January 15, 2008

Mr. Robert E. Brown
Senior Vice President, Regulatory Affairs
GE-Hitachi Nuclear Energy Americas, LLC
3901 Castle Hayne Road MC A-45
Wilmington, NC 28401

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 132 RELATED TO ESBWR DESIGN CERTIFICATION APPLICATION

Dear Mr. Brown:

By letter dated August 24, 2005, GE-Hitachi Nuclear Energy Americas, LLC (GEH) submitted an application for final design approval and standard design certification of the economic simplified boiling water reactor (ESBWR) standard plant design pursuant to 10 CFR Part 52. The Nuclear Regulatory Commission (NRC) staff is performing a detailed review of this application to enable the staff to reach a conclusion on the safety of the proposed design.

The NRC staff has identified that additional information is needed to continue portions of the review. The staff's request for additional information (RAI) is contained in the enclosure to this letter.

To support the review schedule, you are requested to provide the requested additional information within 45 days of the date of this letter.

If you have any questions or comments concerning this matter, you may contact me at 301-415-5787 or rdf@nrc.gov, or you may contact Thomas Kevern at 301-415-0224 or tak@nrc.gov.

Sincerely,

/RA/

Rocky D. Foster, Project Manager
ESBWR/ABWR Projects Branch 2
Division of New Reactor Licensing
Office of New Reactors

Docket No. 52-010

Enclosure: Request for Additional Information

cc: See next page

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Distribution: See next page

ACCESSION NO: ML080090295 NRO-002

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DATE	1/11/2008	1/15/2008	1/11/2008	1/15/2008	1/14/2008	1/15/2008

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Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD), Revision 4

RAI Number	Reviewer	Question Summary	Full Text
19.1-4S01	Pohida M	Missing Key Risk Insights from DCD, Tier 2, Table 19.2-3	Please include the following key risk assumptions, or explain why they are missing from the DCD,Tier 2, Revision 4, Table 19.2-3, "Risk Insights and Assumptions". A. Regarding lower drywell hatch closure, two key assumptions which substantiate the human reliability estimates are: (1) outage personnel will be continuously located in the area of the doors (Disposition - Operational Program), and (2) closure of both the equipment hatch and the personnel hatch can be done from outside the lower/drywell/containment (Disposition - Design Requirement). B. As stated by, GEH in the PRA, the COL applicant shall develop maintenance procedures with provisions to prohibit coincident removal of the control rod and CRD of the same assembly. In addition, the COL applicant shall develop contingency procedures to provide core and spent fuel cooling and mitigative actions during CRD replacement with fuel in the vessel (Disposition - Operational Program). C. The RTNSS focused PRA results were based on both trains of RWCU/SDC running until the reactor cavity is flooded (Disposition - Operational Program). D. The high reliability of the leakage detection and isolation systems provides the basis for the screening of (1) shutdown LOCAs outside containment and (2) operator-induced losses of reactor vessel inventory during shutdown (Disposition - DCD, Tier 1). E. Regarding operator-induced vessel draining through lines attached to the vessel, as stated by GEH:

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			(1) To eliminate the need for freeze seals on lines attached to the vessel, all power operated equipment and valves that require maintenance have maintenance valves installed such that freeze seals will not be required (Disposition - Design Requirement). (2) Lines to the Low Conductivity Waste are located down stream of the containment isolation valves (Disposition-Design Requirement). (3) The lines to the Primary Sampling System are monitored by the Leak Detection and Isolation System and have two redundant isolation valves (Disposition - Design Requirement). (4) The only piping penetrations that are not downstream of the isolation valves are 20mm drain and vent lines near the isolation valves. These small lines have two normally closed manual valves and a threaded cap (Disposition - Design Requirement). F. GEH screened drywell/containment fires that could result in loss of the RWCU/SDC and the RWCU inboard containment isolation valves based on spatial separation of the RWCU.
19.1-116S01	Caruso M	Disposition of Risk Assumptions listed in Column Two of DCD, Tier 2, Table 19.2-3	Assumptions in the ESBWR PRA pertaining to each of the systems modeled in the PRA are listed in Chapter 4 of NEDO-33201, Revision 2. These assumptions relate to the design, operation and control of the systems. In response to RAI 19.1-116, DCD, Chapter 19, Revision 4, Table 19.2-3 was revised to identify design and operational requirements based on PRA risk insights and assumptions. The staff requests additional information in order to understand why many of the assumptions in Chapter 4 of NEDO-33201, Revision 2 have not been reflected in Table 19.2-3 of Revision 4 to the

