Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

October 25, 2012

10 CFR 54.7

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Browns Ferry Nuclear Plant, Units 1, 2, and 3
Renewed Facility Operating License Nos. DPR-33, DPR-52, and DPR-68
NRC Docket Nos. 50-259, 50-260, and 50-296

Subject: **Response to Request for Additional Information Regarding BWRVIP- 25 Core Plate Bolt Stress Analysis for BFN Units 1, 2, and 3**

References:

1. Letter from TVA to NRC, "BWRVIP-25 Core Plate Bolt Stress Analysis," dated June 15, 2011
2. Letter from TVA to NRC, "Browns Ferry Nuclear Plant (BFN) – Units 1, 2, and 3 – License Renewal Application (LRA) – Revised Commitment List," dated April 21, 2006
3. NRC Letter to TVA, "Browns Ferry Nuclear Plant, Units 1, 2, and 3, Request for Additional Information Related to Core Plate Bolt Stress Analysis (TAC NOS. ME6615, ME6616, and ME6617)," dated June 28, 2012

On June 15, 2011, the Tennessee Valley Authority (TVA) submitted "BWRVIP-25 Core Plate Bolt Stress Analysis" for BFN Units 1, 2, and 3, (Reference 1) to complete a License Renewal Commitment contained in the April 21, 2006 letter (Reference 2). By NRC letter dated June 28, 2012 (Reference 3), TVA received a Request for Additional Information (RAI) regarding the BWRVIP-25 Core Plate Bolt Stress Analysis for BFN Units 1, 2 and 3. The NRC requested the response within 30 days from the date of issuance. During a telephone conversation prior to issuance, TVA requested 90 days to respond to the RAI letter. The NRC granted TVA's request for a 90 day response in an email dated July 2, 2012. Per telecon with Siva Lingham on September 25, 2012, TVA was granted an

A105
NRR

additional 30 days to respond to the RAI Letter. Therefore, the response is due 120 days from date of issuance, i.e., by October 25, 2012.

Enclosure 1 to this letter provides the TVA response to the NRC RAI.

Enclosures 1 and 3 to this letter contain information that GE Hitachi considers to be proprietary in nature, and subsequently, pursuant to 10 CFR 2.390, "Public inspections, exemptions, requests for withholding," paragraph (a)(4), it is requested that this information be withheld from public disclosure.

Enclosures 2 and 4 contain the redacted version of Enclosures 1 and 3 with the proprietary material removed, suitable for public disclosure.

Enclosure 5 provides the affidavit supporting the request for withholding from public disclosure.

This letter does not include any new regulatory commitments. Please direct any questions concerning this matter to Tom Hess at (423) 751-3487.

Respectfully,

Beth A. Wetzel, for

J. W. Shea
Vice President, Nuclear Licensing

Enclosures:

1. TVA Response to NRC Request for Information (GE Proprietary)
2. TVA Response to NRC Request for Information (Non-Proprietary)
3. RAI Response Support for "Core Plate Hold Down Bolt Stress Analysis" Performed to Address License Renewal Commitment for Tennessee Valley Authority Browns Ferry Nuclear Plant, Units 1, 2 and 3, NEDC-33779P Rev 1 (GE Proprietary)
4. RAI Response Support for "Core Plate Hold Down Bolt Stress Analysis" Performed to Address License Renewal Commitment for Tennessee Valley Authority Browns Ferry Nuclear Plant, Units 1, 2 and 3, NEDC-33779 Rev 1 (GE Non-Proprietary)
5. 10 CFR 2.390 Affidavit

cc (Enclosures):

NRC Regional Administrator – Region II
NRC Senior Resident Inspector – Browns Ferry Nuclear Plant
Alabama State Department of Public Health

ENCLOSURE 2

Response to Request for Additional Information Regarding BWRVIP-25 Core Plate Bolt Stress Analysis for BFN Units 1, 2 and 3

TVA Response to NRC Request for Information (Non-Proprietary)

ENCLOSURE 2

Response to Request for Additional Information Regarding BWRVIP-25 Core Plate Bolt Stress Analysis for BFN Units 1, 2 and 3

TVA response to NRC Request for Information (Non-Proprietary)

NRC Request for Additional Information (RAI) Question 1

Provide the details of the fast neutron fluence that the core plate hold down bolts have seen to date and the evaluation that was used to determine projected total fast neutron fluence for a 60-year life of each unit. This should include the assumptions made in performing the projection taking into account both approved and submitted power uprates for all three plants.

TVA Response

GE Hitachi Nuclear Energy has provided this response in NEDC-33779P, Rev. 1 (Enclosure 3).

NRC Request for Additional Information (RAI) Question 2

Provide a summary of the inspection history for the core plate hold down bolts from each unit. Justify any deviations from the inspection plan recommended in Boiling-Water Reactor Vessel Internals Program (BWRVIP)-25, "BWR Core Plate Inspection and Flaw Evaluation Guidelines."

TVA Response

BFN Units 1, 2 and 3 Core Plate Hold Down Bolt Inspection Summary is provided in Attachment 3. Attachment 4 contains an evaluation of all deviations from BWRVIP Inspection Program.

