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Attachment 1 contains proprietary information.

GNRO-2012/00009

February 15, 2012

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

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

REFERENCES:

1. Entergy Operations, Inc. letter to the NRC (GNRO-2010/00056), *License Amendment Request - Extended Power Uprate*, September 8, 2010 (ADAMS Accession No. ML102660403)
2. Entergy Operations, Inc. letter to the NRC (GNRO-2012/00006), *Request for Additional Information Regarding Extended Power Uprate*, dated February 6, 2012

Dear Sir or Madam:

The Nuclear Regulatory Commission (NRC) has requested additional information regarding the steam dryer discussed in the Grand Gulf Nuclear Station, Unit 1 (GGNS) Extended Power Uprate (EPU) License Amendment Request (LAR) (Reference 1). Attachment 1 provides responses to the requests for additional information items 1, 4, 9, 11, and 13 requested by the Mechanical and Civil Engineering Branch. Responses to items 2, 3, 5, and 6 were provided in Reference 2 and RAI 7 was dropped during the review. The responses to RAIs 8, 10 and 12 will be provided by February 21, 2012.

GE-Hitachi Nuclear Energy Americas, LLC (GEH) considers 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.

When Attachment 1 is removed, the entire letter is non-proprietary.

No change is needed to the no significant hazards consideration included in the initial LAR (Reference 1) as a result of the additional information provided. There are new commitments summarized 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 February 15, 2012.

Sincerely,

M. A. Krupa

MAK/FGB

Attachments:

1. Response to Request for Additional Information, Mechanical and Civil Engineering Branch, Steam Dryer (Proprietary)
2. Response to Request for Additional Information, Mechanical and Civil Engineering Branch, 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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U. S. Nuclear Regulatory Commission
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NRC Senior Resident Inspector
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State Health Officer
Mississippi Department of Health
P. O. Box 1700
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Attachment 2

GNRO-2012/00009

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: [[ ]].

Response to Request for Additional Information
Mechanical and Civil Engineering Branch

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). The NRC has requested additional information regarding the steam dryer; the responses are provided below.

<u>RAI 01</u>

Rebenchmarking of PBLE and Clean Reanalysis

a. Based on examining the images and cutaway views of the Quad Cities Unit 2 (QC2) benchmarking model provided by GEH during staff interviews at GEH-Wilmington on 7 December 2011, the NRC staff can no longer confirm the conservatism of the PBLE approach using a [[ ]] and its accompanying bias errors and uncertainties. Many of the acoustic elements in the QC2 benchmark are too large to resolve adequately frequencies up to [[ ]] while maintaining a minimum of [[ ]] Also, the MSL nozzle regions are under-resolved, may be inaccurate and several inconsistencies between the acoustic model and structural models have been identified. The current [[ ]] frequency benchmarking is limited to frequencies [[ ]] Finally, many regions in the model appear to use only [[ ]] between adjacent dryer bank regions, which cannot accurately resolve acoustic loads.

   The licensee is therefore requested to provide:

   - An updated QC2 PBLE benchmark that satisfies acoustic mesh resolution requirements, is shown to be converged in spatially narrow regions (such as those within the dryer) and over [[ ]], and is shown to resolve previously provided LMS concerns about meshing errors and discrepancies between the acoustic and structural FE models. The revised QC2 acoustic model should be consistent with the model developed for the GGNS and Susquehanna Steam Electric Station (SSES) calculations. Benchmarks for both [[ ]] PBLE approaches should be revised.

   - [[ ]] plots of QC2 dryer surface pressures, delta pressures for locations where inner and outer pressure transducers are available, and accompanying low frequency (LF), high frequency (HF), and [[ ]] bias errors and uncertainties for [[ ]] PBLE calculations.

   - Plots of the updated [[ ]] terms for the revised QC2 benchmark.

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The licensee is also requested to apply their updated QC2 [[ ]] PBLE approach to demonstrate its conservatism (including bias errors and uncertainties) to the GGNS valid prototype- the SSES replacement dryer. This updated calculation should be performed using a converged, accurate SSES PBLE acoustic model, with mesh resolution satisfying the [[ ]] requirement, accurate MSL nozzle representations, and an appropriately [[ ]] The licensee should confirm that the resulting SSES PBLE bias errors and uncertainties are bounded by the QC2 benchmark bias errors and uncertainties. If they are not bounded, the licensee should provide an updated set of bias errors and uncertainties for the [[ ]] PBLE that bound the worst-case conditions from both the QC2 and SSES benchmarks.

