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Attachment 1 contains proprietary information

GNRO-2011/00018

March 30, 2011

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

SUBJECT: Request for Additional Information Regarding
Extended Power Uprate
Grand Gulf Nuclear Station, Unit 1
Docket No. 50-416
License No. NPF-29

REFERENCES:
1. NRC Letter to Entergy Operations, Inc., "Grand Gulf Nuclear Station, Unit 1 – Request for Additional Information Regarding Extended Power Uprate Application License Amendment Request (TAC NO. ME4679) dated March 2, 2011 (Accession Number ML110550475)
2. License Amendment Request, Extended Power Uprate, dated September 8, 2010 (GNRO-2010/00056, Accession Number ML102660403)

Dear Sir or Madam:

The Nuclear Regulatory Commission (NRC) requested additional information (Reference 1) regarding certain aspects of the Grand Gulf Nuclear Station, Unit 1 (GGNS) Extended Power Uprate (EPU) License Amendment Request (LAR) (Reference 2). Attachment 1 provides responses to the additional information related to the steam dryer.

GE-Hitachi Nuclear Energy Americas, LLC (GEH) consider portions of the information provided in support of the responses to the request for additional information (RAI) in Attachment 1 to be proprietary and therefore exempt from public disclosure pursuant to 10 CFR 2.390. An affidavit for withholding information, executed by GEH, is provided in Attachment 3. The proprietary information was provided to Entergy in a GEH transmittal that is referenced in the affidavit. Therefore, on behalf of GEH, Entergy requests to withhold Attachment 1 from public disclosure in accordance with 10 CFR 2.390(b)(1). A non-proprietary version of the RAI responses is provided in Attachment 2.

No change is needed to the no significant hazards consideration included in the initial LAR (Reference 2) as a result of the additional information provided. There are new commitments included in Attachment 4.

If you have any questions or require additional information, please contact Jerry Burford at 601-368-5755.

I declare under penalty of perjury that the foregoing is true and correct. Executed on March 30, 2011.

Sincerely,

MAK/FGB/dm

Attachments:
1. Response to Request for Additional Information, Steam Dryer (Proprietary)
2. Response to Request for Additional Information, Steam Dryer (Non-Proprietary)
3. GEH Affidavit for Withholding Information from Public Disclosure
4. List of Regulatory Commitments

cc: Mr. Elmo E. Collins, Jr.
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Attachment 2

GNRO-2011/00018

Grand Gulf Nuclear Station Extended Power Uprate

Response to Request for Additional Information

Mechanical and Civil Engineering Branch, Steam Dryer (Non-Proprietary)

This is a non-proprietary version of Attachment 1 from which the proprietary information has been removed. The proprietary portions that have been removed are indicated by double square brackets as shown here: [[ ]].

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Response to Request for Additional Information
Steam Dryer

By letter dated September 8, 2010, Entergy Operations, Inc. (Entergy) submitted a license amendment request (LAR) for an Extended Power Uprate (EPU) for Grand Gulf Nuclear Station, Unit 1 (GGNS) (Accession No. ML102660403). The U.S. Nuclear Regulatory Commission (NRC) staff has determined by correspondence dated March 2, 2011 (Accession No. ML110550475) that the following additional information related to the steam dryer is needed for the NRC staff to complete their review of the amendment. Entergy's response to each item is also provided below.

The proprietary version of GE Hitachi Nuclear Energy Americas LLC (GEH) report NEDC-33601P, Revision 0, "Engineering Report Grand Gulf Replacement Steam Dryer Fatigue Stress Analysis Using PBLE [Plant Based Load Evaluation] Methodology," as cited below, was included as Attachment 11B to the EPU LAR. The non-proprietary version of NEDO-33601 was included as Attachment 11A to the EPU LAR and is publicly available under the following ADAMS accession numbers: ML102660401 (Cover through Appendix A); ML102660406 (Appendix B through Appendix D); and ML102660407 (Appendix E through Appendix G).

RAI # 1

The GE Hitachi Nuclear Energy Americas LLC (GEH) report NEDC-33601P, Revision 0, "Engineering Report Grand Gulf Replacement Steam Dryer Fatigue Stress Analysis Using PBLE [Plant Based Load Evaluation] Methodology," provides several comparisons between the design loading functions at the extended power uprate (EPU) level for the steam dryer of GGNS and sample loading functions from other plants. Figures 3.19 to 3.21 show that the loading on the [[ ]] steam dryer is higher than the EPU design load for GGNS over a wide range of frequencies (up to 200 Hertz (Hz)). While the GGNS loading at the safety relief valve (SRV) resonance frequencies has been increased to envelope the [[ ]] loading, the broadband loading function at the lower frequency range (0 to 200 Hz) has not been increased to envelope the loading of the [[ ]]. The licensee is requested to substantiate the reasons for not increasing the GGNS low frequency loading to envelope the loading function of the [[ ]], similar to the approach used in the high frequency range.

Response

In the GGNS replacement dryer analysis, the PBLE acoustic loads developed from [[

]] combined with [[ ]] SRV resonance load adders at [[
]] were used in the finite element structural evaluation. The amplitude of SRV resonance load adders were determined in such a way that the projected GGNS design basis loads at these [[ ]] SRV resonances bounded the projected peak resonant loads from

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plants with [[ ]], as shown in Figures 3-19 through 3-21. This design approach applied to the potential SRV resonances is a means to accommodate the additional uncertainty associated with predicting the onset and magnitude of these loads.

However, it is not necessary to use a similar approach for the non-resonance frequencies within the loading spectrum, because the [[ ]]. Furthermore, using the dryer loads developed from [[ ]] together with [[ ]] SRV resonances, a detailed structural analysis on GGNS replacement dryer was performed and demonstrated that the dryer will maintain structural integrity under normal, upset, emergency and faulted conditions at EPU power levels.

