

November 5, 2008

ORGANIZATION: GE Hitachi Nuclear Energy
PROJECT: Economic Simplified Boiling Water Reactor (ESBWR) Design Certification
SUBJECT: SUMMARY OF AUDIT FOR RESOLUTION OF OUTSTANDING
REQUEST FOR ADDITIONAL INFORMATION (RAI) IN
SECTION 3.8, JUNE 23-27, 2008

On June 23 through June 27, 2008, the U.S. Nuclear Regulatory Commission (NRC) conducted an audit of GE-Hitachi Nuclear Energy (GEH) to discuss the resolution of remaining open RAIs in Section 3.8 of ESBWR. This audit was conducted at the GEH office in Wilmington, NC. A summary of the audit, including open items discussed during the audit, is enclosed.

All 19 RAIs were discussed during the audit in numerical order. The subject of each RAI is identified in the enclosure along with the status reached by the end of the audit. Three RAIs were classified as Resolved (R); seven RAIs were classified as Unresolved but technical agreement in the approach to be taken by GEH was reached (identified as U-AIA); one RAI is considered to be Unresolved (U) which is still under staff review; and 8 RAIs are Unresolved (U) with additional technical work needed by GEH to resolve.

/RA/

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ESBWR/ABWR Projects Branch 1
Division of New Reactor Licensing
Office of New Reactors

Docket No. 52-010

Enclosure:
As stated

cc w/enclosure: See next page

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Summary of Audit for Resolution of Chapter 3.8 Requests for Additional Information
June 23 – June 27, 2008

Date: June 23-27, 2008

Place: General Electric-Hitachi (GEH) Office, Wilmington, NC

Subject: Audit - Resolution of Outstanding Requests for Additional Information (RAIs)

Purpose:

The purpose of this audit was to discuss the resolution of the remaining 19 open RAIs related to the structural design of the ESBWR. The applicable sections of the DCD that this covers are Section 3.8 - Seismic Category I Structures, Appendix 3B - Containment Hydrodynamic Load Definitions, Appendix 3C - Computer Programs Used in the Design and Analysis of Seismic Category I Structures (those applicable to structural design), Appendix 3F - Response of Structures to Containment Loads, and Appendix 3G - Design Details and Evaluation Results of Seismic Category I Structures.

Background:

The 19 outstanding RAIs consist of RAI numbers (followed by supplement nos.) 3.8-9 S4, 17 S2, 25 S5, 26 S1, 28 S3, 41 S5, 79 S3, 80 S3, 91 S4, 93 S3, 94 S3, 96 S3, 107 S2, 110 S2, 113, 117, 119, 120 S1, and 121 S1. The RAI or follow-up RAI for each of these is contained in the NRC letter from Jeffrey Cruz (NRC) to Robert Brown (GEH), dated June 5, 2008 (ML081560128).

The agenda prepared for this five-day meeting is presented in Enclosure 1 to this Audit Report. Representatives from NRC, Brookhaven National Lab (BNL), GEH, Hitachi-GE Nuclear Energy, and Empresarios Agrupados were present during the audit. These included key technical personnel including analysts who participated in performing the calculations and designs. The list of attendees who were present at the entrance and exit meeting is provided in Attachment 2.

Audit Process

On Monday afternoon, GEH, NRC staff and BNL (consultant to the NRC staff) initiated discussion of the outstanding RAIs in the order identified in the Background section above. Generally, GEH provided their proposed technical response to address each of the RAIs and the staff/BNL provided the assessment of the approach being utilized. In a number of cases, the staff/BNL clarified what was requested in the RAI, what information is still lacking, and/or what the current NRC staff position is for certain technical areas that still present difficulties.

GEH had available the supporting technical reports and calculations for the related open RAIs in hard copy form. In addition, key project documents, references from the reports and calculations, and related industry standards were available and proved to be very useful.

Enclosure

Since four RAI responses were submitted by GEH to the NRC for review shortly before the audit (RAIs 3.8-17, 107, 113, and 117), the staff/BNL provided their assessment of these recent RAI responses during the audit. These four RAIs relate to the analysis of containment penetrations (RAI 3.8-17), treatment of cracked concrete for thermal and other loads (RAI 3.8-107), spent fuel pool thermal analysis at the boiling temperature of water (RAI 3.8-113), and the analysis and design of the passive containment cooling system (PCCS) condensers (RAI 3.8-117).

