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Your ref: Docket No. 52-006
Our ref: DCP/NRC2240

August 29, 2008

Subject: AP1000 Response to Request for Additional Information (SRP3.12)

Westinghouse is submitting a revised response to the NRC request for additional information (RAI) on SRP Section 3.12. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in the response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

A revised response is provided for RAI-SRP3.12-EMB-01 through -03. This response completes all requests received to date for SRP Section 3.12. A response to RAI-SRP3.12-EMB1-04 and -05 was submitted under letter DCP/NRC2173 dated June 20, 2008. A response to RAI-SRP3.12-EMB1-01 through -03 was submitted under letter DCP/NRC2153 dated June 6, 2008.

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

Very truly yours,

Robert Sisk

Robert Sisk, Manager
Licensing and Customer Interface
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/Enclosure

1. Response to Request for Additional Information on SRP Section 3.12

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NRO

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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 3.12

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.12-EMB-01
Revision: 1

Question:

What are the zero period acceleration (ZPA) and ZPA frequency cut-off for AP1000 design and the HRHF analyses, respectively? Section 3.7.3.7 of AP1000 DCD stated that "For the seismic response spectra analyses, the ZPA cut-off frequency is 33 Hz". Figures 6.3.2.1-3 & 6.3.2.2-3 have shown that the beginning of the rigid region occurs at much higher frequency than 33 Hz for both AP1000 design and HRHF design. The analysis in the TR-115 does not appear to use 33 Hz as the ZPA cut-off frequency as defined in DCD, resulting in inconsistency which needs to be addressed.

Westinghouse Response:

~~The AP1000 Certified Design Response Spectra was created to have high frequency input. These response spectra are based on Regulatory Guide 1.60 with an additional control point specified at 25 Hz. The spectral amplitude at 25 Hz is 30 percent higher than the Regulatory Guide 1.60 spectral amplitude. This increased seismic input at 25 Hz results in amplifications that occur above 33 Hz.~~

~~Both the AP1000 design spectra and HRHF spectra PIPESTRESS models were built with the automatic mass modeling option set to 99 Hz. In this sense, the PIPESTRESS models are identical: allowing for a 1:1 comparison of stresses. This allows the distinction between AP1000 design and HRHF analysis to be the input spectra only. Since a 33 Hz piping analysis model has fewer mass points than the corresponding 99 Hz model, the two cannot be compared directly. Therefore, the two models need to have the same mass modeling to allow for a complete comparison of results.~~

The issue will be addressed in Revision 1 of APP-GW-GLR-115 (TR-115). The modified Section 6.3 of TR-115 is attached to RAI-SRP3.12-EMB-03 and states the following:

The cutoff frequency for the AP1000 CSDRS base case was 33 Hz. The cutoff frequency for the HRHF GMRS case was the ZPA frequency.

Reference: APP-GW-GLR-115, "Effect of High Frequency Seismic Content on SSCs", Technical Report Number 115 (TR-115)

Design Control Document (DCD) Revision: None

PRA Revision: None

Technical Report (TR) Revision: TR-115 will be revised as described above.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.12-EMB-02
Revision: 1

Question:

What is the justification for stating that the two piping systems chosen are representative for all piping systems? For example, the floor response spectrum at Elevation 134.25' of the Containment Building has more exceedance in the high frequency region than those used in the demonstration. Floor Response Spectra should be taken into account in determining which packages envelope the complete piping design.

Westinghouse Response:

~~This problem has two facets: the comparison of response spectra at individual node locations vs. envelope of multiple locations, and the occurrence of both exceedances in response spectra and high frequency participation.~~

~~Looking at AP1000 vs. HRHF response spectra comparisons reveal several locations in which exceedances occur at individual node locations. However, when these comparisons are taken over multiple nodes that encompass a piping system, the AP1000 design response spectra tend to bound the HRHF response spectra. For example, the package APP-PXS-PLA-030 has node locations with exceedances as high as 200% in the high frequency region, see node 2247 for example. When these nodes are compared with other locations, these exceedances are muted, if not eliminated. Therefore, exceedances of the AP1000 design response spectra by the HRHF spectra at individual node locations do not properly reflect the response spectra applied to these piping systems for qualification.~~

~~Exceedance in the high frequency region are insignificant without participation. For the AP1000, the occurrence of the two are rare. The exceedance and participation comparisons of APP-PXS-PLA-030 seems like a poor candidate. However, in comparison with other packages it is not a poor candidate for analysis, by contrast, a strong one. This comparison alone, shows the piping systems of the AP1000 are not aligned to high frequency excitation if the strongest candidate seams weak. Also, the comparison was not limited to 40 packages, many more isometrics were reviewed.~~

~~TR-115 states that to determine if the initial list of analysis packages was or was not a narrow representation, isometric drawings from the remaining unanalyzed piping analysis packages were reviewed. Piping layout was examined for vertical runs and valves with closely spaced supports. The packages with these vertical runs and valves were then further examined, along with the corresponding local high frequency seismic response spectra. This examination produced no further candidates for analysis.~~

The issue will be addressed in Revision 1 of Technical Report 115 (TR-115). The modified Section 6.3 of TR-115 is attached to RAI-SRP3.12-EMB-03 and states the following:

Both the AP1000 CSDRS and HRHF GMRS have been enveloped across entire building elevations. This is not only a conservative approach, but this also eliminates concerns of building location as the spectra is respresentative of an entire elevation.

Reference:
APP-GW-GLR-115, "Effect of High Frequency Seismic Content on SSCs", Technical Report Number 115 (TR-115)

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
TR-115 will be revised as described above.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.12-EMB-03
Revision: 1

Question:

Why were two inconsistent methods (enveloped vs. multiple-level response) used for piping analysis comparison? In TR-115, the applicant used enveloped floor response spectra for AP1000 design and multiple level response spectra for HRHF analysis, respectively. This comparison does not demonstrate that ***normal design practices*** result in an AP1000 design that is considered to be **safer and more conservative** than that which would result if designed for the high frequency input. For AP1000, Table 3.7.1-1 of DCD states that independent support motion response spectra (i.e., multiple-level response spectra) analysis shall use either 2 percent or 3 percent damping, not the 5 percent damping used in TR-115. Staff requests that the applicant provides comparison between AP1000 design and HRHF analysis using the methodology called out in the DCD.

Westinghouse Response:

~~The purpose of this study is to compare the capabilities of the piping systems designed for AP1000 response spectra. The design basis analysis represents the capabilities of the piping system. The high frequency analysis represents the realistic conditions that may be seen by the piping system. Excessive conservatism was removed for the high frequency analysis, so that realistic conditions could be reflected. These two different purposes call for two different analyses. This study does not require the design analyses and high frequency analyses be identical to be meaningful.~~

~~Running an enveloped response spectra for the AP1000 design case is appropriate, since this is they way analyses are performed. Running multiple-level response for the HRHF case is appropriate because it more closely reflects the response spectra seen by the various segments of the piping system. The two can be directly compared because the purpose of this comparison is to reflect the high frequency results against the design capabilities of the piping systems.~~

The issue will be addressed in Revision 1 of Technical Report 115 (TR-115). The modified Section 6.3 of TR-115 is attached and states the following:

Both the AP1000 CSDRS and HRHF GMRS analyses used uniform support motion methodology (USM), which allows damping values of 4% and 5% to be used.

See below, the SRP3.12 changes to Revision 1 of Technical Report 115.

Reference: APP-GW-GLR-115, "Effect of High Frequency Seismic Content on SSCs", Technical Report Number 115 (TR-115)

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
TR-115 will be revised as described below.

6.3 Piping Systems

To determine the effect of HRHF ~~seismic response spectra~~GMRS on piping, a comparison of stress analyses was made using the PIPESTRESS computer program. The study compared results for HRHF ~~seismic~~ GMRS input against the AP1000 CSDRS ~~basis~~ input. Since piping lines and piping supports are designed throughout the plant using specific guidelines, the stress analysis of a sample of lines is representative of all lines in the plant.

Susceptibility to excitation caused by high frequency input requires a number of factors:

- The local HRHF ~~floor response spectra~~GMRS needs to have exceedances relative to AP1000 ~~design spectra~~CSDRS in the high frequency range.
- The system must have modes or natural frequencies in the high frequency range.
- The system layout must include valves or other concentrated masses that would require closely spaced supports and therefore, cause high local natural frequencies. This generally yields significant cumulative mass in the high frequency range.

6.3.1 Package Consideration

Packages taken into consideration were those with already completed AP1000 analyses, as outlined in Table 6.3.1-1. Several steps were taken to filter these packages to find the package most susceptible to high frequency excitation. First, a layout of piping lines was inspected to determine if valves or other concentrated masses existed. To further narrow the most eligible packages: 1.) input seismic response spectra was reviewed for elevations with exceedances, and 2.) modal mass was reviewed for high frequency participation.
~~Then a pair of tasks were performed, in parallel, to further narrow the most eligible packages: 1.) review of the input seismic response spectra for the plant, and 2.) examination of modal mass participation of the systems.~~

To determine if the initial list of analysis packages was or was not a narrow representation, isometric drawings from the remaining unanalyzed piping analysis packages were reviewed. Piping layout was examined for vertical runs and valves with closely spaced supports. The packages with these vertical runs and valves were then further examined, along with the corresponding local high frequency seismic response spectra. This examination produced no further candidates for analysis.

6.3.1.1 Layout

Layout was examined to determine whether the analyzed piping package could be susceptible to high frequency excitation. The existence of valves usually results in closely spaced supports. Though the mass of such a valve would reduce the natural frequency, the nearby supports could drive that frequency upward. Packages without valves or concentrated masses were not included in the sample because the majority of the modal mass has lower frequency participation.

6.3.1.2 Review of Spectra

The ~~AP1000 CSDRS seismic in-structure response spectra for the~~ HRHF ~~input~~ GMRS ~~were~~ was reviewed for exceedances of ~~in-structure design~~the AP1000 CSDRS in the high frequency region. The elevations with exceedances of seismic response spectra in high frequency were examined~~The location of nodes with exceedances of seismic response spectra in high frequency was examined for patterns across the plant~~ to either highlight or dismiss packages.

The Passive Core Cooling System (PCS) piping packages are located above the Steel Containment Vessel in the Shield Building. This area does not have exceedances in high frequency seismic response spectra, so the PCS packages (APP-PCS-PLA-050, 060, 070, 100, 200, 210, 220, 230, 240, 250, 270, 290, 300, 310, 410, 420, and 430) were eliminated from consideration.

Packages below elevation 100 ft are not considered since exceedances in both the Containment and Auxiliary buildings are small at this elevation. More significant exceedances occur at the 135 ft elevation and above. Therefore, packages closer to the 135 ft elevation are given more consideration than packages closer to the 100 ft elevation.
~~Since the AP1000 is a two loop plant, many of the systems, equipment, and structures are mirrored, at least in functionality, for the two loops. By examining the spectra, pairs of packages were cut in half on the basis of location and the package in the area with greater exceedance was chosen. The area near the West Steam Generator Compartment is stiffer than that of the East Compartment because of the attached Pressurizer Compartment; therefore, seismic response spectra associated with analysis packages in the west side of containment were given more consideration than on the east side of containment. Consequently, Automatic Depressurization Stage 4 East (APP-RCS-PLA-030) was eliminated in favor of the Automatic Depressurization Stage 4 West package (APP-PXS-PLA-030).~~

~~Similarly, the offset of containment internal structures stiffens the southern areas of containment. The spectra in these southern areas show greater exceedances than that of the northern areas. Therefore, Direct Vessel Injection B and CMT 2B Supply lines (APP-PXS-PLA-020 and APP-PXS-PLA-060), which are north of the containment internal structures, were eliminated in favor of Direct Vessel Injection A and CMT 2A Supply lines (APP-PXS-PLA-010 and APP-PXS-PLA-050).~~

6.3.1.3 Modal Analysis

Packages with layouts susceptible to high frequency excitation and exceedances in local seismic spectra had modal extraction run in PIPESTRESS to determine the mass participation factors of the systems. Large equipment, such as heat exchangers and pumps, were decoupled for this analysis to reveal the characteristics of only the ~~system~~ piping. The mass participation factors were then calculated and plotted as a cumulative mass participation against frequency. The cumulative mass represents the accumulated percentage mass of the system excited as the modes are included. Packages determined to be of further interest have significant mass participation among all directions in the high frequency range.