It should be noted that the [[ ]] plant whose data are shown in Figures 3-19 through 3-21 has been operating with the original [[ ]] dryer at the [[ ]] OLTP power level for more than seven years with only minimal fatigue cracking at locations [[ ]]. Minimal fatigue cracking has also occurred at these locations on other [[ ]]. These [[ ]] have been eliminated in the GGNS replacement dryer design. The GGNS replacement dryer design introduces a substantial amount of margin to fatigue cracking when compared to the original [[ ]] dryer design and operating experience, which provides further assurance that the GGNS replacement dryer will maintain structural integrity during operation at EPU power levels.

The acoustic loads for GGNS have been evaluated and trended up through CLTP. During power ascension to EPU conditions, the acoustic pressure within the main steam lines will be monitored, the trending updated, and the resulting pressure loads on the dryer will be compared to the power ascension limit curves, which were determined from the FIV analysis results. The differences in the acoustic loads between the original [[ ]] dryer design and the GGNS replacement dryer shown in Figures 3-19 through 21 are [[ ]]. Based on trending from GGNS and from other EPU efforts, the non-resonant loading is most reliably determined using [[ ]]. During the subsequent refueling outages, the replacement dryer will be inspected following the recommendations in General Electric Service Information Letter 644 “BWR Steam Dryer Integrity” dated August 30, 2006. The analysis, measurement and inspection program ensures the structural soundness of the GGNS replacement dryer during operation at EPU power levels.

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Given the design approach, as well as the fact that comprehensive monitoring and inspection plan will be applied to GGNS, additional bounding loads for the low frequency acoustic signals were not deemed necessary.

RAI # 2

In NEDC-33601P, Revision 0, the licensee states that the plant measurements on the main steam lines (MSLs) of GGNS were performed at high power levels [[ ]] in 2008 and at low power levels [[ ]] in 2010. Based on comparisons of the noise floor of GGNS with those used to benchmark the PBLE methodology, the licensee concluded that no additional bias error due to differences in the noise floor levels is needed in the stress analysis computations of the steam dryer of GGNS. Since the noise floor for GGNS appears to be determined from the low power measurements in 2010, while the CLTP measurements were performed in 2008, the licensee is requested to explain how the conservatism is maintained in the stress analysis computations. In addition, the licensee is requested to explain how the noise floor level measured at high power in 2008 is ensured to be similar to that determined at low power measurements during 2010.

Response

NEDC-33601P Appendix A Section 4.2 describes how the low power testing measurements are used to assess the noise floor of the subject plant against the noise floor for the benchmark plant measurements. [[

]] Based on the GGNS low power measurements, as well as the low power measurements taken for the BWR/4 prototype plant, it was determined [[

]]

The Main Steam Line (MSL) strain gage data acquired in 2008 at CLTP conditions was used in developing the dryer pressure load definition for structural evaluation. [[

]]

In the PBLE load generation process for GGNS, the 2008 MSL measurement data was applied through the [[ ]] to produce the acoustic loads. [[

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]] the NRC staff has determined that a minimum alternating stress ratio of 2.0 be maintained between the maximum predicted stress intensity results and the allowable alternating stress intensity. One of the stated bases for the 2.0 margin requirement is to ensure that there is adequate margin to the fatigue acceptance criteria for cases where the subject plant noise floor is lower than the noise floor in the QC2 benchmark data (Reference 1).

[[

]] Although the GGNS steam flow velocity is lower than QC2, [[

]]

[[

]]

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[[ ]] Again, the PBLE load definition used in the GGNS structural analysis was not adjusted or manipulated based on the noise floor comparison between the GGNS plant and the PBLE benchmark plant.

References:

1. Letter, Stephen S. Philpott (NRC) to Jerald G. Head (GEH), “Boiling Water Reactor Operating Fleet – Extended Power Uprate Technical Basis for the Requirement of a Minimum Alternating Stress Ratio of 2.0,” dated July 27, 2010 (MFN-10-219).

[[

]]

Figure 1: Noise Floor Comparison between 2008 and 2010 B-Upper Location (three channel average)

[[

]]

Figure 2: Noise Floor Comparison between 2008 and 2010 C-Lower Location (three channel average)

[[

]]

Figure 3: Noise Floor Comparison: GGNS three channel average to BWR/4 Four Strain Gauge Average (unfiltered data)

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[[

]]

Figure 4: NEDC-33601P Appendix A, Revised Figure 4-4

RAI # 3

NEDC-33601P, Revision 0, Section 3.3.4.3.1, "Weld Quality Factor," states that,

> To assure high quality welds, new or replacement steam dryer fabrication employs weld processes that have been fully qualified. [[
>]].

The licensee is requested to confirm that the minimum detectable flaw size will be less than the critical flaw size. The licensee is also requested to confirm that the critical flaw size will be larger than the thickness of the weld bead for root and final pass.

Response

GEH designs and fabricates the steam dryer based on the ASME Section III Subsection NG Code (Reference 1). The steam dryer is a non-safety related component and is classified as an Internal Structure as defined in Subsection NG, Paragraph NG-1122. BWR steam dryers are manufactured from Austenitic 300 series stainless steel conforming to the GEH material and fabrication specifications.

Similar to safety related reactor internals, a newly constructed steam dryer is acceptable for service as long as the rules of NG are followed. Examinations of the welds are conducted as per the acceptance standards specified in NG-5352. In the GGNS replacement dryer, full penetration welds are inspected on both surfaces and the weld root pass. The welder inspects each pass, prior to depositing the next layer. There are groove welds designed with other dryer components as a backing bar. Root and near face of the backed groove welds are examined using visual and liquid penetrant test. The base metal surfaces, which are backing the weld root are also inspected prior to performing the single side groove welds. Therefore, flaws on the surface of these welds are not an issue.

