

**Enclosure 2 Contains Sensitive Proprietary Information**

September 15, 2009

APPLICANT: GE Hitachi Nuclear Energy

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

SUBJECT: REPORT OF THE AUGUST 25, 2009, AND SEPTEMBER 9, 2009,  
REGULATORY AUDIT OF REACTOR PRESSURE VESSEL INTERNALS OF  
THE ECONOMIC SIMPLIFIED BOILING WATER REACTOR AT  
GENERAL ELECTRIC HITACHI (GEH) OFFICE IN WILMINGTON, NC

On August 25, 2009, the U.S. Nuclear Regulatory Commission (NRC) staff conducted an audit of the Reactor Pressure Vessel Internals which support Chapter 3 of the ESBWR Design Certification Application. The audit was conducted at the GEH offices in Wilmington, North Carolina. On September 9, 2009, the NRC staff and GEH held a follow up conference call to discuss remaining issues from the Audit on August 25, 2009. An audit report, including participants, audit activities, and list of follow-up items, is enclosed. A response from GEH to the follow-up items is requested to consider all the issues resolved.

Pursuant to 10 CFR 2.390, we have determined that the enclosed audit report contains proprietary information. We have prepared a non-proprietary version of the audit report (Enclosure 1) that does not contain proprietary information. The proprietary information is indicated in brackets and underlined in Enclosure 2. We will delay placing this document in the public document room for a period of ten (10) working days from the date of this letter to provide you with the opportunity to comment on the proprietary aspects only. If you believe that any additional information in the enclosure is proprietary, please identify such information line by line and define the basis pursuant to the criteria of 10 CFR 2.390 before the public release date.

*/RA/*

Zahira Cruz Perez, Project Manager  
ESBWR/ABWR Projects Branch 1  
Division of New Reactor Licensing  
Office of New Reactors

Docket No. 52-010

Enclosures:

1. Audit Summary –(Non-Proprietary)
2. Audit Summary – (Proprietary)

cc: See next page (w/o enclosure 2)

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

SUBJECT: REPORT OF THE AUGUST 25, 2009, AND SEPTEMBER 9, 2009, REGULATORY AUDIT OF REACTOR PRESSURE VESSEL INTERNALS OF THE ECONOMIC SIMPLIFIED BOILING WATER REACTOR AT GENERAL ELECTRIC HITACHI (GEH) OFFICE IN WILMINGTON, NC

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<u>Hard Copy</u>	<u>E-Mail</u>	ACubbage
NGE1 R/F	TSpicher	JDixon-Herrity
ZCruz Perez	PSekerak	ZCruz-Perez

ADAMS ACCESSION NO. ML092540004

NRO-002

<b>OFFICE</b>	PM:NGE1:NRO	PM:NGE1:NRO	BC:EMB2:NRO	BC:NGE1:NRO
<b>NAME</b>	ZCruz Perez	ACubbage	JDixon-Herrity	JCruz
<b>DATE</b>	09/14/09	09/10/09	09/15/09	09/15/09

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**EXECUTIVE SUMMARY**

GE-HITACHI NUCLEAR ENERGY, INC. (GEH)  
Docket No. 052-000010

The NRC staff, upon review of Sections 3.9.2 and 3.9.5 of the GEH ESBWR Design Control Document, requested confirmation information for Reactor Pressure Vessel Internals and Dynamic Testing and Analysis of Systems, Structures, and Components. The purpose of the regulatory audit was to verify that the ESBWR component design and analysis is being performed in accordance with the methodology and criteria described in the ESBWR Design Control Document (DCD) in support of the ESBWR Design Certification (DC) application.

The results of the audit are summarized below.

The NRC staff, with assistance of Argonne National Laboratory contractors, successfully reviewed and discussed the engineering calculations and analysis that support the design and dynamic testing and analysis for reactor internals to confirm the provisions within the ESBWR DCD. The staff recommended document improvements and specific changes to the ESBWR DCD to supplement those either within or identified in Rev.6 of the DCD.

