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Your ref: Docket No. 52-006
Our ref: DCP_NRC_003042

September 10, 2010

Subject: AP1000 Response to Request for Additional Information (SRP TR03)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section TR03. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in this 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(s):

RAI-TR03-022 R5
RAI-TR03-037 R3

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 Strategy

/Enclosure

1. Response to Request for Additional Information on SRP Section TR03

D063
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 TR03

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR03-022
Revision: 5

Question:

Section 6.3 states "The maximum seismic deflections that were obtained from the time history analyses and SASSI analyses given in Tables 6.3-1 to 6.3-3 for the auxiliary and shield building, containment internal structure, and steel containment vessel." For the staff to properly evaluate this information, the following additional information is needed:

a. Are the deflections in the tables a consistent set, based on the worst-case time history result, or are they an envelope of maximum deflections from all the time history results?

b. How do these tabulated deflections compare to the corresponding deflections obtained from the equivalent static acceleration analyses? Please provide a tabulated comparison, and an explanation of any significant differences.

Additional Question: (Revision 4)

During a phone call with the NRC staff on August 30, 2010, it is requested that Section 6.3, Seismic Displacement Calculation, of Technical Report 03 be expanded to address all methods used to calculate the displacement relative to the basemat.

Additional Question: (Revision 5)

In the response, on page 4 of 5, at the very end of the TR-03 Section 6.3 markup, it states: "The synthesized time histories are corrected for drift based on the slope of the drift. However, it is not necessary to adjust for drift since relative deflections to the basemat are calculated and the drift would be subtracted from the results." Staff is unclear about the process for correcting time history drift based on the slope of the drift.

Westinghouse Response:

(Westinghouse responses to Revisions 0 and 1 of this RAI were entirely replaced by the Revision 3 response due to a change in analysis method.)

Westinghouse Additional Response: (Revision 2)

a. During the October 8-12, 2007 audit, the NRC requested that Westinghouse consider adjusting the deflections obtained from SSI analyses for drift in the frequency domain, and not use a baseline correction that subtracts the slope of the relative displacement multiplied by the time from the relative displacement at each time step. Westinghouse has adopted the recommended approach by calculating displacements internally within the SASSI program based on an analytical complex frequency domain approach that uses inverse fast-fourier transforms (FFT) to compute relative displacement histories instead of double numerical integration in the time domain for computing absolute displacement time histories from absolute acceleration time histories. The analytical approach is more accurate than a typical baseline correction (time integration) algorithm.

Westinghouse Additional Response: (Revision 3)

During the May 19-23, 2008 NRC review, Westinghouse was requested to revise Section 6.3, Seismic Displacement Calculation, of the technical report adding more detail of the analysis methodology. The following words are added:

> "The relative displacement time history is calculated using ACS SASSI RELDISP module. The complex acceleration transfer functions (TF) are computed for reference and all selected output nodes. The relative acceleration transfer function is calculated by subtracting the reference node TF from the output node TF. The relative displacement transfer function is obtained by dividing the circular frequency square (ω^2) for each frequency data point. The relative displacement time history is obtained by taking the inverse FFT."

In Figure RAI-TR03-022-01 is presented a comparison for the baseline double integration (old, Dbl Int) method compared to the FFT (new method) shown for the soft to medium soil case at the top of the shield building.

b. Westinghouse has switched to a seismic response spectrum analysis and is not using equivalent static analyses. The responses for this request for additional information are no longer applicable.

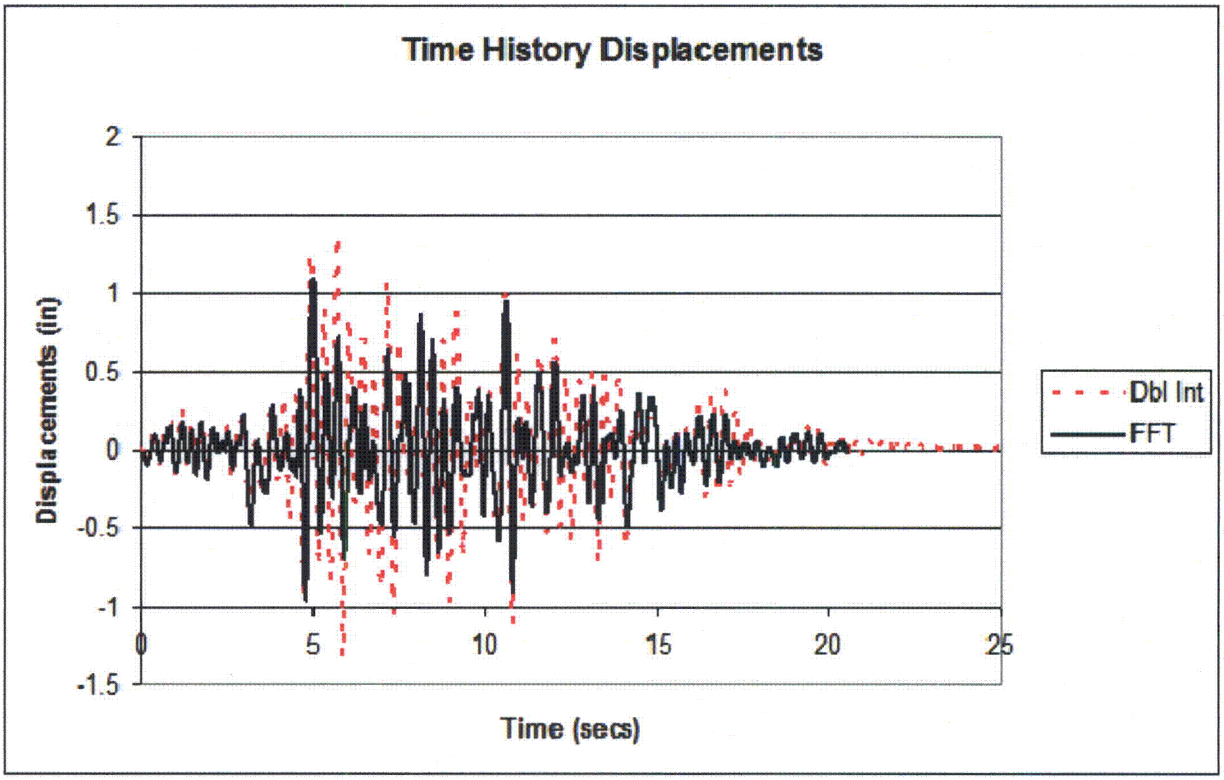

Figure RAI-TR03-022-01 – Comparison of Time History Displacements using Double Integration and Fast Fourier Transforms

Response to Additional Question: (Revision 4)

Section 6.3 of Technical Report 03 is expanded to include the three methods used to calculate displacements. The three methods use ACS SASSI, ANSYS, and soft springs to calculate the maximum relative displacement between adjacent buildings and the Nuclear Island. All of the methods used are recognized acceptable methods to calculate displacement.

It is not possible to give comparison results between the different methods since the results are not based on the same seismic input. ACS SASSI provides results for the individual soil cases, and ANSYS is used for the hard rock site and a case that envelops all of the soil cases and the hard rock case.

RAI-TR03-037 can be referenced for the inclusion of the calculation of displacement into DCD Appendix 3G.

Response to Additional Question: (Revision 5)

The statement about adjusting synthesized time histories for drift is removed in the mark-up for TR-03 Section 6.3. This statement is not required to describe the analysis method.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision: **(Revisions 2, 3, 4, and 5)**

Section 6.3 is modified as ~~given in the Westinghouse Response (part a).~~ shown below:

6.3 Seismic Displacement Calculation

[Revision 2] Westinghouse has adopted the approach that calculates displacements internally within the ACS SASSI program based on an analytical complex frequency domain approach that uses inverse Fast-Fourier Transforms (FFT) to compute relative displacement histories instead of double numerical integration in the time domain that computes absolute displacement time histories from absolute acceleration time histories.

[Revision 3] The relative displacement time history is calculated using ACS SASSI RELDISP module. The complex acceleration transfer functions (TF) are computed for reference and all selected output nodes. The relative acceleration transfer function is calculated by subtracting the reference node TF from the output node TF. The relative displacement transfer function is obtained by dividing the circular frequency square (ω^2) for each frequency data point. The relative displacement time history is obtained by taking the inverse FFT.

[Revision 4] Relative displacements are calculated between adjacent buildings and the nuclear island using soft springs between the buildings. The spring stiffness is very small so that it does not affect the dynamic response. These calculations are performed using 2-D models and SASSI 2000. The relative deflection is calculated using the maximum compressive spring force and the stiffness value.

Maximum relative deflections to the nuclear island basemat are also calculated using ANSYS. These deflections are calculated for the hard rock case.

[Revision 5 changes shown as markup to this Revision 4 added paragraph]
ANSYS is ~~**also**~~ used to calculate the maximum relative deflection to the nuclear island for the envelop case that considers all of the soil and hard rock site cases. Synthesized displacement time histories are developed using the envelope seismic response spectra from the six site conditions (hard rock, firm rock, soft rock, upper-bound-soft-to-medium, soft-to-medium, and soft soil). Seismic response spectra at nine locations are used (4 edge locations, 1 center location, and 4 corner locations). ~~**The synthesized time histories are corrected for drift based on the slope of the drift. However,**~~ It is not necessary to adjust for drift since relative deflections to the basemat are calculated and the drift would be subtracted from the results.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR03-037
Revision: 3

Question:

10 CFR Part 50, Appendix A, GDC 2 requires, in part, that SSCs important to safety be designed to withstand the effects of natural phenomena such as earthquakes without loss of capability to perform their intended safety functions. Applicable guidance for implementation of and achieving compliance with the requirements set forth in GDC 2 is provided in Regulatory Guides 1.60 and 1.61. Regulatory Guide 1.60 provides a procedure that is acceptable to the staff for defining ground response spectra for input into the seismic design/analysis of nuclear power plants.

In TR-03, Revision 4, Section 4.4.1.2, the applicant added a new soil case for the deep soil site, and indicated that the deep soil site profile uses a unique input time history that is only used to develop in-structure design response spectra. The staff is unclear about how applicant would include this case as part of the seismic design basis. In TR-03, the deep soil site is not fully characterized nor is it clear regarding how the SSI analysis was performed using the CSDRS as the ground motion input. Therefore, the staff requests the applicant to provide a detailed description of the deep soil site condition, and provide the SSI results and justification for its application to the AP1000 design response spectra (CSDRS).

