Attachment 2 to PLA-6323
Non-Proprietary Version of Susquehanna Replacement Steam Dryer Stress Analysis at Extended Power Uprate Conditions

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Engineering Report

Susquehanna Replacement Steam Dryer Stress Analysis at Extended Power Uprate Conditions

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REVISION SUMMARY

Rev	Required Changes to Achieve Revision
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ACRONYMS AND ABBREVIATIONS

Item	Short Form	Description
1	ACM	Acoustic Circuit Model
2	ASME	American Society of Mechanical Engineers
3	BWR	Boiling Water Reactor
4	CLTP	Currently Licensed Thermal Power
5	EPU	Extended Power Uprate
6	FEA	Finite Element Analysis
7	FEM	Finite Element Model
8	FFT	Fast Fourier Transform
9	FIV	Flow Induced Vibration
10	GE	General Electric
11	GEH	GE Hitachi Nuclear Energy
12	Hz	Hertz
13	IGSCC	Intergranular Stress Corrosion Cracking
14	ksi	1000 Pounds per Square Inch
15	Mlbm/hr	Millions Pounds Mass per Hour
16	MS	Main Steam
17	MSL	Main Steam Line
18	MW_t	Megawatt Thermal
19	NA	Not Applicable
20	NRC	Nuclear Regulatory Commission
21	OBE	Operational Basis Earthquake
22	OLTP	Original Licensed Thermal Power
23	Pb	Primary Bending Stress Intensity
24	Pl	Local Primary Membrane Stress Intensity
25	Pm	General Primary Membrane Stress
26	PPL	Pennsylvania Power & Light
27	PSD	Power Spectral Density
28	psi	Pounds per square inch
29	Ref.	Reference
30	RMS	Root-Mean-Squared
31	RPV	Reactor Pressure Vessel
32	SCF	Stress Concentration Factor
33	Sm	ASME Code Stress Intensity Limit

Item	Short Form	Description
34	SRSS	Square Root Sum of Squares
35	SRV	Safety Relief Valve
36	SSES	Susquehanna Steam Electric Station
37	Su	Tensile Strength

1. EXECUTIVE SUMMARY

This report documents the finite element stress analyses of the replacement steam dryer for the Susquehanna Steam Electric Station (SSES). The focus of these analyses is to predict the replacement dryer's susceptibility to fatigue under flow-induced vibration (FIV) and mechanically induced vibration loads during normal operation at Extended Power Uprate (EPU) power levels. A detailed finite element model (FEM) is used to perform the structural dynamic analyses. The results of these analyses are used to assess dryer component stresses versus fatigue and ASME design criteria under the operating conditions.

The fatigue evaluations are performed at steam flow conditions closely matching the flow conditions expected at 113% of the Original Licensed Thermal Power (OLTP). The applied pressure loads were developed by Continuum Dynamics, Inc. (CDI) based on in-plant steam line pressure measurements taken during the spring of 2006. The 113% OLTP analysis is used as the basis for extrapolating the dryer stress to full EPU conditions by using the benchmark study and scaling law previously developed for the Susquehanna dryer analysis.

The fatigue evaluation indicates that at full EPU conditions, all dryer components meet the fatigue acceptance criteria with adequate or high margins. The ASME load combination analysis results indicate that the stresses for all structural components are under the ASME Code allowable limits at EPU operating conditions.

Therefore, the fatigue evaluation and ASME load combination analysis results demonstrate the acceptability of the Susquehanna replacement steam dryer design at EPU operating conditions.

2. INTRODUCTION AND BACKGROUND

The original Susquehanna steam dryer's structural responses were analyzed for component fatigue evaluation at Extended Power Uprate (EPU) conditions [Reference 1]. The analyses used a finite element model to calculate the steam dryer transient dynamic responses. The pressure loads used in the analyses were developed by Continuum Dynamics, Inc. (CDI) based on in-plant steam line pressure measurements taken at various power levels during the spring of 2006, which included the Original Licensed Thermal Power (OLTP), the Current Licensed Thermal Power (CLTP), and at steam flow conditions approximating 113% OLTP. In order to evaluate uncertainties in the steam dryer structural frequency response, the time scale of the loads was stretched by plus and minus 10% from the nominal value to create frequency shifts in the load definition. In all the transient response analyses, Rayleigh damping equivalent to a 1% damping ratio was applied. The maximum stresses for each of the modeled dryer components were searched from all the solutions over the range of time histories analyzed. Based on a benchmarking comparison of the analytical results to strain gauge data taken from on-dryer instrumentation in 1985, a scaling factor was developed and applied to address underprediction in the stresses due to both flow and mechanically induced vibration. A second scale factor was developed based on power ascension measurements and used to extrapolate the stress results of 113% OLTP to the full EPU conditions. The resulting stress values were used for component fatigue evaluation.

The results of the analyses for the original Susquehanna dryer indicated that several dryer components were susceptible to fatigue damage under EPU operating condition. After a comprehensive review of alternative dryer modifications and a review of the operational history of the Susquehanna dryers, a replacement dryer configuration was proposed to better withstand the vibration loading environment at EPU conditions. The proposed replacement dryer configuration, [[

]] The proposed dryer was analyzed in Reference 2 to determine the acceptability of the replacement dryer concept. The

design evaluated in Reference 2 analysis did not include all the fabrication design details, including changes to plate thicknesses and weld configurations that provide additional structural margin in the final as built replacement dryer. The structural analyses described in this report were performed to evaluate the final as built replacement steam dryer structural responses to the vibration loads and ASME load combinations, and to confirm that the final dryer meets the design criteria.

This report documents the fatigue analysis and ASME load combinations for the Susquehanna replacement dryer, and summarizes the predicted component stresses and fatigue margins.

