Nuclear Innovation
North America LLC
4000 Avenue F, Suite A
Bay City, Texas 77414

March 15, 2011
U7-C-NINA-NRC-110043

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

South Texas Project
Units 3 and 4
Docket Nos. 52-012 and 52-013
Revised Response to Request for Additional Information

Attached is the Nuclear Innovation North America LLC (NINA) revised or supplemental responses to Request for Additional Information (RAI) related to Combined License Application (COLA) Part 2, Tier 2, Sections 3.7 and 3.8. The attachments address the revised or supplemental responses to the RAI questions listed below:

03.07.02-22	03.07.02-29
03.07.02-25	03.08.04-18
03.07.02-28	03.08.04-30

Where there are COLA markups, they will be made at the first routine COLA update following NRC acceptance of the RAI response.

There are no commitments in this letter.

If you have any questions, please contact Scott Head at (361) 972-7136 or Bill Mookhoek at (361) 972-7274.

D091
NRO

STI 32833064

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

Executed on 3/15/2011

Mark McBurnett
Senior Vice President, Oversight & Regulatory Affairs
Nuclear Innovation North America LLC

jep

Attachments:

1. RAI 03.07.02-22
2. RAI 03.07.02-25, Revision 1
3. RAI 03.07.02-28
4. RAI 03.07.02-29, Revision 1
5. RAI 03.08.04-18, Revision 1, Supplement 2
6. RAI 03.08.04-30, Revision 1
7. RAI 03.08.04-30, Supplement 1

cc: w/o attachment except*
(paper copy)

Director, Office of New Reactors
U. S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Regional Administrator, Region IV
U. S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, Texas 76011-8064

Kathy C. Perkins, RN, MBA
Assistant Commissioner
Division for Regulatory Services
Texas Department of State Health Services
P. O. Box 149347
Austin, Texas 78714-9347

Alice Hamilton Rogers, P.E.
Inspection Unit Manager
Texas Department of State Health Services
P. O. Box 149347
Austin, Texas 78714-9347

*Steven P. Frantz, Esquire
A. H. Gutterman, Esquire
Morgan, Lewis & Bockius LLP
1111 Pennsylvania Ave. NW
Washington D.C. 20004

*Tom Tai
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852

(electronic copy)

*George F. Wunder
*Tom Tai
Loren R. Plisco
U. S. Nuclear Regulatory Commission

Steve Winn
Joseph Kiwak
Jamey Seely
Eli Smith
Nuclear Innovation North America

Peter G. Nemeth
Crain, Caton and James, P.C.

Richard Peña
Kevin Pollo
L. D. Blaylock
CPS Energy

RAI 03.07.02-22

QUESTION:

Follow-up Question to RAI 03.07.02-12 and 03.07.01-13 S2 (STP-NRC-090129 & 090230)

10CFR50, Appendix S requires that evaluation for SSE must take into account soil-structure interaction (SSI) effects. In the response to RAI 03.07.02-12 regarding the dynamic soil pressures on the UHS Basin and RSW Pump House, the applicant has provided the calculated pressures that include the effect of SSI in Supplement 2 response to RAI 03.07.01-13 (see letter U7-C-STP-NRC-090230 dated 12/30/2009). A comparison of the envelop of calculated soil pressures on the RSW Pump House and UHS Basin walls calculated from the SSI analysis (Figure RAI 03.07.01-13A and RAI 03.07.01-13B in the Supplement) and those calculated using the ASCE 4 procedures (shown in Figures 3H.6-41, 3H.6- 42 and 3H.6-43 of the same supplement) reveals that for the UHS Basin, the SSI pressures for the west and east walls are significantly higher than those of ASCE 4 (approximately by a factor of 2 or more everywhere). For the UHS Basin north and south walls, the SSI pressures are higher at all points but, in particular, significantly higher near grade. For the RSW Pump House, the overall difference between the magnitude of the calculated SSI and ASCE 4 pressures are less than those of the UHS Basin but the distribution of the pressures are different. As such, use of pressures using the methodology of ASCE 4 may under predict the pressure loads on the wall and thus, could impact the wall designs. As such, the applicant is requested to provide justification for not using the dynamic soil pressures calculated from the SSI analysis for design of the UHS Basin and RSW Pump House walls that takes into account the inertia effect of the structure and SSI effects.

RESPONSE:

Design of the Ultimate Heat Sink (UHS) and Reactor Service Water (RSW) Pump House has been revised to consider, in addition to incremental seismic soil pressures per ASCE 4-98, incremental seismic soil pressures from soil-structure interaction (SSI) analyses for full and empty UHS basin cases and incremental seismic soil pressures from structure-soil-structure interaction (SSSI) analysis.

Further information regarding SSI analyses for full and empty basin cases is provided in the response to RAI 03.07.02-24, Supplement 2, submitted with letter U7-C-STP-NRC-100268 dated December 14, 2010. The details for the SSSI analysis of the UHS/RSW Pump House are provided in the response to RAI 03.07.02-24, Supplement 1, Revision 1 submitted with letter U7-C-NINA-NRC-110042 dated March 7, 2011.

Figures 3H.6-218 through 3H.6-220 (see Enclosure 1) provide incremental seismic soil pressures from the SSI analysis, SSSI analysis and per Subsection 3.5.3.2.2 of ASCE 4-98 as well as total soil pressure used for design of RSW Pump House south wall, RSW Pump House north wall, and UHS basin south wall, respectively.

The revised design results are provided in the response to RAI 03.08.04-30, Supplement 1, which is being submitted concurrently with this response.

COLA Part 2, Tier 2 Section 3H.6 will be revised as shown in Enclosure 1.

Enclosure 1

Revision to COLA Section 3H.6

3H.6.2 Summary

- Lateral soil pressures for design (Figures 3H.6-41 through 3H.6-44 and Figures 3H.6-218 through 3H.6-220).

3H.6.6.2.1 UHS Basin, UHS Cooling Tower Enclosure, and RSW Pump House

- Envelope of Ddynamic lateral soil pressures on the walls of the UHS basin and RSW pump houses due to an SSE, calculated from: ~~using the~~ (a) methodology defined in Subsection 3.5.3.2.2 of ASCE 4, (b) SSI analysis, and (c) structure-soil-structure (SSSI) analysis. At rest lateral soil pressures are presented in Figures 3H.6-41 through 3H.6-43. Figures 3H.6-218 through 3H.6-220 provide a comparison of lateral soil pressures from SSI and SSSI analysis to those from ASCE 4 methodology.

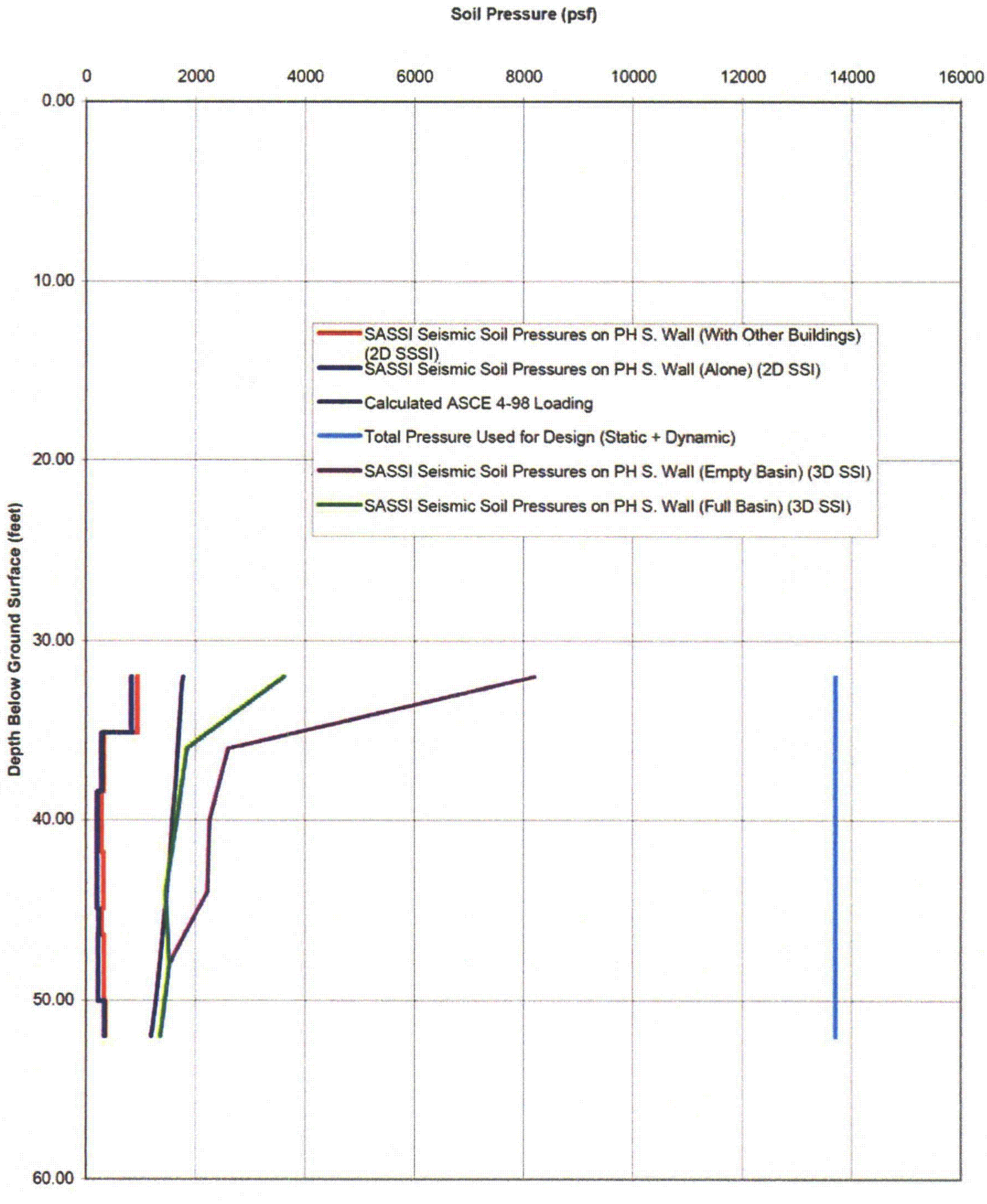

Figure 3H.6-218: SSI, SSSI, ASCE 4-98 and Design Lateral Seismic Soil Pressures on RSW Pump House South Wall

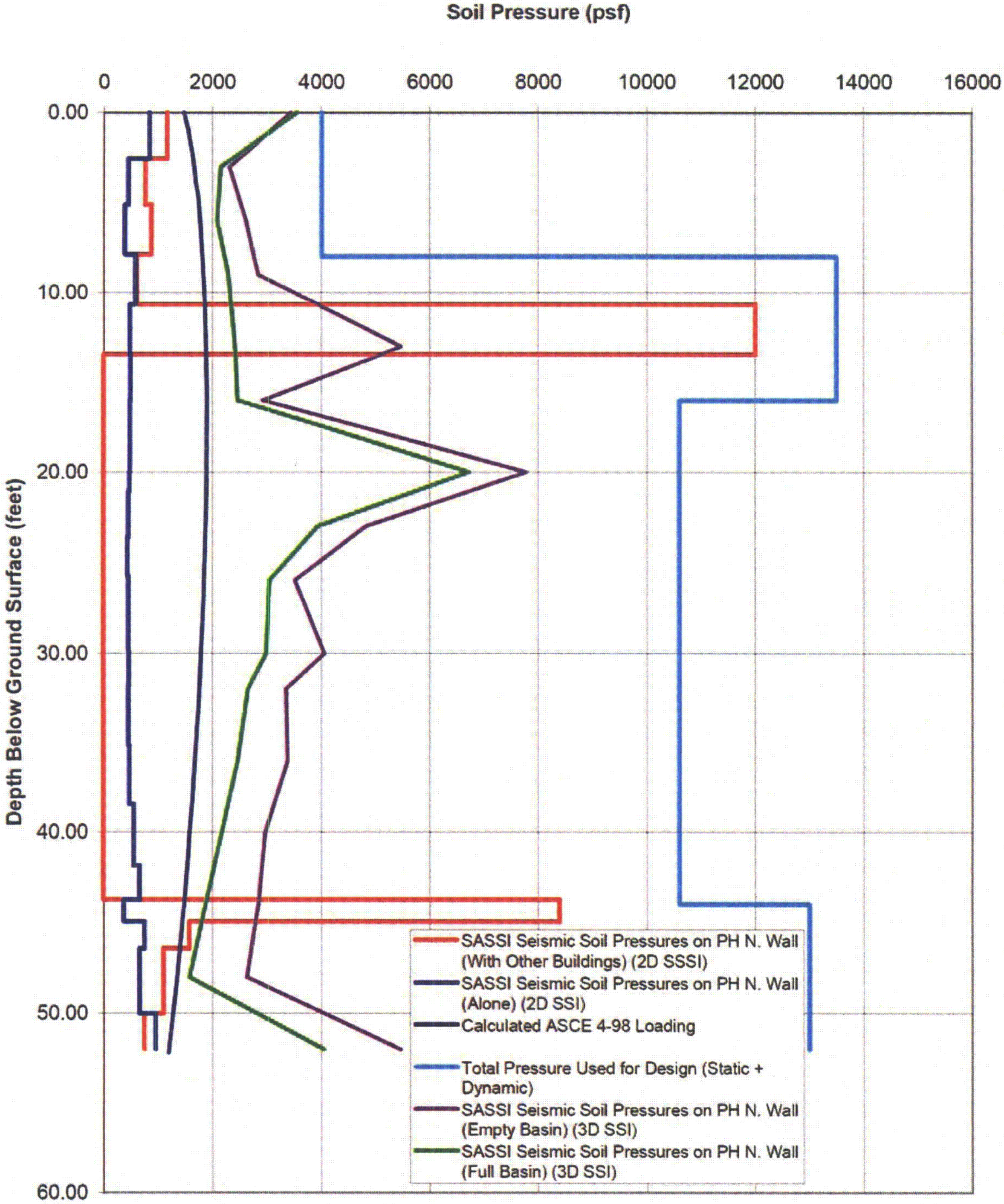

Figure 3H.6-219: SSI, SSSI, ASCE 4-98 and Design Lateral Seismic Soil Pressures on RSW Pump House North Wall

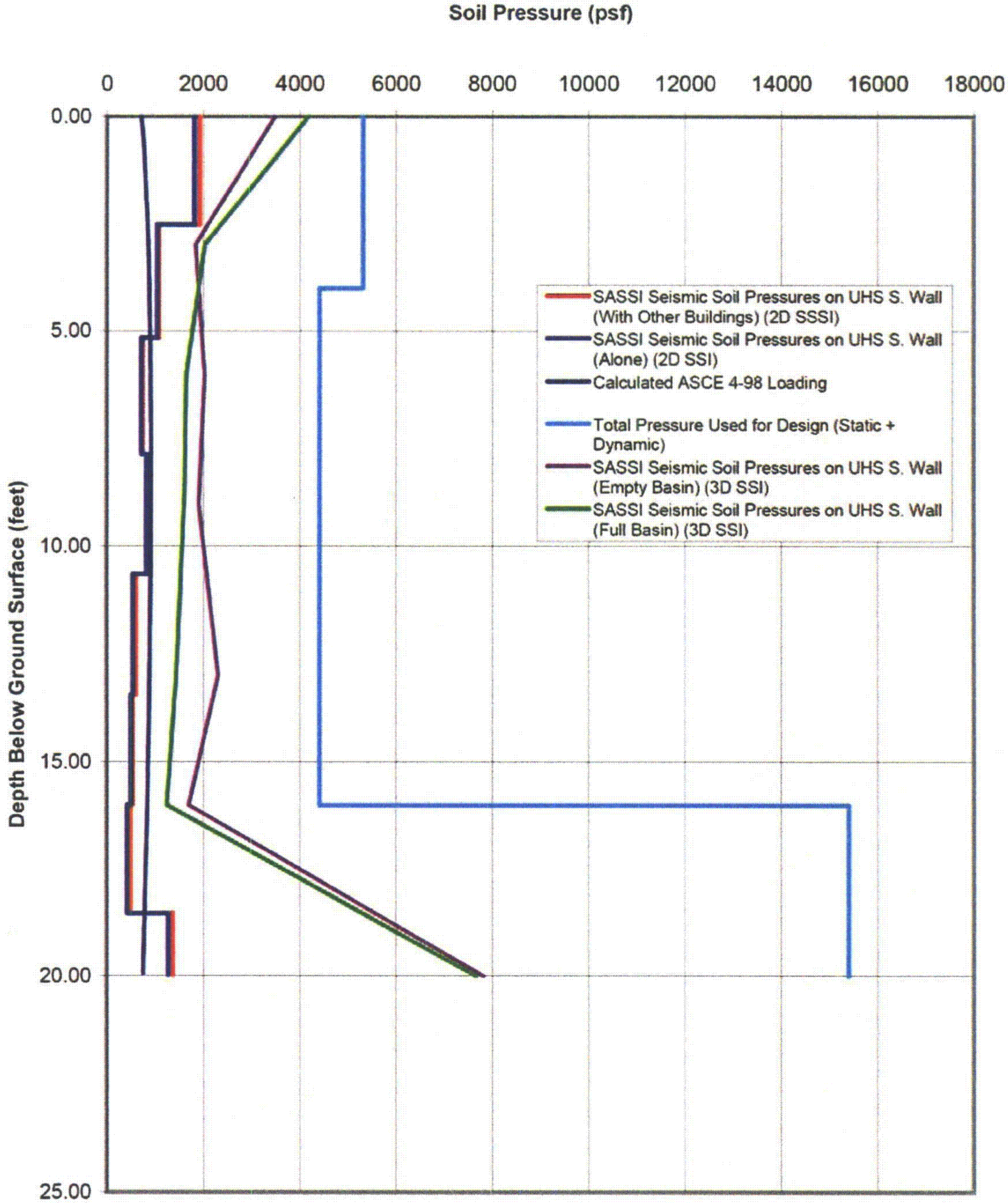

Figure 3H.6-220: SSI, SSSI, ASCE 4-98 and Design Lateral Seismic Soil Pressures on Ultimate Heat Sink Basin South Wall

RAI 03.07.02-25, Revision 1

QUESTION:

Follow-up Question to RAI 03.07.02-16 (STP-NRC-100036)

10CFR50, Appendix S requires that evaluation for SSE must take into account soil-structure interaction (SSI) effects. In the response to Item 1 of RAI 03.07.02-16 with regard to the adequacy of the structural mesh size used in the SSI analysis, the applicant has presented comparisons of the first two modes of the fixed-base structure in the E-W direction (f1 = 2.133 and f2 = 2.056 Hz) and N-S direction (f1 = 3.187 and f2 = 3.028 Hz) calculated using the SSI and design meshes. Although the comparisons of the two modes are good, they only represent a mass participation of about 17.1% and 15.4% for the E-W and N-S directions, respectively. In addition, the local modes are not reflected in these comparisons. As such, the applicant is requested to provide comparisons of the higher modes that include the out-of-plane modes of the slabs and walls to ensure the adequacy of the SSI mesh for transmitting frequencies of at least 33 Hz. This should include comparisons of in-structure response spectra of slabs, roofs and wall panels for the fixed-base structure calculated using the coarse SSI and fine design meshes subject to representative horizontal and vertical foundation motions. The staff needs this information to determine that the coarse mesh size (for modeling the structure) used in the SSI analysis is adequate for evaluation of SSI effect.