Additional Request: (Revision 1)

The staff had also requested the applicant to clarify the use of SASSI2000 and ACS-SASSI in the design-basis SSI analyses. The applicant included its response in RAI-TR03-037. The staff is currently waiting for the applicant's revised response, based on discussions between the staff and the applicant on 07/22/2010.

Additional Question: (Revision 2)

During a phone call with the NRC staff on August 30, 2010, it was requested that ACS SASSI be reflected in Table 4.2.6-1 and Appendix 3G and Table 3G.1-1 for the calculation of relative seismic deflections to the basemat. Further, it was requested that the use of ANSYS for the calculation of the maximum seismic relative deflection be reflected in DCD Appendix 3G.

Additional Question: (Revision 3)

In the DCD markups on page 30 of the response, it states: "The synthesized time histories are corrected for drift based on the slope of the drift. However, it is not necessary to adjust for drift since relative deflections to the basemat are calculated and the drift would be subtracted from the results." Staff is unclear about the process for correcting time history drift based on the slope of the drift.

This information was not discussed in previous discussion with the NRC staff about this request for additional information

Westinghouse Response: (Revision 0)

The deep soil site is removed from Technical Report (TR-03). If applicable, a deep soil site will be considered within a COL application. The changes to TR-03 are identified in the Technical Report (TR) Revision sections below. In DCD subsection 3G.4.3.3, a sentence is added to recognize that the design seismic response spectrum is conservatively adjusted in the low frequency range.

During the audit of Week June 14, 2010 the NRC provided suggested editorial comments to be included in the next revision to Technical Report (TR03). These comments are given in the section Technical Report (TR03) Revision below and the DCD that are given in Appendix E (DCD Appendix 3G).

Westinghouse Additional Response: (Revision 1)

Clarification of the use of SASSI 2000 in the design-basis SSI analyses is identified in the Technical Report (TR) Revision below. In DCD subsection 3G.4.2, the first sentence is revised to recognize the use of SASSI 2000. In addition, the staff requested that Table 4.2.6-1 and Table 3G.1-1 be revised to remove the reference to obtaining maximum displacements using SASSI.

Additional Question Response: (Revision 2)

The requested information related to the calculation of displacement is reflected in the DCD markups given in the section below. The changes made in Technical Report 03 were reflected in RAI-TR03-022, Rev. 4. Given in DCD Appendix 3G.4.1 is the alternate method used to calculate relative seismic deflection to the basemat using ANSYS. In DCD Appendix 3G.4.2 is the description of the methods used to calculate deflections using SASSI.

Additional Question Response: (Revision 3)

The statement about adjusting synthesized time histories for drift is removed in the mark-up for DCD Subsection 3G.4.1. This statement is not required to describe the analysis method.

References:

None.

Design Control Document (DCD) Revision: (Revision 0, 1, 2, 3)

(Revision 0) The following sentence is added at the end of subsection 3G.4.3.3:

"The design seismic response spectra are conservatively adjusted in the low frequency range in anticipation of future sites having slightly higher response at the lower frequency."

See Technical Report (TR) Revision below for Appendix E.

PRA Revision:

None.

Technical Report (TR) Revision: (Revision 0, 1, 2, 3)

In the next revision of TR-03 (Rev. 5) the following changes will be made to remove the deep soil site:

- Remove deep soil case from Table 4.2.6-1:
- Remove maximum displacements relative to basemat language from Table 4.2.6-1

Table 4.2.6-1- Summary of Models and Analysis Methods

3D shell model of auxiliary and shield building and containment internal structures [NI20] (including steel containment vessel, polar crane, RCL, and pressurizer).	Time history analysis	SASSI	Performed for the ~~six~~five soil profiles of firm rock, soft rock, upper bound soft to medium soil, soft to medium soil~~, deep soil~~ and soft soil. To develop time histories for generating plant design floor response spectra for nuclear island structures. To obtain maximum absolute nodal accelerations (ZPA) to be used in equivalent static analyses To obtain maximum displacements relative to basemat. To obtain SSE bearing pressures for all generic soil cases. To obtain maximum member forces and moments in selected elements for comparison to equivalent static results.

- Remove last paragraph in Section 4.4.1.2.

~~In addition to these six cases, Westinghouse has established a seventh case for the deep soil site. The deep soil site profile uses a unique input time history for the response spectra analysis and will only be used to develop the design response spectra. The properties of the deep soil site are given in Table 4.4.1-3, sheet 6 of 6.~~

- Remove sheet 6 of 6 from Table 4.4.1-3.

- The deep soil case is removed from the first paragraph of Section 4.4.2:

  The SASSI Soil-Structure Interaction analyses are performed based on the Nuclear Island 3D SASSI-Model for the three soil conditions established from the AP1000 2D SASSI analyses, in addition to soft rock, and soft soil~~ and deep soil~~. These soil conditions are firm rock, upper bound soft-to-medium soil, and soft-to-medium soil. The model includes a surrounding layer of excavated soil and the existing soil media. Acceleration time histories and floor response spectra are obtained. Adjacent structures have a negligible effect on the Nuclear Island structures and thus are not considered in the 3D SASSI analyses.

- The following changes are made in Section 6.2.

- Remove the deep soil case:

  The seismic acceleration obtained from the time history analyses of the hard rock and soil cases (firm rock, soft rock, upper bound soft to medium, soft to medium and soft soil ~~and deep soil~~) are given in Figures 6.2-1 to 6.2-4.

- Remove deep soil case (DS) from Figures 6.2-1 to 6.2-4.

- Remove Deep Soil case from first paragraph of Section 6.4:

  The input spectra are envelopes of the design ground motion spectra (Figures 2.1-1 and 2.1-2) which are applicable for hard rock, and of the basemat response spectra for ~~6~~ 5 soil types (Firm Rock, Soft Rock, Upper Bound Soft to Medium, Soft to Medium~~, Deep Soil~~ and Soft Soil) obtained from SASSI analyses. The soil input spectra is the envelope of the center, edge, and corner nodes of the ASB basemat at elevation 60.5'. The nodes enveloped are shown in Figure 6.4-1. The input spectra are applied at the Nuclear Island basemat.

- Remove note on Figure D-1:

Figure D-1 - 2D SASSI FRS Comparison Node 41 X (ASB El. 99')

~~Note : Deep Soil not included in Figures D-1 through D-10~~

- Appendix E – In Table 3G.1-1 of Appendix 3G remove the additional soil case.
- Appendix E – In Table 3G.1-1 of Appendix 3G remove maximum displacements relative to basemat language.

Table 3G.1-1 (Sheet 2 of 4)
SUMMARY OF MODELS AND ANALYSIS METHODS

Model	Analysis Method	Program	Type of Dynamic Response/Purpose
3D finite element coarse shell model of auxiliary and shield building and containment internal structures [NI20] (including steel containment vessel, polar crane, RCL, and pressurizer)	Time history analysis	SASSI	Performed for the ~~six~~ five soil profiles of firm rock, soft rock, upper bound soft to medium soil, soft to medium soil~~, deep soil~~ and soft soil. To develop time histories for generating plant design floor response spectra for nuclear island structures. To obtain maximum absolute nodal accelerations (ZPA) to be used in equivalent static analyses. To obtain maximum displacements relative

			to basemat. To obtain SSE bearing pressures for all generic soil cases. To obtain maximum member forces and moments in selected elements for comparison to equivalent static results.

- Appendix E - At the end of DCD Appendix 3G Section 3G.3 remove the additional soil case:

  Based on review of the above results, five soil conditions were selected for 3D SASSI analyses in addition to the hard rock condition evaluated in the existing AP1000 Design Certification. Thus, the following five soil and rock cases identified in subsection 3.7.1.4 are considered: hard rock, firm rock, soft rock, soft-to-medium soil, upper bound soft-to-medium, and soft soil. ~~In addition to the six site cases, a seventh case was established for the deep soil site. The deep soil site profile uses unique input time history for the response spectra analysis and will be only used to develop the design response spectra.~~

- Appendix E – In the first paragraph of DCD Appendix 3G Section 3G.4.2 remove the additional soil case:

  … These soil conditions are firm rock, soft rock, soft-to-medium soil, upper bound soft-to-medium~~,~~ ~~deep soil~~ and soft soil. The model includes a surrounding layer of excavated soil and the existing soil media as shown in Figures 3G.4-3 and 3G.4-4. Acceleration time histories and floor response spectra are obtained. Adjacent structures have a negligible effect on the nuclear island structures and, thus, are not considered in the 3D SASSI analyses.

- Appendix E – In the note to Figure 3G.3-1of DCD Appendix 3G remove the Deep soil case:

  Note: Fixed base analyses were performed for hard rock sites. These analyses are applicable for shear wave velocity greater than 8000 feet per second. ~~Deep soil not included in Figures 3G.3-1 through 3G.3-11.~~

- Appendix E – Remove the deep soil case from Figures 3G.4-5X to 3G.4-10Z as shown below:

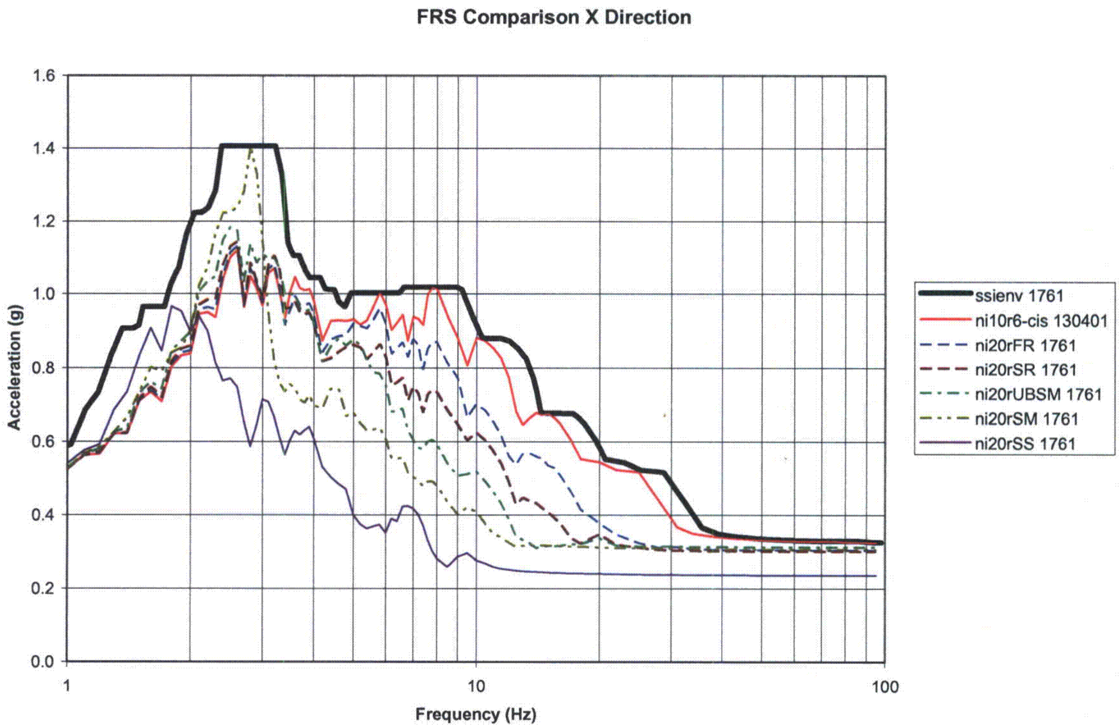

Figure 3G.4-5X:X Direction FRS for Node 130401 (NI10) or 1761 (NI20) CIS at Reactor Vessel Support Elevation of 100′

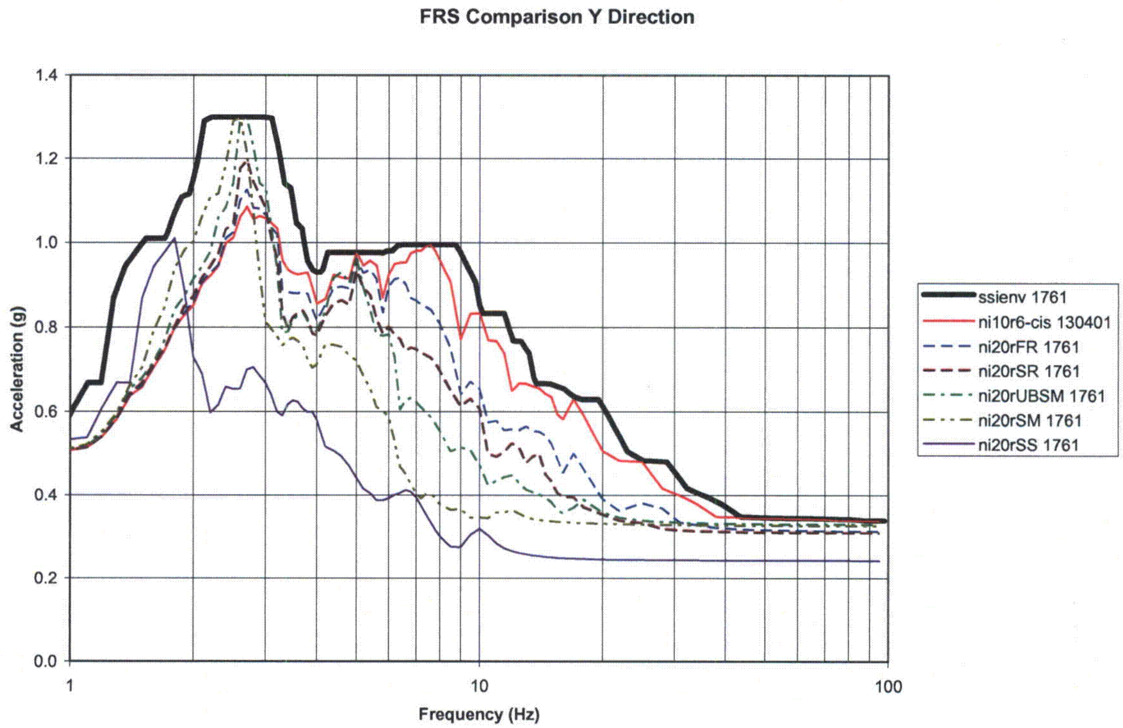

Figure 3G.4-5Y: Y Direction FRS for Node 130401 (NI10) or 1761 (NI20) CIS at Reactor Vessel Support Elevation of 100′

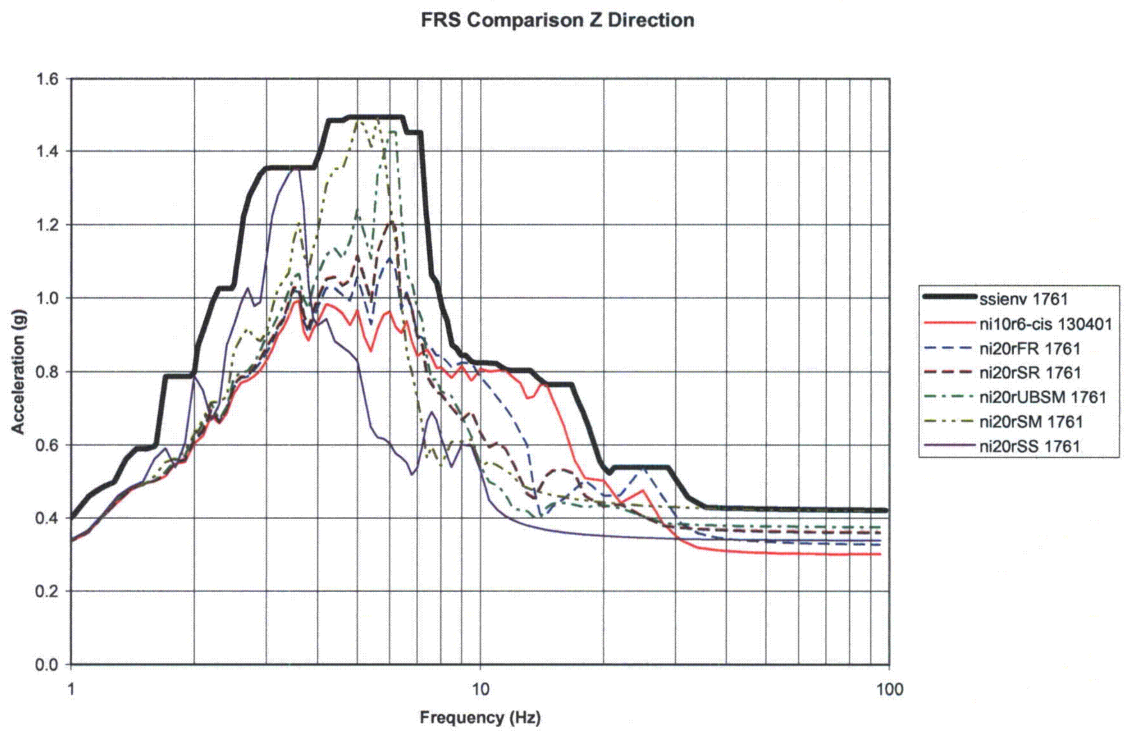

Figure 3G.4-5Z: Z Direction FRS for Node 130401 (NI10) or 1761 (NI20) CIS at Reactor Vessel Support Elevation of 100′

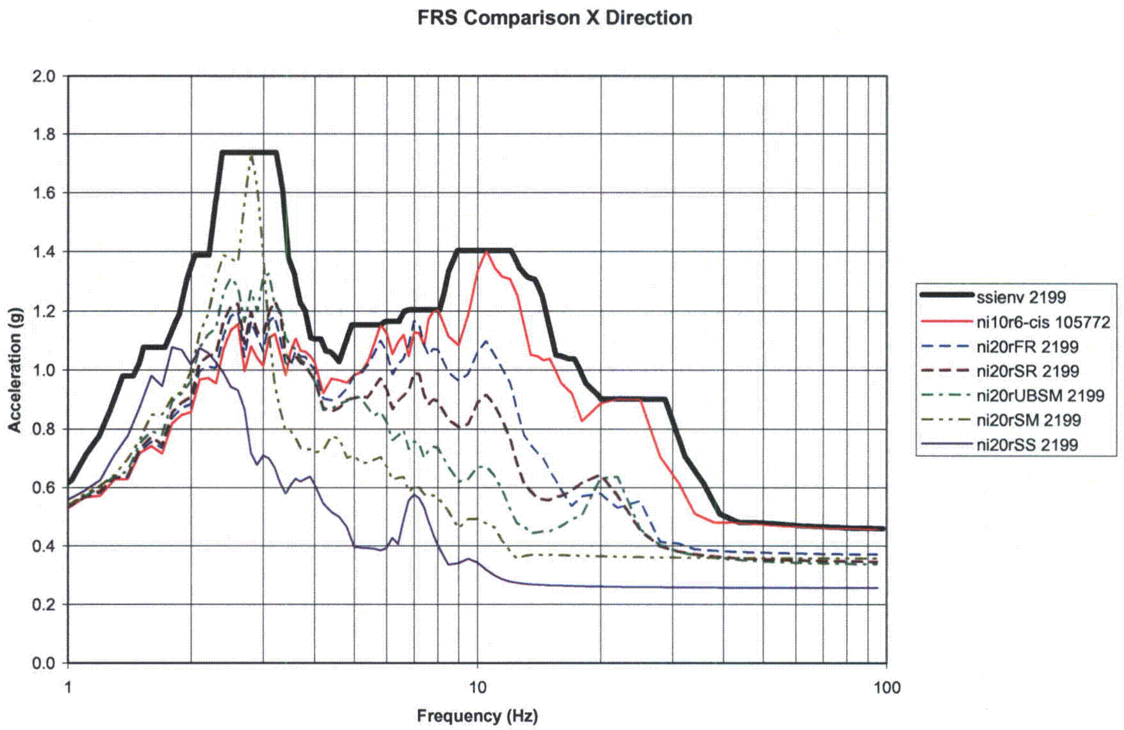

Figure 3G.4-6X: X Direction FRS for Node 105772 (NI10) or 2199 (NI20) CIS at Operating Deck Elevation 134.25′