Finally, the licensee is requested to update their finite element stress modeling bias error and uncertainty calculations using end-to-end benchmarking of both the QC2 and SSES instrumented dryer datasets. Worst-case bias errors and uncertainties should be provided based on the re-benchmarking.

b. Following the resolution of part (a) above, the licensee is requested to provide a clean reanalysis of the GGNS dryer as there are many errors noted in QC2 benchmark as well as GGNS to capture the integrated cumulative effect of the errors rather than addressing individual effects as some of the effects may not be linear or fully captured by superposition of the linear effects.

<u>Response</u>

This RAI essentially requests a complete re-analysis of each of the current benchmarks as well as the development of new end-to-end benchmarks and bias and uncertainty calculations for both Quad Cities Unit 2 (QC2) and Susquehanna (SSES). The RAI then requests a complete re-analysis of the Grand Gulf (GGNS) replacement steam dryer incorporating the results of the above benchmarks.

Various concerns with the benchmark documentation have been identified (as outlined in the RAI). As discussed here, all of these concerns have been addressed in the work done in support of the PBLE-LTR, the GGNS SDAR report, and the extensive work done in response to RAIs received from 2008 to date. The SDAR submittal, the internal reanalysis performed following the submittal, and the reanalysis work done in response to RAIs concerning PBLE and end-to-end benchmarks continue to demonstrate that the RSD maintains a factor of 2.0 margin to the ASME endurance limit.

GGNS has discussed with the NRC Staff the extensive analysis effort that would be required to address this RAI. It is projected that the requested benchmarks and reanalysis would have only a small impact and continue to demonstrate the qualification of the GGNS replacement dryer.

As an alternative, GGNS has elected to install on-dryer instrumentation. The instrumentation, in conjunction with the data collection and evaluation as part of the power ascension testing program, will provide a direct validation of the plant-specific load and dryer response predictive analysis methodology. A discussion of the planned instrumentation and test program are provided in the response to RAI 09 (EMCB Steam Dryer Round 5).

The issues, as noted above include:

- Concerns over the QC2 Benchmark mesh resolution, nozzle area and geometry.
- Concerns that the narrow-band frequency test data is limited to frequencies [[ ]]
- Use of single linear elements in spatially narrow regions
- Request to address differential pressure bias and uncertainty in the benchmark data.
- Updates of the [[ ]] terms and scaling of the [[ ]] term
- Performing additional plant benchmarks for both the PBLE and FE models.
- Using most limiting results for both SSES and QC2 benchmarks in projecting stress for GGNS.

GGNS believes that the issues identified in this RAI have been addressed in the GGNS analysis and previous RAI submittals to date. The following four sections, QC2 Benchmarking, SSES Benchmarking, End-to-End Benchmarking, and GGNS Reanalysis, address each of the NRC concerns described in the RAI.

<u>QC2 Benchmarks</u>

The NRC Staff has indicated that based on examining the images and cutaway views of the Quad Cities Unit 2 (QC2) benchmarking model provided during staff interviews at the GEH-Wilmington offices on December 7, 2011, that they are concerned about the QC2 acoustic model, the resulting QC2-based transformation matrix [[ ]], and the associated bias errors and uncertainties.

In December prior to the interviews, the Staff was provided with copies of the design record files that supported the development, verification, and approval of these models as pictured and described in the PBLE (Plant Based Load Evaluation) reports. The QC2, SSES, and GGNS acoustic model work was performed by a GEH subcontractor (LMS) working under the GEH Quality Assurance (QA) program. The information provided for QC2 included details on the model development, verifier's comments, resolution of comments by the responsible engineer

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and verifier, and approval by the responsible manager. Some of the verification comments were displayed on Power Point slides with the LMS logo. All personnel, responsible engineers, verifiers, and engineering managers, were LMS personnel well qualified in acoustic modeling and in the use of the LMS Sysnoise software. Small geometric differences were called out in the verification of the QC2 acoustic model in 2008 documentation. These differences were resolved to the satisfaction of the responsible engineer, verifier and manager in the final approval of the acoustic model as part of the normal verification process. The acoustic model was approved as sufficiently accurate for benchmarking PBLE load projections against QC2 data. The models and descriptions included in the PBLE reports were supported by verified design record files.

The images and cutaway views of the QC2 benchmarking acoustic model are clearly depicted in NEDC-33601P Appendix B Section 2.2.2 of the GGNS EPU submittal. The report includes a QC2 mesh and a refined mesh sensitivity study. Table 10 (reproduced below) from the report described the nominal and refined meshes.