NRC Request for Additional Information (RAI) Question 3

Section 3.2.2 of the BWRVIP-25 report appears to indicate that wedges should be installed. If wedges are not installed, the core plate bolts need to be inspected to ensure adequate number of bolts are intact to prevent lateral displacement of the core plate.

In the submittal Tennessee Valley Authority indicates that Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN) did not install wedges, but elected to submit a plant-specific analysis which is currently being reviewed by the staff. However, the licensee did not submit either the inspection method or inspection frequency that is to be used to monitor intergranular stress-corrosion cracking in the bolts. Per Section 3.2.2 of the BWRVIP-25, the inspection criteria, inspection method and inspection frequency shall be submitted with the structural analysis.

TVA Response

The core plate rim holddown bolts (Location 10) that become accessible during normal refueling activities require examination in accordance with BWRVIP-25 to ensure that their locking devices are in place. There are thirty-four (34) holddown bolts present for the core plates at BFN. BWRVIP-25 requires an EVT-1 examination from below the core plate, or UT from above the core plate, of 50% (17) of the holddown bolts. If cracking is detected, the remaining 50% of the bolts will be inspected. Visual exams performed for Units 1, 2, and 3 have been extremely difficult to perform because of poor accessibility and high radiation conditions with fuel in an operating reactor pressure vessel (RPV). Additionally, UT at this time has significant limitations due to bolt geometry. The BWRVIP is addressing this issue and intends to develop revised guidance. Until such guidance is developed, a VT-3 examination of 100% of the holddown bolts from above the core plate will be performed to verify that each bolt is still performing its design function in accordance with a generic deviation disposition developed by the BWRVIP (Attachment 4). This deviation will remain in place until December 31, 2015, or until the NRC approves revised BWRVIP guidance, whichever comes first.

NRC Request for Additional Information (RAI) Question 4

Section 5.0 of Enclosure 1 to June 15, 2011, letter (or the submittal) documents the loads and load combinations considered in the analysis of the BFN core plate hold down bolts. It was stated that [[

]] However, the annulus pressurization (AP) due to a postulated circumferential pipe break at the reactor pressure vessel (RPV) nozzle safe-end interface weld or any nuclear steam supply system piping that penetrates the biological shield wall causes AP dynamic loading due to the mass and energy release into the annular cavity between the RPV and shield wall and into the drywell. This AP loading does not appear to be due to [[

]] and may have an impact on the stress analysis of core plate bolts.

[[

]]

TVA Response

In accordance with guidance in BWRVIP-25, loads for plant specific analysis should be combined acorrding to plant licensing basis. Annulus Pressurization (AP) Loads are not part of the Licensing Basis Load Combinations for BFN Units 1, 2 and 3.

NRC Request for Additional Information (RAI) Question 5

Table 5-1 of Enclosure 1 to the submittal indicates that an acoustic (AC) load was imposed on the shroud as part of the structural analysis of the BFN core plate hold down bolts due to the AC effects resulting from a postulated recirculation suction line break event. However, no basis is provided for the [[ ]]

With respect to the values outlined in [[ ]] confirm that the [[

]] are consistent with those that have been previously approved for use at BFN and provide the applicable references documenting the regulatory acceptance of these values. Additionally, confirm that the values used for the aforementioned AC loads adequately consider the issues regarding potential AC load nonconservatisms raised in General Electric Hitachi Safety Information Communication SC 09-03, "Shroud Screening Criteria Reports."

ENCLOSURE 2

TVA Response

GE Hitachi Nuclear Energy has provided this response in NEDC-33779P, Rev. 1 (Enclosure 3).

NRC Request for Additional Information (RAI) Question 6

Section 5.6 of Enclosure 1 to the submittal discusses the preload that was accounted for in the BFN core plate hold down bolt stress analysis. However, there is no discussion regarding the value of preload used or the basis for this value.

State the value of the preload stress used in the analysis. Provide a justification for why the value of preload used in the analysis is representative of the condition of the hold down bolts at BFN. This justification should also demonstrate that the loss in preload due to fluence and [[ ]] as described in Section 5.0 of the submittal, has been adequately considered.

TVA Response

GE Hitachi Nuclear Energy has provided this response in NEDC-33779P, Rev. 1 (Enclosure 3).

NRC Request for Additional Information (RAI) Question 7

Section 5.7 of Enclosure 1 to the submittal provides a description of the friction factor [[ ]] It is indicated in this section that [[ ]] based on information contained in BWRVIP-51A, "[BWRVIP]: Jet Pump Repair Design Criteria," [[.]]

[[ ]]

TVA Response

GE Hitachi Nuclear Energy has provided this response in NEDC-33779P, Rev. 1 (Enclosure 3).

NRC Request for Additional Information (RAI) Question 8

Section 5.8 of Enclosure 1 to the submittal indicates that the effect of bolt preload loss due to fluence [[ ]]

Address whether the [[

]]

TVA Response

GE Hitachi Nuclear Energy has provided this response in NEDC-33779P, Rev. 1 (Enclosure 3).