3. DESIGN CRITERIA

3.1 Fatigue Criteria

The steam dryer fatigue evaluation consists of calculating the alternating stress intensity from FIV and mechanical induced vibration loading at all locations in the steam dryer structure and comparing it with the allowable design fatigue threshold stress intensity. The recommended fatigue threshold stress intensity considered is the ASME Code Curve C value of 13,600 psi. Stresses below the ASME Code Curve C value are assumed to be below the level required to initiate a fatigue crack. The fatigue design criteria for the steam dryer is based on Figure I-9.2.2 of ASME Section III [Reference 3], which provides the fatigue threshold values for use in the evaluation of stainless steels. [[

]]

3.2 Acceptance Criteria for Normal, Upset, Emergency and Faulted Conditions

The analysis uses the ASME Code [Reference 3] as a design guide although the dryer is not an ASME Code component. The ASME Code stress limits used in the evaluation of the Susquehanna dryer are listed in Table 3.2-1. Service Level Limits for Service Levels A, B and C are according to NG-3221 and Appendix F Paragraph F-1331 for Level D. Upset condition stress limits are increased by 10% above the limits shown in this table per NG-3223 (a).

Table 3.2-1 ASME Code Stress Limits

			Value (ksi) at Temperature	
Service Level	**Stress Category**	**Stress Limit**	120°F	550.5°F
Design and Service Levels A, B	Pm	Sm	16.7	14.35
	Pm+Pb	1.5Sm	25.05	21.525
Service Level C	Pm	1.5 Sm	25.05	21.525
	Pm+Pb	2.25 Sm	37.575	32.29
Service Level D	Pm	Min(.7Su or 2.4 Sm)	49	34.44
	Pl	1.5(Pm Allowable)	73.5	51.66
	Pl + Pb	1.5(Pm Allowable)	73.5	51.66

Legend:

Pm: General primary membrane stress intensity
Pl: Local primary membrane stress intensity
Pb: Primary bending stress intensity
Sm: ASME Code stress intensity limit
Su: Tensile strength

Table 3.2-2 shows the ASME Code Section III load combinations as discussed in Reference 15 and used in the Susquehanna replacement steam dryer primary stress evaluation.

Table 3.2-2 Susquehanna Units 1 & 2 Steam Dryer Load Combinations

Comb. No	Level	Combination
A-1	Normal	$DW + \Delta P_N + FIV_N$
B-1	Upset	$DW + \Delta P_N + TSV_1 + FIV_N$
B-2	Upset	$DW + \Delta P_N + TSV_2$
B-3	Upset	$DW + \Delta P_U + SRV + FIV_U$
B-4	Upset	$DW + \Delta P_N + OBE + FIV_N$
B-5	Upset	$DW + \Delta P_U + [SRV^2 + OBE^2]^{0.5} + FIV_U$
C-1	Emergency	$DW + \Delta P_E + SRV_{ADS} + FIV_N$
D-1	Faulted	$DW + \Delta P_{F1} + [SRV_{ADS}^2 + SSE^2]^{0.5}$
D-2	Faulted	$DW + \Delta P_N + [AC_1^2 + SSE^2 + FIV_N^2]^{0.5}$
D-3	Faulted	$DW + \Delta P_{F2}$
D-4	Faulted	$DW + \Delta P_N + AC_2 + FIV_N$
D-5	Faulted	$DW + \Delta P_U + [SRV^2 + SSE^2]^{0.5} + FIV_U$

Definition of Load Acronyms:

AC_1 = Acoustic load due to Main Steam Line Break (MSLB) outside containment, at the Rated Power and Core Flow (Hi-Power) Condition (Inward load on the outermost hood closest to the nozzle for the broken line).

AC_2 = Acoustic load due to Main Steam Line Break (MSLB) outside containment, at the Low Power/High Core Flow (Interlock) Condition (Inward load on the outermost hood closest to the nozzle for the broken line)..

DW = Metal Weight + Water Weight.

ΔPn = Differential 'static' Pressure Load during Normal Operation.

ΔPu = Differential 'static' Pressure Load during Upset Operation (including the effects of stuck-open relief valve (SORV) condition).

ΔP_E = Differential 'static' Pressure Load during Emergency Operation (inadvertent actuation of ADS).

ΔP_{F1} = Differential Pressure Load in the Faulted condition, due to Main Steam Line Break outside containment at the Rated Power and Core Flow (Hi-Power) condition.

ΔP_{F2} = Differential Pressure Load in the Faulted condition, due to Main Steam Line Break outside containment at the Low Power/High Core Flow (Interlock) Condition.

FIV_N = Flow Induced Vibration Load during Normal Operation.

FIV_U = Flow Induced Vibration Load during Upset Operation.

OBE = Operating Basis Earthquake.

SSE = Safe Shutdown Earthquake.

SRV = Safety Relief Valve Containment Discharge Loads (Greater of all SRV or SRV-Asymmetric)

SRV_{ADS} = SRV Containment Discharge Loads caused by the "Automatic Depressurization System".

TSV_1 = The Initial Acoustic Component of the Turbine Stop Valve (TSV) Closure Load (Inward load on the outermost hoods closest to the nozzles).

TSV_2 = The Flow Impingement Component (following the Acoustic phase) of the TSV Closure Load (Inward load on the outermost hoods closest to the nozzles).

4. INPUTS

This section describes the key inputs that are used for the steam dryer structural analysis.

4.1 Material Properties

The dryer assembly is manufactured from Type 304L conforming to the requirements of the material and fabrication specifications. ASME material properties are used [Reference 4]. The applicable properties are shown in Table 4.1-1.

