November 5, 2008

ORGANIZATION: GE Hitachi Nuclear Energy (GEH)

PROJECT: Economic Simplified Boiling Water Reactor (ESBWR) Design Certification

SUBJECT: FINAL AUDIT SUMMARY INCLUDING PHASE 4 FOR ESBWR GAMMA THERMOMETER JULY 2008

From July 21 through July 24 and on July 31, 2008, the U.S. Nuclear Regulatory Commission (NRC) completed the fourth phase of an audit of GE-Hitachi Nuclear Energy (GEH) documentation regarding ESBWR gamma thermometer at the GEH office in Washington, DC. During Phase 4 of this audit, the NRC team conducted a review of the remaining design record files (DRFs) relevant to requests for additional information (RAIs) 4.2-12, 4.3-2, 7.2-14, 7.2-18, 7.2-20, 7.2-51, and 7.2-64 and held an exit meeting with GEH at the conclusion. A list of attendees is provided in Enclosure 1, and a non-proprietary version summary of the meeting, including a list of RAIs briefed during the audit exit, is provided in Enclosure 2. Enclosure 3 contains a proprietary version of the audit summary.

During continuing review of the ESBWR design certification, the staff will be considering information gained during this audit and will communicate any additional issues or requests for information with the applicant on the ESBWR docket.

***/RA/***

Bruce M. Bavol, Project Manager
ESBWR/ABWR Projects Branch 1
Division of New Reactor Licensing
Office of New Reactors

Docket No. 52-010

Enclosures:
1. Audit Participation Summary
2. Audit Summary – (Non-Proprietary)
3. Audit Summary – (Proprietary)

cc: See next page (w/o enclosure 3)

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| OFFICE | PM:NGE1 | PM:NGE1 | BC:SNPB | BC:SRSB (Acting) | BC:NEG1 |
|---|---|---|---|---|---|
| NAME | BBavol | ACubbage | AMendiola | JMcKirgan | JCruz |
| DATE | 10/21/2008 | 10/21/2008 | 10/29/2008 | 11/03/2008 | 11/05/2008 |

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**Table 1: Phase 4 Audit Participation Summary (July 21 through 31, 2008)**

Table 1 provides a comprehensive list of the audit participants from both NRC and GEH. Their attendance at either the entrance meeting or at the exit meeting (via teleconference) has been noted.

| Last Name | First Name | Affiliation | Attended Entrance 7/21/2008 | Attended Exit 7/31/2008 |
|---|---|---|---|---|
| Armstrong | David | GEH | X | X |
| Bowman | Scott | GEH | X | |
| Cuevas-Vivas | Gabriel | GEH | X | X |
| Golub | Pareez | GEH | X | X |
| Kingston | Richard | GEH | X | |
| Mills | V. Webb | GEH | X | X |
| Moore | Brian | GEH | | X |
| Sugawara | Toshi | GEH | | X |
| Washburn | Tyson | GEH | X | X |
| Williamson | Daniel | GEH | X | |
| Bavol | Bruce | NRC | | X |
| Cubbage | Amy | NRC | | X |
| Galvin | Dennis | NRC | X | |
| Gilmer | James | NRC | | X |
| McKirgan | John | NRC | | X |
| Yarsky | Peter | NRC | X | X |

**Summary of Phase 4 Audit (Including Exit Meeting Discussions) for ESBWR Gamma Thermometer (GT) July 2008**

From July 21 through July 24 and on July 31, 2008, the U.S. Nuclear Regulatory Commission (NRC) completed the fourth phase of an audit of GE-Hitachi Nuclear Energy (GEH) documentation regarding ESBWR gamma thermometer at the GEH office in Washington, DC. During Phase 4 of this audit, the NRC team conducted a review of the remaining design record files (DRFs) relevant to requests for additional information (RAIs) 4.2-12, 4.3-2, 7.2-14, 7.2-18, 7.2-20, 7.2-51, and 7.2-64 and held an exit meeting with GEH at the conclusion.

