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Your ref: Docket No. 52-006
Our ref: DCP/NRC2374

February 4, 2009

Subject: AP1000 Responses to Requests for Additional Information (SRP3)

Westinghouse is submitting this response to the NRC request for additional information (RAI) on SRP Section 3. 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.

Enclosure 1 provides the response for the following RAI:

RAI-SRP3.7.1-SEB1-09 R2

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,

D. A. Lindgren /FOR

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

/Enclosure

1. Response to Request for Additional Information on SRP Section 3



D063
NRO

| | | | | |
|---|---|---|---|---|
| cc: | D. Jaffe | - | U.S. NRC | 1E |
| | E. McKenna | - | U.S. NRC | 1E |
| | B. Gleaves | - | U.S. NRC | 1E |
| | T. Spink | - | TVA | 1E |
| | P. Hastings | - | Duke Power | 1E |
| | R. Kitchen | - | Progress Energy | 1E |
| | A. Monroe | - | SCANA | 1E |
| | P. Jacobs | - | Florida Power & Light | 1E |
| | C. Pierce | - | Southern Company | 1E |
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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 3

# AP1000 TECHNICAL REPORT REVIEW

## Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.7.1-SEB1-09
Revision: 2

***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.

**Additional Request (Revision 2):**

The staff reviewed Westinghouse's responses to RAI-SRP3.7.1-SEB1-09 Rev.1, RAI-SRP3.7.1-SEB1-10 Rev.1, and RAI-SRP3.7.1-SEB1-11 Rev.1. The staff noted that the -10 figures add the coherent results to the incoherent results presented in the -09 response. The -11 response presents coherent, incoherent, and CSDRS comparisons for 2 additional locations (Nodes 2675 and 3067), and also repeats the -09 and -10 results for Node 2711. The staff noted that there is consistency of common information among the -09, -10, and -11 responses.

After review of the three (3) RAI responses and the information contained in the figures, the staff requests the following clarifications and additional information, to facilitate its further evaluation of the calculated reductions in FRS, obtained by considering the effects of incoherency:

(a) Explain why Node 2711 is included in the -11 response, considering that Node 2711 is also included in the -09 and -10 responses. Specifically identify any differences between the -11 results and the -09 and -10 results for Node 2711.

(b) Based on the data presented in Figures RAI-SRP3.7.1-SEB1-10-1 thru -21, the spectral acceleration ratio for coherent motion to incoherent motion is as high as 3. See Figure RAI-SRP3.7.1-SEB1-10-4 at 50 Hz, and Figure RAI-SRP3.7.1-SEB1-10 -6 at 40-50 Hz. A ratio of 2 is fairly common in other figures. Please provide the detailed technical basis for concluding that the calculated reductions are reasonable, and consistent with the expectations of the industry and staff experts that negotiated the ISG on this subject. Describe any independent peer review of Westinghouse's results.

(c) Based on the data presented in Figures RAI-SRP3.7.1-SEB1-10-1 thru -21, spectral acceleration reductions are calculated for frequencies as low as 6-10 Hz. See Figures RAI-SRP3.7.1-SEB1-10 -1, -2, -3, -17, -19, -20, -21. Please provide the detailed technical basis for concluding that the calculated reductions at low frequency are reasonable, and consistent with the expectations of the industry and staff experts that negotiated the ISG on this subject. Describe any independent peer review of Westinghouse's results.

(d) Even when the beneficial effects of incoherency are included, there are high-frequency exceedances at a number of the sample locations evaluated. See Figures RAI-SRP3.7.1-SEB1-10-4, -5, -6, -7, -8, -9, -12, -15, and Figure RAI-SRP3.7.1-SEB1-11-7. However, Westinghouse apparently has concluded that the worst-case exceedances have been determined, without expanding the sample size and evaluating additional locations. Please provide a detailed technical basis for concluding that the seismic response of AP1000 structures, systems, and components to the HRHF GMRS is enveloped by the response at the selected sample locations.

(e) Considering that the fundamental vertical vibration mode at the top of the shield building (El. 327') is around 6 Hz, it would be expected that the HRHF GMRS may excite a second vertical vibration mode. Figure RAI-SRP3.7.1-SEB1-09-01c: ASB at Elevation 327.4' Z Direction (Node 3345), and Figure RAI-SRP3.7.1-SEB1-10-3: ASB at Elevation 327.4' Z-Direction (Node 3329) do not show this behavior. Figure RAI-SRP3.7.1-SEB1-11-3: Seismic Response Spectra on Roof of Shield Building Z-Direction (Node 3067) does show a second amplified response for the HRHF GMRS at around 14 Hz. Provide a picture depicting the location of Nodes 3345, 3329, and 3067, and provide the technical explanation for the difference in results at these nodes.

(f) Based on the data presented in Figures RAI-SRP3.7.1-SEB1-10-1 thru -21, two (2) of the sample locations that Westinghouse selected for evaluation of the effects of the HRHF GMRS appear to be poor choices. In Figures RAI-SRP3.7.1-SEB1-10-1, -2, -3 [ASB at Elevation 327.4' (Node 3329)], and Figures RAI-SRP3.7.1-SEB1-10-19, -20, -21 [RCP at elevation 99' (Node 1757)], there is no evidence of high frequency excitation. This is inconsistent with a major criterion for selection of sample locations. Provide a detailed technical explanation for selection of these two (2) sample locations, especially in light of Westinghouse's argument for not including any sample locations in the steel containment shell (i.e., no high frequency excitation).

(g) The staff reviewed the spectral plots in Figures RAI-SRP3.7.1-SEB1-10-4, -5, -6 [Containment Operating Floor, East Side, Elevation 134.25' (Node 2136)], and Figures RAI-SRP3.7.1-SEB1-7, -8, -9 [Containment Operating Floor, West Side, Elevation 134.25' (Node 2170)]. The staff notes that these plots are also contained in TR 115 Rev. 1, Figure 5.2-2. The staff observed that the East Side and West Side y-direction spectra are very similar. However, the East Side and West Side x-direction spectra and the East Side and West Side z-direction spectra are very different, for the HRHF-coherent and HRHF-incoherent cases. The peak spectral accelerations are as follows for the HRHF-coherent and HRHF-incoherent cases:

| Location | Direction | HRHF-coherent | HRHF-incoherent |
|---|---|---|---|
| East Side | X | 1.6g (20 Hz) | 1.05g (20 Hz) |
| West Side | X | 3.5g (13 Hz) | 2.8g (13 Hz) |

| | | | |
|---|---|---|---|
| East Side | Y | 3.5g (16 Hz) | 1.95g (16 Hz) |
| West Side | Y | 3.7g (16 Hz) | 2.05g (16 Hz) |
| East Side | Z | 1.9g (40-50 Hz) | 0.65g (40-50 Hz) |
| West Side | Z | 3.2g (30 Hz) | 1.7g (30 Hz) |

The staff cannot determine the reason for this behavior. Provide a detailed technical explanation for these apparently inconsistent results.

**Westinghouse Response (Revision 0 & 1):**

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.

**Westinghouse Response (Revision 2):**

a) There are no differences in Node 2711 results given in -11 from those given in -09 and -10. The node was included responding to the various requests made by the NRC as noted below:

- The figures included in RAI-SRP3.7.1-SEB1-09, Rev.1 are in response to "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."

- The figures included in RAI-SRP3.7.1-SEB1-10 Rev. 1 are in response to "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." The coherent curves are added for all the nodes 2136, 2170, 2341, 2669, 2711 and 1757. Node 3345 is replaced by node 3329 because coherent data were not available for node 3345. Node 3345 is at west corner and node 3329 is at the south corner of the ASB at elevation 327.4' as shown in Figure RAI-SRP3.7.1-09-A in item (e) below.

- The figures included in RAI-SRP3.7.1-SEB1-11, Rev. 1 are in response to the request to provide additional incoherent and coherent comparison response spectra.

b) SASSI-Simulation incoherency approach used to generate the seismic response spectra is in accordance with Section 4, subsection 1.0 of "Interim Staff Guidance (ISG) on

Seismic Issues Associated with High Frequency Ground Motion in Design Certification and Combine License Applications" supplements to Section 3.7.1, "Seismic Design Parameters," of NUREG-0800. In generating the seismic response spectra Westinghouse made no changes to the accepted industry methodology. The technical basis for incoherence is discussed in EPRI report 1012966, "Effect of Seismic Wave Incoherence on Foundation and Building Response", Dec. 2005. Similar results were shown in Figure 6-1 to 6-11 of EPRI report 1012966. Figure 6-12 showed 5 times reduction at 50 Hz.

c) See b) above. Figure 6-6 of EPRI report 1012966 showed the similar reduction at 10 Hz.

d) Westinghouse had agreed to evaluate a representative sample of SSCs located in areas that are subject to high frequency response, and have frequency content in the high frequency region, to confirm that high frequency seismic input is not damaging, and to demonstrate that normal design practices using the Certified Seismic Design Response (CSDRS) result in an AP1000 design that is safer and more conservative. This evaluation is reported in TR 115. The SSCs selected based on the screening criteria are sufficient to demonstrate that high frequency seismic events are not damaging. There may be spectra that have higher exceedances; however safety related equipment may not be located in these locations, SSCs located in these areas may not have high frequency response, and further the evaluation performed demonstrate that the HRHF seismic event is not damaging and there is margin between the CSDRS and HRHF response. Westinghouse evaluation approach is in compliance with Section 4, subsection 3.0 and 4.0 of the "Interim Staff Guidance on Seismic Issues Associated with High Frequency Ground Motion in Design Certification and Combined License Applications," ML081400293.

   i. 3.1 Structure Modeling:
   Section 5.1 is used to demonstrate the SASSI NI20 Model is adequate for ISG 3.1.1 "The range of HF to be transmitted should cover a model refinement frequency of at least equal to 50 Hz." RAI-SRP3.7.1-SEB1-6, Rev.2 further demonstrates the adequacy of the SASSI NI20 model. Two additional figures are added in TR115 (figure 5.1-7 and 5.1-8) to demonstrate the responses up to 50 Hz as requested in the NRC review meeting.

   ii. 3.2 Evaluation of SSC's other than HF Sensitive Mechanical and Electrical Equipment and Components
   Section 5.2 is used to demonstrate the HRHF responses do exceed the CSDRS in several locations; this is under ISG 3.2.2 "For those cases where the GMRS/FIRS-based ISRS exceed the CSDRS-based ISRS below 50 Hz, further structure structural integrity and functionality evaluations are required." Section 6.0 of TR115 is in compliance with ISG 3.2.2 for further structural integrity and

functionality evaluations.

iii. 3.2.3 If a screening approach is used, the following information will be provided.

3.2.3.1 The selection criteria "safety significance, location in the vicinity of the HF response, potential for significant effects of rotational components, and significant increase in forces on supports and anchorage of rigid equipment."