Table 4.1-1 Properties of SS304L [Reference 4]

Material / property	Operating temperature 550.5°F
SS304L	
S_y, Yield strength, psi	15,950
S_u, Ultimate strength, psi	57,200
E, Elastic modulus, psi	25,598,000

4.2 Replacement Dryer Design

The structural analysis of the replacement steam dryer is based on the design input drawings [Reference 5] for the replacement design. Key criteria for the replacement steam dryer design are:

1. Increase the structural margin for withstanding the effect of increased structural loading at EPU conditions. This is accomplished by [[

   ]]

   Details of these changes were transmitted to the USNRC in Reference 6 in the response to RAI 6A.

2. Maintain the same dryer hood shape, hood width, hood height and hood setback from the reactor pressure vessel main steam line nozzles so that the pressure load definition for flow induced vibration that was developed from in-plant measurements with the original Susquehanna steam dryer can be directly applied to the replacement steam dryer design. For the replacement steam dryer, this criterion is met. The replacement dryer hood height is identical to the original dryer hood height. Other shape and setback parameters have less than one-percent difference between the original steam dryer and the replacement steam dryer. These differences are much smaller than the acoustic wavelengths for the dominant frequencies observed in the pressure load measurements observed in the plant and, therefore, will have a negligible effect on the acoustic pressure load definition.

3. Introduce a Brace Tube (Trans Brace) under the Trough and Base Plate components and normal to the Trough assemblies. Connectors from the tube extend to both the bottom side of the Trough center and to the bottom edge of the Hood Supports. This Brace Tube controls the motion and provides additional structural margin for all components of the inner Vane Bank Assemblies.

Figure 4.2-1 shows the configuration design of the replacement steam dryer.

4.3 Operational Pressure Loading

4.3.1 Pressure Loading for Flow Induced Vibration

The replacement steam dryer FIV response analysis uses loads developed by CDI, which are based upon steam flow conditions representative of 113% OLTP. The loads were derived from in-plant pressure measurements taken on the reactor main steam lines in 2006. These measurements were used as the inputs to CDI's acoustic circuit model to develop the detailed time histories of the pressure over entire dryer structure [Reference 7]

By searching through the load data, the two extreme pressure magnitudes can be found within the provided time period. The positive pressure peak is +0.41 psi, which occurs on the outer hood (90° side) at load step 547. The negative pressure

peak is -0.43 psi, which occurs on the outer hood (270° side) at load step 666 The spatial distributions of pressure on the dryer at these two instances are shown in Figures 4.3.1-1 and 4.3.1-2, respectively. The spatial distribution shows that the high pressure occurs near the MSL nozzles for the steamlines with deadlegs.

The pressure time histories, measured at the two maximum pressure locations on the outer hoods, are shown in Figures 4.3.1-3 and 4.3.1-4. [[

]] Therefore, a pressure power spectral density (PSD) evaluation is used to describe the frequency contents of the pressure time history. The results of the PSD evaluation for the time histories of Figures 4.3.1-3 and 4.3.1-4 are shown in Figures 4.3.1-5 and 4.3.1-6, respectively. The PSD results indicate that the pressure loads contain significant harmonic contents at 15 Hz, 24 Hz, 44 Hz, 54 Hz, and 83 Hz.

In Reference 1, benchmark comparisons were made between the Susquehanna FEA predictions and in-plant measurements taken during testing in 1985. The benchmark study included comparisons between predicted and measured pressures at the pressure drum and outer hood locations. A more detailed comparison was also made of the predicted strains versus measured strains at specific strain gauge locations. It was concluded that Susquehanna FEA results were under predicted [[

]] the FEA stress results to match the testing measurements. Because the stress underprediction was predominantly due to the amplitude underprediction in the load definition, this stress underprediction factor will be used in the replacement Susquehanna dryer fatigue evaluation.

The FIV analysis for the replacement steam dryer was performed with the loading developed from the Susquehanna in-plant main steam line pressure measurements for steam flow conditions equivalent to a power level of 113% OLTP (3721 MWt). The results of the finite element analyses must then be extrapolated to determine the stresses on the dryer at full EPU conditions. Dynamic operating measurements are available from three sources for

determining the extrapolation to EPU. Reference 1 documented the process of extrapolating the results of 113% OLTP to EPU conditions, which included the use of three data sources: The 1985 in-plant instrumented dryer measurements [Reference 8], the MSL pressure measurements [Reference 9], and SSES-specific scale model testing [Reference 10]. [[

]]

4.3.2 Seismic and SRV Containment Discharge Loading

Seismic events transmit loads to the dryer through the vessel support brackets. The SRV containment discharge loads are transmitted to the dryer through the same path. The original steam dryer seismic loads and SRV containment discharge loads are documented in Reference 11. The original seismic loads were based upon a dryer weight of 80,000 pounds. The replacement steam dryer weight is approximately 110,000 lbs. An analysis was performed by GEH to determine the effect of the increased replacement dryer weight on the Susquehanna plant primary structure seismic/dynamic model. A conservative dryer replacement dryer weight of 117,000 pounds was used in the evaluation. The results of the evaluation demonstrate that the [[

]] Therefore, the seismic loads and SRV containment discharge loads in Reference 11 remain applicable for the replacement steam dryer design.

OBE and SSE loads for spectral analysis input are selected to envelope spectra for both Uncracked and Cracked Shroud configuration as presented in Reference 11 and shown in Figure 4.3.2-1 through 4.3.2-4. SRV spectra and SRV maximum acceleration value are used per Reference 12. Figure 4.3.2-5 shows the spectra for the SRV load case. Structural damping of 2% is used per Table 5.8.1-1 of Reference 13.

