



HITACHI

GE Hitachi Nuclear Energy

Jerald G. Head
Senior Vice President, Regulatory Affairs

PO Box 780 M/C A-18
Wilmington, NC 28402-0780
USA

T 910 819 5692
F 910 362 5692
jerald.head@ge.com

MFN 12-045, Revision 2

Docket number: 05200010

August 9, 2013

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

Subject: NRC Requests for Additional Information Related to the Audit of the Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document – GEH Response to RAIs 3.9-271 and 3.9-271 S01

References:

1. MFN 12-037, Letter from USNRC to Jerald G. Head, GEH, Subject: Request for Additional Information Letter No. 414 related to ESBWR Design Certification Application (DCD) Revision 9, received May 1, 2012
2. MFN 12-045, Letter From Jerald Head to David Misenhimer (USNRC), Subject: NRC Requests for Additional Information Related to the Audit of the Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document – Draft Response RAI 3.9-271, dated June 26, 2012
3. MFN 12-045, Revision 1, Letter from Jerald Head to USNRC Document Control Desk, Subject: NRC Requests for Additional Information Related to the Audit of the Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document – GEH Final Response to RAI 3.9-271, dated February 8, 2013
4. MFN 13-019, Email from USNRC to Jerald G. Head, GEH, Subject: ESBWR Supplemental RAIs, dated March 27, 2013

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In regard to the Requests for Additional Information that you have transmitted in your May 1, 2012 Letter, Reference 1, and your March 27, 2013 Email, Reference 4, to support the NRC ESBWR Steam Dryer Methodology Audit conducted March 21 – 23, 2012, Docket 05200010, please find attached the responses for RAIs 3.9-271 and RAI 3.9-271 S01. Please note that the response to RAI 3.9-271 is essentially the same as that provided in Reference 3, but with administrative corrections tracked using revision bars.

Enclosure 1 contains the complete response, and is acceptable for public release.

If you have any questions concerning this letter, please contact Peter Yandow at 910-819-6378.

I declare under penalty of perjury that the foregoing information is true and correct to the best of my knowledge, information, and belief.

Sincerely,



Jerald G. Head
Senior Vice President, Regulatory Affairs

Commitments: No additional commitments are made in this response.

Enclosure:

1. GEH Final Responses to RAIs 3.9-271 and 3.9-271 S01

cc: Glen Watford, GEH
Peter Yandow, GEH
Patricia Campbell, GEH
Mark Colby, GEH
Daniel Pappone, GEH
Tim Enfinger, GEH
DRF Section 0000-0146-9752, R1

Enclosure 1

MFN 12-045, Revision 2

GEH Final Responses to RAIs 3.9-271 and 3.9-271 S01

IMPORTANT NOTICE REGARDING CONTENTS OF THIS DOCUMENT

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NRC RAI 3.9-271

GEH is requested to confirm that the PBLE method 1 and 2 benchmarks are performed using the same version of PBLE that will be used for the ESBWR certified design. In the event an updated version of PBLE will be used for future ESBWR calculations, GEH is requested to provide a procedure for computing the updated version bias and uncertainties. Additionally, GEH is requested to describe the process for quality control of the PBLE program. In consideration of the significance of the PBLE program in providing confidence in the structural integrity of the ESBWR steam dryer, GEH is requested to address the need to describe the PBLE program in ESBWR DCD, Tier 2, Appendix 3D, "Computer Programs Used in the Design of Components, Equipment, and Structures."

GEH Response

Responses to each element of the NRC request are provided below.

Item 1 – PBLE Versions

GEH is requested to confirm that the PBLE method 1 and 2 benchmarks are performed using the same version of PBLE that will be used for the ESBWR certified design.

The Plant Based Load Evaluation (PBLE01 or referred to here as simply "PBLE") methodology is described in Reference 1, which will be used for the ESBWR certified design, as well as applied to the Method I benchmark¹.

Item 2 – Potential Updates

In the event an updated version of PBLE will be used for future ESBWR calculations, GEH is requested to provide a procedure for computing the updated version bias and uncertainties.

There are two types of changes that could occur with any computational method: (1) a change to the algorithm that has no impact on results², e.g., adding new variables to an output file to enable plotting, or (2) a change to the algorithm that changes the results, such as the addition of a new encoded mathematical model or a new correlation used to represent a physical phenomenon. New or changed models (i.e., a "Type 2" change as defined here, which would not be described in Reference 1) could impact previously reviewed bias and uncertainty values, and place the modified PBLE outside of the NRC reviewed ESBWR standard design, which would have to be addressed through the

¹ GEH has revised the Reference 2 report and removed the Method II approach from the ESBWR licensing basis (see Reference 3).