**Table 1: Audit Participation Summary**

Table 1 provides a comprehensive list of the audit participants from NRC, Argonne National Laboratory and GEH.

<b>Name</b>	<b>Affiliation</b>
Zahira Cruz	NRC
Terri Spicher	NRC
Vik Shah	Argonne National Laboratory
Tom Mulcahy	Argonne National Laboratory
Hugh Upton	GEH
Jerry Deaver	GEH
Enrico Betti	GEH
Dan Pappone	GEH
Larry Tucker	GEH
Glen Schroeder	GEH
David Piepmeyer	GEH
Rick Kingston	GEH
Jerry Head	GEH
Jim Klapproth	GEH
Dave Keck	GEH

Enclosure 1

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### **REPORT DETAILS**

#### **Audit Scope/Summary:**

The overall scope of the audit was to accomplish the following:

- Verify that the ESBWR accurately reflects the design of reactor pressure vessel internals.
- Verify that the design calculations and engineering analysis for reactor pressure vessel internals have been adequately prepared in accordance with requirements defined in the ASME design specifications.
- Verify that the design for the reactor pressure vessel components meets the design criteria, and that the analytical methods and functional capability satisfy the guidance provided in SRP Sections 3.9.2 and 3.9.5.
- Identify further information that is necessary for the applicant to submit to allow the staff to reach a safety determination for the ESBWR Design Certification.

Members present at the audit are provided within Attachment 1 of this audit report.

The purpose of the regulatory audit was to verify that the ESBWR component design and analysis are being performed in accordance with the methodology and criteria described in the ESBWR Design Control Document (DCD) in support of the ESBWR Design Certification (DC) application. This includes verification that the calculations and analysis describe the design documented in ESBWR DCD Section 3.9.2 and 3.9.5. In addition, the staff discussed with GE-Hitachi Nuclear Energy, Inc. (GEH) engineering staff specific design criteria, testing, and analysis that supports conclusions described in ESBWR DCD Sections 3.9.2 and 3.9.5, ESBWR Steam Dryer Acoustic Load Definition, NEDE-33312P – Rev. 1, ESBWR Steam Dryer Structural Evaluation, NEDE-33313P – Rev. 1, ESBWR Steam Dryer – Plant Based Load Evaluation Methodology, NEDC-33408P – Rev. 1, and ESBWR Steam Dryer – Plant Based Load Evaluation Methodology Supplement 1 - NEDC-33408P – Supplement 1 – Rev. 0. Additionally, the staff identified further information that the applicant will have to submit for the staff to reach a safety determination for the ESBWR DC application.

GEH made the reactor pressure vessel internals design specifications, supporting design calculations, test data, and analysis available for the audit. Based on the information reviewed, the staff found that the design documents for the reviewed components reflected the methodology and criteria contained in the DCD. During the audit, some issues and questions were raised by the staff, and are considered follow-up items as discussed later in this report. The follow-up items will be considered closed when GEH supplies additional information in response to this audit, or the staff performs an additional onsite review for confirmatory purposes.

## Observations and Findings

GEH began by presenting the interactive, 3-D model of the reactor internals for the ESBWR. During the presentation, the NRC staff asked specific questions regarding the methodology and detail design for the reactor internal components as well as the dynamic testing and analysis. GEH answered all questions and a summary of areas resolved is listed below:

1. Identified the significant improvements already incorporated [[ ]].
2. Provided the criteria that will be used to [[ ]].
3. Provided the computer model of the [[ ]].
4. Provided the out-of-reactor test report on an [[ ]].
5. Using the GEH computer model of the reactor internals, showed how the [[ ]].
6. Explained why the flow rate through the [[ ]].
7. Verified that the information provided in Table 4 of NEDE-33259 Rev. 1 [[ ]].
8. Elaborated on the FIV analyses that were made for the [[ ]].
9. Staff reviewed the GEH [[ ]].

