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MFN 06-299
Supplement 6

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U.S. Nuclear Regulatory Commission
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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 148 Related to ESBWR Design Certification Application -- Design and Selection of Pipe Whip Restraints -- RAI Number 3.6-7 S02**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) partial response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) received from the NRC via Reference 1 (RAI 3.6-7 S02).

Enclosure 1 contains the GEH response to NRC RAI 3.6-7 S02 that was received from the NRC on February 19, 2008, via MFN 08-158 (NRC Letter 148) (Reference 1). Previously GEH received RAI 3.6-7 S01, on May 20, 2007, via an e-mail from the NRC (Amy Cubbage) (Reference 3), to which GEH responded, on December 14, 2007, via MFN 06-299, Supplement 1 (Reference 2). Original RAI 3.6-7 was received by GEH, on August 3, 2006, via MFN 06-271 (NRC Letter 45) (Reference 5), to which GEH responded on August 28, 2006, via MFN 06-299 (Reference 4).

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

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NRO

If you have any questions or require additional information, please contact me.

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

References:

1. MFN 08-158 from Leslie Perkins, Project Manager, ESBWR/ABWR Projects Branch 2, Division of New Reactor Licensing, Office of New Reactors, to Robert E. Brown, *Request for Additional Information Letter No. 148 Related to ESBWR Design Certification Application, [concerning quality control procedures for computer programs]*, dated February 19, 2008

2. MFN 06-299 Supplement 1 from Jim Kinsey to the U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information E-mail from Amy Cubbage (NRC) Related to ESBWR Design Certification Application – Evaluation of Postulated Pipe Breaks – RAIs 3.6-7 S01 and 3.6-8 S01*, dated December 14, 2007

3. E-mail from Amy Cubbage, U.S. Nuclear Regulatory Commission to GEH, (RAIs 3.6-7 S01 and 3.6-8 S01), comment that responses to RAIs 3.6-7 and 3.6-8 are incomplete, dated May 20, 2007

4. MFN 06-299 from Jim Kinsey to the U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 45 Related to ESBWR Design Certification Application – Protection against Dynamic Effects Associated with the Postulated Rupture of Piping - RAI Numbers 3.6-1 through 3.6-10*, dated August 28, 2006

5. MFN 06-271 from Lawrence Rossbach, Project Manager, ESBWR/ABWR Projects Branch, Division of New Reactor Licensing, Office of Nuclear Reactor Regulation, to David H. Hinds, *Request for Additional Information Letter No. 45 Related to ESBWR Design Certification Application* [RAI concerning the evaluation of postulated pipe breaks as described in Section 3.6 of the ESBWR Design Control Document], dated August 3, 2006

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 148 Related to ESBWR Design Certification Application -- Design and Selection of Pipe Whip Restraints -- RAI Number 3.6-7 S02

cc:

AE Cubbage	USNRC (with enclosure)
RE Brown	GEH/Wilmington (with enclosure)
GB Stramback	GEH/San Jose (with enclosure)
DH Hinds	GEH/Wilmington (with enclosure)
EDRF	0000-0081-9611 (RAI 3.6-7 S02)

Enclosure 1

MFN 06-299
Supplement 6

Response to Portion of NRC Request for

Additional Information Letter No. 148

Related to ESBWR Design Certification Application

Design and Selection of Pipe Whip Restraints

RAI Number 3.6-7 S02

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

The original response to RAI 3.6-7 was previously submitted via MFN 06-299 and the response to RAI 3.6-7 S01, previously submitted via MFN 06-299 Supplement 1, are included without DCD updates to provide historical continuity during review.

NRC RAI 3.6-7

In DCD Section 3.6.2.2 and Appendix 3J, GE provides details regarding assumptions in the piping dynamic analysis. The staff notes that SRP Section 3.6.2, item III.2.a, provided dynamic analysis criteria and discusses material capacity limitations for a crushable material type of whip restraint, while SRP Section 3.6.2, item III.2.b discusses various methods of analyses. Also, ANSI/ANS-58.2-1988, Paragraph 6.3 presents several different types of dynamic analysis methods. Provide answers to the following:

(a) In SRP Section 3.6.2, item III.2.a, it is stated that for piping pressurized during normal operation at power, the initial condition should be the greater of the contained energy at hot standby or at 102% power. Clarify if this is applicable to all approaches used for the ESBWR. If not, then provide technical justification for the alternate initial conditions assumed in the analyses.

