GE-Hitachi Nuclear Energy Americas LLC

James C. Kinsey
Project Manager, ESBWR Licensing

PO Box 780 M/C A-55
Wilmington, NC 28402-0780
USA

T 910 675 5057
F 910 362 5057
jim.kinsey@ge.com

MFN 07-477 Docket No. 52-010

September 21, 2007

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

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 91 Related to ESBWR Design Certification Application ESBWR Probabilistic Risk Assessment RAI Numbers 19.1-134 through 19.1-137,19.1-139,19.1-141 and 19.1-145 through 19.1-147.**

The purpose of this letter is to submit the GE-Hitachi Nuclear Energy Americas LLC (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by NRC letter dated January 31, 2007. The GEH responses to 19.1-137,19.1-139,19.1-141 and 19.1-145 through 19.1-147 are addressed in the Enclosure.

Should you have any questions about the information provided here, please contact me.

Sincerely,

James C. Kinsey
Project Manager, ESBWR Licensing

Reference:

1. MFN 07-104, Letter from U.S. Nuclear Regulatory Commission to David H. Hinds, *Request for Additional Information Letter No. 91 Related to ESBWR Design Certification Application.* January 31, 2007.

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 91 Related to ESBWR Design Certification Application ESBWR Probabilistic Risk Assessment RAI Numbers 19.1-134 through 19.1-137,19.1-139,19.1-141 and 19.1-145 through 19.1-147.

cc:	AE Cubbage	USNRC (with enclosure)
	GB Stramback	GEH/San Jose (with enclosure)
	RE Brown	GEH/Wilmington (with enclosure)
	eDRF Section	0000-0072-2404 RAI 19.1-134
		0000-0072-5436 RAI 19.1-135
		0000-0073-7556 RAI 19.1-136
		0000-0072-2410 RAI 19.1-137
		0000-0072-4030 RAI 19.1-139
		0000-0073-7560 RAI 19.1-141
		0000-0073-3716 RAI 19.1-145
		0000-0073-3836 RAI 19.1-146
		0000-0073-3955 RAI 19.1-147

Enclosure 1 to MFN 07-477

Response to Portion of NRC Request for Additional Information Letter No. 91 Related to ESBWR Design Certification Application ESBWR Probabilistic Risk Assessment RAI Numbers 19.1-134 through 19.1-137,19.1-139, 19.1-141 and 19.1-145 through 19.1-147

NRC RAI 19.1-134

In the shutdown flooding PRA (general assumption 30), the feedwater and condensate systems are assumed to be available during Modes 5 and 6. This assumption is inconsistent with the internal events shutdown PRA which credits feedwater for RCS injection. Please revise the PRA to explain which assumption is correct.

GEH Response

Feedwater and Condensate are no longer credited in the shutdown PRA. Shutdown and shutdown flooding are now consistent in this regard.

DCD/NEDO-033201 Impact

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

NEDO-33201 Section 13, Rev. 2 has been revised as described above.

NRC RAI 19.1-135

In the shutdown flood PRA (general assumption 31), it is assumed that both manual and automatic depressurization (ADS) of the reactor vessel are available while the vessel head is in place. This assumption is inconsistent with Technical Specifications which do not require the operability of ADS during Modes 5 and 6. Please explain why this inconsistency exists between the PRA and Technical Specifications.

GEH Response

General assumption 31 in the shutdown flooding PRA assumed both manual and automatic depressurization (ADS) of the reactor vessel are available while the head is in place. The reason for this assumption was to ensure that an adequate vent path was available such that GDCS could be credited for decay heat removal. While other vent paths are available, such as blocking open the MSIVs only ADS is credited in the shutdown flooding PRA. This is conservative since: a) other paths are available which would typically be manually opened to provide a vent path, and; b) failure closed of normally open manual valves is expected to occur with a lower frequency than the GDCS system which requires valves to change position. RAI 16.2-74 Supplement 1 GE Response inserted SR Basis for 3.5.3.1 states this vent requirement can be met by OPERABILITY of the ADS system. ADS would be operable if manual and automatic initiation were available.

The revised assumption will be consistent with the Technical Specifications as discussed in the RAI 16.2-74 response and proposed Technical Specification Changes as discussed in the GEH response to RAI 16.2-74 Supplement 1.

The RAI 16.2-74 response reviewed the operability requirements of the GDCS outlined in DCD Tier 2, Revision 1 Chapter 16, LCO 3.5.3. Prior to the removal of the head, GDCS operability requires sufficient RPV venting capacity to maintain the RPV depressurized following loss of the normal DHR capability. If the Automatic Depressurization System (ADS) is selected as the available vent path, decay heat is released to the containment atmosphere.

RAI 16.2-74 Supplement 1 GE Response committed to revising DCD, Tier 2, Revision 3, Chapters 16 and 16B LCO 3.5.3 "Gravity Driven Cooling System (GDCS) – Shutdown", to include a Surveillance Requirement (SR) for Reactor Pressure Vessel (RPV) venting capability. This SR will require verification that the RPV has venting capacity capable of maintaining the RPV sufficiently depressurized to allow GDCS injection following loss of decay heat removal capability.

