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Supplement 5

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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 3.6-8 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 3.6-8 S02).

Enclosure 1 contains the GEH response to NRC RAI 3.6-8 S02 that was received from the NRC on February 19, 2008, via MFN 08-158 (NRC Letter 148) (Reference 1). Previously GEH received RAI 3.6-8 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 3.6-8 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).

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

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

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 3.6-8 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	0000-0082-6455 (RAI 3.6-8 S02)

Enclosure 1

MFN 06-299
Supplement 5

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 3.6-8 S02

RAI 3.6-8 and RAI 3.6-8 S01 and the GEH responses are included (without DCD updates) to provide historical continuity during review.

NRC RAI 3.6-8

In DCD Section 3.6.2.3.2, GE states that for components on the ruptured piping required for safe shutdown or that serve to protect the structural integrity of a safety-related component, limits to meet the ASME Code requirements for faulted conditions and limits to ensure required operability are met. The staff needs further clarification on what this particular criterion means. If it means that meeting the ASME Code requirements for faulted conditions ensures meeting the required operability of these components, provide technical justification for the criterion. Otherwise, describe the limits to ensure the operability of these components.

GE Response

The paragraph that reads: "If these components are required for safe shutdown or serve to protect the structural integrity of a safety-related component, limits to meet the ASME Code requirements for faulted conditions and limits to ensure required operability are met" establishes the acceptance criterion for pipe whip restraint design.

Components in the same pipe run that protect the structural integrity of a safety-related component but that do not have to maintain their operability to fulfill that function are designed to meet the ASME code requirements for faulted conditions. This would be the case, for instance, in pipe runs close to the break whose displacements are limited by pipe whip restraints to avoid damaging the safety-related components located in the vicinity. This criterion is applied in Subsection 3.6.2.2, second part of the fifth bullet under Pipe Whip Dynamic Response Analysis: "Piping systems are designed so that plastic instability does not occur in the pipe at the design dynamic and static loads unless damage studies are performed which show the consequences do not result in direct damage to any safety-related system or component".

On the other hand, the required operability has to be assured in components in the same pipe run that are required for safe shutdown and that have to operate to fulfill their safety function. This would be the case, for instance, of ruptures in pipes connected to containment isolation valves. Further clarifications are included in Appendix 3J. Jet map and jet impingement analysis on safety components will be analyzed to insure safety equipments remains functional considering jet impingement.

For a ruptured pipe, such as main steam pipe break at the RPV nozzle as an example, the pipe stresses within the containment penetration region are required to be less than 2.25 Sm in accordance with BTP EMEB 3-1 criteria. This will ensure the operability of the MSIV installed within the containment penetration.

DCD Impact

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

NRC RAI 3.6-8 S01

In RAI 3.6-8, the staff requested GE to provide the technical justification for operability criteria in the DCD Section 3.6.2.3.2 for components on the ruptured piping required for safe shutdown or that serve the structural integrity of a safety-related component. The DCD states that limits to meet the ASME Code requirements for faulted conditions and limits to ensure required operability are to be met for these components.

In the letter dated August 28, 2006 (MFN 06-299), GE did not entirely address this RAI. For a ruptured pipe, GE claims that for a main steam line the pipe stresses within the containment penetration region are required to be less than 2.25 Srm in accordance with BTP EMEB 3-1 criteria. GE referred to Subsection 3.6.2.2, second part of the fifth bullet for the technical justification for this claim. This is acceptable because it meets the ASME code requirement for faulted condition. However, GE did not address the technical justification concerning the limits used to ensure the required operability of the safety-related components. GE in its response states that further clarifications are included in appendix 3J, which is not specific. Also, in the last paragraph on main steam isolation valve (MSIV) operability GE states that only satisfying 2.25 Sm in accordance with BTP EMEB 3-1 criteria will ensure the operability of the MSIV installed within the containment penetration. However, only satisfying the code limit does not ensure the component operability without meeting the operability requirements specified in SRP section 3.9.3. Therefore, this response is incomplete and unacceptable.

GEH Response

GEH acknowledges that meeting faulted allowable does not assure the operability of the component. The component specification shall stipulate the requirements for operability assurance. However, it should be noted that the 2.25 S_m stress limit in the main steam pipe adjacent to MSIV corresponds to the emergency (i.e. Level C) and not the faulted (i.e. Level D) allowable limit. To meet the BTP EMEB 3-1 criteria, a 5-way interface anchor is designed to protect the operability of the outboard Main Steam Isolation Valve (MSIV) for a postulated pipe break beyond the Break Exclusion Zone. Consequently, the moment stress in the main steam pipe adjacent to the MSIV for a postulated pipe break beyond Break Exclusion Zone concurrent with the SSE Loading Event is maintained within the stress limit 2.25 S_m. The MSIV operability and durability are qualified for Service Level D event by shake table tests. By virtue of these design features, the operability of MSIV for postulated faulted condition is assured.

The DCD Section 3.9.3.5 adequately provides guidelines for operability requirements for components, which is in compliance to SRP 3.9.3.