These plots of system behavior were compared against the corresponding plots of input seismic response spectra. Packages with high frequency behavior shown in the cumulative mass curves but without high frequency input were eliminated. Inversely~~Likewise~~, packages with high frequency seismic input spectra but without high frequency behavior were eliminated. Only packages with high frequency modal mass participation and corresponding exceedances of seismic response spectra in high frequency were considered.

Table 6.3.1-1 lists the reasons for susceptibility of the analysis packages to high frequency excitation. The table also shows the two packages determined to be most susceptible to high frequency seismic input spectra, and therefore representative of the entire plant; Automatic Depressurization Stage 4 West (APP-PXS-PLA-030) inside containment and Normal RHR Heat Exchanger Inlet and Outlet between containment penetrations (APP-RNS-PLA-170) outside containment.

Table 6.3.1-1: Reviewed Lines

Analysis Package Description	Package Designator	Candidate	Reason
Direct Vessel Injection Line A	APP-PXS-PLA-010	No	Due to the low elevation of APP-PXS-PLA-010, exceedances in high frequency are small.~~Exceedances in high frequency only exist for the Z direction, where modal mass participation is small~~
Direct Vessel Injection Line B	APP-PXS-PLA-020	No	Due to the low elevation of APP-PXS-PLA-020, exceedances in high frequency are small.~~Because of its location near the northern section of containment, APP-PXS-PLA-010 was considered over APP-PXS-PLA-020.~~
ADS 4th Stage West and PRHR Supply	APP-PXS-PLA-030	Yes	See section 6.3.2.1
Passive RHR Return Line	APP-PXS-PLA-040	No	Due to the low elevation of APP-PXS-PLA-040, this location does not have exceedances of seismic response spectra in high frequency.
CMT 2A Supply Line	APP-PXS-PLA-050	No	The increases in modal mass and exceedances of high frequency spectra are not aligned at the same frequencies for APP-PXS-PLA-050.
CMT 2B Supply Line	APP-PXS-PLA-060	No	The increases in modal mass and exceedances of high frequency spectra are not aligned at the same frequencies for APP-PXS-PLA-060.~~Because of its location near the northern section of containment, APP-PXS-PLA-050 was considered over APP-PXS-PLA-060.~~
PSADS System (Lower Tier/Upper Tier)	APP-RCS-PLA-010	No	APP-RCS-PLA-010 does not contain significant X and Y modal mass participation in the high frequency region. Modal mass participation in the Z direction is similar to that of the chosen packages.
ADS 4th Stage East	APP-RCS-PLA-030	No	APP-PXS-PLA-030 was considered over APP-RCS-PLA-030 for its greater complexity and higher elevation.~~Because of its location in the West Steam Generator and Pressurizer Compartments, APP-PXS-PLA-030 was considered over APP-RCS-PLA-030.~~
Pressurizer Surge Line	APP-RCS-PLA-040	No	APP-RCS-PLA-040 contains no valves.

Reactor Coolant Loop Piping	APP-RCS-PLA-050	No	This analysis is reviewed in section 6.2 of this report.
Normal RHR Suction Line	APP-RNS-PLA-010	No	APP-RNS-PLA-010 lies in lower elevations of Containment, where the spectra contains small exceedances in high frequency.~~APP-RNS-PLA-010 lies in a location that contains no exceedances in the high frequency region~~
Spent Resin from Cont. Pen.	APP-CVS-PLA-520	No	APP-CVS-PLA-520 lies in lower elevations of the Auxiliary Building, where the spectra contains small exceedances in high frequency.~~APP-CVS-PLA-520 lies in the northern half of the Auxiliary Building, where the spectra does not contain exceedances in high frequency.~~
From SCV Pen. to CVS-12A0007	APP-CVS-PLA-530	No	APP-CVS-PLA-530 lies in lower elevations of the Auxiliary Building, where the spectra contains small exceedances in high frequency.~~APP-CVS-PLA-530 lies in the northern half of the Auxiliary Building, where the spectra does not contain exceedances in high frequency.~~
Hydrogen Supply from CVS-12A0022	APP-CVS-PLA-700	No	APP-CVS-PLA-700 lies in lower elevations of the Auxiliary Building, where the spectra contains small exceedances in high frequency.~~APP-CVS-PLA-700 lies in the northern half of the Auxiliary Building, where the spectra does not contain exceedances in high frequency.~~
HX Inlet and Outlet between P19 & P20	APP-RNS-PLA-170	Yes	See section 6.3.2.2
Main Steam Line A	APP-SGS-PLA-030	No	The valves of APP-SGS-PLA-030/040 ~~these lines~~ reside outside containment in lower elevations of the Auxiliary Building, where the spectra contains small exceedances in high frequency.~~in the northern half of the Auxiliary Building, where the spectra does not contain exceedances in high frequency.~~
Main Steam Line B	APP-SGS-PLA-040	No	
Blowdown Line B from Cont. Pen. to TB	APP-SGS-PLA-090	No	APP-SGS-PLA-090/100 does not contain any valves.
Blowdown Line A from Cont. Pen. to TB	APP-SGS-PLA-100	No	

From SCV Pen. to VFS-12A2004	APP-VFS-PLA-010	No	The increases in modal mass and exceedances in high frequency spectra are not aligned at the same frequencies for APP-VFS-PLA-010/030.
From Cont. Pen. to past Valve V010	APP-VFS-PLA-030	No	
From Cont. Pen. to past Valve V024	APP-WLS-PLA-520	No	The valves of APP-WLS-PLA-520 reside outside containment in lower elevations of the Auxiliary Building, where the spectra contains small exceedances in high frequency.~~in the northern half of the Auxiliary Building, where the spectra does not contain exceedances in high frequency.~~
Supply to Distribution Bucket (Embed)	APP-PCS-PLA-050	No	The PCS system is located at the top of the Shield Building. The spectra at these elevations do not contain exceedances in high frequency.
Recirculation Line inside PCS Tank	APP-PCS-PLA-060	No	
Recirculation Line inside PCS Tank	APP-PCS-PLA-070	No	
PCS Room 12306 (Auxiliary Building)	APP-PCS-PLA-100	No	
Overflow inside PCS Tank	APP-PCS-PLA-200	No	
Vent Line inside PCS Tank	APP-PCS-PLA-210	No	
Room 12701 PCS Tank Vent	APP-PCS-PLA-220	No	
Vent Line inside PCS Tank	APP-PCS-PLA-230	No	
Room 12701 PCS Tank Vent	APP-PCS-PLA-240	No	
Discharge Line inside PCS Tank	APP-PCS-PLA-250	No	
Discharge Line inside PCS Tank	APP-PCS-PLA-270	No	
Discharge Line inside PCS Tank	APP-PCS-PLA-290	No	
Instrumentation Line	APP-PCS-PLA-300	No	
Instrumentation Line	APP-PCS-PLA-310	No	
Overflow Line from PCS Tank	APP-PCS-PLA-410	No	
Supply to Distribution Bucket	APP-PCS-PLA-420	No	
Auxiliary Supply to Distribution Bucket	APP-PCS-PLA-430	No	
From RNS-12A2037 to Spent Fuel Pool	APP-RNS-PLA-100	No	The modal mass and high frequency spectra are not aligned at the same frequencies for APP-RNS-PLA-100.

The two packages determined to be most susceptible to high frequency excitation are Automatic Depressurization System 4th West (APP-PXS-PLA-030) inside containment and Normal RHR Heat Exchanger Inlet and Outlet between containment penetrations (APP-RNS-PLA-170) outside containment. These two packages have layout sensitive to high frequency excitation and local seismic response spectra with exceedances in high frequency.

6.3.2 Analysis of Selected Candidates

6.3.2.1 Automatic Depressurization System 4th Stage West and Passive RHR Supply (APP-PXS-PLA-030)

Figures 6.3.2.1-1 through 6.3.2.1-3 are the plots of the AP1000 CSDRS with 5% damping and HRHF GMRS with 5% damping and incoherence. The response spectra for both AP1000 CSDRS and HRHF GMRS are representative of the containment building up to elevation 135'.