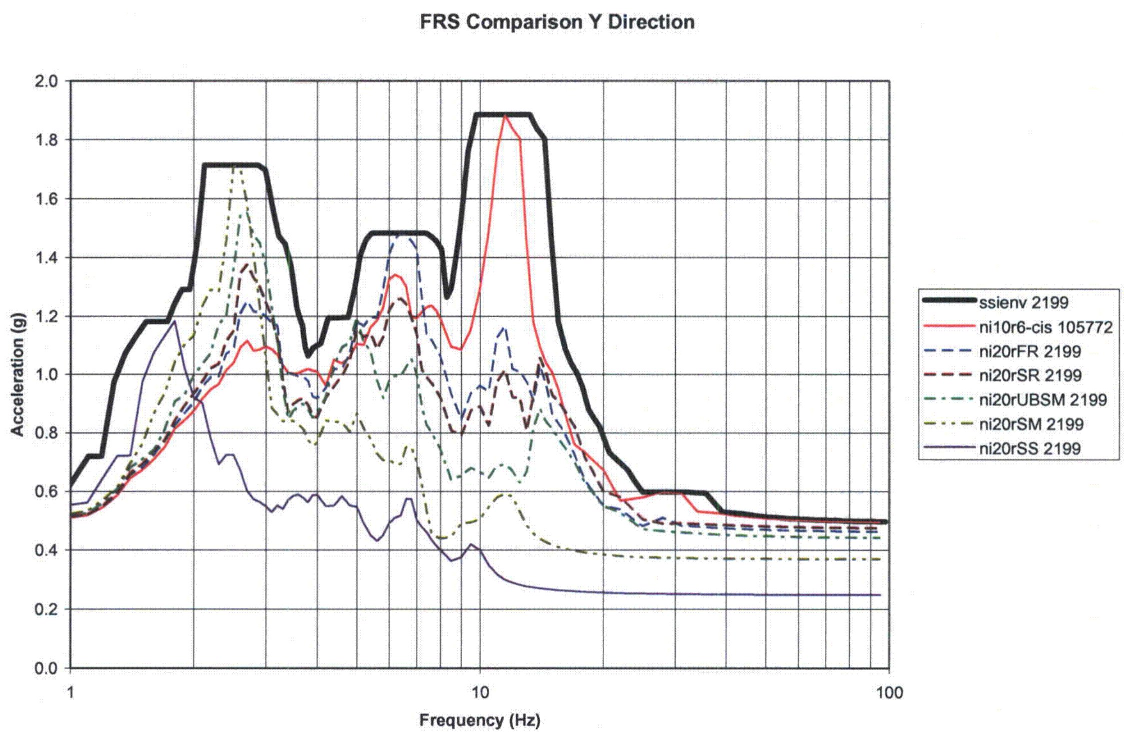

Figure 3G.4-6Y: Y Direction FRS for Node 105772 (NI10) or 2199 (NI20) CIS at Operating Deck Elevation 134.25′

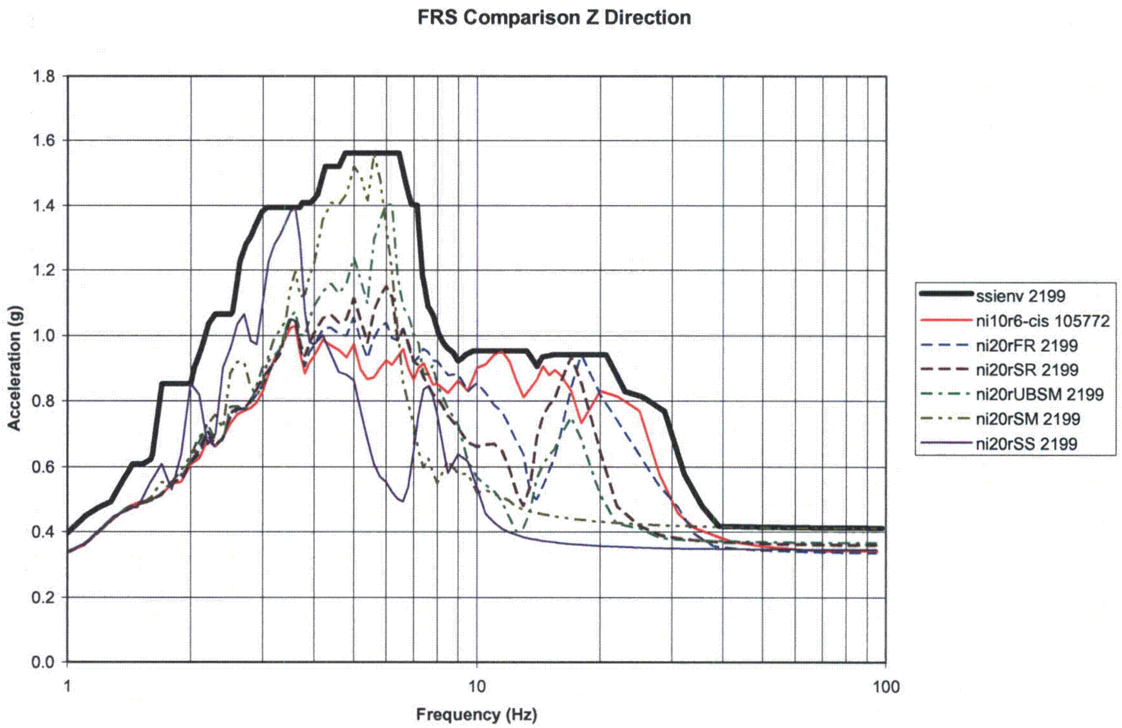

Figure 3G.4-6Z: Z Direction FRS for Node 105772 (NI10) or 2199 (NI20) CIS at Operating Deck Elevation 134.25′

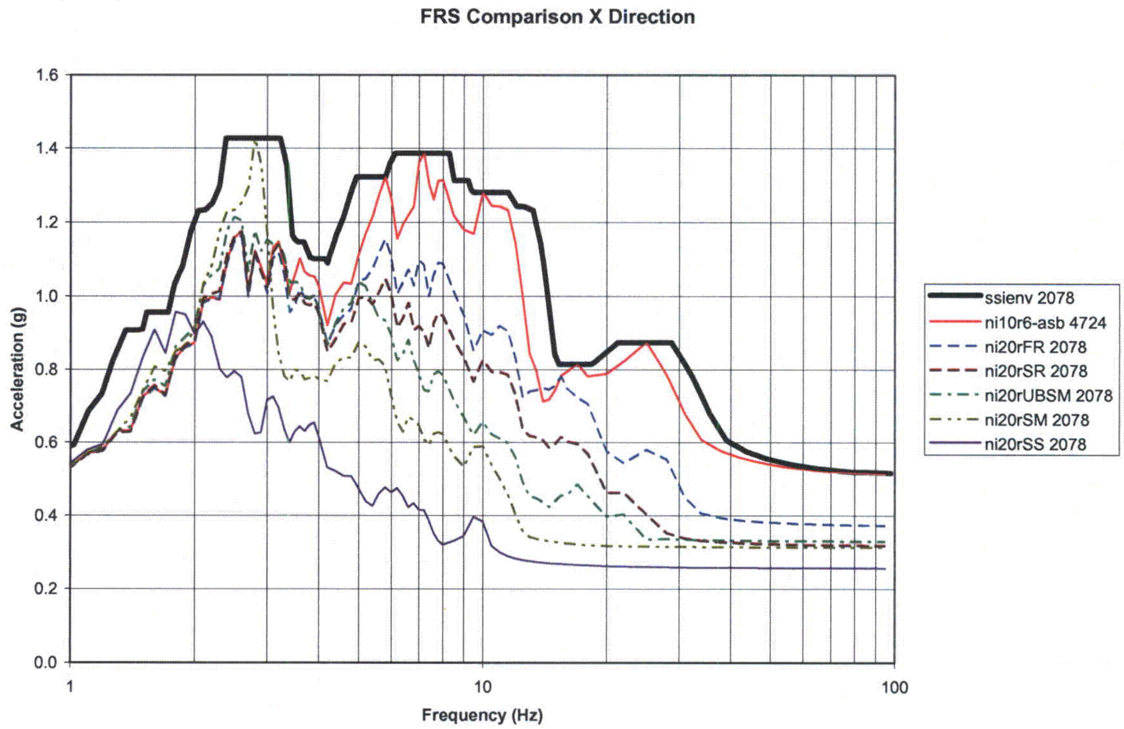

Figure 3G.4-7X: X Direction FRS for Node 4724 (NI10) or 2078 (NI20) ASB Control Room Side Elevation 116.50′

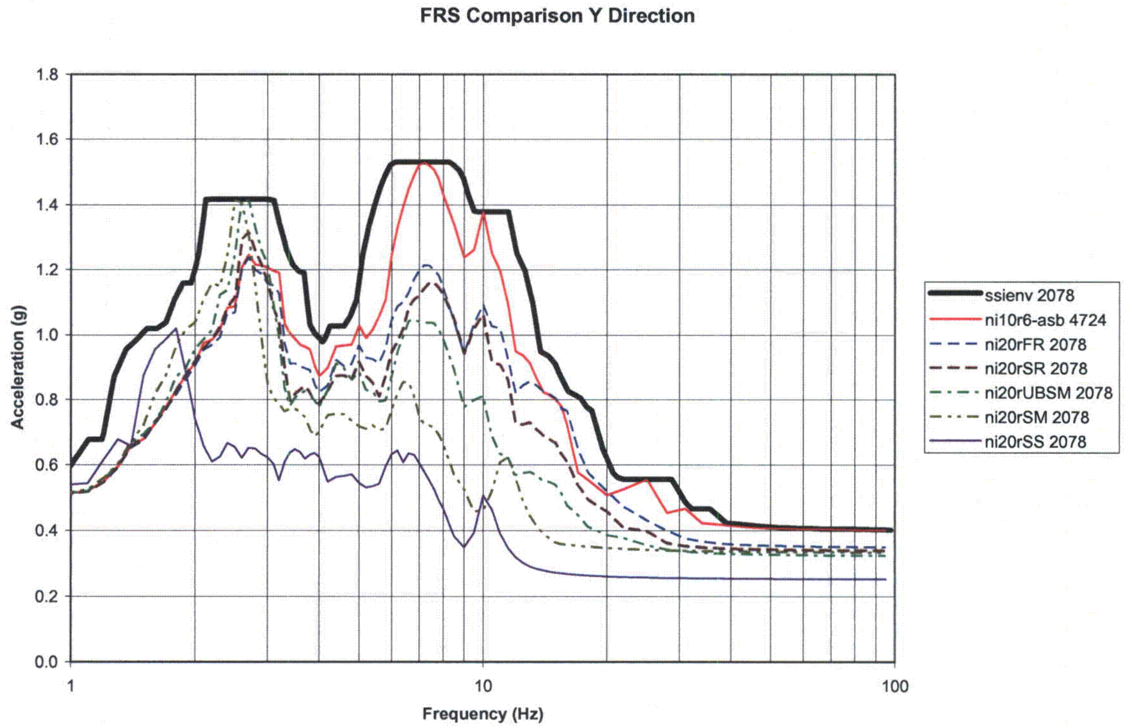

Figure 3G.4-7Y: Y Direction FRS for Node 4724 (NI10) or 2078 (NI20) ASB Control Room Side Elevation 116.50′