The DCD impact of RAI 16.2-74 Supplement 1 GE Response is as follows:

DCD Tier 2, Chapters 16 and 16B, Revision 4, will include the following SR and supporting Bases:

Specification 3.5.3 INSERT:

SURVEILLANCE		FREQUENCY
SR 3.5.3.1	Verify availability of RPV venting capacity sufficient to allow GDCS injection following loss of decay heat removal capability.	24 hours

Specification 3.5.3 Bases INSERT:

SR 3.5.3.1

This SR requires verification every 24 hours that the RPV has venting capacity capable of maintaining the RPV sufficiently depressurized to allow GDCS injection following loss of decay heat removal capability. This SR may be met by the OPERABILITY of the ADS function. The ADS capacity needed to meet this SR is established based on the existing decay heat and include an allowance for a single failure.

RPV vent paths other than the ADS may also be used to meet this SR provided those vent path(s) are sufficient for the existing decay heat load and are maintained open.

The 24 hour Frequency for performing this SR is based on engineering judgment. This Frequency is acceptable because this SR ensures that the required RPV venting capacity is available when required to support the decay heat removal function of the GDCS.

After the above revision, Revision 2 of NEDO-33201 Chapter 13, General Assumption 31 will be consistent with the Technical Specifications.

DCD/NEDO-033201 Impact

No DCD changes will be made in response to this RAI. Refer to MFN 06-431-Supp_3 for a description of DCD changes for RAI 16.2-74 S01.

No NEDO-33201 Rev. 2 changes will be made in response to this RAI.

NRC RAI 19.1-136

For each flooding area considered in the flooding risk analysis (Section 13), please discuss the maximum expected flood height, flood propagation potential (e.g., wall penetrations, doors open for maintenance, under doors and down stairwells), and the location of equipment with respect to the maximum expected flood height.

GEH Response

In general the maximum expected flood height for the shutdown flooding PRA is not critical since no credit is provided for operation of equipment in a zone that has been flooded by unscreened flooding sources unless the equipment has been environmentally qualified. Therefore, since there is no critical flood height assigned to the flood zones, the maximum expected flood height is not required.

When flood sources were screened based on the capacity of the system not being able to affect PRA related equipment, the location of equipment was assumed to be 1 foot above the floor.

Flood propagation is through doorways and stairwells. These openings were used since they are able to propagate large volumes of water sufficient to overwhelm the sump pumps/ equipment drain pumps. No propagation through wall penetrations has been defined.

In general, doors have not been considered as significant flooding pathways. Watertight doors are credited in the PRA. The remaining doors are not expected to be open long enough to contribute to a flooding hazard.

The location of equipment with respect to the maximum flood height is assumed to be below maximum flood height, which means no credit is provided for equipment in the flood area.

DCD/NEDO-033201 Impact

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

NEDO-33201 Section 13, Rev. 2 has been revised as described above.

NRC RAI 19.1-137

In the shutdown flooding PRA (general assumption 32), it is assumed that none of the fire protection system piping located in the Electrical or Turbine Buildings have the capacity to affect operation of the RCCWS. Please explain why this assumption is valid.

GEH Response

NEDO Section 13 will be revised to delete general assumption 32. Revision 1 of NEDO Section 13 used a method that only evaluated the most limiting flood. In Revision 2, all potential flooding sources have been considered. There is a potential effect of the fire protection system piping located in the Turbine Building on the operation of the RCCWS and it is included in the shutdown flooding PRA. The RCCWS equipment, which is modeled in the PRA and is located in the turbine building, is included as potential flooding targets in the turbine building. The 6.9 KV, PIP buses, which supply the RCCWS, are located in the electrical building and, based on the assumed fire protection pipe routing, do not have fire protection flood sources. Consequently, none of the fire protection system piping located in the Electrical building will affect operation of the RCCWS. Major fire protection system piping and equipment which is assumed to be located in the turbine building will be included as potential flooding sources.

DCD/NEDO-033201 Impact

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

NEDO-33201 Section 13, Rev. 2 has been revised as described above.

NRC RAI 19.1-139

In the shutdown flood PRA, the accident sequence modeling considers the flood impacts on two critical safety functions during shutdown: 1) decay heat removal (DHR) and 2) RCS inventory control. However, the critical safety function of RCS pressure control is necessary for low-pressure RCS injection and gravity driven injection. Please evaluate the impact of flooding on RCS pressure control in the shutdown PRA, or please explain why this evaluation is not needed.

GEH Response

Flooding is not expected to impact the RCS pressure control function because the RCS pressure control components are located above elevation +18500 inside the containment upper drywell. The free air space for the lower drywell is 1190 cubic meters. The free air space for the upper drywell to an elevation of +17500 is 967 cubic meters. The volume of water to reach +17500 in the drywell would be 2157 cubic meters or more than 500,000 gallons which is still 1 meter below the pressure control components. The probability of a flooding event occurring, which would require pressure relief after releasing this volume of water, is considered statistically insignificant and will not be evaluated further.