Audit Results

All 19 RAIs were discussed during the audit in numerical order. The subject of each RAI is identified in Attachment 3 along with the status reached by the end of the audit. Three RAIs were classified as Resolved (R); seven RAIs were classified as Unresolved but technical agreement in the approach to be taken by GEH was reached (identified as U-AIA); one RAI is considered to be Unresolved (U) which is still under staff review; and 8 RAIs are Unresolved (U) with additional technical work needed by GEH to resolve.

Some of the observations and discussions of the more significant RAIs are presented below.

RAI 3.8-94

GEH explained that the DCD dynamic soil bearing pressure demands are satisfied at North Anna Unit 3 (a rock site) and Grand Gulf Unit 3 (a soil site) that have submitted COL applications based on the ESBWR design. GEH indicated that values as high as 259 ksf can be achieved. The basis for this very high soil bearing capacity for the soil site at Grand Gulf was not available, and thus could not be evaluated. Therefore, GEH was requested to provide the technical basis for demonstrating that the bearing capacity demand calculated from the ESBWR analyses are achievable for various soil sites. This may be based on bearing capacity equations using expected range of soil properties. In addition, the staff requests that GEH indicate what type of tests will be utilized by the COL applicants to demonstrate that these values can be met.

RAI 3.8-96

While good progress has been made in many of the 10 items in this RAI, the major concern still remains in the sliding stability calculation of the seismic category I structures under seismic loads. GEH made a presentation to show that if the time phasing of horizontal and vertical shear forces from the seismic lumped mass model and the SASSI layered (and embedded) model are used, then the time history of the factors of safety (FS) are generally above the 1.1 required FS and sometimes dip below 1.1. However, GEH indicated that the dips below 1.1 are for a short time duration and thus the structure would not slide. The staff indicated that this does not clearly demonstrate that the criteria of the FS equal to 1.1, referred to in SRP Section 3.8.5, is satisfied. GEH needs to consider how to address this issue.

Another outstanding item is the technical basis for the use of 0.7 coefficient of friction for the sliding interface of concrete (mudmat) to soil and the sliding resistance between the basemat and mudmat. Currently, ACI 349 Section 11.7.4.3 states that the coefficient of friction is 0.6 for concrete placed on concrete with a surface not intentionally roughened, and 1.0 if the surface is

intentionally roughened as specified in Section 11.7.9 (roughened to 1/4-inch). How will GEH ensure that the coefficient of friction of 0.7 will be satisfied for the sliding interface between the basemat and mudmat? Additionally, no information was provided to demonstrate that the coefficient of friction between the mudmat and soil is 0.7.

RAI 3.8-79

During the audit, all seismic category II (C II) and non-seismic (NS) structures, which are part of the ESBWR design certification, were discussed. These structures are listed below:

Radwaste Bldg.	NS [Category RW-IIa for RG 1.143]
Turbine Bldg.	NS [bldg. contains radwaste gaseous system & reactor protection system]
Electric Bldg.	NS (RTNSS C) – Far enough away from C I, no II/I interaction
Service Bldg.	C II
Ancillary diesel bldg.	C II (RTNSS B)
Radwaste Tunnel	NS
Access tunnel	C II (RTNSS B)
Buried duct banks associated with the ancillary bldg.	C II (RTNSS B)

GEH indicated that C II buildings are seismically analyzed the same as C I. C II structures are not designed to resist tornado missiles. Ancillary bldg. is designed to resist hurricane category 5 missiles. All C I & C II buildings are designed to resist tornado winds.

Radwaste Bldg: GEH has already indicated in DCD Rev. 5 (DCD Table 2.0-1 and 5.1-1) that the Radwaste bldg. will be designed using RG 1.143 with the full SSE (not OBE or 1/2SSE). GEH recognizes that DCD Sections 3.7.2.8 and 3.8.4 also need to be revised to properly reflect the use of the SSE and other associated criteria. RG 1.143 has the required design code of ACI 349, load combinations, and acceptance criteria. This evaluation for SSE applies to the Radwaste building structure, not for components within the structure.