NRC Request for Additional Information (RAI) Question 9

Section 7.1 of Enclosure 1 to the submittal states [[

]]

Based on the fact that the [[

*]] provide a technical justification that demonstrates [[**the use of an averaging technique**]] provides reasonable assurance that the BFN core plate hold down bolts will maintain their structural integrity under the BFN design basis loading cases.*

TVA Response

GE Hitachi Nuclear Energy has provided this response in NEDC-33779P, Rev. 1 (Enclosure 3).

NRC Request for Additional Information (RAI) Question 10

Tables 7-1 and 7-2 of Enclosure 1 to the submittal present [[

]]

Address whether the core plate hold down bolts [[

]]

TVA Response

GE Hitachi Nuclear Energy has provided this response in NEDC-33779P, Rev. 1 (Enclosure 3).

ENCLOSURE 2

ATTACHMENTS:

1. BFN Core Plate Holddown Bolt Inspection History
2. Deviation Disposition for Variance from BWRVIP-25 Guidance for Inspection of Core Plate Bolt

ENCLOSURE 2

ATTACHMENT 1 - BFN CORE PLATE HOLDDOWN BOLT INSPECTION HISTORY

UNIT 1 INSPECTION HISTORY:

Core Plate (Rim, etc.)	2005	EVT-1, VT-3	Baseline inspection (2005) per BWRVIP-25: All thirty-four (34) holddown bolts (Location 10) were EVT-1 inspected from the bottom side with no reportable indications.
	2008	VT-3	Reinspection (2008) per BWRVIP-25: All thirty four (34) holddown bolts (Location 10) were VT-3 inspected from above with no reportable indications.
	2010	VT-3	Reinspection (2010) per BWRVIP-25: All thirty four (34) holddown bolts (Location 10) were VT-3 inspected from above with no relevant indications.

ENCLOSURE 2

ATTACHMENT 1 - BFN CORE PLATE HOLDDOWN BOLT INSPECTION HISTORY

UNIT 2 INSPECTION HISTORY:

Core Plate (Rim, etc.)	1999	VT-3	Baseline Inspection (1999): Inspected core plate bolts (VT-3) at accessible locations per BWRVIP-25 with no reportable indications.
	2001	VT-3	Reinspection (2001) per BWRVIP-25: Holddown Bolts (Location 10) VT-3 inspected with no reportable indications.
	2003	VT-3	Reinspection (2003) per BWRVIP-25: All thirty-four (34) holddown bolts (Location 10) were VT-3 inspected with no reportable indications.
	2005	VT-3	Reinspection (2005) per BWRVIP-25: All thirty-four (34) holddown bolts (Location 10) were VT-3 inspected with no reportable indications. Thirty-three (33) plugs (Location 13) were VT-3 inspected with no reportable indications.
	2007	VT-3	Reinspection (2007) per BWRVIP-25: All thirty-four (34) holddown bolts (Location 10) were VT-3 inspected with no reportable indications.
	2009	VT-3	Reinspection (2009) per BWRVIP-25: All thirty-four (34) holddown bolts (Location 10) were VT-3 inspected with no relevant indications.
	2011	VT-3	Reinspection (2011) per BWRVIP-25: All thirty-four (34) holddown bolts (Location 10) were VT-3 inspected from above with no relevant indications.

ENCLOSURE 2

ATTACHMENT 1 - BFN CORE PLATE HOLDDOWN BOLT INSPECTION HISTORY

UNIT 3 INSPECTION HISTORY:

Core Plate (Rim, etc.)	2000	VT-3	Inspection (2000) per BWRVIP-25: Eighteen (18) of thirty-four holddown bolts (Location 10) were VT-3 inspected from above with no reportable indications.
	2002	VT-3	Reinspection (2002) per BWRVIP-25: All thirty-four (34) holddown bolts (Location 10) were VT-3 inspected from above with no reportable indications.
	2004	VT-3	Reinspection (2004) per BWRVIP-25: All thirty-four (34) holddown bolts (Location 10) were VT-3 inspected from above with no reportable indications.
	2006	VT-3	Reinspection (2006) per BWRVIP-25: All thirty-four (34) holddown bolts (Location 10) were VT-3 inspected from above with no reportable indications.
	2008	VT-3	Reinspection (2008) per BWRVIP-25: All thirty-four (34) holddown bolts (Location 10) were VT-3 inspected from above with no reportable indications.
	2010	VT-3	Reinspection (2010) per BWRVIP-25: All thirty-four (34) holddown bolts (Location 10) were VT-3 inspected from above with no reportable indications.
	2012	VT-3	Reinspection (2012) per BWRVIP-25: All thirty-four (34) holddown bolts (Location 10) were VT-3 inspected from above with no reportable indications.

