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Susquehanna Replacement Steam Dryer Fatigue Analysis

December 2006

(Non Proprietary)

GE Energy Nuclear

General Electric Company
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Engineering Report

Susquehanna Replacement Steam Dryer Fatigue Analysis

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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	GENE	General Electric Nuclear Energy
12	Hz	Hertz
13	IGSCC	Intergranular Stress Corrosion Cracking
14	Mlbm/hr	Millions pounds mass per hour
15	MS	Main Steam
16	MSL	Main Steam Line
17	MW_t	Megawatt Thermal
18	NA	Not Applicable
19	NRC	Nuclear Regulatory Commission
20	OBE	Operational Basis Earthquake
21	OLTP	Original Licensed Thermal Power
22	Pb	Primary Bending Stress
23	Pm	Primary Membrane Stress
24	PPL	Pennsylvania Power & Light
25	psi	Pounds per square inch
26	Ref.	Reference
27	RMS	Root-Mean-Squared
28	RPV	Reactor Pressure Vessel
29	SCF	Stress Concentration Factor
30	SRSS	Square Root Sum of Squares
31	SRV	Safety Relief Valve
32	SSES	Susquehanna Steam Electric Station

1. EXECUTIVE SUMMARY

This report documents the finite element stress analyses of the proposed 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 the 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 versus fatigue and ASME design criteria under the operating conditions.

The fatigue evaluations are performed at steam flow closely matching 113% of the Original Licensed Thermal Power (OLTP) flow conditions. 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 Susquehanna dryer.

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 dryer is structurally adequate to accommodate the FIV and mechanically induced vibration loads 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 proves the acceptability of the Susquehanna replacement steam dryer design.

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 the steam dryer's finite element model to calculate its 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 the 113% OLTP. In addition to these provided nominal loads, the time scale of the loads was stretched by plus and minus 10% respectively to create frequency shift in loads, in order to capture structural uncertainty. In all these transient response analyses, Rayleigh damping equivalent to 1% damping ratio was applied. The maximum stresses of dryer components were searched from all the solutions over the calculated response time histories. Based on a benchmarking analysis of 1985 strain gauge data, a scaling factor was applied to these stresses to include both flow and mechanically induced vibration. Subsequently, a scale factor is then used to extrapolate the stress results of 113% OLTP to EPU conditions, and the resulting stress values were used for component fatigue evaluation.

The results of the analyses on the original Susquehanna dryer identified that several dryer components were susceptible to fatigue failure under EPU operating condition. After a comprehensive review of alternative dryer modifications and a review of the operational history of previous dryer modifications, a replacement dryer configuration was proposed to sustain the vibration environment at EPU condition. This replacement dryer uses [[

]] thus to reduce component stresses and increase fatigue margin. The corresponding structural analyses are performed to predict the dryer's structural responses to the vibration loads and ASME load combination, and to assure the dryer meets the design criteria.

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

3. MATERIAL PROPERTIES

The dryer assembly is manufactured from Type 304 conforming to the requirements of the material and fabrication specifications. ASME material properties are used [Reference 2]. The applicable properties are shown in Table 3-1.

Table 3-1 Properties of SS304 [Reference 2]

Material / property	Room temperature 70°F	Operating temperature 545°F
SS304		
S_y, Yield strength, psi	30,000	17,000
S_u, Ultimate strength, psi	75,000	63,500
E, Elastic modulus, psi	28,300,000	26,430,000

4. DESIGN CRITERIA

4.1 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. [[

]]

4.2 ASME Code Criteria for Load Combination

The ASME Code stress limits used in the evaluation of the Susquehanna dryer are listed in Table 4-1.

Table 4-1 ASME Code Stress Limits [Reference 3]

Service level	Stress category	Core Support Structures Stress limits (NG)	
			Stress Limit (ksi)
Service levels A & B	P_m	S_m	16.9
	$P_m + P_b$	$1.5\ S_m$	25.35
Service levels C	P_m	$1.5\ S_m$	25.35
	$P_m + P_b$	$2.25\ S_m$	38.03
Service level D	P_m	Min ($.7S_u$ or $2.4\ S_m$)	40.56
	$P_m + P_b$	1.5 (P_m Allowable)	60.84

Legend:

P_m: General primary membrane stress intensity
P_b: Primary bending stress intensity
S_m: ASME Code stress intensity limit
S_U: Ultimate strength

Table 4-1 Note: 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).