² Other changes in this category include platform (e.g., a new MatLab version) or computer operating system upgrades. These changes typically produce slight changes in results (e.g., "round off" in trailing digits). However, this is a very small impact and any variation in calculated results is insignificant.

appropriate regulatory change process (e.g., license amendment, Section VIII of design certification rule, or addressed in a COL application). “Type 1” changes, by definition, would not impact calculated bias and uncertainty values, and would be accomplished in compliance with standard quality procedures (see item #3).

In the event that a method change results in a need to update biases and uncertainties, the values would be produced in a manner consistent with the methodology contained in Reference 1, which would include narrow band values. Changes to regulatory documents would be made (as necessary) according to appropriate change control processes (as discussed above).

Item 3 – Quality Control

Additionally, GEH is requested to describe the process for quality control of the PBLE program.

The GEH design control procedures implement ASME NQA-1 requirements [4]. In general, the results of computer programs used for design analysis are verified with each use or pre-verified to show the following³:

- The computer program produces correct solutions for the encoded mathematical model within defined limits for each parameter employed.
- The encoded mathematical model produces a valid solution to the physical problem associated with the particular application.

Pre-verified computer programs are controlled to ensure that changes are documented and approved by authorized personnel. When pre-verified computer programs are used, the encoded mathematical model does not need to be verified with each application. Pre-verified computer programs that comply with GEH procedures are well documented, extensively tested, and maintained under a configuration management system.

Currently, PBLE programs and related information are stored as permanent design records. While this is an effective means of maintaining a version for archival/retrieval, it does not meet the more stringent requirements for control applied to pre-verified programs under NQA-1. Therefore, each application of PBLE must be extensively verified as a unique calculation in order to ensure compliance with design control requirements. From a practical standpoint, prior work may be leveraged, so that verification activities will typically include checks for changes and a demonstration that prior results can be reproduced.

³ These NQA-1 design control requirements for the use of computer programs are given in Section 3.4.1 of Reference 4.

Item 4 – ESBWR Computer Program List

In consideration of the significance of the PBLE program in providing confidence in the structural integrity of the ESBWR steam dryer, GEH is requested to address the need to describe the PBLE program in ESBWR DCD, Tier 2, Appendix 3D, "Computer Programs Used in the Design of Components, Equipment, and Structures."

While it is recognized that PBLE is important for the Flow Induced Vibration (FIV) analysis of the ESBWR steam dryer, Appendix 3D is limited to descriptions of the computer programs used in the analysis of seismic Category I (safety-related) components, equipment, and structures. Therefore, PBLE should not be included in Appendix 3D. Additional information below provides the rationale for why the PBLE computer programs were not included in Appendix 3D and how that is consistent with NRC regulatory guidance. On this basis, GEH does not consider a change to the DCD is necessary to add PBLE to Appendix 3D.

NRC RAI 3.9-100 previously requested: *"Provide a listing and description of the computer programs and calculational procedures used for the analysis of the reactor pressure vessel and the reactor pressure vessel internals, including the core support structures."* GEH responded to RAI 3.9-100 in MFN 07-225, dated April 18, 2007 (ML071160076).

The computer programs included in Appendix 3D of the DCD are those related to Seismic Category I structures, systems, and components. The content of Appendix 3D is specifically discussed in the NRC FSER for Chapter 3 in Sections 3.9.1.2.2 and 3.9.1.3.3, and the GEH response to RAI 3.9-100 is specifically addressed in Section 3.9.3.3.2, which explains that the NRC found the response to be acceptable.

- According to DCD Section 3.2.1: *"Structures, systems and components that perform no safety-related function, but whose structural failure or interaction could degrade the functioning of a Seismic Category I item to an unacceptable level of safety or could result in incapacitating injury to occupants of the main control room, are designated Seismic Category II. These items are designed to structurally withstand the effects of an SSE."*
- As listed in DCD Table 3.2-1 (under item B11 for the reactor pressure vessel system, item 8 – reactor internals non-safety-related components), the steam dryer is Seismic Category II component and, thus, is not within the scope of the guidance for Section 3.9.1 of the DCD. Instead, the steam dryer is subject to NRC regulatory guidance in Sections 3.9.2 and 3.9.5 for reactor internals subject to operational flow transients. NRC regulatory guidance in SRP 3.9.2 refers to RG 1.20 for the review acceptance criteria of the computer programs and modeling approaches for the steam dryer. Thus, the level of detail in the DCD and LTRs is deemed appropriate in this regard.

The PBLE programs and supporting information are stored as permanent design records; the methodology description is included in Reference 1.

This approach is consistent with NRC regulatory guidance. Specifically, Tier 2 Appendix 3D of the ESBWR DCD is referenced in Section 3.9.1, which is consistent with NRC regulatory guidance in RG 1.206 (see, e.g., C.I.3.9.1) and the Standard Review Plan (SRP) Section 3.9.1, both of which state that this section of the DCD should provide information concerning the design transients and resulting loads and load combinations with appropriate specified design and service limits for seismic Category I components and supports.