REVISED RESPONSE:

The original response to this RAI was submitted with STPNOC letter U7-C-STP-NRC-100268, dated December 14, 2010. This revision clarifies the program used for generation of Figures 03.07.02-25.10 and 03.07.02-25.11 based on discussions with the NRC on February 2nd and 3rd, 2011. The revisions are indicated by revision bars in the margin.

To assess the adequacy of the structural mesh size used in the Ultimate Heat Sink (UHS) and Reactor Service Water (RSW) Pump House Soil-Structure Interaction (SSI) model, the following three (3) fixed-base time history analyses were performed for comparison of in-structure response spectra and maximum accelerations at various locations:

1. Fixed-base time history analysis of the structural model which was used in the original SSI model (called original SSI model hereinafter)

2. Fixed-base time history analysis of the structural model which was used in the refined SSI model (called refined SSI model hereinafter) in the refined SSI analysis described in Supplement 2 response to RAI 03.07.02-24 which is being submitted concurrently with this response.

3. Fixed-base time history analysis of a more refined structural model (called refined structural model hereinafter). In this refined structural model each element of the original SSI model was divided into four (4) elements.

The following provides additional details for the above analyses:

- Figures 03.07.02-25.1 thru 03.07.02-25.3 show original SSI model, refined SSI model, and refined structural model, respectively. Figures 03.07.02-25.6 thru 03.07.02-25.8 show Pump House roof to the same scale from the original SSI model, refined SSI model, and refined structural model, respectively.

  Note that the comparison of the mesh in the above noted figures for the original SSI model, refined SSI model, and refined structural model shows that the mesh refinement of these models is significantly different from each other, with the mesh refinement of the refined SSI model being in between those for the original SSI model and refined structural model.

- The node locations for comparison of in-structure response spectra are shown in Figures 03.07.02-25.1 thru 03.07.02-25.3 for the original SSI model, refined SSI model, and refined structural model, respectively. These locations include the Pump House Operating Floor, Pump House Roof, UHS Basin Walls, and UHS Cooling Tower Walls. The node locations for comparison of maximum accelerations, in addition to those locations for comparison of in-structure response spectra, include those shown in Figures 03.07.02-25.4 and 03.07.02-25.5.

  Note: The node selection for comparison of the in-structure response spectra and maximum accelerations described above is in excess of the nodes selected in the discussions on this topic during the August 4, 2010 NRC public meeting in Rockville, MD.

- Thick shell elements are used to represent the walls, floors, and roofs of the UHS/RSW Pump House. The basemat of the UHS/RSW Pump House is modeled using solid elements.

- Time history analyses were performed using 4% structural damping.

- Modal superposition was used.

- Cut-off frequency of 51 Hz was used resulting in consideration of 890, 890, and 829 modes for the original SSI model, refined SSI model, and refined structural model, respectively.

- Site-specific safe shutdown earthquake (SSE) motions were selected as input motions and the results from the X, Y, and Z excitations were combined using square-root-sum-of-squares (SRSS) method.

In the above analyses, consistent with the SSI analysis and design of the UHS/RSW Pump House, thick shell elements are used because thick shell formulations are more accurate. For shell elements, two thickness formulations are available, thin or thick, with the difference being in the consideration of transverse shear deformations as noted below:

- Thick shell formulation includes the effects of transverse shear deformation
- Thin shell formulation neglects transverse shear deformation

For situations where shear deformations are rather negligible and, therefore, use of thin shell elements may be justified, use of thick shell elements will not introduce any inaccuracy and the results using thick shell elements will be nearly identical (yet more accurate) to those using thin shell elements. To demonstrate this, a 49 ft x 78 ft slab panel (similar to the Pump House roof slab panel), fixed on all four edges as shown in Figure 03.07.02-25.9, was analyzed for slab thicknesses of six inches and six feet, using both thin and thick shell formulations. Using SAP2000 program, a time history analysis of these slabs was performed by exciting the models in the out-of-plane direction with the vertical site-specific SSE motion. Comparison of the resulting in-structure response spectra at the center of the six inch thick slab from the SAP2000 analysis is shown in Figure 03.07.02-25.10. As seen from this comparison, both thick and thin shell element formulations yield nearly identical results, as should be expected. Comparison of the in-structure response spectra from the SAP2000 analysis for the six feet thick slab is shown in Figure 03.07.02-25.11. This comparison shows, as expected, that the resulting spectra are significantly different showing the significance of the transverse shear deformations. For validation and verification of the generated response spectra in Figures 03.07.02-25.10 and 03.07.02-25.11 using SAP2000 program see RAI 03.07.02-29, Revision 1, which is being submitted concurrently with this response.

Figures 03.07.02-25.12 through 03.07.02-25.39 provide comparison of un-widened in-structure response spectra, for 5% damping, from the analyses of the three structural models as described above. Table 03.07.02-25.1 provides a comparison of maximum accelerations from the analyses with original SSI model and refined structural model. Based on these comparisons, it is concluded that there is good agreement between the spectra and maximum accelerations generated from the original SSI model and the refined structural model in all three X, Y, and Z directions with the exception of the following cases:

- Vertical excitation at the center of the Pump House Roof (see Figure 03.07.02-25.20)
- Vertical excitation at the center of the Pump House Operating Floor (see Figure 03.07.02-25.14)
- Vertical excitation of the Cooling Tower Walls (see Figure 03.07.02-25.36)
- Out-of-plane excitation of the UHS Basin Walls (see Figures 03.07.02-25.24 and 03.07.02-25.25)

The above results indicate that a more refined mesh for Pump House Roof, Pump House Operating Floor, UHS Basin Walls, and Cooling Tower Walls results in higher spectra and/or maximum accelerations.

Comparison of the response spectra shown in Figures 03.07.02-25.12 through 03.07.02-25.39 also shows that the structural mesh of the refined SSI model used for the refined SSI analysis described in Supplement 2 response to RAI 03.07.02-24 (being submitted concurrently with this response) have converged, since the changes between the results from the refined SSI model and refined structural model are in general insignificant. In a few cases where the differences are more pronounced, the results from the refined structural model are lower than the results from refined SSI model signifying that further refinement is not required.

For resolution of the above findings and the COLA revisions, please see the response to RAI 03.07.02-24, Supplement 2 which is being submitted concurrently with this response.

No additional COLA revision is required as a result of this response.

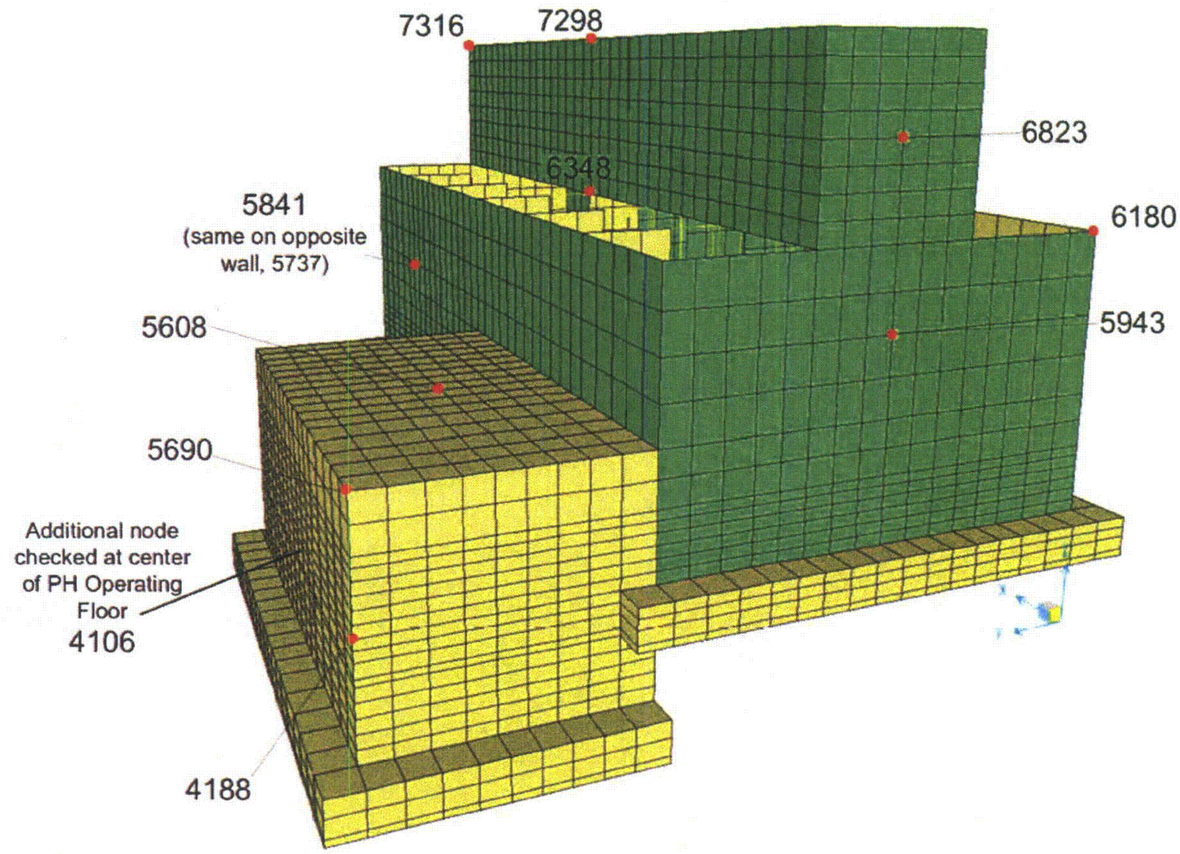

Figure 03.07.02-25.1: Node locations for spectra comparison on Original SSI Model (North is along Y-Axis)

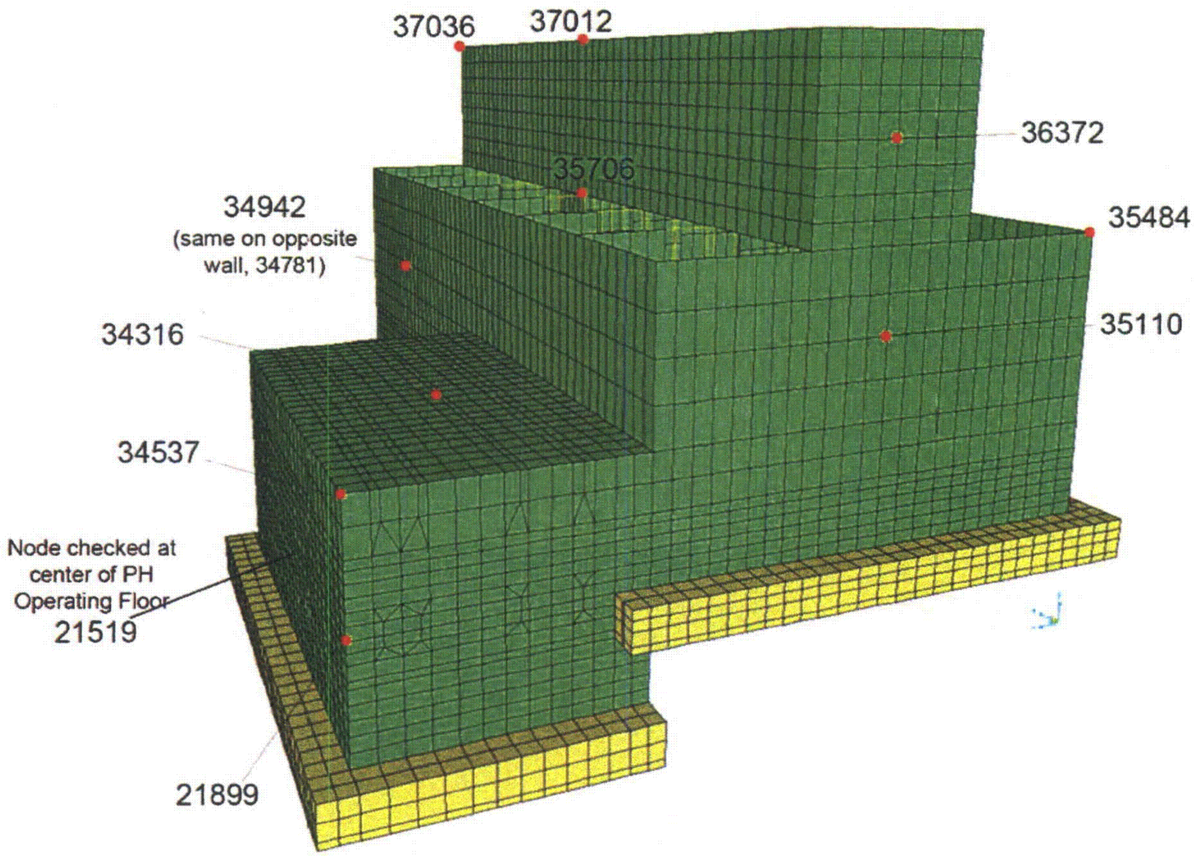

Figure 03.07.02-25.2: Node locations for spectra comparison on Refined SSI Model (North is along Y-axis)

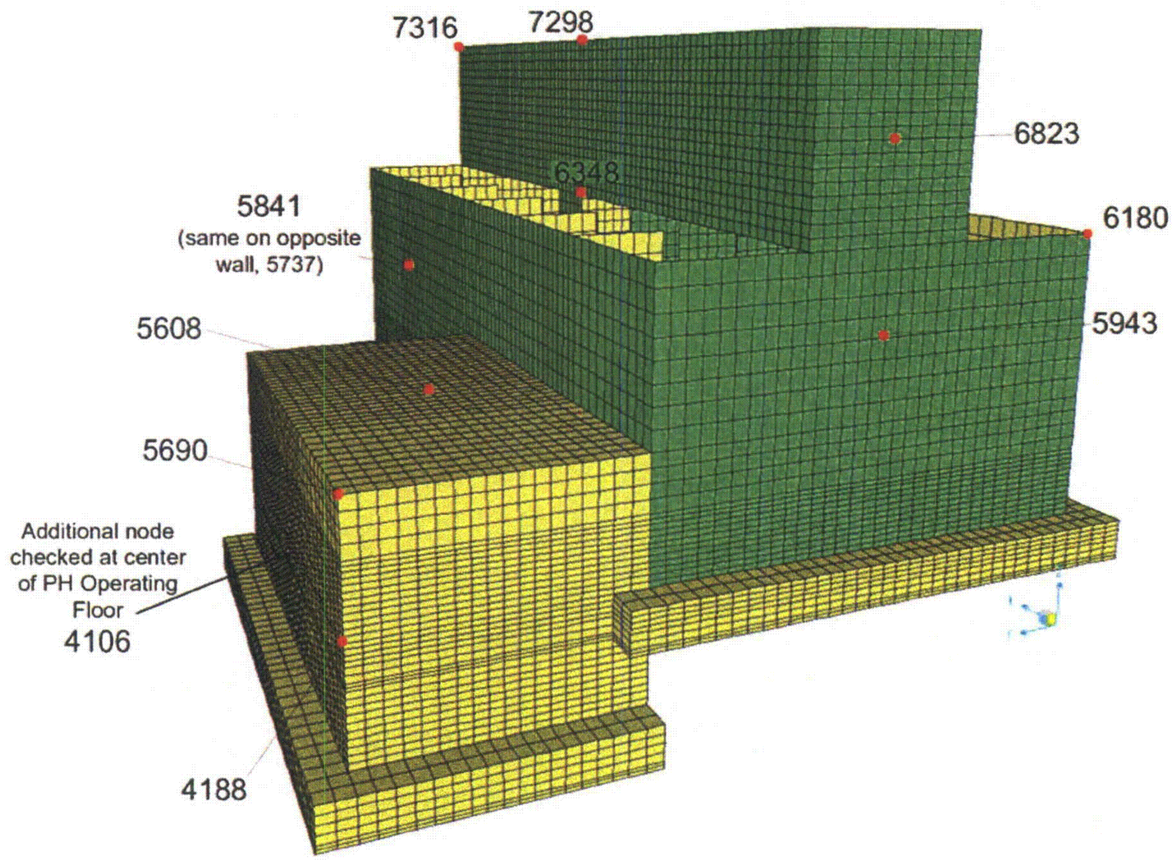

Figure 03.07.02-25.3: Node locations for spectra comparison on the Refined Structural Model (North is along Y-axis)

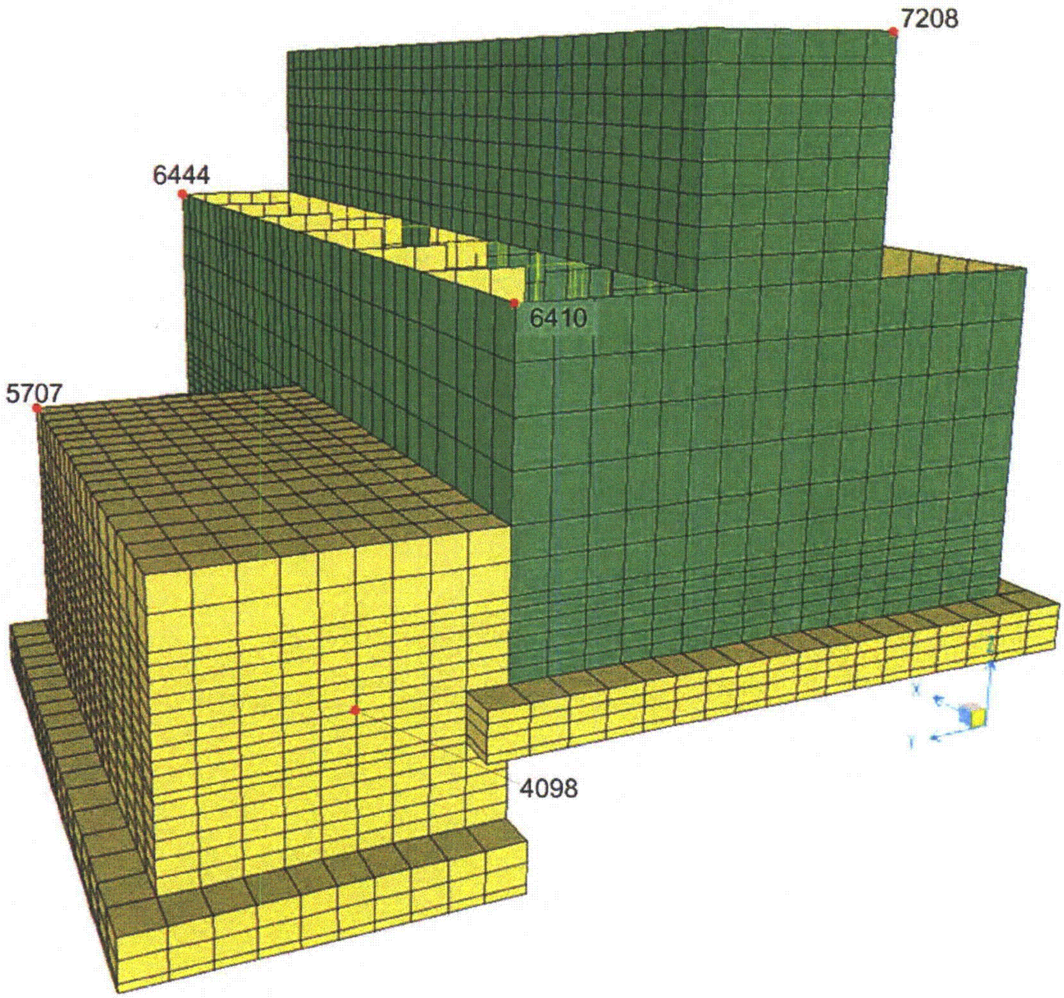

Figure 03.07.02-25.4: Additional node locations for acceleration comparison on the Original SSI Model (North is along Y-axis)

