DUKE ENERGY.

CHRISTOPHER M. FALLON
Vice President
Nuclear Development

Duke Energy
EC12L/526 South Church Street
Charlotte, NC 28201-1006

Mailing Address:
EC12L / P.O. Box 1006
Charlotte, NC 28201-1006

o: 704.382.9248
c: 704.519.6173
f: 980.373.2551

christopher.fallon@duke-energy.com

August 07, 2014

10 CFR 52.79

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: Duke Energy Carolinas, LLC
William States Lee III Nuclear Station - Docket Nos. 52-018 and 52-019
AP1000 Combined License Application for the William States Lee III Nuclear Station Units 1 and 2
Response to Request for Additional Information Letter No. 120 (eRAI 7570)
Ltr#: WLG2014.08-01

Reference: Letter from Brian Hughes (NRC) to Robert Kitchen (Duke Energy), Request for Additional Information Letter No. 120, Related to SRP Section 03.07.02 – Seismic System Analysis for the William States Lee III Units 1 and 2 Combined License Application, dated July 11, 2014 (ML14192B073)

This letter provides Duke Energy's response to the Nuclear Regulatory Commission's requests for additional information (RAI) included in the referenced letter. The responses to RAI 03.07.02-3 through 03.07.02-5 are addressed in separate enclosures, which also identify associated changes when appropriate, to be made in a future revision of the Final Safety Analysis Report for the Lee Nuclear Station.

If you have questions or require additional information, please contact Robert H. Kitchen, Nuclear Development Licensing Director, at (704) 382-4046.

I declare under penalty of perjury that the forgoing is true and correct. Executed August 07, 2014.

Sincerely,

Christopher M Fallon

Christopher M. Fallon
Vice President
Nuclear Development

D093
LIRO

Enclosures:

1) Lee Nuclear Station Units 1 and 2 Response to Request for Additional Information (RAI) Letter No. 120, RAI 03.07.02-3 (eRAI 7570)

2) Lee Nuclear Station Units 1 and 2 Response to Request for Additional Information (RAI) Letter No. 120, RAI 03.07.02-4 (eRAI 7570)

3) Lee Nuclear Station Units 1 and 2 Response to Request for Additional Information (RAI) Letter No. 120, RAI 03.07.02-5 (eRAI 7570)

xc (w/o enclosures):

Frederick Brown, Deputy Regional Administrator, Region II

xc (w/ enclosures):

Brian Hughes, Senior Project Manager, DNRL

Enclosure 1

Lee Nuclear Station Units 1 and 2 Response to Request for Additional Information (RAI)

RAI Letter No. 120

RAI 03.07.02-3 (eRAI 7570)

Lee Nuclear Station Response to Request for Additional Information (RAI)

RAI Letter No. 120

NRC Technical Review Branch: Seismic System Analysis

Reference NRC RAI Number(s): 03.07.02-3 (eRAI 7570)

NRC RAI:

WLS FSAR (Rev. 8) Section 3.7.2.15 states that the site-specific seismic evaluation uses the same methodology described in AP1000 DCD Appendix I to evaluate and qualify the AP1000 HRHF spectra. Further, and as stated on page 3.7.8 of Section 3.7.2.15, the methodology in AP1000 DCD Appendix I includes the incorporation of seismic motion incoherency effects on SASSI 3D analyses. Appendix A to Westinghouse report WLG-GW-GLR-815 Rev 0, included as Enclosure 4 to Duke Energy's January 30, 2014 letter (LTR# WLG2014.01-02) RAI response provides graphical comparisons of coherent and incoherent motion.

Staff review of Duke Ltr#WLG2014.01-02 Appendix A to WLG-GW-GLR-815 Rev 0 finds that while the graphical comparisons are helpful in assessing the impacted frequency ranges due to incoherency, they do not indicate the percentage reduction of coherent motion; [1- (incoherent response /coherent response)] x100%.

To assist the staff in its review of the site-specific implementation of seismic motion incoherency, the applicant is requested to quantify the range of reductions to coherent motion for both the AP1000 HRHF and site-specific evaluations.

Duke Energy Response

This enclosure presents plots of the range of reduction factors, derived from three-dimensional (3D) SASSI horizontal (X and Y) and vertical (Z) incoherent and coherent analyses results, which are quantified across the frequency spectrum for the nine (9) Nuclear Island (NI) nodes and locations presented in Appendix A to WLG- GW-GLR -815.

A comparison of the Duke Lee and AP1000 hard rock high frequency (HRHF) reduction factors, i.e., [1-(Incoherent/Coherent)] is presented using the in-structure floor response spectra (FRS) accelerations for the NI nodes presented in both Duke Lee WLG-GW-GLR-815 and AP1000 APP-GW-GLR-115 (TR115).

Note that although node numbers between TR115 and WLG- GW-GLR -815 are different in the figures presented below, the locations are the same and differ only because of model updates. Reduction percentages are simply the reduction factors multiplied by 100.

The following summarizes the data presented below in Figures 03.07.02-3-1 through 03.07.02-3-9:

- The Duke Lee and AP1000 TR115 FRS coherent reductions are comparable for the NI nodes and directional FRS presented. Reduction factors trend similarly in shape and magnitude, and reduction factor differences, both positive and negative occur for both Duke Lee and AP1000;
- Duke Lee and AP1000 TR115 FRS incoherent reduction factor differences are influenced by model refinements to the NI20u finite element model for Duke Lee versus the AP1000 NI20r model to reflect the latest design; and;

- Rock profile differences between the AP1000 generic hard rock profile and the site-specific Duke Lee concrete/rock profiles, i.e., lower shear wave velocity (Vs) in the 50' below basemat.

In conclusion, the Duke Lee and TR115 FRS coherent reductions are similar given the variations in Duke Lee versus AP1000 site conditions and the seismic model updates.

Associated Revision to the Lee Nuclear Station Final Safety Analysis Report:

None

Attachment:

1. Attachment 1 Figures 03.07.02-3-1 through 03.07.02-3-9

Attachment 1

Lee Nuclear Station Units 1 and 2 Response to Request for Additional Information (RAI)

RAI Letter No. 120

RAI 03.07.02-3 (eRAI 7570)

Figures

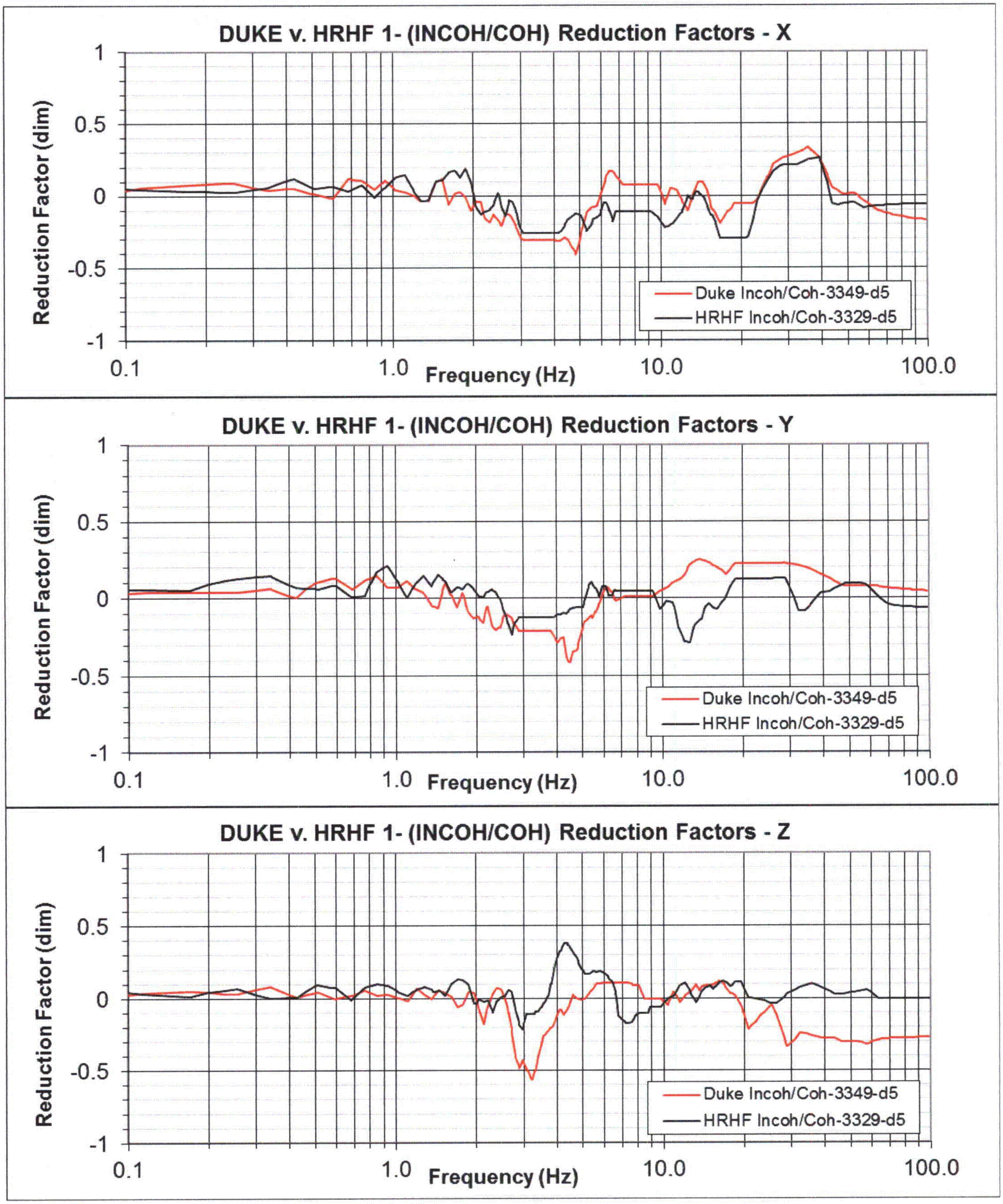


Figure 03.07.02-3-1 - Auxiliary Shield Building (ASB) Spectra at Elevation 327.4'