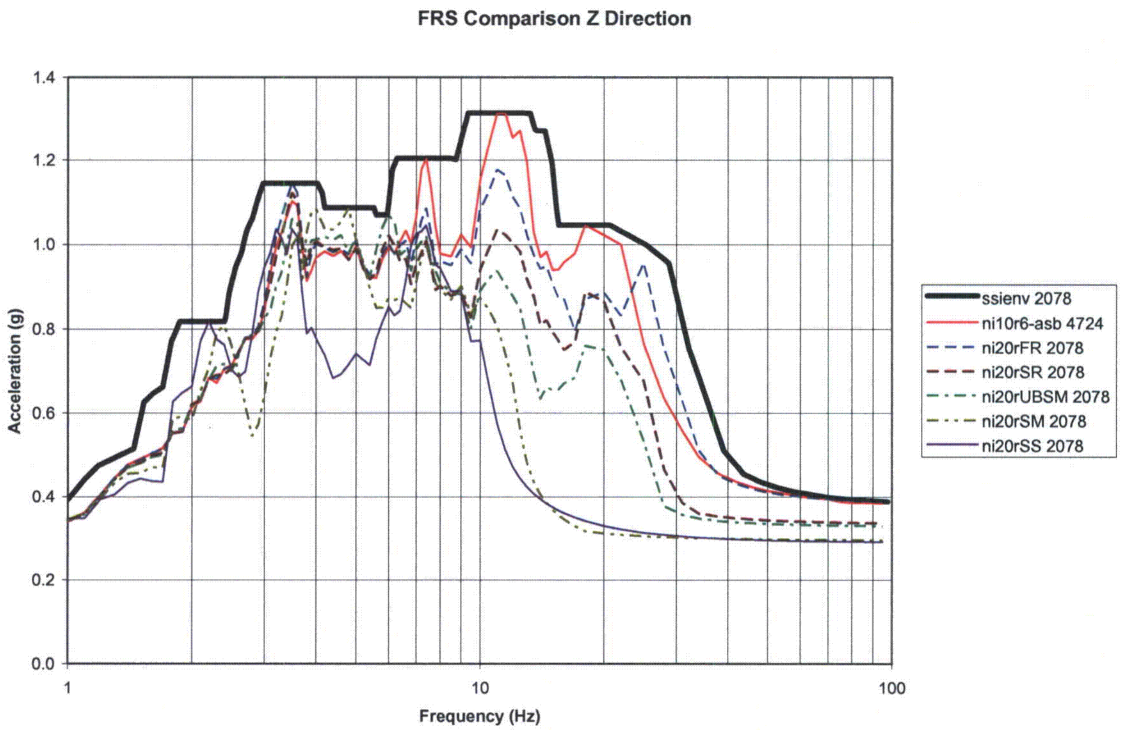

Figure 3G.4-7Z: Z Direction FRS for Node 4724 (NI10) or 2078 (NI20) ASB Control Room Side Elevation 116.50′

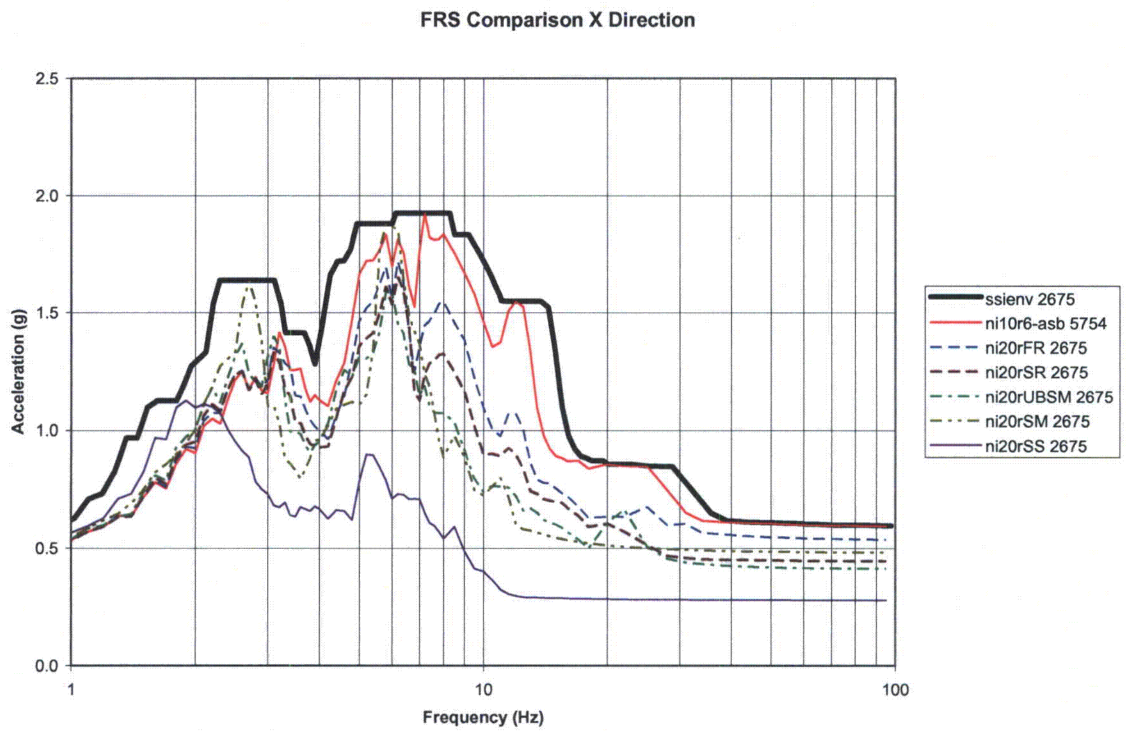

Figure 3G.4-8X: X Direction FRS for Node 5754 (NI10) or 2675 (NI20) ASB Fuel Building Roof Elevation 179.19′

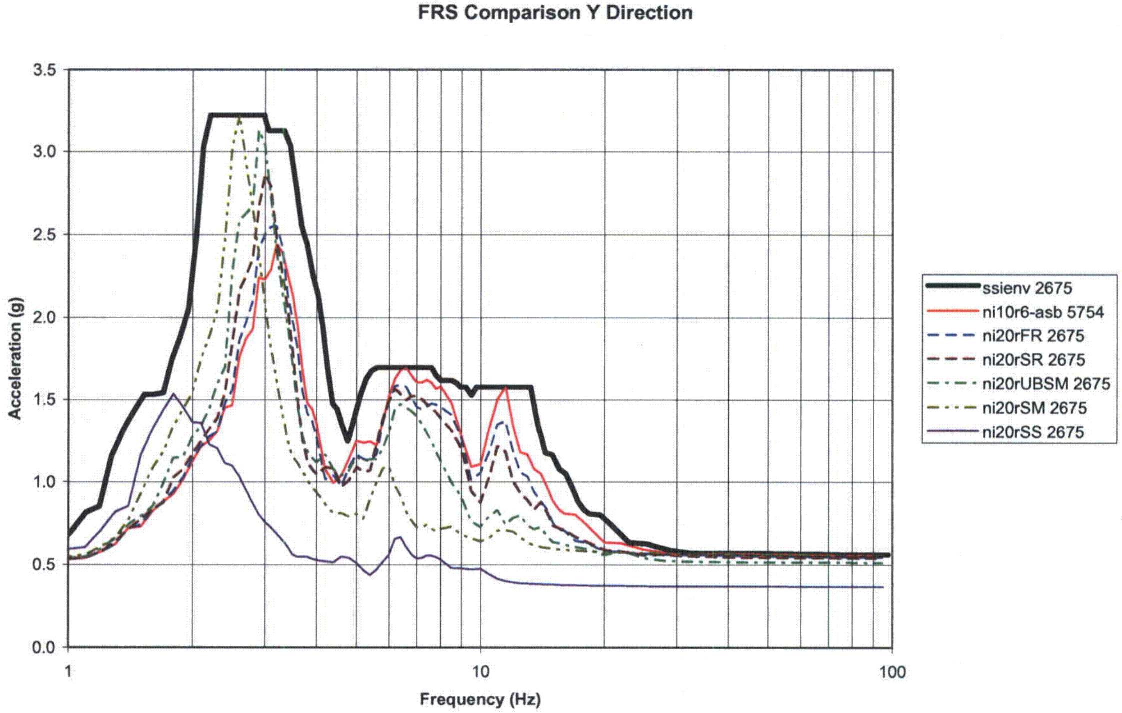

Figure 3G.4-8Y: Y Direction FRS for Node 5754 (NI10) or 2675 (NI20) ASB Fuel Building Roof Elevation 179.19′