4.3.3 Steady State, Upset Transient, Emergency and Faulted Condition Loads

The pressure differentials across the steam dryer are calculated for four categories of events; normal, upset, emergency and faulted conditions. Normal conditions are the steady-state operating conditions. Upset conditions are the anticipated transient events. [[

]] Emergency condition is within the Susquehanna reactor internals design basis and is defined by the rapid vessel depressurization via operation of the automatic depressurization system relief valves. Faulted conditions are the design basis accident events (e.g. main steam line break). [[

]]

The loads were originally developed for the Reference 1 and 2 evaluation of the Susquehanna steam dryer. These loads were confirmed to remain bounding for the replacement steam dryer due to the small geometric differences between the original Susquehanna steam dryer and the replacement steam dryer.

The pressure differentials across the steam dryer for the normal conditions (ΔPn) at EPU power level are summarized in Table 4.3-1.

Table 4.3-1 Steam Dryer Pressure Differentials for Normal Conditions at EPU

Description	Value[1] (psid)
[[	

]]

The maximum [[ ]] loads on the dryer face at EPU power level for the Turbine Stop Valve (TSV) fast closure event are summarized in Table 4.3-2.

Table 4.3-2 Maximum TSV [[ ]] Load on the Dryer Face at EPU

[[

]]

The maximum [[ ]] loads on the dryer face at EPU power level due to the [[ ]] for the Main Steam Line Break event are summarized in Table 4.3-3.

Table 4.3-3 Maximum MSL Break [[ ]] Load on the Dryer Face at EPU

[[

]]

4.4 Weld Factors

The calculation of fatigue alternating stress intensity using the prescribed stress concentration factors in ASME Code Section III; Subsection NG [Reference 3] is straightforward when the nominal stress is calculated using the standard

strength of material formulas. However, when a finite element analysis (FEA) approach is used, the available stress component information is more detailed than that which would be obtained from the standard strength-of-materials formulas and requires added guidance for determining a fatigue stress intensity to be used in conjunction with the ASME Code S-N fatigue design curve.

For the case of full penetration welds, [[

]]

Note that the above discussion of stress concentration effects (SCF's, fatigue factors, weld factors) only applies to the fatigue evaluation. SCF, "fatigue factor," and "weld factor" are used interchangeably. For the SSES dryer, the weld quality factor used was 1.0.

5. DRYER FEA MODEL

5.1 Full Dryer Shell Finite Element Model

The three-dimensional shell model of the replacement dryer was constructed from the replacement dryer design drawings using the ANSYS finite element analysis code. The model is primarily [[

]] Nominal dimensions are used at all locations.

[[

]]

6. VIBRATION ANALYSIS AND PREDICTED COMPONENT STRESSES

6.1 Vibration Analysis Approach

The structural responses of the replacement steam dryer [[

]] A total of 9 analysis cases are performed with time step variations of +/- 2.5% from nominal to +/10%. Rayleigh damping is used in all of the analyses. Rayleigh damping coefficients [[

]]

6.2 Maximum Stresses, Structural Uncertainty and Design Criteria

Following each of the transient solutions, an ANSYS macro is used to search through all time steps on every component to extract the maximum stress intensity and the corresponding time and location. The element stress values from the shell element top, bottom, and middle surfaces are surveyed. The maximum values of stress intensity on the shell top or bottom are used for fatigue evaluation, and the maximum values of stress intensity on the middle surface are used in the ASME load combination. This search is termed "Primary Scoping". The results of this primary scoping may indicate that the peak stress intensity does not occur either at a weld line or plate thickness mismatch. For components where the primary scoping shows that the maximum stress intensity does not occur at a weld line or plate mismatch, the components stress intensities are searched along the weld line or plate mismatches to ensure that the maximum stress intensity after the application of weld factors is reported for each component. Plate mismatch stress intensity is calculated by [[

]]

The fatigue margin is calculated for the maximum stress intensity of each of the nine time shift analysis cases using the following formula:

$$\text{Fatigue Margin} = \frac{13600}{\text{Stress x SF}} - 1$$

[[

]]

6.3 Calculated Component Maximum Stress Intensities

Table 6.3-1 summarizes the component stresses from the 9 load cases. The component identifications correspond to Figures 5.1-5 through 5.1-33. [[

]]

Table 6.3-1 Maximum Stress Intensity from Vibration Solution under 113%OLTP Loads

[[

]]

6.4 [[ ]] Stress Investigation

The Susquehanna dryer FIV analysis showed [[

]] The objective was to show that stress predictions in this region of the full dryer model are high due to the simplifications made to accommodate a course mesh in the larger full dryer finite element model. Figure 6.4-1 shows the area of high stress intensity from the full dryer FE model results.

[[

]]

6.5 [[ ]] Stress Prediction

As shown in Figure 6.5-1, the peak stress intensity for the [[

]]

6.6 [[ ]] Stress Prediction

The peak stress intensity for the [[

]]

6.7 Component Stress Intensities with Submodels

Table 6.7-1 summarizes the component stresses from the 9 load cases, incorporating the results from the sub-component investigations in Sections 6.4, 6.5 and 6.6 of this report. [[

]]

Table 6.7-1 SSES Dryer Component Fatigue Margin under EPU Condition

[[

]]

7. ASME LOAD COMBINATIONS

The Susquehanna steam dryer was analyzed for the ASME Code load combinations (primary stresses) shown in Table 7.1-1. The acceptance criteria used for these evaluations are specified in Section 3.2 and are the same as those used for safety related components. The FIV stresses, where applicable, were added from the existing results obtained for the EPU condition.