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The Staff has previously cited row 4 of this table and asked GEH to illustrate that further refinement of the mesh to satisfy the requirement [[ ]] will not increase the PBLE uncertainties. In response it was noted that for plants with significant frequency content [[ ]] at the interface with the structures and [[ ]] is adequate and supported by the PBLE benchmarking. The larger elements are permitted in areas where high pressure gradients would not occur. A [[ ]] at the interface with the structures is a reasonable standard for accurate results while keeping the model size manageable.

As described in NEDC-33601P, the sensitivity assessment with the finer mesh demonstrates that the benchmarked mesh captures the acoustic response characteristics [[

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]] Small shifts in the frequency responses are completely enveloped within the [[ ]] shift cases in the structural analysis. The QC2 mesh resulted in lower load projections at high frequency and more conservative bias values for the PBLE model. When these bias values are then used with the finer mesh acoustic model developed for GGNS, the projected loads with PBLE bias values will be conservative.

It was subsequently concluded that based on further application experience, [[ ]] would be met everywhere when applied to future plant-specific applications. This change is reflected in the PBLE report in NEDC-33601P, Appendix B. This document requires that the acoustic model mesh must satisfy the [[ ]] requirement in plant applications.

In summary, while it is agreed that [[ ]] should be and is a required criterion for meshing going forward, it was mutually agreed that the QC2 benchmark analysis need not be revised for this concern.

The NRC Staff was concerned that the [[ ]] may be adversely affected by the mesh density of the QC2 model. [[

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In the discretization necessary to develop an acoustic FE model, it is not practical to draw a perfect circle with the correct diameter using finite elements, hence the approach used is to scale the Frequency Response Functions (FRFs) to correct for the difference between real nozzle area and modeled nozzle area. The [[ ]] and associated benchmark data used in the final GGNS analysis were developed with the adjusted FRFs. As described in Reference 6, the small difference in nozzle area has been resolved for both the QC2 benchmark and the GGNS acoustic models. Updated [[ ]] terms that correct for the nozzle area error were developed in response to Action Item 2 from the NRC Audit in September of 2011. Plots of the [[ ]] terms are included here as Figures 1.1 through 1.4. The Revision 0 [[ ]] terms from the PBLE Supplement 1 report are included for comparison with the updated terms.

Wide-band low frequency and high frequency bias errors and narrow band bias errors were provided in the PBLE Supplement 1 report for both MSL-based and dryer-based PBLE models.

Updated low frequency, high frequency and narrow band bias errors for MSL-based PBLE models were provided in References 6 and 7 and have been used in the revised stress projections for GGNS.

The nozzle area difference (modeled vs. actual) will not affect the PBLE benchmark for those plants using on-dryer sensors for input. [[

]] Therefore, the PBLE benchmarking and sensitivity assessments provided in the GGNS Steam Dryer Analysis Report (SDAR, NEDC-33601P), Appendices B and C with on-dryer sensors for input are not affected.

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The NRC Staff has raised a concern that many regions in the acoustic FE model [[

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In order to demonstrate the potential sensitivity of the frequency response functions (FRFs) to the mesh density, the dryer analysis boundary conditions and material properties were applied to the simplified model as shown in Figure 2.3. Figure 2.3 also illustrates the excitation applied to the model. Figure 2.4 shows the location of the FRF points used for comparison. Figures 2.5 and 2.6 provide comparisons of the FRF responses at two locations for the three mesh densities. [[

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In September 2011, the NRC Staff noted the PBLE benchmarking was based on external pressure sensors and asked that Entergy address bias errors and uncertainties in predicting differential pressure with the PBLE model (Audit Action Item 6 in Reference 10). [[

]] From the available data, additional uncertainty values were calculated for the PBLE model in predicting differential pressure. These values were provided in the response to the RAI. These additional uncertainties were incorporated into the final adjusted stress table for GGNS as described in Reference 6.

In summary, the benchmark data and plots provided for QC2 on-dryer and MSL-based PBLE characterizes the performance of the PBLE model in projecting FIV loads on the dryer. The small geometric differences in nozzle area and geometry in the acoustic model were addressed and resolved by LMS personnel expert in acoustic modeling. [[

]] Therefore, all of the concerns associated with the QC2 benchmark analyses have been adequately addressed in the GGNS RSD analysis.