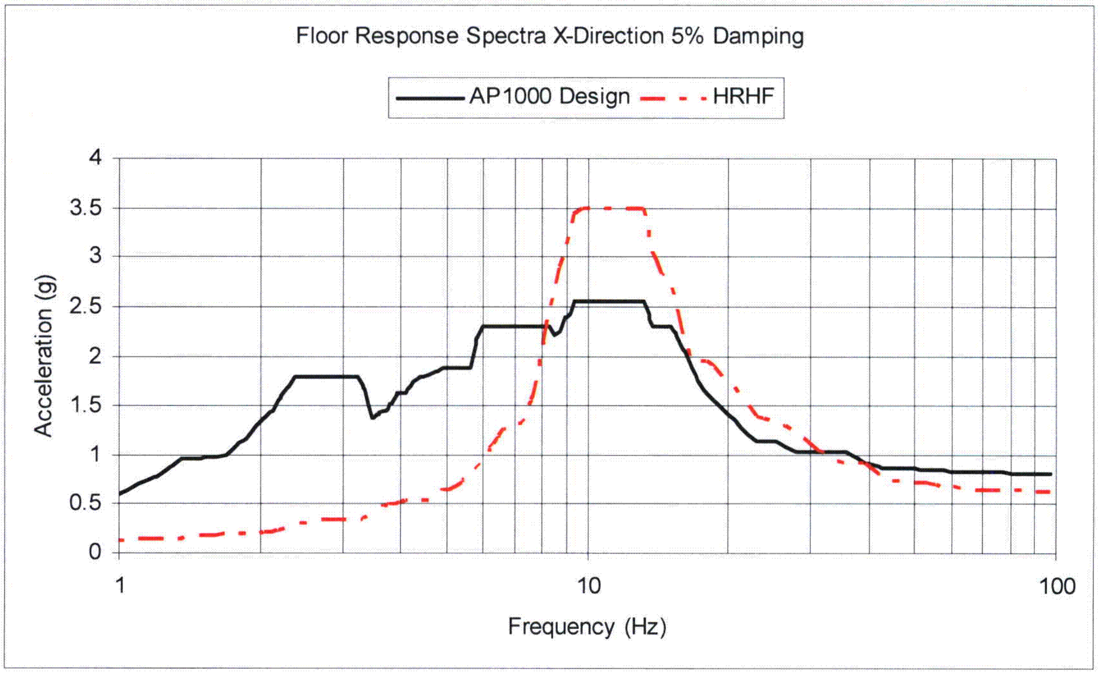

Figure 6.3.2.1-1: APP-PXS-PLA-030 Floor Response Spectra X-Direction

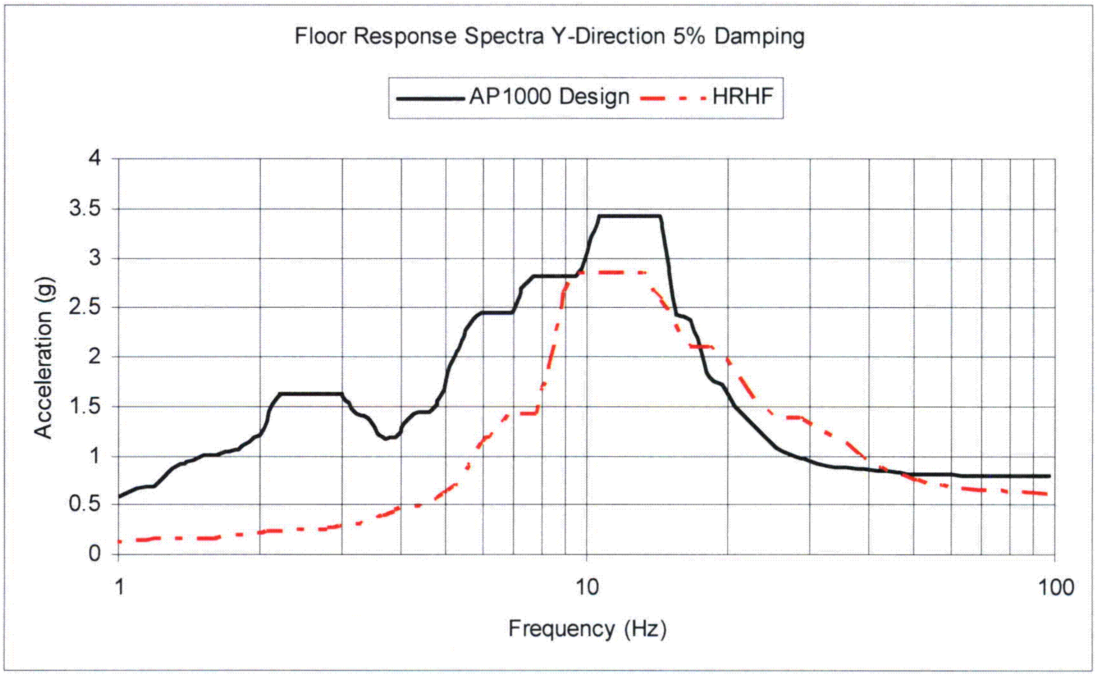

Figure 6.3.2.1-2: APP-PXS-PLA-030 Floor Response Spectra Y-Direction

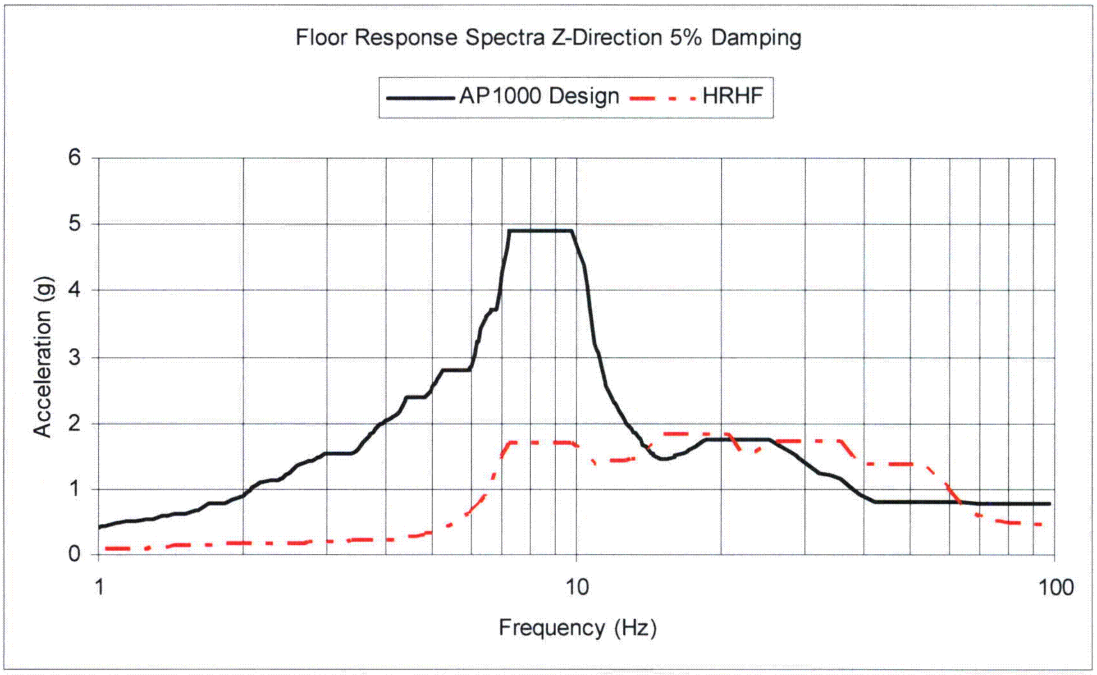

Figure 6.3.2.1-3: APP-PXS-PLA-030 Floor Response Spectra Z-Direction

The layout of APP-PXS-PLA-030 is potentially sensitive to high frequency response; the package spans a very small distance, yet has sixteen supports and anchors. The package also has five large valves, three of which are greater than 10,000 lbs. Figure 6.3.2.1-4 shows the cumulative mass of the analysis package; approximately forty, twenty, and fifty mass percent of the package (in the X, Y, and Z directions, respectively) is active in frequencies of HRHF exceedance.

~~Figure 6.3.2.1-4 shows the cumulative mass of the analysis package; thirty, sixty, and eighty mass percent of the package (in the X, Y, and Z directions, respectively) is active in the high frequency range.~~

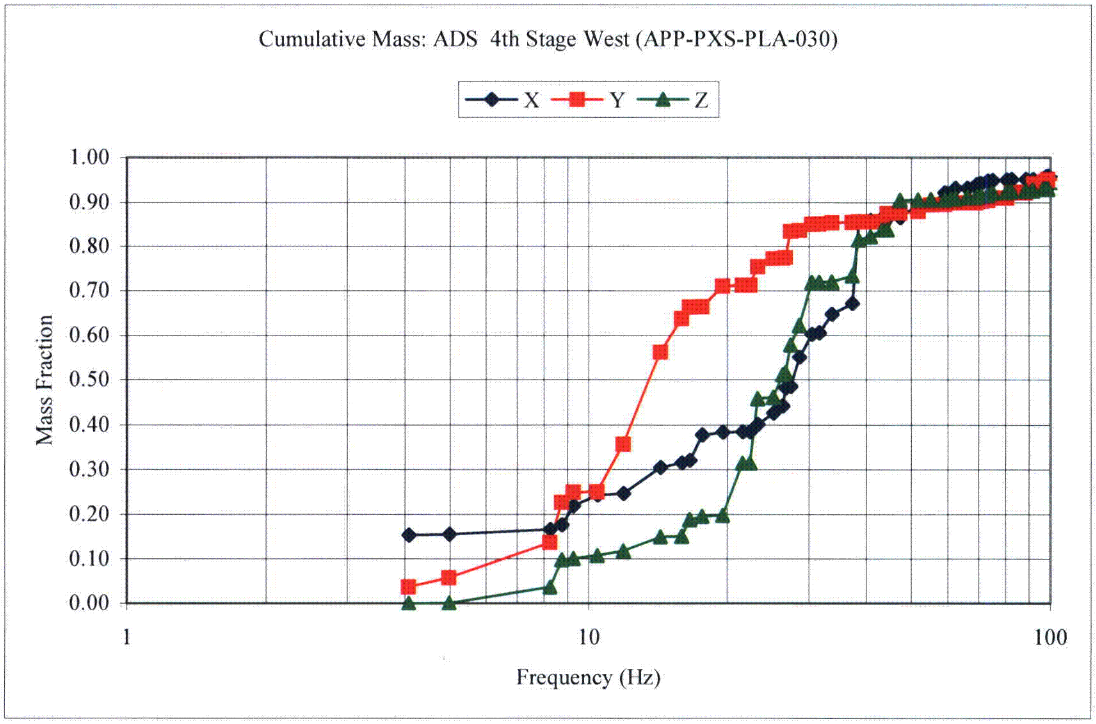

Figure 6.3.2.1-4: APP-PXS-PLA-030 Cumulative Mass: ADS 4th Stage West

Due to exceedances of high frequency seismic response spectra and its high frequency sensitive layout, APP-PXS-PLA-030 is representative of a piping package most susceptible to excitation caused by high frequency input inside containment.

6.3.2.2 Normal RHR Heat Exchanger Inlet and Outlet (APP-RNS-PLA-170)

Figures 6.3.2.2-1 to 6.3.2.2-3 are plots of local 4% damping and HRHF seismic response spectra with 4% damping and incoherence. The response spectra for both AP1000 CSDRS and HRHF GMRS are representative of the auxiliary building up to elevation 135'.
~~APP-RNS-PLA-170 has two heat exchangers, ME-01A and B, which are flexible equipment, so seismic response spectra at 4% damping was used.~~

~~APP-RNS-PLA-170 resides entirely in the Auxiliary Building except for the two containment penetrations, and spans multiple elevations and causes input seismic response spectra with exceedances in high frequency. Figures 6.3.2.2-1 to 6.3.2.2-3 are plots of local AP1000 design seismic response spectra and HRHF seismic response spectra with 4% damping and incoherence.~~

~~The dashed line represents the envelope of high frequency input seismic response spectra used at the multiple support levels.~~