7.1 ASME Code Load Case Stress Results

The stresses reported from the ANSYS analysis runs are maximum stresses and not general primary membrane or membrane plus bending stresses. Comparing the maximum stresses (rather than primary stresses as it is required by the Code) against the ASME limits (Table 3.2-1) is a very conservative way of structural components evaluation. However, as it is shown in Table 7.1-1, this conservative qualification has been successful for all the components and load combinations. Table 7.1-1 lists the components maximum stresses obtained from the ANSYS analysis.

Table 7.1-1 summarizes the ASME load combination analysis results and indicates that the stresses for all structural components are under the allowable ASME Code limits at EPU operating conditions.

Table 7.1-1 EPU ASME Results for Normal, Upset, Emergency and Faulted Conditions: Maximum Stresses

[[

]]

8. CONCLUSIONS

Finite element stress analyses were performed for the replacement Susquehanna steam dryer to predict dryer structural responses to the Flow Induced Vibration (FIV) and mechanically induced vibration loads under the Extended Power Uprate (EPU) condition and ASME load combination.

A detailed finite element model is used to perform the structural dynamic analyses. The applied pressure loads were developed by Continuum Dynamics, Inc. (CDI) based on in-plant steam line pressure measurements taken at 113% OLTP power levels during the spring of 2006. The results are used as basis for extrapolating the dryer stresses to full EPU conditions.

The fatigue evaluation indicates that at full EPU conditions, all dryer components meet the fatigue acceptance criteria with adequate or high margins, and the replacement Susquehanna design is structurally adequate to accommodate the vibration environment at EPU condition.

The ASME load combination analysis results indicate that the stresses for all structural components are under the allowable ASME Code limits at EPU operating conditions. Therefore, the fatigue evaluation and ASME load combination analysis demonstrates the acceptability of the Susquehanna replacement steam dryer design.

9. REFERENCES

[1] "Susquehanna Steam Dryer Fatigue Analysis", GENE 0000-0057-4166-R1, September 2006

[2] "Susquehanna Replacement Steam Dryer Fatigue Analysis", GE-NE-0000-0061-0595-P-R1, June 2007.

[3] ASME B&PV Code, Section III, 1989 Edition with no Addenda.

[4] ASME B&PV Code, Section II, Part D-Properties, 2001 and Addenda through 2003 Addenda.

[5] GEH Drawing 223D5360, Steam Dryer Assembly (Including subtier drawings from Part List PL223D5360).

[6] PPL Letter PLA-6242, B. T. McKinney (PPL) to Document Control Desk (USNRC), "Proposed License Amendment Numbers 285 for Unit 1 Operating License No. NPF-14 and 253 for Unit 2 License NPF-22 - Extended Power Uprate Application Regarding Steam Dryer and Flow Effects Request for Additional Information Responses," dated July 31, 2007- Response to RAI 6A

[7] C.D.I. Report No. 06-22 Rev. 0, "Hydrodynamic Loads at OLTP, CLTP, and 113% OLTP on Susquehanna Unit 1 Steam Dryer to 250 Hz," September 2006

[8] MDE #199-0985, "Susquehanna – 1 Steam Dryer Vibration Steady State and Transient Response," October 1985.

[9] Horvath, R., and Trubelja, M.; SIA Calculation Package: Susquehanna Unit 1 Main Steam Line Strain Gage Data Reduction; File No. SSES-23Q-302, Project No. SSES-23Q.

[10] Neiheisel, M., Test Report # 1 Susquehanna Steam Electric Station, Unit 1 Scale Model Test. GENE-0000-0054-2552. May 2006.

[11] NSSS Seismic Load Evaluation for Susquehanna Steam Electric Station Units 1 & 2, VPF 299X126-037, Rev. 0

[12] Dynamic Loads Report - Safety Relief Valve, GE 22A7402

[13] Dynamic Load Method & Criteria - NSSS Equipment, Piping, RPV & Internals, Design, Specification, GE 386HA596

[14] "Recommended Weld Quality and Stress Concentration Factors for use in the Structural Analysis of Exelon Replacement Steam Dryer", GE-NE 0000-0039-4817-1, Class II, April 2005

[15] "Susquehanna Units 1 and 2 Steam Dryer Load Combinations", GE-NE-0000-0051-3346-R0, Class III, April 2006

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Figure 4.2-1 Susquehanna Replacement Steam Dryer Configuration

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Figure 4.3.1-1 Pressure Distribution on 90° Hood at LS547, 113% OLTP Nominal

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Figure 4.3.1-2 Pressure Distribution on 270° Hood at LS666, 113% OLTP Nominal

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Figure 4.3.1-3 Peak Pressure Time History, 90° Hood

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Figure 4.3.1-4 Peak Pressure Time History, 270° Hood

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Figure 4.3.1-5 Peak Pressure PSD, 90° Hood

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Figure 4.3.1-6 Peak Pressure PSD, 270° Hood