ENCLOSURE 2

ATTACHMENT 2

Deviation Disposition for Variance from BWRVIP-25 Guidance for Inspection of Core Plate Bolts

R06 110328 079

QA Record

BROWNS FERRY NUCLEAR PLANT

DEVIATION DISPOSITION NUMBER: DD-2011-01

For

Deviation Disposition for Variance from BWRVIP-25 Guidance for Inspection of Core Plate Bolts

Prepared by: Victor D. Schiavone Date: 03-24-2011
Site Engineering - BWRVIP Site Program Owner

Checked by: [signature] Date: 3/24/11
Corporate BWRVIP Program Owner

Checked by: [signature] Date: 3/25/2011
Site Engineering - Engineering Programs

Reviewed by: [signature] Date: 3/27/11
Site Engineering Manager

Approved by: [signature] Date: 3-27-11
Site Vice-President

1.0 SUMMARY

BWRVIP-25 requires that core plate bolts be inspected by Ultrasonic (UT) or Visual (VT) methods for plants that do not have core plate wedges installed. Currently, UT has significant limitations due to bolt geometry and VT is not able to interrogate the susceptible threaded areas of the bolting. The BWRVIP is addressing this issue and intends to develop revised guidance. Until such guidance is developed, a VT-3 exam of the bolting will be performed periodically as an alternative to the required BWRVIP-25 bolt inspections. This deviation will remain in place until December 31, 2015 or until the NRC approves revised BWRVIP guidance, whichever occurs first.

2.0 BACKGROUND

A typical BWR core plate bolt is shown in Figure 1. The bolt is threaded at its upper and lower ends and is unthreaded over the remainder of its length. Anywhere from 30 to 72 bolts (dependent on plant design) are used to secure the core plate to the core plate support ring (NOTE: BFN Units 1, 2, and 3 contain 34 core plate bolts). BWRVIP-25 [1] requires that the bolts be inspected using either visual methods (EVT-1) from below the core plate or with an ultrasonic (UT) technique. In spite of significant effort on the part of the BWRVIP Inspection Focus Group and the EPRI NDE Center, the development of UT techniques for this application has been unsuccessful. The only feasible location for delivering acoustic energy to the bolt is through its upper end and access to the upper end is restricted by the presence of a keeper that is fillet welded to the top of the bolt. The resulting geometry does not allow for effective wave transmission and, consequently, a UT inspection has not been possible (as is recognized in Reference 2).

Visual inspections are also problematic. As shown in Figure 1, an EVT-1 inspection may be able to examine the unthreaded shank of the bolt. However, the threaded portion which is theoretically more susceptible to IGSCC is surrounded by the core plate and the core plate support ring and is hidden from view. Thus, meaningful EVT-1 exams cannot be performed and, in hindsight, should not have been recommended in BWRVIP-25.

The BWRVIP is currently performing analyses that will result in revised guidance for managing potential degradation of core plate bolting. Until that guidance is issued, the alternative inspections described in Section 3 will be performed to ensure continued integrity of the bolting. This alternative approach is justified for the short term by a number of reasons that are discussed below in Section 4.

3.0 INTERIM INSPECTION APPROACH

Until such time as the BWRVIP provides additional guidance on inspection of core plate bolting, a random sample of 25% of the bolts (9 total) is required to be inspected by VT-3 from the upper end by 2015. At least 10% (4 total) of the bolts shall require inspection by *December 31, 2012* for BFN Unit 1 (during Unit 1 Refueling Outage 9 (U1R9) in 2012) or *June 30, 2013* for BFN Units 2 and 3 (during Unit 2 Refueling Outage 17 (U2R17) in 2013 and Unit 3 Refueling Outage 15 (U3R15) in 2012). Should any significant degradation be observed, a plan for scope expansion and enhanced inspections will be developed on a case-by-case basis. Credit may be taken for prior inspections performed during or after 2005. BFN has been inspecting 100% of the bolts (34 total) by VT-3 from the upper end starting with U1R8 (in 2008) for Unit 1, U2R11 (in 2001) for Unit 2, and U3R10 (in 2002) for Unit 3. BFN plans to continue this practice until the BWRVIP provides additional guidance, and so will meet the interim inspection requirements of this deviation. Since BFN will continue to follow BWRVIP inspection guidance for the core plate bolts, this deviation is not in violation of our NRC commitment to implement the BWRVIP guidelines and as such does not impact our licensing basis.

4.0 ACCEPTABILITY OF INTERIM APPROACH

While the interim approach does not accomplish the thorough inspection intended by BWRVIP-25, it is considered to be acceptable for the short term for the reasons discussed in the remainder of this section.

4.1 FIELD EXPERIENCE

Extensive VT-3 exams of the upper portion of the bolting have been performed in accordance with GE SIL-588. In addition, some plants have performed VT-3 exams as an alternative to the BWRVIP-25 requirements. Twenty-one plants have reported the results of these inspections to the BWRVIP and none have reported any degradation. It is likely that additional inspections, not reported to the BWRVIP, have also been conducted per the GE SIL and no degradation has been reported to the industry.

Browns Ferry Unit 1 performed an EVT-1 of all bolts from below the core plate during an extended outage. No degradation was observed.

While these exams are not sufficient to completely rule out the possibility of minor cracking in areas that cannot be observed visually, they do indicate that no degradation of consequence has occurred.

4.2 HARDWARE REDUNDANCY

The core plate is attached to the shroud with between 30 and 72 bolts. A generic analysis described in Reference 1 which assumed 32 bolts showed that only approximately 80 percent of the bolts are necessary to resist loads during faulted conditions. This indicates that a significant amount of cracking in the bolts can be tolerated before the ability of the core plate to maintain control rod alignment is compromised.