As a result of the audit, the NRC Staff recommended the following document improvements and specific changes to the ESBWR DCD to supplement those either within or identified in Revision 6:

1. Provide a methodology or road map that incorporates GEH's [[  
]]. Include references to design documents where specific information, processes, acceptance criteria, etc. are contained.
2. In Section 3L.4.6 of Appendix 3L to DCD Tier 2, the applicant provides acceptance criteria for the strains measured on the instrumented steam dryer during power ascension. This response is acceptable for the first few ESBWR plants where the steam dryers will be instrumented with strain gages. [[

]].

3. Ensure modifications to [[

]].

The applicant has also clarified that vibration data for all equipment listed in DCD Tier 2, Table 3L.4, will be acquired during initial startup and power ascension testing. [[

]]

4. The staff is concerned about the structural integrity of [[

]].

5. GEH has stated that the dryer of the first ESBWR will be instrumented during power ascension to ensure that the [[

]]

6. GEH is asked to explain how it will determine the size of the [[

]].

7. In NEDE-33259 Rev. 2, the support of the ESBWR shroud was changed from Rev. 1. Show the [[

]].

8. Explain the planned supports for the [[

]].

9. Verify that FIV stress analysis of the internal components has been repeated that accounts for the [[

]].

10. GEH has proposed three approaches in calculating fatigue stress [[

]].

11. GEH agreed that rejectable root defects will not always penetrate the surface. Therefore, for [[

]].

12. GEH agreed that the TRANSMATRIX coefficients used in the PBLE methodology [[

]]. GEH will modify NEDE-33312P to include this commitment.

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13. In NEDE-33312P, GEH will clearly identify the ESBWR loads and where they come from. Additionally, the loads will be shown on a plot in NEDE-33312P.
14. GEH has provided frequency-dependent bias errors and uncertainties in RAI responses, but has not committed to using them for ESBWR design purposes. GEH should provide a clear summary table of frequency dependent bias errors and uncertainties for both PBLE-based dryer loads, as well as dryer FE frequency response functions used for stress calculations. The bias errors and uncertainties may be computed over [[ ]].
15. GEH should provide their planned procedure for ensuring any [[ ]] of dryer stresses will be conservative and included in NEDE-33312P.
16. GEH needs to update their PBLE bias error and uncertainty table to include the frequency dependent values they calculated and clarify their statement that PBLE bias errors and uncertainties [[ ]] in NEDE-33312P.

#### Exit Meeting

On August 25, 2009 the NRC staff presented the audit scope and findings during an exit meeting with Hugh Upton and GEH personnel.



DC GE - ESBWR Mailing List

(Revised 09/09/2009)

cc:

Ms. Michele Boyd  
Legislative Director  
Energy Program  
Public Citizens Critical Mass Energy  
and Environmental Program  
215 Pennsylvania Avenue, SE  
Washington, DC 20003