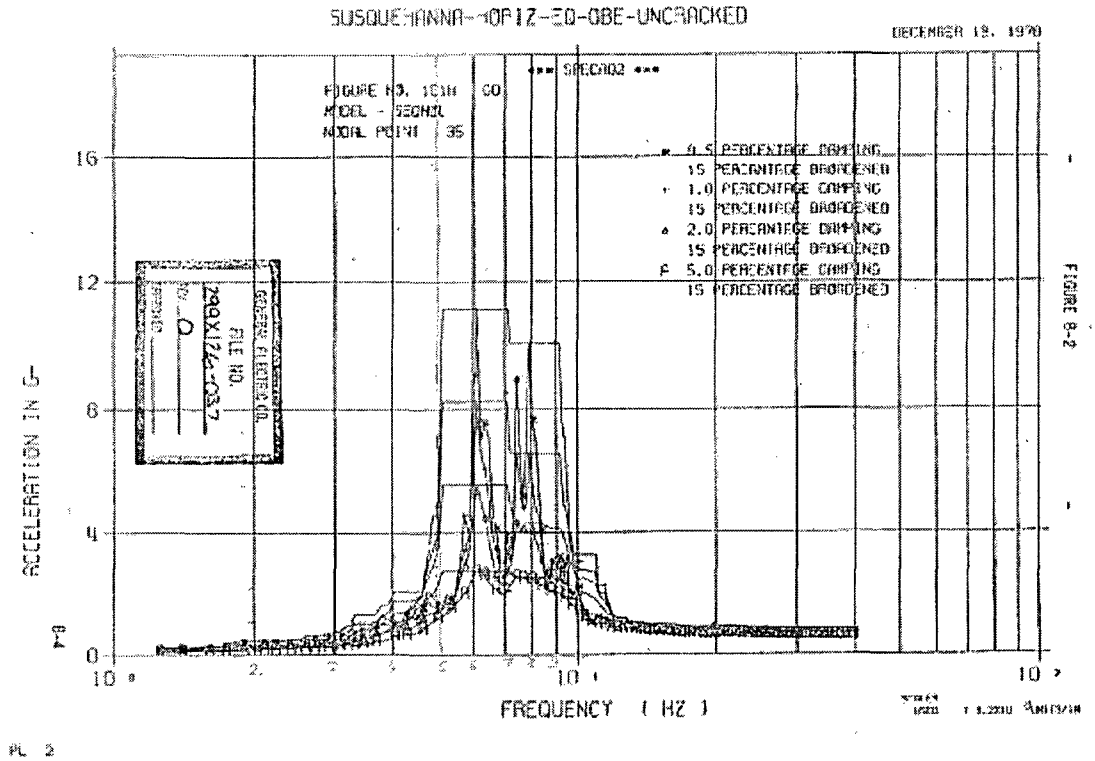

Figure 4.3.2-1 OBE-Uncracked Seismic Spectra

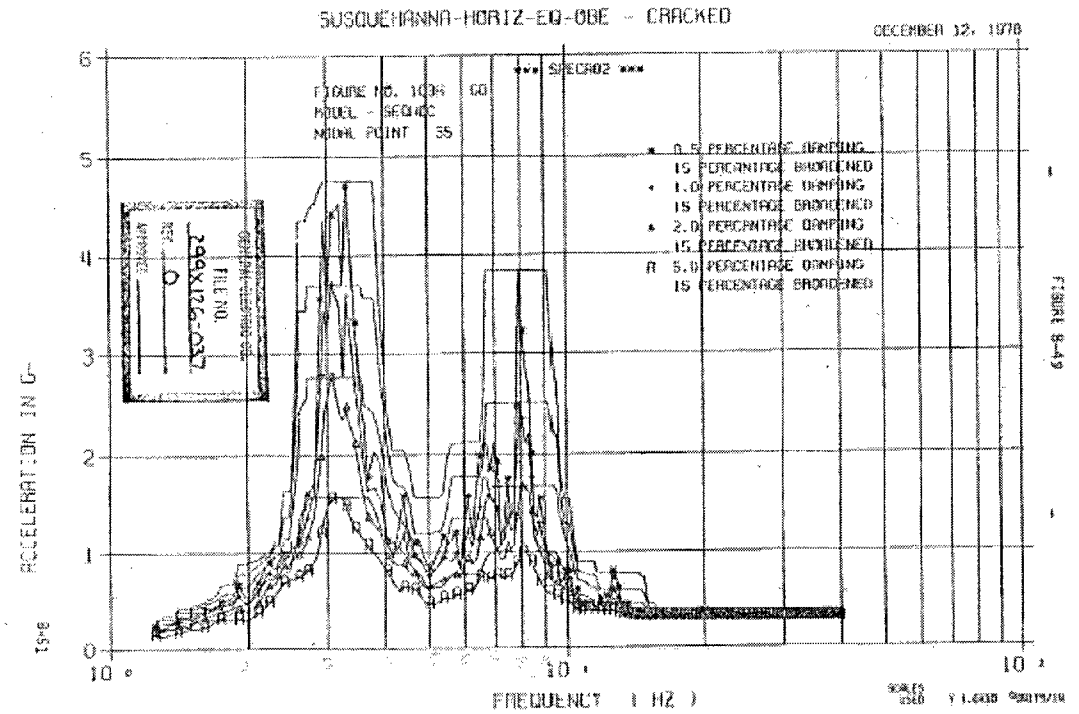

Figure 4.3.2-2 OBE-Cracked Seismic Spectra

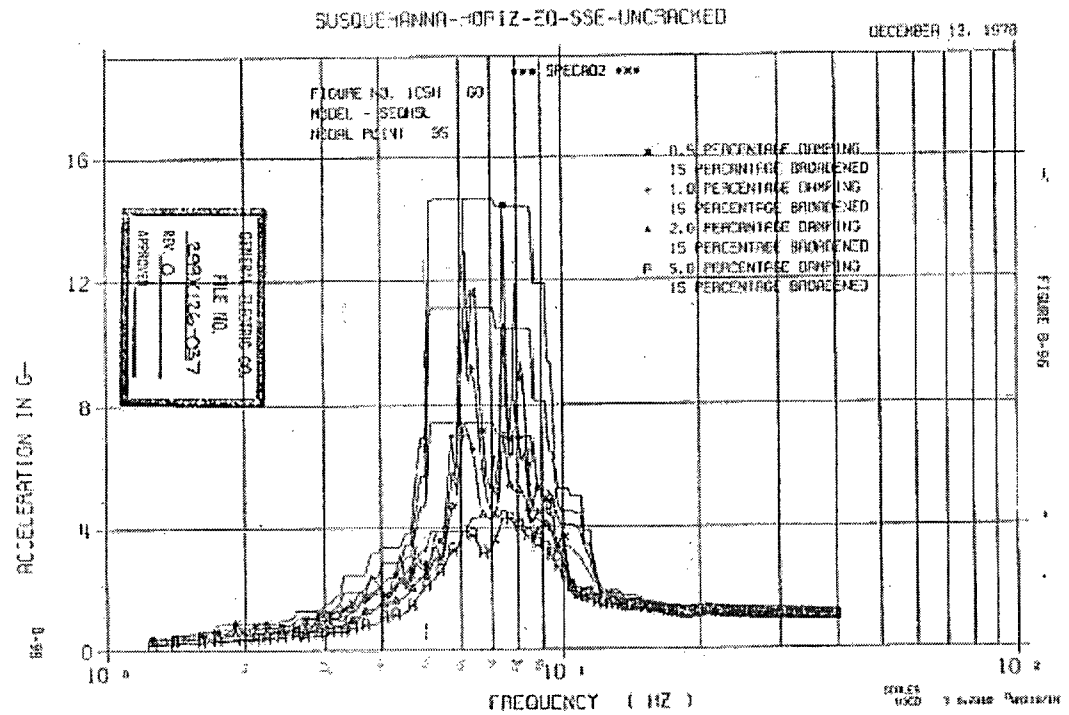

Figure 4.3.2-3 SSE-Uncracked Seismic Spectra

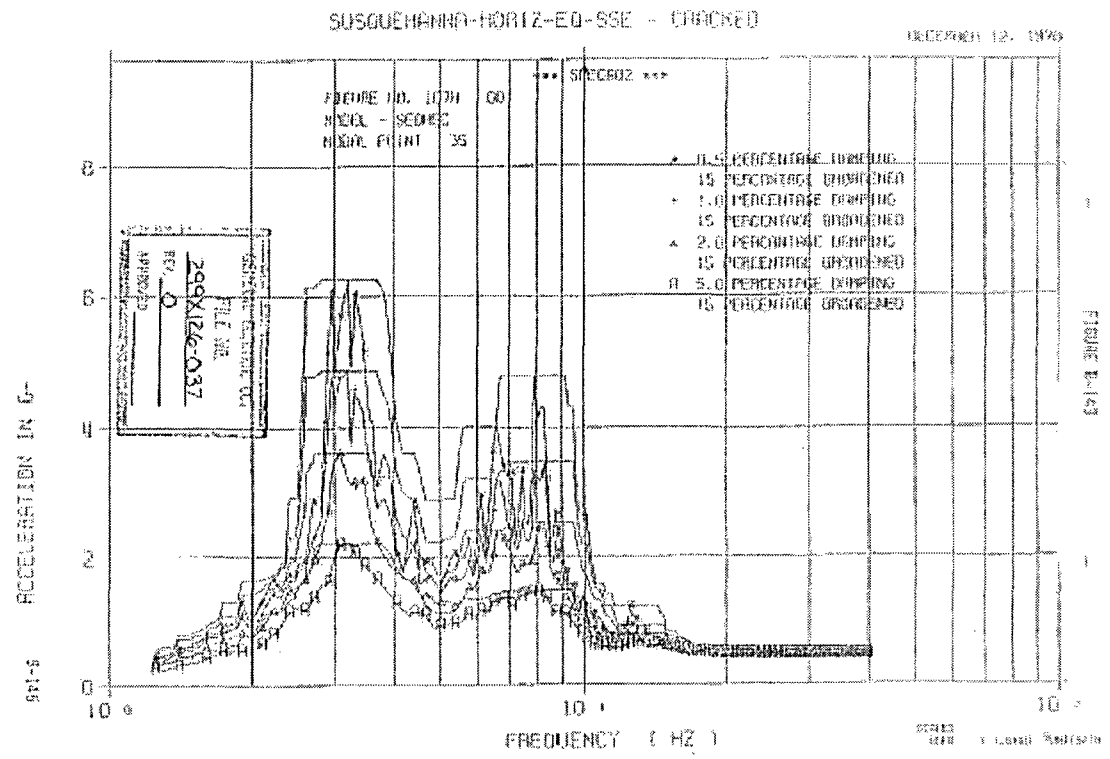

Figure 4.3.2-4 SSE-Cracked Seismic Spectra

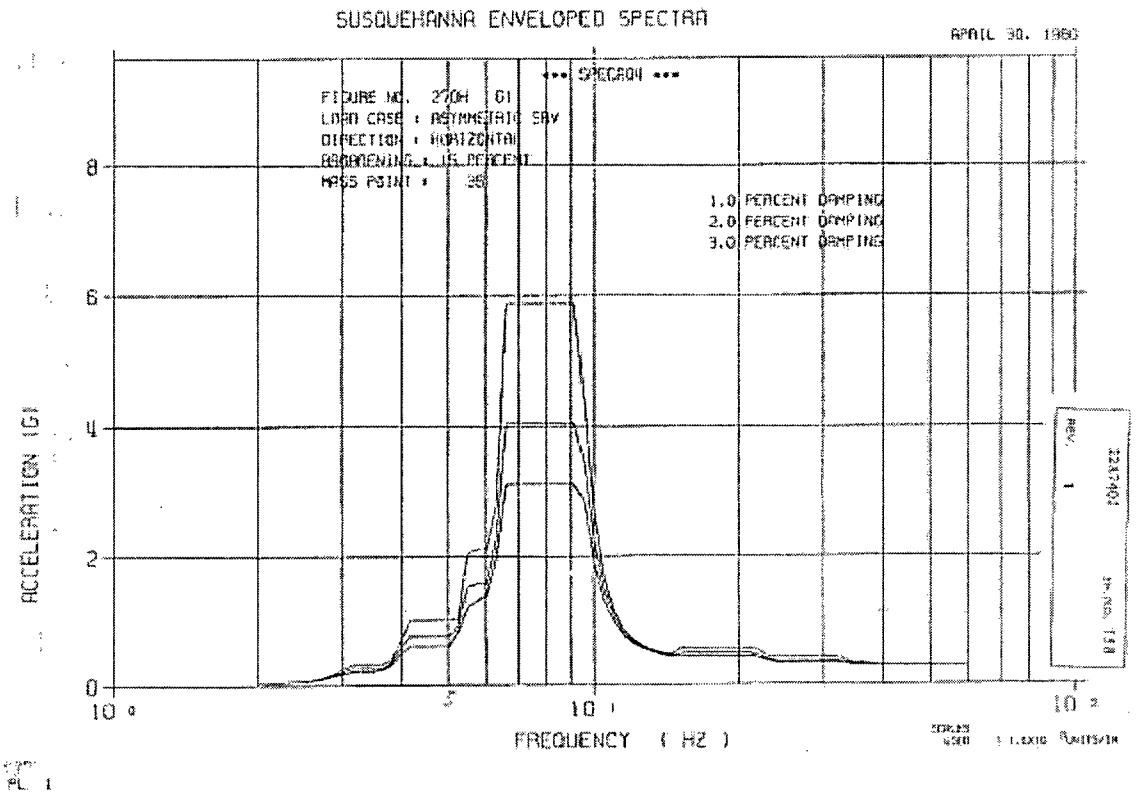

Figure 4.3.2-5 SRV Spectra

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Figure 5.1-1 Susquehanna Replacement Dryer Finite Element Model

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Figure 5.1-2 Section of Water Element

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Figure 5.1-3 Dryer Half Section and Vane Bank Model Detail

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Figure 5.1-4 Dryer Divider Plate, Hood Support and Center Cross Beam Model Detail

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Figure 5.1-5 Dryer Base Plate

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Figure 5.1-6 Trough Thin Section

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Figure 5.1-7 Trough Thick Section

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Figure 5.1-8 Bank End Plates - Inner

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Figure 5.1-9 Bank End Plates Outer

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Figure 5.1-10 Outlet End Plates Inner

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Figure 5.1-11 Outlet End Plates - Outer

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Figure 5.1-12 Hoods Inner

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Figure 5.1-13 Hoods Outer

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Figure 5.1-14 Inlet End Plates Inner

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Figure 5.1-15 Inlet End Plates Outer

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Figure 5.1-16 Skirt

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Figure 5.1-17 Drain Pipes

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Figure 5.1-18 Drain Channel

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Figure 5.1-19 Lower Skirt Ring