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			Tier 2, DCD. The staff requests that GEH review the assumptions listed in each section of Chapter 4 of NEDO-33201, Revision 2; and, for those that relate to the design, operation and control of systems, structures and components, and have not been reflected in Table 19.2-3, to either disposition them in Table 19.2-3 or provide justification as to why they should not be reflected in Table 19.2-3.
19.1-156	Pohida M	Maintenance and departures from DCD, Tier 2, Table 19.2-3	The Staff is requesting GEH to update DCD, Tier 2, Revision 4, Section 19.4.2 PRA Maintenance and Update Program as follows, “The PRA will be updated to reflect plant design, operational, and PRA modeling changes, consistent with NRC-endorsed standards in existence 1 year prior to issuance of the update, which will be prior to initial fuel load, and then every four years. The key assumptions in the PRA as documented in DCD Tier 2, Table 19.2-3 will be maintained or any departures shall be addressed. The COL Holder maintains this information in accordance with documentation and records retention requirements.”
19.1-157	Pohida M	Clarify Definitions of Disposition of Risk Assumptions listed in Column Two of DCD, Tier 2, Table 19.2-3	The staff is requesting GEH to clarify the definitions of the disposition of key risk assumptions and risk insights listed in Column 2 in DCD, Tier 2, Revision 4, Table 19.2-3, "Risk Insights and Assumptions" as follows: A. GEH should clarify that "Operational Program" means that development of Operating and Maintenance Procedures is the responsibility of the COL Applicant in accordance with COL Item 13.5-2-A. These PRA assumptions will be addressed by the COL applicant as part of this COL action item. B. GEH should provide reference to a specific DCD section for each item identified as a "design requirement."

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19.1-158	Pohida M	ESBWR Shutdown Flooding CDF is negligible.	It is stated in Section 19.2.4.13 of the DCD, Revision 4, that the shutdown flooding CDF is negligible. Based on comparison of the reported shutdown internal events CDF and shutdown flooding CDF, GEH is requested to justify or revise this statement in the DCD.
19.1-159	Pohida M	Shutdown Severe Accident Consequences	In Section 19.2.4.2 of the DCD, Revision 4, GEH states that, ‘‘The offsite consequences from shutdown risk are judged to be negligible on the following basis: “The significant shutdown events occur during Mode 6, which does not begin until approximately 96 hours after shutdown. The decay of fission products after 96 hours reduces the source term to less than 1% of the value at power operating conditions....”. The staff is requesting GEH to justify or revise this statement based on the following: As reported in Chapter 16 of the PRA, over 40% of the internal shutdown CDF is related to Mode 5. In addition, in NUREG/CR 6595, <u>An Approach for Estimating the Frequencies of Various Containment Failure Modes and Bypass Events</u>, on pages 4-3, it states, “The results indicate that source terms which involve a release of about 10% or less of the core iodine inventory (10% iodine releases are associated with early fatalities in accidents that occur at full-power), offsite doses generally fall below the early fatality threshold approximately 8 days or less after shutdown.” Therefore, the consequences of severe accidents occurring during Modes 5 and 6 approximately 8 days or less after shutdown should not be characterized as negligible in the DCD, Chapter 19.

