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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. 151 Related to ESBWR Design Certification Application - Containment Systems - RAI Number 6.2-138 S01

Enclosure 1 contains the GE Hitachi Nuclear Energy (GEH) response to the subject NRC RAI originally transmitted via the Reference 1 letter and supplemented by an NRC request for clarification in Reference 2.

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

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 06-419, Letter from U.S. Nuclear Regulatory Commission to David H. Hinds, *Request for Additional Information Letter No. 80 Related to ESBWR Design Certification Application*, November 2, 2006
2. MFN 08-118, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 151 Related to ESBWR Design Certification Application*, February 7, 2008

Enclosure:

1. MFN 08-602 - Response to Portion of NRC Request for Additional Information Letter No. 151 Related to ESBWR Design Certification Application - Containment Systems - RAI Number 6.2-138 S01

cc:	AE Cubbage	USNRC (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	GB Stramback	GEH/San Jose (with enclosures)
	RE Brown	GEH/Wilmington (with enclosures)
	eDRF	0000-0084-7115R1

Enclosure 1

MFN 08-602

Response to Portion of NRC Request for Additional Information Letter No. 151 Related to ESBWR Design Certification Application

Containment Systems

RAI Number 6.2-138 S01

NRC RAI 6.2-138 S01:

Staff requested in RAI 6.2-138 that GEH describe and justify a mixed containment atmosphere during design-basis and significant beyond design-basis accidents.

GEH response to RAI 6.2-138 stated that adequate mixing within the ESBWR containment system is assured based on the configuration of the ESBWR containment coupled with the dynamics of the design basis loss-of-coolant accident and the mitigation components within the containment volume. GEH also stated that another consideration with respect to the mixing process is the incorporation of Passive Autocatalytic Recombiners (PARs) into both the ESBWR drywell and wetwell.

Based on the analysis assumptions provided in the DCD, Revision 4 and in response to RAI 6.2-138, an initial containment oxygen concentration of 4% was assumed with an allowable containment concentration of 5%. To keep the oxygen concentration below 5%, a certain recombination rate must be assumed. The recombination rate of a PAR is dependent on the concentration of hydrogen and oxygen, the size of the PAR, and possible poisons.

Please provide the following additional information about the PARs:

A. *What was the concentration of hydrogen and oxygen assumed? Is the adequate mixing assumption appropriate for PAR sizing because oxygen from radiolysis could be disproportionably distributed between the drywell and the wetwell? State the number, size and location PARS in the drywell and wetwell. If PARS locations have not been determined, state the criteria that will be used to locate the PARs. Include the above requested information in the DCD.*

B. *What margin was included to account for possible poisoning effect of the PAR catalyst? What was the basis for the margin used to account for possible poisoning? Include the information in the DCD.*

C. *Provide the modeling of energy generated from the PAR exothermal reaction in the containment performance analysis.*

D. *Include in the DCD a surveillance to verify the assumed recombination rate.*

GEH Response:

A. The concentration of hydrogen and oxygen assumed is from the GEH analysis that shows that at the 72-hour point in the accident scenario, the hydrogen concentration is 2.84% vol and the oxygen concentration is 4.80% vol. In terms of hydrogen production, the rate of production for hydrogen at this 72-hour point is 9.6E-05 lb-mole/sec, which is conservatively 0.32 Kg H_2/hr. At this point in the accident scenario the production rate of both hydrogen and oxygen gasses is decreasing and will continue to do so for the remainder of the event. Since the Passive Autocatalytic Recombiners (PARs) are conservatively assumed to begin operating at this 72-hour point, there is more than adequate capacity for the PARS to maintain both gasses well below a flammable mixture during this period. However, the PARs will actually begin working when the necessary minimum stoichiometric quantities of oxygen and hydrogen are present such that the hydrogen production rate at the 72-hour point will actually be less than the value provided by the analysis.

The adequate mixing assumption is appropriate for PARs sizing, even if the oxygen from radiolysis could be disproportionably distributed between the drywell and the wetwell, because of the conservative PARs safety factor for sizing and placement employed by GEH during the detailed design phase. The drywell and the wetwell are considered separately for PARs sizing and placement. The hydrogen production rate from the above analysis is applied to each of these two compartments when sizing. The number and sizing of PARs to be installed in each compartment (drywell and wetwell) assures that each compartment's PARs system has the capacity to mitigate a flammable gas potential in that compartment, while maintaining a safety factor of two. Each compartment's PARs system is sized to mitigate 100 percent of the post-accident gasses produced from radiolysis in the core.

The number, size and location of PARs in the drywell and wetwell is determined during the detailed design phase using the following criteria. As stated above, each compartment's PARs system will be sized to mitigate the flammable gas potential from 100 percent of the post-accident gasses produced from radiolysis in the core. Based upon the current analysis for the hydrogen production rate at 72 hours following a loss-of-coolant accident (LOCA), the number and sizing of PARs required is more than sufficient to provide for a minimum safety factor of two. PARs sizing and placement is made based on criteria such as adequately mixed atmosphere with azimuthally arranged PARs, no loss of capacity due to jet impingement forces, PARs placement such that driving gas flow is diverted from containment sprays or fan cooler discharge streams, PARs are protected from containment compartment flooding and pool swell, PARs discharge streams are appropriately routed so as not to adversely affect any safety–related components, and PARs units are sized and placed considering accessibility for testing and maintenance.

DCD Tier 2, Revision 5, Subsection 6.2.5.1, last four paragraphs, include the relevant information related to the design and operation of the PARs, and associated analysis for determining the quantity, size, and location of the PARs units, discussed in this response.

B. The PARs system is designed such that a minimum safety factor of two is realized for each containment compartment. As previously described, the quantity, size, and location of the PARs units are determined based on many factors to ensure adequate mixing and efficiency.

   DCD Tier 2, Revision 5, Subsection 6.2.5.1, last four paragraphs, include the relevant information related to the design and operation of the PARs, and associated analysis for determining the quantity, size, and location of the PARs units, discussed in this response.

C. Energy generated from the PARs exothermic reaction is modeled per the GEH analysis. The worst-case scenario for heat addition to the wetwell involves PARs operation using maximum reasonable PARs capacity required, beginning at

72 hours after the accident and operating with no safety factor and an overall assumed efficiency of 85%. With the PARs operating with these assumptions, a maximum total of 649,443 BTU/hr is added to the wetwell space over an approximate 6-hour time span, after which heat addition subsides.

D. DCD Tier 2, Revision 5, Chapter 19, Appendix A, Availability Controls Manual (ACM), contains a specific section for PARs in Availability Controls Limiting Condition for Operation (ACLCO) 3.6.2. ACLCO 3.6.2, Revision 5, includes an Availability Controls Surveillance Requirement (ACSR) 3.6.2.1 requiring a visual examination of PARs for abnormal indications. ACSR 3.6.2.2 was added in Revision 5 to require a performance test of a representative catalyst plate from the PARs in either the drywell or the wetwell on a staggered test basis per compartment. These surveillances are adequate to ensure the assumed recombination rate of the PARs units is maintained.

DCD Impact:

DCD Tier 2, Revision 5, Subsection 6.2.5.1, and Chapter 19, ACLCO 3.6.2 (previously ACLCO 3.6.2), include the changes described in the response above. The DCD Tier 2, Revision 5, Chapter 19 Change List item number 107, Description of Change, mistakenly refers to RAI 6.2-139 S01 instead of RAI 6.2-138 S01. No other DCD changes will be made in response to this RAI.