A structural analysis of the steam dryer that will meet the required fatigue and ASME load combination stress criteria has been performed. The dryer austenitic material is ductile, therefore brittle failure is not an issue. The controlling loading on the dryer is high cycle fatigue. The dryer has been analyzed to the requirements described in NEDC-33601P. Subsection NG requires no specific analysis to evaluate critical crack size for the defined load conditions. Method of examination employed meets the requirements of Table NG-3352-1 for the fatigue factor used in the analysis. The replacement dryer will employ weld processes that have been fully qualified including metallurgical evaluations with initial and final PT to assure high quality welds. PT and VT examination on austenitic stainless steam dryer components surfaces provide reasonable assurance that undetected flaws as defined by the acceptance standard in NG-5352 will be below the threshold where crack growth will be a concern.

The root pass of all steam dryer full penetration welded joints, partial penetration welds and fillet welds is made by using a Gas Tungsten Arc Welding process. The thicknesses of the deposited welds are controlled by limiting the heat input to 50,000 Joules / inch, employing the stringer bead technique and depositing root bead with a maximum thickness of ~3/16".

References:

1. ASME Boiler and Pressure Vessel Code Section III Division 1- Subsection NG

RAI # 4

NEDC-33601P, Revision 0, Section 5.6.1.2, "Structural FEM [Finite Element Model] Bias and Uncertainty," states that,

[[

]]

The licensee is requested to provide a basis or a reference in support of this statement.

Response

The quoted summary statement is a qualitative conclusion based closely upon the end-to end PBLE and FEM wideband biases and uncertainties reported in MFN 09-509, Enclosure 2, Attachment 1, pages 21-23 (Reference 1). A similar discussion also appears on page 99 of Appendix C to NEDC-33601P.

References:

1. MFN 09-509, Letter from R.E. Kingston, GEH, to U.S. Nuclear Regulatory Commission, "Response to Portion of NRC RAI Letter No. 220 and 339 Related to ESBWR Design Certification Application – DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Numbers 3.9-213 and 3.9-217 S01," July 31, 2009.

RAI # 5

Fig. 3.20 in Appendix A, "Steam Dryer Integrity Analysis Methodology," of NEDC-33601P, Revision 0, shows the method of extrapolating the SRV resonance amplitudes. The licensee is requested to explain:

(a) Why the higher SRV resonance frequencies (e.g., [[ ]]) are excited at reduced velocities, lower than those corresponding to the lower resonance frequencies (e.g., [[ ]])?

(b) What is meant by "Total dryer pressure load," which represents the Y-axis?

Response

(a) [[

]]

[[

]]

(b) The "total dryer pressure loads" in Figure 3-20 is [[

]] as well as determining the scaling factors to be used in generating the SRV resonance pressure loads on the dryer.

[[

]]

[[
]]

Figure 3-20 below has been revised to better describe the amplitudes of the plotted data.

[[

]]

Figure 3-20 [[ ]]

[[
]]

RAI # 6

In Appendix A of NEDC-33601P, Revision 0, the licensee states that CLTP Bias and Uncertainty are needed to adjust “SRV resonance load adders to observed CLTP amplitude.” Since CLTP load, including SRV resonances, is measured in the plant and the SRV load adders at EPU are determined from [[ ]] the CLTP measurements, it is not clear to the NRC staff why SRV load adders are needed at CLTP. The licensee is requested to clarify the need for SRV load adders at CLTP.

<u>Response</u>

In the GGNS replacement dryer analysis, a combination of the simulated SRV resonance loads at [[ ]] selected frequencies ([[ ]]) with the non-resonance PBLE acoustic loads developed from MSL strain gauge measurements at the CLTP power levels was used in the finite element structural analysis of the dryer. Simulating all [[ ]] of the selected SRV resonance load frequencies provide several design advantages that outweigh preserving the SRV resonance loads measured at CLTP.

By adjusting the [[ ]] in the four MSLs, the simulated SRV resonance loads were added in such a way that they provide excitation to [[ ]] at the measured ([[ ]]) and projected ([[ ]]) SRV resonance frequencies that might be encountered at EPU conditions. The B wave represents a source from downstream in the MSL. [[

]]

Another reason for adding the SRV synthesized signals to CLTP data is that using the measured MSL signals would tie the load definition to [[ ]] in each MSL relative to the position of the sensors. [[

]] This provides a direct comparison of dryer design loads with projected loads from plant data. [[

]]

In the evaluation process, after the dryer was exercised with the load spikes at SRV resonance frequencies in structural analysis, [[

]]

In summary, the SRV load adders were necessary at CLTP to facilitate the analysis process and the development of limit curves.

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RAI # 7

In Appendix A of NEDC-33601P, Revision 0, the licensee explains the procedure of determining the amplitudes of SRV load adders at EPU conditions. However, the bandwidth of these adders is not discussed in the report. The licensee is requested to explain how the bandwidth of the SRV load adders is determined.

Response

The bandwidths for SRV resonances observed in the ABWR, BWR/6 and BWR/4 plant measurements are approximately [[ ]]. As stated in NEDC-33601-Rev 0, Appendix A, Section 5.3.2.1 (just before Table 5-5), [[ ]], was used in the GGNS evaluation. [[ ]]

[[ ]]

RAI # 8

The licensee is requested to confirm that, after accounting for all bias and uncertainties, the projected SRV load adders at EPU conditions do bound the dryer loads of similar plants (BWR6, BWR4, and ABWR) operating at conditions similar to those of GGNS.