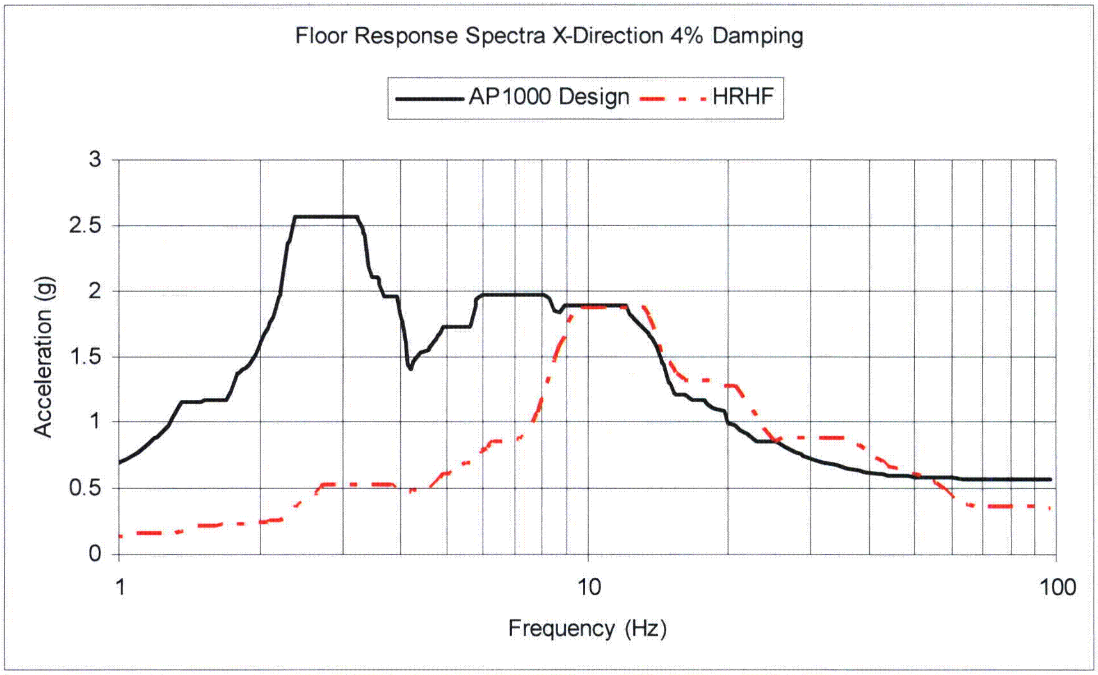

Figure 6.3.2.2-1: APP-RNS-PLA-170 Floor Response Spectra X-Direction

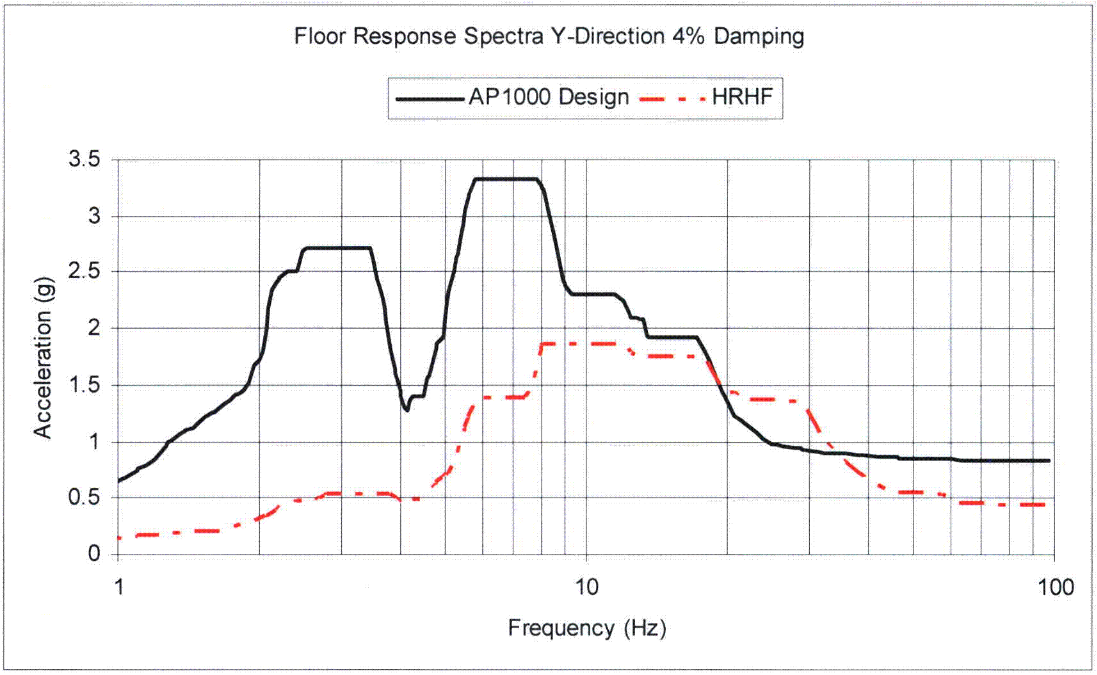

Figure 6.3.2.2-2: APP-RNS-PLA-170 Floor Response Spectra Y-Direction

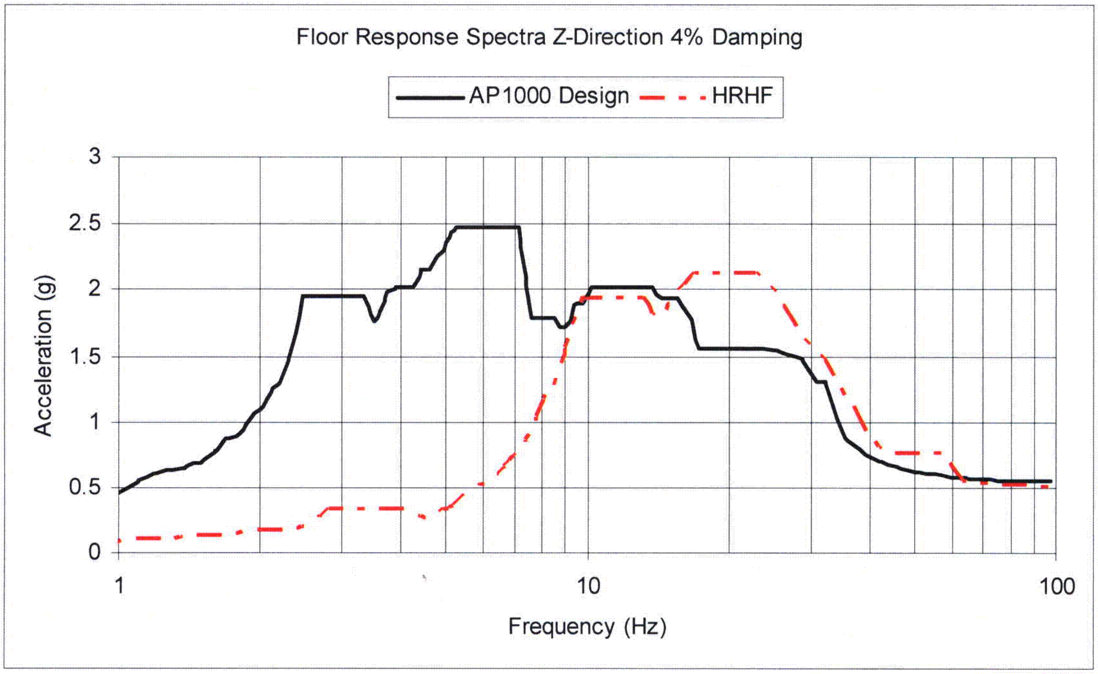

Figure 6.3.2.2-3: APP-RNS-PLA-170 Floor Response Spectra Z-Direction

APP-RNS-PLA-170 is a system with many vertical runs. The package has fourteen valves; as well as eighty-three supports and anchors. The complexity of the package represents a wide number of piping layout configurations, which should encompass the layouts throughout the plant. Figure 6.3.2.2-4 shows the cumulative mass of the analysis package; approximately forty, thirty, and fifty mass percent of the package (in the X, Y, and Z directions, respectively) is active in frequencies of HRHF exceedance.~~Figure 6.3.2.2-4 shows the cumulative mass of the analysis package; fifty, sixty, and seventy mass percent of the package (in the X, Y, and Z directions, respectively) is active in the high frequency range.~~

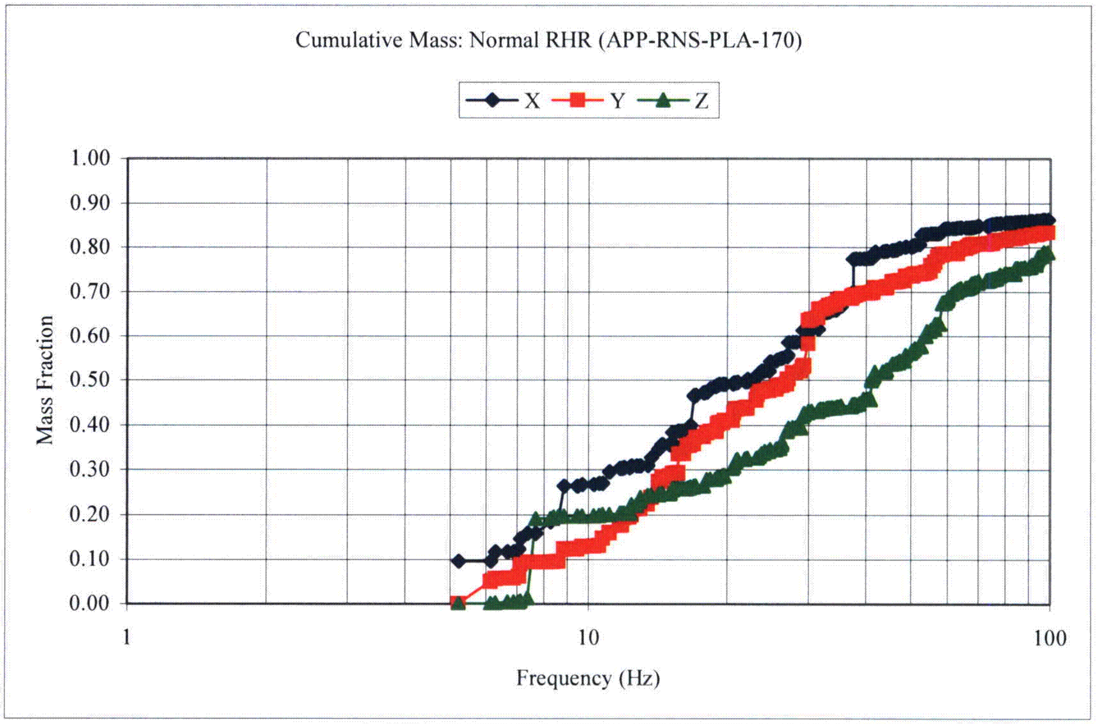

Figure 6.3.2.2-4: APP-RNS-PLA-170 Cumulative Mass: Normal RHR

Due to its location near exceedances of seismic response spectra in high frequency, APP-RNS-PLA-170 is representative of a piping package that is susceptible to excitation caused by high frequency input outside containment.

6.3.2.3 Analysis Method

The analysis method for both the AP1000 CSDRS and HRHF GMRS analyses, shown below, are consistent with normal design practices.

Both the AP1000 CSDRS and HRHF GMRS have been enveloped across entire building elevations. This is not only a conservative approach, but this also eliminates concerns of building location as the spectra is representative of an entire elevation.

Identical PIPESTRESS models were run for the two selected analysis packages, with the exception of the input seismic response spectra. The base case used AP1000 CSDRS with 15%

peak broadened and enveloped response spectra. Input for the high frequency comes from the HRHF GMRS with 15% peak broadened and enveloped response spectra with incoherence.

The cutoff frequency for the AP1000 CSDRS base case was 33 Hz. The cutoff frequency for the HRHF GMRS case was the ZPA frequency. Both the AP1000 CSDRS and HRHF GMRS analyses used uniform support motion methodology (USM), which allows the same damping values of 4% and 5% to be used.

The seismic analyses were combined with deadweight and pressure analyses to show that the HRHF results do not exceed the limits of ASME Section III Equation 9F.
~~Identical PIPESTRESS models were run for the two selected analysis packages, with the exception of the input seismic response spectra. The base case used AP1000 design seismic response spectra. Input for the high frequency comes from the HRHF GMRS with incoherence. Only a seismic analysis was performed. Deadweight, pressure, thermal, and other analyses were not performed so that the differences between the two cases are due only to the seismic loads.~~

~~The base case was run with an enveloped, 15% peak broadened, floor response spectra at 5% and 4% damping, for APP-PXS-PLA-030 and APP-RNS-PLA-170, respectively. The high frequency case was run as a multiple-level response, 15% peak broadened floor response spectra with incoherence at 5% and 4% damping for APP-PXS-PLA-030 and APP-RNS-PLA-170, respectively. The response from the different support levels is combined using the SRSS method, which is consistent with licensing basis.~~

6.3.3 Results

~~The stresses shown are moment stresses for seismic analysis only, calculated with the moment stress term of Equation 9 of the ASME Boiler and Pressure Vessel Code Section III NB-3652 Class 1 1989 Edition up to and including the 1989 Addenda.~~

~~Moment stress term of Equation 9:~~

$$B_2 \frac{M}{Z}$$

6.3.3.1 Automatic Depressurization System Stage 4 West (APP-PXS-PLA-030)

Comparisons of the AP1000 CSDRS ~~seismic response spectra~~ and HRHF GMRS analyses are listed in Tables 6.3.3.1-1 to 6.3.3.1-~~7~~8.