5. DRYER FEA MODEL AND APPLIED LOADS

5.1 Full Dryer Shell Finite Element Model

The replacement dryer configuration only [[

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5.2 Dynamic Pressure Loads

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. [[

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The loading time history developed with the CDI acoustic circuit model is used as the nominal load case for the replacement steam dryer FIV analysis. In order to capture structural uncertainties, the time scale of this nominal load is stretched or compressed to create load cases with frequency shifts. In this replacement dryer fatigue analysis, a total of 9 load cases are created and analyzed. These 9 load cases include the nominal, minus10 (-10%), minus7.5 (-7.5%), minus5 (-5%), minus2.5 (-2.5%), plus2.5 (+2.5%), plus5 (+5%), plus7.5 (+7.5%), and plus10 (+10%) load cases.

5.3 Spatial Distribution, Time History and Frequency Contents of the Loads

[[

]] The spatial distributions of pressure on the dryer at these two instances are shown in Figures 5-16 and 5-17, respectively. The spatial distribution shows that the high pressure occurs near the MSL locations.

The pressure time histories, measured at the two maximum pressure locations on the outer hoods, are shown in Figures 5-18 and 5-19. [[

]] 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 5-18 and 5-19 are shown in Figures 5-20 and 5-21, respectively. [[

]]

5.4 [[ ]] and Extrapolation to EPU

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 such that a stress under-prediction factor of 2.17 should be applied to the FEA stress results to bring them inline with the testing measurements. This approach (i.e., use of an adjustment factor) will be used in the replacement Susquehanna dryer fatigue evaluation.

The FIV analysis for the replacement steam dryer is performed with the loading developed from the Susquehanna in-plant main steam line pressure measurements for 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 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 5], the MSL pressure measurements [Reference 7], and SSES-specific scale model testing [Reference 8]. [[

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6. VIBRATION ANALYSIS AND PREDICTED COMPONENT STRESSES

6.1 Vibration Analysis Approach

The structural responses of the replacement steam dryer [[

]] 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.

Of the 9 load cases, the maximum stress intensity of nominal load is to be used for fatigue margin calculation using the following formula:

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

[[

]]

The difference between the nominal case and the maximum stress of all 9 cases is used to evaluate structural uncertainty using the following formula:

$$\text{Structural Uncertainty} = \frac{\text{Maximum Stress}}{\text{Nominal Stress}} - 1$$

The design criteria based on these fatigue margin and structural uncertainty values is to require each component to have fatigue margin greater than its structural uncertainty.

Table 6-1 summarizes the component stresses and the associated structural uncertainty. Corresponding to the stress values of the nominal load case, the component stress plots are shown in Figures 6-2 through 6-21.

Table 6-1 Maximum Stress Intensity from Vibration Solution under 113%OLTP Loads

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6.3 Initial Fatigue Assessment and [[ ]]

The scale factors applying to the stresses for fatigue evaluation for EPU conditions include a weld factor of 1.0, 1.4, or 1.8 depending on the weld configuration [Reference 1], a stress under-prediction factor of 2.17 and an EPU scale factor of 1.15 (Section 5.4). With these factors included, an initial fatigue assessment was made. The results indicated that the skirt and the inner vane bank end plate might be susceptible to fatigue.

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6.3.1 [[ ]] Stress Prediction

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At this region, the dryer FE model has introduced simplifications in order to capture the dynamic behavior without complicating the FE model. [[

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6.3.2 [[ ]] Stress Investigation

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7. FATIGUE PREDICTION AT EPU CONDITIONS

Based on the vibration response in Section 6.2 and [[
]] in Section 6.3, the Susquehanna replacement dryer's component stresses are summarized in Table 7-1, [[

]] Structural uncertainty is also calculated for every component in Table 7-1. Correspondingly, the component fatigue margins are calculated in Table 7-2.

The results in Table 7-2 indicate that all dryer components' fatigue margins are greater than their structural uncertainty. Therefore, all components of this Susquehanna replacement dryer meet the design criteria, and, this replacement dryer concept is structurally adequate to accommodate the vibration environment at EPU condition. This proves the replacement dryer concept's feasibility of sustaining the vibration loads.