Response

The GGNS Replacement Steam Dryer stress analysis includes a range of potential SRV resonance frequencies to evaluate the dryer sensitivity to loads induced by the SRV branch line acoustic resonance. These frequencies may vary from plant to plant. Therefore, when scaling the resonance peaks to EPU, the following criteria were adopted:

- [[ ]]

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- [[

]]

NEDC-33601P Appendix A, Section 5.3.2.1 provides a comparison of the projected SRV loads used in the GGNS analysis to the projected dryer load data at test conditions for the BWR/6, BWR/4 and ABWR plants. Table 5-4 provides the [[ ]] needed to ensure that the GGNS EPU resonance loads meet or exceed the projected loads for the comparison plants. Table 5-5 provides [[ ]] applied to the SRV resonance load adders. Table 5-6 compares the resulting GGNS dryer SRV loads for [[ ]] Because the bias values are expressed in the form:

[[ ]] for the bias indicates that the GGNS dryer design load [[ ]] that of the comparison plant.

The approach described above ensures that the GGNS dryer design loads meet or exceed those of the comparison plants when accounting for the applicable biases and uncertainties because the comparisons are made at the same stage in the load definition process. [[ ]] Therefore, the margins shown in Table 5-6 remain the same after the applicable biases and uncertainties have been accounted for.

RAI # 9

Based on the information provided regarding EPU operation of GGNS, some or all SRVs will be continuously exposed to acoustic resonance in their standpipes at EPU operating conditions. The licensee is requested to explain the measures that will be taken to ensure safe operation of the SRVs and avoid any eventual damage such as those that occurred to the SRVs of the Quad Cities, Unit 2 plant.

Response

Based on the GGNS steam line configuration, CLTP measurements and EPU steam velocities, acoustic resonance peaks are expected between 190 and 250Hz. The following measures are being taken to ensure safe operation of the GGNS SRVs and avoid any damage from acoustic resonances as occurred to the Quad Cities pressure relief valves.

1. Instrument and monitor the MSL piping and valves to maintain maximum accelerations to within acceptance limits that will minimize fatigue and wear and ensure valve operability.

   As described in the EPU LAR Attachment 10, Table 5.2 (Accession Number ML102660400), the main steam lines in containment will be monitored with a minimum of 14 accelerometers on the piping and 12 accelerometers on 4 SRVs during EPU power ascension. The final instrument locations are those representative of the most limiting conditions considering the combined low frequency FIV loads and high frequency acoustic resonance loads at EPU conditions. The GGNS EPU acceptance criteria have been modified in Attachment 10 (see discussion that follows) to highlight that acceleration acceptance limits on the main steam safety relief valves will be maintained at amplitudes that will assure operability and preclude fatigue damage. The EPU LAR Attachment 10, Table 5.2 valve acceleration limit of [[
   ]].

   These valves were seismically qualified in testing at Wyle labs in 1977. [[
   ]]. The test valve operated normally during and after testing with no noted signs of degradation, thus providing assurance of the vibration capability of the valve design.

   SRV acceleration data acquired during the power ascension testing will be used to evaluate the significance of any acoustic resonance peaks or excessive acceleration levels that were not present during pre-EPU operation of the SRVs or projected to occur at EPU. [[
   ]].

2. Various indicators of vibration degradation are observable during normal operation. These indicators include steam leakage (discharge line temperature), electrical integrity (short circuit and continuity detection circuitry), and pneumatic supply make-up rates.

   Discharge line temperature provides an indication of leakage past the seat of the SRVs. The presence of such leakage is not necessarily indicative of a vibration issue, but does initiate further evaluation of the condition. Unusually high or increasing discharge line temperatures may indicate reduced setpoint spring loads that could eventually lead to a spurious actuation. Actuator circuitry is monitored for continuity and shorting. The Seitz solenoid design that is used in the GGNS SRV actuator is not known to be susceptible to vibration degradation. Although no failures of the pneumatic supply due to vibration effects have been identified, such a failure would be identifiable as an increase in pneumatic supply make-up requirements.

3. To ensure the dynamic resistance of the Dikkers SRV is maintained for EPU, the GGNS SRVs are tested and refurbished using proven procedures and experienced craft. It should be noted that plants with SRV vibration issues at EPU also had SRV maintenance issues prior to EPU. To date, the GGNS main steam SRVs have not exhibited any effects of vibration that would be observable as unusual wear or seat leakage, or increased failure rates.

These measures provide assurance that excessive vibration levels can be detected early and mitigated. Early detection serves to avoid vibration related damage and ensure that minor degradation during a single cycle of operation does not accumulate to present a problem over multiple cycles. These measures will ensure the continued safe and reliable operation of the SRVs.

Benchmarking Against Experience at Other Plants

The Dikkers valve, Sempress actuator and Seitz solenoids (See Figure 1) are of a very robust design. Based on GEH and Entergy's knowledge and experience, there have been no vibration-related operability issues with these valves at GGNS or other operating BWRs.

It should be noted that the main steam pressure relief valve damage experienced at Quad Cities Units 1 and 2 from vibration occurred with Target Rock 3-Stage Safety Relief Valves (SRV) and Dresser Electromatic pilot operated Relief Valves (ERV). This damage scenario seems to have been unique to Quad Cities. Based on a review of Operating Experience reports, no other BWR plants have identified a similar failure of an SRV to open due to EPU-related vibration damage.

It is noteworthy that spring Safety Valves are also mounted on the Quad Cities Main Steam lines. There was no reported damage to the Quad Cities spring Safety Valves. GGNS has the Dikkers design SRV. This design is basically a spring Safety Valve with an attached auxiliary actuator. Based on similarity to the Quad Cities spring Safety Valves, the Dikkers SRV is considered more resistant to vibration degradation than the Quad Cities SRVs and ERVs.