SSES Benchmarks

The SSES acoustic finite element model used in the benchmarks presented in the GGNS SDAR and SDAR Appendix C, including the acoustic FE model used for the load generation in the structural FE analysis end-to-end benchmark, meets the [[ ]] requirement [[ ]] A section of the model is shown in NEDC-33601P Appendix C Section 2.2. The load definition for the structural FE analysis end-to-end benchmark used the measurements from in-vessel sensors and, therefore, is not affected by the nozzle area difference.

The NRC Staff has asked that Entergy submit the PBLE benchmark analyses for SSES using MSL input measurements. Internal SSES MSL PBLE benchmark analyses were made available and discussed during the NRC Audit of the ESBWR application in August of 2009. These internal SSES MSL PBLE benchmark analyses were updated to include narrow band bias and uncertainty data in May 2010 in parallel with development of the narrow band bias and uncertainty data that was incorporated into the NEDC-33601P Appendix C. These benchmarks were performed with the QC2 Rev. 0 [[ ]]. This internal benchmark was provided to the NRC during the December 2011 interviews in the GEH Wilmington offices. This benchmarking demonstrated that the SSES PBLE benchmarks are comparable to QC2 benchmarks.

The NRC Staff has asked that the SSES benchmark [[

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]] In the response to Audit Action Item 3 (Reference 10), Entergy reiterated the application of the constant [[ ]] values for GGNS (Reference 6). [[

]] This is consistent with the benchmarks used in the generation of the bias errors and uncertainties used in the GGNS analysis.

This benchmark data for SSES using MSL input measurements was not used in the GGNS analysis. The NRC has recommended that a factor of 2 margin be maintained to the ASME fatigue endurance limit based on the limited amount of benchmarking (one plant benchmark for the PBLE load definition and one plant benchmark for the FE analysis) submitted in support of the PBLE methodology (Reference 9). Therefore, qualification of the GGNS replacement steam dryer has been demonstrated by satisfying the factor of 2 margin to the ASME endurance limit.

End to End Benchmarks

The NRC Staff has asked that Entergy update their finite element stress modeling bias error and uncertainty calculations using end-to-end benchmarking of both the QC2 and SSES instrumented dryer datasets.

The PBLE and structural FE benchmark that was performed for SSES and used in the GGNS dryer analysis is not affected by the mesh resolution, geometry, or nozzle resolution issues raised by the NRC Staff with respect to the QC2 acoustic model. [[

]] The SSES structural FE benchmark did not use the QC2 Revision 0 [[ ]] or QC2 benchmark data. [[

]] Therefore, there is no reason to update the SSES end-to-end benchmark.

The end-to-end benchmarking of the QC2 dryer is an intensive undertaking that would require significant effort and time. The NRC has recommended that a factor of 2 margin to the ASME fatigue endurance limit be applied based on the limited benchmark comparisons that were submitted in support of the methodology (Reference 9). Therefore, qualification of the GGNS replacement steam dryer has been demonstrated by satisfying the factor of 2 margin to the ASME endurance limit and including the biases and uncertainties based on the submitted SSES end-to-end benchmark. [[

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[[ ]] as described in our response to RAI-9 (EMCB Steam Dryer Round 5).

GGNS Reanalysis

The NRC Staff has requested that Entergy [[ ]]

The final GGNS acoustic model mesh will adequately define the [[ ]] Small discretization differences in nozzle area have been addressed by [[ ]] used in the development of the GGNS PBLE loads. [[ ]] A complete structural reanalysis was also performed at that time. This reanalysis demonstrated that the NEDC-33601P analysis with bias and uncertainty adjustments was conservative and the replacement steam dryer had increased margin to the endurance limit when compared to the original submittal results.

While the GGNS MSL flow velocities are less than those for QC2, the GGNS analysis methodology applies [[ ]] In the high frequency range for GGNS, the synthesized safety/relief valve acoustic resonance design loads and, to a lesser extent, the VPF loads predominate. [[ ]]

The NRC concerns with the QC2 benchmarks including nozzle area and PBLE projected differential pressure load bias error and uncertainty have been addressed and applied in the

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final stress values for GGNS. The conservative analysis results continue to demonstrate that the RSD maintains the NRC recommended factor of 2.0 margin to the ASME endurance limit.

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There are a limited number of instruments that can be applied for dryer monitoring and benchmarking purposes. [[

]] Extensive reanalysis and numerical post processing has demonstrated that this methodology is sufficiently accurate. This approach is consistent with the reactor internals flow-induced vibration test programs used in new plant startup testing.

Entergy has proposed that the dryer be instrumented and, in the response to RAI 9, describes the instrumentation and criteria to be used to validate the stress projections and acceptance limit methodology provided in NEDC-33601P for GGNS.