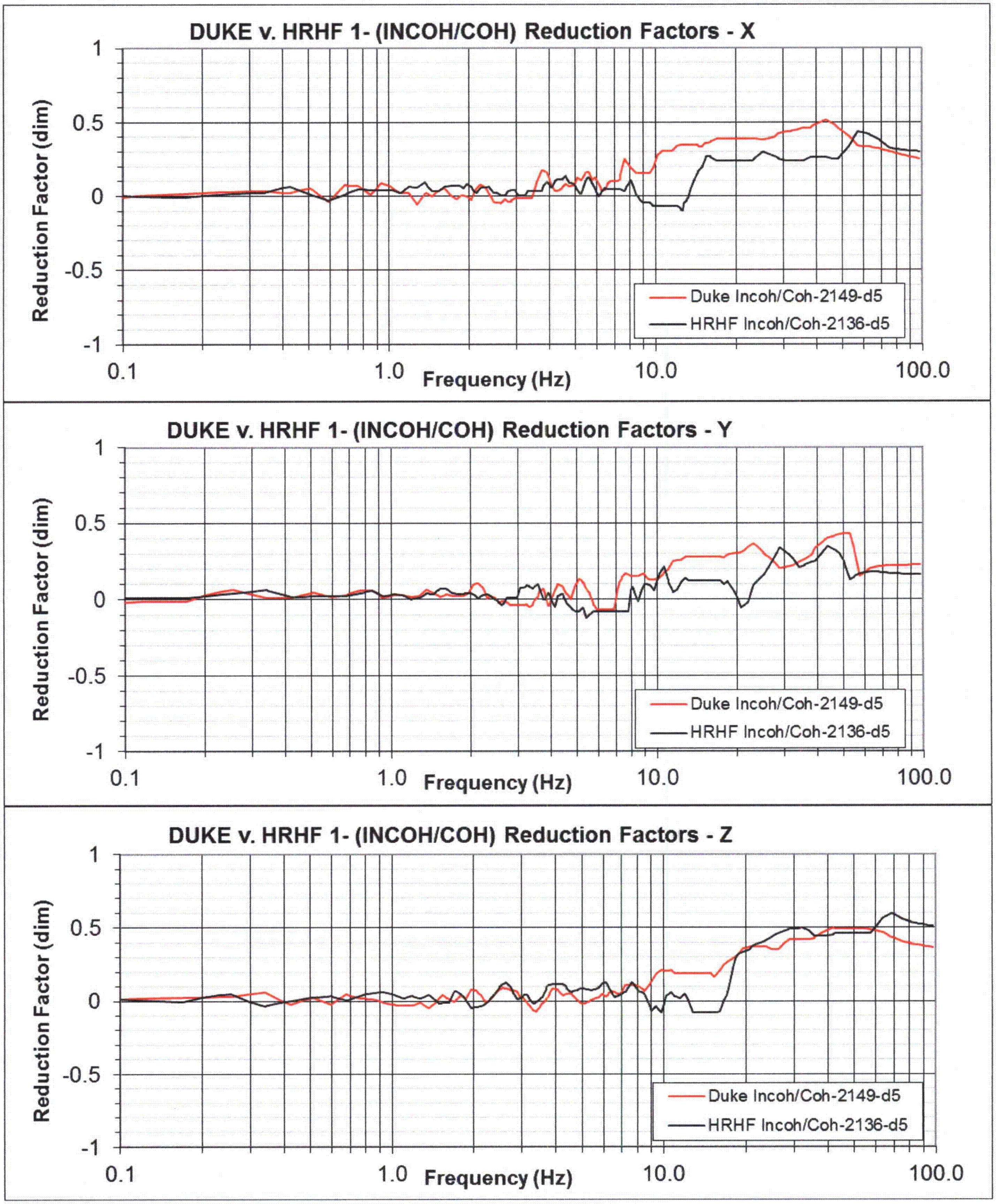
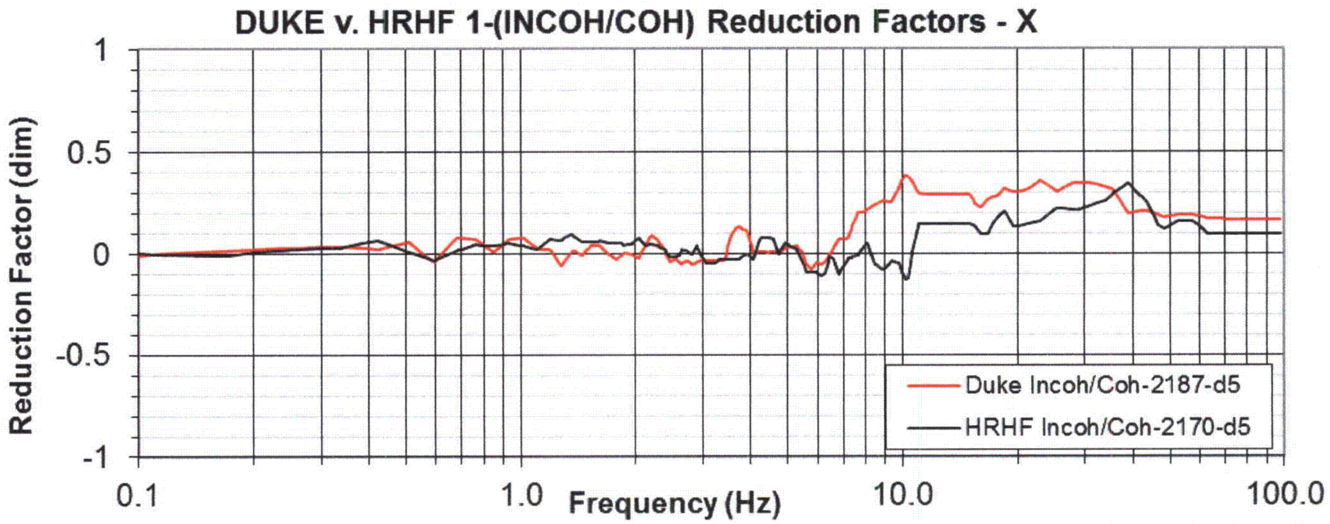
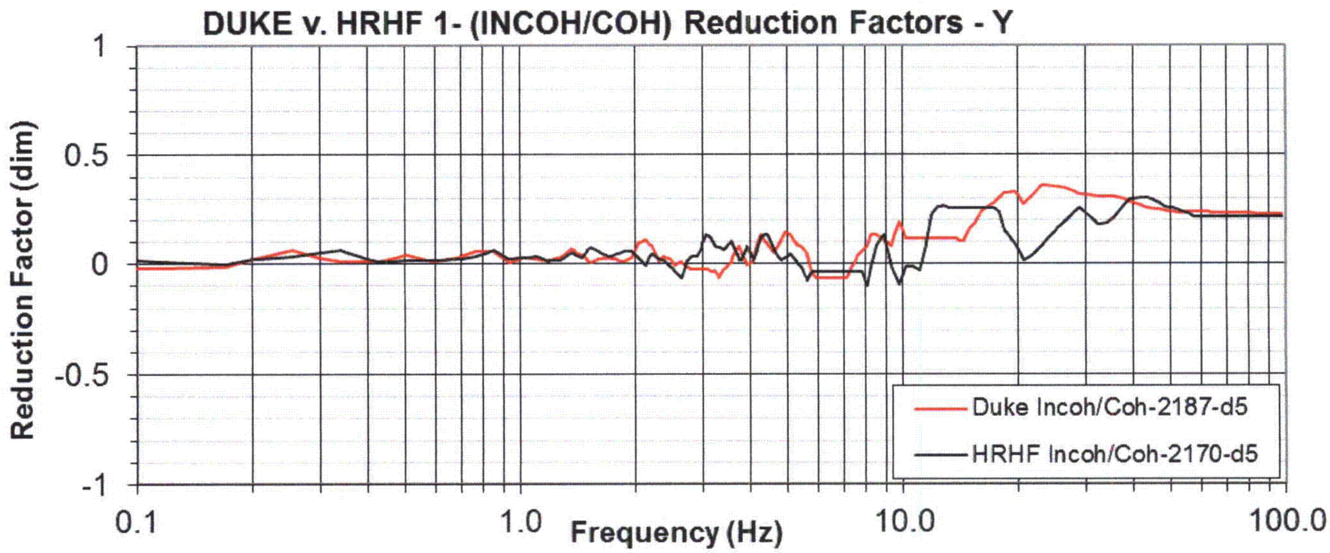


Figure 03.07.02-3-2 - Containment Operating Floor Spectra – East Side (Elevation 134.25')





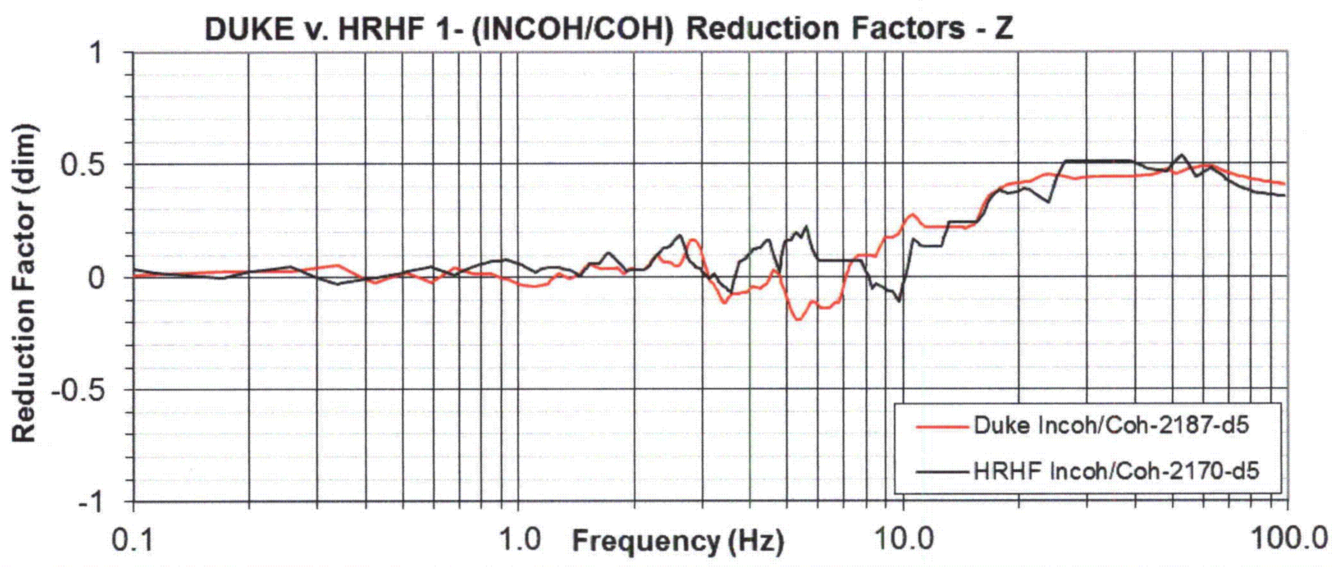


Figure 03.07.02-3-3 - Containment Operating Floor Spectra – West Side (Elevation 134.25')