DCD/NEDO-033201 Impact

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

No NEDO-33201 Rev. 2 changes will be made in response to this RAI.

NRC RAI 19.1-141

Please describe the top events used in the shutdown flooding event trees in the PRA.

GEH Response

The top events used in the shutdown flooding PRA are the same as those used in the shutdown PRA (refer to NEDO 33201 Revision 2 Section 16). NEDO 33201 Revision 2 Section 16 provides a description of the top events used in the shutdown flooding event trees in the PRA.

DCD/NEDO-033201 Impact

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

NEDO-33201 Section 13, Rev. 2 has been revised to describe the shutdown flooding top events.

NRC RAI 19.1-145

Explain why modeling Mode 6 conditions with the reactor vessel head removed is sufficient for the shutdown seismic risk analysis. The shutdown seismic event tree for Mode 6 (unflooded condition) includes conditions with the reactor vessel head removed and with the head in place (but one or more of the closure bolts less than fully tensioned). The evaluation assumes that the head is removed and, therefore, no RCS pressure control is needed for RCS injection and GDCS. Please revise the evaluation to model Mode 6 conditions with the head on and with the head removed, or please explain why modeling of Mode 6 with the vessel head on is not needed.

GEH Response

Modeling the Mode 6 condition alone is not sufficient for the Shutdown Seismic Margin Analysis. That is why Mode 5 is also included.

To address the specific time of concern in the shutdown risk analysis (Chapter 16 of NEDO-33201), Mode 5 was divided into two, one being the Tech Spec defined Mode 5 and the other called "Mode 5 Open" (Mode 5 with open containment).

"Mode 5 Open" is not a Tech Spec defined Mode, and actually includes a period of time from two separate Tech Spec defined Modes. "Mode 5 Open" is essentially the same as Mode 5 except containment is not intact. The reactor vessel head is still on, but containment is open.

Part of the "Mode 5 Open" period is actually part of Mode 6 as defined in the Tech Specs. According to the Tech Spec mode definitions, Mode 6 begins when one or more reactor vessel head closure bolts is less than fully tensioned. "Mode 5 Open" sequences consider pressure relief in the model. Mode 6 sequences do not since the RPV head is removed for the majority of the mode. Using the Tech Spec definition, there is a small period of time that is technically Mode 6, but when the vessel head may still provide a pressure seal. The period of Mode 6 with the vessel head still on is included in the "Mode 5 Open" shutdown risk analysis.

It is assumed in the shutdown risk analysis that the period when the reactor vessel head is on in Mode 6 is bounded by the "Mode 5 Open" shutdown risk analysis.

In the shutdown Seismic Margin Analysis, Chapter 15 of NEDO-33201, Mode 5 and "Mode 5 Open" are included.

DCD/NEDO-033201 Impact

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

NEDO-33201 Chapter 15, Rev 2 has been revised as described above.

NRC RAI 19.1-146

Address passive containment cooling system operation for an open containment in the shutdown seismic risk analysis. Please discuss in the shutdown seismic risk analysis whether the passive containment cooling system (PCCS) is functional with an open containment. If PCCS is not functional, credit for PCCS should be removed from the shutdown seismic event trees for Modes 5 and 6, since containment integrity is not required in Modes 5 and 6

GEH Response

PCCS is not credited in NEDO-33201 Chapter 15, Rev 2 during Modes 5 and 6.

Chapter 15 of NEDO-33201 presents a comparison with and without PCCS for Mode 5.

The comparison shows that the HCLPF values would be the same for the sequences where PCCS was called upon in the shutdown Mode 5 event tree given the assumption that successful operation of either GDCS or FPS leads to a "success" end state. Moreover, a minimum seismic margin capacity of 1.67*SSE is assumed for components.

DCD/NEDO-033201 Impact

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

NEDO-33201 Rev 2 Chapter 15 has been revised as described above.

<u>NRC RAI 19.1-147</u>

Address the use of temporary penetrations associated with refueling in the shutdown seismic risk analysis. Please (1) address the fragility of temporary penetrations that may be used during refueling (e.g. refueling cavity seal) and (2) assess their fragility in the seismic event trees.

<u>GEH Response</u>

Permanent penetrations for service equipment during refueling have been added to the ESBWR design. These should be adequate for refueling outages so temporary penetrations are not evaluated in the design PRA. Temporary penetrations would only be needed for extraordinary maintenance evolutions, and these entire evolutions would be evaluated when and if they are planned.

There are no "temporary seals" identified in the design. The cavity seal is a seismic Category I permanent seal.

All seismic Category I equipment is required to have a HCLPF margin of 1.67. See DCD Chapter 19, Table 19.2-4.

<u>DCD/NEDO-033201 Impact</u>

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

No changes to NEDO-33201 Rev. 2 will be made in response to this RAI.