~~HRHF moment stress results at the 198 points of the model were lower than AP1000 CSDRS seismic response spectra.~~

Table 6.3.3.1-1 shows the ten highest stressed ~~piping~~ points ~~(not including tees, which are compared in Table 6.3.3.1-4)~~ of the AP1000 ~~design seismic response spectra~~CSDRS analysis. Table 6.3.3.1-2 shows the ten highest stressed ~~piping~~ points ~~(not including tees, which are compared in Table 6.3.3.1-4)~~ of the HRHF GMRS analysis. Table 6.3.3.1-3 shows the ten highest stress increases of the HRHF GMRS analysis from the AP1000 CSDRS analysis.

Table 6.3.3.1-~~3~~4 compares the valve end ~~moment~~ stresse~~s~~ ratios. Table 6.3.3.1-~~4~~5 compares stresse~~s~~ ratios of tee connections~~ at both the run and branch sides~~. Tables 6.3.3.1- ~~5~~6 and ~~6~~7 compare support and anchor loads, respectively. Support loads are listed for individual restraint directions. Table 6.3.3.1-~~7~~8 compares the equipment nozzle stresse~~s~~ ratios.

Table 6.3.3.1-1: Ten Highest AP1000 Design Stress Points for APP-PXS-PLA-030

Node #	Equation 9F Stress Ratio		
	AP1000 CSDRS	HRHF	% Change
1276	0.610	0.484	-20.66%
1275	0.558	0.433	-22.40%
1261	0.557	0.483	-13.29%
1045	0.533	0.453	-15.01%
1005	0.531	0.447	-15.82%
1345	0.500	0.409	-18.20%
Z002	0.498	0.423	-15.06%
Z013	0.494	0.398	-19.43%
1331	0.489	0.410	-16.16%
1040	0.469	0.399	-14.93%

Label	Moment Stress (psi)		
	AP1000 CSDRS	HRHF	% Change
TANGENT	13969	4599	-67.1%
LR ELBOW	13089	6789	-48.1%
TANGENT	12594	5595	-55.6%
PIPING	12323	5015	-59.3%
LR ELBOW	12180	6297	-48.3%
TANGENT	11793	5497	-53.4%
TANGENT	11647	6002	-48.5%
TANGENT	11272	4771	-57.7%
TANGENT	11196	3688	-67.1%
TANGENT	11094	4685	-57.8%

Table 6.3.3.1-2: Ten Highest High Frequency Stress Points for APP-PXS-PLA-030

Node #	Equation 9F Stress Ratio		
	AP1000 CSDRS	HRHF	% Change
1276	0.610	0.484	-20.66%
1261	0.557	0.483	-13.29%
1045	0.533	0.453	-15.01%
1005	0.531	0.447	-15.82%
1275	0.558	0.433	-22.40%
Z002	0.498	0.423	-15.06%
1331	0.489	0.410	-16.16%
1345	0.500	0.409	-18.20%
Z012	0.469	0.406	-13.43%
1040	0.469	0.399	-14.93%

Label	Moment Stress (psi)		
	AP1000 CSDRS	HRHF	% Change
LR ELBOW	13089	6789	-48.1%
LR ELBOW	12180	6297	-48.3%
TANGENT	11647	6002	-48.5%
LR ELBOW	11028	5672	-48.6%
TANGENT	12594	5595	-55.6%
TANGENT	11793	5497	-53.4%
LR ELBOW	10118	5414	-46.5%
TANGENT	10360	5370	-48.2%
LR ELBOW	9241	5125	-44.5%
TANGENT	10189	5047	-50.5%

Table 6.3.3.1-3: Ten Highest Stress Increases from AP1000 CSDRS to HRHF GMRS for APP-PXS-PLA-030

Node #	Equation 9F Stress Ratio		
	AP1000 CSDRS	HRHF	% Change
1420	0.142	0.142	0.00%
1421	0.140	0.140	0.00%
1425	0.139	0.139	0.00%
1160	0.034	0.034	0.00%
1345	0.146	0.145	-0.68%
1055	0.037	0.036	-2.70%
1155	0.036	0.035	-2.78%
1060	0.035	0.034	-2.86%
1110	0.318	0.302	-5.03%

1111	0.335	0.318	-5.07%

Table 6.3.3.1-~~3~~4: Valve End Stresses for APP-PXS-PLA-030

Label	Equation 9F Stress Ratio		
	AP1000 CSDRS	HRHF	% Change
V004A	0.035	0.034	-2.86%
V004C	0.034	0.034	0.00%
V014A	0.325	0.298	-8.31%
V014A	0.350	0.317	-9.43%
V014C	0.321	0.304	-5.30%
V014C	0.293	0.266	-9.22%
V101	0.397	0.331	-16.62%
V101	0.455	0.382	-16.04%

~~Label~~	~~Moment Stress (psi)~~		
	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~
~~V101~~	~~7241~~	~~3700~~	~~-48.9%~~
	~~9286~~	~~4470~~	~~-51.9%~~
~~V004A~~	~~156~~	~~80~~	~~-48.7%~~
~~V004C~~	~~8923~~	~~4397~~	~~-50.7%~~
	~~8924~~	~~4397~~	~~-50.7%~~
~~V014A~~	~~8431~~	~~4167~~	~~-50.6%~~
	~~8432~~	~~4168~~	~~-50.6%~~
~~V014C~~	~~10031~~	~~5016~~	~~-50.0%~~

Table 6.3.3.1-45: Tee Connection Stresses for APP-PXS-PLA-030

Type	Equation 9F Stress Ratio		
	AP1000 CSDRS	HRHF	% Change
WELDING TEE	0.621	0.539	-13.20%
WELDING TEE	0.442	0.385	-12.90%
WELDING TEE	0.470	0.388	-17.45%

Table 6.3.3.1-~~5~~6: Seismic Support Loads for APP-PXS-PLA-030

Type	Force - X (lb)			Force - Y (lb)			Force - Z (lb)			Resultant Force (lb)		
	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change
RIG SUPORT							-56952	-55629	-2.32%	-56952	-55629	-2.32%
RIG SUPORT	-35327	-35216	-0.31%				-20397	-20332	-0.32%	-40792	-40664	-0.31%
RIG SUPORT	-30307	-29233	-3.54%	-17497	-16877	-3.54%	-20205	-19488	-3.55%	-40410	-38977	-3.55%
SNUBBER				-46119	-38248	-17.07%				-46119	-38248	-17.07%
RIG SUPORT	-47176	-44831	-4.97%				-27238	-25884	-4.97%	-54474	-51766	-4.97%
RIG SUPORT	-44054	-40976	-6.99%	-16020	-14900	-6.99%	-27060	-25169	-6.99%	-54127	-50344	-6.99%
RIG SUPORT				-47750	-41295	-13.52%	-47750	-41295	-13.52%	-67529	-58401	-13.52%
RIG SUPORT				-68771	-56763	-17.46%				-68771	-56763	-17.46%
RIG SUPORT				-38839	-31784	-18.16%				-38839	-31784	-18.16%
RIG SUPORT							-31622	-25324	-19.92%	-31622	-25324	-19.92%
RIG SUPORT	-41722	-33079	-20.72%							-41722	-33079	-20.72%
RIG SUPORT	-5911	-5240	-11.35%				-15737	-13951	-11.35%	-16810	-14902	-11.35%
RIG SUPORT							-63958	-53087	-17.00%	-63958	-53087	-17.00%
RIG SUPORT				-63216	-48648	-23.04%				-63216	-48648	-23.04%

~~Type~~	~~Force - X (lb)~~			~~Force - Y (lb)~~			~~Force - Z (lb)~~			~~Resultant Force (lb)~~		
	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~
~~RIG SUPORT~~							~~32156~~	~~16958~~	~~-47.3%~~	~~32156~~	~~16958~~	~~-47.3%~~
~~RIG SUPORT~~	~~23611~~	~~12201~~	~~-48.3%~~				~~13632~~	~~7045~~	~~-48.3%~~	~~27263~~	~~14089~~	~~-48.3%~~
~~RIG SUPORT~~	~~20945~~	~~9937~~	~~-52.6%~~	~~12092~~	~~5737~~	~~-52.6%~~	~~13963~~	~~6624~~	~~-52.6%~~	~~27927~~	~~13249~~	~~-52.6%~~
~~SNUBBER~~				~~43030~~	~~17287~~	~~-59.8%~~				~~43030~~	~~17287~~	~~-59.8%~~
~~RIG SUPORT~~	~~29237~~	~~13477~~	~~-53.9%~~				~~16880~~	~~7781~~	~~-53.9%~~	~~33760~~	~~15562~~	~~-53.9%~~
~~RIG SUPORT~~	~~27686~~	~~13223~~	~~-52.2%~~	~~10068~~	~~4808~~	~~-52.2%~~	~~17006~~	~~8122~~	~~-52.2%~~	~~34016~~	~~16246~~	~~-52.2%~~
~~RIG SUPORT~~				~~35112~~	~~15491~~	~~-55.9%~~	~~35112~~	~~15491~~	~~-55.9%~~	~~49656~~	~~21908~~	~~-55.9%~~
~~RIG SUPORT~~				~~47577~~	~~24615~~	~~-48.3%~~				~~47577~~	~~24615~~	~~-48.3%~~

~~RIG SUPORT~~				~~34696~~	~~13305~~	~~-61.7%~~				~~34696~~	~~13305~~	~~-61.7%~~
~~RIG SUPORT~~							~~17334~~	~~10396~~	~~-40.0%~~	~~17334~~	~~10396~~	~~-40.0%~~
~~RIG SUPORT~~	~~36111~~	~~17576~~	~~-51.3%~~							~~36111~~	~~17576~~	~~-51.3%~~
~~RIG SUPORT~~	~~4004~~	~~2708~~	~~-32.4%~~				~~10660~~	~~7210~~	~~-32.4%~~	~~11387~~	~~7702~~	~~-32.4%~~
~~RIG SUPORT~~							~~36895~~	~~20603~~	~~-44.2%~~	~~36895~~	~~20603~~	~~-44.2%~~
~~RIG SUPORT~~				~~52839~~	~~30375~~	~~-42.5%~~				~~52839~~	~~30375~~	~~-42.5%~~

Table 6.3.3.1-67: Seismic Anchor Loads for APP-PXS-PLA-030

Point	Force - X (lb)			Force - Y (lb)			Force - Z (lb)			Resultant Force (lb)		
Label	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change
West Hot Leg	-29681	-25436	-14.30%	-14853	-10785	-27.39%	-18466	-16241	-12.05%	37981	32048	-15.62%
PRHR HX	-21320	-14836	-30.41%	-22864	-12991	-43.18%	-26831	-20206	-24.69%	41197	28234	-31.47%
Point	Moment - X (ft-lb)			Moment - Y (ft-lb)			Moment - Z (ft-lb)			Resultant Moment (ft-lb)		
Label	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change
West Hot Leg	-61630	-50094	-18.72%	-97519	-81270	-16.66%	-103248	-69578	-32.61%	154817	118133	-23.70%
PRHR HX	-62587	-36544	-41.61%	-133172	-67113	-49.60%	-42188	-23996	-43.12%	153074	80097	-47.67%

~~Point~~	~~Force - X (lb)~~			~~Force - Y (lb)~~			~~Force - Z (lb)~~			~~Resultant Force (lb)~~		
~~Label~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~
~~West Hot Leg~~	~~22572~~	~~10991~~	~~-51.3%~~	~~10960~~	~~6758~~	~~-38.3%~~	~~10136~~	~~4903~~	~~-51.6%~~	~~27062~~	~~13803~~	~~-49.0%~~
~~PRHR HX~~	~~17633~~	~~8606~~	~~-51.2%~~	~~18775~~	~~8346~~	~~-55.5%~~	~~21211~~	~~10675~~	~~-49.7%~~	~~33366~~	~~16053~~	~~-51.9%~~
~~Point~~	~~Moment - X (ft-lb)~~			~~Moment - Y (ft-lb)~~			~~Moment - Z (ft-lb)~~			~~Resultant Moment (ft-lb)~~		
~~Label~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~
~~West Hot Leg~~	~~50361~~	~~28017~~	~~-44.4%~~	~~80496~~	~~40443~~	~~-49.8%~~	~~69778~~	~~48178~~	~~-31.0%~~	~~27062~~	~~13803~~	~~-49.0%~~
~~PRHR HX~~	~~48429~~	~~22601~~	~~-53.3%~~	~~101714~~	~~44823~~	~~-55.9%~~	~~35436~~	~~16873~~	~~-52.4%~~	~~33366~~	~~16053~~	~~-51.9%~~

Table 6.3.3.1-78: Equipment Nozzle Stresses for APP-PXS-PLA-030

Label	Equation 9F Stress Ratio		
	AP1000 CSDRS	HRHF	% Change
West Hot Leg	0.324	0.303	-6.48%
PRHR HX	0.324	0.226	-30.25%

Label	Moment Stress (psi)		
	AP1000 CSDRS	HRHF	% Change
West Hot Leg	3216	1721	-46.5%
PRHR HX	8095	2943	-63.6%

Results Summary for APP-PXS-PLA-030

- Equation 9F stress ratios are all less than 1.0. No point of the HRHF GMRS analysis fails qualification.
- No points show an increase in stress ratio.
- Valve nozzles stress ratios show no increase.
- Tee connection stress ratios show no increase.
- Resultant support loads show no increase.
- Resultant anchor loads show no increase.
- Piping stress ratios at equipment show no increase.