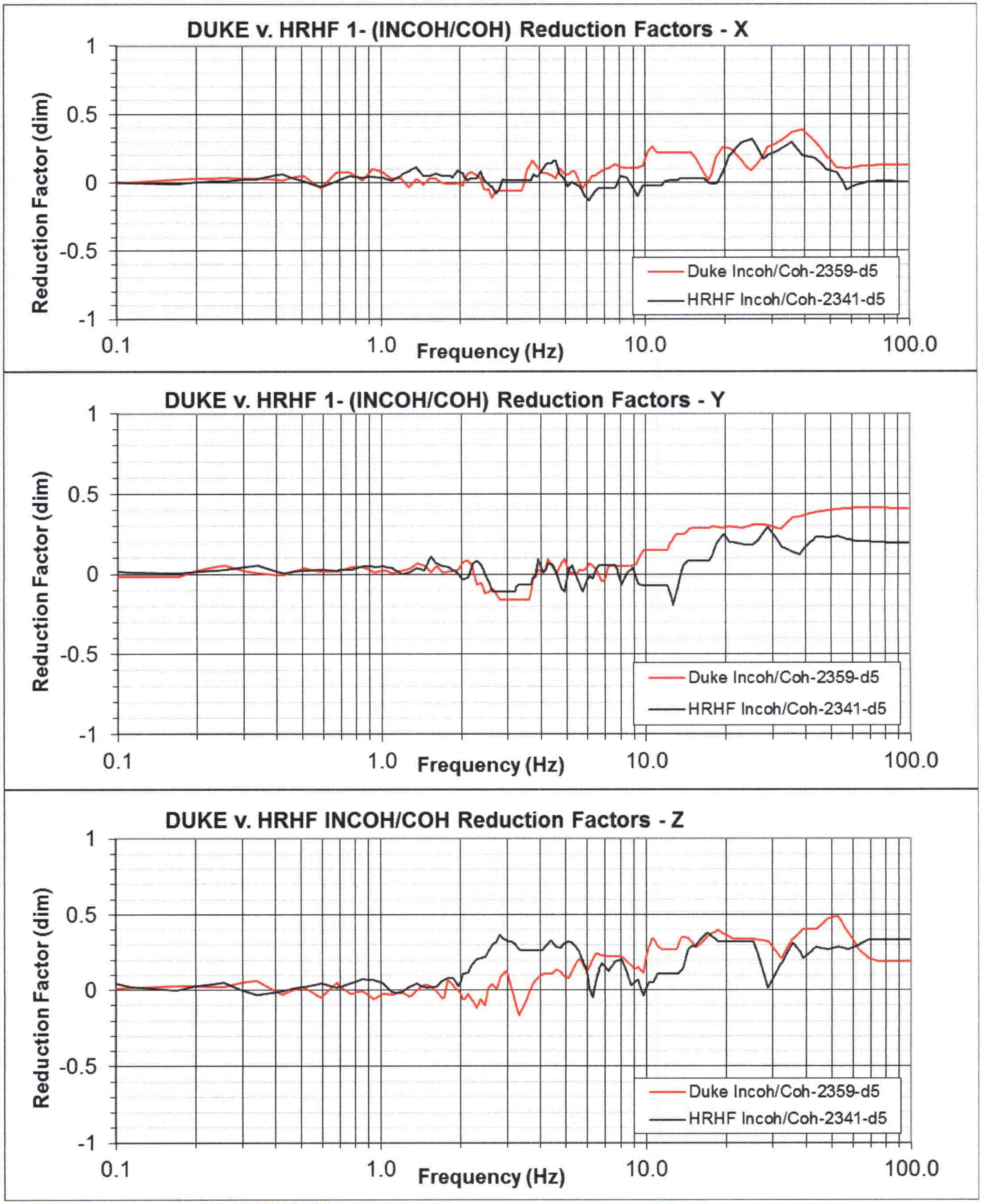


Figure 03.07.02-3-4 - ASB at Northeast Corner (Elevation 134.5')

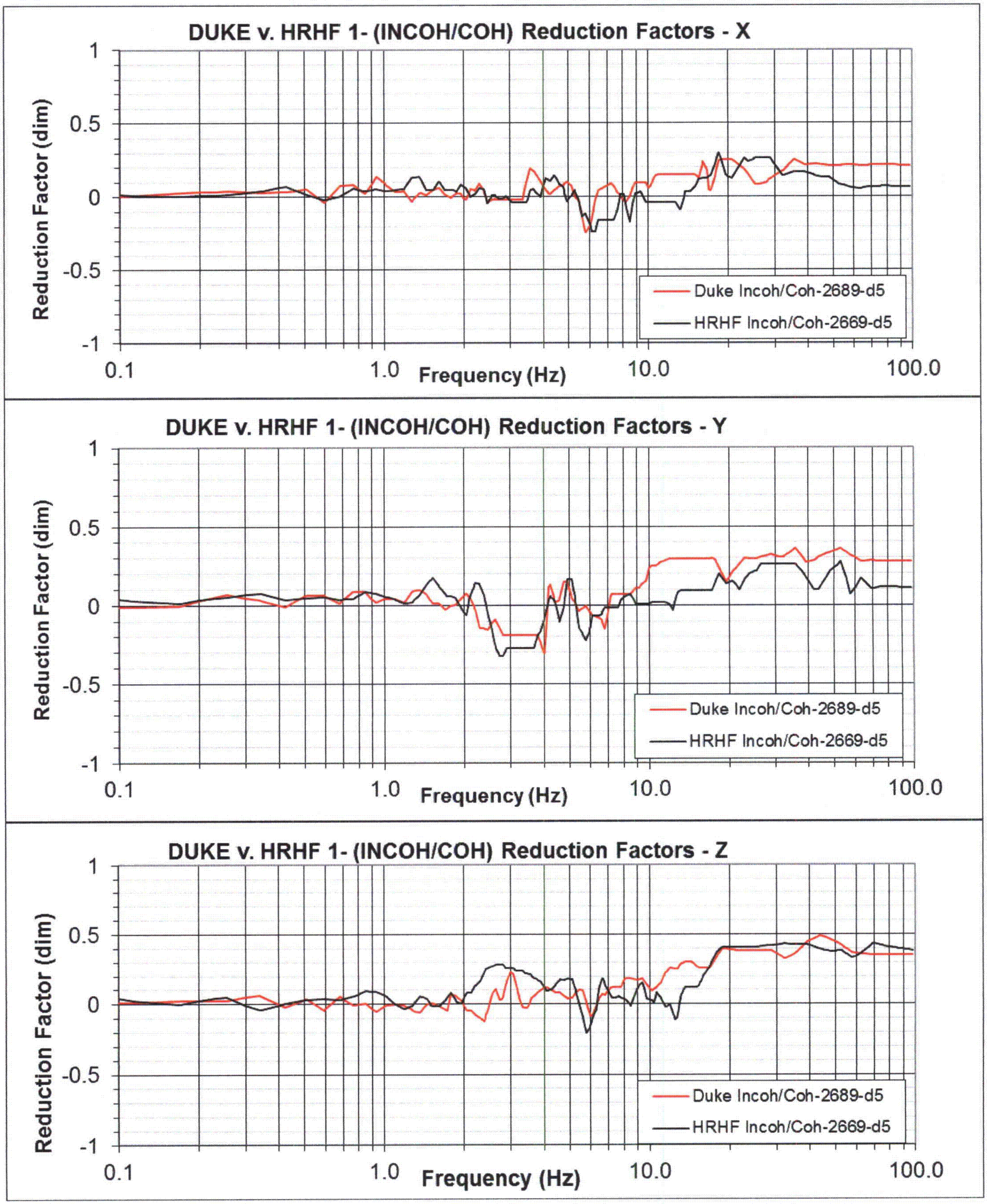
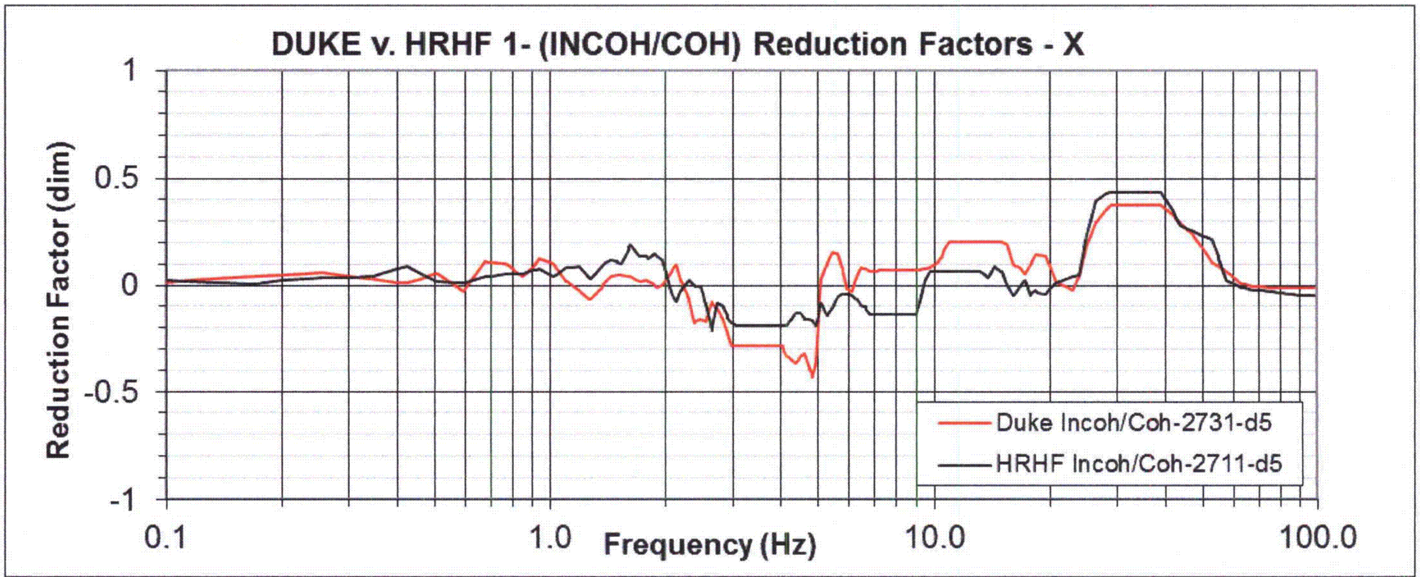
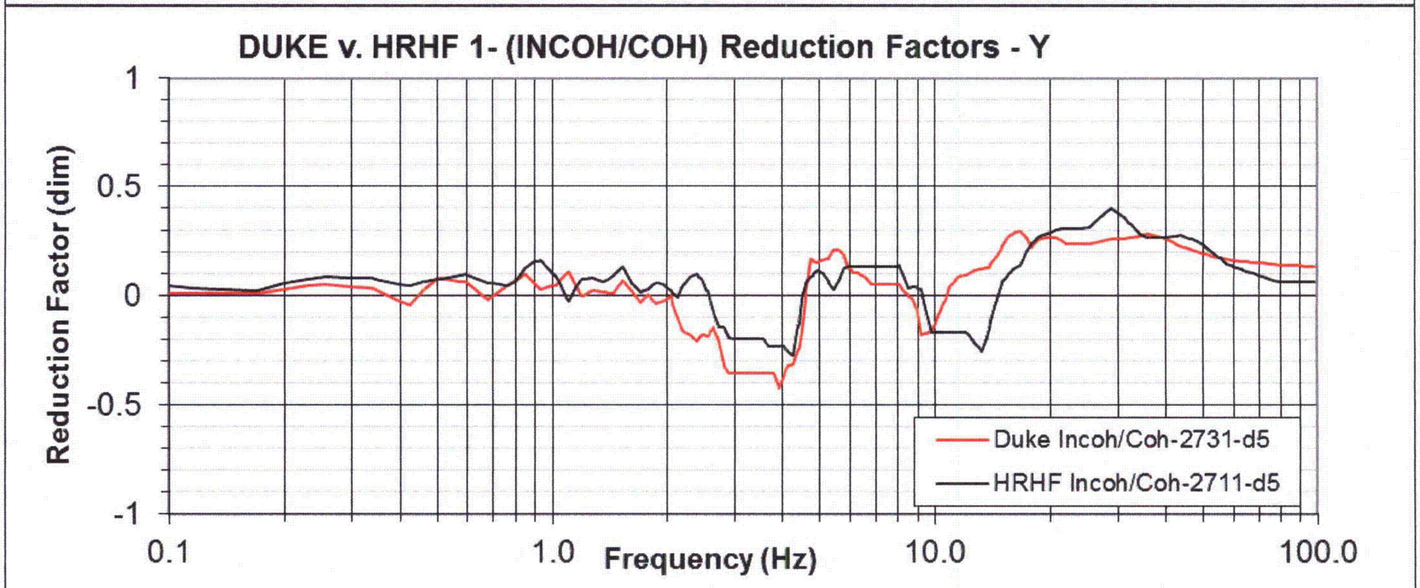


Figure 03.07.02-3-5 - ASB at Fuel Building Roof (Elevation 179.56 feet)