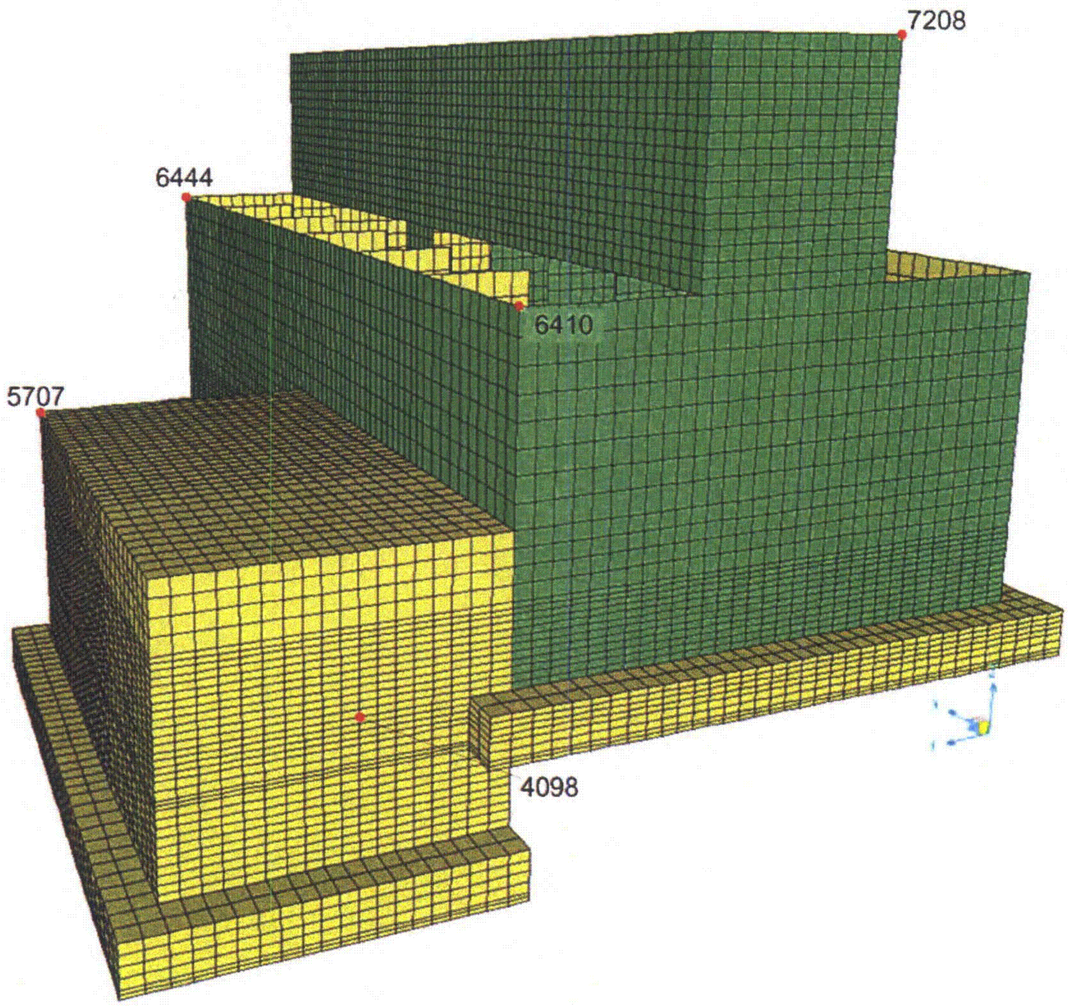

Figure 03.07.02-25.5: Additional node locations for acceleration comparison on the Refined Structural Model (North is along Y-axis)

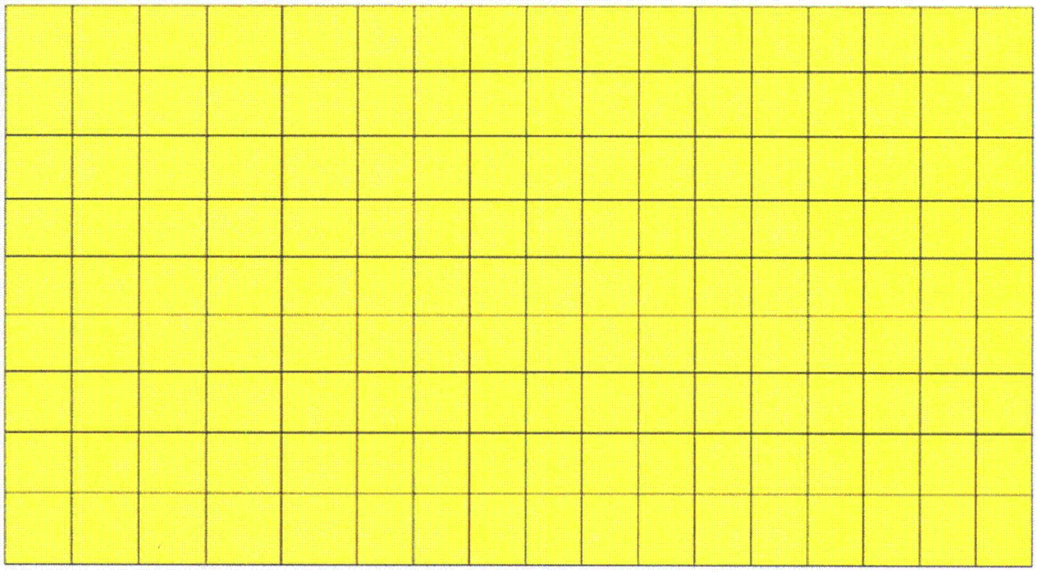

Figure 03.07.02-25.6: Sample mesh (Pump House Roof) from Original SSI Model.

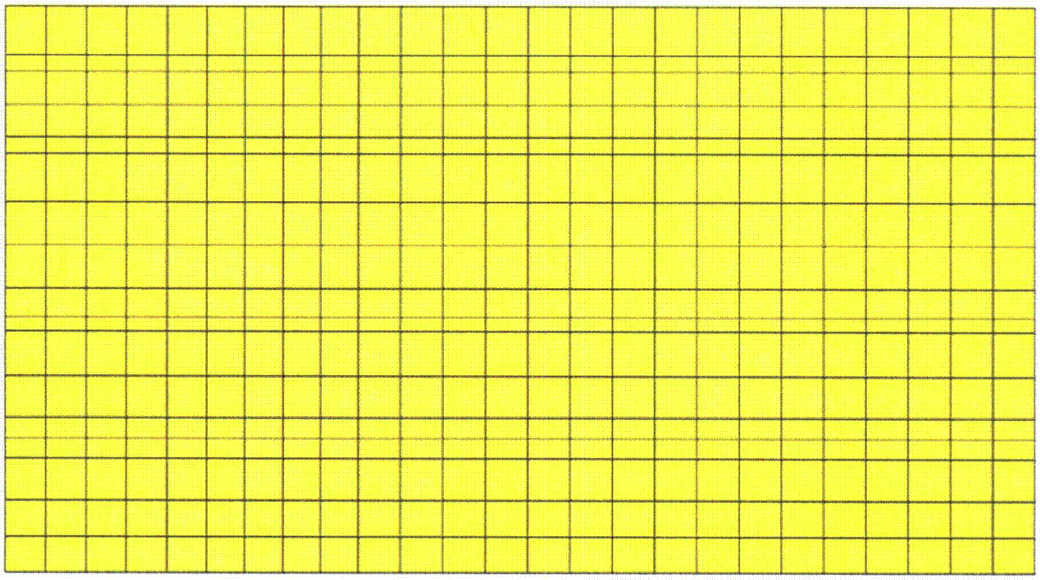

Figure 03.07.02-25.7: Sample mesh (Pump House Roof) from Refined SSI Model.

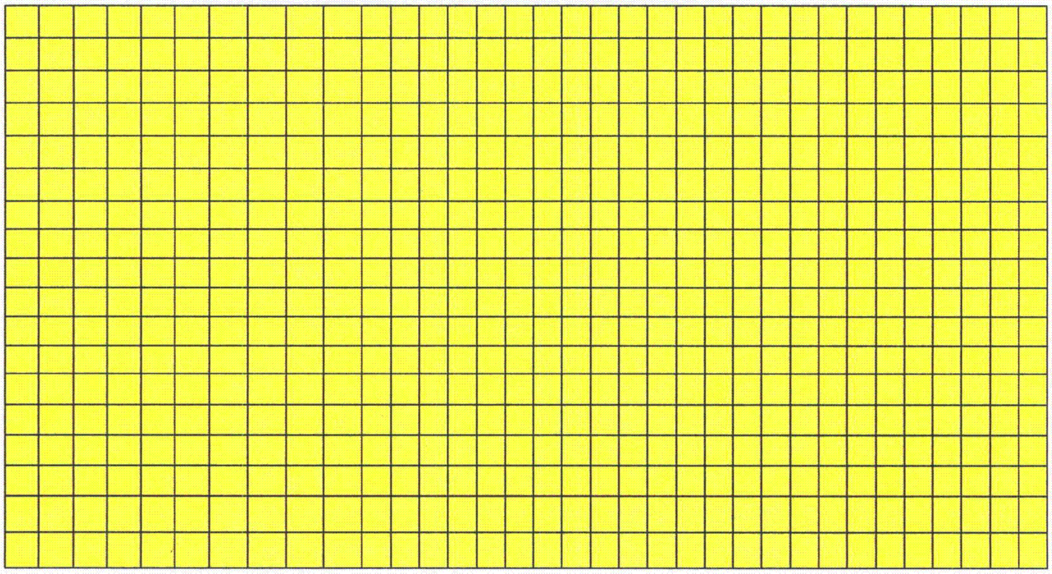

Figure 03.07.02-25.8: Sample mesh (Pump House Roof) from Refined Structural Model.

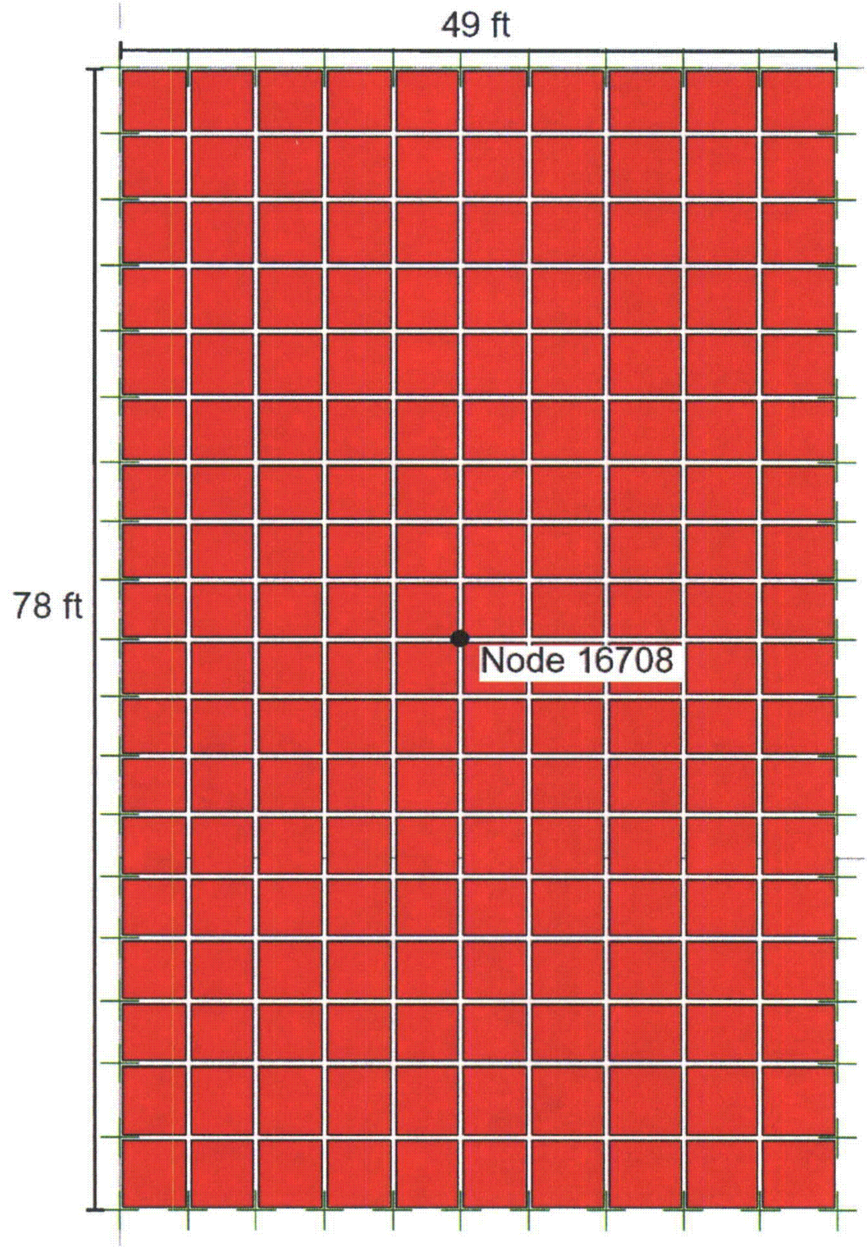

Figure 03.07.02-25.9: Slab model (dimensions equal to one bay of Pump House Roof).

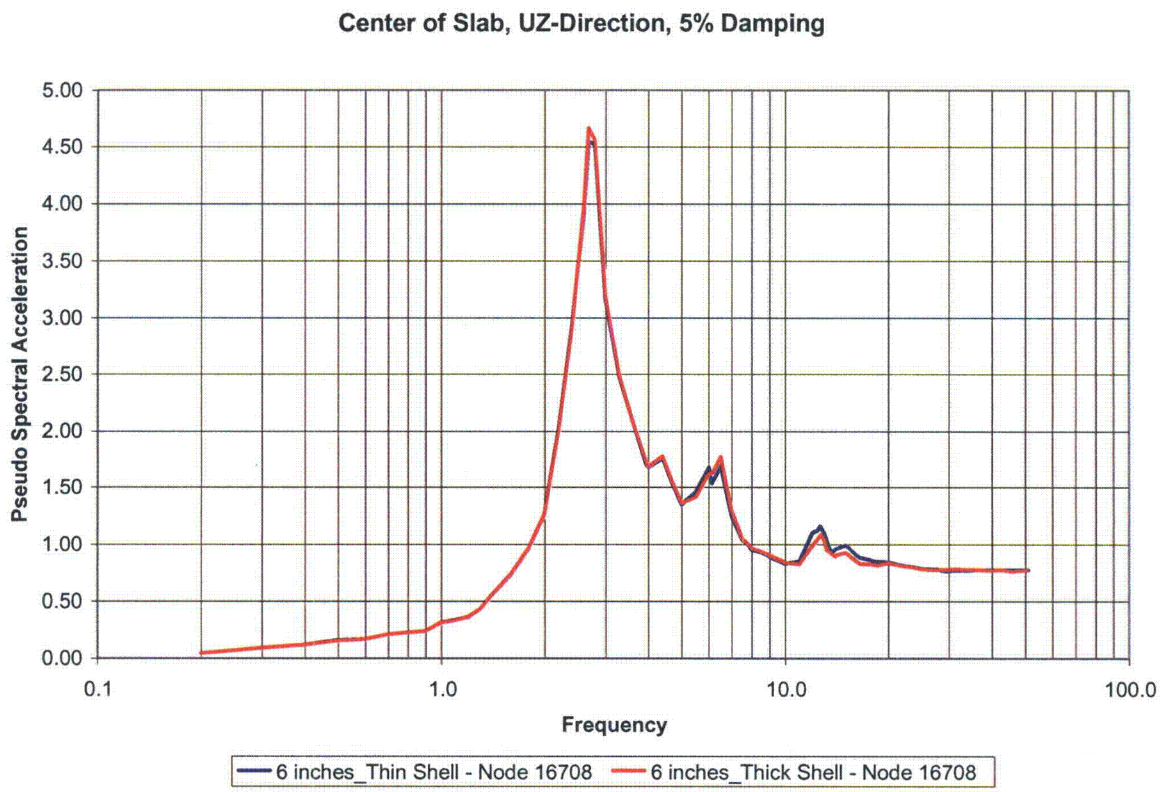

Figure 03.07.02-25.10: Spectra comparison at center of 6 inch slab with thin and thick shell elements.

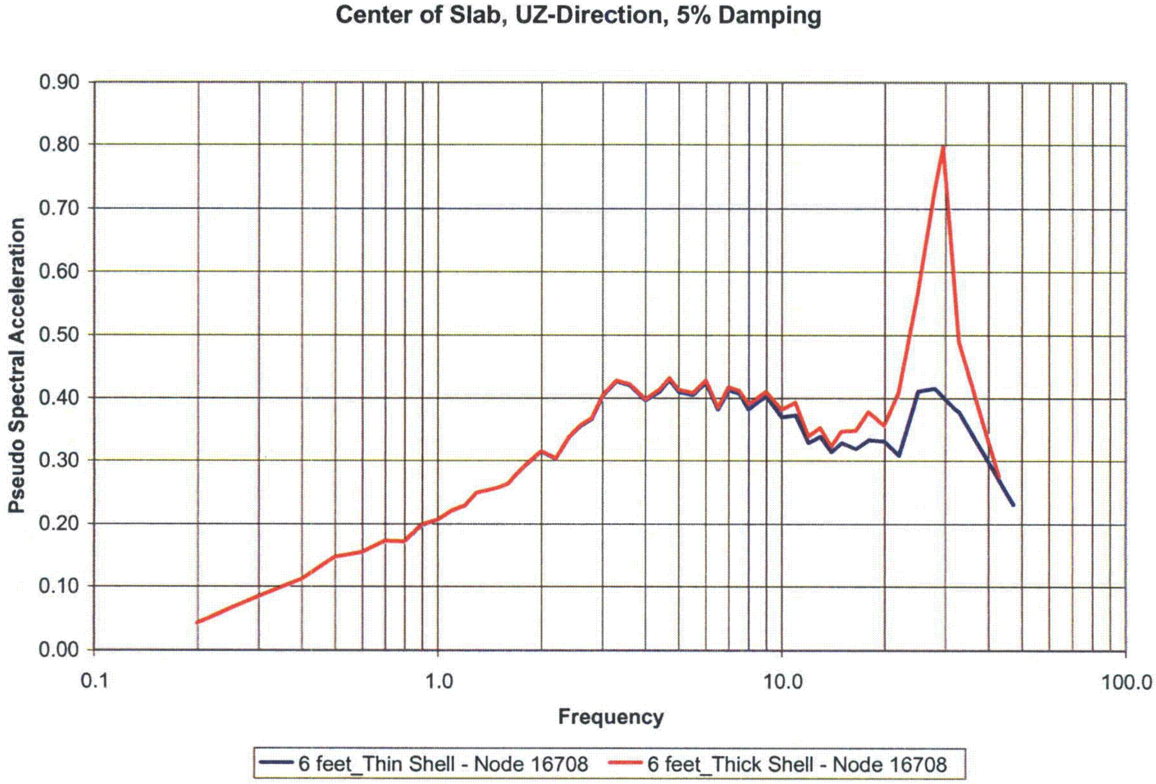

Figure 03.07.02-25.11: Spectra comparison at center of 6 foot slab with thin and thick shell elements.