Table 7-1 Updated Component Stress Summary

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Table 7-2 Predicted Fatigue Margin under EPU Condition

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8. ASME LOAD COMBINATIONS

The Susquehanna steam dryer was analyzed for the ASME Code load combinations (primary stresses) shown in Table 8-1. The acceptance criteria used for these evaluations are specified in Section 4.2 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.

8.1 ASME Code Load Combinations

Susquehanna is a "New Loads" plant. The resulting load combinations for each of the service conditions are discussed in Reference 9 and summarized in Table 8-1.

Table 8-1 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:

AC1 = Acoustic load due to Main Steam Line Break (MSLB) outside containment, at the Rated Power and Core Flow (Hi-Power) Condition.

AC2 = Acoustic load due to Main Steam Line Break (MSLB) outside containment, at the Low Power/High Core Flow (Interlock) Condition.

AP = Annulus Pressurization Loads

CHUG = Chugging (LOCA) Loads, Greater of symmetric or asymmetric chugging loads.

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.

JR = Jet Reaction Loads

OBE = Operating Basis Earthquake.

SSE = Safe Shutdown Earthquake.

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

SRV_{ADS}= SRV Loads caused by the "automatic depressurization system"

TSV1 = The Initial Acoustic Component of the Turbine Stop Valve (TSV) Closure Load (Inward load on the outermost hood closest to the nozzle).

TSV2 = The Flow Impingement Component (following the Acoustic phase) of the TSV Closure Load (Inward load on the outermost hood closest to the nozzle).

8.2 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 4-1) is a very conservative way of structural components evaluation. However, as it is shown in Table 8-2 and Table 8-3, this conservative qualification has been successful for all the components and load combinations. Table 8-2 and Table 8-3 list the components maximum stresses obtained from the ANSYS analysis.

For ASME load combination analysis, [[

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Table 8-2 and Table 8-3 summarize the ASME load combination analysis results and indicate that the stresses for all structural components are under the allowable ASME Code limits at EPU operating conditions.

Table 8-2 EPU ASME Results for Normal and Upset Conditions: Maximum Stresses

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Table 8-3 EPU ASME Results for Emergency and Faulted Conditions: Maximum Stresses

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9. CONCLUSIONS

Finite element stress analyses are performed for the replacement Susquehanna steam dryers to predict dryer's 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 (FEM) 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 proves the acceptability of the Susquehanna replacement steam dryer design.

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Figure 5-1 Thickness Increase of Susquehanna Replacement Dryer

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Figure 5-2 Susquehanna Dryer Finite Element Model

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Figure 5-3 Section of Water Element

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Figure 5-4 Dryer Top Plate Details

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Figure 5-5 Trough Thin and Thick Section Details

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Figure 5-6 Bank Top Plate and Top Side Plate Details

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Figure 5-7 Outer Vane Bank End Plate and Inner Vane Bank Plate Details

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Figure 5-8 Thin and Thick End Plate Details

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Figure 5-9 Inner Hood and Outer Hood Details

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Figure 5-10 Hood Support Details

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Figure 5-11 Inlet End Plates (Thin and Thick) Details

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Figure 5-12 Drain Pipes, Drain Channels, Skirt and Lower Skirt Ring

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Figure 5-13 Vane Banks with Perforated Plates

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Figure 5-14 Susquehanna Dryer FE Model's Boundary Conditions

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Figure 5-15 Vane Bundle-Trough Interface Boundary Conditions

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Figure 5-16 Pressure Distribution on 90° Hood at LS547. 113% OLTP Nominal

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Figure 5-17 Pressure Distribution on 270° Hood at LS666. 113% OLTP Nominal

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Figure 5-18 Peak Pressure Time History, 90° Hood

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Figure 5-19 Peak Pressure Time History, 270° Hood

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Figure 5-20 Peak Pressure PSD, 90° Hood

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Figure 5-21 Peak Pressure PSD, 270° Hood

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Figure 6-1 Rayleigh Damping Curve

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Figure 6-2 Dryer Base Plate Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-3 Trough Thin Section Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-4 Trough Thick Section Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-5 Bank Top Plate Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-6 Bank Top Side Plates Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-7 Outer Vane Bank End Plate Max. Stress Intensity, 113%OLTP Nominal