Dresden 2 and 3 are sister plants to Quad Cities 1 and 2. [[

]]

The Quad Cities combination of steam line flow velocity and valve standpipe configuration is unique, resulting in resonance peaks between 140 and 160 Hz driven by the highest EPU main steam line flow velocity in the BWR fleet. [[ ]]

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[[

]]

RAI Impact to other LAR Sections

Extensive work was performed for the Steam Dryer evaluation presented in NEDC-33601P Rev. 0, “Steam Dryer Integrity Analysis Methodology,” which was included in EPU LAR Attachment 11. Plant data taken at pre-EPU conditions was considered along with expected EPU system operating conditions in evaluating the potential for SRV acoustic resonance at EPU. [[

]] Prior to this extensive effort, acoustic screening evaluations concluded that SRV resonance between CLTP and EPU steam flows was not an issue. This conclusion was still reflected in statements made in EPU LAR Attachment 10. The following section of this response includes a discussion of the changes to EPU LAR Attachment 10 acknowledging this more extensive evaluation and highlighting the requirement that acceleration acceptance limits on the main steam safety relief valves be maintained at amplitudes that will assure operability and preclude fatigue damage.

Changes to EPU LAR Attachment 10

The following sentence is being added as a new paragraph at the bottom of page 4 of EPU LAR Attachment 10, Vibration Analysis and Testing Program (underlined text is added):

> Acceleration acceptance limits for the main steam safety relief valves will be established at amplitudes that will ensure operability and preclude fatigue damage.

The single paragraph on page 11 of EPU LAR Attachment is being modified and an additional paragraph is being added as follows (underlined text is added):

> The vibration monitoring locations described in Tables 5.2 and 5.3 were selected where, based on the “1g” spectra analysis results, significant displacements or accelerations occurred relative to other locations. The measurement locations were also selected such that the general overall piping responses were high such that significant vibrations would not be missed. Where applicable, symmetry between trains or loops was considered to remove

redundancy to reduce the overall number of monitoring locations. The EPU vibration monitoring locations determined for the MSS and FWS piping inside containment from the analyses are summarized in Tables 5.2 for Main Steam piping and Table 5.3 for Feedwater piping. GGNS has performed analyses and testing which investigated and addressed the potential for acoustic resonance due to the increased steam flow past the safety relief valve (SRV) standpipe, as well as other branch connections, and concluded that the onset of second shear layer vortex shedding is present at CLTP and could be expected ~~beyond~~ to intensify through full EPU power steam flow rates. ~~Therefore, SRV vibration resulting from acoustic resonance is not expected at the EPU operating conditions. However, monitoring locations were also selected for Main Steam safety-related valve (SRV) to identify SRVs which are susceptible to potential flow induced vibration/vortex resonance, as shown in Table 5.2.~~

The locations and limits described in Tables 5.2 and 5.3 were based on the "1g" spectra analysis results. Final monitoring locations and applicable limits at those locations could change as a result of in situ conditions or additional analytical assessments of piping and valve responses to combined FIV and Strouhal resonance at projected EPU flow rates. For the main steam lines inside containment, a minimum of 14 pipe accelerations and 12 SRV accelerations will be instrumented on a minimum of 4 valves. Acceleration criteria will be established to limit pipe stresses to 7,692 psi and acceleration acceptance limits on the main steam SRVs will be established at amplitudes that will ensure valve operability and preclude potential fatigue damage. For the feedwater piping in containment, a minimum of 12 accelerations will be monitored.

The following paragraph is added as a new paragraph at the bottom of page 15 of EPU LAR Attachment 10 (underlined text is added):

Final monitoring locations and applicable limits at those locations could be changed as a result of in situ conditions at the proposed locations or further analytical assessments of piping and valve responses to projected FIV conditions at EPU flow rates. A minimum of 11 dynamic signals on main steam and 12 dynamic signals on feedwater piping outside containment will be instrumented. The acceptance limits will be established to limit pipe stresses to 7,692 psi.

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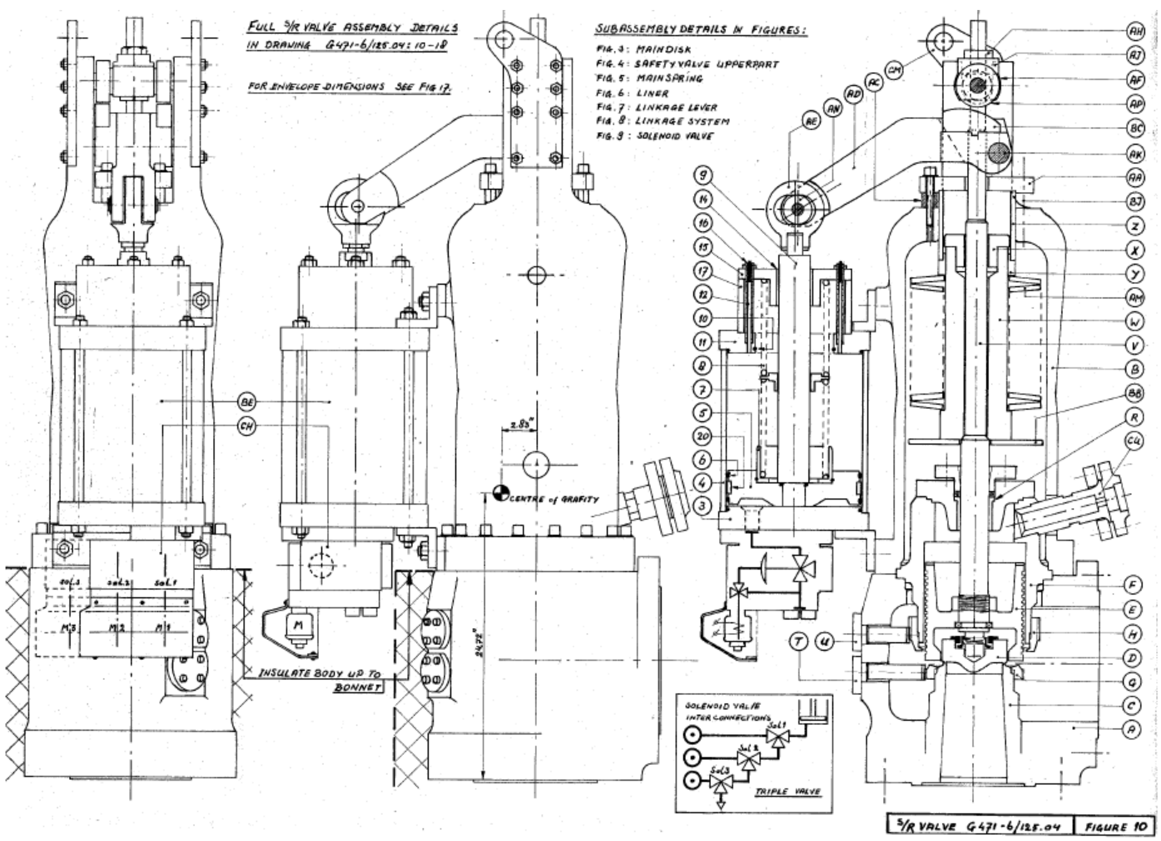