Mr. Tom Sliva  
7207 IBM Drive  
Charlotte, NC 28262

## DC GE - ESBWR Mailing List

### Email

aec@nrc.gov (Amy Cubbage)  
APH@NEI.org (Adrian Heymer)  
art.alford@ge.com (Art Alford)  
awc@nei.org (Anne W. Cottingham)  
bevans@enercon.com (Bob Evans)  
BrinkmCB@westinghouse.com (Charles Brinkman)  
cberger@energetics.com (Carl Berger)  
charles.bagnal@ge.com  
charles@blackburncarter.com (Charles Irvine)  
chris.maslak@ge.com (Chris Maslak)  
CumminWE@Westinghouse.com (Edward W. Cummins)  
cwaltman@roe.com (C. Waltman)  
dan1.williamson@ge.com (Dan Williamson)  
Daniel.Chalk@nuclear.energy.gov (Daniel Chalk)  
david.hinds@ge.com (David Hinds)  
david.lewis@pillsburylaw.com (David Lewis)  
David.piepmeyer@ge.com (David Piepmeyer)  
donaldf.taylor@ge.com (Don Taylor)  
erg-xl@cox.net (Eddie R. Grant)  
Frostie.white@ge.com (Frostie White)  
gcesare@enercon.com (Guy Cesare)  
GEH-NRC@hse.gsi.gov.uk (Geoff Grint)  
george.honma@ge.com (George Honma)  
GovePA@BV.com (Patrick Gove)  
greshaja@westinghouse.com (James Gresham)  
gzinke@entergy.com (George Alan Zinke)  
hickste@earthlink.net (Thomas Hicks)  
hugh.upton@ge.com (Hugh Upton)  
james.beard@gene.ge.com (James Beard)  
jeff.waal@ge.com (Jeff Waal)  
jerald.head@ge.com (Jerald G. Head)  
Jerold.Marks@ge.com (Jerold Marks)  
jgutierrez@morganlewis.com (Jay M. Gutierrez)  
Jim.Kinsey@inl.gov (James Kinsey)  
jim.riccio@wdc.greenpeace.org (James Riccio)  
JJNesrsta@cpsenergy.com (James J. Nesrsta)  
joel.Friday@ge.com (Joel Friday)  
John.O'Neill@pillsburylaw.com (John O'Neill)  
john.sorensen@ge.com (John Sorensen)  
Joseph\_Hegner@dom.com (Joseph Hegner)  
junichi\_uchiyama@mnes-us.com (Junichi Uchiyama)  
kimberly.milchuck@ge.com (Kimberly Milchuck)  
KSutton@morganlewis.com (Kathryn M. Sutton)  
kwaugh@impact-net.org (Kenneth O. Waugh)

## DC GE - ESBWR Mailing List

Ichandler@morganlewis.com (Lawrence J. Chandler)  
lee.dougherty@ge.com  
lou.lanese@ge.com (Lou Lanese)  
Marc.Brooks@dhs.gov (Marc Brooks)  
maria.webb@pillsburylaw.com (Maria Webb)  
mark.beaumont@wsms.com (Mark Beaumont)  
Marvin.Smith@dom.com (Marvin L. Smith)  
matias.travieso-diaz@pillsburylaw.com (Matias Travieso-Diaz)  
media@nei.org (Scott Peterson)  
mike\_moran@fpl.com (Mike Moran)  
MSF@nei.org (Marvin Fertel)  
mwetterhahn@winston.com (M. Wetterhahn)  
nirsnet@nirs.org (Michael Mariotte)  
pareez.golub@ge.com (Pareez Golub)  
patriciaL.campbell@ge.com (Patricia L. Campbell)  
paul.gaukler@pillsburylaw.com (Paul Gaukler)  
Paul@beyondnuclear.org (Paul Gunter)  
peter.yandow@ge.com (Peter Yandow)  
pshastings@duke-energy.com (Peter Hastings)  
rick.kingston@ge.com (Rick Kingston)  
RJB@NEI.org (Russell Bell)  
RKTemple@cpsenergy.com (R.K. Temple)  
Russell.Wells@Areva.com (Russell Wells)  
sabinski@suddenlink.net (Steve A. Bennett)  
sandra.sloan@areva.com (Sandra Sloan)  
sara.andersen@ge.com (Sara Anderson)  
SauerB@BV.com (Robert C. Sauer)  
sfrantz@morganlewis.com (Stephen P. Frantz)  
stephan.moen@ge.com (Stephan Moen)  
steven.hucik@ge.com (Steven Hucik)  
stramback@westinghouse.com (George Stramback)  
tdurkin@energetics.com (Tim Durkin)  
timothy1.enfinger@ge.com (Tim Enfinger)  
tom.miller@hq.doe.gov (Tom Miller)  
trsmith@winston.com (Tyson Smith)  
Vanessa.quinn@dhs.gov (Vanessa Quinn)  
VictorB@bv.com (Bill Victor)  
Wanda.K.Marshall@dom.com (Wanda K. Marshall)  
wayne.marquino@ge.com (Wayne Marquino)  
whorin@winston.com (W. Horin)