REFERENCES

1. Deleted
2. Deleted
3. Deleted
4. Deleted
5. Deleted
6. Entergy letter *Response to Request for Additional Information Regarding Extended Power Uprate*, GNRO-2011/00088 dated October 10, 2011 (NRC Accession No. ML112840174).
7. Entergy letter, *Response to NRC Request for Additional Information Regarding Extended Power Uprate*, GNRO-2011/00101, dated November 14, 2011 (NRC Accession No. ML113190403).
8. Deleted

9. NRC Letter, R.A. Nelson (NRC) to J.G. Head (GEH), *Clarification of Intent on Methodologies for Demonstrating Steam Dryer Integrity for Power Uprate – GE-Hitachi Nuclear Energy*, September 14, 2011 (MFN 11-230) (NRC Accession No. ML111450645).

10. NRC Letter, A.B. Wang (NRC) to Vice President, Operations (Entergy), *Grand Gulf Nuclear Station, Unit 1 – Audit of Calculations Related to Extended Power Uprate (TAC No. ME4679)*, October 19, 2011 (NRC Accession No. ML112730341).

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Figure 1.1: [[

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Figure 1.2: [[

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Figure 1.3: [[

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Figure 1.4: [[

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Figure 2.1 [[ ]]

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Figure 2.2 [[ ]]

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Figure 2.3 [[

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Figure 2.5 [[ ]]

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Figure 2.6 [[ ]]

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Figure 2.7 [[ ]]

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Figure 2.8 [[ ]]

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RAI 04

Solid to Shell transition Interface Modeling (Follow-Up to Action Item #5)

In response to Action Item #5 (GNRO-2011/00088, dated October 10, 2011, ML112840174), the applicant explains how it determined the [[ ]] based on a study of [[ ]] The response appears to be acceptable as it shows that for the [[

]] would modify the steam dryer structure and makes it stiffer at the shell-solid interface, and may affect the steam dryer overall structural response. For solid-shell transition interface modeling, the ANSYS general purpose finite element program does have an option to use constraint equations with *Command CEINTF*. In addition, ANSYS has another option for modeling shell-solid assembly as described in Section 9.2, *Modeling a Shell-Solid Assembly*, of ANSYS Documentation, Release 11. The licensee is requested to confirm whether the use of these options provides the steam dryer stresses that are similar to the ones obtained using the [[ ]]

Response

Care must be taken when joining elements that have different degrees of freedom (DOFs) as with connecting beam and shell elements having nodes with six DOFs to solid elements with nodes having three DOFs. The ANSYS software recognizes this issue stating that "To be consistent, two elements must have the same DOFs; for example, they must both have the same number and type of displacement DOFs and the same number and type of rotational DOFs. Furthermore, the DOFs must overlay (be tied to) each other; that is, they must be continuous across the element boundaries at the interface." In practice, several methods are used to connect such elements together. Among the methods to tie the shell element rotations to the surrounding solid element nodes are the use of [[ ]], the use of constraint equations (CEs), and the use of multi-point constraints (MPCs). [[
]] for modeling the connection in the global finite element model (FEM) was chosen where the GGNS dryer [[ ]]. The primary reason for this choice is that [[ ]] in determining some of the components minimum alternating stress ratio (MASR). [[
]] of transferring the shell element moments into the solid element nodes is the least invasive to these results.

The ANSYS CEINTF command generates general CEs between element interfaces. It is used to tie together two regions with dissimilar meshes. However, a restriction is placed on the algorithm that the elements at the interface must have the same nodal DOFs in number and type. As described above, shell elements and solid elements differ in the number of DOFs.

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Therefore, the CEINTF method cannot be used to tie the shell element moments to the solid element nodes.

The use of MPCs is another method recognized by the ANSYS program. To connect a shell to solid interface together, the ANSYS contact technology provides the "bonded always" option. This option enforces compatibility at the solid-to-shell interface by generating internal MPCs during the solution phase. Reference 1 provides a more detailed explanation of how the bonded always contact pairs should be used.

Advantages of the MPC approach include:

- Degrees of freedom of the contact nodes are eliminated.
- No additional normal or tangential stiffness is generated.
- No iteration is needed for small deformation problems, (*i.e.,* it represents "true linear contact" behavior.)
- The method can be used to bond shell-to-solid.