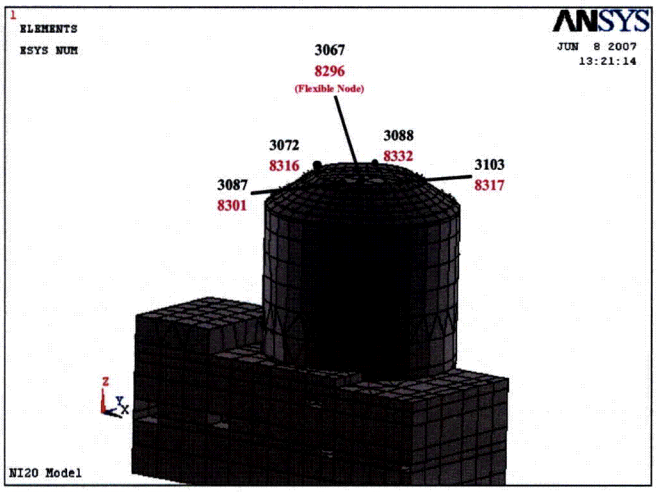
Section 6.0 is based on the screening criteria. Three groups of SSC's are selected: Building Structure, Primary Equipment, and Piping systems.

iv. 3.2.3.2 for selected SSC's, describe the evaluation methodologies (including selection of failure modes) used for the assessment and their basis.

1. Section 6.1 Building Structures are analyzed according to the parameters provided in 3.2.3.2. Based on the analysis result and additional analysis for SCV provided in RAI-SRP3.7.1-SEB1-04, Rev. 2, the following conclusion is reached as stated in the RAI. "Westinghouse has selected an adequate sample of structure locations for demonstrating that the AP1000 structure responses due to the HRHF GMRS are enveloped by the structure responses due to the CSDRS."
2. Section 6.2 Primary Coolant Loop is analyzed according to the parameters provided in 3.2.3.2. The analysis result showed that CSDRS cases are bounding at all Primary Coolant Loop system.
3. Section 6.3 Piping Systems are analyzed according to the parameters provided in 3.2.3.2. The conclusion is in Section 6.3.4.

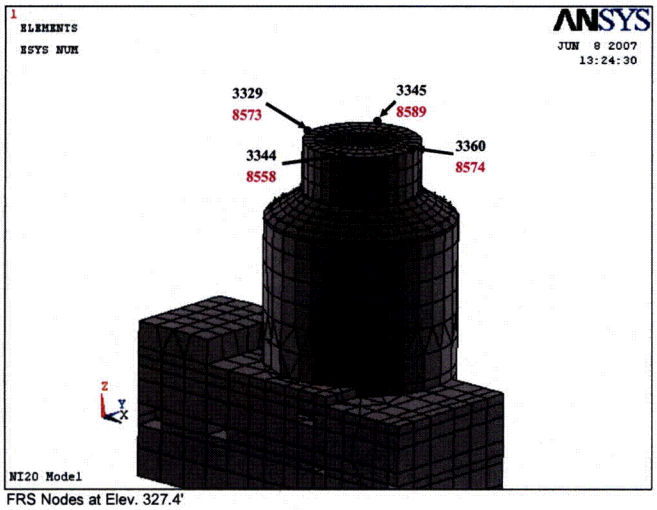
v. 4.0 Identification and Evaluation of HF Sensitive Mechanical and Electrical Equipment/Components.
Section 6.4 Safety-Related Electrical Equipment is in complying with ISG section 4.0.

e) Figures RAI-SRP3.7.1-09-A and RAI-SRP3.7.1-09-B show the location of the three nodes 3067, 3329, and 3345. Node 3067 shown in Figure RAI-SRP3.7.1-09-A is at flexible area (response in 14 Hz region) that is not influenced by rocking motion as much as nodes 3329 and 3345.



FRS Nodes at Elev. 289.2'

**Figure RAI-SRP3.7.1-09-A: FRS nodes at Elevation 289.2'**



FRS Nodes at Elev. 327.4'

**Figure RAI-SRP3.7.1-09-B: FRS nodes at Elevation 327.4'**

f) The seismic response spectra were provided to respond to the NRC request to show HRHF broadened spectra with coherent and incoherent considerations. Westinghouse provided response spectra where these comparisons were available. Some of these locations show that the high frequency response does not transmit to these areas. In some of the Figures in RAI-SRP3.7.1-SEB1-10-1 thru -21 shows that some structures will transmit the high frequency vibration and some structures will not transmit the high

frequency vibration because the major frequency content is below 10 Hz. For example, Figures RAI-SRP3.7.1-SEB1-10-1, 2 and 3 (Node 3329 located on top of the shield building) show that the HRHF GMRS does not excite the shield building. Westinghouse followed the screening criteria given in TR115 and DCD 3I.5, Revision 17. The SSCs evaluated must be in an area of high frequency response which exceeds the CSDRS floor response spectra. The spectra associated with RCP demonstrate that the HRHF seismic response has been filtered and the CSDRS does envelope. The RCP was not chosen for evaluation, the reactor internals and primary coolant loop supports and nozzles were evaluated (TR 115, Section 6.2). These areas are subject to high frequency response that exceeds the CSDRS as seen in Figure 5.2-2 in TR 115. See RAI-SRP3.7.1-SEB1-04, Rev. 2, for a discussion of the SCV.

g) Figure RAI-SRP3.7.1-09-C show the location of nodes 2136 and 2170. Node 2170 is surrounded by a large semi-circle IRWST water tank while node 2136 is surrounded by concrete structure floor and steam generator compartment wall. Node 2136 showed more interaction in X and Z direction between the containment internal structures. The responses of both nodes in Y direction are similar because of less structure interaction between the steam generator compartment wall and other concrete structure. The differences between coherent and incoherent responses are justified in b) and c) above.

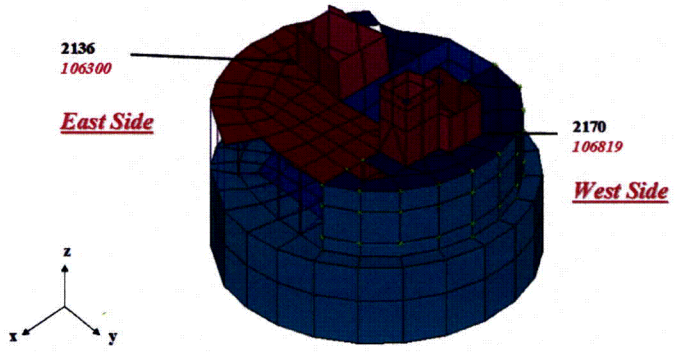
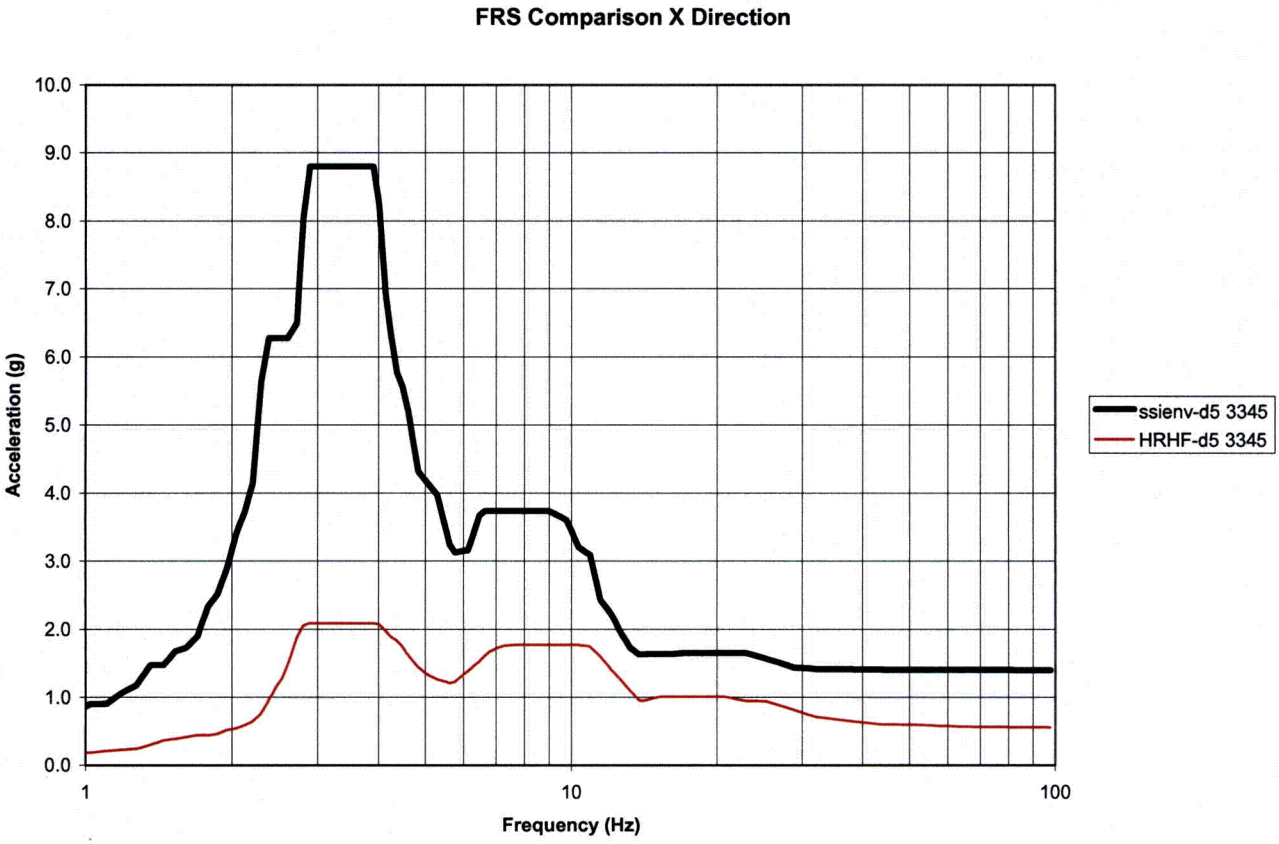
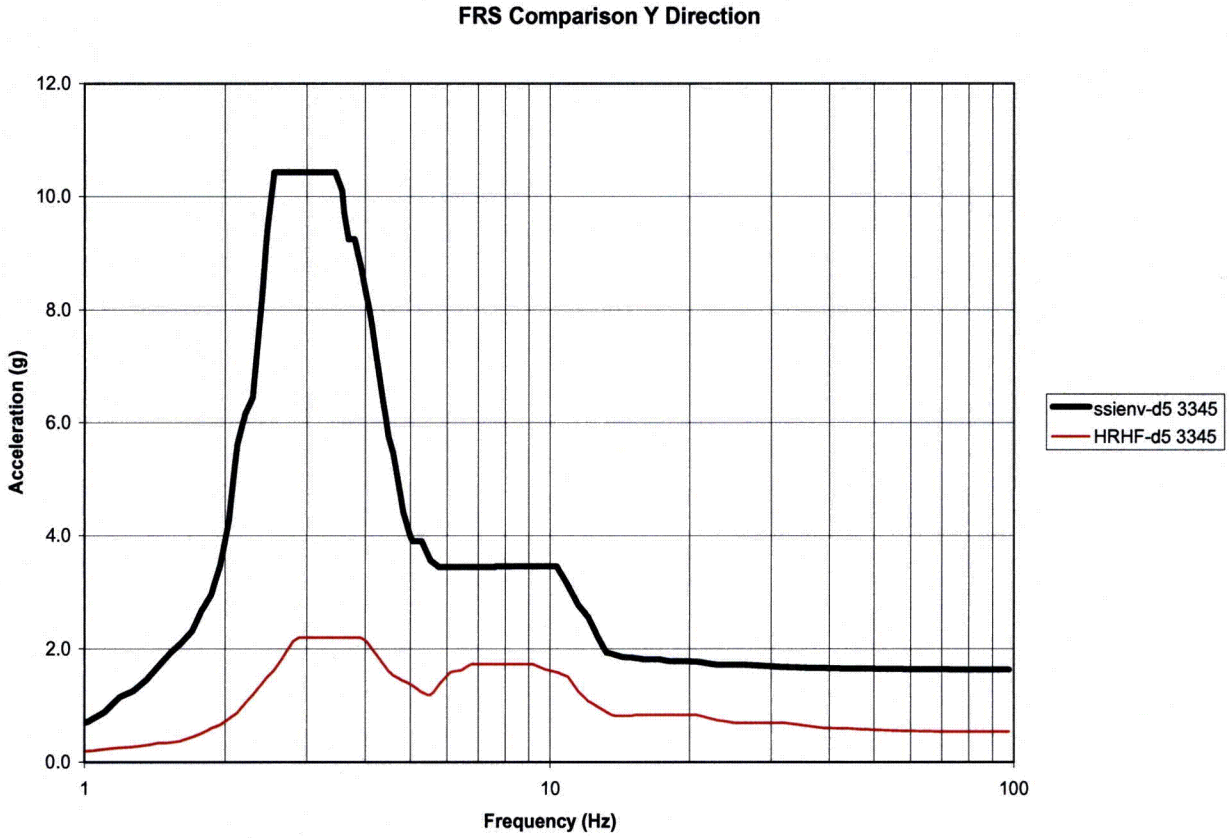