GEH will investigate including a description of the seismic analysis method (i.e., type of model to be used, how soil structure interaction (SSI) analysis will be performed, seismic analysis will be similar to which other structure already presented in the DCD, etc.) and refer to the appropriate sections in DCD Section 3.7.

For C II structures listed above (excluding the tunnels), GEH will investigate using the same approach in the paragraph immediately preceding this paragraph.

For tunnels, this issue is being addressed separately under RAI 3.7-52.

For the turbine building, GEH needs to resolve the proper classification of the building. For the seismic interaction (II/I issue), while both options identified in the GEH draft RAI response are possible, it appears that option b is the better approach. The analysis approach is straightforward (i.e., the same as C I) and would probably address the concerns related to safety related components installed in the turbine building (see list above). GEH will investigate using the same approach in the paragraphs for the Radwaste building and C II above.

RAI 3.8-121

During the audit, the issue of design of composite floor slabs was discussed. The analysis and design method of treating the steel plate as two orthogonal rebars is a unique approach, and is not addressed by AISC or ACI codes. The RAI had asked five questions in order to assess the technical basis for using the design approach. During the audit GEH presented a draft response stating that the Japanese codes address the design of modular composite structures, and the ESBWR modular composite design is consistent with the Japanese practice.

The staff did not consider that the draft response adequately addressed the original RAI questions, and more detailed and specific response was needed including relevant test reports (with English translation as required) to address the issue.

Exit Meeting

On June 27, 2008, prior to the exit meeting, some discussions were held to address last minute items. This was followed by the exit meeting. During the exit meeting, the staff summarized the work performed during the audit, highlights of the results, and the status of the RAIs.

GEH ESBWR DCD SECTION 3.8 AUDIT AGENDA

Date: Week of June 23, 2008

Place: GEH Offices, Wilmington, NC

Subject: Resolution of Outstanding RAIs and Audit of Selected Portions of Calculations/Reports Related to Outstanding RAIs

First Day – Monday June 23, 1:30 PM

Discuss resolution of remaining 19 open RAIs in Section 3.8 of the DCD. These consist of RAI numbers (followed by supplement nos.) 3.8-9 S4, 17 S2, 25 S5, 26 S1, 28 S3, 41 S5, 79 S3, 80 S3, 91 S4, 93 S3, 94 S3, 96 S3, 107 S2, 110 S2, 113, 117, 119, 120 S1, and 121 S1. The latest RAI or follow-up RAI for each of these is contained in NRC letter from Jeffrey Cruz (NRC) to Robert Brown (GEH), dated June 3, 2008.

GEH should be prepared to provide their proposed technical response to address each of these remaining open items. Since responses were recently submitted by GEH for RAIs 3.8-17, 107, 113, and 117 the staff will provide their assessment of these for discussion.

Any RAI that becomes difficult to make sufficient progress should be deferred to the following day or to Thursday, to ensure that all RAIs can be discussed at least once by the end of Wednesday.

To make this meeting productive, it is recommended that all of the key technical personnel, including analysts, who participated in performing the calculations and designs related to the remaining open RAIs, be available.

GEH is requested to have available the supporting technical reports and calculations for the related open RAIs available in hard copy form. This includes the analysis/design of the containment liner/anchor design, PCCS/isolation condenser/piping that are part of the containment boundary, FWSC, and key references cited in the technical reports and calculations. Also, if it becomes necessary it would be prudent to have some means available to GEH to gain access to other reports and calculations (e.g., electronically accessible).

If a review of any technical report or calculation related to an RAI is needed, the review should be deferred until Wednesday or Thursday until all RAIs have been discussed at least once.

GEH is requested to have available, a computer projector to facilitate the review of computer/electronic information by participants present.

Second Day - Tuesday

Continue discussion of remaining open RAIs identified above under the First Day heading.

If sufficient progress is made on Tuesday, then any RAI deferred from Monday can be discussed.