(b) Acceptable dynamic models suggested in the SRP include lumped parameter analysis models, energy balance analysis models, and static analysis models. Also, alternate analytical approaches are discussed in ANS standard Paragraphs 6.3.1 through 6.3.5. DCD Appendix 3J presents only two specific approaches:
dynamic time-history analysis with simplified models and dynamic time-history analysis with detailed piping models. Clarify if any other analytical (nonlinear) methods and modeling techniques (discussed in SRP and ANS standard) will be used for ESBWR plants.

(c) Discuss acceptable procedures and computer programs to be used to calculate the pipe whip dynamic responses for all those methods not discussed in DCD Appendix 3J.

(d) Provide examples illustrating nonlinear and simplified methods of analysis that will be used in the ESBWR design, demonstrating compliance with SRP Section 3.6.2 stress limit requirements. Also, describe the computer programs for selecting the size and different types of whip restraints (i.e., crushable or rigid, if any)

(e) Discuss the validation of the computer programs which the NRC staff has not yet approved.

GE Response

The ESBWR Plant design does not utilize "crushable" material type of whip restraint as allowed by SRP Section 3.6.2.

(a) The criterion of energy at hot standby or 102 % power is applicable to ESBWR. DCD Subsection 3.6.2.3.1 will be updated as noted in the attached markup.

(b) Enclosure 4 provides sample calculations prepared for a typical ABWR Plant for the pipe break nonlinear method and modeling technique for main steam pipe break at terminal end RPV nozzles, which is a representative method to be used for ESBWR Plant.

(c) GEs computer program Pipe Dynamic Analysis (PDA) is used. ANSYS computer program can also be used.

(d) Response to this question is included in attached Enclosure 3.

(e) The analytical approach for (1) a complete system dynamic analysis as defined in Paragraph 6.3.1 of ANS 58.2 using ANSYS computer program, and (2) a simplified dynamic analysis as defined in Paragraph 6.3.2 of ANS 58.2 using the PDA computer program.

NRC RAI 3.6-7 S01

In the same letter [letter dated August 28, 2006] GE responded to RAI 3.6-7(a) through (e). The staff, in this RAI, requested

(a) GE to clarify certain details of the analytical methods and modeling techniques in DCD Appendix 3J and the use of computer programs to calculate the pipe whip dynamic responses. The following responses are incomplete.

(b) Acceptable dynamic models suggested in the Standard Review Plan (SRP) include lumped parameter analysis models, energy balance analysis models, and static analysis models. Also, alternate analytical approaches are given in ANS standard Paragraphs 6.3.1 through 6.3.5. DCD Appendix 3J presents only two specific approaches: dynamic time-history analysis with simplified models and dynamic time-history analysis with detailed piping models. The RAI was if any other analytical (nonlinear) methods and modeling techniques (discussed in the SRP and ANS standard) will be used for ESBWR plants. GE's response refers to enclosure 4 which should be enclosure 3. Enclosure 3 provides a sample calculation prepared for a typical ABWR plant for pipe break nonlinear method and modeling technique for main steam pipe break at terminal end reactor pressure vessel (RPV) nozzles, which claims to be the representative method to be used. But the question was if any other methods discussed in SRP and the ANS Standard will be used for ESBWR. GE should address whether any other analytical (nonlinear) methods and modeling techniques (discussed in the SRP and ANS standard) will be used for ESBWR plants.

(c) GE identified computer program PDA and ANSYS to be used to calculate the pipe whip dynamic responses. This part of the RAI was related to the question raised in (b) above. Without identifying the methods to be used, this response is not complete. Hence, GE should identify the methods to be used and then the computer programs to be used for each of these methods.

(e) The original question was related to the quality control of the computer programs and the computed results. GE's response was the analytical approach used for the two types of analyses presented in DCD appendix 3J, without addressing the quality control of computer codes. GE should address the quality control of computer programs and the computer results as requested.

GEH Response

(b) To perform the dynamic time-history analysis for pipe rupture evaluations, GEH will use either (1) Dynamic Time-History Analysis with Simplified Model Method, or, (2) Dynamic Time-History Analysis Using Detailed Piping Model Method as described in the DCD Tier 2, Appendix 3J subsection 3J.4. ESBWR is committed to using these two methods only.

(c) Computer programs such as, "Pipe Dynamic Analysis" (PDA) and ANSYS finite element program may be used for a simplified piping model or for a detailed piping model to perform the pipe rupture evaluations. The use of these computer programs are identified in the DCD Tier 2, Appendix 3J, subsections 3J.4.2.3 and 3J.4.3.2.