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Figure 5.1-20 Cover Plate

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Figure 5.1-21 Hood Tee Inner

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Figure 5.1-22 Hood Tee Outer

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Figure 5.1-23 Support Ring

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Figure 5.1-24 Tie Bars – Bank-to-Bank

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Figure 5.1-25 Tie Bars at Center

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Figure 5.1-26 Trans Brace Under Base Plate

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Figure 5.1-27 Trans Brace Brackets

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Figure 5.1-28 Bank Top Cap – Inner

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Figure 5.1-29 Bank Top Cap – Outer

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Figure 5.1-30 Divider Plate – Inner Bank

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Figure 5.1-31 Divider Plate – Outer Banks

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Figure 5.1-32 Hood Support – Inner Bank

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Figure 5.1-33 Hood Support – Outer Banks

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Figure 5.1-34 Susquehanna Dryer FE Model Boundary Conditions

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Figure 6.1-1 Rayleigh Damping Curve

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Figure 6.4-1 [[ ]] Stress Intensity from Full FE Model

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Figure 6.4-2 [[ ]] Submodel Details

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Figure 6.4-3 [[ ]] Submodel Cut boundary Conditions

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Figure 6.4-4 [[ ]] – Inner Submodel Results

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Figure 6.4-5 [[ ]] Submodel Results

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Figure 6.5-1 [[ ]] Bank to Bank Peak Stress Intensity

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Figure 6.5-2 [[ ]] Configuration Showing Tie Bar Pad

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Figure 6.6-1 [[ ]] – Inner Bank Peak Stress Intensity