Phase 4: Audit for ESBWR Gamma Thermometer (GT)

The fourth phase of the audit began on July 21, 2008, resuming at the GEH offices in Washington, DC. The staff reviewed documents pertaining to the GT power shape monitoring methodology and uncertainty, instrument failure analysis, and instrument biases that were relevant to the staff's review of the core monitoring system power distribution uncertainty. The staff held discussions with the applicant regarding the conditions, limitations, and restrictions that will be imposed on the core monitoring methodology licensing topical reports (LTRs), namely, NEDE-33197P, "Gamma Thermometer System for LPRM Calibration and Power Shape Monitoring" and NEDC-33239P, "ESBWR Nuclear Design Report."

Over the course of phase 4, several ongoing items were resolved as described below. One ongoing item (6) was not adequately resolved by the time of the final audit exit and was therefore documented as an open item. This open item was subsequently resolved several weeks later.

1. GEH investigated the impact on GT response and subsequent interpolation for GTs located coincident with fuel spacers (RAI 4.2-12 S02-22). GEH provided additional information regarding the spacer effect in response to RAI 7.2-20 S01-B. The staff reviewed the response to RAI 7.2-20 S01-B and found that the studies are adequate to determine the GT instrument bias and that the methodology is acceptable for cycle specific applications.

2. GEH addressed actions taken and uncertainties in power distribution associated with the failure of GT instruments and GT strings (RAI 4.2-12 S02-20). GEH provided this information to the staff in the response to RAI 7.2-66 and RAI 7.2-18 S02*. The staff reviewed the response to RAI 7.2-18 S02* and found that the GT failure uncertainty analysis is acceptable and that this uncertainty component has been adequately quantified.

3. GEH developed the GT calibration procedure and addressed GT response during GT calibration. (RAI 7.2-64 S01). The information requested by the staff was provided, in part, in response to RAI 7.2-59 S02. The [[_____]] were specified in the response to RAI 7.2-20 S01-G. The response adequately addresses the issue.

4. GEH determined a method for converting the interpolation fit of the GT signals to a discrete array for the purposes of axial power shape monitoring (7.2-64 S01). GEH provided the revised technique, as modified, in RAI 7.2-18 S02*. The modified technique is being used for the ESBWR design.

5. GEH addressed bypass conditions and their effect on the GT instruments, including the effects of bypass voiding (RAI 4.3-2 S02-C-2). GEH provided information in several RAI responses addressing bypass void formation and bypass conditions and the impact on GT response. The staff finds that the responses are acceptable to demonstrate adequate GT performance under various bypass conditions.

6. GEH updated the bundle power and LHGR uncertainty analysis accounting for the additional uncertainties discussed during the course of the audit (RAI 4.2-12 S02-17). The response to RAI 7.2-18 S02* supersedes the response to RAI 4.2-12 S02-17 and was found to be acceptable.

Audit Exit for ESBWR Gamma Thermometer (GT)

On July 31, 2008, the NRC team and GEH personnel conducted an exit meeting via teleconference following phase 4 of the audit. The staff discussed the original purpose of the audit which was to review documentation regarding the development and qualification of nuclear design methods used by the core monitoring software to use in-core instrumentation measurements to perform power shape monitoring and calibrations. With the resolution of the following RAIs the staff will be able complete its review of the nuclear design methods and core instrumentation using the requirements of GDC 10 or GDC 13.

The following RAIs were discussed in detail with GEH and subsequently resolved or superseded by another relevant RAI:

RAIs 4.2-12 S02, 4.3-2 S02, 7.2-14 S01, 7.2-18 S02*, 7.2-20 S01, 7.2-51 S01, 7.2-55 S01, 7.2-56 S01, 7.2-58 S01, 7.2-59 S02, 7.2-60 S01, 7.2-64 S01, and 7.2-66.

Following the audit exit and two subsequent conference calls with GEH on GT conditions, the NRC staff generated two additional RAIs. The staff identified a concern in the detailed software implementation of the GT based Core Monitoring System (CMS) and issued RAI 7.2-72. This RAI requires GEH to provide a refinement to the method to account for the detailed axial bundle geometry and to include this refinement description in LTR NEDE-33197P prior to issuing the approved (–A) version. RAI 7.2-71 has also been issued detailing 21 conditions GEH will need to update in LTRs NEDE-33197P and/or NEDC-33239P.

*RAI 7.2-18 S02 was not adequately resolved by the time of the audit exit and was therefore documented as an open item. This RAI was subsequently resolved several weeks later.

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