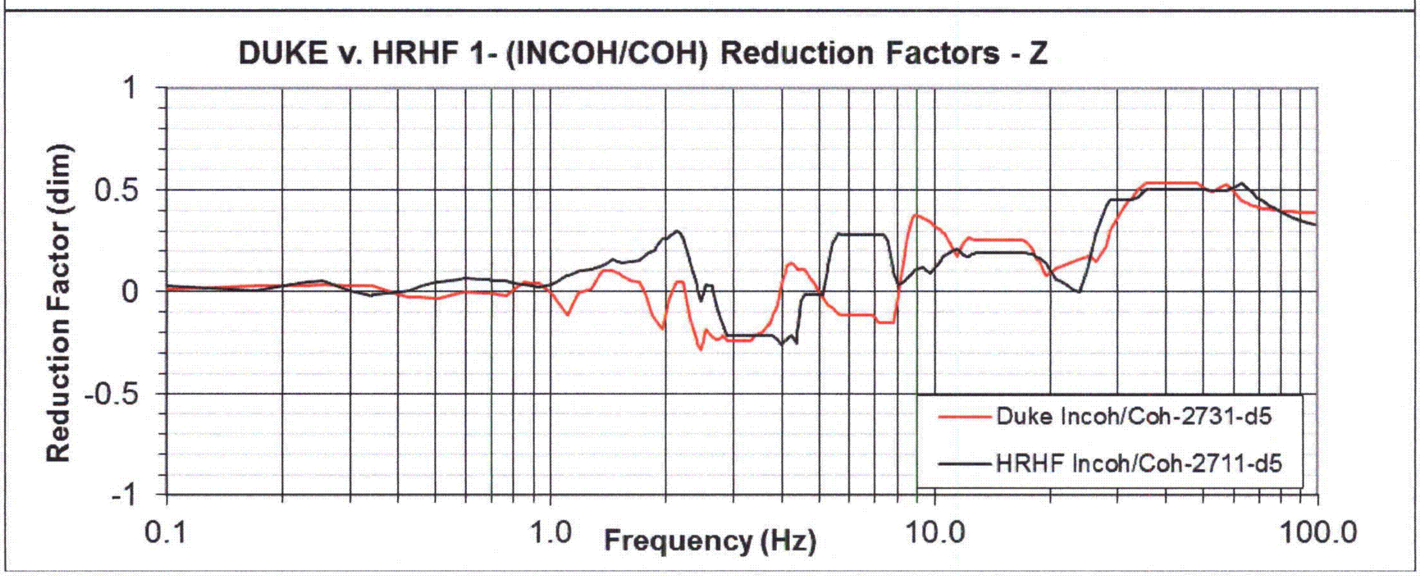


Figure 03.07.02-3-6 - Floor Response Spectra (FRS) Nodes – West Wall at Elevation 180 feet

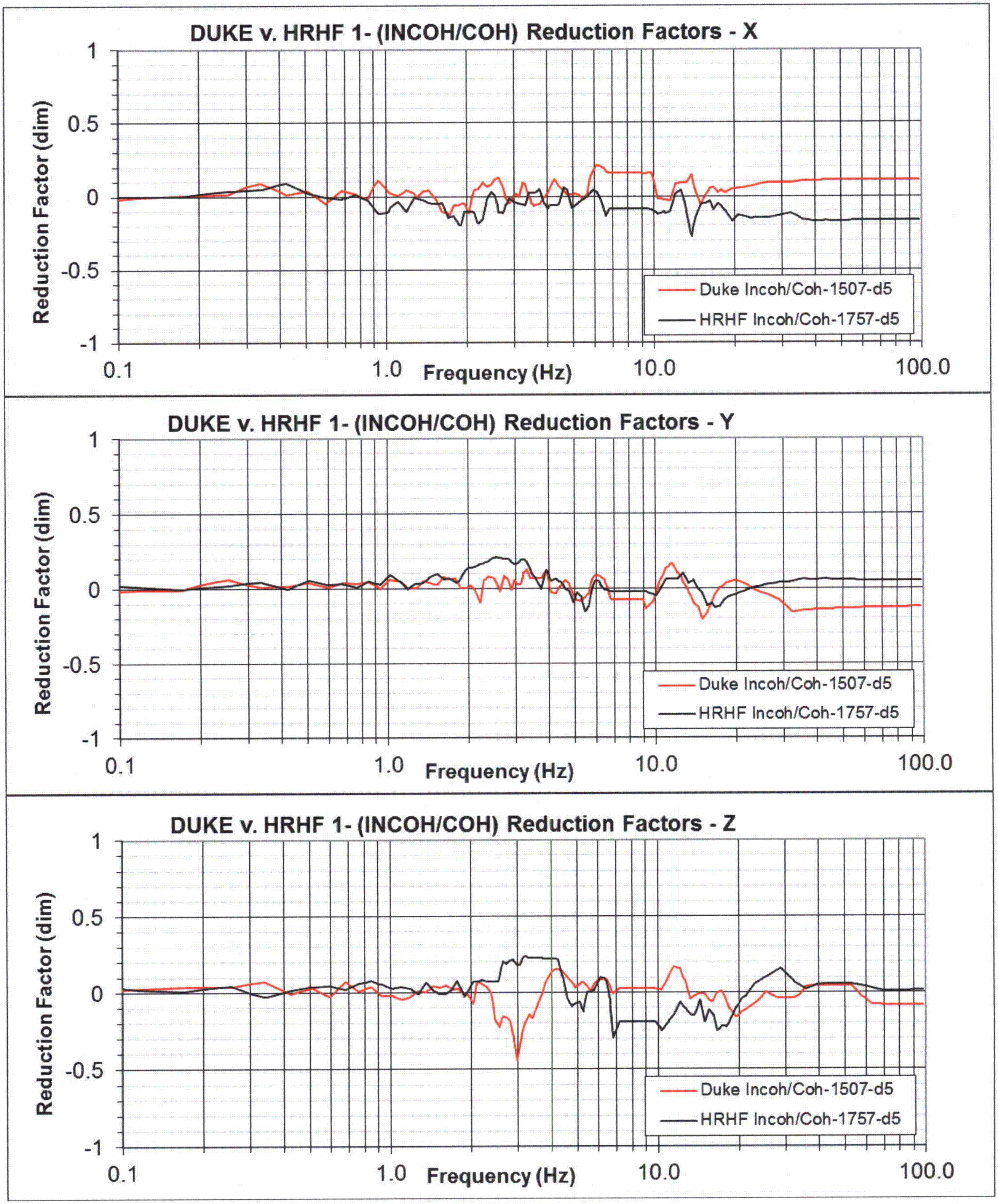
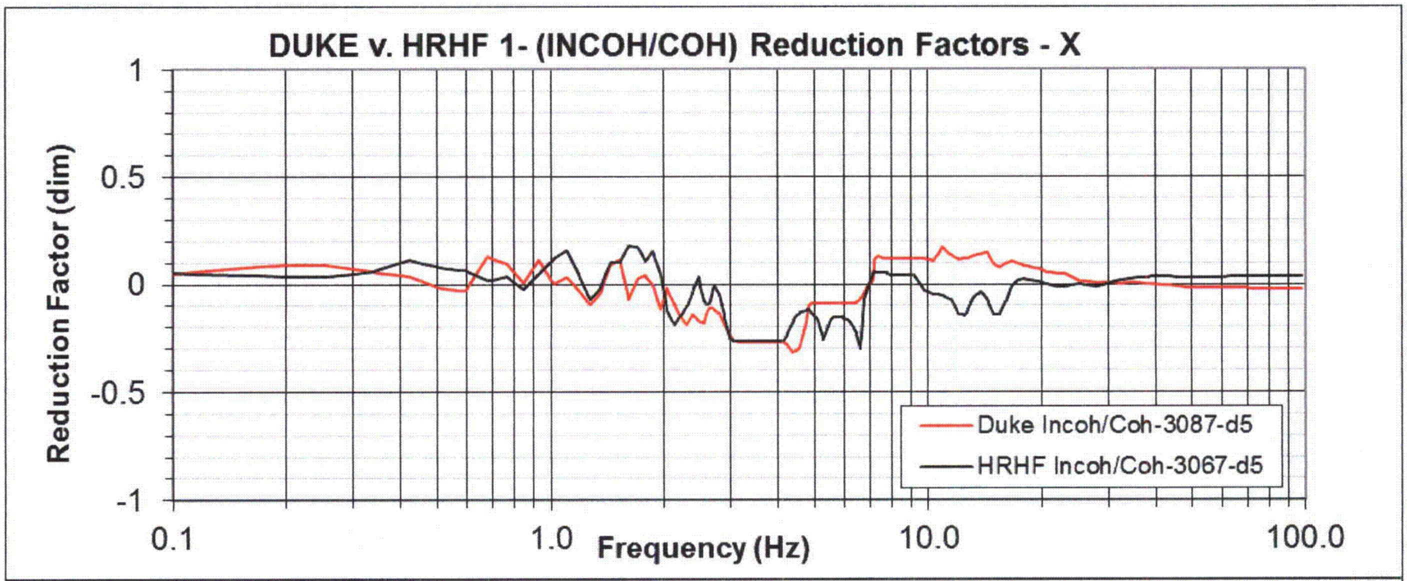
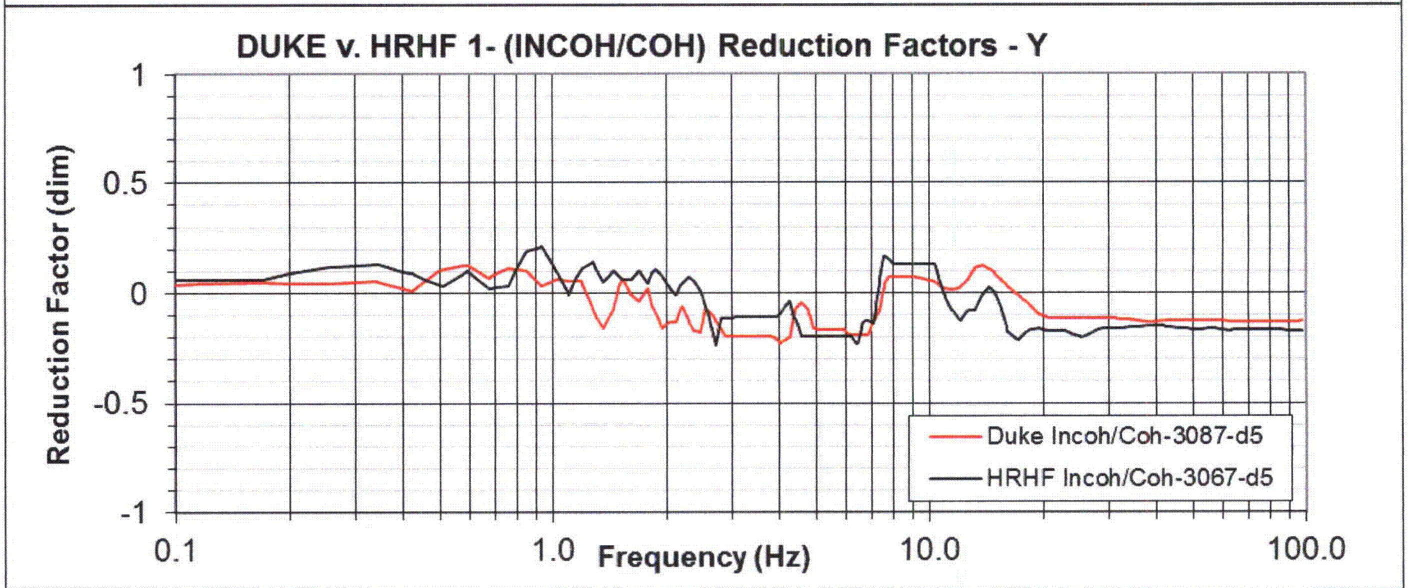