The aligner hardware (Figure 2) also provides redundant structural capability. The generic analysis in Reference 1 concludes that even with 100% of the bolting failed, the stress on the aligners is less than ASME Code allowables. Thus, the aligners by themselves are capable of maintaining the horizontal position of the core plate during a seismic event. The vertical motion of the core plate (in the event of complete failure of the bolts) is limited to an acceptable value by contact with the CRD guide tube alignment tabs.

The aligner hardware is inaccessible for inspection which could be used to ensure its complete integrity and, thus, its ability to provide redundant restraint. However, the probability that a sufficient number of bolts are failed AND significant degradation of the aligners exists is very small.

4.3 IGSCC SUSCEPTIBILITY

The bolts and nuts are typically finished with techniques that minimize susceptibility to IGSCC. The threads at the top of the bolt and the threads on the top nut are subjected to liquid honing and/or electro-polishing techniques to ensure smooth contact between the nut and bolt. These finishing techniques reduce surface stresses and greatly reduce the susceptibility of the components to crack initiation.

The bottom of the bolt and its accompanying nut may not receive such treatment. However, even absent this stress relief, the thread-form itself reduces the crack-susceptibility of the bolt. The threads are typically fabricated with a short flat region at the root of the thread. This flat region is usually rounded to blend with the thread angle. The resulting smooth transitions reduce the local stresses and thus the susceptibility of the component to cracking.

4.4 MITIGATION

Radiolysis models show that plants with hydrogen water chemistry (HWC) and noble metal chemical application (NMCA) (such as Browns Ferry) are provided some level of protection in the region of the core plate bolting. Thus, the susceptibility of the bolting to new initiation is much reduced. In addition, the growth rate of any cracking that pre-dated mitigation will be greatly retarded.

4.5 STANDBY LIQUID CONTROL

The discussion in Sections 4.1 through 4.4 demonstrates that there is a very low probability that a sufficient degradation of the bolting could occur such that the resultant displacement of the core plate during a seismic event would inhibit or slow control rod insertion. However, in the unlikely case that such degradation did occur and control rods could not be inserted, the reactor could be brought to a safe shutdown using the standby liquid control (SLC) system.

5.0 CONCLUSION

Inspection techniques are not currently available to perform the core plate bolt inspections required by BWRVIP-25. However, as described in Section 4, there is reason to believe that the bolting has a relatively low susceptibility to cracking particularly with the addition of HWC and NMCA at BFN. Even if significant cracking did occur in the bolting, redundant structural components will prevent adverse displacement of the core plate. And finally, even with the extremely conservative assumptions of failures of both the bolting and the redundant hardware, the SLC system could be used to bring the reactor to a safe shutdown.

Given the low likelihood that the function of the core plate will be compromised by bolting failures, there is little risk in postponing a detailed inspection of the bolts until such time as the BWRVIP develops revised guidance. In the interim, the only viable inspection is a VT-3 of the top portion of the bolts. Such an inspection will be performed as described in Section 3.

6.0 REFERENCES

1. "BWR Vessel and Internals Project, BWR Core Plate Inspection and Flaw Evaluation Guidelines (BWRVIP-25)," EPRI Report TR-107284, December 1996.
2. "BWRVIP-94 Revision 1: BWR Vessel and Internals Project, Program Implementation Guide," EPRI Technical Report 1011702, December 2005.