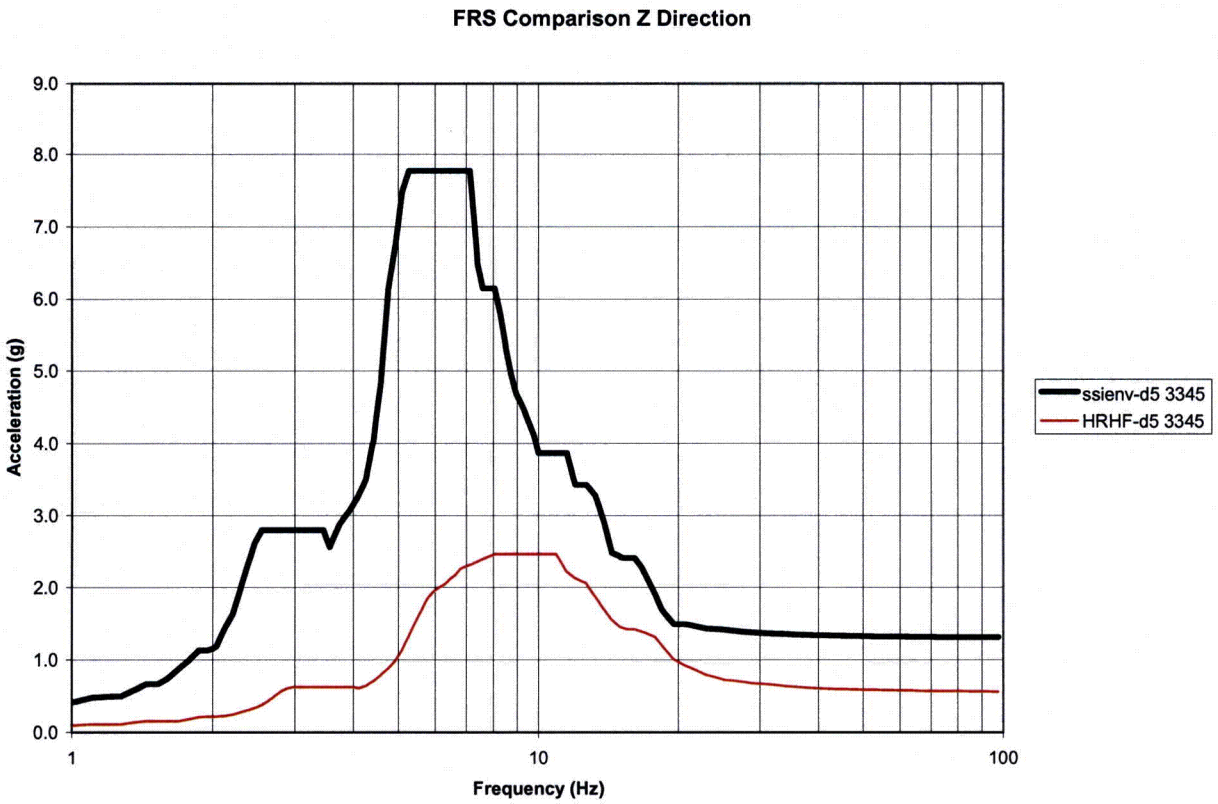

**Figure RAI-SRP3.7.1-09-C: Containment Operating Floor (Elevation 134.25')**



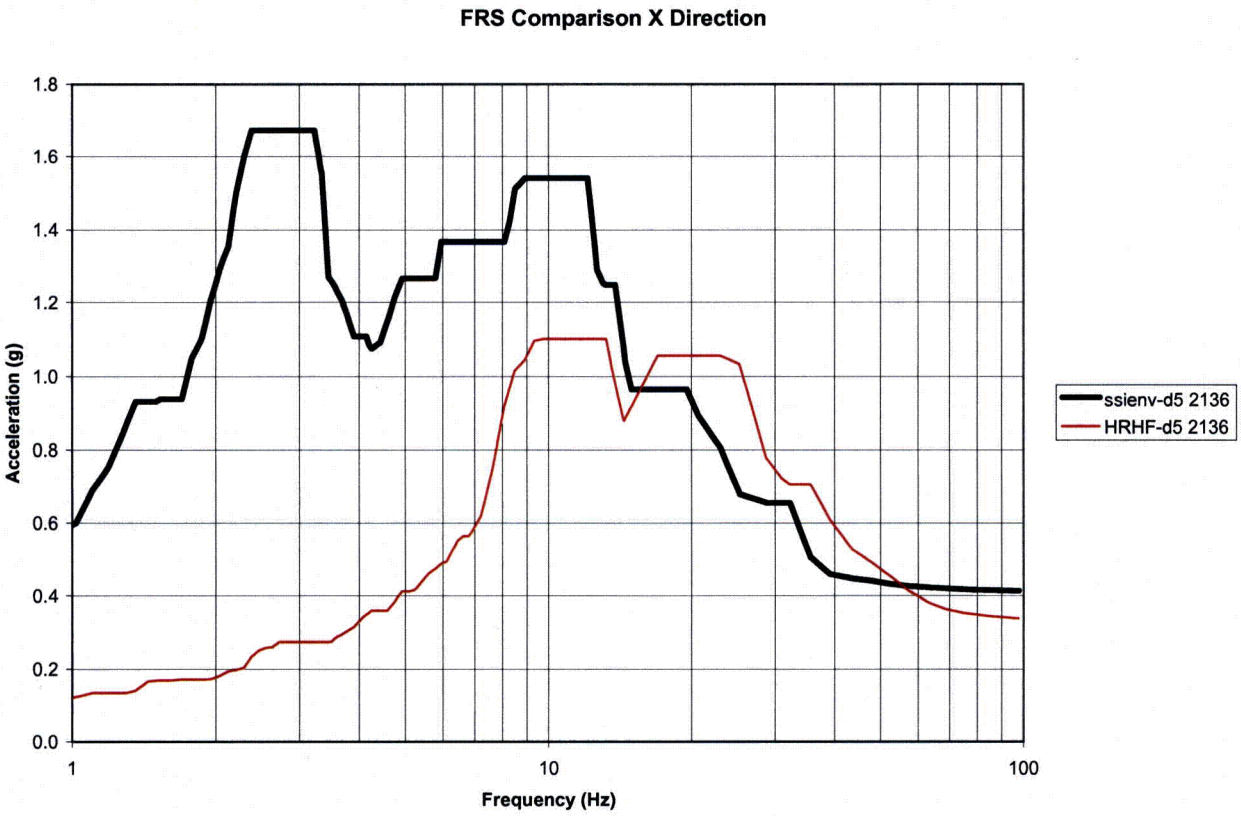

**RAI-SRP3.7.1-SEB1-09-01a: ASB at Elevation 327.4' X Direction**



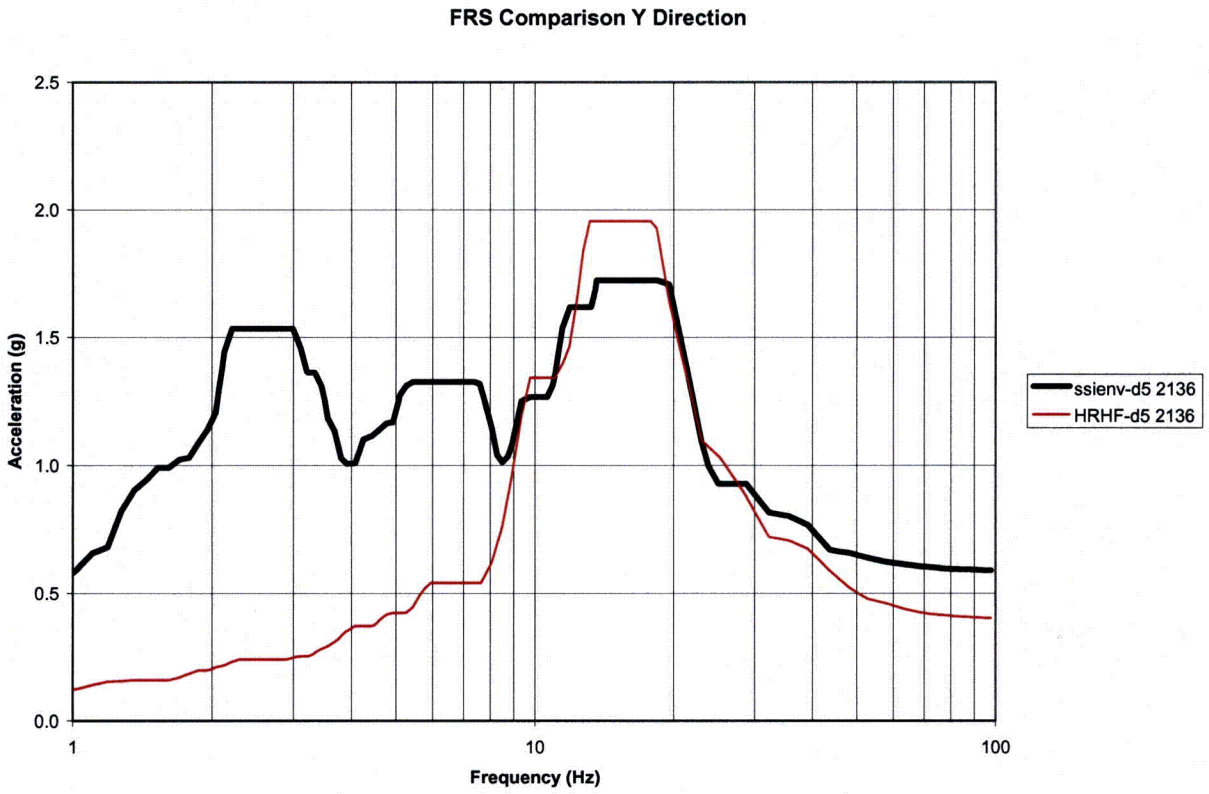

**RAI-SRP3.7.1-SEB1-09-01b: ASB at Elevation 327.4' Y Direction**



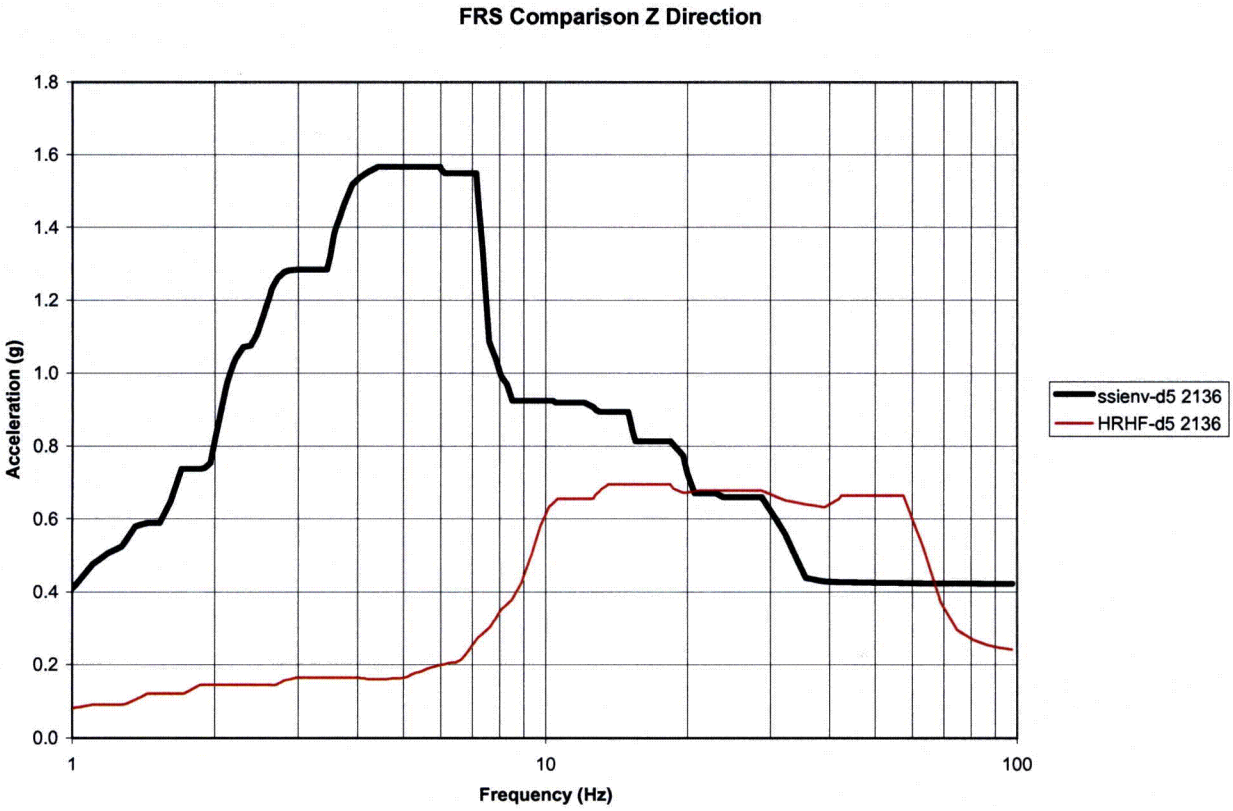

**RAI-SRP3.7.1-SEB1-09-01c: ASB at Elevation 327.4' Z Direction**



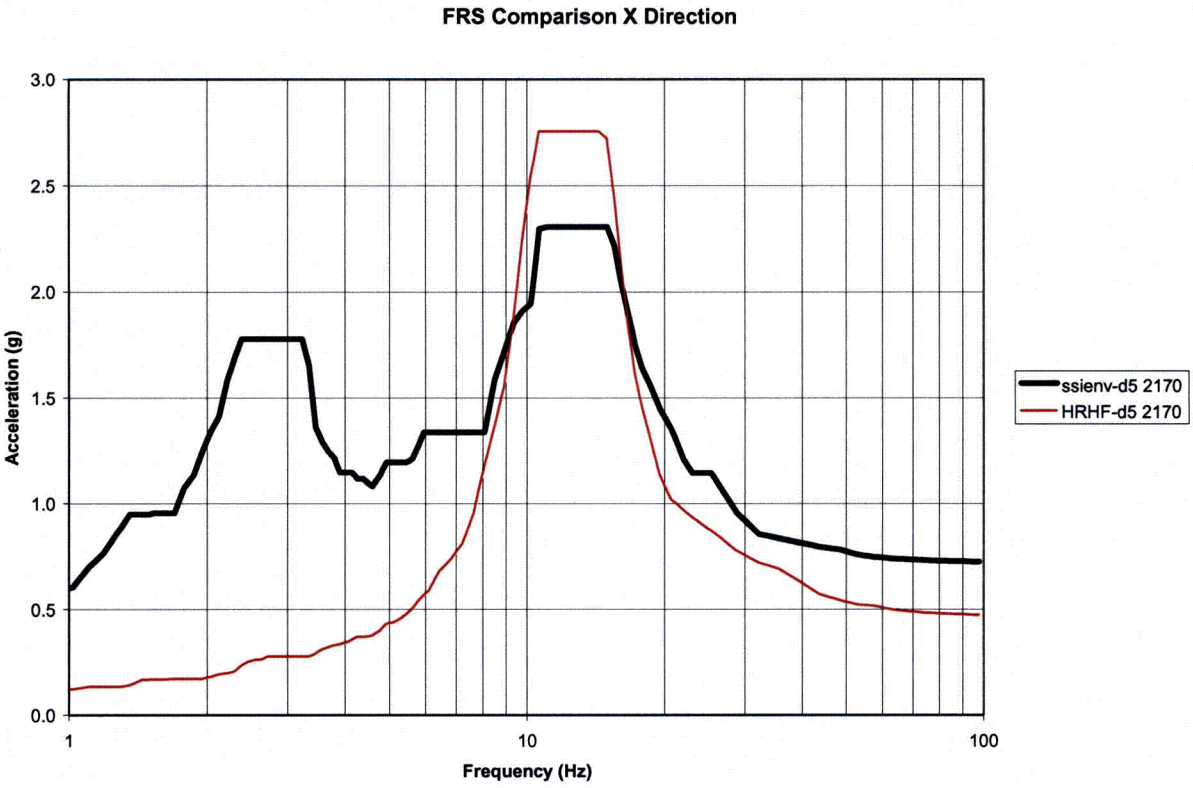