Figure 03.07.02-3-7 - Reactor Coolant Pump





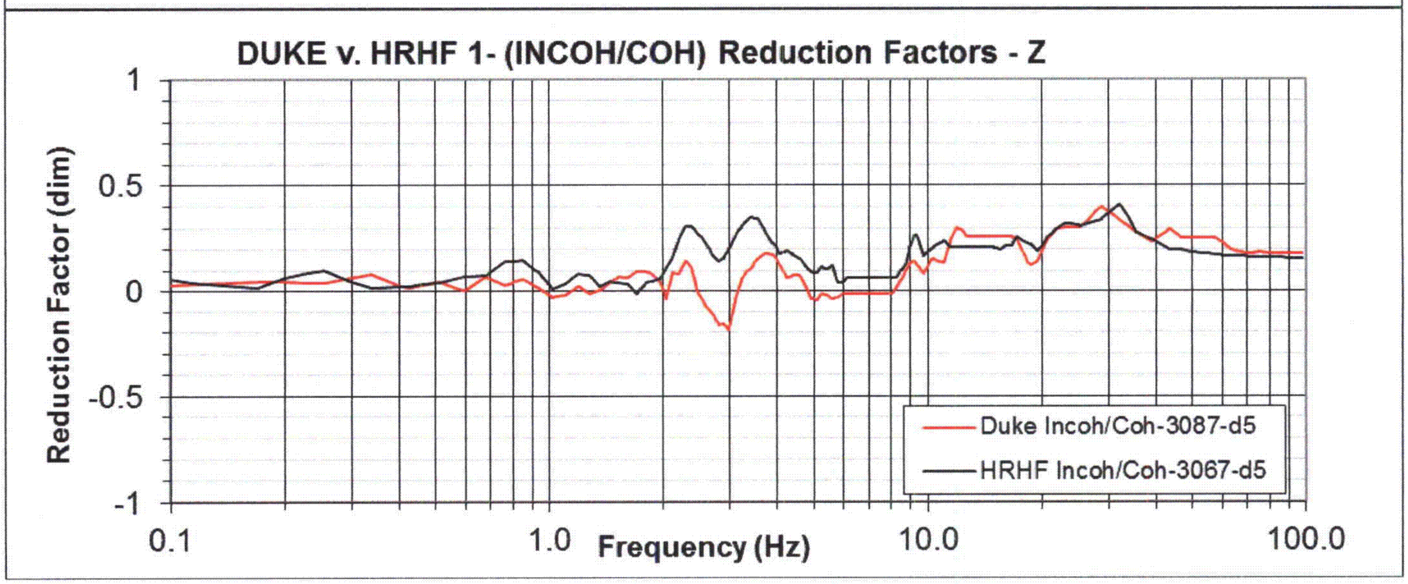
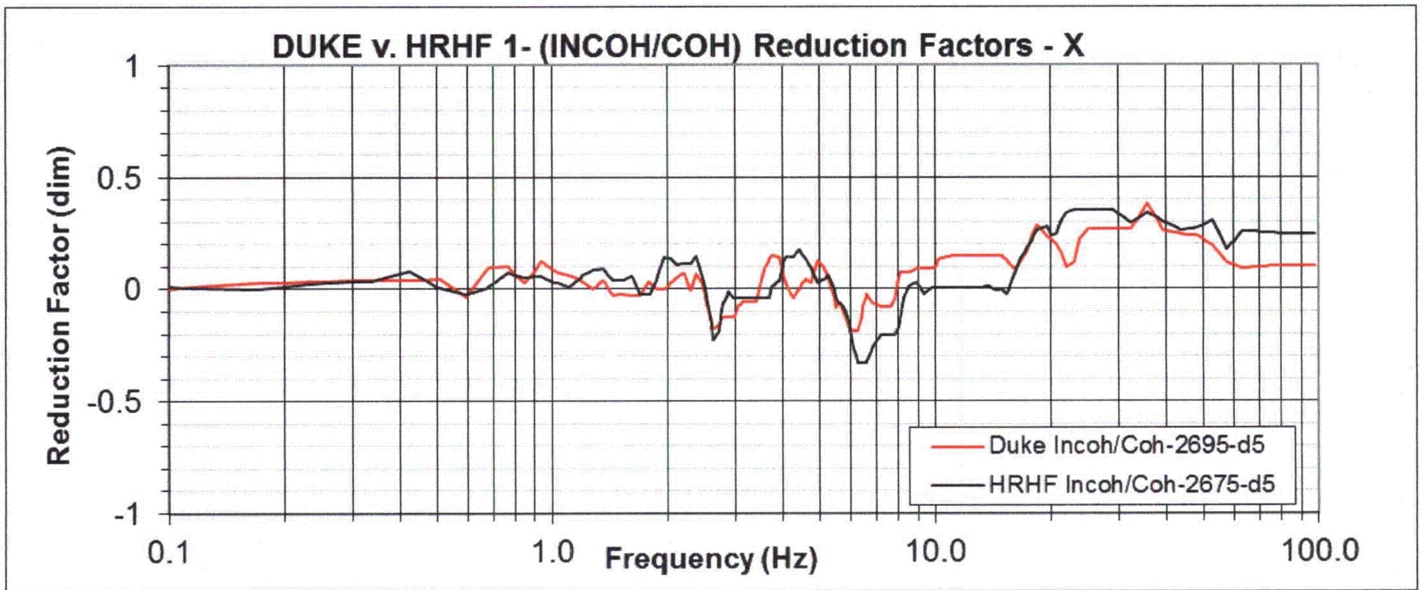
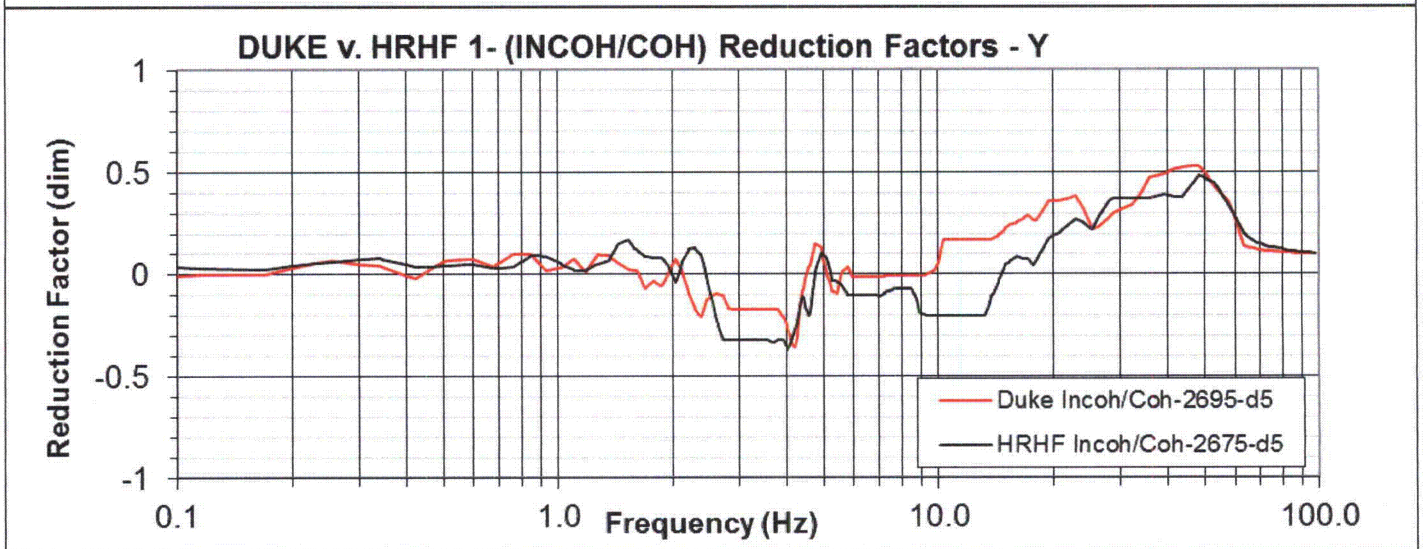


Figure 03.07.02-3-8 - Seismic Response Spectra for Shield Building Roof Area





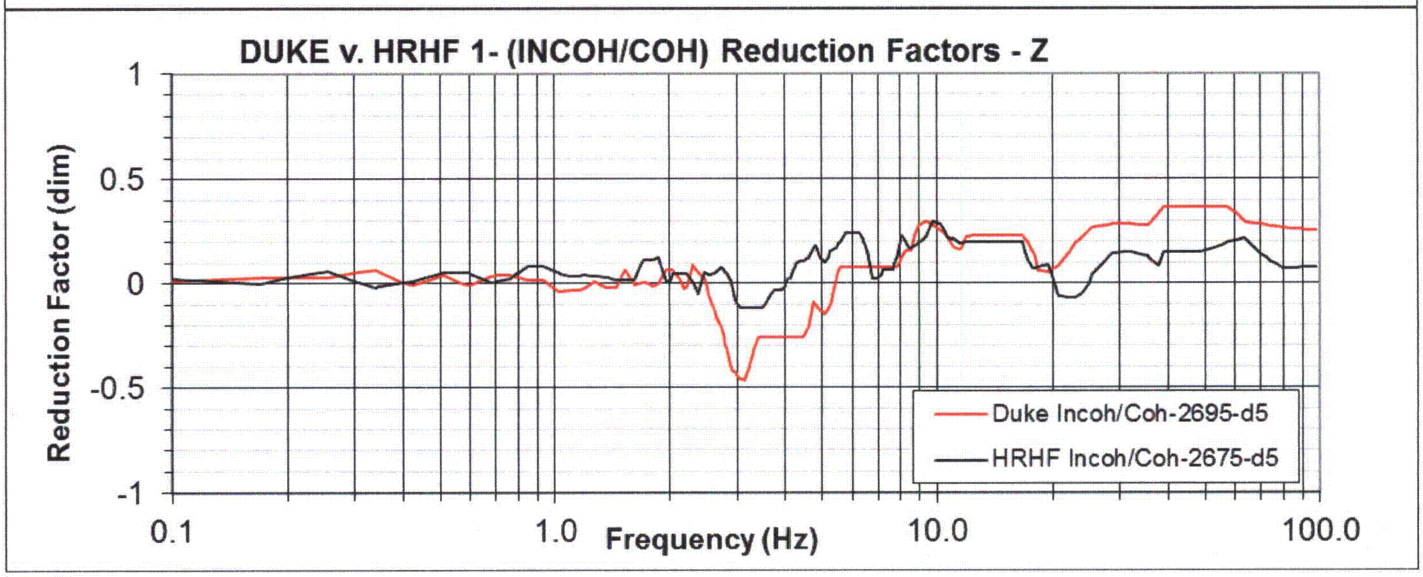


Figure 03.07.02-3-9 - Seismic Response Spectra for South Side of Shield Building

Enclosure 2

Lee Nuclear Station Units 1 and 2 Response to Request for Additional Information (RAI)

RAI Letter No. 120

RAI 03.07.02-4 (eRAI 7570)

Lee Nuclear Station Response to Request for Additional Information (RAI)

RAI Letter No. 120

NRC Technical Review Branch: Seismic System Analysis

Reference NRC RAI Number(s): 03.07.02-4 (eRAI 7570)

NRC RAI:

In reviewing the WLS FSAR Revision 8, the staff has identified areas which need further clarification, additional information, or editorial revision. The applicant is requested to address the following in the WLS FSAR:

(b) On page 3.7-5 of WLS FSAR Rev. 8 the applicant states that the calculated site-specific relative displacements of the Seismic Category II adjacent buildings are much less than the building separation provided. The staff requests the applicant to include in the FSAR the site specific values for relative displacements between the NI and adjacent SCII structures. Further, the applicant is requested to include site-specific values for relative displacements between the NI and adjacent SCII structures for 1.67xWSL GMRS to ensure margin above the design basis seismic ground motion.