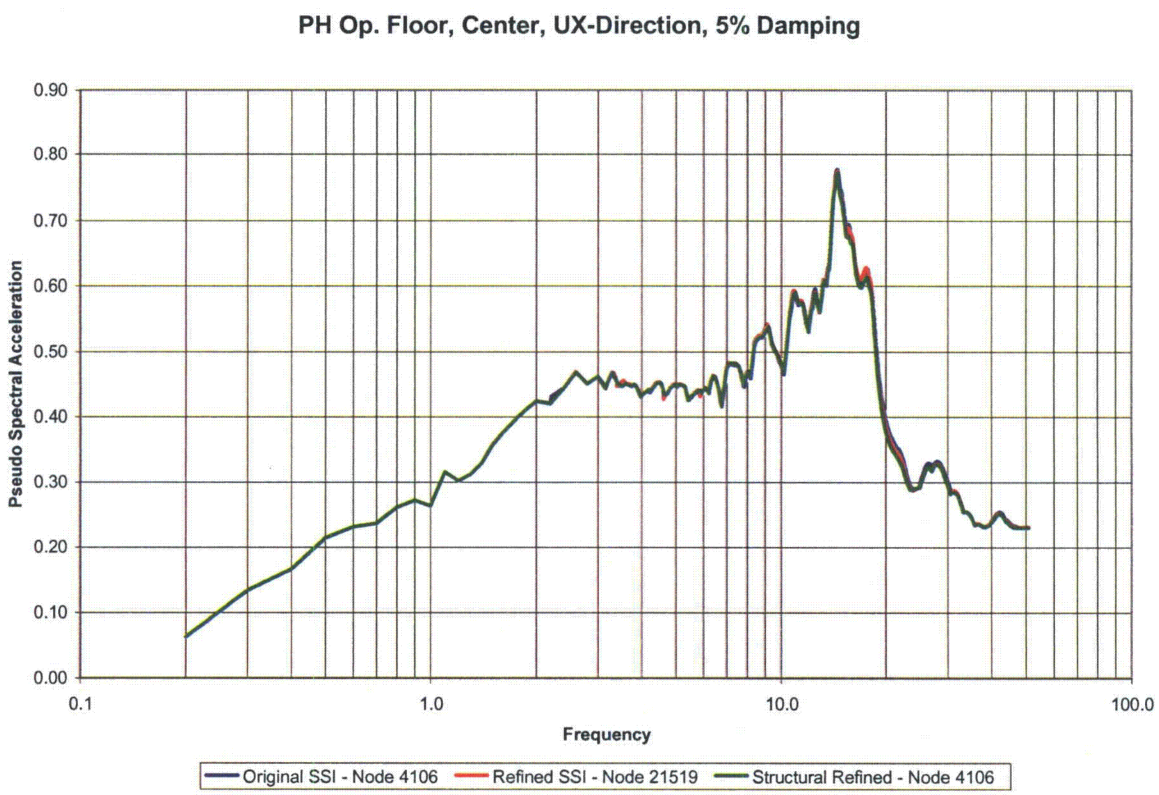

Figure 03.07.02-25.12: Center of Pump House Operating Floor, X-direction, 5% Damping

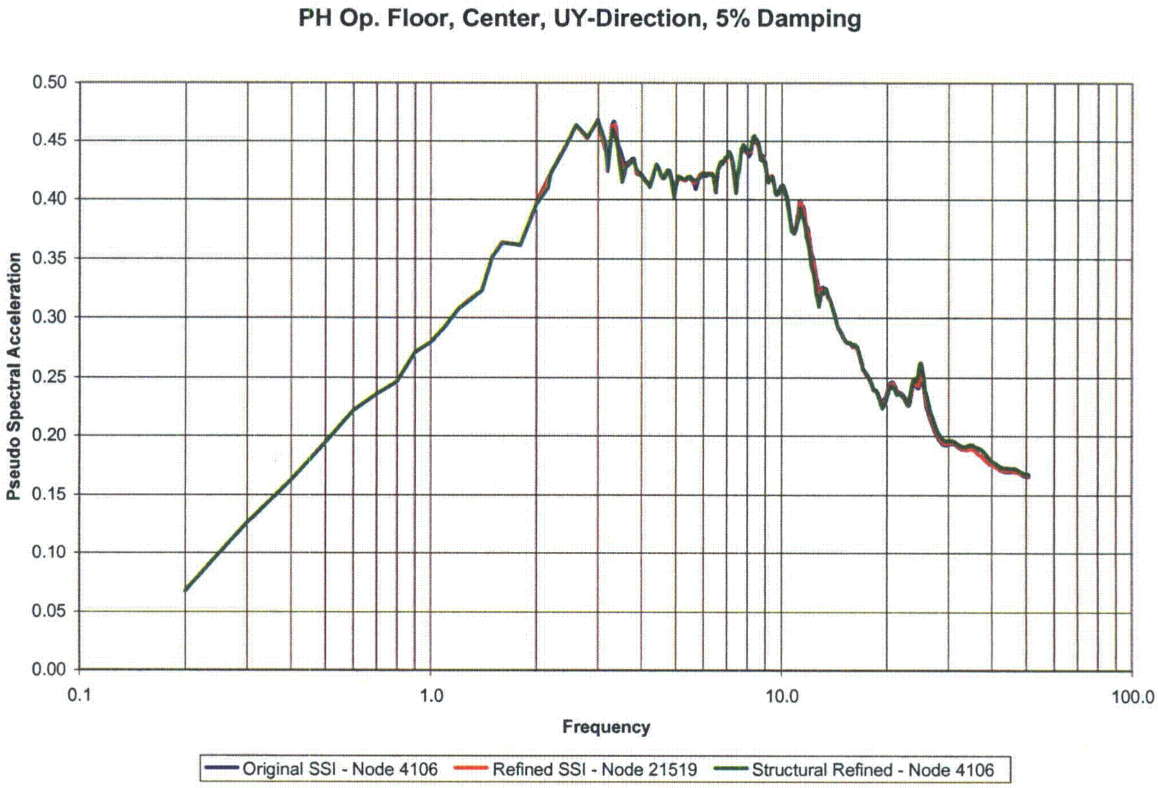

Figure 03.07.02-25.13: Center of Pump House Operating Floor, Y-direction, 5% Damping

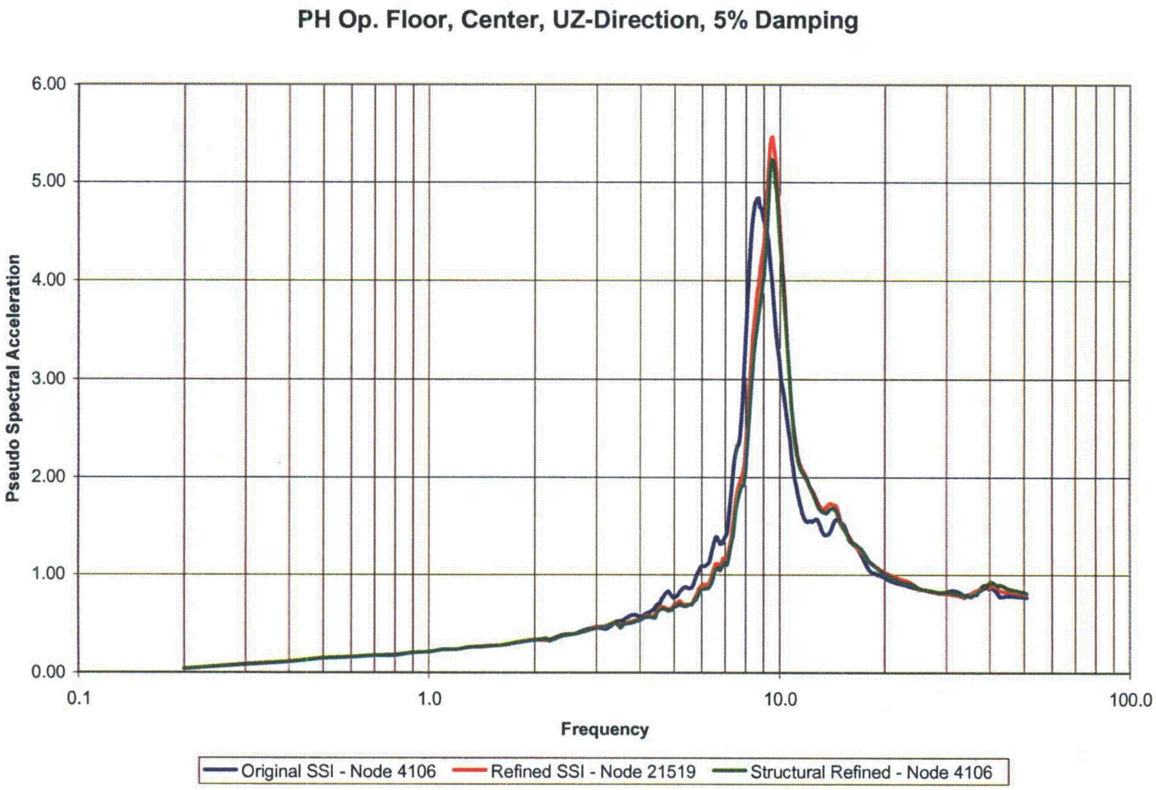

Figure 03.07.02-25.14: Center of Pump House Operating Floor, Z-direction, 5% Damping

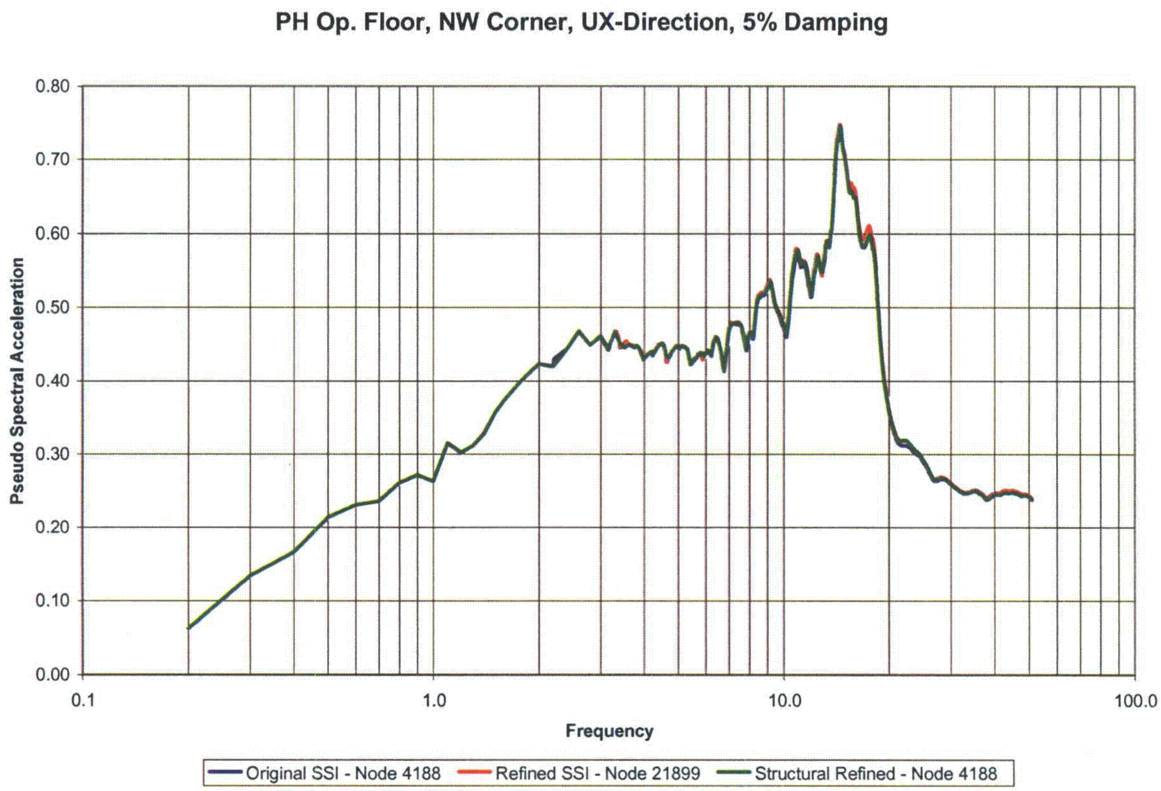

Figure 03.07.02-25.15: Pump House Operating Floor, NW Corner, X-direction, 5% Damping

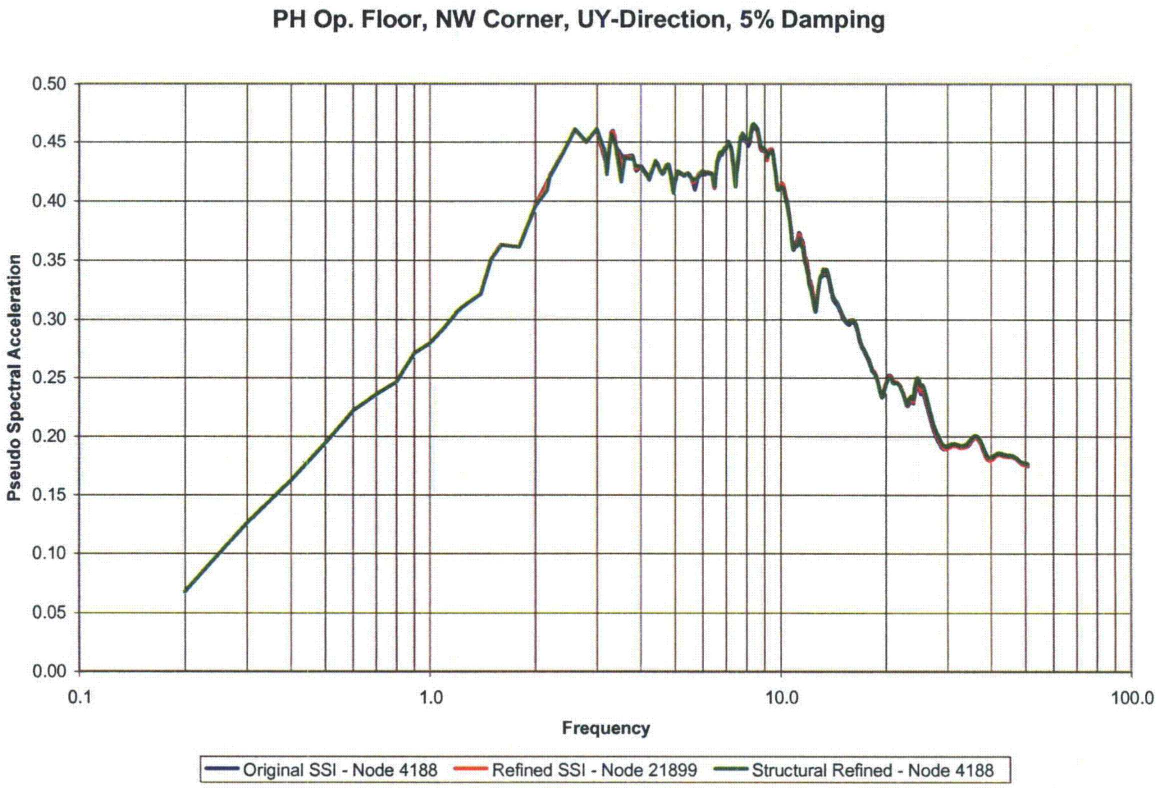

Figure 03.07.02-25.16: Pump House Operating Floor, NW Corner, Y-direction, 5% Damping

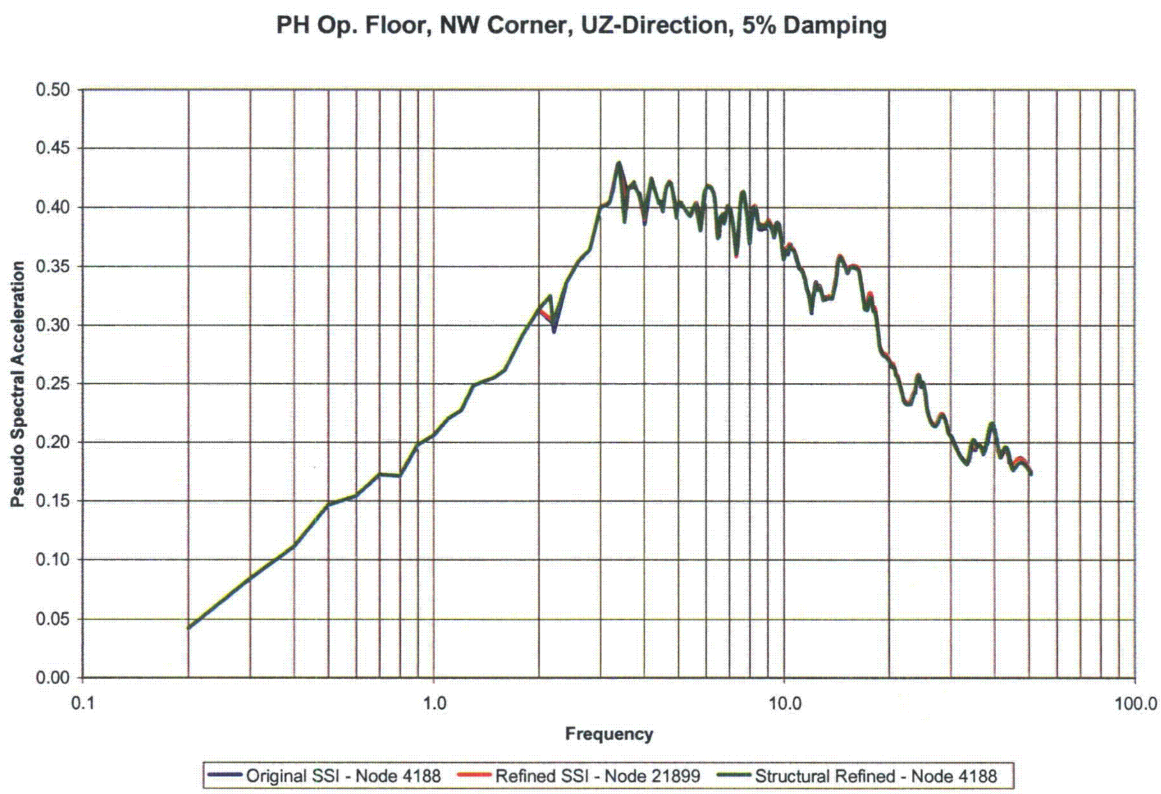

Figure 03.07.02-25.17: Pump House Operating Floor, NW Corner, Z-direction, 5% Damping