The disadvantages of the MPC approach are:

- The solid mesh density should be sufficiently refined to have a minimum of two elements through the shell thickness.
- "The accuracy of local stresses near the shell-solid interface (at least within the shell thickness range) is not guaranteed." (Reference 1)

In industry, [[
]] Some of the key advantages and disadvantages are as follows:

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Evaluations were performed to assess the differences in the structural response between the [[ ]] and the MPC methods. The first evaluation is a modal analysis to determine if the [[ ]] significantly alter the fundamental dryer modes. The ANSYS modal analysis results indicate that the [[ ]] (Figure 1 top) [[ ]] (Figure 1 bottom). [[ ]] Based on the mode shape similarity, it is expected that the steam dryer stress predictions from the [[ ]] approach and MPC approach will not vary significantly.

Calculations were performed utilizing the results from the full transient dynamic analysis due to the flow induced vibration (FIV) loading for the [[ ]]. The calculations are used to assess the impact of the added membrane stiffness to the overall state of stress of the steam dryer. The FIV analysis was performed on the steam dryer FEM using the MPC method (bonded always contact technology) for comparison to the [[ ]]. The maximum stress comparison for each component is provided as Table 1. For most components, the stress difference is [[ ]]. However, as highlighted in Table 1, the stress differences are [[ ]], thus warranting further examination. The contour plots compare the maximum stress locations between the [[ ]] and MPC methods for the components exhibiting the [[ ]] between the methods. The comparative contour plots for [[ ]] components are provided as Figures 2 through 8, respectively. The plots show that the maximum stress is located at the [[ ]].

Several stress time histories were obtained [[ ]] (see Figures 9 and 10). The power spectrum (PS) curves, plotting the square root of the power spectral density (PSD) using both methods (i.e., [[ ]] and MPC) were compared for several of the components. Figures 11 through 14 present these curves for the [[ ]] components, respectively. The PS plots show that the stress responses a short distance away from the shell-to-solid interface are [[ ]] and MPC methods.

A detailed solid submodel analysis was also performed in the area of the [[ ]]. Figure 15 illustrates this submodel. The model is comprised entirely of [[ ]] in and around the location of interest (*i.e.* [[ ]]). A stress contour plot showing the location of the maximum stress intensity predicted in the submodel analysis is provided in Figure 16. [[ ]] The submodel stress prediction is lower than that for both [[ ]] and MPC global model methods. These results also show that the global model result for the [[ ]] method provides a conservative stress prediction.

In conclusion, the CEINTF method of connection at the shell-to-solid interface is dismissed based on the limitations of the algorithm with respect to this application. The [[ ]] and MPC methods provide comparable global stress responses. A comparison of the modal analysis results showed that the mode shapes are comparable between the two methods. This is also evident in the maximum predicted stress comparisons of the components located away from the interface. Power spectrum comparisons of the stresses at locations a short distance from the interfaces show that the local stress response of the two methods is comparable. In addition, a submodel analysis shows that both the [[ ]] and MPC methods provide conservative stress predictions at the interface. Therefore, the use of the [[ ]] is acceptable.

REFERENCE

1. ANSYS Release 11.0 Documentation, *Contact Technology Guide*.

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Table 1: Comparison of Maximum Stress Intensities for all Steam Dryer Components using MPC Algorithm and Embedded/Overlay Approach

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Figure 1: [[

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Figure 2: [[

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Figure 11: [[
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Figure 12: [[

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Figure 13: [[
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Figure 15: [[

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Figure 16: [[**]]**

RAI 09

Instrumenting the Steam Dryer

The staff notes that the licensee is planning to instrument the GGNS Replacement Steam Dryer (RSD). The licensee is requested to provide a strong, technically sound, defensible and convincing justification for the type, number, location, and redundancy of instruments to be used on the steam dryer. The licensee is also requested to provide the calibration and measurement errors associated with the instruments. In addition, the licensee is requested to describe (1) how the PBLE validation will be made using the actual GGNS plant data at various power plateaus during power ascension using main steam line (MSL) and on-dryer instrument data, particularly pressure differences between internal and external sensors; (2) how the validation of the overall end-to-end strain calculations will be made using the structural finite element model based on actual GGNS plant data at various power plateaus during power ascension using loads derived from [[ ]] instrument data, and (3) how the maximum fatigue stress location and magnitude will be determined during power ascension.

Response

GGNS is planning to install on-dryer instrumentation to [[
]] The details of the planned design are outlined below. [[

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Instruments

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The locations are depicted in Figures 1 through 5.