If a review of any technical report or calculation related to an RAI is needed, the review should be deferred until Wednesday or Thursday until all RAIs have been discussed at least once.

Third Day - Wednesday

Complete the discussion of remaining open RAIs identified above under the First Day heading.

If discussion of all open RAIs has been completed, then any RAI deferred from Monday, Tuesday, and/or Wednesday can be discussed.

If a review of any technical report or calculation related to an RAI is needed, the review should be deferred until all RAIs have been discussed at least once.

Fourth Day - Thursday

Complete the discussion of RAIs that have been deferred from Monday, Tuesday, and/or Wednesday.

Complete the review of any technical report or calculation related to an RAI identified in the prior days.

Fifth Day - Friday

Discuss any last minute items needing resolution

Staff discussion prior to Exit Meeting

Exit Meeting (Tentatively set for 9:30 AM)

Audit Participation Summary

This Table provides a comprehensive list of the audit participants from NRC and GEH, Empresarios Agrupados (EA), and Hitachi GE Nuclear Energy (HE) . Their attendance at either the entrance meeting or at the closing meeting has been noted.

Last Name	First Name	Affiliation	Entrance Meeting	Closing Meeting
Patel	Chandu	NRC	X	X
Chakrabarti	Samir	NRC	X	X
Shams	Mohamed	NRC	X	
Braverman	Joe	BNL	X	X
Blake	Taylor	GEH	X	X
Waal	Jeff	GEH	X	X
Jordan	Peter	GEH	X	X
Clement	Rajendra	GEH	X	X
Liu	Ai-shen	GEH	X	X
Herzog	Maryann	GEH	X	X
Orden	Alfredo	EA	X	X
Perez	Francisco	EA	X	X
Nagata	Tetsuya	HGE	X	X
Furukawa	Hideyasu	HGE	X	X
Osaka	Masaaki	HGE	X	X
Kinsey	James	GEH		X
Kingston	Rick	GEH		X

STATUS OF OUTSTANDING RAIS

Summary

Resolved (R) = 3
 Unresolved (U) = 16

U broken down as follows:

Unresolved (U-AIA)* = 7
 Unresolved (NRC reviewing) = 1
 Unresolved (U) need additional technical work = 8

U-AIA* – Unresolved but technical agreement in the approach to be taken by GEH was reached.

RAI No.	Subject	Status
9	Use of SRSS method to combine dynamic loadings	U
17	Evaluation of penetrations done in separate FEM analysis	R
25	Adequacy of modeling, analysis, and design of liner/anchors	U-AIA
26	Design of liner/anchors now addressed under RAI 3.8-25	R
28	Need to identify in DCD/COL action item to ensure appropriate evaluation of mechanical & electrical penetration design/details	U
41	Consideration of 100% infill concrete, revised containment thermal DBA time history (identified in RAI 6.2-180 S01), and widening of the buffer pool gate.	U-AIA
79	Analysis & design of Radwaste Bldg., seismic Category II structures & NS structures	U
80	Design requirements for Radwaste Bldg. (GEH indicated that this is being addressed under RAI 3.8-79)	U-AIA
91	Sample calculation to verify SSDP computer code used for design of concrete members	R
93	Commitment in DCD related to construction sequence for foundation basemat & walls	U-AIA
94	Issues related to high seismic soil bearing demand	U
96	Soil stability calculations, soil properties, and crystalline powder in mud mat beneath basemat for waterproofing	U
107	Formulations used for design of concrete members in SSDP computer code	U-Only item 3

110	Compliance with Regulatory Guide 1.57, Revision 1 and consistency of steel materials listed in DCD with those specified in ASME Section III, Division 1, Subsection NE for containment	U-AIA
113	Fuel pool design for thermal temperature at water boiling point	U-AIA
117	Structural issues related to inclusion of PCCS condensers as part of containment boundary	U-AIA
119	Adequacy of DCD Appendix B and definition of containment hydrodynamic loads presented in separate referenced GEH report	U – Staff reviewing
120	Issues related to the use of A-709 HPS 70W for containment and internal structures (including reactor shield wall)	U
121	Technical basis for analysis & design approach for composite floor slabs	U

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(Revised 09/29/2008)

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