**RAI-SRP3.7.1-SEB1-09-02 Ea: Containment Operating Floor (Elevation 134.25') East Side X Direction**



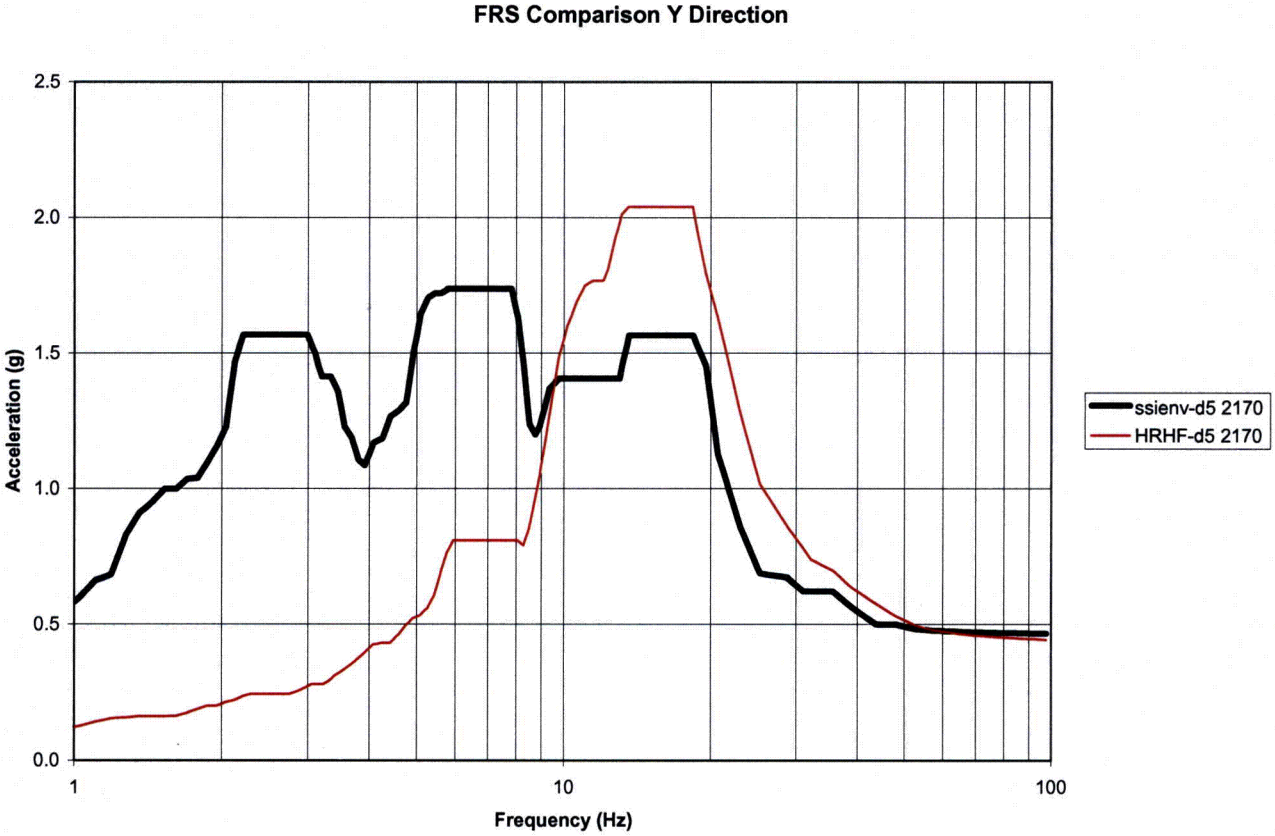

**RAI-SRP3.7.1-SEB1-09-02 Eb: Containment Operating Floor (Elevation 134.25')**
**East Side Y Direction**



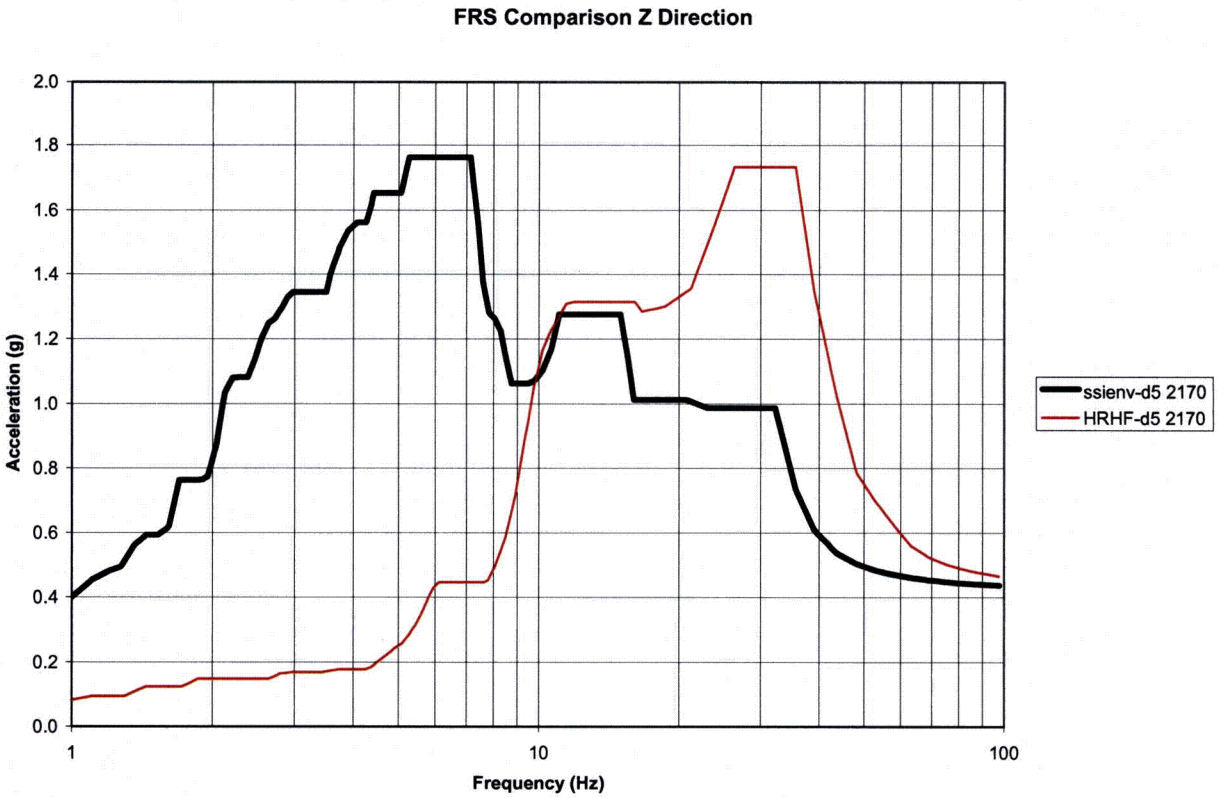

**RAI-SRP3.7.1-SEB1-09-02 Ec: Containment Operating Floor (Elevation 134.25') East Side Z Direction**



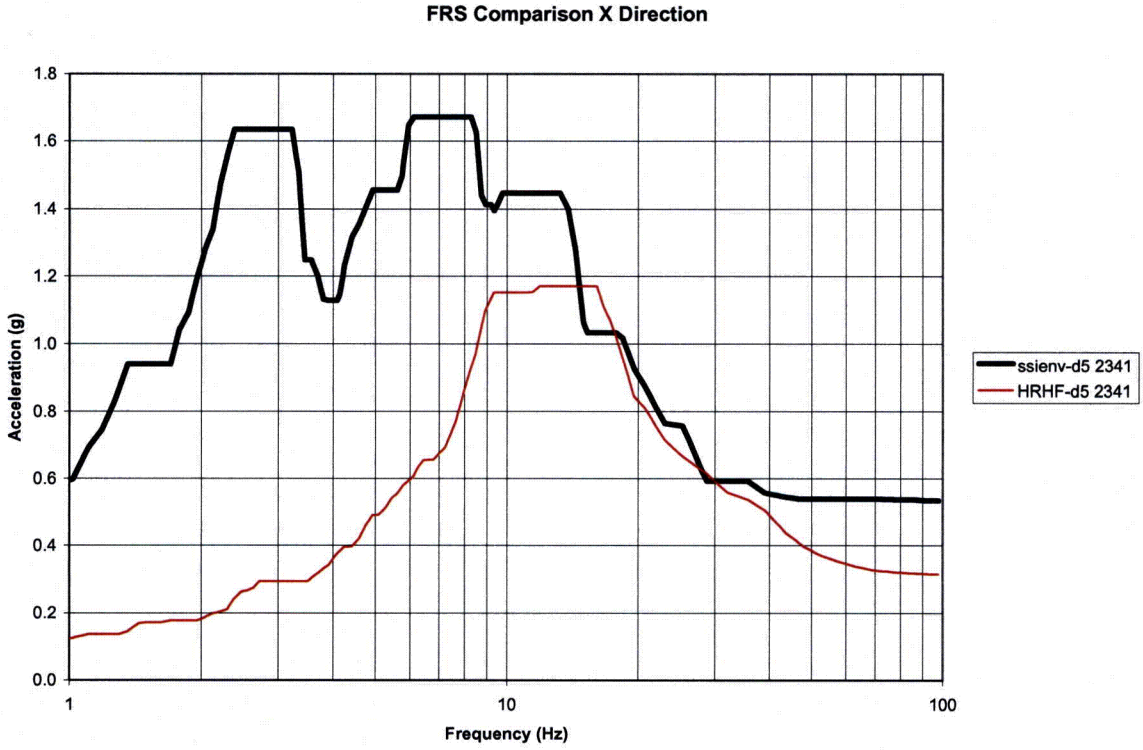

