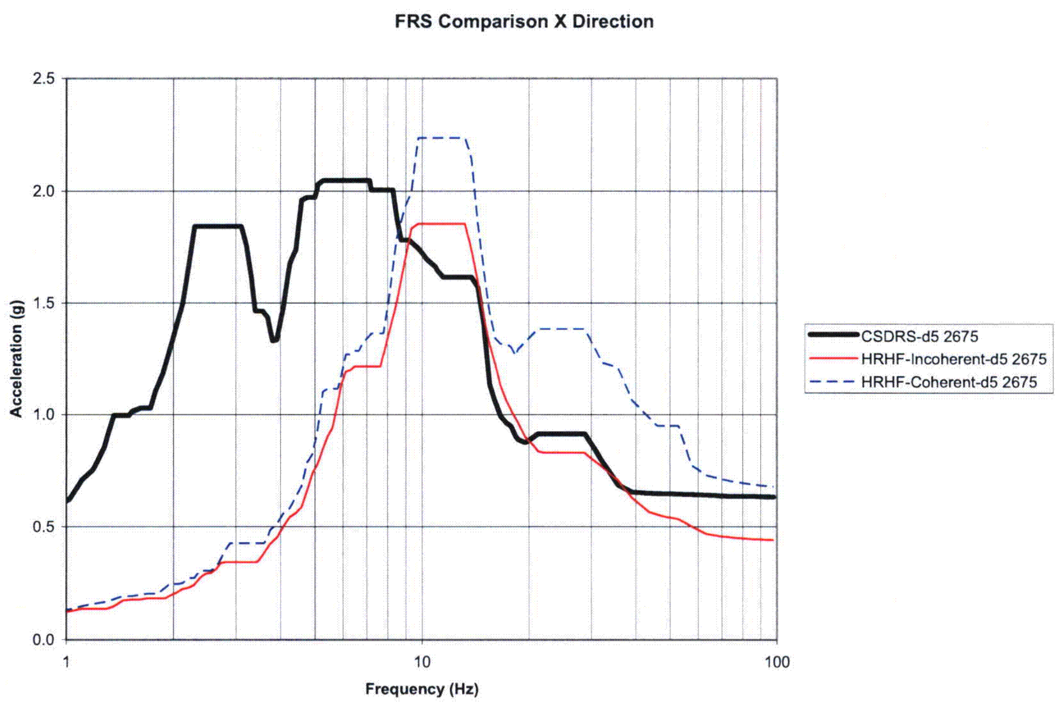
RAI-SRP3.7.1-SEB1-11-4: Seismic Response Spectra for West Side of Shield Building X-Direction



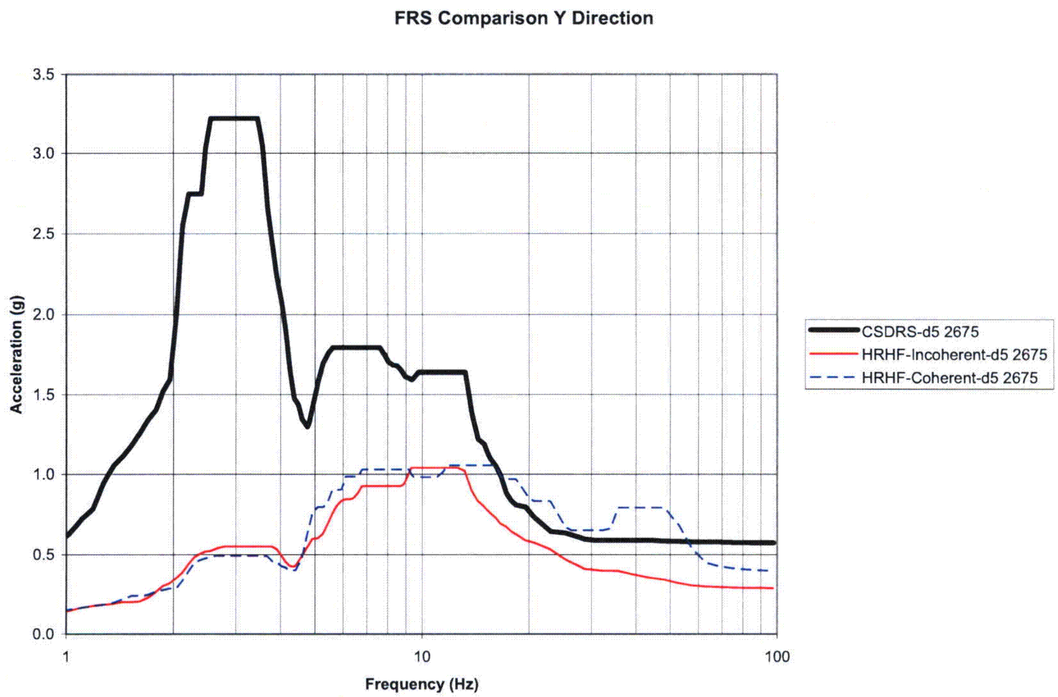
RAI-SRP3.7.1-SEB1-11-5: Seismic Response Spectra for West Side of Shield Building Y-Direction