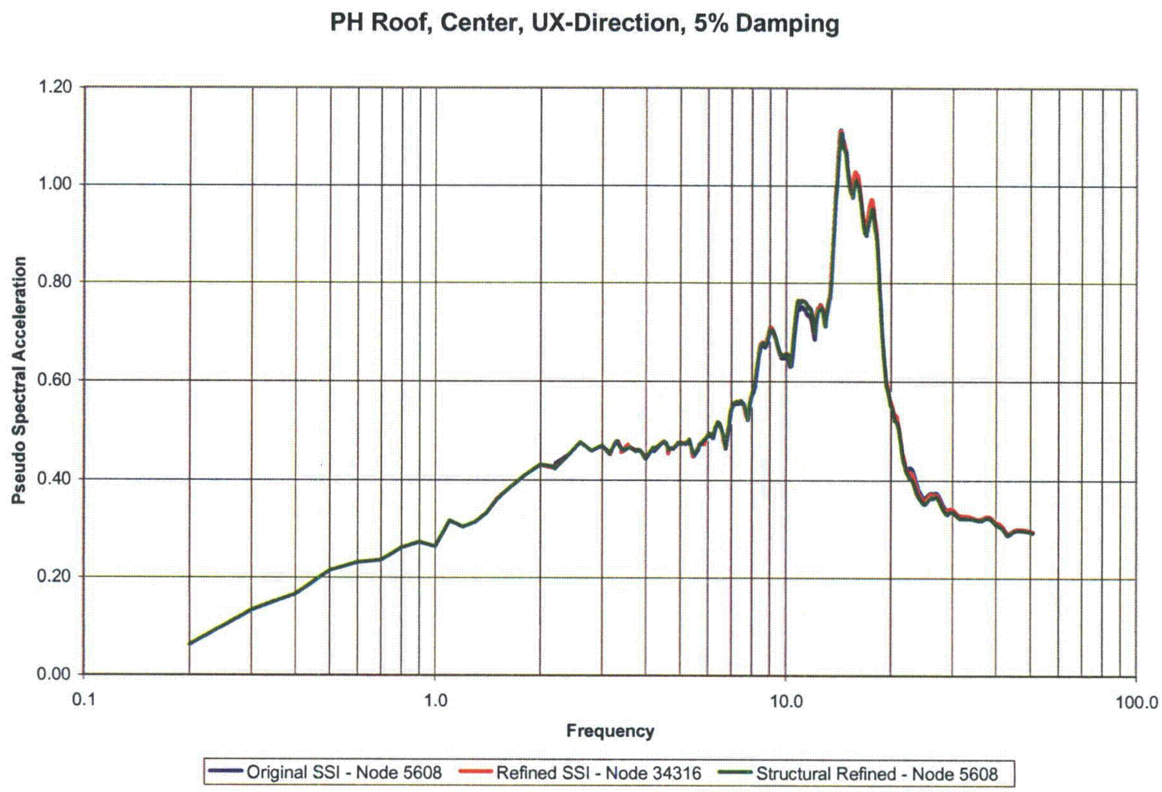

Figure 03.07.02-25.18: Center of Pump House Roof, X-direction, 5% Damping

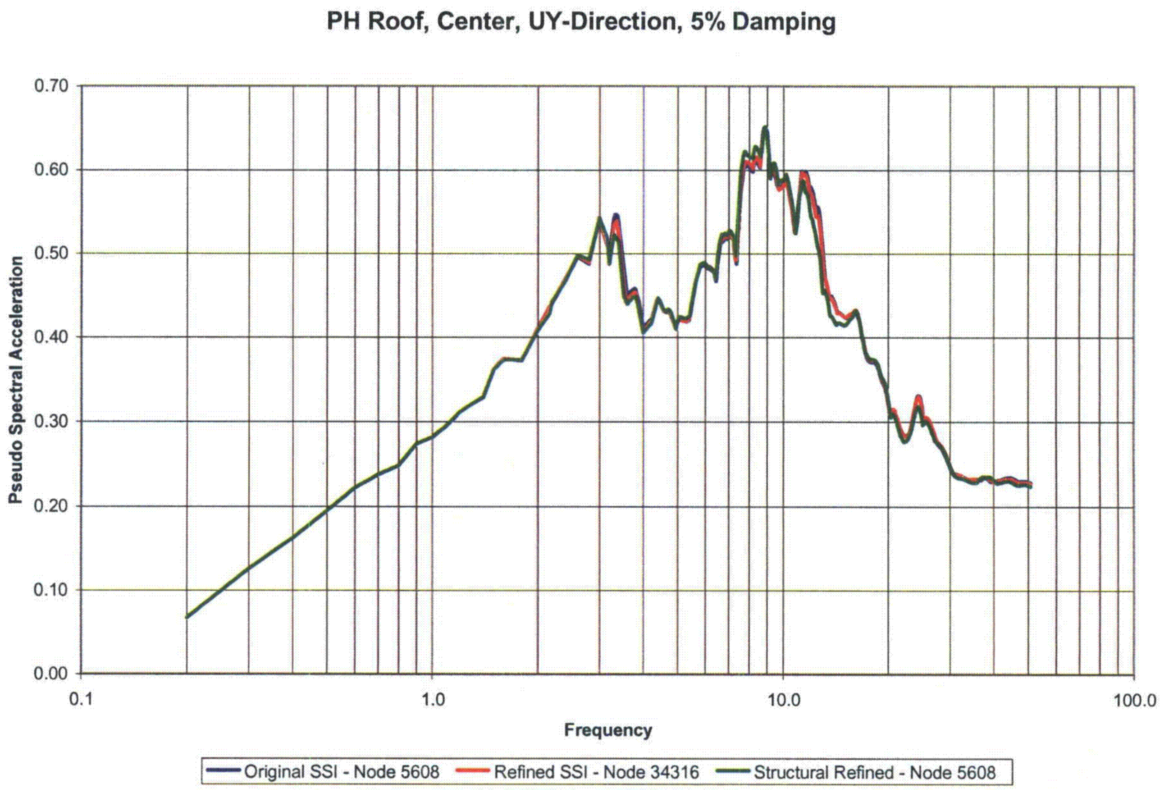

Figure 03.07.02-25.19: Center of Pump House Roof, Y-direction, 5% Damping

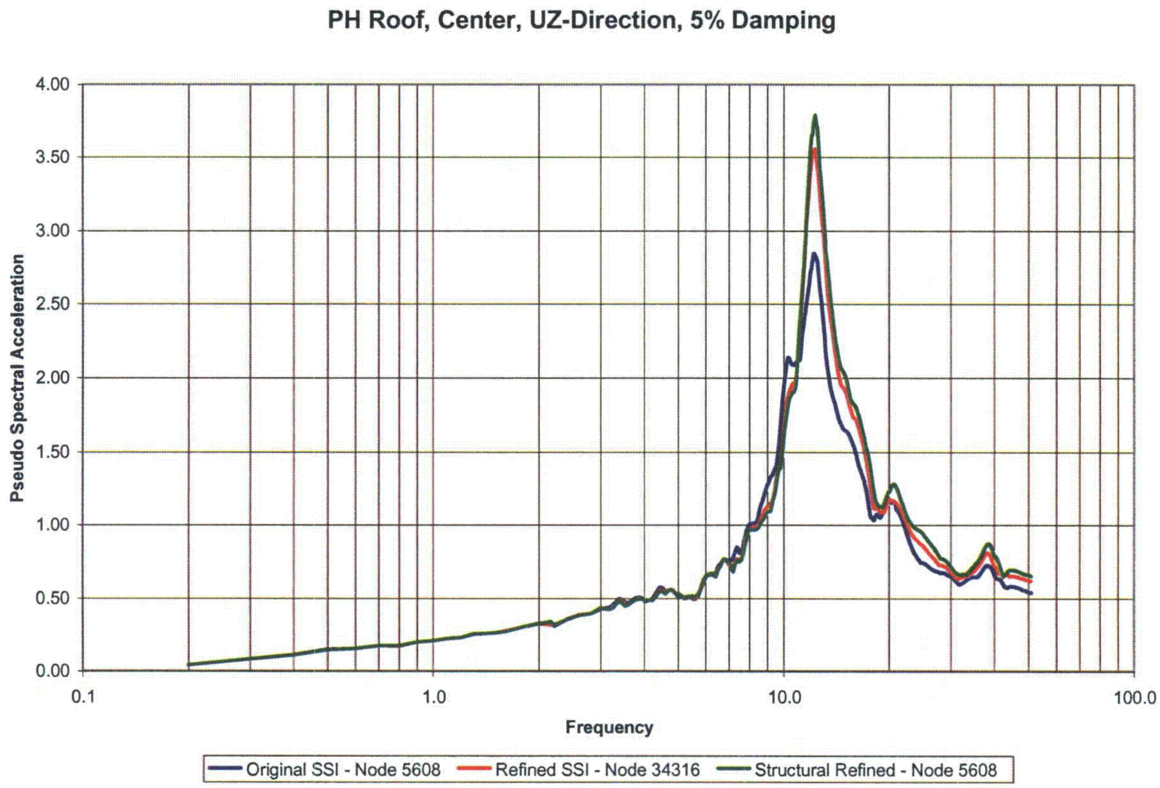

Figure 03.07.02-25.20: Center of Pump House Roof, Z-direction, 5% Damping

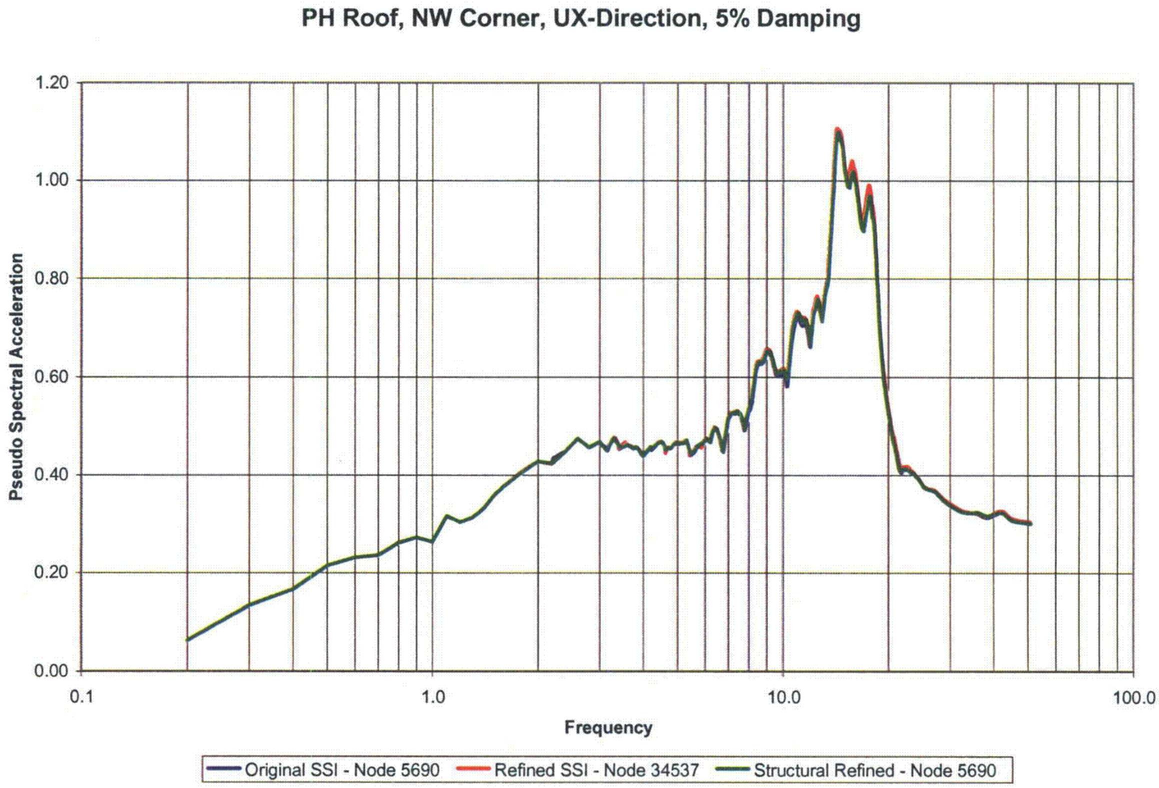

Figure 03.07.02-25.21: Pump House Roof, NW Corner, X-direction, 5% Damping

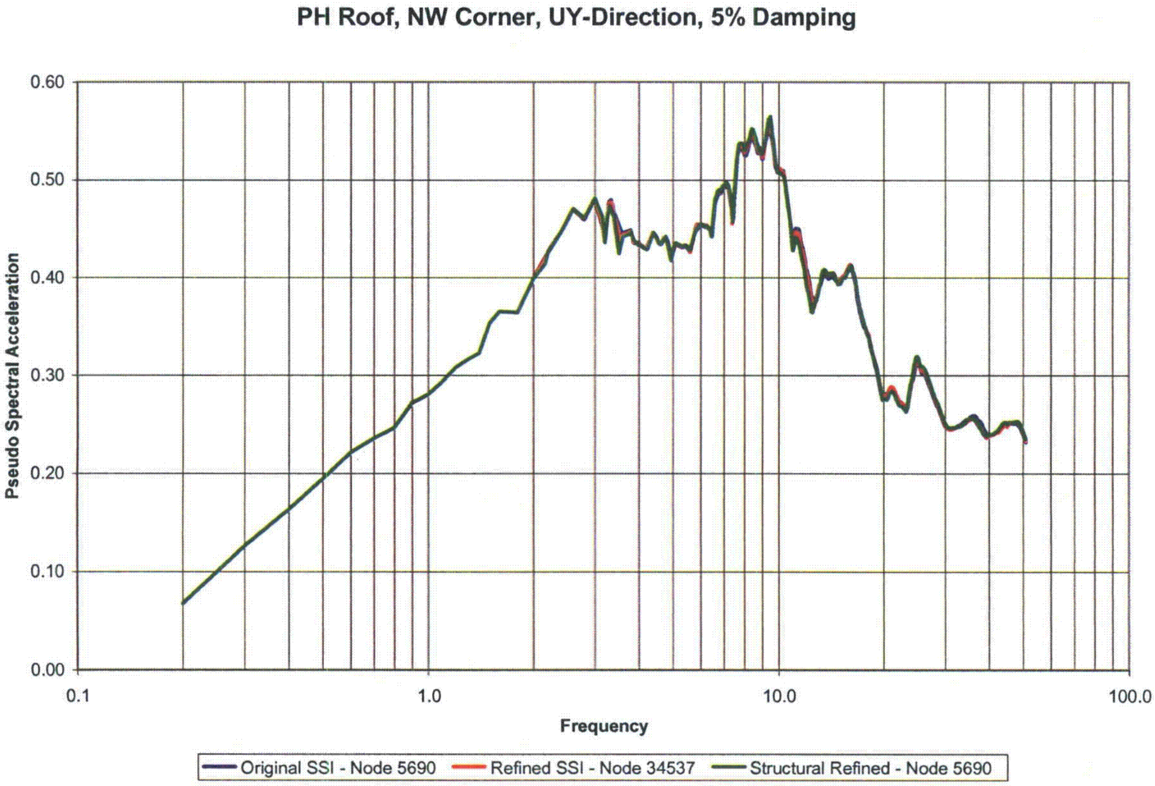

Figure 03.07.02-25.22: Pump House Roof, NW Corner, Y-direction, 5% Damping

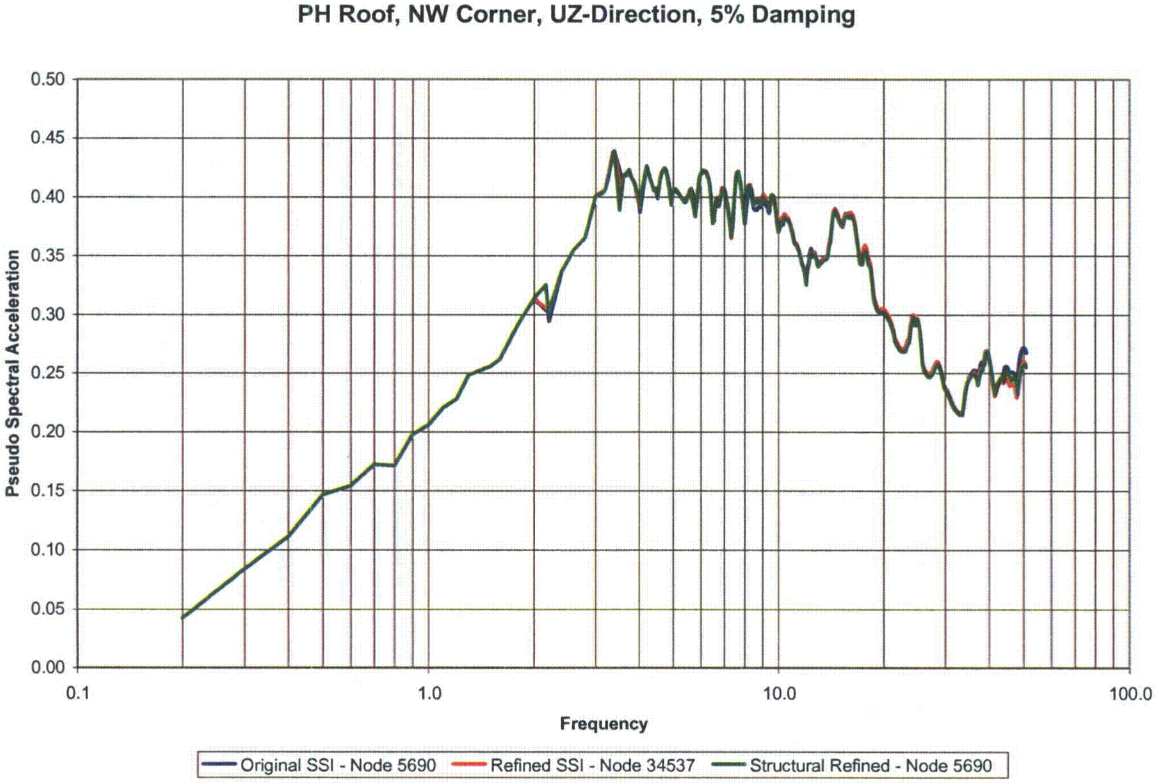

Figure 03.07.02-25.23: Pump House Roof, NW Corner, Z-direction, 5% Damping

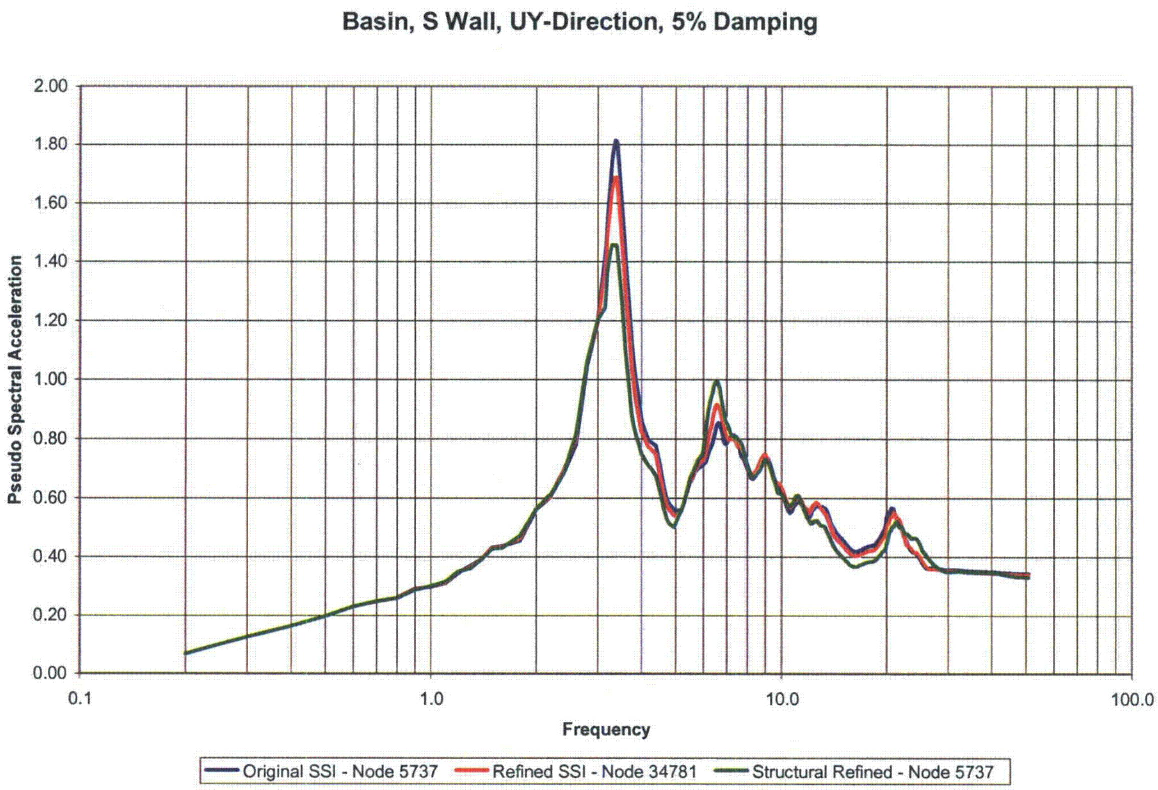