**RAI-SRP3.7.1-SEB1-09-02 Wa: Containment Operating Floor (Elevation 134.25')**
**West Side X Direction**



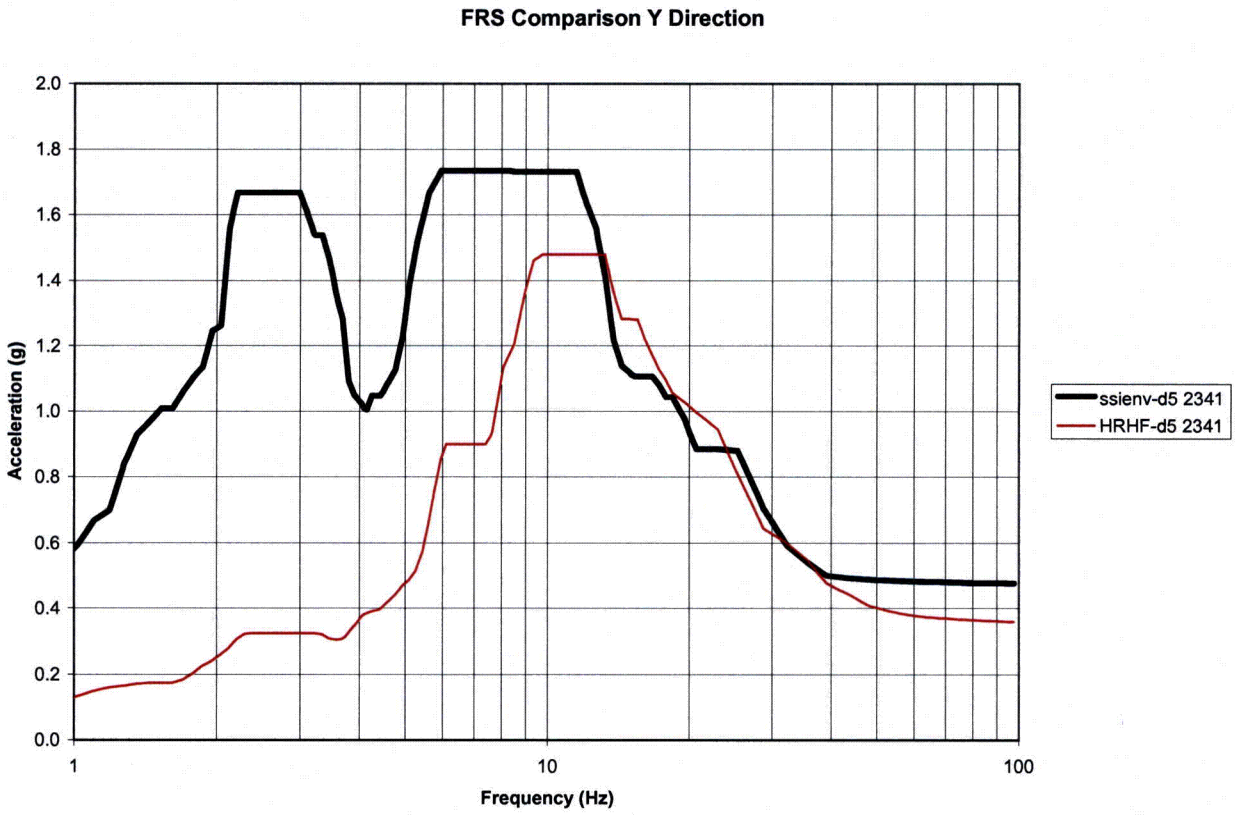

**RAI-SRP3.7.1-SEB1-09-02 Wb: Containment Operating Floor (Elevation 134.25')**
**West Side Y Direction**



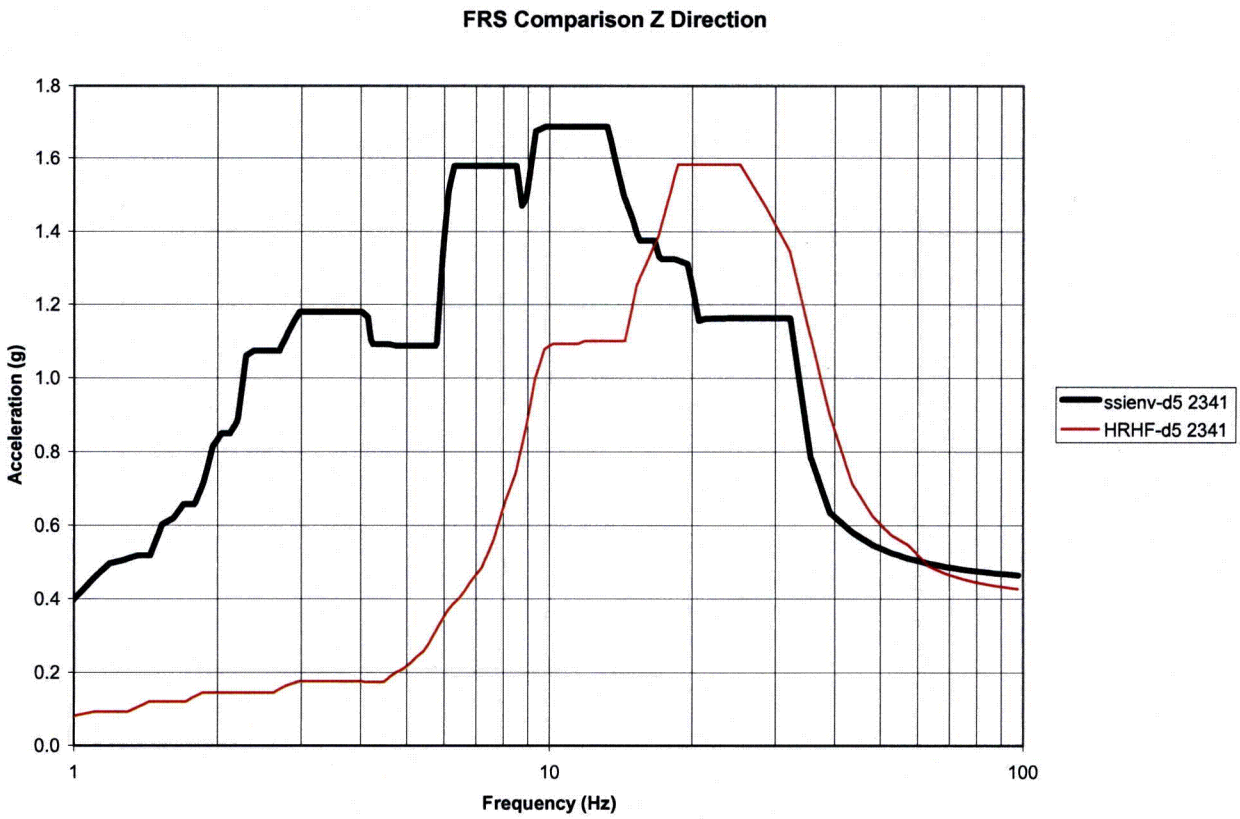

**RAI-SRP3.7.1-SEB1-09-02 Wc: Containment Operating Floor (Elevation 134.25')**
**West Side Z Direction**



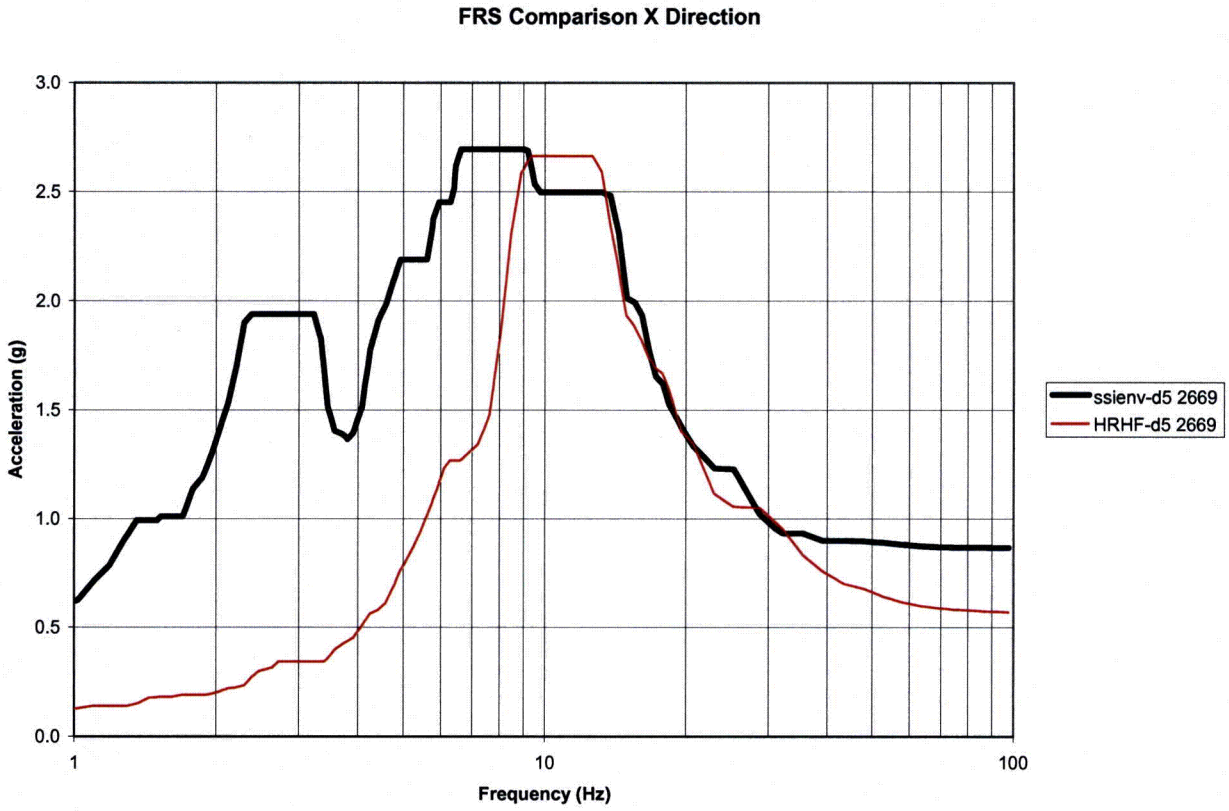