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Figure 6-8 Inner Vane Bank End Plate Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-9 Thin End Plates Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-10 Thick End Plates Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-11 Inner Hood Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-12 Outer Hood Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-13 Hood Support Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-14 Inlet End Plate (Thin) Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-15 Inlet End Plate (Thick) Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-16 Skirt Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-17 Support Ring Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-18 Drain Pipe Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-19 Drain Channel Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-20 Lower Skirt Ring Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-21 Cover Plate Max. Stress Intensity, 113% OLTP Nominal

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Figure 6-22 Skirt Max. Stress Intensity, 113% OLTP Minus75

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Figure 6-23 [[ ]]

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Figure 6-24 [[ ]]

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Figure 6-25 [[ ]]

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Figure 6-26 [[ ]]

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Figure 6-27 Inner Vane Bank End Plate Max. Stress Intensity, 113% OLTP, Plus10

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Figure 6-28 Sketch of the Tie rod and Inner Vane Bank End Plate Joint

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Figure 6-29 Inner Vane Bank End Plate without Tie rod Joint Regions

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Figure 6-30 Updated Inner Vane Bank End Plate Max. Stress, 113% OLTP, Minus10

Enclosure 5 to PLA-6146
Description of PPL Commitment Closure

(Non Proprietary Version)

Introduction

In the Attachment to PLA-6128 (Reference 4), PPL committed to provide the following:

1) A summary of proposed steam dryer structural modifications;

2) The results of the final finite element analyses at 120% original licensed thermal power (OLTP), based on the final dryer structural configuration;

3) ASME load combination tables, based on the 120% OLTP condition; and,

4) A description of the steam dryer power ascension test plan.

The following provides a summary description of how each of these commitments have been satisfied.

Regulatory Commitment (1)

Provide a Summary of Proposed Steam Dryer Structural Modifications

In Attachment 10 of PPL's CPPU submittal (Reference 1), several dryer sub-components were identified has having little, or no fatigue margin. Thus, the fatigue analysis indicated that modifications to the dryer will be required for CPPU operation.

In Attachment 1 of PPL letter (Reference 3), PPL stated that a review had been completed of modifications required to resolve the over stress conditions identified with the current Susquehanna steam dryer design. The review concluded that structural modifications to the existing steam dryer are not justifiable when economic and ALARA factors are considered. As a result, PPL directed General Electric (GE) to design and fabricate two new steam dryers for the Susquehanna units. The new Unit 1 steam dryer will be installed during the 2008 refueling outage and the new Unit 2 steam dryer will be installed during the 2009 refueling outage.

The new Susquehanna steam dryer design has resolved the over stress conditions. The new Susquehanna steam dryer design maintains the current curved hood configuration and the current geometry and dimensional envelope. Critical structural components have had their thickness increased to improve the overall stiffness of the steam dryer. The critical component changes are:

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These changes are graphically depicted in Figure 5-1 of the "Susquehanna Replacement Steam Dryer Fatigue Analysis," which is provided in Enclosure 1.

Regulatory Commitment (2)

Provide the Results Of The Final Finite Element Analyses At 120% Original Licensed Thermal Power (OLTP), Based On The Final Dryer Structural Configuration

GE has constructed a finite element model for the new steam dryer and has completed the required fatigue analysis. The 113% OLTP Acoustic Circuit Model (ACM) loads calculated for the existing steam dryer were input to the new Finite Element Analysis (FEA) model. These 113% OLTP loads are based on a composite load definition from main steam line strain gauge data obtained during MSIV slow closure testing, where each of the four MSIVs were closed one at a time. In the FEA, small time steps were used which correspond to frequency shifts of [[

]] to determine the maximum stress intensities. Weld factors were then applied, and the maximum stress intensities [[ ]]. The 113% stress intensities were then scaled to the full CPPU steam flow conditions. The FEA model used to generate the stress intensities is discussed in detail in Sections 5 and 6 of the "Susquehanna Replacement Steam Dryer Fatigue Analysis," which is provided in Enclosure 1

The final results of the GE FEAs indicate that the maximum stress intensities for all components, including structural uncertainties, are below the ASME 13,600 PSI fatigue design limit for 304 stainless steel with adequate margins. In addition, Table 1 below identifies the margins for the critical dryer structural components, with consideration given to Susquehanna's "end-to-end" uncertainty evaluation, which was provided in Attachment 10 of PPL's CPPU submittal (Reference 1).