Figure 03.07.02-25.24: Basin South Wall, Y-direction, 5% Damping

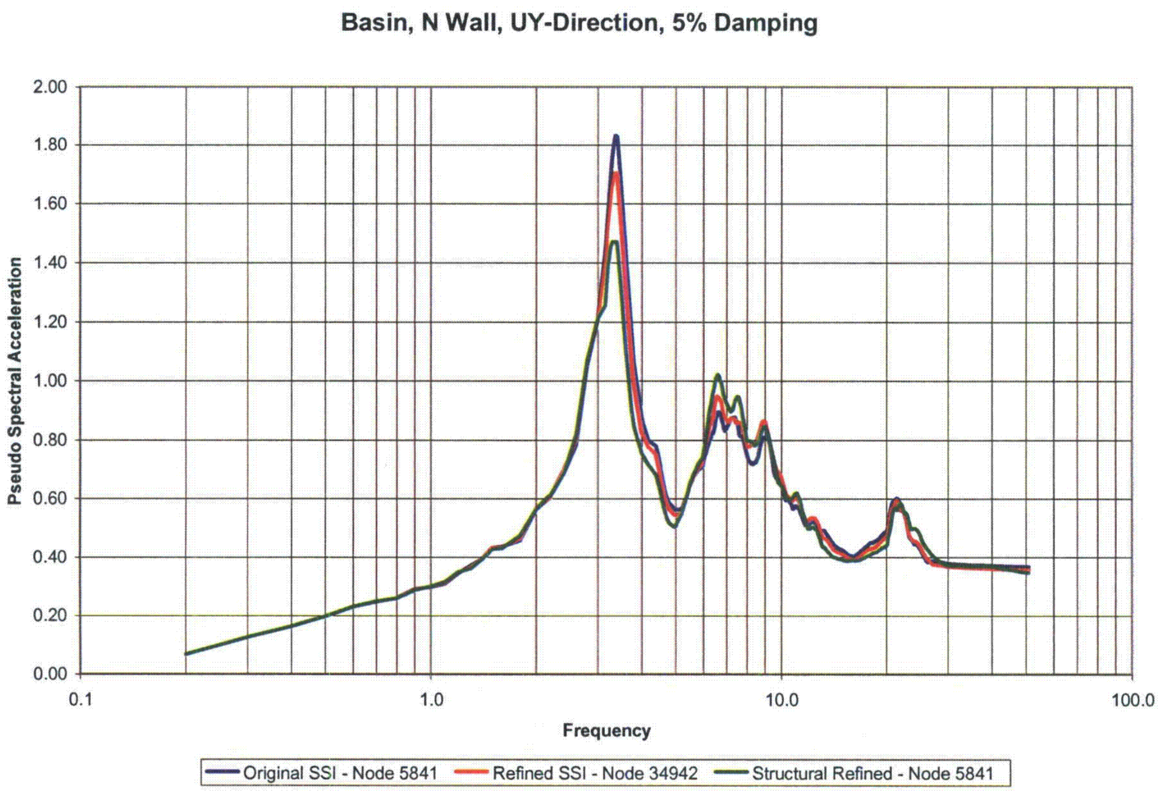

Figure 03.07.02-25.25: Basin North Wall, Y-direction, 5% Damping

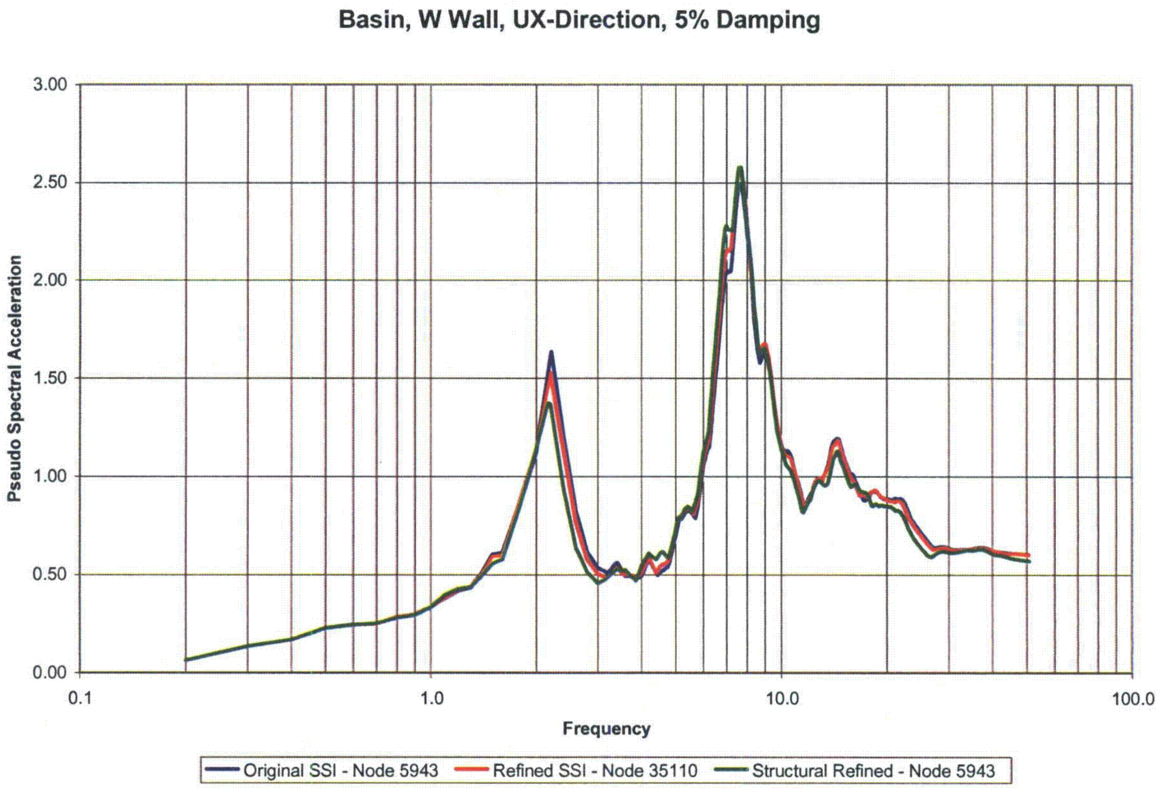

Figure 03.07.02-25.26: Basin West Wall, X-direction, 5% Damping

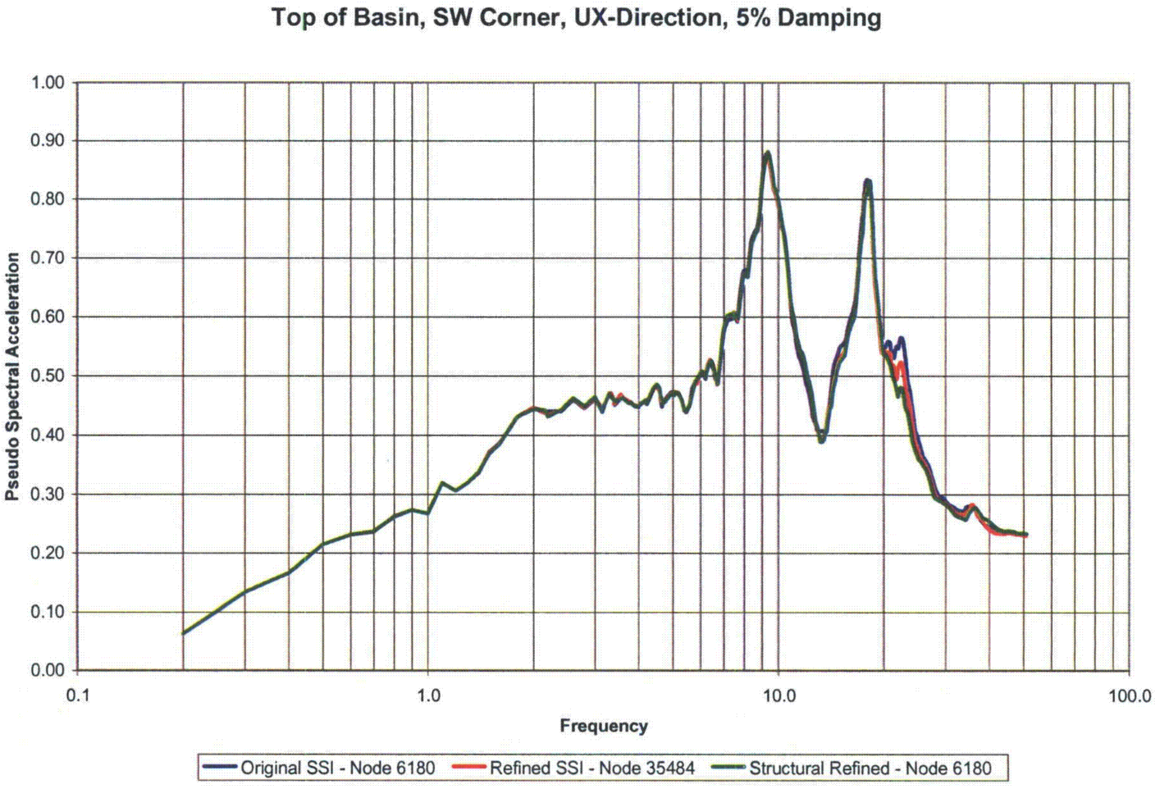

Figure 03.07.02-25.27: Top of Basin, SW Corner, X-direction, 5% Damping

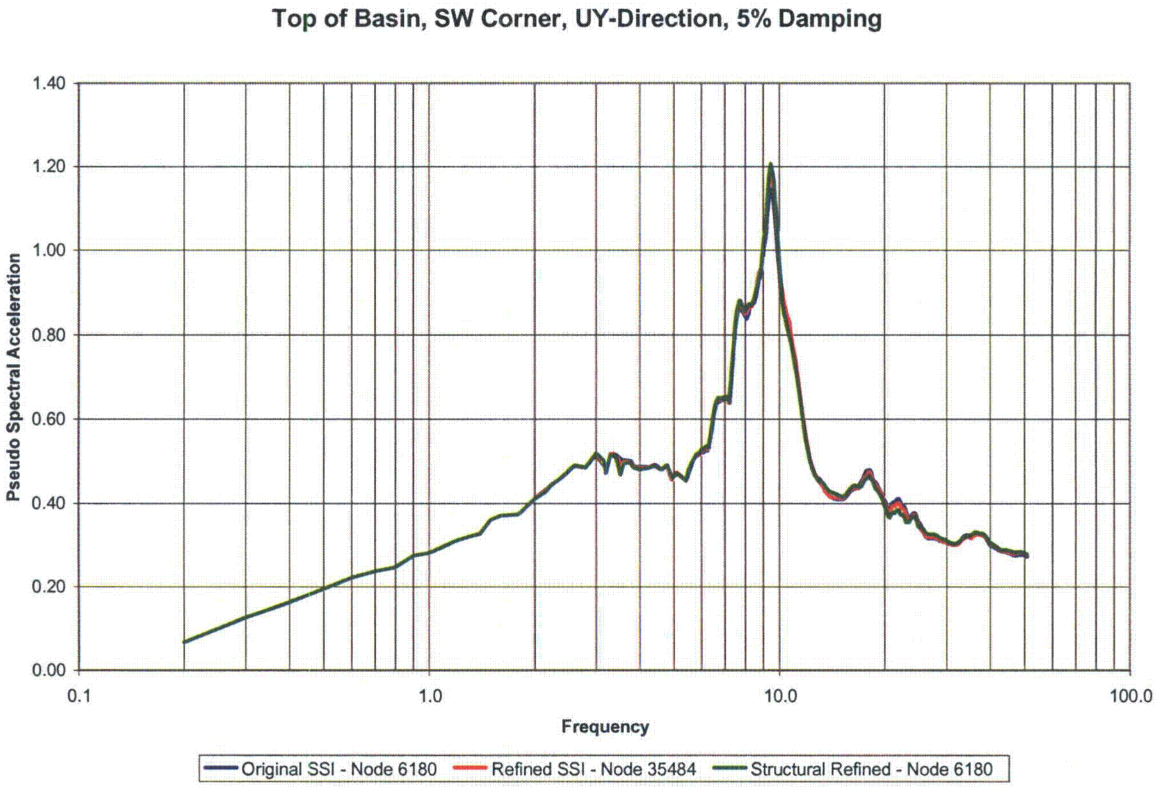

Figure 03.07.02-25.28: Top of Basin, SW Corner, Y-direction, 5% Damping

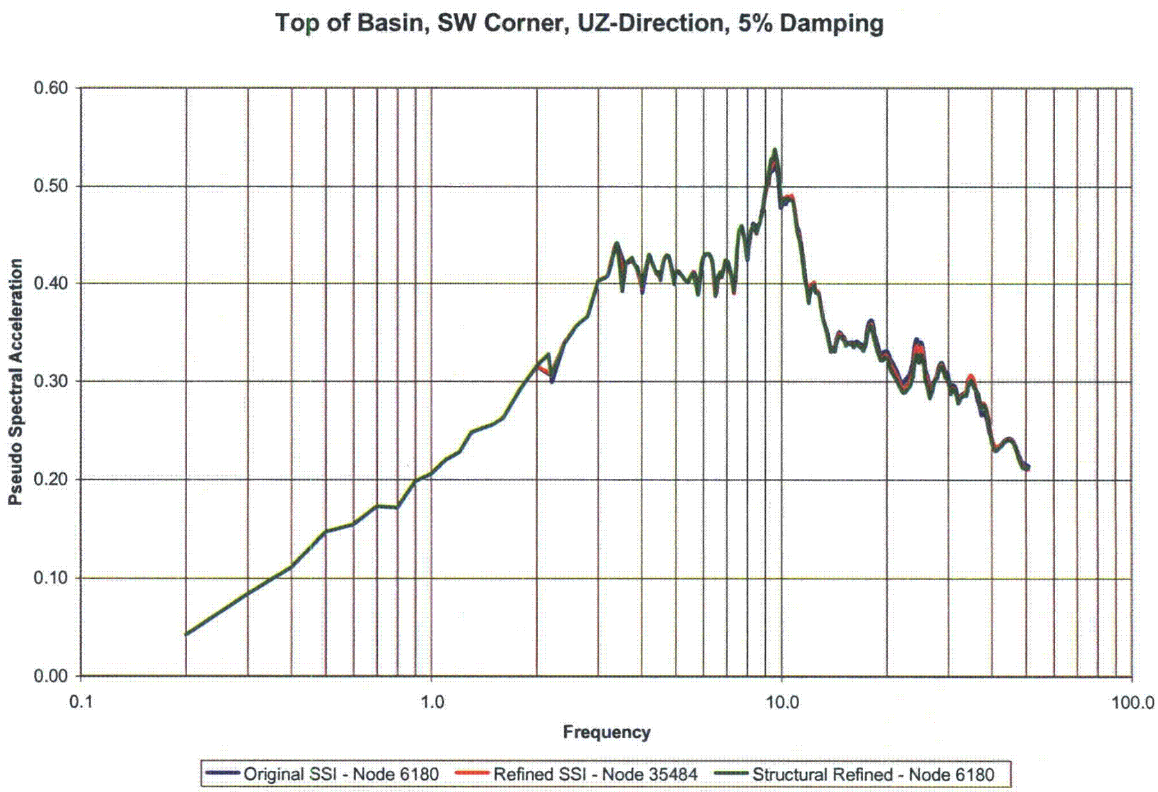

Figure 03.07.02-25.29: Top of Basin, SW Corner, Z-direction, 5% Damping

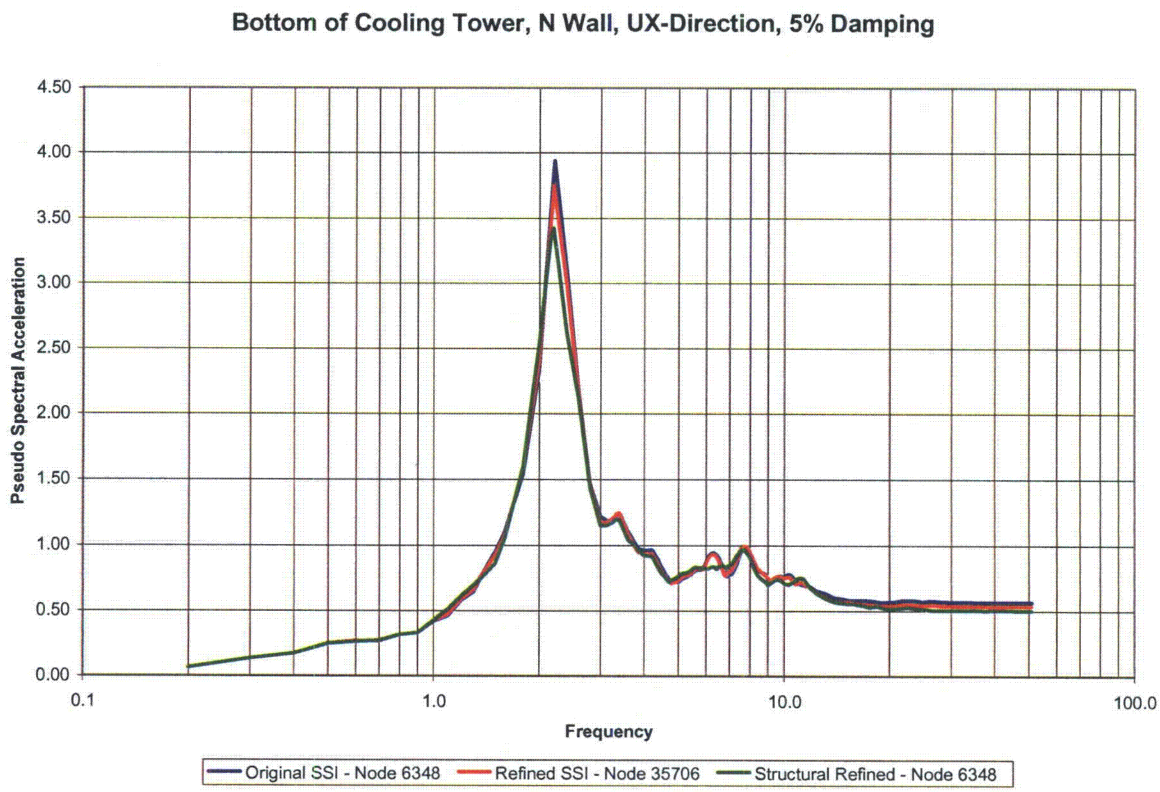

Figure 03.07.02-25.30: Bottom of Cooling Tower North Wall, X-direction, 5% Damping