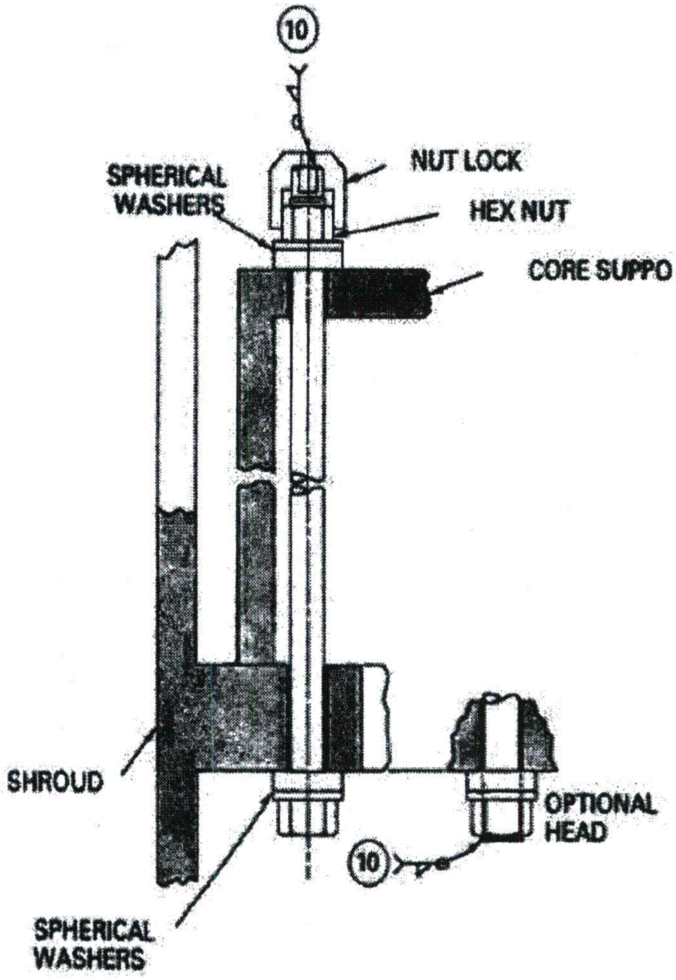

Figure 1: Typical Core Plate Bolt

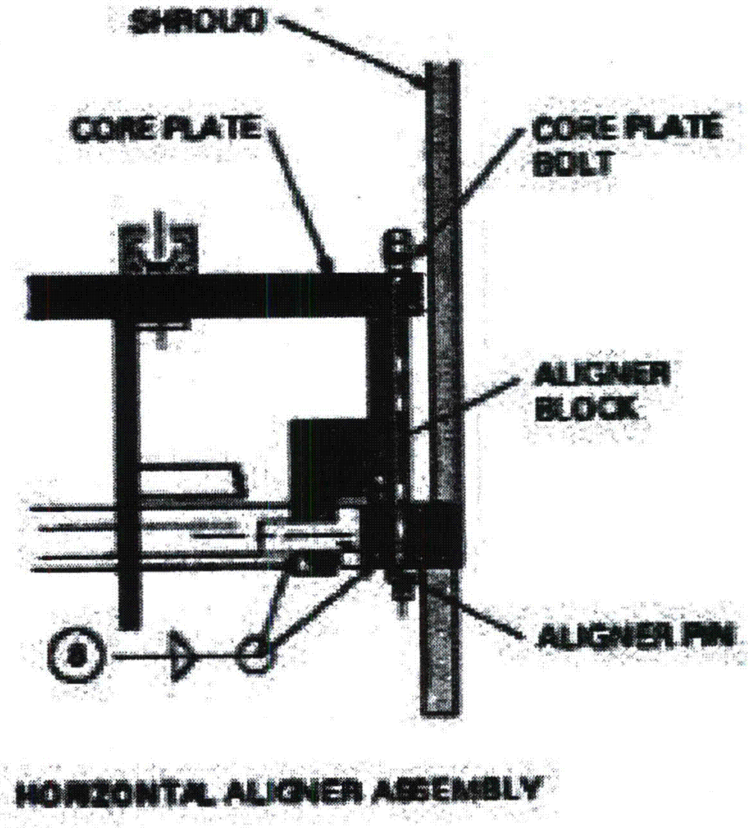

Figure 2: Core Plate Aligner Assembly

ENCLOSURE 4

Response to Request for Additional Information Regarding BWRVIP-25 Core Plate Bolt Stress Analysis for BFN Units 1, 2 and 3

RAI Response Support for "Core Plate Hold Down Bolt Stress Analysis" Performed to Address License Renewal Commitment for Tennessee Valley Authority Browns Ferry Nuclear Plant, Units 1, 2 and 3, NEDC-33779NP, Revision 1, (GE Non Proprietary)

HITACHI

GE Hitachi Nuclear Energy

NEDO-33779
Revision 1
DRF 0000-0151-4751-R0
October 2012

RAI Response Support for Core Plate Hold Down Bolt Stress Analysis Performed to Address License Renewal Commitment for Tennessee Valley Authority Browns Ferry Nuclear Plant, Units 1, 2 and 3

NON-PROPRIETARY NOTICE

This is a non-proprietary version of the document NEDC-33779P, Revision 1, from which the proprietary information has been removed. Portions of the document that have been removed are identified by white space within double square brackets, as shown here [[ ]].

IMPORTANT NOTICE REGARDING CONTENTS OF THIS REPORT

Please read carefully

The design, engineering, and other information contained in this document is furnished for the purpose of supporting the Browns Ferry Nuclear Plant license renewal in proceedings before the U.S. Nuclear Regulatory Commission. The only undertakings of GEH with respect to information in this document are contained in the contracts between the contract between GEH and TVA, and nothing contained in this document shall be construed as changing that contract. The use of this information by anyone other than TVA, or for any purpose other than that for which it is intended is not authorized; and with respect to any unauthorized use, GEH makes no representation or warranty, and assumes no liability as to the completeness, accuracy, or usefulness of the information contained in this document or that its use may not infringe privately owned rights.

INTRODUCTION

In December 2010, GE Hitachi Nuclear Energy (GEH) provided to Tennessee Valley Authority (TVA) the *Browns Ferry (Units 1-3) Core Plate Bolt Analysis Stress Analysis Report* (NEDC-33632-R0). This plant-specific core plate hold-down bolt stress analysis was performed as part of the Time Limiting Aging Analysis (TLAA) for the Browns Ferry Nuclear Plant (BFN) license renewal. The plant-specific analysis contained in NEDC-33632-R0 is consistent with Electric Power Research Institute (EPRI) Boiling Water Reactor Vessel and Internals Project (BWRVIP)-25 Appendix A and BFN's current licensing basis. This analysis shows that the core plate bolts in BFN Units 1–3 meet American Society of Mechanical Engineers (ASME) code allowable limits; this demonstrates that BFN core plate bolts can withstand normal, upset, emergency, and faulted loads considering the effects of stress relaxation on the bolts until the end of the 60-year period of extended operation.