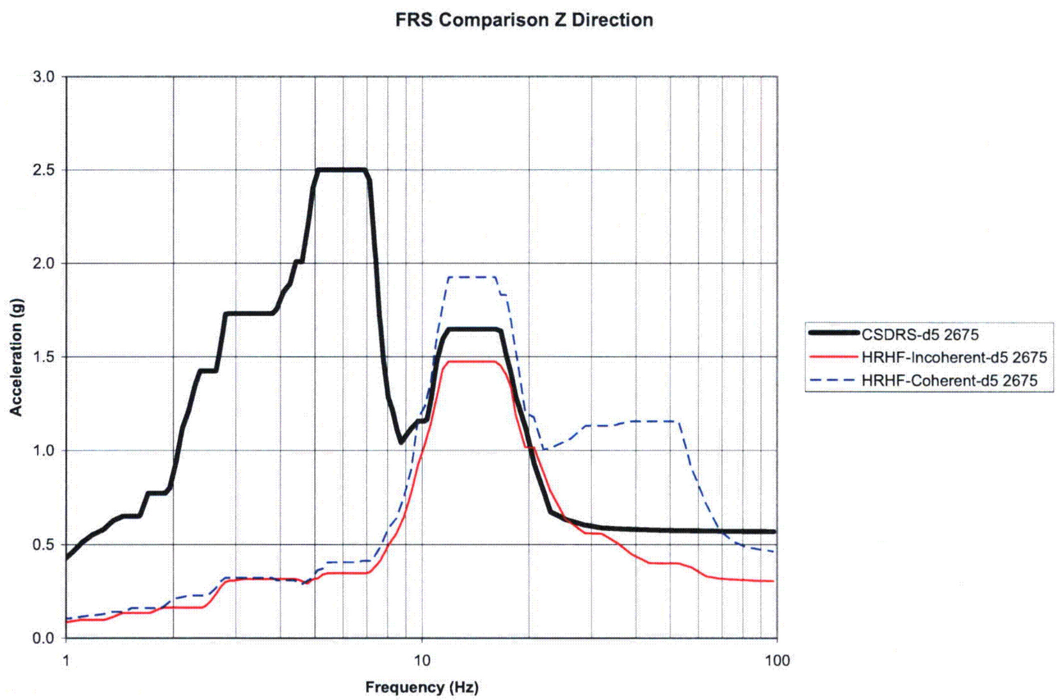
RAI-SRP3.7.1-SEB1-11-6: Seismic Response Spectra for West Side of Shield Building Z-Direction



RAI-SRP3.7.1-SEB1-11-7: Seismic Response Spectra for South Side of Shield Building X-Direction



RAI-SRP3.7.1-SEB1-11-8: Seismic Response Spectra for South Side of Shield Building Y-Direction



RAI-SRP3.7.1-SEB1-11-9: Seismic Response Spectra for South Side of Shield Building Z-Direction

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

~~None~~The figures presented in this response request will be added to Section 5.2 of the TR-115 to supplement the existing data as Figures 5.2-7 and 5.2-8. Note that Figure 5.2-5 will be replaced by Figures RAI-SRP3.7.1-SEB1-11-4 to RAI-SRP-SEB1-11-6. Each figure will have the floor response spectra associated with the X, Y, and Z response. See also RAI-SRP-3.7.1-10 for additional changes to Section 5.2.

5.2 Comparison of CSDRS and HRHF Response Spectra

To show the significance of the HRHF response spectra, the CSDRS and HRHF seismic responses are compared. Figures 5.2-1 through 5.2-8 (5% damping) compare the response spectra with coherent and incoherent considerations at a number of locations in the nuclear island. There are some exceedances, mostly above the 15 Hz region. These curves are typical of the plant comparative responses found throughout the plant.