(e) The quality control of these programs is controlled by the GEH internal procedures [Engineering Operating Procedure (EOP)/GEH Policies and Procedure (P&P)]. Design/analyses production computer programs such as PDA and ANSYS have been used for this application for prior BWR plants. In GEH, these programs are identified as "Level 2" status that is, the programs are procedurally required to be maintained in a computer library under the control of a responsible individual. The Level 2 documentation includes Users Manual, Software Requirements Description, Software Design Description, Software Test Plan, Software Test Report, and Independent Design Verification. Any revision to the program requires a review by a design review team prior to implementation.

DCD Impact

No DCD changes will be made in response to this RAI.

NRC RAI 3.6-7 S02

NRC Summary:
Provide quality control procedures for computer programs.

NRC Full Text:
In response to RAI 3.6-7 S01, Item (e), GEH indicated that both PDA and ANSYS computer programs are controlled by the GEH internal procedures. However, GEH is using another computer code or file "REDEP" to define the pipe whip restraint (PWR) force and deflection relationship based on its design parameters. In accordance with DCD Subsection 3J.3.1, REDEP is a file containing a large database and is used to supply the force/deflection data for the design of GEH U-Bar whip restraint. GEH must control the quality of REDEP by internal procedures, similar to that of PDA and ANSYS.

Therefore, the staff requests GEH to revise DCD, Tier 2 to indicate that all of the above programs will have proper quality control procedures in place.

GEH Response

The "REDEP" file mentioned in Appendix 3J subsection 3J.3.1 DCD Tier 2, revision 4, is only used as a data file and not a computer program similar to PDA or ANSYS. Therefore, the program control procedures applicable to computer program codes such as PDA and ANSYS are not applicable to "REDEP" file. The "REDEP" file as described in section 3J.3.1 contains a set of tables for selecting force/deflection data for the design of pipe whip restraint components. The data obtained is then used as input to the PDA program. A structural analysis is then performed on the preliminary pipe whip restraint design to confirm the adequacy of the final configuration. The "REDEP" file data is maintained in accordance with GEH quality requirements that are pertinent to a data file.

DCD Impact

DCD Tier 2, Appendix 3J subsection 3J.3.1 will be is revised in revision 5 of the DCD as shown in the attached markup.

3J.2.2 Ruptures in Areas other than Containment Penetration.

Breaks in Class 1 piping are postulated in accordance with Subsection 3.6.2.1.1.

Breaks in Class 2 and 3 piping are postulated in accordance with Subsection 3.6.2.1.1.

Breaks in seismically analyzed non-ASME Class piping are postulated in accordance with the above requirements for Class 2 and 3 piping.

3J.2.3 Determination of the Type of Pipe Break

Determination of whether the high energy line break is longitudinal or circumferential is in accordance with Subsection 3.6.2.1.3.

3J.3 DESIGN AND SELECTION OF PIPE WHIP RESTRAINTS

3J.3.1 Preliminary Selection of Pipe Whip Restraint

The load carrying capability of the GE U-Bar pipe whip restraint is determined by the number, size, bend radius and the straight length of the U-bars. The pipe whip restraint must resist the thrust force at the pipe rupture location and the impact force of the pipe. The magnitude of these forces is a function of the pipe size, fluid temperature, and operating pressure.

A preliminary selection of one of the standard GE pipe whip restraints is made by matching the thrust force at the rupture location with a pipe whip restraint capable of resisting this thrust force. ~~This is done by access to the large database contained in the~~The GE REDEP computer file contains a set of tables for selecting the design of pipe whip restraint components. This file correlates the pipe size and the resulting thrust force at the pipe rupture with the U-bar pipe whip restraints designed to carry the thrust force. REDEP then supplies the force/deflection data for each pipe whip restraint.

RAI 3.6-7 S02

3J.3.2 Preparation of Simplified Computer Model of Piping-Pipe Whip Restraint System.

A simplified computer model of the piping system is prepared as described in Subsection 3J.4.2.1 and as shown in Figure 3J-1 and Figure 3J-2. Critical variables are the length of pipe, type of end condition, distance of pipe from structure and location of the pipe whip restraint. The pipe whip restraint is located as near as practical to the ruptured end of the pipe, but so as to minimize interference to inservice inspection.

3J.3.3 Piping Dynamic Analysis

The Pipe Dynamic Analysis (PDA) computer program is run using the following input:

- The information from the simplified piping model, including pipe length, diameter, wall thickness and pipe whip restraint location.
- Piping information such as pipe material type, stress/strain curve and pipe material mechanical properties.
- Pipe whip restraint properties such as force-deflection data and elastic plastic displacements.
- Force time-history of the thrust at the pipe rupture location.