In June of 2012, GEH agreed to support the Requests for Additional Information (RAIs) from the NRC related to NEDC-33632-R0. Specifically, GEH agreed to evaluate and respond to Items 1 and 5 through 10 in the NRC RAI letter TAC ME6615 and include the associated affidavit. RAI 4 is also included because there is GEH proprietary information in the RAI itself. The following section supports this effort.

RESPONSES TO NRC REQUESTS FOR ADDITIONAL INFORMATION

NRC RAI-1

Provide the details of the fast neutron fluence that the core plate hold down bolts have seen to date and the evaluation that was used to determine projected total fast neutron fluence for a 60-year life of each unit. This should include the assumptions made in performing the projection taking into account both approved and submitted power uprates for all three plants.

GEH Response to RAI-1

The methodology used to calculate the fluence follows that of NEDC-32983P, "General Electric (GE) Methodology for Reactor Pressure Vessel Fast Neutron Flux Evaluation," approved by the NRC in a letter dated September 14, 2001, from S.A. Richards, NRC, to J.F. Klapproth, GE.

The core plate studs (hold-down bolts) have currently experienced a fluence of [[ ]]. This is based on data from fluence calculations performed in support of BFN's Time Limited Aging Analyses (TLAA) in 2005 and includes the power uprates implemented at that point in time. The analysis also assumed an Extended Power Uprate (EPU) occurring in 2007, which would result in [[ ]] at pre-EPU conditions. The calculation for Unit 2 bounds Units 1 and 3. The pre-EPU flux calculated was [[ ]]. To extend this to 2012 (5 more years) with an assumed [[ ]] capacity factor, the following calculation is performed: [[ ]]. This is multiplied by [[ ]] to account for the uncertainty of the flux calculation to obtain [[ ]].

The 60-year (54 EFPY) fluence used in NEDC-33632-R0 is [[ ]], which also bounds Units 1-3. This value also includes a factor of safety for flux uncertainty and was calculated assuming an Extended Power Uprate (EPU) in 2007, which is conservative.

NRC RAI-4
Section 5.0 of Enclosure 1 to June 15, 2011, letter (or the submittal) documents the loads and load combinations considered in the analysis of the BFN core plate hold down bolts. It was stated that [[

]] However, the annulus pressurization (AP) due to a postulated circumferential pipe break at the reactor pressure vessel (RPV) nozzle safe-end interface weld or any nuclear steam supply system piping that penetrates the biological shield wall causes AP dynamic loading due to the mass and energy release into the annular cavity between the RPV and shield wall and into the drywell. This AP loading does not appear to be due to [[
]] and may have an impact on the stress analysis of core plate bolts.

[[
]]

TVA Response to RAI-4
The text of RAI-4 has been included to cover the proprietary content with the enclosed affidavit. TVA is responsible for the response to RAI-4.

NRC RAI-5
Table 5-1 of Enclosure 1 to the submittal indicates that an acoustic (AC) load was imposed on the shroud as part of the structural analysis of the BFN core plate hold down bolts due to the AC effects resulting from a postulated recirculation suction line break event. However, no basis is provided for the [[ ]]
With respect to the values outlined in [[ ]], confirm that the [[
]] are consistent with those that have been previously approved for use at BFN and provide the applicable references documenting the regulatory acceptance of these values. Additionally, confirm that the values used for the aforementioned AC loads adequately consider the issues regarding potential AC load non-conservatisms raised in General Electric Hitachi Safety Information Communication SC 09-03, "Shroud Screening Criteria Reports."

GEH Response to RAI-5
The acoustic load values were based on TRACG methodology. These values were used to support the stress integrity evaluation documented in Browns Ferry's power uprate licensing amendments (GEH's reports NEDC-32751P and NEDC-33101P, NRC Accession Numbers ML042670047 and ML063350404 respectively).

The concern raised in GEH SC 09-03 regarding the AC load due to a Recirculation Suction Line Break (RSLB) was that the AC load was not considered in some plants' shroud screen criteria reports. The AC load was included in this analysis, although the core plate bolts are not affected significantly by the AC load.

NRC RAI-6

Section 5.6 of Enclosure 1 to the submittal discusses the preload that was accounted for in the BFN core plate hold down bolt stress analysis. However, there is no discussion regarding the value of preload used or the basis for this value.

State the value of the preload stress used in the analysis. Provide a justification for why the value of preload used in the analysis is representative of the condition of the hold down bolts at BFN. This justification should also demonstrate that the loss in preload due to fluence and [[ ]] as described in Section 5.0 of the submittal, has been adequately considered.

GEH Response to RAI-6

Browns Ferry units 1, 2, and 3 have an installation torque value of [[ ]] per the vessel assembly drawing. Converting this torque to a preload using a torque coefficient of [[ ]] results in [[ ]] of preload per bolt. This preload is reduced due to neutron fluence by multiplying by [[ ]] The preload is further reduced due to thermal effects (change in elastic modulus from installation to operating temperature) by multiplying by [[ ]]. This final preload is [[ ]] for a stress of [[ ]] Combining this with the vertical loads the core plate experiences results in the presented mean membrane stresses of [[ ]] in Tables 7-1 and 7-2 of NEDC-33632-R0.