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Figure 6.6-2 Center Bank [[ ]] Modification

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Figure 6.6-3 [[ ]] Submodel Stress Results

Attachment 3 to PLA-6323
GE- Hitachi Nuclear Energy Americas, LLC
Affidavit

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, Tim Abney, state as follows:

(1) I am Vice President, Services Licensing, Regulatory Affairs, GE-Hitachi Nuclear Energy Americas LLC ("GEH"), have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in GEH report, GE-NE-0000-0079-2250-P-R0, Susquehanna Replacement Steam Dryer Stress Analysis at Extended Power Uprate Conditions, January, 2008. The proprietary information is identified by a dotted underline inside double square brackets. [[This sentence is an example.{3}]] In each case, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GEH relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH's competitors without license from GEH constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals aspects of past, present, or future GEH customer-funded development plans and programs, resulting in potential products to GEH;

d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. above.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or subject to the terms under which it was licensed to GEH. Access to such documents within GEH is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist, or other equivalent authority for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2) above is classified as proprietary because it contains results and details of structural analysis methods and techniques developed by GEH for evaluations of BWR Steam Dryers. Development of these methods, techniques, and information and their application to the design, modification, and analyses methodologies and processes for the Steam Dryer Program was achieved at a significant cost to GEH.

The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GEH asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply

the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 18th day of January, 2008.

Tim E. Abney
GE-Hitachi Nuclear Energy Americas LLC