The Quad Cities (QC2) and Susquehanna (SSES) dryer instrumentation design included [[

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The following table summarizes the basis for [[ ]] Appendix A to Enclosure to Attachment 1 in GGNS the November 28, 2011 Submittal, GNRO 2011-107, (NRC Accession No. ML113320403). This was supporting information in Entergy's response to RAI 2, Round 4.

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In addition to the on-dryer instrumentation, [[

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In addition to the MSL strain gages, the four MSLs will have [[

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Calibration

The MSL strain gage bias and uncertainty is described in Appendix A of the SDAR. The current plan [[

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The Gage Factor (GF) determination is an important input into the dynamic strain equation, [[

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Power Ascension Testing

On-dryer sensors will be used to [[

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At CLTP, GGNS-specific [[

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Power ascension above CLTP will be performed in accordance with [[

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GGNS End-to-End Bias and Uncertainty

The end-to-end bias and uncertainty values for projected stresses at high stress regions will be based [[

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The test data will be used to assess [[

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The PBLE [[

]]

The dynamic pressure loading on the outer surface [[

]] (see response to Round 3 RAI 6, in Entergy letter "Request for Additional Information Regarding Extended Power Uprate", dated October 10, 2011, NRC Accession No. ML112840174).

Full FE Reanalysis

Projected pressure, strain, and acceleration data from the PBLE and FE results [[

]]

Summary of the Adjusted Stress Calculations Using [[
]] **as Described in Appendix A of the SDAR.**

The FE analysis results [[

]]

To illustrate the process, [[

]]

Non-Proprietary

[[

]]

Figure 1: Projected Instrument Arrangement GGNS Steam Dryer (Top View)

[[

]]

Figure 2: Projected Instrument Arrangement GGNS Steam Dryer (180° Side)

[[

]]

Figure 3: Projected Instrument Arrangement GGNS Steam Dryer (90° Side)

Non-Proprietary

[[

]]

Figure 4: Projected Instrument Arrangement GGNS Steam Dryer (270° Side)

[[

]]

Figure 5: Projected Instrument Arrangement GGNS Steam Dryer (0° Side)

Non-Proprietary

RAI 11

Repair/Rework of the Replacement Steam Dryer

The staff notes that the GGNS RSD is being modified at several partial penetration weld locations. The licensee is requested to describe what quality control and other measures are implemented to ensure that these locations do not become locations for intergranular stress corrosion cracking (IGSCC), due to any cold work and residual stresses that could grow under fatigue loading. Therefore, the staff also requests the licensee to describe whether the requirements addressed in the topical reports BWRVIP-84, "Guidelines for Selection and Use of Materials for Repairs to BWR Internal Components", October 2000, and BWRVIP-181, "Steam Dryer Repair Design Criteria", November 2007, will be followed during the repair of the steam dryers.

Response

For the modification of partial penetration welds to the full depth requirement, the welding and material processing controls are in compliance with the requirements specified for the original dryer fabrication. [[

]] The fabrication and cold work controls include polishing of all weld heat-affected zone surfaces to remove any cold work-induced effects from fabrication and also provide additional margin to IGSCC.

The requirements applied include the following:

- The modifications are in compliance with BWRVIP-84 and BWRVIP-181 Category C requirements. The provisions of BWRVIP-181 Sections 9.1 through 9.3 are applied in addition to those presented in BWRVIP-84.
- The modifications conform to applicable ASME Section III Subsection NG requirements (e.g., NG-4000 for steam dryer fabrication and NG-4450 for making weld repairs).
- [[

Non-Proprietary

-]]

- The steam dryer fabrication and modifications are fully compliant with ASME NQA–1, 1994 Edition or Later, Subpart 2.2, with No Addenda, Quality Assurance Program Requirements for Nuclear Facilities, and 10 CFR 50 Appendix B, Quality Assurance Criteria for Nuclear Power Plant and Fuel Reprocessing Plants. Hold point checklists are prepared so that GEH and Entergy Quality Assurance can sign off on all critical stages of the job thus ensuring the work is fully compliant with all the requirements and of the highest quality.