**RAI-SRP3.7.1-SEB1-09-03a: ASB at Northeast Corner (Elevation 134.5') X Direction**



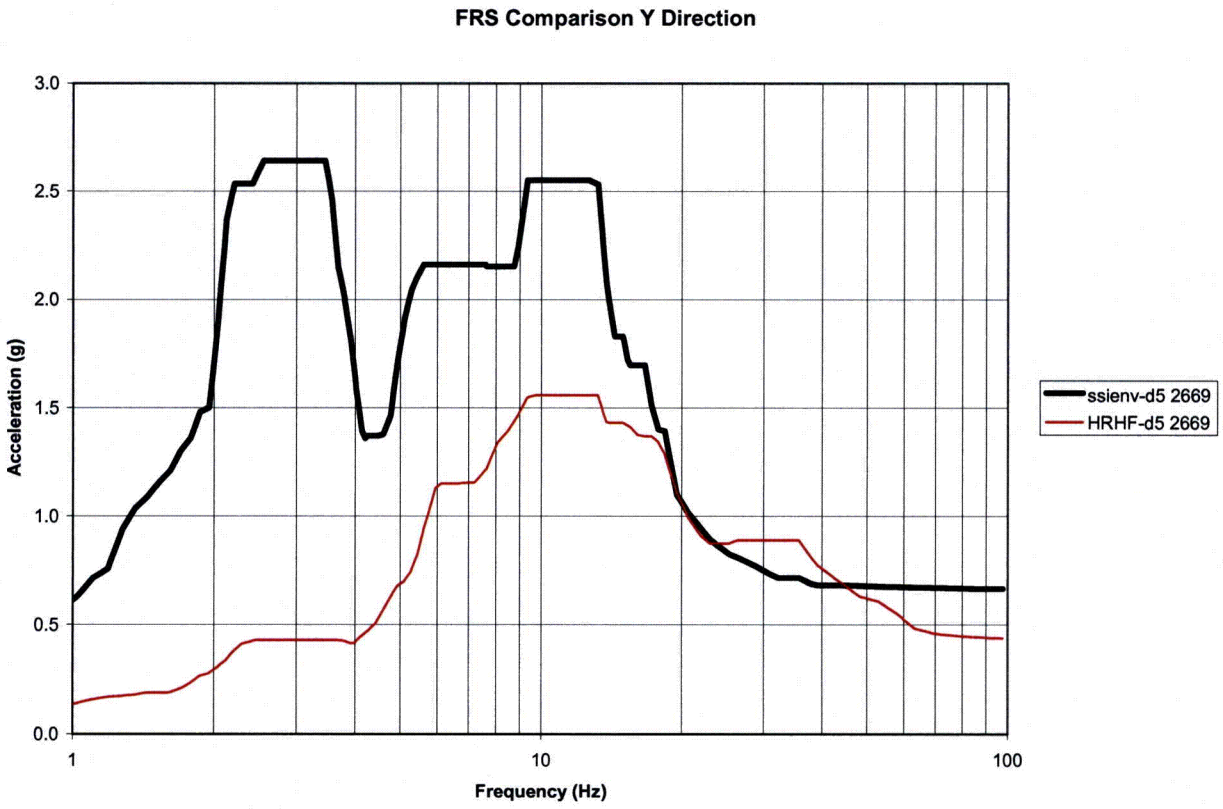

**RAI-SRP3.7.1-SEB1-09-03b: ASB at Northeast Corner (Elevation 134.5') Y Direction**



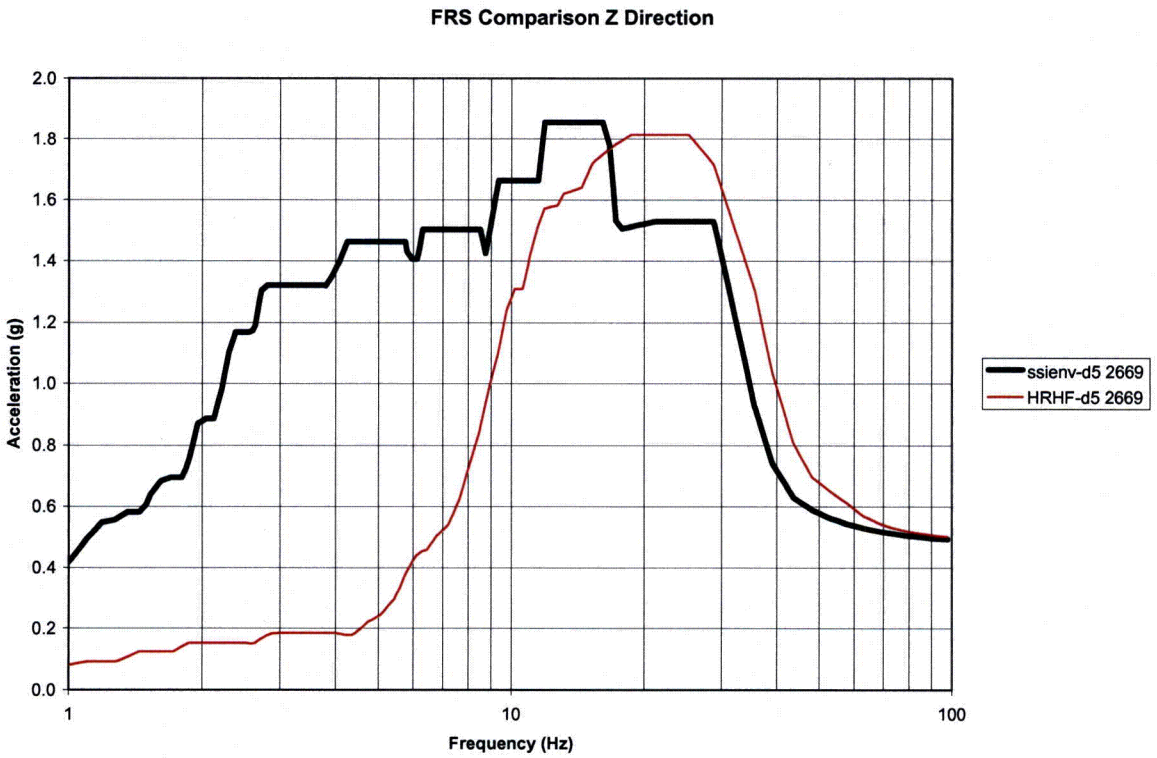

**RAI-SRP3.7.1-SEB1-09-03c: ASB at Northeast Corner (Elevation 134.5') Z Direction**



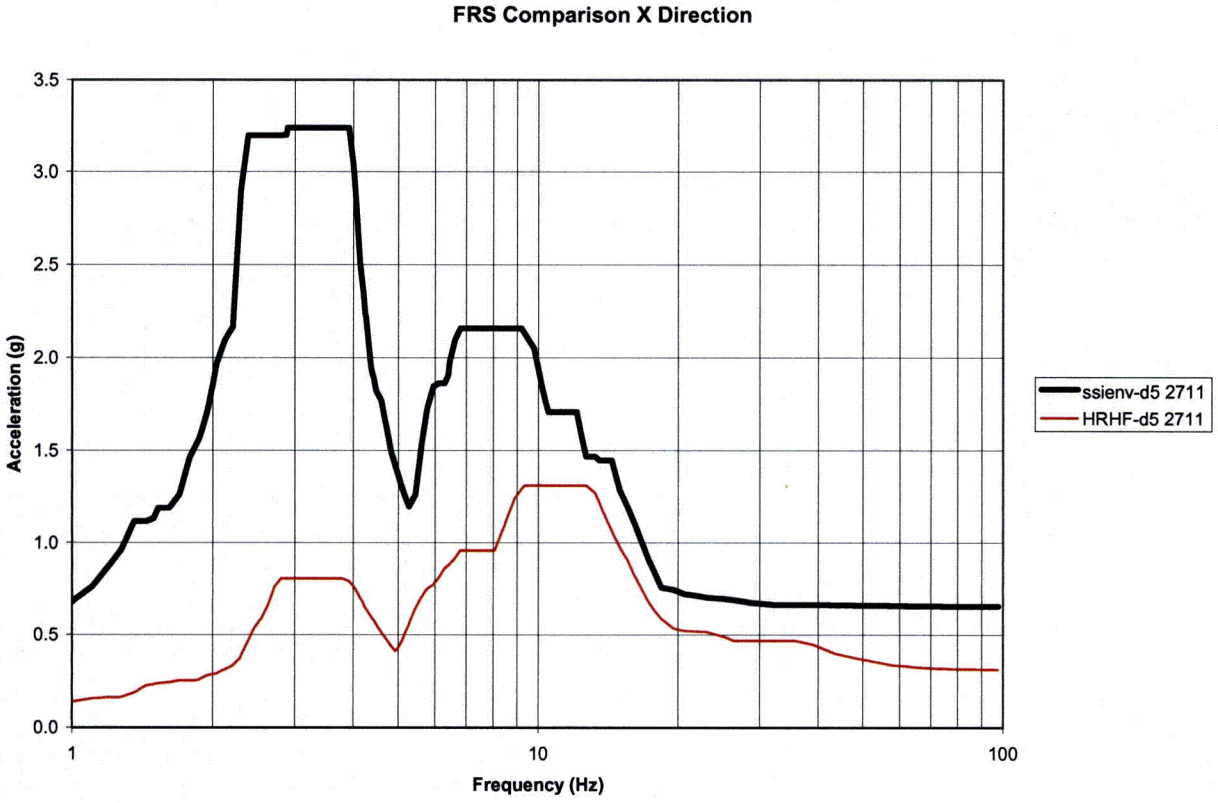

**RAI-SRP3.7.1-SEB1-09-04a: ASB at Fuel Building Roof (Elevation 179.56') X Direction**



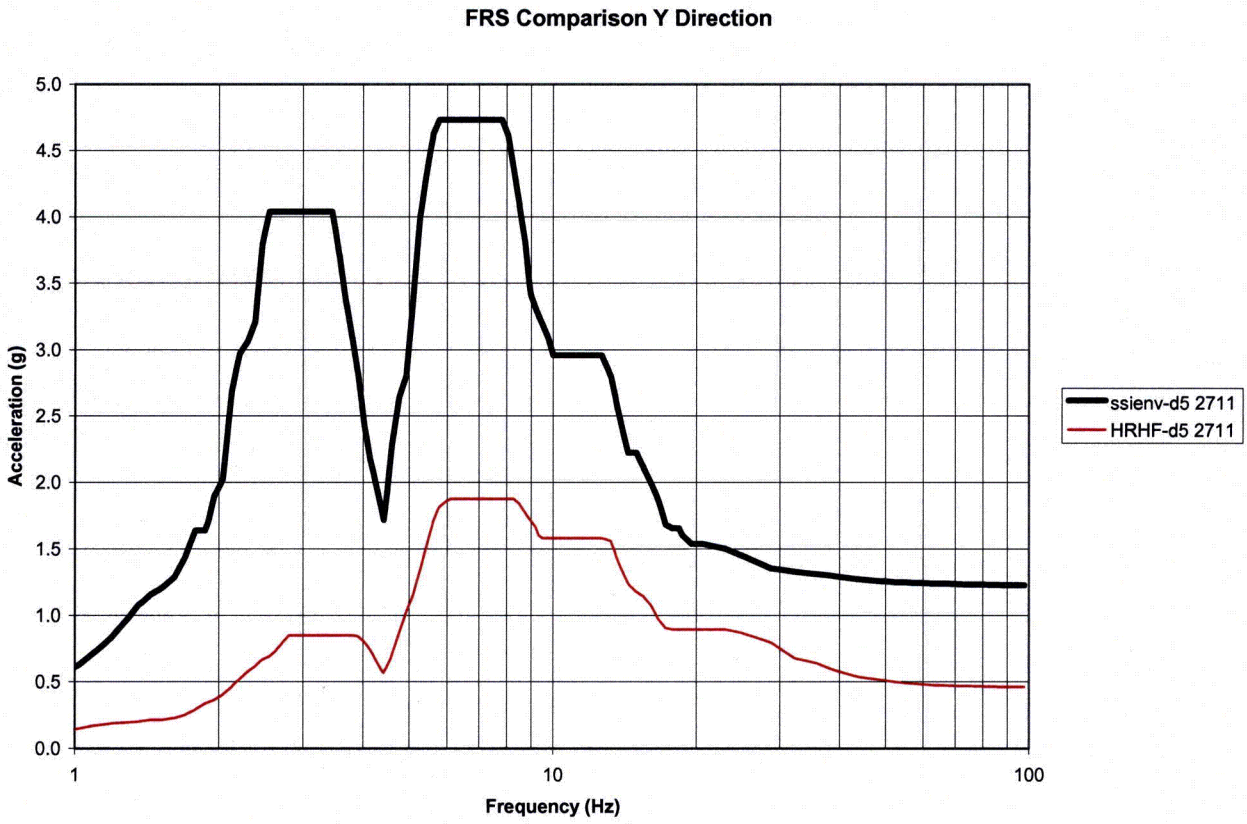