Figure 1: Dikkers 8x10 SRV with Pneumatic Actuator and Solenoid Air Control Valve

RAI # 10

In Appendix A of NEDC-33601P, Revision 0, Section 5.0, “Non-Prototype Justification,” discusses the basis and method used to project the dryer load to EPU conditions. The trend lines of the [[ ]] pressure data are based on the measured [[ ]] amplitudes at [[ ]]. For some frequency ranges (e.g., as shown in Figures 5.5 and 5.7), these trends are not maintained at power levels lower than [[ ]]. In fact, the pressure amplitude is substantially higher than the trend lines over the velocity range from [[ ]]. Please explain why the pressure data at lower power levels deviate from the trend postulated for high power levels. In addition, please explain why the projected trends at EPU conditions are considered conservative, despite the large non-conservative deviations observed at low power levels.

Response

NEDC-33601P, Appendix A, Section 5.1.1 provides a discussion of the trending evaluation and the curve fitting process. The purpose of the trending is to develop scaling factors to project the 100% CLTP loads to EPU conditions. As stated in Section 5.1.1, the [[ ]] are used for developing the scaling factors. [[

]]

Therefore, the [[ ]] are not used for the trending calculations. Additionally, the [[ ]] in these frequency bands are not useful for [[ ]] based on the curve fits at higher power levels. This is the case for Figures 5-5 and 5-7.

[[

]]

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RAI # 11

In Appendix A of NEDC-33601P, Revision 0, Section 5.3, "SRV Scaling Factor," describes the SRV scaling factor at CLTP and EPU conditions. It appears that the [[

]] It is not clear why the measured amplitudes and phases of the B-waves are not used. The licensee is requested to provide a concise step-by-step explanation of the procedure used to determine the SRV scaling factors.

Response

In GGNS analysis, based on the review of the GGNS power ascension data and assessment on other plants with similar steam lines and SRV standpipe geometries, [[

]] were selected to be included in the GGNS structural analysis. The following provides a step-by-step overview of the process for evaluating the structural impact of these potential resonances.

General Approach Overview:

A. Since the CLTP loading has [[ ]] pressure loads at the postulated SRV resonance frequencies, [[

]].

B. The dryer stresses are scaled [[ ]] and provide a means to assess the dryer stress [[ ]].

C. The dryer stresses are scaled to EPU for [[
]].

D. All of the other bias and uncertainty values [[
]] are applied to the analytical stresses to determine final minimum alternating stress ratio.

The SRV resonance scaling factors were developed at resonance frequencies, together with EPU scaling factor at non-resonances, to scale the stresses to EPU at Step C. The following provides details regarding the SRV resonance scaling factor development.

1) [[
]] (NEDC-33601P Appendix A, Section 5.3.1.2).

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2) [[ ]] (NEDC-33601P Appendix A, Figure 5-10).

3) Generate the PBLE dryer pressure loads and run the finite element analysis (FEA).

4) [[ ]] (NEDC-33601P Appendix A, Section 3, also refer to the response to RAI 5).

5) [[ ]] (NEDC-33601P Appendix A, Table 5-4).

6) [[ ]] amplitude growth to EPU from step 4 and minimum loads in Step 5 (NEDC-33601P Appendix A, Table 5-5).

7) [[ ]] (NEDC-33601P Appendix A, Table 5-6).

8) [[ ]]

As mentioned in Step C above, [[ ]] are evaluated. These conditions are:

[[ ]]

[[ ]] were generated to provide a specific set of [[ ]] In addition, calculations were performed to assure that for [[ ]] with respect to the [[ ]] for the three reference plants. An excerpt from the [[ ]]

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[[ ]] showing the user interface region is provided as Figure 1. The various calculation areas are:

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[[ ]]

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RAI # 12

On page 67 of Appendix E, "Steam Dryer Structural Analysis Methodology," of NEDC-33601P, Revision 0, it is stated that [[ ]]. The licensee is requested to explain whether this section path, [[ ]], provides the maximum stress intensity. If not, please explain how the section path, providing the maximum stress intensity in the fillet weld, is determined.

Response

Although NEDC-33601P, Appendix E states, [[ ]], it further states, [[ ]].

For the submodel used to resolve the [[ ]] weld stress for the GGNS replacement dryer, [[ ]] were considered, each of them at or near the location of maximum stress. [[ ]] illustrates the [[ ]] examined. Once the section stress was obtained for these sections, the maximum was chosen for further use. [[

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RAI # 13

On page 30 of Appendix E of NEDC-33601P, Revision 0, the licensee explains how the master degrees of freedom are selected. Please explain how the selected master degrees of freedom preserve the relevant dynamic characteristics of the model (i.e., natural frequencies in the range of 0 to 250 Hz and the corresponding mode shapes). The licensee is also requested to explain what errors are introduced in the calculated stresses because of the use of substructure analysis.