Additional Discussion

The initial GEH response to this RAI did not fully address NRC staff concerns [5]. Additional points requiring clarification were discussed during a teleconference and are summarized (and paraphrased) below.

- GEH should document, in an ESBWR licensing basis document, the version and specified assumptions for that version, of PBLE used for the benchmark analysis and load definition.
- It was pointed out that reviewers are accustomed to seeing specific versions of a program referred to in Extended Power Uprate (EPU) projects (but PBLE has not historically had a version designation, e.g., PBLE01, in its name).
- GEH should specifically state and add more detail about control under a Quality Assurance (QA) program. For example, if PBLE analyses are controlled as “engineering calculations,” describe the controls that are in place for an engineering calculation and how those apply.

In summary, GEH was requested to clarify how the PBLE methodology is controlled so that analysts use the NRC-approved methodology and how changes are controlled under a QA process.

The Plant-Based Load Evaluation (PBLE) methodology is relatively new and can be thought of as the first generation of the methodology, even though it has historically been referred to with only a name (without a numerical designator). The description of the method is provided in the Reference 1 engineering report, which contains the model basis, including assumptions. Referring to Item #2, if a Type 2 change were introduced, such as a newly developed physical model or a solution technique based on a new set of governing equations, then the resulting new method would either be renamed (something other than PBLE) or a numerical suffix would be added to make it unique, e.g., “PBLE02.” This practice complies with GEH internal procedures, which is a good lead-in to the second topic of discussion.

The implementation of the NRC approved PBLE methodology through computer software complies with 10 CFR Part 50 Appendix B and NQA-1 requirements, as described in Reference 4. Only one set of quality assurance procedures exist within GEH that govern engineering tasks. These procedures are applied regardless of the safety classification of the structure, system, component or item subject to analysis. Stated simply, the engineering procedural controls applied to PBLE calculations are the same as those that are applied to new plant design calculations or operating plant EPU analyses (i.e., safety evaluations for transients, loss of coolant accidents, stability and radiological, etc.). No new or unique procedures are required to ensure the correct application of PBLE.

The PBLE computer programs are verified with each use, in compliance with the GEH procedure for independent verification. Verification requirements include the correctness of the technical formulation, the adequacy or correctness of the implementation, and checks that an acceptable range of inputs and outputs for the application were applied and achieved. Verification methods include any one or a combination of design reviews, alternate calculations, and tests (e.g., validation test cases created during computer program development). Again, these requirements are based on Appendix B and NQA-1, and applied to all engineering tasks as part of GEH's procedural framework.

ESBWR Licensing Basis Changes

No change is proposed in regard to this response for the DCD or other licensing basis documents.

References:

1. NEDC-33408P, *ESBWR Steam Dryer - Plant Based Load Evaluation Methodology - PBLE01 Model Description*, Revision 2, February 2013, Class III.
 2. NEDC-33408P-A, *ESBWR Steam Dryer Plant Based Load Evaluation Methodology*, Revision 1, October 2010, Class III.
 3. MFN 12-130, Jerald G. Head (GEH) to the USNRC Document Control Desk, "Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document," December 12, 2012.
 4. NEDO-11209-A, *GE Hitachi Nuclear Energy Quality Assurance Program Description*, Rev. 9, August 2011, Class I.
 5. MFN 12-045, Jerald G. Head (GEH) to David Misenhimer (NRC), "NRC Requests for Additional Information Related to the Audit of the Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document – Draft Response RAI 3.9-271," June 26, 2012.
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NRC RAI 3.9-271 S01

In its response to RAI 3.9-271 (MFN 12-045, Revision 1, February 8, 2013), GEH stated that the PBLE01 methodology is described in NEDC-33408P, "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology – PBLE01 Model Description), Revision 2, February 2013. GEH provided NEDC-33408 (Revision 2) in its response to RAI 3.9-269 (MFN 12-043, Revision 1, February 7, 2013). Section 2.0 of NEDC-33408P provides a high level description of the PBLE01 methodology. The NRC staff requests that GEH specify the identifying assumptions for the PBLE01 methodology to be applied for the ESBWR steam dryer that can be marked as Tier 2 information.*

GEH Response

GEH has designated the entirety of NEDE-33408P (formerly NEDC-33408P) Tier 2* information. In addition, GEH also has designated NEDE-33312P, "ESBWR Steam Dryer Acoustic Load Definition," and NEDE-33313P, "ESBWR Steam Dryer Structural Evaluation" as Tier 2* in their entirety. GEH will accomplish this by using Tier 2* marking for each reference of any of these three reports in the ESBWR DCD. Markups to this effect are provided in the GEH response to RAI 3.9-292 S03.

ESBWR Licensing Basis Changes

ESBWR DCD markups will be provided in the GEH response to RAI 3.9-292 S03 (GEH Letter MFN 13-007, Revision 1), expected to be submitted in September 2013.