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TABLE 1 - Worst Case Margin Analysis With "End-To-End" Uncertainties

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Regulatory Commitment (3)

Provide the ASME Load Combination Tables, Based On The 120% OLTP Condition

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The complete ASME load combination analysis is presented in Section 8 of the "Susquehanna Replacement Steam Dryer Fatigue Analysis", which is provided in Enclosure 1.

Regulatory Commitment (4)

Provide a Description Of The Steam Dryer Power Ascension Test Plan

PPL will instrument the new Susquehanna Unit 1 steam dryer with various instrumentation at selected high stress locations. As a result, during power ascension, dryer stress intensities will be determined via the direct measurement of subcomponent strains, accelerations, etc. Concurrent data will be obtained from the main steam line strain gauges for comparison to future Unit 2 measurements, which will be obtained during that unit's power ascension testing.

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Power will be increased at 2.5% increments and instrument output will be recorded and compared to ASME Code fatigue limits. If any stress intensity

above the Code allowable is recorded, power will be decreased to the point where acceptable stresses are maintained, and an engineering evaluation will be performed prior to ascending to the next power level.

In addition, MSIV slow closure testing will be performed at a selected power level to simulate the full 120% OLTP steam flow conditions, and dryer strain gauge data will be collected. This data will be used to confirm the absence of branch line acoustic resonances at the full CPPU steam flows. In addition, this data will provide the bases to allow Unit 2 to proceed to the full CPPU operating conditions.

Finally, PPL will continue to inspect the new steam dryers following each cycle of operation in accordance with the BWRVIP and GE recommendations.

General Electric Company

AFFIDAVIT

I, George B. Stramback, state as follows:

(1) I am Manager, Regulatory Services, General Electric Company ("GE") and 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 Enclosure 1 to GE letter GE-SSE-EP-315, Larry King to Mike Gorski (PPL), *GE Review of draft PPL letter, PLA-6146*, dated December 21, 2006. The Enclosure 1 (*GE Review of PPL Letter PLA-6146*) proprietary information is delineated by a double underline inside double square brackets. Figures and large equation objects are identified with double square brackets before and after the object. In each case, the sidebars and 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, GE 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 General Electric's competitors without license from General Electric 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 General Electric customer-funded development plans and programs, resulting in potential products to General Electric;

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 GE, 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 GE, 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. Access to such documents within GE 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, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GE 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 details of steam dryer testing and analyses of the design of the Susquehanna BWR Steam Dryer. Development of this information and its application for the design, procurement and analyses methodologies and processes for the Steam Dryer Program was achieved at a significant cost to GE, on the order of approximately two million dollars.

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

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GE's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GE'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 GE.

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.

GE's competitive advantage will be lost if its competitors are able to use the results of the GE 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 GE 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 GE of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing 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 21st **day of** December **2006.**

George B. Stramback

George B. Stramback
General Electric Company

General Electric Company

AFFIDAVIT

I, George B. Stramback, state as follows:

(1) I am Manager, Regulatory Services, General Electric Company ("GE") and 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 GE proprietary report GE-NE-0000-0061-0595-P-R0, *Susquehanna Replacement Steam Dryer Fatigue Analysis*, Class III (GE Proprietary Information), dated December 2006. The proprietary information is delineated by a double underline inside double square brackets. Figures and large equation objects are identified with double square brackets before and after the object. In each case, the sidebars and 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, GE 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).

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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 General Electric customer-funded development plans and programs, resulting in potential products to General Electric;

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.

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(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. Access to such documents within GE 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, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GE 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 details of steam dryer fatigue analyses of the design of the replacement Susquehanna BWR Steam Dryer. Development of this information and its application for the design, procurement and analyses methodologies and processes for the Steam Dryer Program was achieved at a significant cost to GE, on the order of approximately two million dollars.

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

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GE's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GE'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 GE.

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.

GE's competitive advantage will be lost if its competitors are able to use the results of the GE 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 GE 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 GE of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing 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 22nd day of December 2006.

George B. Strámback
General Electric Company