The value of preload used in this analysis is the net preload after considering fluence and thermal relaxation. The amount of relaxation due to fluence is conservative [[
]]

NRC RAI-7

Section 5.7 of Enclosure 1 to the submittal provides a description of the friction factor [[ ]] It is indicated in this section that [[ ]] based on information contained in BWRVIP-51A, "[BWRVIP]: Jet Pump Repair Design Criteria," [[ ]]

[[ ]]

GEH Response to RAI-7

Neglecting friction in a situation like the clamped core plate is extremely conservative. Friction is the main method of resisting horizontal motion for the core plate (the other methods being the aligner pins, bolt shear, and bolt bending). Mostly due to lower loads and a smaller core plate, the example in BWRVIP-25 Appendix A was able to meet allowable stress limits without friction. For Browns Ferry, a small amount of friction was included to reduce this large conservatism. Reasons for the applicability of the [[ ]] coefficient of friction are mentioned in NEDC-33632-R0 Section 5.7. Although BWRVIP-51A is for jet pumps, the clamping interface for the core plate assembly is very similar to that described in BWRVIP-51A, which has been approved by the NRC. This value is on the low end for coefficient of friction of any stainless-steel-to-stainless-steel interface with surface finishes similar to the core plate. Therefore, it is still conservative.

NRC RAI-8

Section 5.8 of Enclosure 1 to the submittal indicates that the effect of bolt preload loss due to fluence [[ ]]

Address whether the [[ ]]

GEH Response to RAI-8
Thermal relaxation reduces preload by [[ ]], as listed in Section 5.9 of NEDC-33632-R0. The response to RAI-6 provides more detail on calculating the final preload. Both thermal relaxation and relaxation due to fluence reduce the clamping force. A reduction in clamping force reduces horizontal frictional resistance available at the interface.

Once the final clamping force is determined (after both relaxations are accounted for), the maximum final static frictional horizontal resistance is calculated by multiplying the clamping force by [[ ]] Because a portion of the horizontal external load is resisted by friction, the aligner pins or core plate bolts (depending on the Scenario) experience less of the applied force than if friction were not included. Reducing the initial preload to account for relaxations essentially reduces the clamping force and increases the load resisted by the aligner pins or bolts.

NRC RAI-9
Section 7.1 of Enclosure 1 to the submittal states [[

]]

Based on the fact that the [[ ]] provide a technical justification that demonstrates [[ ]] provides reasonable assurance that the BFN core plate hold down bolts will maintain their structural integrity under the BFN design basis loading cases.

GEH Response to RAI-9
The total load in a core plate bolt is the relaxed preload plus any external loads. The plots shown in (BWRVIP)-25 Appendix A and Figure 7-1 of NEDC-33632-R0 only depict forces from externally-applied loads. They do not include the force due to preload. Compare the figure below with the aforementioned figures. The seemingly large variation in amplitudes is reduced greatly. This is the main reason for applicability of the averaging technique. The horizontal force in the bolts is even closer to the average value (omitted from the figure below for clarity). Therefore, it is acceptable to consider the average horizontal and vertical forces in the bolt when calculating the stresses.

[[

]]

Figure 1: [[ ]]

NRC RAI-10
Tables 7-1 and 7-2 of Enclosure 1 to the submittal present [[

]]

Address whether the core plate hold down bolts [[

]]

GEH Response to RAI-10
Shear stresses are significant for the aligner pins, but not the core plate bolts. In Scenario 2, aside from the amount resisted by friction, the horizontal load is supported by the aligner pins. Of the aligner pins assemblies, shear of the circular aligner pin cross section is the most limiting stress.

In Scenarios 1 and 3, aside from the amount resisted by friction, the horizontal load is supported by [[ ]]. This is a total shear area of [[ ]], which results in an average bolt shear stress of [[ ]]. When compared with their allowable limits, the bolt shear stress ratio is much smaller than the membrane and bending stress ratio. Consistent with BWRVIP-25 Appendix A, only the most limiting stresses are reported.

ENCLOSURE 5

Response to Request for Additional Information Regarding BWRVIP-25 Core Plate Bolt Stress Analysis for BFN Units 1, 2 and 3

10 CFR 2.390 Affidavit

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 GEH proprietary report, NEDC-33779P, "RAI Response Support for Core Plate Hold Down Bolt Stress Analysis Performed to Address License Renewal Commitment for Tennessee Valley Authority Browns Ferry Nuclear Plant, Units 1, 2 and 3," Revision 1, dated October 2012. GEH text proprietary information in NEDC-33779P is identified by a dotted underline inside double square brackets. [[This sentence is an example.{3}]] Figures 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 that 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 GEH and/or 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, that may include potential products of 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 the 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 results and details of structural analysis methods and techniques developed by GEH for the stress analysis of the Browns Ferry core plate bolts. Development of these methods, techniques, and information and their application for the design, modification, and analyses methodologies and processes for the core plate bolt stress analysis was achieved at a significant cost to GEH. The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a 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 8th day of October, 2012.

Edward D. Schrull
Vice President, Regulatory Affairs
GE-Hitachi Nuclear Energy Americas LLC
3901 Castle Hayne Rd
Wilmington, NC 28401