Response

Various guidelines to select master degrees of freedom (DOFs) are published in the literature. An analytical selection of master degrees of freedom for the reduced eigenvalue problem is provided in Reference 1. This analytical selection procedure preserves lower frequency dynamic responses of the model by the substructure analysis. This method provides guidance for selecting master DOFs so that the dynamic characteristics and corresponding mode shapes of the substructure can be preserved.

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Figure 1 Vane Assembly FEM and Master DOFs

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Figure 2 Modified Vane Assembly FEM with Additional Master DOFs

Table 1 The BWR/4 Prototype Dryer Sensor Locations

[[

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Figure 3 Measured vs. Predicted Maximum Strains and Acceleration

References:

1. V. N. Shah and M. Raymunds, Analytical Selection of Masters for the Reduced Eigenvalue Problem, International Journal For Numerical Methods In Engineering, Vol. 18, 89-98 (1982).

RAI # 14

Section 9.0 of Appendix E of NEDC-33601P, Revision 0, provides templates (Tables 9.0-1 to 9.0-5) in table format for final stress processing. Only two of these tables, Tables 9.0.3 and 9.0.4, have been completed and presented in Section 4.0 of the main report as Tables 4.1 and 4.4, respectively. The licensee is requested to complete the remaining tables (Tables 9.0.1, 9.0.2, and 9.0.5) and submit them for the NRC staff's review. Additionally, the licensee is requested to confirm whether component-based and frequency-based bias and uncertainty errors have been applied to the [[ ]] analysis results.

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Response

The maximum stress intensities of each dryer component for the [[ ]] FIV analyses from both the primary scoping and the weld scoping evaluations are presented in Table 1 (*Table 9.0.1*) and Table 2 (*Table 9.0.2*). These tables include results for the nominal run, as well as all of the time shift runs. The weld factor is included in the stresses presented in the tables, but the stresses have not been adjusted through [[

]]

Table 1 (*Table 9.0.1*) Maximum Stress Intensities of Dryer Components
[[ ]]

[[

]]

Table 2 (*Table 9.0.2*) Maximum Stress Intensities of Dryer Components
[[ ]]

[[

]]

A reconciliation analysis was performed that demonstrates that the installation of the replacement steam dryer in the GGNS Unit 1 reactor will not affect the structural integrity of the Reactor Pressure Vessel (RPV). This evaluation demonstrates that the brackets satisfy ASME Boiler and Pressure Vessel Code, Section III, Division I, Nuclear Power Plant Components, Subsection NB, Class 1 Components, 2004 Edition stress intensity limits [[

]]. Table 3 (*Table 9.0.5*) summarizes the limiting stress results for the dryer bracket and affected section of the RPV.

Table 3 (*Table 9.0.5*): Minimum Design and Operational Stress Margins for Replacement Steam Dryer Bracket and RPV Stress

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The ASME and FIV bias and uncertainty calculations have [[

]].

RAI # 15

In Section F.2 of Appendix F, "Power Accession Test Plan," of NEDC-33601P, Revision 0, the licensee evaluates the dryer stress response for each of the [[ ]] different potential resonance frequencies [[ ]]) in addition to the base case for the [[ ]] and [[ ]] SRV resonance peaks observed in the CLTP measurements. The licensee is requested to explain why the dryer dynamic response, considering all [[ ]] resonance peaks taking place simultaneously, is not evaluated.

Response

As shown in Figure 3-15 of GEH report NEDC-33601P Appendix A, because of the differences in SRV standpipe length, as well as the interaction between the acoustics in the SRV standpipes and the main steam lines (MSL), a wide spread of SRV acoustic resonance frequencies have been observed in [[ ]] However, based on plant observations to date, [[

]] So in the GGNS analysis, [[ ]] different projected EPU conditions were evaluated as scenarios. These include SRV resonances at each of [[ ]] identified frequencies ([[ ]]), as well as one case with [[

]]

One of the acceptance limits included in NEDC-33601P Appendix F requires that [[

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[[

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As described in section F.5 of Appendix F, at each power ascension plateau, [[

]] This process will ensure that Entergy addresses any observed combination of SRV resonance that could challenge Level 1 limit before proceeding with power ascension.

While we could have elected to include many combinations of [[ ]], we elected to evaluate the [[ ]] described in Appendix A and [[ ]] This approach is most effective in aligning potential resonant frequencies with the sensitive structural response frequencies of dryer components.

RAI # 16

In Section F.2 of Appendix F NEDC-33601P, Revision 0, the licensee imposes three criteria (related to the [[ ]]) during power ascension for all [[ ]] dryer regions, to provide limits to assure that the allowable stress limits are not exceeded. Tables F-2 to F-7 provide quantitative data for these criteria for Level 1 and Level 2 limit curves. The licensee is requested to provide an example of the detailed calculations performed in determining the quantitative data (for dryer region 1) presented in these tables.

Response

The procedures that were used to calculate the GGNS quantitative criteria for Level 1 and Level 2 limits (Table F-2 through F-7) are as follows:

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Refer to Table 2 Refer to Table 3

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Maintaining the [[ ]] below the acceptance limits defined in Table F-2 through F-7 of Appendix F of NEDC-33601P will assure that the FIV peak stress amplitude on the GGNS replacement dryer will remain below the ASME code endurance limit.

<u>RAI # 17</u>

Section F.2 of Appendix F of NEDC-33601P, Revision 0, states that,

[[

]]

The licensee is requested to clarify the meaning of the term "load energy in frequency domain" and explain the statement.