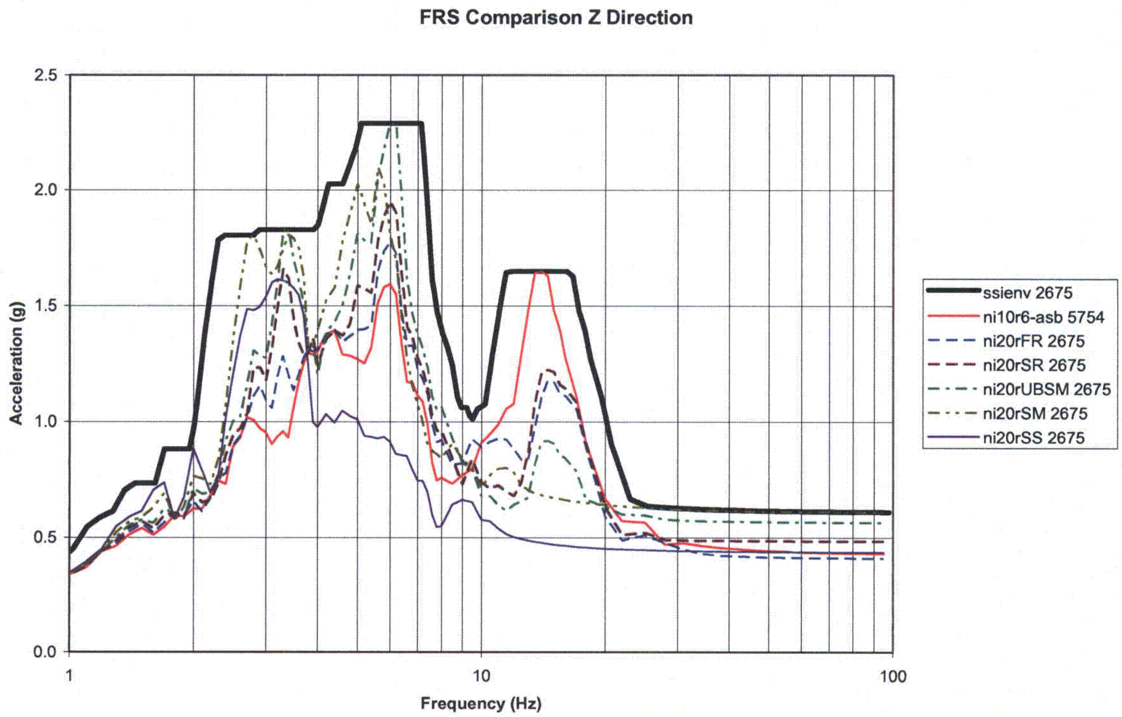

Figure 3G.4-8Z: Z Direction FRS for Node 5754 (NI10) or 2675 (NI20) ASB Fuel Building Roof Elevation 179.19′

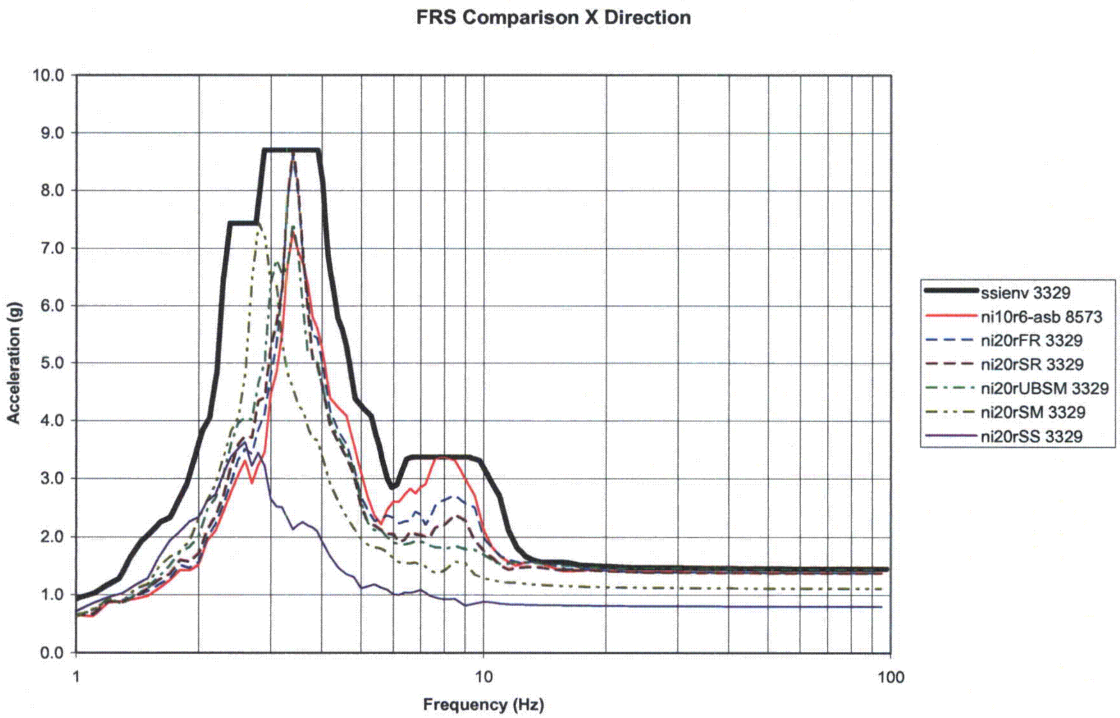

Figure 3G.4-9X: X Direction FRS for Node 2862 (NI10) or 3329 (NI20) ASB Shield Building Roof Elevation 327.41′

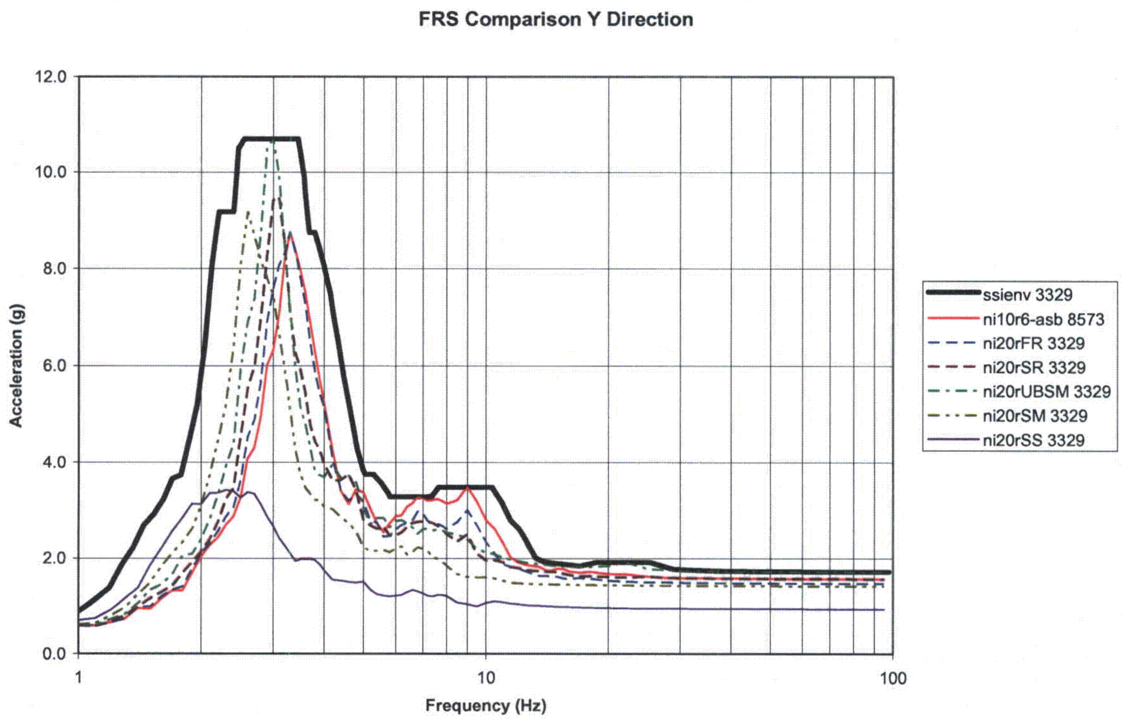

**Figure 3G.4-9Y: Y Direction FRS for Node 2862 (NI10) or 3329 (NI20)
ASB Shield Building Roof Elevation 327.41′**

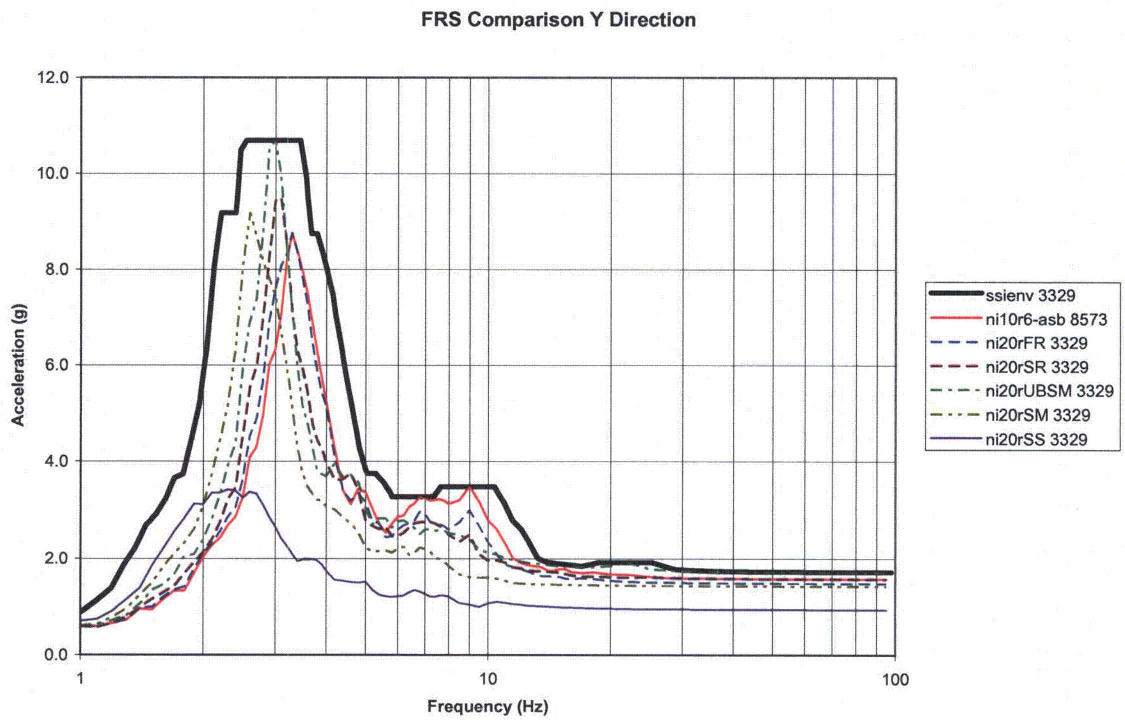

Figure 3G.4-9Z: Z Direction FRS for Node 2862 (NI10) or 3329 (NI20)
ASB Shield Building Roof Elevation 327.41′