Duke Energy Response

The differential displacements between the nuclear island and the Seismic Category (SC) II adjacent structures are shown in Table 6.2-1 of Westinghouse Electric Company Report WLG-1000-S2R-804, Revision 3, William S. Lee Site Specific Adjacent Buildings Seismic Evaluation Report, February 2014 (FSAR Subsection 3.7 Reference 205). The maximum relative displacements at the foundation level are approximately 0.10 inches and 0.20 inches for the Annex Building and Turbine Building First Bay, respectively, compared to 2" separation provided at the foundation level. The maximum relative displacement between the top of the adjacent structures and the nuclear island is approximately 0.27" and 0.58" for the Annex Building and Turbine Building, respectively, compared to 4" separation provided.

The maximum site-specific bearing demand was determined to be approximately 24.5 kips per square foot (ksf) for the Annex Building and 5.3 ksf for the Turbine Building First Bay, which is significantly less than the corresponding site-specific allowable dynamic bearing capacity (shown in FSAR Table 2.5.4-228) of 33.55 ksf and 45.03 ksf, respectively, including a factor of safety of 3, demonstrating that the granular fill material selected is adequate for supporting the SCII adjacent structures.

Ensuring margin above the design basis ground motion for the Review Level Earthquake (RLE), defined as 1.67 times the Safe Shutdown Earthquake (SSE), is demonstrated by increasing the Duke Lee site-specific SCII relative displacements sixty-seven percent and comparing these relative displacements to the gap provided between the Nuclear Island and SCII adjacent structures. Duke Lee site-specific RLE relative displacements at the foundation and top of the SCII Annex Building and Turbine Building First Bay are estimated to be approximately 0.17 inches and 0.34 inches at the foundation compared to the 2-inch gap provided, and 0.45 inches and 0.97 inches at the top of the adjacent structures compared to the 4-inch top gap provided. Therefore, for RLE and seismic margin considerations, significant margin still exists within the available foundation and top of structure gaps.

Finally, site-specific bearing demand for the seismic margin RLE condition suggest Annex Building and Turbine Building First Bay bearing demands of 40.9 kips per square foot (ksf) and 8.9 ksf, respectively, which are compared to the corresponding ultimate bearing capacity (i.e., allowable bearing capacity multiplied by a factor of safety of 3) used for seismic margin of 101 ksf and 135 ksf, respectively. Therefore, significant margin exists compared to the anticipated Duke Lee RLE and corresponding seismic margin bearing demand. FSAR Subsection 3.7.2.8.4 will be revised to reflect SCII building relative displacements in a future revision to the FSAR.

Associated Revision to the Lee Nuclear Station Final Safety Analysis Report:

FSAR Subsection 3.7.2.8.4

Attachment:

1. Attachment 1 – Revision to FSAR Subsection 3.7.2.8.4

Attachment 1

Lee Nuclear Station Units 1 and 2 Response to Request for Additional Information (RAI)

RAI Letter No. 120

RAI 03.07.02-4 (eRAI 7570)

Revision to FSAR Subsection 3.7.2.8.4

1.) COLA Part 2, FSAR Chapter 2, Subsection 3.7.2.8.4, eighth paragraph is revised and a new ninth paragraph is added as follows:

The analyses presented in Reference 205 confirm that the calculated site-specific relative displacements of the Seismic Category II adjacent buildings are much less than the building separation provided, so there is no contact between the nuclear island and the Seismic Category II adjacent buildings. The maximum relative displacements at the foundation level are approximately 0.10" and 0.20" for the Annex Building and Turbine Building, respectively, compared to 2" separation provided at the foundation level. The maximum relative displacement between the top of the adjacent structure and the nuclear island is approximately 0.27" and 0.58" for the Annex Building and Turbine Building, respectively, compared to 4" separation provided. The maximum site-specific bearing demand (approximately 24.5 ksf for the Annex Building and 5.3 ksf for the Turbine Building) is significantly less than the site-specific allowable bearing pressure shown in FSAR Table 2.5.4-228 (approximately 33.55 ksf for the Annex Building and 45.03 ksf for the Turbine Building), demonstrating that the granular fill material selected is adequate for supporting those structures.

FSAR Subsection 19.55 discusses confirming the seismic design margin for potential events up to a Review Level Earthquake (RLE) of 1.67 times the SSE. By scaling the differential displacements above for the RLE, the estimated maximum relative displacements at the foundation level are approximately 0.17" and 0.34" for the Annex Building and Turbine Building, respectively, compared to 2" separation provided at the foundation level. For the RLE, the maximum relative displacement between the top of the adjacent structures and the nuclear island is approximately 0.45" and 0.97" for the Annex Building and Turbine Building, respectively, compared to 4" separation provided. These comparisons demonstrate the building separation design margin available is adequate for the RLE. Similarly, since the allowable bearing pressures shown in FSAR Table 2.5.4-228 already include a factor of safety of three against bearing failure, the granular fill material supporting the Seismic Category II buildings also clearly satisfies the bearing capacity design margin requirements for the RLE.

Enclosure 3

Lee Nuclear Station Units 1 and 2 Response to Request for Additional Information (RAI)

RAI Letter No. 120

RAI 03.07.02-5 (eRAI 7570)

Lee Nuclear Station Response to Request for Additional Information (RAI)

RAI Letter No. 120

NRC Technical Review Branch: Seismic System Analysis

Reference NRC RAI Number(s): 03.07.02-5 (eRAI 7570)

NRC RAI:

WLS FSAR (Rev. 8) Section 3.7.2.15 states that stresses resulting from site-specific high frequency input are bounded by AP1000 design basis analysis results and the effect of site-specific high frequency input on piping is non-damaging. Further, Section 3.7.2.15 states that although some of the site-specific ISRS exhibit minor exceedances of the comparable standard AP1000 equipment qualification RRS, in all cases the actual TRS used in completed testing exceed the site-specific demands by a significant margin. To assist the staff in its evaluation of the effect of high frequency input to piping and equipment, the applicant is requested to provide a discussion on sources of conservatism in piping analysis and equipment testing. Further, the applicant is requested to provide an estimate of the range of the seismic margin associated with piping analysis and equipment testing.

Duke Energy Response:

Duke Lee and AP1000 Piping System Analysis Qualification and Sources of Margin

To determine the effect of high frequency seismic motion on piping, a comparison of the Duke Lee and AP1000 Certified Seismic Design Response Spectra (CSDRS) and Hard Rock High Frequency (HRHF) stress analyses was made using the PIPESTRESS computer program. As shown in Tables 6.3-1, 6.3-2 and 6.3-3 of the WLG-GW-GLR-815 report (FSAR Subsection 3.7 Reference 206), the study compared results for the Duke Lee high frequency seismic input against CSDRS and HRHF spectra. All three packages show that the CSDRS seismic piping stresses are larger than those resulting from the Duke Lee seismic response with the exception of one node, but for that one point, the AP1000 HRHF seismic piping stresses controls. Therefore, the existing design practices used for CSDRS and HRHF envelope the Duke Lee site-specific demands.

Inherent to these analyses, piping systems include various sources of margin from several factors such as:

- Method of analysis (e.g., seismic response spectra analysis versus actual seismic response, and time history analysis);
- Use of envelope seismic response spectra;
- Margin to code allowable;
- Factors of safety within the code allowable;
- Margin to yield stress or ultimate strength;
- Margin to critical buckling;
- Actual material properties will be higher than the minimum code material allowables;
- Actual piping system structural damping will be higher than the conservative damping values used in design/analysis that will result in lower seismic response;

- A large amount of energy associated with a seismic event will be absorbed and dissipated by inelastic-response that is a function of the system ductility;
- Piping systems are designed for different soil and hard rock sites that introduces additional conservatism into the design;
- Seismic response for most piping systems will be in the lower frequency range away from the high frequency range associated with hard rock high frequency seismic response.

Further expanding on additional margin associated with the method of analysis of piping systems, including the Duke Lee evaluations discussed above, linear elastic modal response spectra analysis was used for qualification and inherent small gaps in pipe supports were neglected. Examples of these include gaps in pin connections or gaps between the support and the pipe. These two areas of the current piping analysis include inherent sources of margin and conservatism in the analysis of the Duke Lee piping packages. As indicated, a source of conservatism is the use of linear elastic response spectrum analysis. These analyses assume a conservative envelope of FRS, which is applied at multiple support locations throughout a pipe length and many of which actually experience significantly lower loading demands.

In contrast to a response spectrum analysis, time history analyses more accurately represent actual floor response and make use of specific floor acceleration time histories. Further, the linear elastic simulation aspect of such analysis precludes the simulation of actual nonlinear support conditions (e.g. bolted connections with gaps) and results in an over-constraining the piping system.

The influence of support gaps on the response of a piping system when subjected to a seismic high-frequency load was investigated through the study of a representative piping configuration located inside the containment building of the AP1000 nuclear power plant. The inside-containment Automatic Depressurization System (ADS) 4th Stage East Compartment piping system is potentially susceptible to high-frequency content excitation, having modes and natural frequencies in the high frequency range and being located so that the HRHF FRS exceeds the FRS from the AP1000 CSDRS in the high frequency range. The response from a nonlinear model including gaps in the supports was compared to the response from a linear model with rigid supports. Valve accelerations were evaluated and are shown in Figure 03.07.02-5-1 below. Pipe stresses for two different elements for both the CSDRS and HRHF seismic conditions are shown in Figures 03.07.02-5-2 and 03.07.02-5-3 below. As shown, both the valve accelerations and pipe stresses were lowered when gaps are considered. Therefore, considering the support gaps in the analyses influences the response of the piping system, and represents a source of conservatism inherent in the current piping system analysis. Note, axial (X), tangential (Y) and vertical (Z) directions represent the orientation of the time history analysis results shown below.