**RAI-SRP3.7.1-SEB1-09-04b: ASB at Fuel Building Roof (Elevation 179.56') Y Direction**



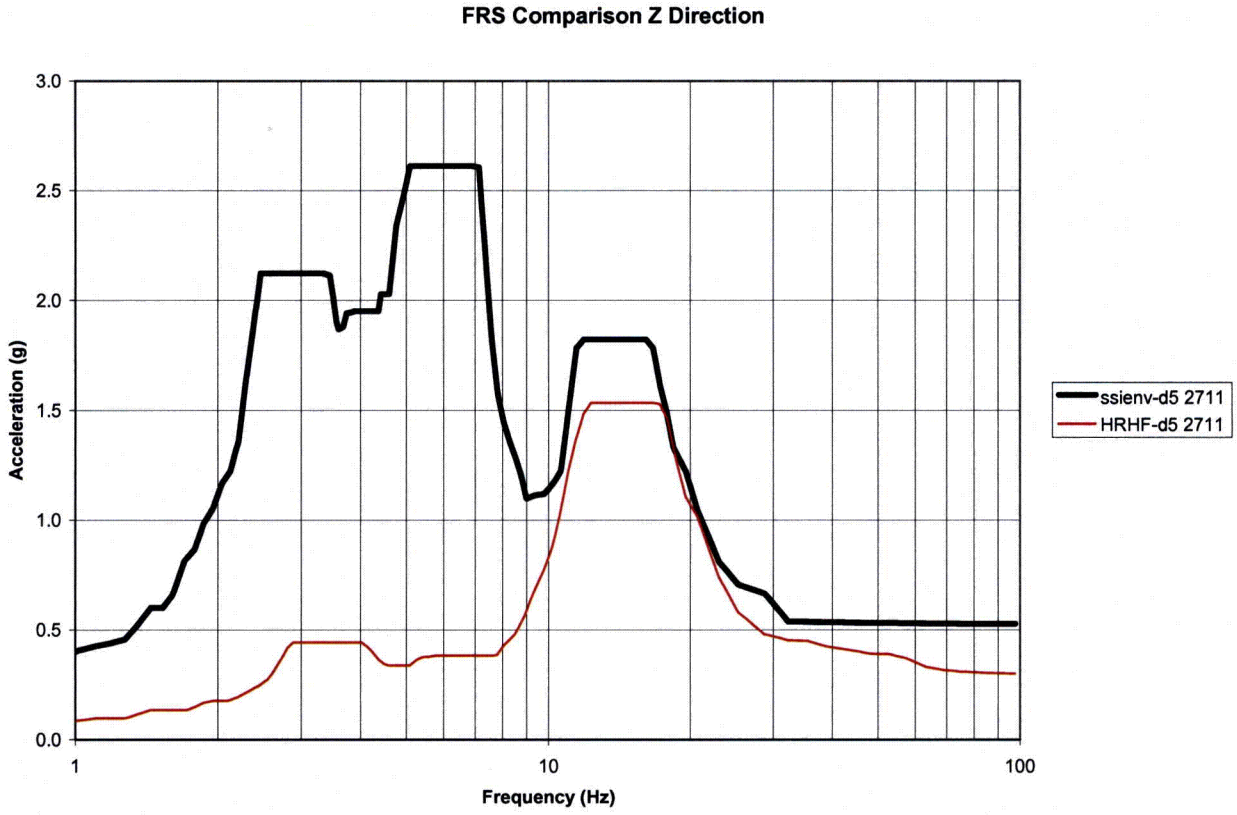

**RAI-SRP3.7.1-SEB1-09-04c: ASB at Fuel Building Roof (Elevation 179.56') Z Direction**



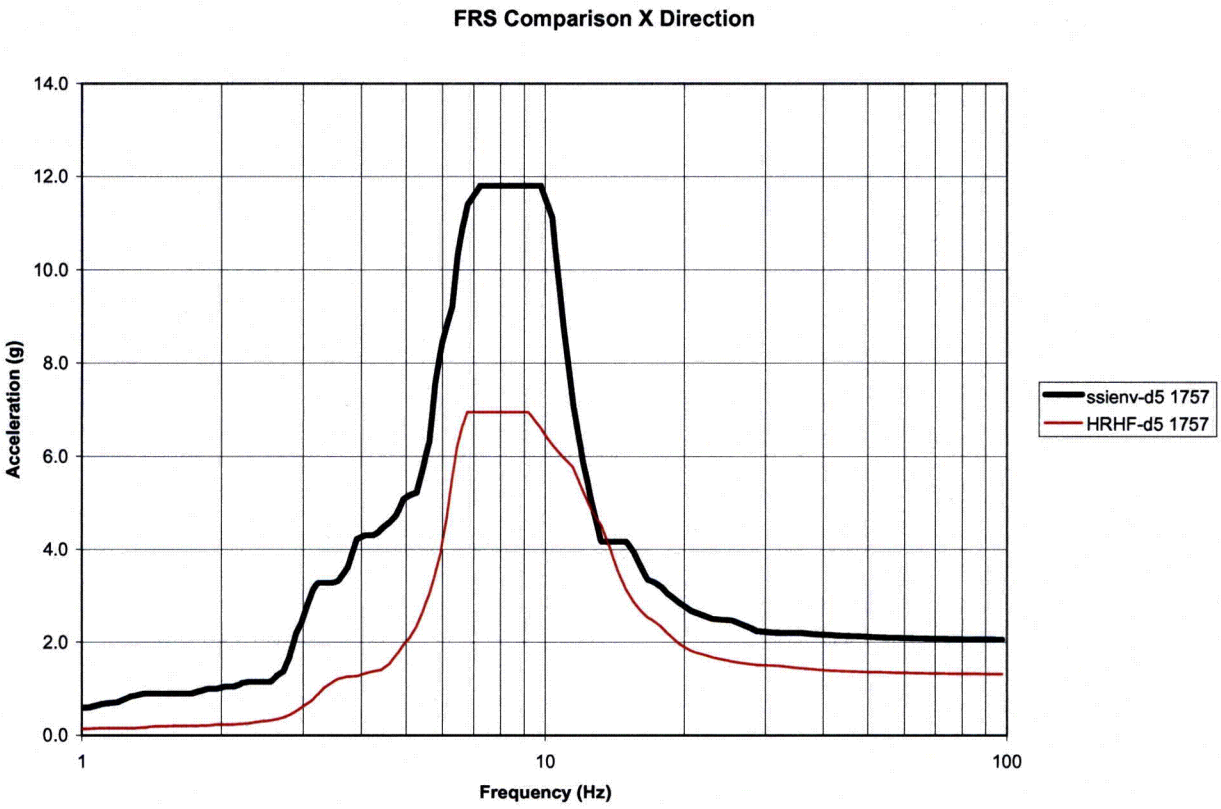

**RAI-SRP3.7.1-SEB1-09-05a: ASB Shield Building (Elevation 180') X Direction**



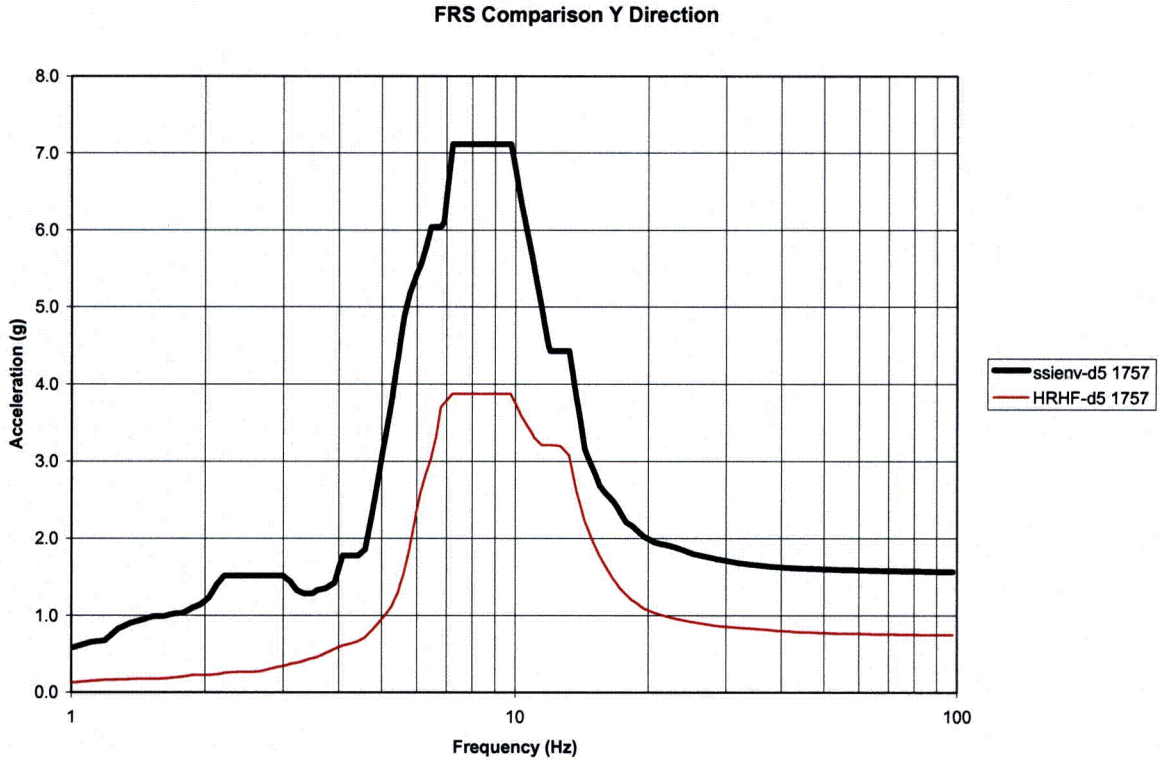