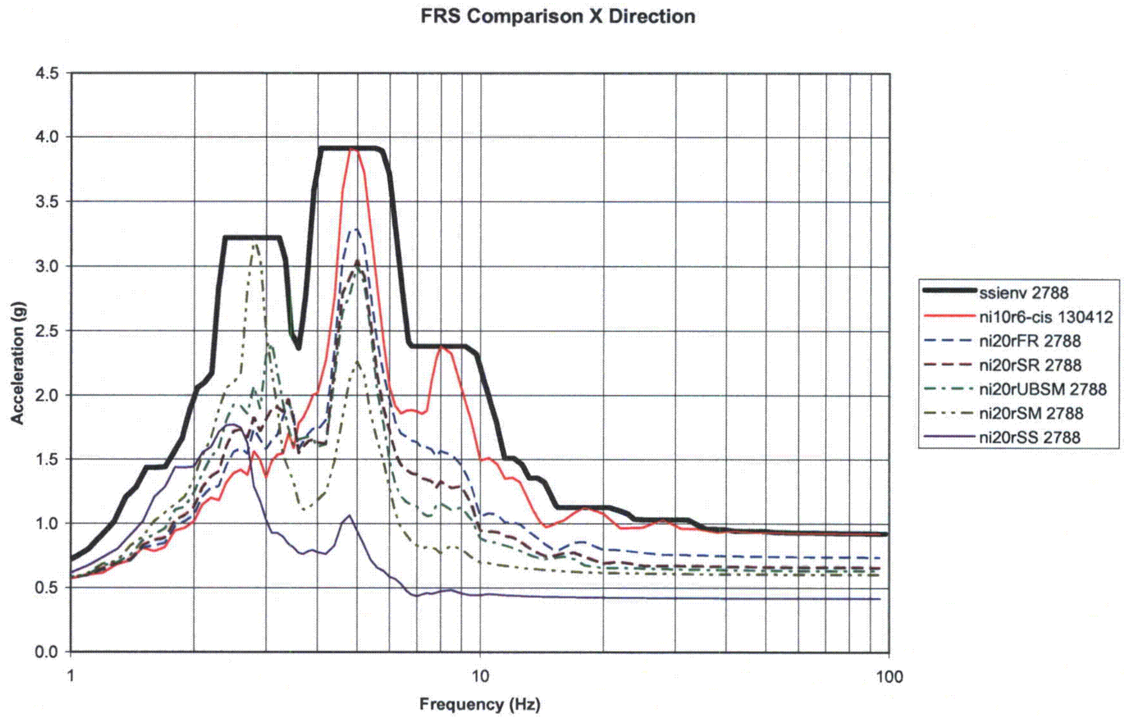

Figure 3G.4-10X: X Direction FRS for Node 130412 (NI10) or 2788 (NI20) SCV Near Polar Crane Elevation 224.00′

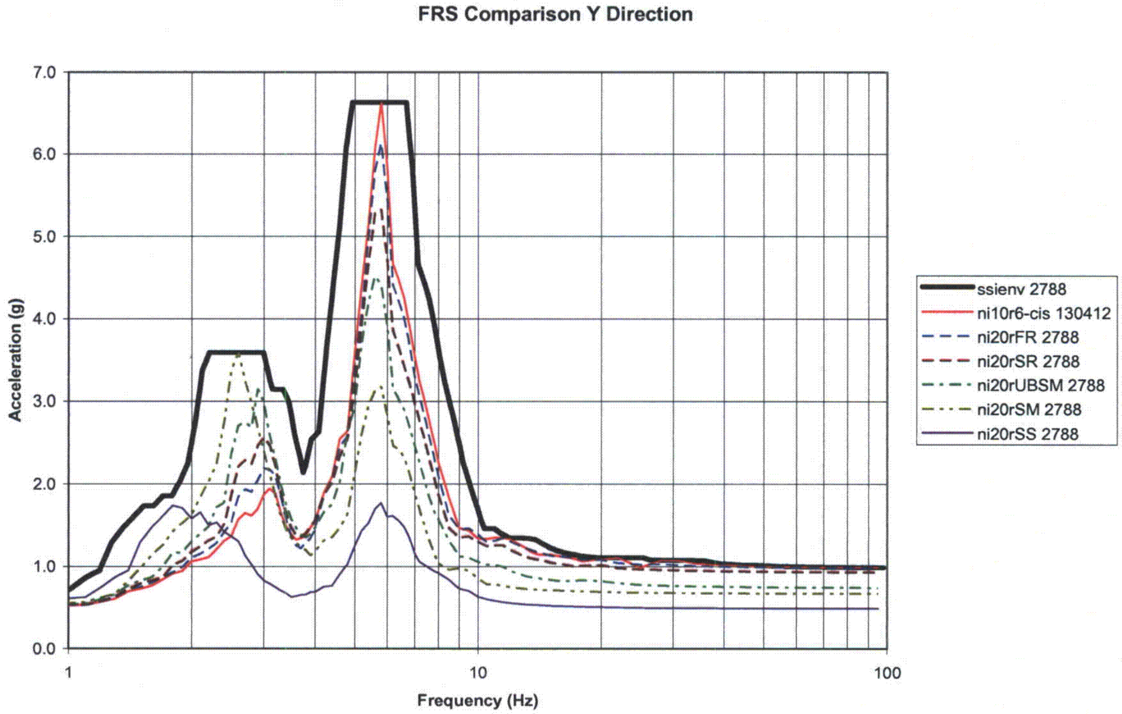

Figure 3G.4-10Y:Y Direction FRS for Node 130412 (NI10) or 2788 (NI20) SCV Near Polar Crane Elevation 224.00′

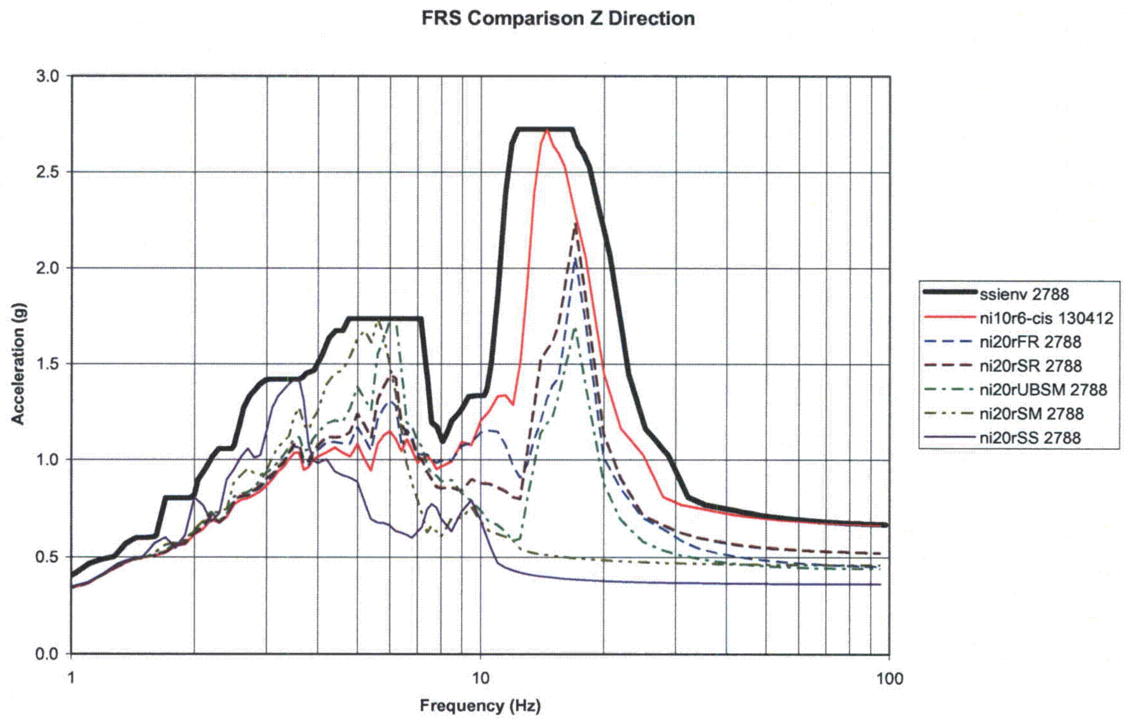

Figure 3G.4-10Z: Z Direction FRS for Node 130412 (NI10) or 2788 (NI20) SCV Near Polar Crane Elevation 224.00′

The following editorial comments will be made in the next revision to technical report TR03:

1. Change the heading for Figures 4.2.3-3 and 4.2.3-4 to the following:
   Figure 4.2.3-3 – Massless Shell Elements at Elevation 100'
   Figure 4.2.3-4 – Massless Shell Elements at Elevation 99'

2. In Section 4.2.5 that describes the NI05 model, include a discussion of the non-linear analysis (non-linear) for the basemat. This discussion will be added at the end of the section and is given below:

   "The NI05 model is used for the analysis of the basemat. These analyses are non-linear equivalent static analyses that consider lift off of the basemat from the soil. The equivalent static loads are developed from accelerations given by time history analyses of the nuclear island on hard rock and soil sites. No credit is taken in these analyses for the effect of side soils. See Reference 14 for more discussion of these analyses, and the nuclear island basemat design."

3. Remove the entry "Floor and wall flexibility included in models" from the fifth row in Table 4.2.6-1. This is shown below.