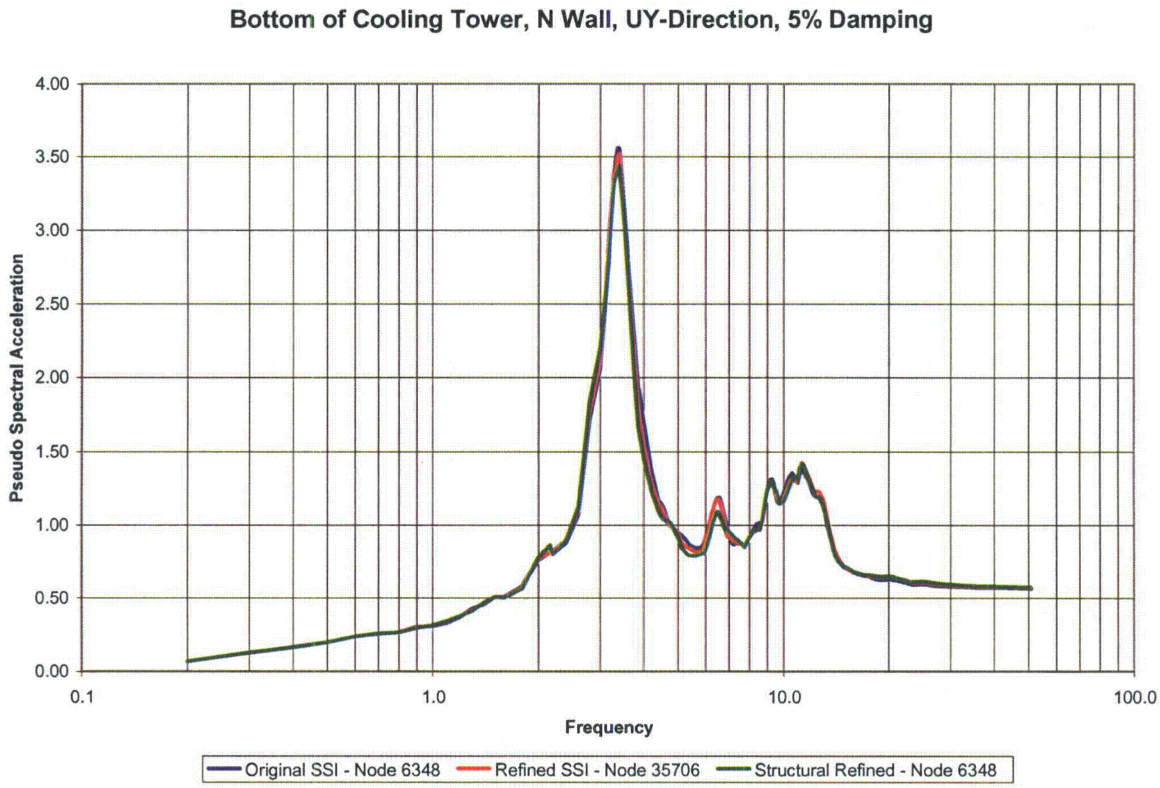

Figure 03.07.02-25.31: Bottom of Cooling Tower North Wall, Y-direction, 5% Damping

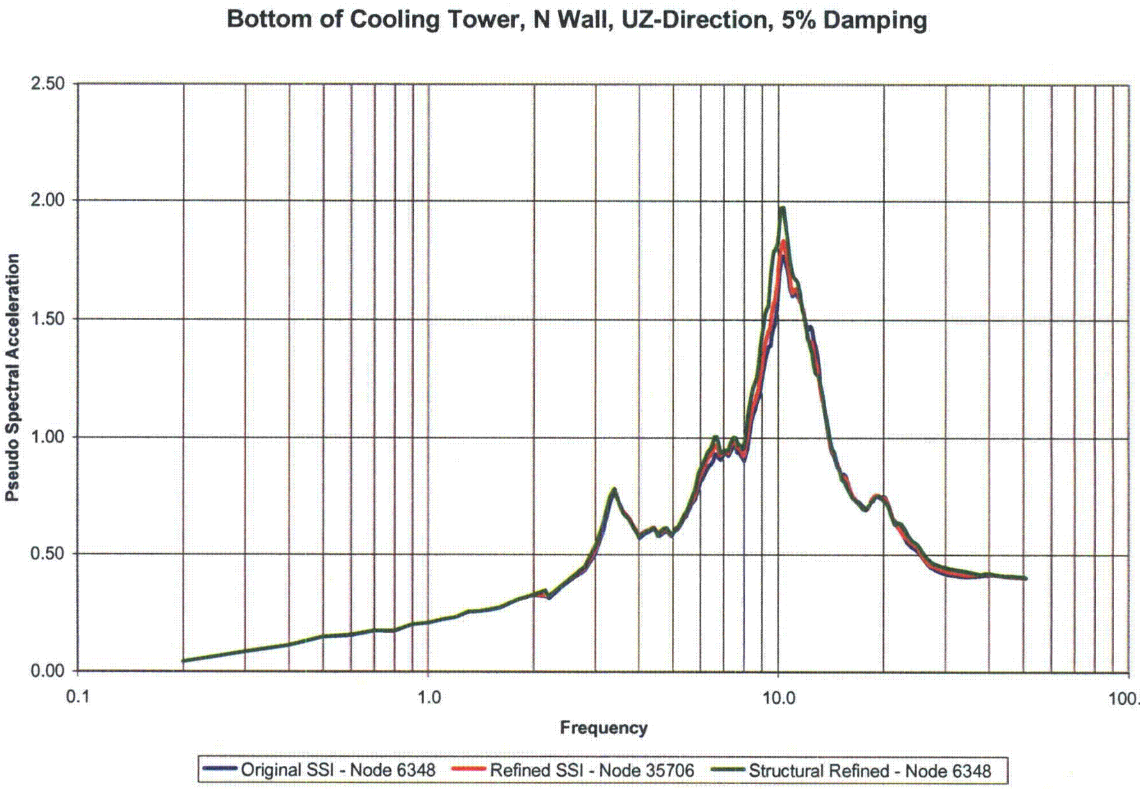

Figure 03.07.02-25.32: Bottom of Cooling Tower North Wall, Z-direction, 5% Damping

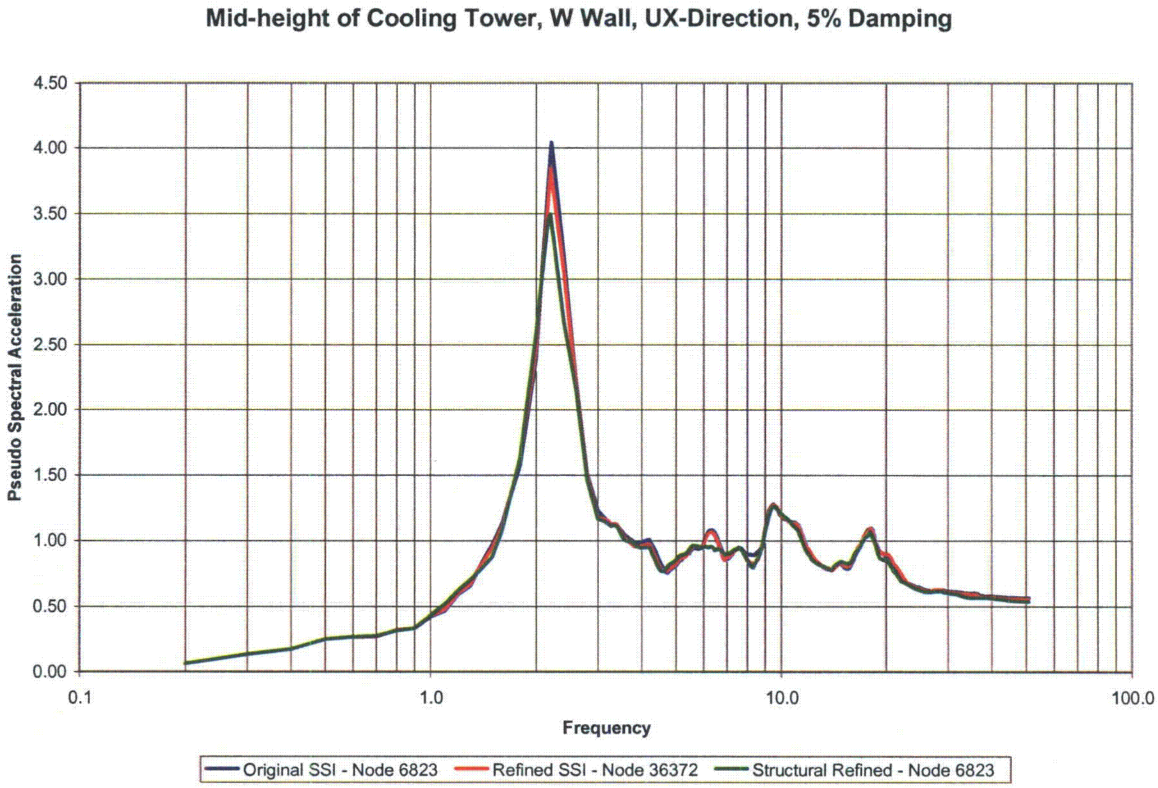

Figure 03.07.02-25.33: Mid-height of Cooling Tower West Wall, X-direction, 5% Damping