6.3.3.2ASME Code Equation 9 moment stresses for HRHF spectra are lower, at all points, than for the AP1000 CSDRS seismic response spectra; see Tables 6.3.3.1-1, 2, 3, 4 and 7.

6.3.3.3All support loads are lower for HF than AP1000 CSDRS seismic response spectra; see Table 6.3.3.1-5.

6.3.3.4All anchor loads are lower for HF than AP1000 CSDRS seismic response spectra; see Table 6.3.3.1-6.

6.3.3.2 Normal RHR Heat Exchanger Inlet and Outlet between P19 and P20 (APP-RNS-PLA-170)

Comparisons of the AP1000 CSDRS seismic response spectra and HRHF GMRS analyses are listed in Tables 6.3.3.2-1 to 6.3.3.2-78.

HRHF moment stresses at all of the 1015 points were lower than AP1000 CSDRS seismic response spectra.

Table 6.3.3.2-1 shows the ten highest stressed piping points (not including tees, which are compared in Table 6.3.3.2-4) of the AP1000 design seismic response spectraCSDRS analysis. Table 6.3.3.2-2 shows the ten highest stressed piping points (not including tees, which are compared in Table 6.3.3.2-5) of the HRHF GMRS analysis. Table 6.3.3.2-3 shows the ten highest stress increases of the HRHF GMRS analysis from the AP1000 CSDRS analysis.

Table 6.3.3.2-~~3~~4 compares the valve end ~~moment~~ stresses ratios. Table 6.3.3.2-45 compares stresses ratios of tee connections ~~at both the run and branch sides~~. Tables 6.3.3.2-~~5~~6 and 6.3.3.2-~~6~~7 compare support and anchor loads, respectively. Support loads are listed for individual restraint directions. Table 6.3.3.2-~~7~~8 compares the equipment nozzle stresses ratios.

Table 6.3.3.2-1: Ten Highest AP1000 Design Stress Points for APP-RNS-PLA-170

Node #	Equation 9F Stress Ratio		
	AP1000 CSDRS	HRHF	% Change
4645	0.840	0.475	-43.45%
Z057	0.811	0.439	-45.87%
Z058	0.789	0.417	-47.15%
4650	0.724	0.381	-47.38%
4581	0.716	0.499	-30.31%
5140	0.713	0.456	-36.04%
Z056	0.706	0.394	-44.19%
4630	0.680	0.377	-44.56%
4582	0.679	0.47	-30.78%
4645	0.670	0.379	-43.43%

~~Label~~	~~Moment Stress (psi)~~		
	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~
~~TANGENT~~	~~41855~~	~~9492~~	~~-77.3%~~
~~TANGENT~~	~~40948~~	~~9268~~	~~-77.4%~~
~~TANGENT~~	~~35625~~	~~7509~~	~~-78.9%~~
~~TANGENT~~	~~32645~~	~~6513~~	~~-80.0%~~
~~LR ELBOW~~	~~31954~~	~~6440~~	~~-79.8%~~
~~LR ELBOW~~	~~30007~~	~~6022~~	~~-79.9%~~
~~TANGENT~~	~~29051~~	~~6336~~	~~-78.2%~~
~~TANGENT~~	~~25313~~	~~5916~~	~~-76.6%~~
~~TANGENT~~	~~25286~~	~~10220~~	~~-59.6%~~
~~TANGENT~~	~~24788~~	~~5862~~	~~-76.4%~~

Table 6.3.3.2-2: Ten Highest High Frequency Stress Points for APP-RNS-PLA-170

Node #	Equation 9F Stress Ratio		
	AP1000 CSDRS	HRHF	% Change
1525	0.607	0.600	-1.15%
2520	0.581	0.587	**1.03%**
5105	0.667	0.540	-19.04%
2600	0.664	0.517	-22.14%
5370	0.577	0.511	-11.44%
4581	0.716	0.499	-30.31%
3570	0.510	0.495	-2.94%
3560	0.492	0.479	-2.64%
4645	0.840	0.475	-43.45%
4582	0.679	0.470	-30.78%

~~Label~~	~~Moment Stress (psi)~~		
	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~
~~TANGENT~~	~~24368~~	~~11753~~	~~-51.8%~~
~~TANGENT~~	~~23889~~	~~11101~~	~~-53.5%~~
~~TANGENT~~	~~25286~~	~~10220~~	~~-59.6%~~
~~TANGENT~~	~~24621~~	~~10191~~	~~-58.6%~~
~~TANGENT~~	~~19307~~	~~9647~~	~~-50.0%~~
~~TANGENT~~	~~41855~~	~~9492~~	~~-77.3%~~
~~TANGENT~~	~~40948~~	~~9268~~	~~-77.4%~~
~~TANGENT~~	~~17879~~	~~8948~~	~~-50.0%~~
~~TANGENT~~	~~16235~~	~~8233~~	~~-49.3%~~
~~TANGENT~~	~~15477~~	~~7810~~	~~-49.5%~~

Table 6.3.3.2-3: Ten Highest Stress Increases from AP1000 CSDRS to HRHF GMRS for APP-RNS-PLA-170

Node #	Equation 9F Stress Ratio		
	AP1000 CSDRS	HRHF	% Change
2750	0.386	0.454	**17.62%**
2760	0.165	0.194	**17.58%**
2720	0.138	0.162	**17.39%**
2710	0.076	0.087	**14.47%**
2740	0.243	0.277	**13.99%**
Z032	0.052	0.057	**9.62%**
4080	0.052	0.057	**9.62%**
1660	0.084	0.092	**9.52%**
Z033	0.054	0.059	**9.26%**
4090	0.092	0.100	**8.70%**

Table 6.3.3.2-34: Valve End Stresses for APP-RNS-PLA-170

Label	Equation 9F Stress Ratio		
	AP1000 CSDRS	HRHF	% Change
V005A	0.197	0.131	-33.50%
V005A	0.317	0.205	-35.33%
V005B	0.178	0.132	-25.84%
V005B	0.268	0.197	-26.49%
V006A	0.134	0.131	-2.24%
V006A	0.106	0.098	-7.55%
V006B	0.129	0.13	**0.78%**
V006B	0.108	0.113	**4.63%**
V007A	0.147	0.148	**0.68%**
V007A	0.094	0.092	-2.13%
V007B	0.2	0.197	-1.50%
V007B	0.122	0.125	**2.46%**
V008A	0.373	0.263	-29.49%
V008A	0.359	0.25	-30.36%
V008B	0.241	0.239	-0.83%
V008B	0.286	0.285	-0.35%
V011	0.375	0.344	-8.27%
V011	0.159	0.125	-21.38%
V022	0.249	0.195	-21.69%
V022	0.257	0.212	-17.51%
V053	0.226	0.179	-20.80%
V053	0.184	0.116	-36.96%
V055	0.135	0.134	-0.74%
V055	0.277	0.253	-8.66%
V056	0.096	0.09	-6.25%
V056	0.132	0.13	-1.52%
V057A	0.421	0.401	-4.75%
V057A	0.492	0.479	-2.64%
V057B	0.346	0.309	-10.69%
V057B	0.395	0.369	-6.58%

~~Label~~	~~Moment Stress (psi)~~		
	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~
~~V005A~~	~~4363~~	~~1260~~	~~-71.1%~~
	~~7644~~	~~2303~~	~~-69.9%~~
~~V005B~~	~~4509~~	~~1259~~	~~-72.1%~~
	~~7221~~	~~2108~~	~~-70.8%~~
~~V006A~~	~~6624~~	~~2450~~	~~-63.0%~~
	~~5056~~	~~1831~~	~~-63.8%~~
~~V006B~~	~~5851~~	~~2795~~	~~-52.2%~~
	~~6271~~	~~2281~~	~~-63.6%~~
~~V007A~~	~~8247~~	~~2627~~	~~-68.1%~~
	~~5941~~	~~2088~~	~~-64.9%~~
~~V007B~~	~~5700~~	~~2359~~	~~-58.6%~~
	~~5829~~	~~2361~~	~~-59.5%~~

V008A	9855	4213	-57.3%
	12515	4181	-66.6%
V008B	8241	3910	-52.6%
	10079	4134	-59.0%
V011	6402	2255	-64.8%
	9740	2945	-69.8%
V022	8116	2058	-74.6%
	7214	1978	-72.6%
V053	10129	3519	-65.3%
	10380	3466	-66.6%
V055	3277	2475	-24.5%
	9466	6411	-32.3%
V056	6605	1899	-71.2%
	5546	1710	-69.2%
V057A	11864	6414	-45.9%
	15477	7810	-49.5%
V057B	14335	6838	-52.3%
	13334	5933	-55.5%

Table 6.3.3.2-45: Tee Connection Stresses for APP-RNS-PLA-170

Type	Equation 9F Stress Ratio		
	AP1000 CSDRS	HRHF	% Change
WELDING TEE	0.511	0.439	-14.09%
WELDING TEE	0.466	0.464	-0.43%
WELDING TEE	0.776	0.730	-5.93%
WELDING TEE	0.597	0.558	-6.53%
WELDING TEE	0.702	0.719	**2.42%**
WELDING TEE	0.800	0.651	-18.63%
WELDING TEE	0.495	0.320	-35.35%
WELDING TEE	0.594	0.605	**1.85%**
BRANCH CONN	0.827	0.663	-19.83%
BRANCH CONN	0.579	0.408	-29.53%
WELDING TEE	0.797	0.578	-27.48%
WELDING TEE	0.801	0.574	-28.34%
WELDING TEE	0.814	0.645	-20.76%