A comprehensive mockup demonstration program was utilized to confirm that the rework procedures and fabrication techniques produce acceptable full depth welds and to minimize the risk of consequential damage. This mockup program includes the following:

- Demonstration of proficiencies for removing existing partial penetration welds and preparation of full depth welds by carbon arc gouging and grinding.
- Where necessary, confirmation of acceptable weld back-purging.
- Demonstrations of welder proficiencies for root pass and weld completion.
- Confirmation of inspection and NDE requirements to assure high quality welds.
- Proper process sequencing to avoid the risk of unacceptable distortion so that critical dimensions are maintained.
- Confirmation that the modifications meet analysis requirements of full depth welds with acceptable weld cross-sections and to ensure that weld root quality is consistent with ASME Section III NG-5231 acceptance requirements.
- [[ ]]
- Sensitization testing of representative mockup welds is performed to confirm that no sensitization in base materials occurs as a result of the modification processes.
- [[ ]]

Non-Proprietary

[[

]]

In some locations, weld buildups have also been used to increase base material thickness near existing original fabrication welds, or near newly applied full depth welds. This occurs at locations where plate thickness was machined to a thinner cross-section near the welds (for example, from 0.75 inch to 0.50 inch thickness) to provide clearance for dryer perforated plate

attachment, or other geometric features. These weld buildups were subjected to the same requirements defined above (original fabrication specifications, BWRVIP-84 and BWRVIP-181, and the appropriate ASME Section III Subsection NG requirements). NDE for these weld buildups would be final surface PT with acceptance in accordance with NG-5300.

The above requirements and controls provide assurance that modification welds comply with all welding quality, Code and BWRVIP requirements. [[

]] The steam dryer materials are low carbon stainless steel which is highly resistant to IGSCC. The fabrication and cold work controls including polishing of all weld heat-affected zone surfaces remove any cold work-induced effects from fabrication processes and provide additional margin to IGSCC.

REFERENCES

1. ASME Boiler & Pressure Vessel Code, Section III, Subsection NG, 2004 Edition, no Addenda.

2. BWRVIP-84: Guidelines for Selection and Use of Materials for Repairs to BWR Internals, EPRI and BWRVIP, 2000. EPRI Report: 1000248.

3. BWRVIP-181-A: Steam Dryer Repair Design Criteria, EPRI, 2007. EPRI Report 1020997.

Non-Proprietary

RAI 13

VPF Loading

In response to Audit Action Item 7 regarding the vane passing frequency (VPF), the licensee states that based on the test results for Susquehanna steam dryer, it is found that [[

]] The licensee is requested to provide response to the following.

a. Since the GGNS has a constant speed recirculation pump and its VPF frequency is different from those for SSES, the licensee is requested to explain why the finding regarding the VPF loads based on the SSES test results is applicable to GGNS.

b. Although [[
]], it acts at different locations on the dryer and its contribution to the dryer dynamic stresses may not be small. The licensee is requested to provide justification to substantiate that [[
]]

Response

The Audit Action Item 7 response (Reference 1) states [[

]]

The relative magnitude of the VPF loading [[

]]
conservatively addressed.

As explained in the Action Item 7 response, a series of tests was performed [[

]]

During power ascension to EPU, Entergy will [[

]]

REFERENCES

1. Letter from Entergy to NRC, “Request for Additional Information Regarding Extended Power Uprate”, Action Item 7, GNRO-2011/00088, dated October 10, 2011. (NRC Accession Number ML112840174)

2. Letter from Entergy to NRC, "Request for Additional Information Regarding Extended Power Uprate Grand Gulf Nuclear Station", GNRO-2011/00101, dated November 14, 2011. (NRC Accession Number ML113190403)

Attachment 3

GNRO-2012/00009

Grand Gulf Nuclear Station Extended Power Uprate

Response to Request for Additional Information

Mechanical and Civil Engineering Branch, Steam Dryer

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-059, "Grand Gulf Steam Dryer: Transmittal of Steam Dryer Responses to Requests for Additional Information 1, 4, 9, 11, and 13," dated February 15, 2012. The GEH proprietary information in Enclosure 1, which is entitled "GEH Responses to GGNS Steam Dryer Requests for Additional Information 1, 4, 9, 11, and 13, GEH Proprietary Information - Class III (Confidential)" is identified by a dotted underline inside double square brackets. [[This sentence is an example.{3}]] Figures, equations and some tables 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 15th day of February 2012.

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-2012/00009

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	
The responses to RAIs 8,10 and 12 will be provided	X		2/21/12
The bounding stress projections using wide band and narrow band methods will be validated for GGNS using on-dryer pressure, acceleration and strain instrumentation as described in our response to RAI-9 (EMCB Steam Dryer Round 5). (Response to RAI-01)	X		8/15/12
During power ascension to EPU, Entergy will assess dryer vibration performance in accordance with the response to RAI-13.	X		8/15/12
Instrument calibration and power accession testing will be performed in accordance with the response to RAI-09.	X		8/15/12