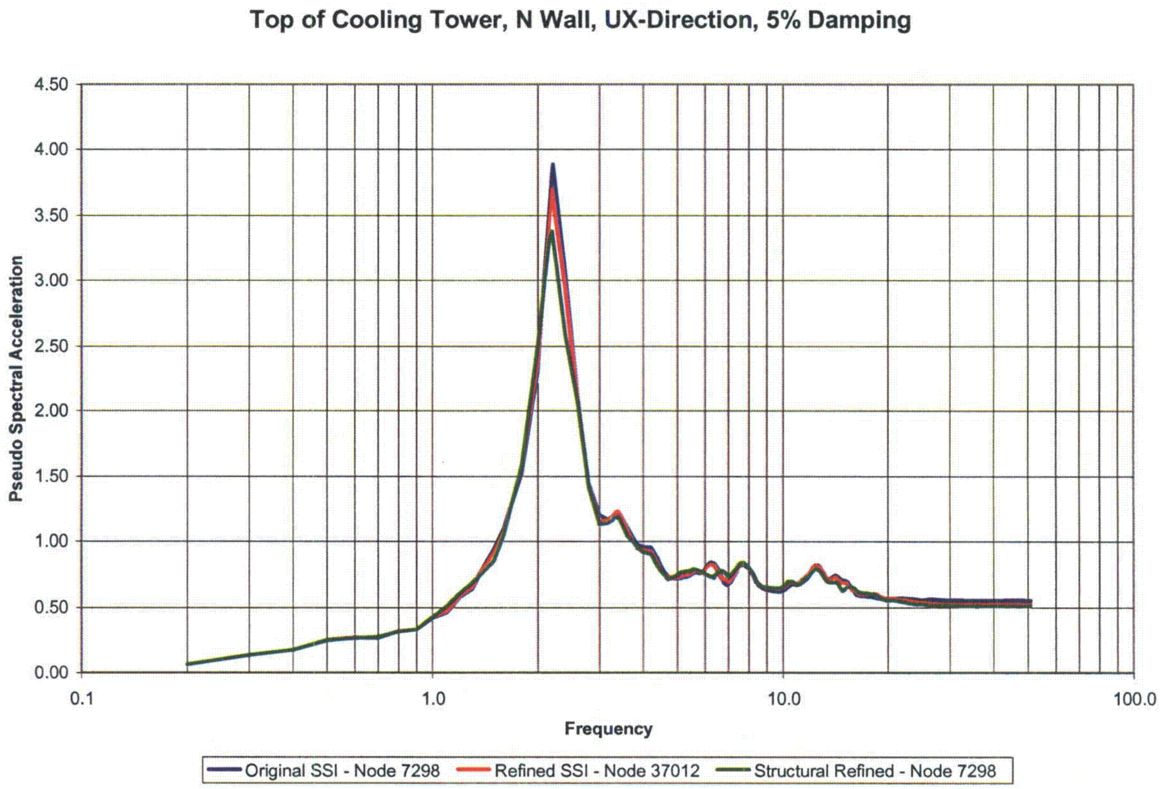

Figure 03.07.02-25.34: Top of Cooling Tower North Wall, X-direction, 5% Damping

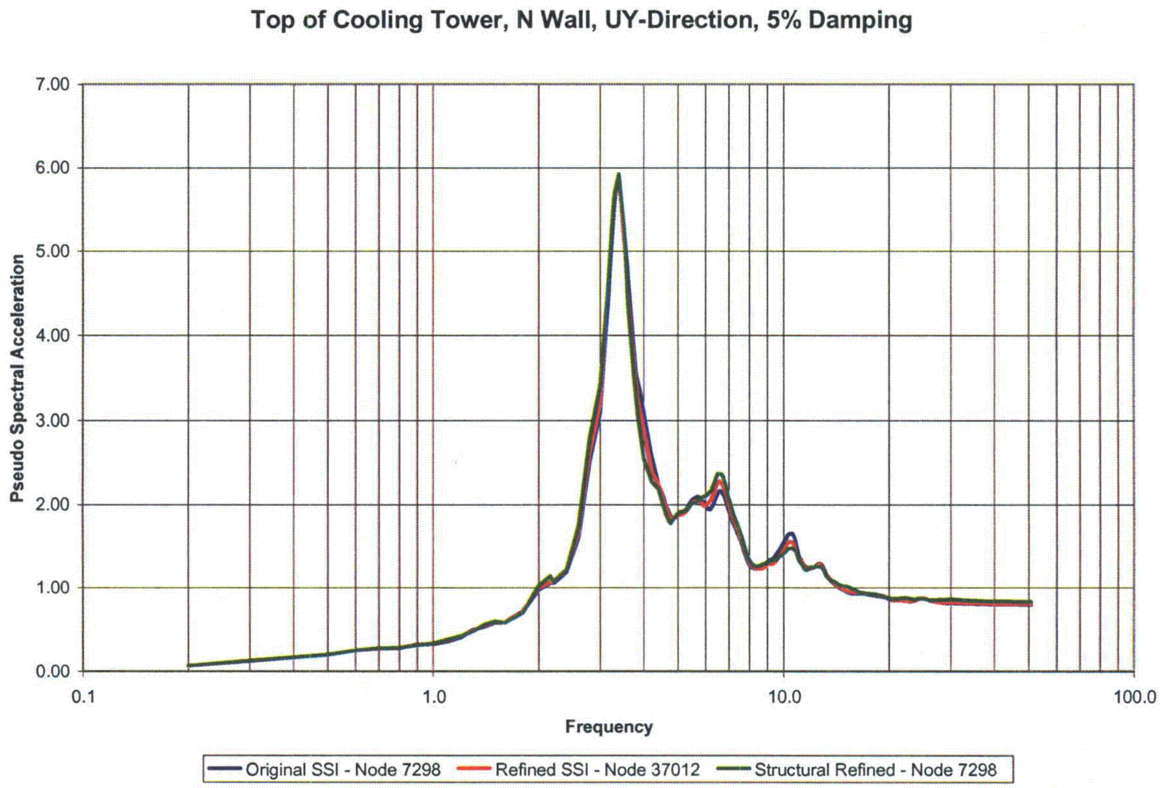

Figure 03.07.02-25.35: Top of Cooling Tower North Wall, Y-direction, 5% Damping

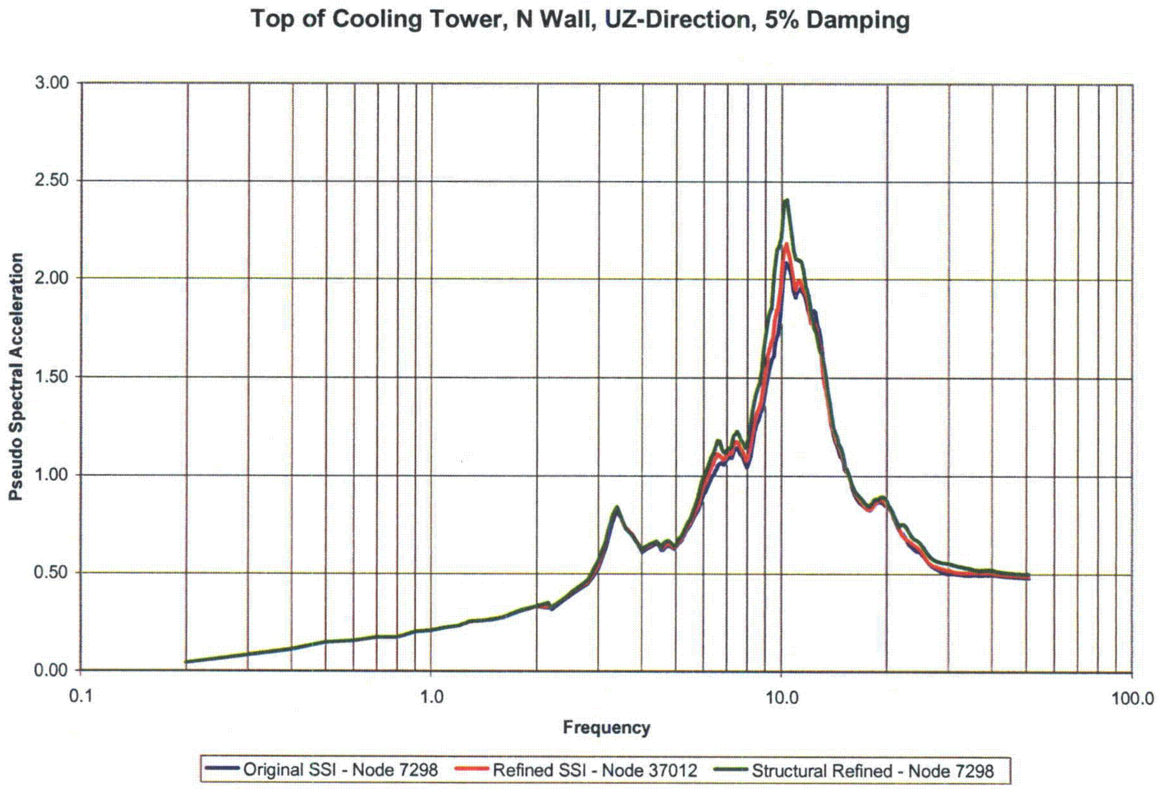

Figure 03.07.02-25.36: Top of Cooling Tower North Wall, Z-direction, 5% Damping

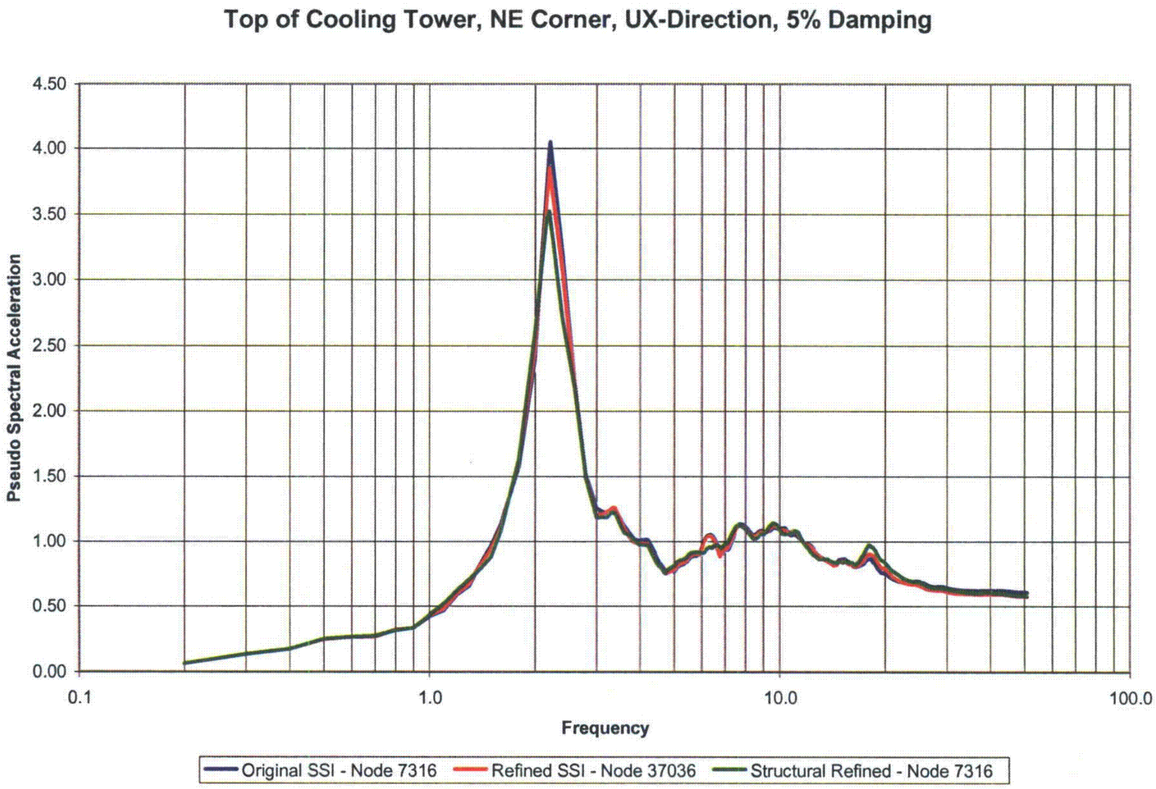

Figure 03.07.02-25.37: Top of Cooling Tower, NE Corner, X-direction, 5% Damping

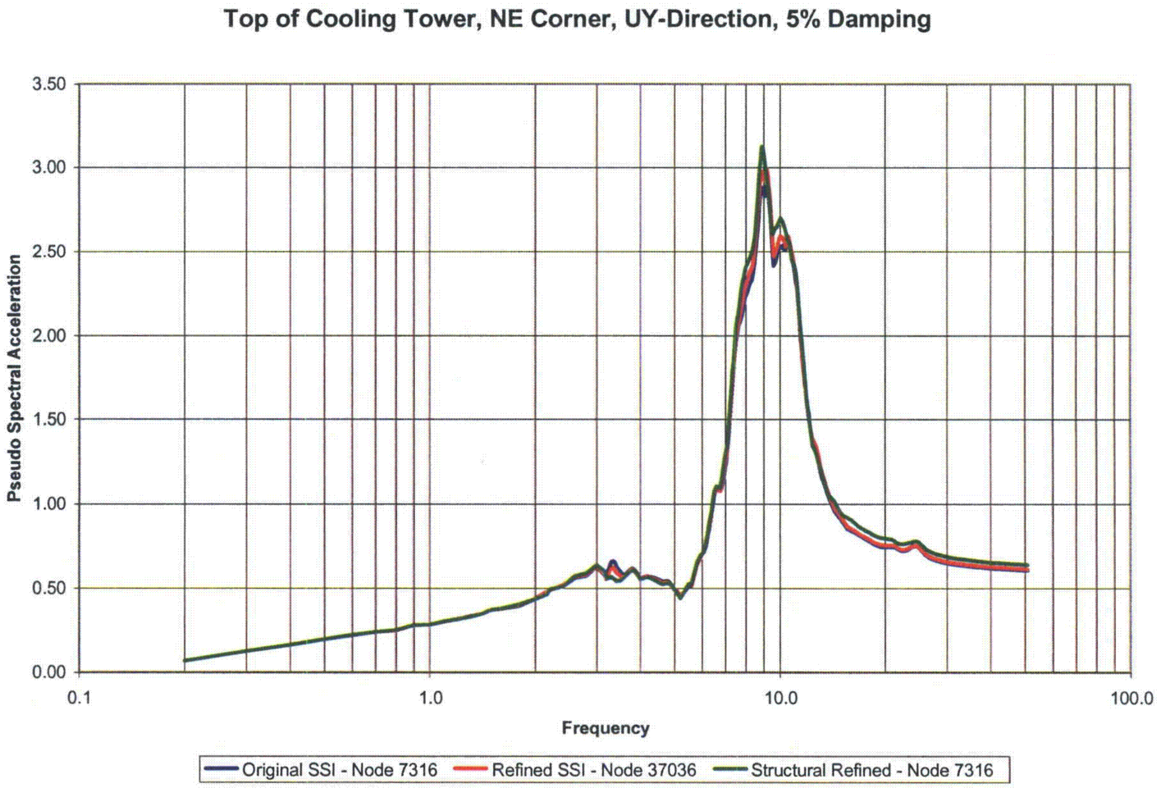

Figure 03.07.02-25.38: Top of Cooling Tower, NE Corner, Y-Direction, 5% Damping

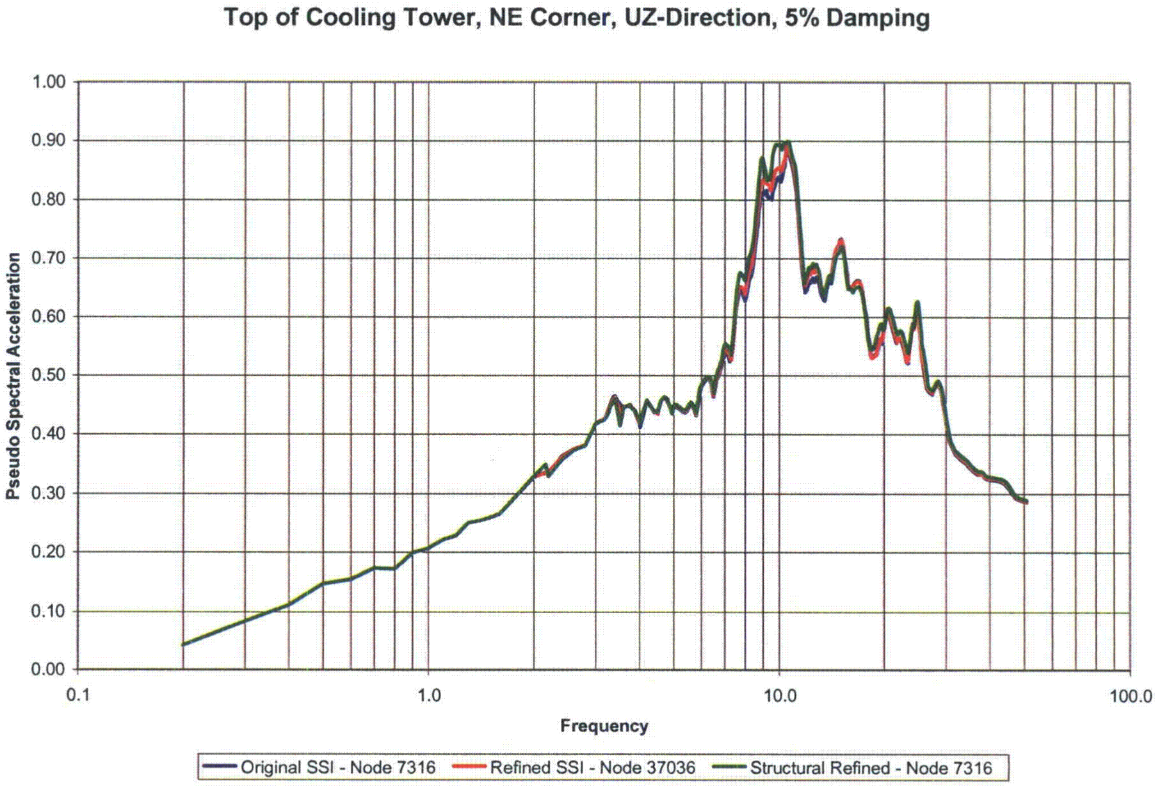

Figure 03.07.02-25.39: Top of Cooling Tower, NE Corner, Z-direction, 5% Damping

Table 03.07.02-25.1: Comparison of Maximum Accelerations

Maximum Accelerations (g)					
Node	**Location**	**Direction**	**Original SSI Mesh**	**Structural Refined Mesh**	**Ratio (Refined / Original)**
4098	PH Operating Floor, W Wall	X	0.242	0.243	1.00
		Y	0.156	0.157	1.01
		Z	0.126	0.127	1.01
4106	PH Operating Floor, Center	X	0.221	0.219	0.99
		Y	0.162	0.162	1.01
		Z	0.739	0.747	1.01
4188	PH Operating Floor, NW Corner	X	0.217	0.218	1.00
		Y	0.166	0.167	1.01
		Z	0.140	0.140	1.00
5608	Top of PH Roof, Center	X	0.284	0.282	0.99
		Y	0.218	0.214	0.98
		Z	0.473	0.598	1.26
5690	Top of PH Roof, NW Corner	X	0.283	0.283	1.00
		Y	0.198	0.200	1.01
		Z	0.152	0.152	1.00
5707	Top of PH Roof, NE Corner	X	0.283	0.281	0.99
		Y	0.188	0.184	0.98
		Z	0.148	0.148	1.00
5737	Basin S Wall	X	0.175	0.172	0.98
		Y	0.337	0.321	0.95
		Z	0.141	0.141	1.00
5841	Basin N Wall	X	0.176	0.173	0.98
		Y	0.360	0.342	0.95
		Z	0.142	0.141	1.00
5943	Basin W Wall	X	0.585	0.553	0.94
		Y	0.220	0.226	1.02
		Z	0.157	0.159	1.01
6180	Top of Basin Wall, SW Corner	X	0.223	0.222	0.99
		Y	0.247	0.253	1.02
		Z	0.159	0.160	1.00
6348	Bottom, Middle, Cooling Tower N Wall	X	0.563	0.499	0.89
		Y	0.559	0.567	1.02
		Z	0.370	0.392	1.06
6410	Top of Basin Wall, NW Corner	X	0.260	0.251	0.97
		Y	0.251	0.249	0.99
		Z	0.160	0.159	1.00
6444	Top of Basin Wall, NE Corner	X	0.215	0.216	1.01
		Y	0.243	0.246	1.01
		Z	0.159	0.160	1.01

Table 03.07.02-25.1: Comparison of Maximum Accelerations (continued)

Maximum Accelerations (g)					
Node	Location	Direction	Original SSI Mesh	Structural Refined Mesh	Ratio (Refined / Original)
6823	Mid-height Cooling Tower W Wall	X	0.558	0.533	0.96
		Y	0.422	0.441	1.05
		Z	0.192	0.193	1.01
7208	Top of Cooling Tower, SW Corner	X	0.587	0.579	0.99
		Y	0.610	0.640	1.05
		Z	0.257	0.261	1.02
7298	Top, Middle, Cooling Tower N Wall	X	0.550	0.509	0.93
		Y	0.787	0.825	1.05
		Z	0.439	0.470	1.07
7316	Top of Cooling Tower, NE Corner	X	0.596	0.566	0.95
		Y	0.590	0.623	1.05
		Z	0.254	0.259	1.02

RAI 03.07.02-28

QUESTION:

Follow-up Question to RAI 03.07.02-21 (STP-NRC-100069)

10CFR50, Appendix S requires that evaluation for SSE must take into account soil-structure interaction (SSI) effects. STP is a deep non-uniform soil-site which is modeled with a large number of soil layers in the SSI analysis. In order for the staff to gain additional assurance and confidence in the SSI analysis results, the staff is performing a confirmatory analysis to verify acceptability of the site specific SSI analysis of the UHS Basin and RSW Pump House for the best-estimate soil case. In performing the confirmatory SSI analysis of the UHS Basin and RSW Pump House, the staff requires the following clarifications:

1. The SSI model assigns no hydrodynamic masses to the submerged columns inside the UHS basin. Because of the relatively large surface area of these columns, their responses and design could be affected by the omission of the hydrodynamic effects. As such, the applicant is requested to provide justification for not assigning hydrodynamic masses to the submerged columns inside the UHS Basin which could have impact on the calculated member forces and stresses in the columns.

2. Based on the review the SSI model of UHS Basin and RSW Pump House as well as the description of the SSI model provided in the STP response to RAI 03.07.02-15 (STP letter U7-STP-NRC-100036 dated February 10, 2010), the columns inside the UHS Basin appears to be rigidly connected to the UHS Basin basemat. To provide moment transfer at the column/basemat connections, all the columns are extended into the solid elements with rigid mass less beams except for two columns located at UD/U4 and UD/U8 line intersections. These two columns have pin-connection at the basemat causing higher accelerations at top as compared to the rest of the columns. The applicant is requested to clarify whether these pinned connections at the base of the columns at UD/U4 and UD/U8 are consistent with the intent of the UHS Basin design.

RESPONSE:

1. The overall hydrodynamic mass effect in the soil-structure interaction (SSI) model of the Ultimate Heat Sink (UHS) and Reactor Service Water (RSW) Pump House is accounted for as described in the response to RAI 03.07.02-15, Item 13 submitted with letter U7-C-STP-NRC-100036, dated February 10, 2010. The impulsive mass effect of the entire water in the UHS basin is distributed on the basin walls and the buttresses in the basin. Since the columns stiffness contribution to the SSI model is small and the full hydrodynamic impulsive mass is accounted for, the lack of hydrodynamic mass on the UHS basin columns will have a negligible effect on the generated in-structure response spectra and the maximum accelerations used for the design of UHS/RSW Pump House. However, the design of UHS

basin columns should account for the additional seismic load due to effect of hydrodynamic mass on these columns.

The three-dimensional (3D) finite element analysis (FEA) model used for the UHS design has been revised to include the seismic loads due to the effective hydrodynamic mass on the UHS Basin columns for calculation of member forces as described below:

- The effective hydrodynamic masses on the UHS basin columns are determined based on the methodology presented in Reference 1, listed below, and are applied as a uniform distributed mass over the height of each submerged column.
- The seismic loads on the UHS basin columns due to hydrodynamic mass are determined as the product of the effective hydrodynamic mass and the envelope of the maximum accelerations at the bottom of the cooling tower walls from the SSI analyses using original SSI model and refined SSI model. Additional details on original SSI model and refined SSI model are provided in the response to RAI 03.07.02-24, Supplement 2, submitted with letter U7-C-STP-NRC-100268, dated December 14, 2010.

Furthermore, the additional hydrodynamic pressure on the UHS basin walls due to vertical excitation of the hydrodynamic mass is accounted for by using the peak vertical acceleration of the 5% damped response spectra for the UHS basin basemat provided in the response to RAI 03.07.02-24, Supplement 2, submitted with letter U7-C-STP-NRC-100268, dated December 14, 2010. The 5% damping is based on recommended damping in Reference 2 listed below.

The revised design results are provided in the response to RAI 03.08.04-30, Supplement 1, which is being submitted concurrently with this response.

2. All UHS basin columns are intended to have fixed connection at the basemat. The pinned connections at the base of columns UD/U4 and UD/U8 are only present in the original SSI model. In 3D FEA design models and the refined SSI model, these columns have fixed connections at the basemat.

   Presence of the pinned connection for the two columns in the original SSI model will have no significant effect on the SSI analysis results because the stiffness contribution of UHS basin columns to the total stiffness of the structure is small. In addition, as described in the response to RAI 03.07.02-24, Supplement 2, submitted with letter U7-C-STP-NRC-100268, dated December 14, 2010, the design of UHS/RSW Pump House and in-structure response spectra are based on the envelope results from SSI analyses with both the original SSI model and refined SSI model. In the refined SSI model, fixed connection at the basemat is used for these two columns.

No COLA revision is required as a result of this response.

References:

1. Fritz, R.J., (February 1972). The Effect of Liquids on the Dynamic Motions of Immersed Solids, Journal of Engineering for Industry
2. Ghaemmaghami, A. R. and Klanoush, M. R. (April 2010). Effect of Wall Flexibility on Dynamic Response of Concrete Rectangular Liquid Storage Tanks under Horizontal and Vertical Ground Motions, ASCE Journal of Structural Engineering