Table 4.2.6-1- Summary of Models and Analysis Methods

Model	Analysis Method	Program	Type of Dynamic Response/Purpose
3D (ASB) solid-shell model	-	ANSYS	Creates the finite element mesh for the ASB finite element model
3D (CIS) solid-shell model	-	ANSYS	Creates the finite element mesh for the CIS finite element model
3D finite element model including shield building roof (ASB10)	-	ANSYS	ASB portion of NI10
3D finite element model including dish below containment vessel	~~response spectrum analysis~~	ANSYS	CIS portion of NI10 ~~To obtain SSE member forces for the containment internal structures.~~
3D finite element shell model of nuclear island [~~NI05~~NI10] (coupled auxiliary/shield building shell model, containment internal structures, steel containment vessel, polar crane, RCL, pressurizer and CMTs)	Mode superposition time history analysis ~~and response spectra analysis~~	ANSYS	Performed for hard rock profile for ASB with CIS as superelement and for CIS with ASB as superelement. ~~Floor and wall flexibility included in models.~~ To develop time histories for generating plant design floor response spectra for nuclear island structures. To obtain maximum absolute nodal accelerations (ZPA) to be used in equivalent static analyses. To obtain maximum displacements relative to basemat. ~~To obtain maximum member forces and moments in selected elements for comparison to equivalent static results.~~

4. In the 9th row of Table4.2.6-1 add "Complex frequency response analysis" under the Analysis Method column to be consistent with DCD Table 3G.1-2. This is shown below:

3D shell model of auxiliary and shield building and containment internal structures [NI20] (including steel containment vessel, polar crane, RCL, and pressurizer).	Time history analysis Complex frequency response analysis	SASSI	Performed for the five ~~six~~ soil profiles of firm rock, soft rock upper bound soft to medium soil, soft to medium soil and soft soil. To develop time histories for generating plant design floor response spectra for nuclear island structures. To obtain maximum absolute nodal accelerations (ZPA) to be used in equivalent static analyses To obtain maximum displacements relative to basemat. To obtain SSE bearing pressures for all generic soil cases. To obtain maximum member forces and moments in selected elements for comparison to equivalent static results.

5. In the 2nd row from the bottom of Table 4.2.6-1 1 align the analysis method with the Type of Dynamic Response/Purpose. Also include "floor and wall flexibility." This is shown below:

3D finite element refined shell model of nuclear island (NI05)	Equivalent static non-linear analysis using accelerations from time history analyses Mode superposition time history analysis for the wall and floor flexibility using synthetic time histories developed to match spectral envelopes applied at the base Response spectrum analysis with seismic input enveloping all soil cases	ANSYS	To obtain SSE member forces for the nuclear island basemat To obtain floor and wall flexibility response characteristics To obtain SSE member forces for the auxiliary and shield building and the containment internal structures. To obtain maximum displacements relative to basemat.

6. Under Section 4.4.1.1 AP600 Soil Studies, 6th paragraph, it is asked to confirm that the statement: "Since the mass of the AP1000 is similar to that of the AP600 the vertical SSI frequency and response are similar. Thus, the specification of the water table at grade is appropriate for the AP1000 soil sites." This was confirmed since the weight of the AP600 is only approximately 10% lower.

7. Confirm that Reference 1 should still refer to Rev. 16 of the DCD. The latest revision to the DCD should be used. This would be Revision 17; however, since Revision 18 will be issued, and this revision will remain appropriate, the revision will be removed so that in the future there is no confusion and it will not be necessary to update the technical report. The change in Section 8.0, References, is shown below:

    1. APP-GW-GL-700, AP1000 Design Control Document, Section 3.7~~, Revision 16~~.

8. In Appendix E that is associated with Appendix 3G of the DCD, the following changes are to be made.

    a. Clarify the use of ACS SASSI and SASSI 2000 in subsection 3G.4.2. This clarification should state where each is used. This clarification is given below and refers to the first paragraph of this DCD section.

See subsection 3G.4.2 given at the end of this section.

"~~The computer program SASSI 2000 and ACS SASSI are used to perform Soil-Structure Interaction analysis with the 3D NI20 Coarse Finite Element Model and the 2D stick model. SASSI 2000 is used for the soil site cases to perform the following functions: 1) Compute the free field displacement vector based on sit soil properties; 2) Compute the flexible matrix for the interaction nodes; 3) Generate the mass and frequency-independent stiffness matrix for the structure and excavated soil; and 4) Compute the impedance matrix for each frequency and obtain the transfer functions from the control motion to the final motions. The ACS SASSI is used together with SASSI 2000 to process the response spectra, and to obtain the transfer function plots and stresses. The SASSI Soil-Structure Interaction analyses are performed for the five soil conditions established from the AP1000 2D SASSI analyses. ...~~"

    b. Make changes to Table 3G.1-1 to be consistent with the changes to Table 4.2.6-1 as given above. These changes are given below:

        i. Modify 5th row of Table 3G.1-1 to be consistent with Table 4.2.6-1 of the Technical Report. This is shown below:

3D finite element shell model of nuclear island [~~NI05~~NI10] (coupled auxiliary and shield building shell model, containment internal structures, steel containment vessel, polar crane, RCL, pressurizer, and CMTs)	Mode superposition time history analysis ~~and response spectra analysis~~	ANSYS	Performed for hard rock profile for ASB with CIS as superelement and for CIS with ASB as superelement. ~~Floor and wall flexibility included in models.~~ To develop time histories for generating plant design floor response spectra for nuclear island structures. To obtain maximum absolute nodal accelerations (ZPA) to be used in equivalent static analyses. To obtain maximum displacements relative to basemat.

ii. In the 9th row of Table3G.1-1 add "Complex frequency response analysis" under the Analysis Method column to be consistent with DCD Table 3G.1-2. This is shown below:

3D shell model of auxiliary and shield building and containment internal structures [NI20] (including steel containment vessel, polar crane, RCL, and pressurizer).	Time history analysis Complex frequency response analysis	SASSI	Performed for the five ~~six~~ soil profiles of firm rock, soft rock upper bound soft to medium soil, soft to medium soil and soft soil. To develop time histories for generating plant design floor response spectra for nuclear island structures. To obtain maximum absolute nodal accelerations (ZPA) to be used in equivalent static analyses To obtain maximum displacements relative to basemat. To obtain SSE bearing pressures for all generic soil cases. To obtain maximum member forces and moments in selected elements for comparison to equivalent static results.

iii. In the 2nd row from the bottom of Table 3G.1-1 align the analysis method with theType of Dynamic Response/Purpose. Also include "floor and wall flexibility." This is shown below:

3D finite element refined shell model of nuclear island (NI05)	Equivalent static non-linear analysis using accelerations from time history analyses~~;~~ Mode superposition	ANSYS	To obtain SSE member forces for the nuclear island basemat To obtain floor and wall flexibility response

	time history analysis for the wall and floor flexibility using synthetic time histories developed to match spectral envelopes applied at the base		characteristics
	Response spectrum analysis with seismic input enveloping all soil cases.		To obtain SSE member forces for the auxiliary and shield building and the containment internal structures. To obtain maximum displacements relative to basemat.

c. In Table 3G.1-2 correct the entry under the column Three Components Combination, 5th row, add 40%. This is shown below.

3D shell of revolution model of steel containment vessel	Equivalent static analysis using nodal accelerations from 3D stick model	ANSYS	SRSS or 100%, 40%, 40%	n/a

In Appendix E that is associated with Appendix 3G of the DCD, the following change is to be made.

Clarify the use of ACS SASSI and SASSI 2000 in subsection 3G.4.2. This clarification is given below and refers to the first paragraph of this DCD section.

3G.4.1 ANSYS Fixed Base Analysis

The NI10 model described in subsection 3G.3.2.2.1 was analyzed by time history modal superposition. To perform the time history analysis of this large model, the ANSYS superelement (substructuring) techniques were applied. Substructuring is a procedure that condenses a group of finite elements into one element represented as a matrix. The reasons for substructuring are to reduce computer time of subsequent evaluations. Two sets of analyses were performed. To obtain the time history response of the ASB, the ASB finite element model was merged with the superelement of the CIS and its major components. To obtain the time history response of the CIS, the CIS finite element model was merged with the superelement of the ASB.

Deflection time history responses were obtained at selected representative locations. These locations included major wall and floor intersections and nodes at the cardinal orientations at key elevations of the shield building. Nodes were also selected at mid-span on flexible walls and floors. Typical locations are shown for the ASB at elevation 135′ on Figures 3G.4-1 and 3G.4-2. Figure 3G.4-1 shows the "rigid" locations, and Figure 3G.4-2 shows the "flexible" locations.

As an alternative, ANSYS is also used to calculate the maximum relative deflection to the nuclear island for the envelop case that considers all of the soil and hard rock site cases. Synthesized displacement time histories are developed using the envelope seismic response spectra from the six site conditions (hard rock, firm rock, soft rock, upper-bound-soft-to-medium, soft-to-medium, and soft soil). Seismic response spectra at nine locations are used (4 edge locations, 1 center location, and 4 corner locations). The synthesized time histories are corrected for drift based on the slope of the drift. However, it It is not necessary to adjust for drift since relative deflections to the basemat are calculated and the drift would be subtracted from the results.

3G.4.2 3D SASSI Analyses

The computer program ACS SASSI and SASSI 2000 is used to perform Soil-Structure Interaction analysis with the NI20 Coarse Finite Element Model. The SASSI Soil-Structure Interaction analyses are performed for the five soil conditions established from the AP1000 2D SASSI analyses. These soil conditions are firm rock, soft rock, soft-to-medium soil, upper bound soft-to-medium, and soft soil. The model includes a surrounding layer of excavated soil and the existing soil media as shown in Figures 3G.4-3 and 3G.4-4. Acceleration time histories and floor response spectra are obtained. Adjacent structures have a negligible effect on the nuclear island structures and, thus, are not considered in the 3D SASSI analyses.

Westinghouse has adopted the approach that calculates displacements internally within the ACS SASSI program based on an analytical complex frequency domain approach that uses inverse Fast-Fourier Transforms (FFT) to compute relative displacement histories instead of double numerical integration in the time domain that computes absolute displacement time histories from absolute acceleration time histories.

The relative displacement time history is calculated using ACS SASSI RELDISP module. The complex acceleration transfer functions (TF) are computed for reference and all selected output nodes. The relative acceleration transfer function is calculated by subtracting the reference node TF from the output node TF. The relative displacement transfer function is obtained by dividing the circular frequency square (ω^2) for each frequency data point. The relative displacement time history is obtained by taking the inverse FFT.

Relative displacements are calculated between adjacent buildings and the nuclear island using soft springs between the buildings. The spring stiffness is very small so that it does not affect the dynamic response. These calculations are performed using 2-D models and the SASSI 2000 code. The relative deflection is calculated using the maximum compressive spring force and the stiffness value.