DCD Impact

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

NRC RAI 3.6-8 S02

NRC Summary:
Update DCD to include response to RAI 3.6-8 S01.

NRC Full Text:
GEH acknowledges that the operability of pipe-mounted components require qualification by shake table tests and satisfies the requirements of SRP Section 3.9.3. DCD Section 3.6.2.3.2 should be revised to include this requirement.

GEH Response

The operability qualification of pipe-mounted components is outlined in the DCD are consistent with the guidance of SRP 3.9.3 as described in DCD Subsection 3.9.3. A statement is added to DCD subsection 3.6.2.3.2 to identify where the appropriate DCD requirements are located.

DCD Impact

DCD Tier 2 subsection 3.6.2.3.2 will be revised in Revision 5 of the DCD as noted in the attached markup.

$$P_I = \frac{F_j}{A_x} \tag{3.6-2}$$

where

P_I = incident pressure

A_x= area of the expanded jet at the target intersection.

Target shape factors are included in accordance with ANS 58.2.

If the effective target area (A_{te}) is less than the expanded jet area ($A_{te} < A_x$), the target is fully submerged in the jet and the impingement load is equal to (P_I) (A_{te}). If the effective target area is greater than the expanded jet area ($A_{te} > A_x$), the target intercepts the entire jet and the impingement load is equal to (P_I) (A_x) = F_j. The effective target area (A_{te}) for various geometries follows:

- Flat Surface — For a case where a target with physical area A_t is oriented at angle ϕ with respect to the jet axis and with no flow reversal, the effective target area A_{te} is:

  $$A_{te} = (A_t)(\sin\phi) \tag{3.6-3}$$

- Pipe Surface — As the jet hits the convex surface of the pipe, its forward momentum is decreased rather than stopped; therefore, the jet impingement load on the impacted area is expected to be reduced. For conservatism, no credit is taken for this reduction and the pipe is assumed to be impacted with the full impingement load. However, where shape factors are justifiable, they may be used. The effective target area A_{te} is:

  $$A_{te} = (D_A)(D) \tag{3.6-4}$$

  where

  D_A = diameter of the jet at the target interface

  D = pipe OD of target pipe for a fully submerged pipe

  When the target (pipe) is larger than the area of the jet, the effective target area equals the expanded jet area

  $$A_{te} = A_x \tag{3.6-5}$$

- For all cases, the jet area (A_x) is assumed to be uniform and the load is uniformly distributed on the impinged target area A_{te}.

3.6.2.3.2 Pipe Whip Effects on Safety-Related Components

This subsection provides the criteria and methods used to evaluate the effects of pipe displacements on safety-related structures, systems, and components following a postulated pipe rupture.

Pipe whip (displacement) effects on safety-related structures, systems, and components can be placed in two categories: (1) pipe displacement effects on components (nozzles, valves, tees, etc.) which are in the same piping run that the break occurs in; and (2) pipe whip or controlled displacements onto external components such as building structure, other piping systems, cable trays, and conduits, etc.

Pipe Displacement Effects on Components in the Same Piping Run

The criteria for determining the effects of pipe displacements on inline components are as follows:

- Components such as vessel safe ends and valves which are attached to the broken piping system and do not serve a safety function or failure of which would not further escalate the consequences of the accident need not be designed to meet ASME Code Section III-imposed limits for safety-related components under faulted loading.
- If these components are required for safe shutdown or serve to protect the structural integrity of a safety-related component, limits to meet the ASME Code requirements for faulted conditions and limits to ensure required operability are met.

  The operability qualification of active pipe mounted components is described in Subsection 3.9.3.
- The methods used to calculate the pipe whip loads on piping components in the same run as the postulated break are described in Subsection 3.6.2.2 under paragraph titled. "Pipe Whip Dynamic Response Analyses".

Pipe Displacement Effects on Safety-Related Structures, Other Systems, and Components

The criteria and methods used to calculate the effects of pipe whip on external components consist of the following:

- The effects on safety-related structures and barriers are evaluated in accordance with the barrier design procedures given in Subsection 3.5.3.
- If the whipping pipe impacts a pipe of equal or greater nominal pipe diameter and equal or greater wall thickness, the whipping pipe does not rupture the impacted pipe. Otherwise, the impacted pipe is assumed to be ruptured.
- If the whipping pipe impacts other components (valve actuators, cable trays, conduits, etc.), it is assumed that the impacted component is unavailable to mitigate the consequences of the pipe break event.
- Damage of unrestrained whipping pipe on safety-related structures, components, and systems other than the ruptured one is prevented by either separating high energy systems from the safety-related systems or providing pipe whip restraints.

3.6.2.3.3 Loading Combinations and Design Criteria for Pipe Whip Restraint

Pipe whip restraints, as differentiated from piping supports, are designed to function and carry loads for an extremely low-probability gross failure in a piping system carrying high-energy fluid. In the ESBWR plant, piping integrity does not depend on the pipe whip restraints for any piping design loading combination, including an earthquake, but the pipe whip restraints are required to remain functional following an earthquake up to and including the SSE (Subsection 3.2.1). When the piping integrity is lost because of a postulated break, the pipe whip