**RAI-SRP3.7.1-SEB1-09-05b: ASB Shield Building (Elevation 180') Y Direction**



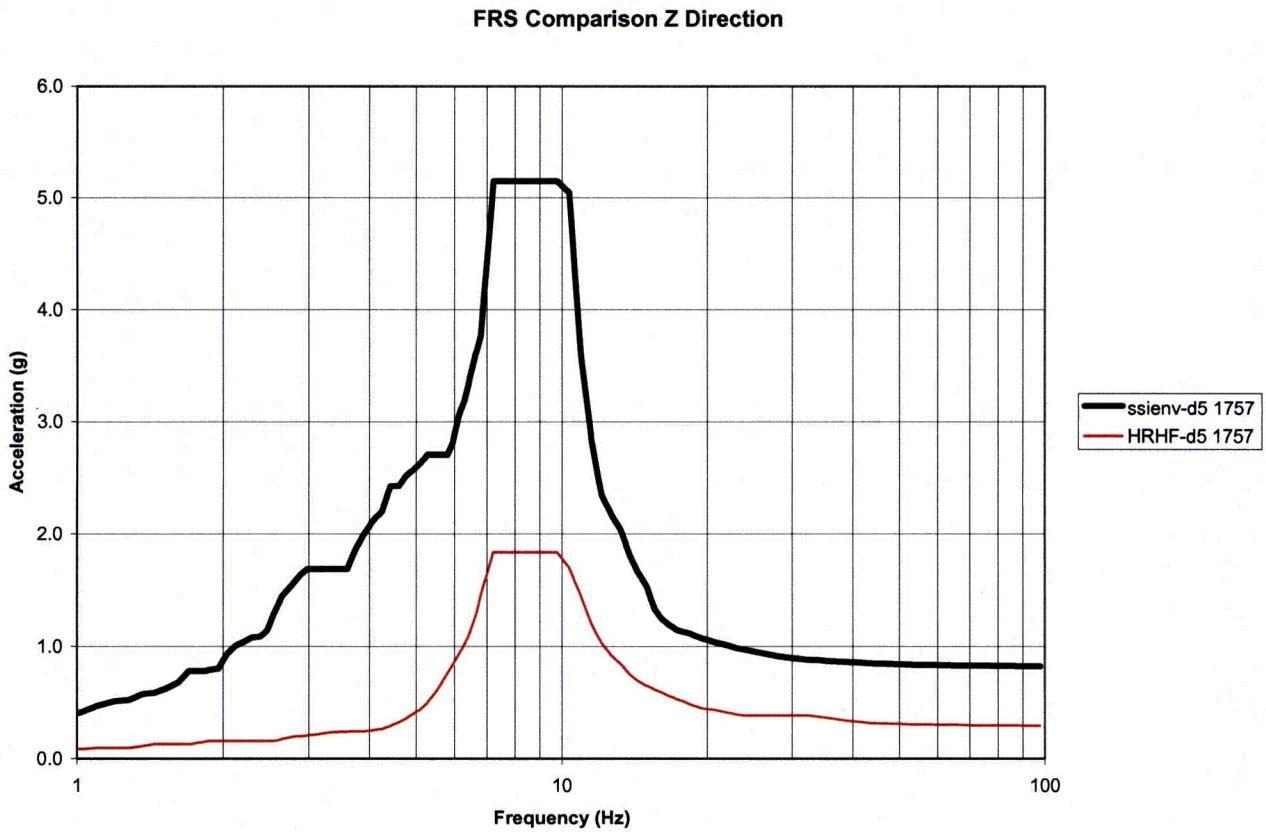

**RAI-SRP3.7.1-SEB1-09-05c: ASB Shield Building (Elevation 180') Z Direction**




**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**

Reference(s):

None

**Design Control Document (DCD) Revision:** none

**PRA Revision:** none

**Technical Report (TR) Revision (The changes indicated below are in Revision 1):**

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.