Table 6.3.3.2-56: Seismic Support Loads for APP-RNS-PLA-170

Label	Force – X (lb)			Force – Y (lb)			Force - Z (lb)			Resultant Force (lb)		
	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change
RIG SUPORT							5001	4817	-3.68%	5001	4817	-3.68%
RIG SUPORT	-6639	-4819	-27.41%							-6639	-4819	-27.41%
RIG SUPORT							7447	5351	-28.15%	7447	5351	-28.15%
RIG SUPORT				-7336	-6684	-8.89%				-7336	-6684	-8.89%
RIG SUPORT							1879	1703	-9.37%	1879	1703	-9.37%
RIG SUPORT				1767	1561	-11.66%				1767	1561	-11.66%
RIG SUPORT							2689	2057	-23.50%	2689	2057	-23.50%
RIG SUPORT	4144	3731	-9.97%							4144	3731	-9.97%
RIG SUPORT				-4114	-4083	-0.75%				-4114	-4083	-0.75%
RIG SUPORT							5369	4861	-9.46%	5369	4861	-9.46%
RIG SUPORT				2105	2150	**2.14%**				2105	2150	**2.14%**
RIG SUPORT	-7046	-6835	-2.99%							-7046	-6835	-2.99%
RIG SUPORT				1423	1439	**1.12%**				1423	1439	**1.12%**
RIG SUPORT							3207	2858	-10.88%	3207	2858	-10.88%
RIG SUPORT				-2158	-2124	-1.58%				-2158	-2124	-1.58%
RIG SUPORT							4209	3402	-19.17%	4209	3402	-19.17%
RIG SUPORT	-1182	-1121	-5.16%							-1182	-1121	-5.16%
RIG SUPORT				917	915	-0.22%				917	915	-0.22%
RIG SUPORT				2006	2081	**3.74%**				2006	2081	**3.74%**
RIG SUPORT	-6194	-5810	-6.20%							-6194	-5810	-6.20%
RIG SUPORT				1098	1222	**11.29%**				1098	1222	**11.29%**
RIG SUPORT							3762	3858	**2.55%**	3762	3858	**2.55%**
RIG SUPORT				-3026	-3047	**0.69%**				-3026	-3047	**0.69%**
RIG SUPORT							3648	3477	-4.69%	3648	3477	-4.69%
RIG SUPORT							2934	2572	-12.34%	2934	2572	-12.34%
RIG SUPORT	2658	2770	**4.21%**							2658	2770	**4.21%**
RIG SUPORT				3485	3008	-13.69%				3485	3008	-13.69%
RIG SUPORT				-2148	-1963	-8.61%				-2148	-1963	-8.61%
RIG SUPORT	-1156	-1167	**0.95%**							-1156	-1167	**0.95%**
RIG SUPORT				1059	1146	**8.22%**				1059	1146	**8.22%**
RIG SUPORT	-4308	-3560	-17.36%							-4308	-3560	-17.36%
RIG SUPORT							4992	4756	-4.73%	4992	4756	-4.73%
RIG SUPORT	-190	-215	**13.16%**							-190	-215	**13.16%**
RIG SUPORT				-224	-223	-0.45%				-224	-223	-0.45%
RIG SUPORT							2485	1964	-20.97%	2485	1964	-20.97%
RIG SUPORT				2465	1218	-50.59%				2465	1218	-50.59%

RIG SUPORT							1808	1431	-20.85%	1808	1431	-20.85%
RIG SUPORT							663	620	-6.49%	663	620	-6.49%
RIG SUPORT	1369	1399	**2.19%**							1369	1400	**2.26%**
RIG SUPORT				1506	1216	-19.26%				1506	1217	-19.19%
RIG SUPORT	-588	-534	-9.18%							-588	-532	-9.52%
RIG SUPORT				-1728	-1748	**1.16%**				-1728	-1747	**1.10%**
RIG SUPORT							4726	4867	**2.98%**	4726	4866	**2.96%**
RIG SUPORT				-863	-652	-24.45%				-863	-642	-25.61%
RIG SUPORT	795	820	**3.14%**							795	821	**3.27%**
RIG SUPORT							-2326	-2484	**6.79%**	-2326	-2481	**6.66%**
RIG SUPORT							2385	2602	**9.10%**	2385	2604	**9.18%**
RIG SUPORT				1133	1265	**11.65%**				1133	1265	**11.65%**
RIG SUPORT				1042	937	-10.08%				1042	964	-7.49%
RIG SUPORT	1051	1094	**4.09%**							1051	1100	**4.66%**
RIG SUPORT				-1343	-1355	**0.89%**				-1343	-1357	**1.04%**
RIG SUPORT							5918	6169	**4.24%**	5918	6177	**4.38%**
RIG SUPORT	-587	-531	-9.54%	1017	919	-9.64%				1174	1073	-8.60%
RIG SUPORT	-1043	-974	-6.62%	-602	-562	-6.64%				-1204	-1126	-6.48%
RIG SUPORT							-3225	-3442	**6.73%**	-3225	-3462	**7.35%**
RIG SUPORT							2068	1851	-10.49%	-2068	-1867	-9.72%
RIG SUPORT							1496	1363	-8.89%	-1496	-1366	-8.69%
RIG SUPORT	1410	1346	-4.54%							1410	1356	-3.83%
RIG SUPORT				-1598	-1614	**1.00%**				-1598	-1614	**1.00%**
RIG SUPORT				728	704	-3.30%				728	704	-3.30%
RIG SUPORT							2109	2044	-3.08%	2109	2081	-1.33%
RIG SUPORT				-608	-976	**60.53%**				-608	-985	**62.01%**
RIG SUPORT							1984	1723	-13.16%	1984	1776	-10.48%
RIG SUPORT	-4043	-3193	-21.02%							-4043	-3325	-17.76%
RIG SUPORT				2143	1199	-44.05%				2143	1381	-35.56%
RIG SUPORT							624	538	-13.78%	624	567	-9.13%

~~Label~~	~~Force - X (lb)~~			~~Force - Y (lb)~~			~~Force - Z (lb)~~			~~Resultant Force (lb)~~		
	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~
~~RESTRAINT~~							~~2446~~	~~1283~~	~~-47.5%~~	~~2446~~	~~1283~~	~~-47.5%~~
~~RESTRAINT~~	~~6911~~	~~2664~~	~~-61.5%~~							~~6911~~	~~2664~~	~~-61.5%~~
~~RESTRAINT~~							~~1905~~	~~1254~~	~~-34.2%~~	~~1905~~	~~1254~~	~~-34.2%~~
~~RESTRAINT~~				~~6732~~	~~3171~~	~~-52.9%~~				~~6732~~	~~3171~~	~~-52.9%~~
~~RESTRAINT~~							~~1529~~	~~723~~	~~-52.7%~~	~~1529~~	~~723~~	~~-52.7%~~
~~RESTRAINT~~				~~3307~~	~~1371~~	~~-58.5%~~				~~3307~~	~~1371~~	~~-58.5%~~
~~RESTRAINT~~							~~1559~~	~~720~~	~~-53.8%~~	~~1559~~	~~720~~	~~-53.8%~~

RESTRAINT	6936	2467	-64.4%							6936	2467	-64.4%
RESTRAINT							2086	1021	-51.1%	2086	1021	-51.1%
RESTRAINT				1849	926	-49.9%				1849	926	-49.9%
RESTRAINT							3147	1218	-61.3%	3147	1218	-61.3%
RESTRAINT				2685	1189	-55.7%				2685	1189	-55.7%
RESTRAINT							4506	1303	-71.1%	4506	1303	-71.1%
RESTRAINT	3772	978	-74.1%							3772	978	-74.1%
RESTRAINT				903	504	-44.2%				903	504	-44.2%
RESTRAINT				2201	1234	-43.9%				2201	1234	-43.9%
RESTRAINT				1458	783	-46.3%				1458	783	-46.3%
RESTRAINT							4351	1465	-66.3%	4351	1465	-66.3%
RESTRAINT				2764	1361	-50.8%				2764	1361	-50.8%
RESTRAINT							2269	1182	-47.9%	2269	1182	-47.9%
RESTRAINT							2946	1111	-62.3%	2946	1111	-62.3%
RESTRAINT	5774	2412	-58.2%							5774	2412	-58.2%
RESTRAINT				2507	1189	-52.6%				2507	1189	-52.6%
RESTRAINT	1974	820	-58.5%							1974	820	-58.5%
RESTRAINT				2231	894	-59.9%				2231	894	-59.9%
RESTRAINT	5130	1936	-62.3%							5130	1936	-62.3%
RESTRAINT							2555	1254	-50.9%	2555	1254	-50.9%
RESTRAINT	182	154	-15.4%							182	154	-15.4%
RESTRAINT				224	81	-63.8%				224	81	-63.8%
RESTRAINT							2910	1138	-60.9%	2910	1138	-60.9%
RESTRAINT				1407	599	-57.4%				1407	599	-57.4%
RESTRAINT							1054	501	-52.5%	1054	501	-52.5%
RESTRAINT				812	348	-57.1%				812	348	-57.1%
RESTRAINT							640	303	-52.7%	640	303	-52.7%
RESTRAINT	2229	839	-62.4%							2229	839	-62.4%
RESTRAINT				2144	849	-60.4%				2144	849	-60.4%
RESTRAINT				1215	713	-41.3%				1215	713	-41.3%
RESTRAINT							2459	1329	-46.0%	2459	1329	-46.0%
RESTRAINT	1725	767	-55.5%							1725	767	-55.5%
RESTRAINT				1803	788	-56.3%				1803	788	-56.3%
RESTRAINT							1786	1208	-32.4%	1786	1208	-32.4%
RESTRAINT				1546	856	-44.6%				1546	856	-44.6%
RESTRAINT							924	555	-39.9%	924	555	-39.9%
RESTRAINT	1653	705	-57.4%							1653	705	-57.4%
RESTRAINT							2621	1332	-49.2%	2621	1332	-49.2%
RESTRAINT				1357	513	-62.2%				1357	513	-62.2%
RESTRAINT							1859	963	-48.2%	1859	963	-48.2%
RESTRAINT				754	444	-41.1%				754	444	-41.1%
RESTRAINT							1267	509	-59.8%	1267	509	-59.8%
RESTRAINT	1998	791	-60.4%							1998	791	-60.4%
RESTRAINT							517	271	-47.6%	517	271	-47.6%
RESTRAINT				897	548	-38.9%				897	548	-38.9%
RESTRAINT	5332	2978	-44.1%							5332	2978	-44.1%
RESTRAINT				4707	1769	-62.4%				4707	1769	-62.4%

~~RESTRAINT~~				~~4266~~	~~1723~~	~~-59.6%~~				~~4266~~	~~1723~~	~~-59.6%~~
~~RESTRAINT~~	~~14432~~	~~4830~~	~~-66.5%~~							~~14432~~	~~4830~~	~~-66.5%~~
~~RESTRAINT~~				~~7488~~	~~2436~~	~~-67.5%~~				~~7488~~	~~2436~~	~~-67.5%~~
~~RESTRAINT~~							~~2730~~	~~1536~~	~~-43.7%~~	~~2730~~	~~1536~~	~~-43.7%~~
~~RESTRAINT~~							~~3430~~	~~2771~~	~~-19.2%~~	~~3430~~	~~2771~~	~~-19.2%~~
~~RESTRAINT~~				~~12461~~	~~5582~~	~~-55.2%~~				~~12461~~	~~5582~~	~~-55.2%~~
~~RESTRAINT~~							~~3856~~	~~2282~~	~~-40.8%~~	~~3856~~	~~2282~~	~~-40.8%~~
~~RESTRAINT~~							~~3980~~	~~1507~~	~~-62.1%~~	~~3980~~	~~1507~~	~~-62.1%~~
~~RESTRAINT~~	~~3570~~	~~1243~~	~~-65.2%~~							~~3570~~	~~1243~~	~~-65.2%~~
~~RESTRAINT~~							~~1976~~	~~1096~~	~~-44.5%~~	~~1976~~	~~1096~~	~~-44.5%~~
~~RESTRAINT~~	~~1567~~	~~922~~	~~-41.2%~~							~~1567~~	~~922~~	~~-41.2%~~
~~RESTRAINT~~							~~1751~~	~~741~~	~~-57.7%~~	~~1751~~	~~741~~	~~-57.7%~~