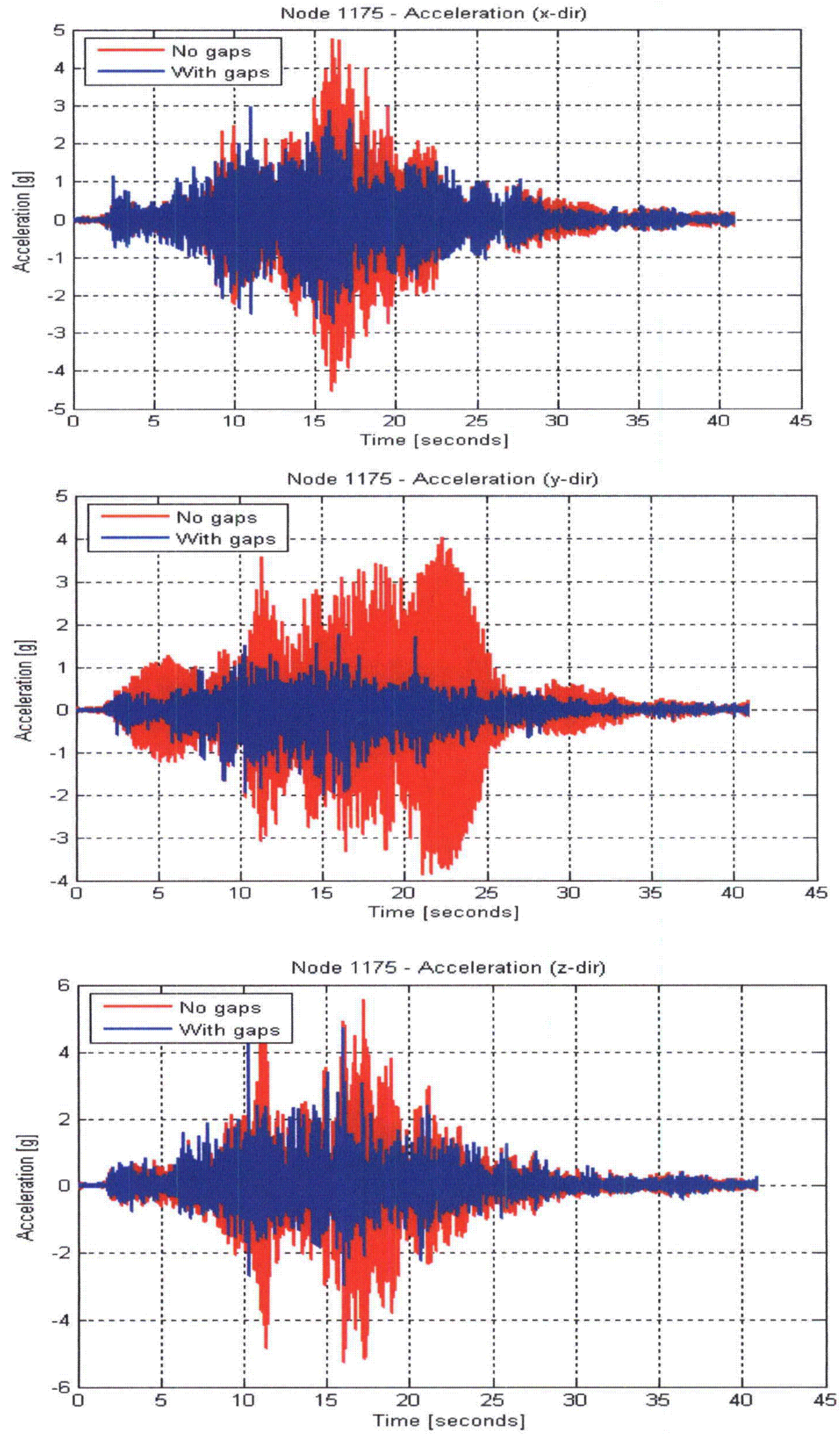
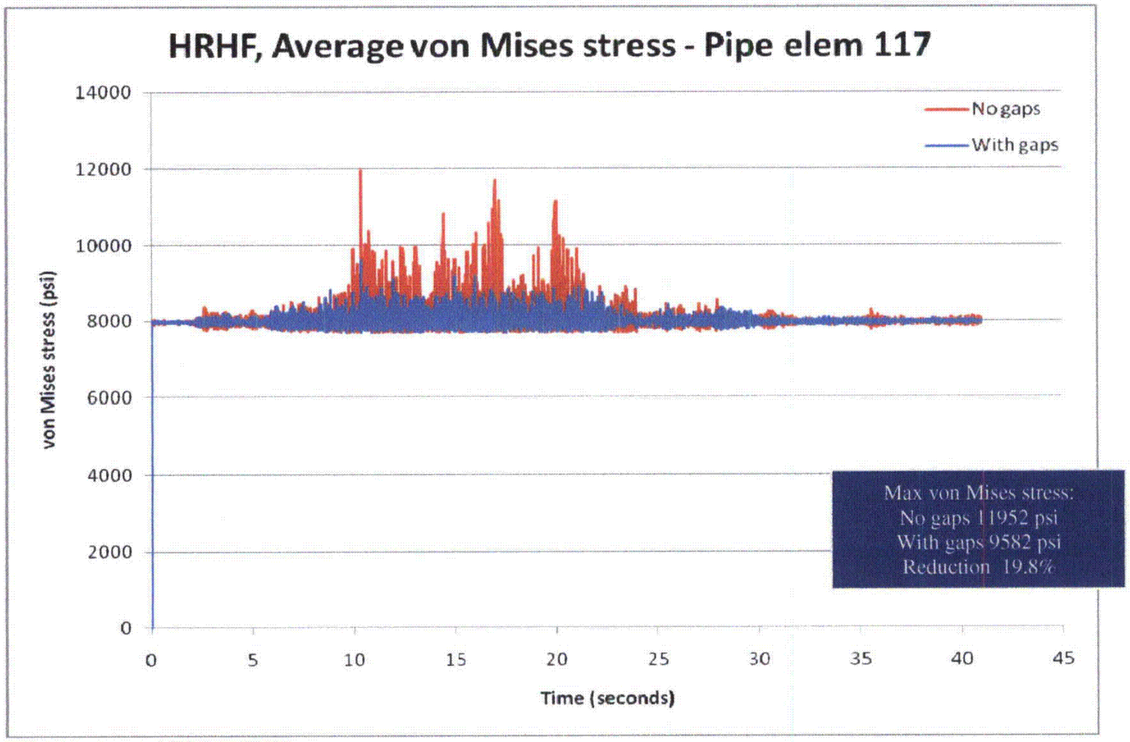


Figure 03.07.02-5-1 Valve Accelerations Time History With and Without Gaps for HRHF Seismic Input – ADS 4th Stage East Compartment Piping System



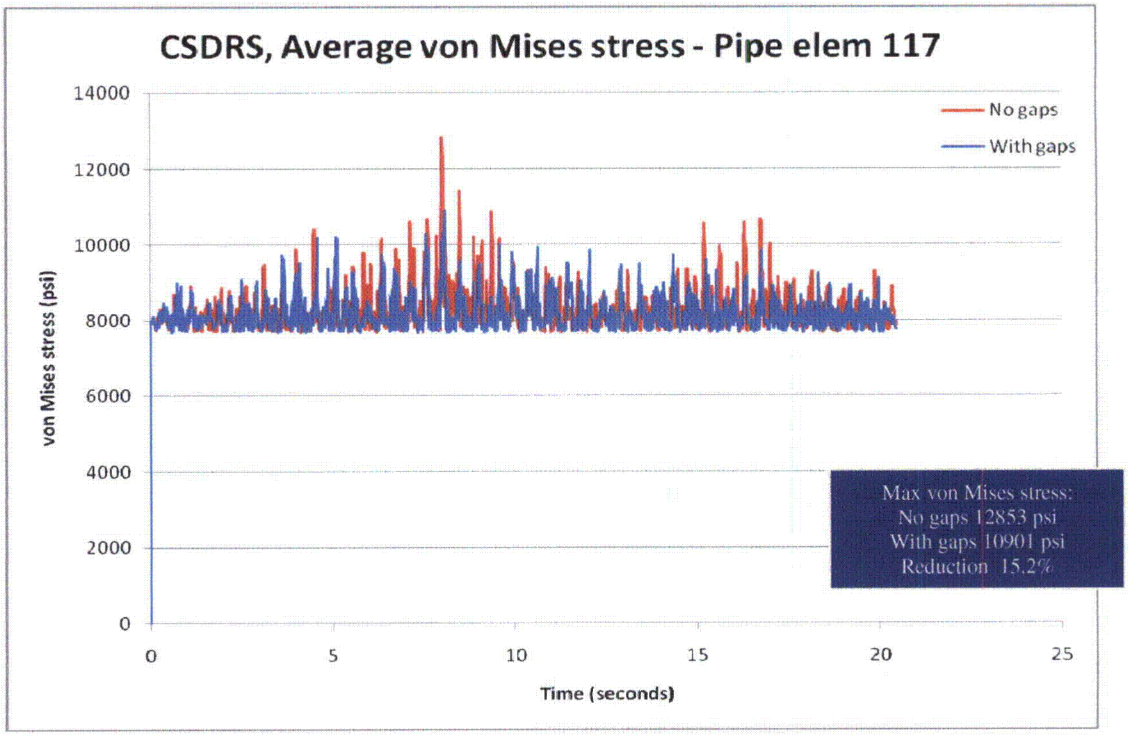
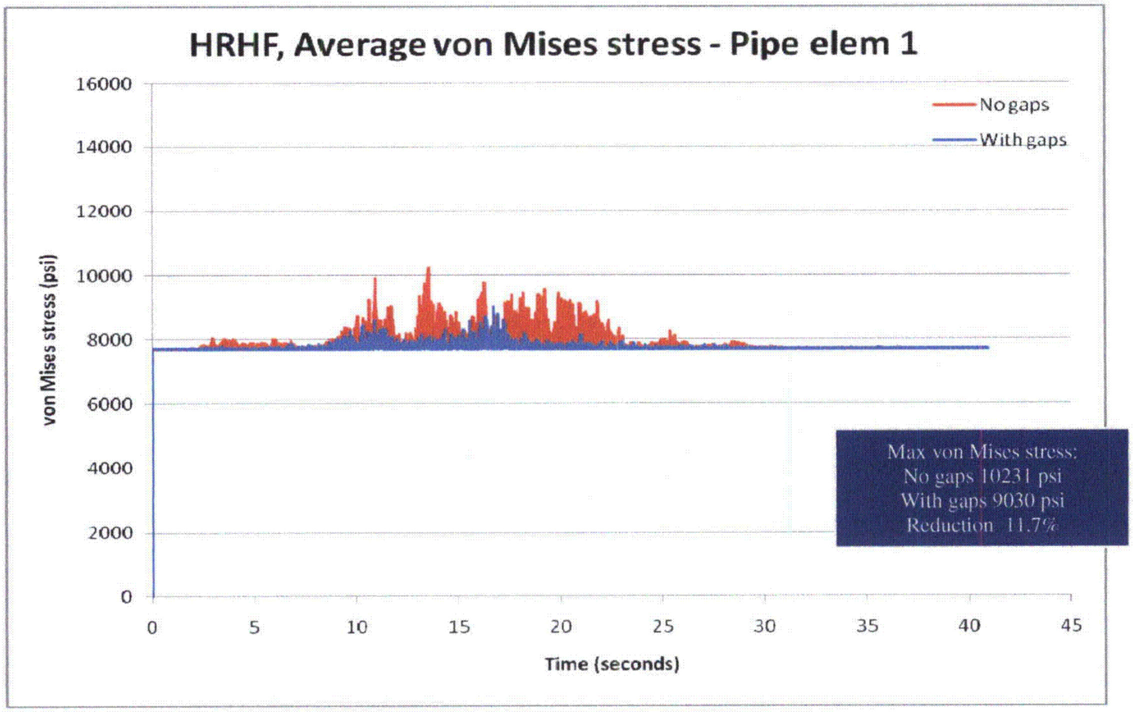


Figure 03.07.02-5-2 Pipe Stress Time History (Element 117) With and Without Gaps for CSDRS and HRHF Seismic Input – ADS 4th Stage East Compartment Piping System