<u>Response</u>

[[

]], the term load energy (in the frequency domain) refers to [[
]] The sentence could have been better stated as, [[ ]]

[[

]]

The acceptance criteria described in section F.2 has [[

]]

RAI # 18

In Appendix G, "Grand Gulf Nuclear Station Main Steam Line Test Report," of NEDC-33601P, Revision 0, the licensee states that during the primary pressurization tests at GGNS, the strain gauges were checked against the plant data of static pressure. However, as discussed in Section 5.3 of this appendix, the internal dynamic pressure during the tests was calculated from the strain gauge data using the formula for thick walled cylinder (with closed ends) and the MSL dimensions (diameter and wall thickness). The licensee is requested to (1) explain whether there is any variation in the wall thickness at a given strain gauge location, and (2) compare the calibration factors obtained by these two different procedures to assess any bias and uncertainties in the conversion of hoop stress to pressure.

Response

(1) Explain whether there is any variation in the wall thickness at a given strain gauge location

During the strain gauge sensor installation, [[ ]] for each MSL measurement location. NEDC-33601 Appendix G Table 3 shows the average wall thickness for the eight UT measurements taken at each MSL measurement location. The average of the eight thickness measurements was used in the strain to pressure conversion. [[

]]

(2) Compare the calibration factors obtained by these two different procedures to assess any bias and uncertainties in the conversion of hoop stress to pressure.

NEDC-33601 Appendix A Section 4.4.3 describes the method used to determine and quantify the bias and uncertainty involved with a given MSL instrumentation system. [[

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[[ ]] The strain gauge measurement bias (or correction factor) is described in more detail in Section 4.4.3.

RAI # 19

The test results presented in Appendix G of NEDC-33601P, Revision 0 include plots of averaged time history data for the strain gauge pairs at various locations. The licensee is requested to elaborate on how these time averages were obtained and explain the relevance of these averaged time history spectra.

Response

At each MSL, [[ ]] strain gauges were oriented circumferentially at each monitoring location. As described in the response to RAI 20, the strain gauge pairs on opposite sides (i.e., 180° apart) were wired together in series. [[ ]] The time history data for the strain gauge pairs at each location were then averaged (defined in the processing as [[ ]]), [[ ]] that are unrelated to the acoustic pressure in the pipe. The strain PSDs for each strain gauge pairs and the averaged PSD (using averaged time history data) were calculated by Welch's method based on a series of PSDs. Each PSD was based on a two second long time segment, with the time segment for each PSD overlapping the adjacent time segments by 50%. Since the series of PSDs used the full 120 seconds recorded data sets, they represent long-term average spectral densities and are indicative of the frequency content in the dryer pressure load definition. These PSD plots were provided in NEDC-33601 Revision 0, Appendix G.

The average PSD is shown as the heavy black trace in the plots in Appendix G. These PSDs are representative of the signals used as inputs to define PBLE dryer pressure loads. As described in NEDC-33601 Revision 0, Appendix C, [[ ]] (refer to Appendix C Figures 357, 358 and 359).

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RAI # 20

In Appendix G of NEDC-33601P, Revision 0, the licensee states that,

> The strain gauges were wired in series, because there were a limited number of penetration cables available.

The licensee is requested to provide additional details about the wiring circuit of the strain gauges.

Response

[[

]] NEDC-33601 Appendix G Figure 10 [[

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[[

]] As shown in Figure 10, [[

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Attachment 3

GNRO-2011/00018

Grand Gulf Nuclear Station Extended Power Uprate

GEH Affidavit for Withholding Information from Public Disclosure

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, Edward D. Schrull, PE state as follows:

(1) I am the Vice President, Regulatory Affairs, Services Licensing, GE-Hitachi Nuclear Energy Americas LLC ("GEH"), 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 of GEH letter, 173280-JB-025, "Grand Gulf Steam Dryer: Transmittal of RAI Responses," dated March 28, 2011. The GEH proprietary information in Enclosure 1, which is entitled "GEH Responses to NRC RAIs 1-20" is identified by a dark red dotted underline inside double square brackets. [[This sentence is an example.{3}]] Figures and large equation objects containing GEH proprietary information are identified with double square brackets before and after the object. 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 qualifies 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, 975 F2d 871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F2d 1280 (DC Cir. 1983).

(4) The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. Some examples of categories of information that 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 that, if used by a competitor, would reduce their expenditure of resources or improve their competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

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

d. Information that discloses trade secret and/or potentially patentable subject matter for which it may be desirable to obtain patent protection.

(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, not been disclosed publicly, and not been made available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary and/or confidentiality agreements that provide for maintaining the information in confidence. The initial designation of this information as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in the following paragraphs (6) and (7).

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

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains detailed GEH design information of the methodology used in the design and analysis of the steam dryers for the GEH Boiling Water Reactor (BWR). Development of these methods, techniques, and information and their application for the design, modification, and analyses methodologies and processes was achieved at a significant cost to GEH.

The development of the evaluation processes along with the interpretation and application of the analytical results is derived from the extensive experience databases that constitute 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 28th day of March 2011.

Edward D. Schrull, PE
Vice President, Regulatory Affairs
Services Licensing
GE-Hitachi Nuclear Energy Americas LLC
3901 Castle Hayne Rd.
Wilmington, NC 28401
Edward.Schrull@ge.com

Attachment 4

GNRO-2011/00018

Grand Gulf Nuclear Station Extended Power Uprate

List of Regulatory Commitments

List of Regulatory Commitments

The following table identifies those actions committed to by Entergy in this document. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

COMMITMENT	TYPE (Check one)		SCHEDULED COMPLETION DATE (If Required)
	ONE-TIME ACTION	CONTINUING COMPLIANCE	
1. During power ascension to EPU conditions, the acoustic pressure within the main steam lines will be monitored, the trending updated, and the resulting pressure loads on the dryer will be compared to the power ascension limit curves, which were determined from the FIV analysis results.	x		
2. During the subsequent refueling outages, the replacement dryer will be inspected following the recommendations in General Electric Service Information Letter 644 “BWR Steam Dryer Integrity” dated August 30, 2006.		x	