Table 6.3.3.2-67: Seismic Anchor Loads for APP-RNS-PLA-170

Label	Force - X (lb)			Force - Y (lb)			Force - Z (lb)			Resultant Force (lb)		
	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change
Penetration P20	1813	1618	-10.76%	-1360	-1118	-17.79%	3607	3230	-10.45%	4259	3781	-11.22%
ANCHOR	1075	669	-37.77%	896	748	-16.52%	3258	2506	-23.08%	3546	2699	-23.89%
ANCHOR	1470	649	-55.85%	-1548	-709	-54.20%	651	555	-14.75%	2232	1111	-50.22%
ANCHOR	636	362	-43.08%	825	438	-46.91%	1079	805	-25.39%	1500	986	-34.27%
Penetration P19	11097	10056	-9.38%	-7929	-5286	-33.33%	5081	5403	**6.34%**	14554	12580	-13.56%
ANCHOR	-4020	-3548	-11.74%	-1532	-1601	**4.50%**	3722	3288	-11.66%	5688	5095	-10.43%
ANCHOR	-3208	-3367	**4.96%**	2431	2250	-7.45%	4053	3933	-2.96%	5713	5645	-1.19%
ANCHOR	3780	2938	-22.28%	4787	4311	-9.94%	6332	4819	-23.89%	8792	7102	-19.22%
Label	Moment - X (ft-lb)			Moment - Y (ft-lb)			Moment - Z (ft-lb)			Resultant Moment (ft-lb)		
	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change
Penetration P20	-3541	-3102	-12.40%	13752	12441	-9.53%	5702	5687	-0.26%	15303	14026	-8.34%
ANCHOR	5593	3902	-30.23%	-8566	-4437	-48.20%	1747	987	-43.50%	10379	5990	-42.29%
ANCHOR	-298	-255	-14.43%	280	237	-15.36%	-301	-131	-56.48%	507	372	-26.63%
ANCHOR	-450	-458	**1.78%**	621	585	-5.80%	-217	-173	-20.28%	797	763	-4.27%
Penetration P19	-21916	-23723	**8.25%**	11168	12148	**8.78%**	69914	54200	-22.48%	74115	60399	-18.51%
ANCHOR	-4880	-4185	-14.24%	-18235	-16218	-11.06%	-8176	-8115	-0.75%	20571	18612	-9.52%
ANCHOR	-9923	-9625	-3.00%	-6067	-6336	**4.43%**	2865	3211	**12.08%**	11979	11962	-0.14%
ANCHOR	-13095	-11856	-9.46%	-11543	-10006	-13.32%	12149	11017	-9.32%	21268	19028	-10.53%

Label	Force - X (lb)			Force - Y (lb)			Force - Z (lb)			Resultant Force (lb)		
	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change
Penetration P20	2453	1187	-51.6%	1250	824	-34.1%	1728	958	-44.6%	3251	1733	-46.7%
HX ME/01B	152894	39709	-74.0%	165893	40145	-75.8%	50248	32852	-34.6%	231132	65327	-71.7%
HX ME/01A	147594	39195	-73.4%	165230	42220	-74.4%	37392	24269	-35.1%	224685	62512	-72.2%
ANCHOR	1921	614	-68.0%	940	370	-60.6%	889	401	-54.9%	2316	821	-64.6%
ANCHOR	1466	319	-78.2%	1533	340	-77.8%	353	131	-62.9%	2150	484	-77.5%
ANCHOR	626	208	-66.8%	823	194	-76.4%	286	142	-50.3%	1073	317	-70.5%
Pump MP/01A	3457	1661	-52.0%	3837	1286	-66.5%	11950	3204	-73.2%	13019	3831	-70.6%
Pump MP/01B	2625	1291	-50.8%	2588	1166	-54.9%	10875	2753	-74.7%	11483	3257	-71.6%
Penetration P19	9926	3961	-60.1%	7589	1992	-73.8%	2003	1232	-38.5%	12654	4601	-63.6%
ANCHOR	1009	682	-32.4%	1162	697	-40.0%	1055	551	-47.8%	1866	1120	-40.0%
ANCHOR	1703	1419	-16.7%	1879	1181	-37.1%	1709	1276	-25.3%	3058	2244	-26.6%
ANCHOR	1520	1053	-30.7%	4766	3201	-32.8%	1631	1142	-30.0%	5262	3558	-32.4%

Label	Moment - X (ft-lb)			Moment - Y (ft-lb)			Moment - Z (ft-lb)			Resultant Moment (ft-lb)		
	+	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change	AP1000 CSDRS	HRHF	% Change
Penetration P20	2043	1449	-29.1%	8321	4240	-49.0%	7445	4362	-41.4%	3251	1733	-46.7%
ANCHOR	3868170	862432	-77.7%	3532301	816810	-76.9%	23480	5858	-75.1%	231132	65327	-71.7%
ANCHOR	3819900	849458	-77.8%	3415758	789030	-76.9%	11548	4956	-57.1%	224685	62512	-72.2%
ANCHOR	6748	2239	-66.8%	16885	4893	-71.0%	2548	817	-67.9%	2316	821	-64.6%
ANCHOR	226	112	-50.4%	187	100	-46.5%	300	64	-78.7%	2150	484	-77.5%
ANCHOR	417	160	-61.6%	294	237	-19.4%	216	66	-69.4%	1073	317	-70.5%
Pump MP/01A	34132	9258	-72.9%	14798	6145	-58.5%	17542	6761	-61.5%	13019	3831	-70.6%
Pump MP/01B	30936	8428	-72.8%	12449	5582	-55.2%	10601	5155	-51.4%	11483	3257	-71.6%
Penetration P19	9310	5851	-37.2%	5755	3319	-42.3%	64761	20716	-68.0%	12654	4601	-63.6%
ANCHOR	3989	2105	-47.2%	4603	2805	-39.1%	4997	2480	-50.4%	1866	1120	-40.0%
ANCHOR	8507	5746	-32.5%	3275	2660	-18.8%	2538	1943	-23.4%	3058	2244	-26.6%
ANCHOR	13094	8804	-32.8%	3777	2748	-27.2%	12186	8179	-32.9%	5262	3558	-32.4%

Table 6.3.3.2-78: Equipment Nozzle Stresses for APP-RNS-PLA-170

Label	Equation 9F Stress Ratio		
	AP1000 CSDRS	HRHF	% Change
HX ME01A Inlet	0.174	0.163	-6.32%
HX ME01A Outlet	0.119	0.119	0.00%
HX ME01B Inlet	0.167	0.174	**4.19%**
HX ME01B Outlet	0.165	0.194	**17.58%**
Pump MP01A Inlet	0.257	0.169	-34.24%
Pump MP01A Outlet	0.042	0.043	**2.38%**
Pump MP01B Inlet	0.248	0.174	-29.84%
Pump MP01B Outlet	0.061	0.06	-1.64%

~~Label~~	~~Moment Stress (psi)~~		
	~~AP1000 CSDRS~~	~~HRHF~~	~~% Change~~
~~Pump MP/01A~~	~~16912~~	~~4707~~	~~-72.2%~~
	~~7872~~	~~2255~~	~~-71.4%~~
~~Pump MP/01B~~	~~9989~~	~~4167~~	~~-58.3%~~
	~~7745~~	~~2132~~	~~-72.5%~~
~~HX ME/01A~~	~~4773~~	~~1891~~	~~-60.4%~~
	~~20989~~	~~4701~~	~~-77.6%~~
~~HX ME/01B~~	~~7578~~	~~3797~~	~~-49.9%~~
	~~7694~~	~~3199~~	~~-58.4%~~

Results Summary for APP-RNS-PLA-170

- Equation 9F stress ratios are all less than 1.0. No point of the HRHF GMRS analysis fails qualification.
- The ten highest stressed points for both the AP1000 CSDRS and HRHF GMRS analyses show decreases in stress ratio at all but one point, which is a 1% increase.
- Less than 15% of all points show an increase in stress ratio. These increases occur at points with low stress ratios (< 0.5). The greatest increase is approximately 18%.
- Valve nozzles stress ratio increases are within 5%.
- Tee connection stress ratio increases are within 2%.
- The greatest resultant support load increases occur at supports with low loads (< 2000 lbs). All other resultant support loads show increases less than 10%.
- Resultant anchor loads show no increase.

- Piping stress ratios at equipment show small to moderate increases, but at stress ratios less than 0.2.

~~1.0ASME Code Equation 9 moment stresses for high frequency spectra are lower, at all points, than for the AP1000 design seismic response spectra; see Tables 6.3.3.2-1, 2, 3, 4, and 7.~~

~~1.0All support loads are lower for high frequency spectra than AP1000 design seismic response spectra; see Table 6.3.3.2-5.~~

~~2.0All anchor loads are lower for high frequency spectra than AP1000 design seismic response spectra; see Table 6.3.3.2-6.~~

6.3.4 Summary and Conclusions

PIPESTRESS seismic analyses of the two packages were performed with both AP1000 CSDRS and HRHF GMRS input. The AP1000 CSDRS analysis was performed with 15% peak broadened and enveloped response spectra. The HRHF GMRS analysis was performed with 15% peak broadened and enveloped response spectra with incoherence.

The majority of all points showed a decrease or no change in stress ratio. For the points that did show stress ratio increases, the stress ratios were already low and remained low (< 0.5). The largest increase was approximately 18%, but this still resulted in a low stress ratio of 0.454.

The few resultant support and anchor loads increases were at points with low loads (< 2000 lbs). At other points with higher loads, increases were within 10%.

These small increases could be reduced or eliminated with more complex analysis techniques. These techniques would further show that HRHF has minimal impact on piping stresses. These techniques include:

- Use of multiple input response spectra. Multiple input response spectra reduces the spectra exciting the lower points dues to attachments at higher elevations.
- Use of more selective input response spectra. The spectra shown here, envelope entire floors: a practice used for the AP1000 design basis analysis. A more localized selection of nodes would lower the input HRHF GMRS to a more appropriate level.
- Use of a time history analysis. A time history analysis would further reduce results by eliminating the conservatism of a response spectrum analysis.
- Use of non-linear analysis. A non-linear analysis would allow for more accurate modeling of gapped supports. The gap of installed supports are not reflected in a PIPESTRESS analysis. By modeling support gaps, the response of higher modes may be eliminated because supports are not engaged due to the low displacements (< 1/16 of an inch) of high frequency inputs.

~~The layouts of ASME Class 1, 2, and 3 packages were reviewed along with local input seismic response spectra for susceptibility to excitation from HRHF seismic input motion. Two piping packages, APP-PXS-PLA-030 and APP-RNS-PLA-170, inside and outside containment respectively, were chosen as the most susceptible to excitation from HRHF seismic input motion.~~

~~PIPESTRESS seismic analyses of the two packages were performed with both AP1000 design seismic response spectra and HRHF seismic input spectra. AP1000 design seismic response spectra analysis was performed with 15% peak broadened and enveloped response spectra. The high frequency analysis was performed with 15% peak broadened, multiple-level HRHF response spectra with incoherence.~~

~~The stress results of the HRHF seismic analysis are bounded by the stress results of the AP100 CSDRS seismic analysis. Despite the different layout and locations, both analysis packages showed similar response to high frequency seismic input against AP1000 design seismic response spectra seismic input. Because of the way the sample packages were selected for study, the results are deemed as representative for all safety class piping in the plant. As a result, the effect of high frequency input on piping analysis is found to be bounded by the CSDRS analysis.~~