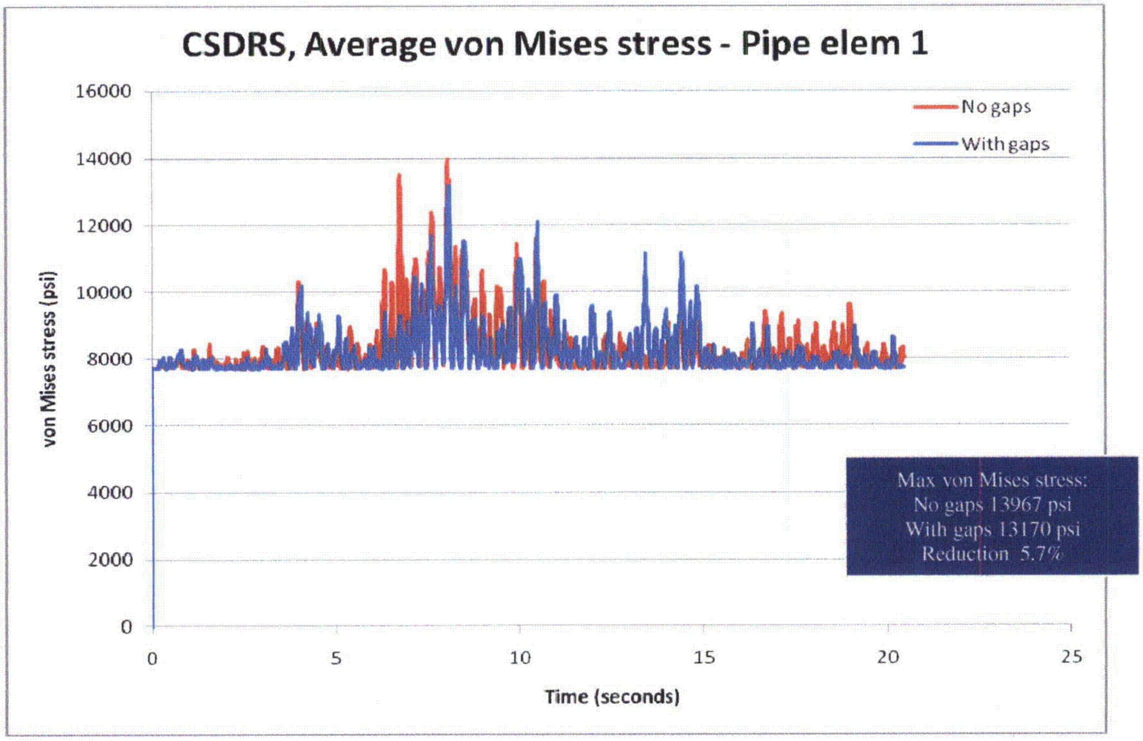


Figure 03.07.02-5-3 Pipe Stress Time History (Element 1) With and Without Gaps for CSDRS and HRHF Seismic Input – ADS 4th Stage East Compartment Piping System

Beyond Design Basis Seismic Margin for Piping System Analysis Qualification

The beyond design basis seismic margin associated with piping systems are generally governed by their supports. Using only two margin factors associated with ductility and code allowable based on bending, results in a margin factor just under two. The minimum seismic margin is assessed as follows:

- Conservative ductility factor = 1.25;
- Code margin with on-set of yielding on outer fiber = 1 / 0.67 = 1.5; and
- Minimum margin = 1.25 x 1.5 = 1.9.

AP1000 Plant HRHF Equipment Qualification – Sources of Margin

APP-GW-GLR-115 (TR115) concluded that low frequency seismic tests envelope high frequency (HF) input up to 2.0 g spectral acceleration (at 5 percent critical damping), and no additional seismic testing is required when the HRHF seismic inputs were below this level. Also, for Duke Lee, susceptibility to excitation caused by HF input requires the following factors to be present:

- The local Duke Lee site-specific floor response spectra (FRS) need to exceed the AP1000 CSDRS and HRHF.
- The safety-related equipment must have modes or natural frequencies in the HF range.
- The safety-related components must have potential failure modes involving change of state, chatter, signal change/drift, and/or connection problems.

Components and equipment determined to be sensitive to HF (i.e. sensitive to high frequency), with potential failure modes involving change of state, chatter, signal change/drift, and connection problems, were demonstrated to be acceptable through the performance of supplemental HF screening in accordance with the industry position EPRI White Paper, "Seismic Screening of Components Sensitive to High Frequency Vibratory Motions". Those components that are sensitive to HF that have failure modes associated with non-high frequency sensitive mounting, connections and fasteners, joints, and interface, are considered to be qualified by traditional low frequency qualification testing per IEEE Standard 344-1987, " Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations", and/or required quality assurance inspection and process/design controls.

The HF screening seismic test is intended as a supplemental evaluation to the required seismic qualification methods performed in accordance with IEEE Standard 344-1987 for those plants that have HF exceedance of the CSDRS and that, therefore, require evaluation of equipment and components potentially sensitive to HF. HF screening tests are conducted as a supplemental test to low frequency seismic excitation for equipment determined to have natural frequencies coinciding with the peak spectral acceleration of the HF required response spectrum when that peak spectral acceleration is greater than 2.0 g (at 5 percent critical damping).

Review of completed low frequency seismic test programs shows that the current qualification test methods envelop the seismic qualification of equipment for HF seismic inputs up to a 2.0 g peak spectral acceleration (at 5 percent critical damping) in the three orthogonal principal axes. This was used to exclude additional seismic testing to HF based inputs below 2.0 g.

Beyond Design Basis Seismic Margin of AP1000 Plant HRHF Equipment Qualification

The Westinghouse seismic margin approach is documented in AP1000 Design Control Document (DCD) APP-GW-GL-700, Chapter 19 (Probabilistic Risk Assessment (PRA)), Section

19.55 (Seismic Margin Analysis). The goal of the seismic margin evaluation is to demonstrate a minimum seismic margin of 1.67 between the equipment plant Design Basis SSE (CSDRS/HRHF) seismic demand and the seismic qualification SSE capacity. The seismic margin evaluation looks at the equipment's reserve capacity expressed in terms of the earthquake motion level. For AP1000 plant, the Design Basis SSE CSDRS and HRHF response spectra are based on 0.3g ground acceleration as defined in AP1000 DCD subsection 3.7.1 and Appendix 3I, respectively. The minimum acceptable HCLPF capacity is 0.5g (1.67 x 0.3g) for the CSDRS and HRHF seismic demands.

For the AP1000 program, this seismic margin evaluation incorporates an earthquake level of 0.5 g. The seismic margin evaluation assesses the capability of critical equipment to survive the beyond Design Basis SSE (CSDRS/HRHF) seismic demand (0.5g) that could compromise plant safety and could lead to core damage or containment failures. The seismic capacity is considered the nominal scaled spectral acceleration capacity at 5% critical damping at the as-installed system fundamental frequency of the safety-related equipment times the appropriate margin factors. Therefore, the minimum acceptable HCLPF capacity is 0.5g (1.67 x 0.3g) for the CSDRS and HRHF seismic demands.

Seismic testing is performed to demonstrate the equipment will operate and maintain structural integrity under specified seismic conditions associated with the certified seismic design. Equipment failures during seismic testing are usually related to the operability of devices mounted at different locations within the structure. For electrical equipment, the failure mechanism is often related to chatter or loss of electrical connection. Because safety-related equipment designs are robust, they rarely fail to perform their intended safety function due to a structural failure. The reserve margin in the equipment to survive the beyond the Design Basis SSE (CSDRS/HRHF) seismic demand in most cases is estimated based on test and industry experience.

Other potential sources of margin are strength of materials and the effects of changes in equipment damping as the magnitude of the earthquake increases. These seismic margin contributors are potential sources for producing the seismic capacity needed to meet or exceed the seismic margin factor of 1.67 for the design basis and plant-specific applications. If the equipment seismic capacity falls below 1.67 times the plant Design Basis SSE (CSDRS/HRHF) seismic demand, expressed in terms of peak ground acceleration, then further evaluation needs to be performed.

As part of the seismic margins evaluation, a systems analysis is performed to identify the principal equipment with the potential to contribute to the risk of core damage frequency caused by an earthquake beyond the Design Basis SSE. The AP1000 system analysis results identifies a list of safety-related equipment necessary to implement the success path determined through a plant systems evaluation consistent with the criteria identified in Chapter 19 of AP1000 DCD. For HRHF applications, a high frequency screening test is performed after completion of seismic qualification testing to demonstrate that potential high frequency sensitive equipment can perform their safety-related function during the HRHF SSE without adversely effecting plant safety. Equipment determined to be high frequency sensitive are screened out and replaced with equipment that is more robust.

The method of showing acceptable seismic margin for safety-related equipment is through a deterministic approach whereas the HCLPF value is defined from comparison of Required Response Spectra (RRS) and Test Response Spectra (TRS) using existing test data or test data for similar types of equipment qualified by type testing or a combination of test and analysis.

Table 1 provides the minimum seismic margin contributing sources and magnitudes applicable to demonstrating the seismic capacity level of at least 1.67 times the FRS for AP1000 CSDRS design basis and HRHF sites. Cumulative CSDRS seismic test margin factors of 1.1 x 1.2 x 1.1 x 1.15 = 1.67. The cumulative HRHF seismic margin factor is 1.73, which conservatively exceeds 1.67.

Table 1

AP1000 Plant Potential Seismic Margin Contributors and Associated Magnitudes

CSDRS Sites	HRHF Sites
Seismic test margin factor of 1.1. Ten (10) % margin recommended by IEEE Std 323	**Seismic test margin factor of 1.1.** Ten (10) % margin recommended by IEEE Std 323
Seismic test margin factor of 1.2. Conservative test margin by increasing the CSDRS SSE test RRS by 20%. Different factors would apply depending on the margin included in the seismic testing.	**Seismic test margin factor of 1.1.** Conservative test margin by increasing the HRHF SSE test RRS by 10%. Different factors would apply depending on the margin included in the seismic testing.
Seismic test margin factor of 1.1. The qualification testing is not typically performed as a fragility test and reserve seismic capacity will exist beyond the CSDRS level. A conservative seismic test margin factor of 1.1 is used for reserve seismic capacity.	**Seismic test margin factor of 1.1.** The qualification testing is not typically performed as a fragility test and reserve seismic capacity will exist beyond the HRHF level. A conservative seismic test margin factor of 1.1 is used for reserve seismic capacity.
Seismic test margin factor of 1.15. Testing beyond the CSDRS SSE level will produce higher damping in the building structure due to the increased stress levels in the structure, which would result in a lower response at the equipment mounting locations. A conservative seismic test margin factor of 1.15 is used for the higher damping in the building structure caused by testing beyond the CSDRS SSE.	**Seismic test margin factor of 1.3.** AP1000 HRHF seismic testing at 5% critical damping test RRS which envelop as a minimum the 3% critical damping AP1000 HRHF response spectra associated with the mounting location of the equipment.

Therefore, when performing seismic testing for beyond design basis of the CSDRS and HRHF, the sources of margin include the IEEE Std. 323 factor, an increased RRS factor to demonstrate the equipment's ability to maintain structural integrity and functionality, and conservatism in the house testing procedure that results in additional margin associated with reserve capacity and damping inherent in the TRS that ensures a minimum factor 1.67.

References:

1. IEEE Std 344-1987, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," June 1987, Institute of Electrical and Electronics Engineers, Inc.

Associated Revision to the Lee Nuclear Station Final Safety Analysis Report:

None