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19.1-160	Lai J	Describe how the calculation was done to determine the "Difference" result shown in the Fire PRA sensitivity study tables.	Results of Fire PRA sensitivity studies are presented in a column entitled "Difference" in tables presented in Chapter 11 of NEDO-33201, Revision 2. The tables include: Table 11.3-4, 11.3-6, 11.3-8, 11.3-11, 11.3-19, 11.3-20, 11.3-22, 11.3-23, 11.3-24, 11.3-25, 11.3-28, 11.3-30, 11.3-32, 11.3-34, 11.3-36, 11.3.-37, 11.3-38 and 11.3-39. However, there is no definition for the "Difference" parameter presented in Section 11. The staff can not reproduce some of the results and is concerned that there may be some errors in the calculation of "Difference". Please provide the definition of the "Difference" result shown in these tables.
19.1-161	Lai J	ESBWR PRA (NEDO-33201) Revision 2, Section 11.3.4.3 Focus Level 2 Flood - Inconsistent results reported in this section. Please verify and correct the inconsistency.	In Section 11.3.4.3, it is stated that: "The focus Level 2 flood generated a nTSL release frequency of 4.49E-4/yr…..". However, 4.49E-06 is shown in Table 11.3-30. Please resolve this inconsistency. In the same section, it is stated that "…NRC goal of 1E-06/y4 LRF is met for both focus and RTNSS…." The figure 1E-6/y4 appears to be a typographical error. The NRC goal for LRF is 1.E-6/yr. The focus Level 2 flood frequency is either 4.49E-4/yr or 4.49E-6/yr. In either case, the NRC goal is not met for the Level 2 focus flood. Please correct the typographical error and revise the quoted sentence to reflect that the goal has not been met.

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19.1-162	Hilsmeier T	ESBWR fire PRA model does not accurately reflect fire area F3140 described in DCD, Tier 2, Revision 4, Appendix 9A.	According to DCD, Tier 2, Revision 4, Appendix 9A, Rooms 3140 and 3301 are included in fire area F3140. However, the ESBWR PRA, Revision 2, Chapter 12 assumes these rooms are separate fire areas (i.e., Room 3301 only is a fire area and is separate from fire area F3140). This discrepancy is considered significant in that core damage frequency from internal fire could significantly increase if Rooms 3140 and 3301 are in the same fire area. The staff requests that GEH clarify the boundary of fire area(s) that include Rooms 3140 and 3301. If Rooms 3140 and 3301 are separate fire areas, then the staff requests that GEH provide the basis for this separation (the cable chase connecting the two rooms could quickly propagate a fire vertically from one room to the other). If Rooms 3140 and 3301 belong to the same fire area (i.e., F3140), then the staff requests that GEH update the ESBWR fire PRA model to reflect this.
19.1-163	Hilsmeier T	Clarify use of term “typically” used in PRA assumptions listed in DCD, Tier 2, Revision 4, Table 19.2-3 and in ESBWR PRA, Revision 2, Section 12.2.4	The staff is requesting GEH to clarify the use of the term “typically” used in the key assumptions listed in DCD, Tier 2, Revision 4, Table 19.2-3, "Risk Insights and Assumptions" and in ESBWR PRA, Revision 2, Section 12.2.4 as follows: - “Typically the main control room (MCR) communicates with the safety-related and nonsafety-related DCIS rooms with fiber optics.” - “Typically two load drivers are actuated simultaneously in order to actuate the component.” - “For the safety-related Q-DCIS cables, it will typically originate from the Q-DCIS divisional room in the control building and pass through its own divisional duct bank, then connect to its divisional cable chase in the reactor building.” - “For non-safety-related N-DCIS cables, it will typically originate from the N-DCIS rooms in the control building and pass through the nonsafety-related divisional tunnel and connect to rooms in the reactor building,

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			turbine building, or electrical building." The use of the word "typically" would imply that there may be some cases where the assumptions do not apply, which presumably would impact the PRA. The staff requests that GEH be more definitive of the atypical cases (i.e., describe the atypical cases).
19.1-164	Hilsmeier T	PRA modeling of FAPCS interface with the high pressure RWCU/SDC is not consistent with DCD, Tier 2, Revision 4, Figure 9.1-1	The ESBWR PRA, Revision 2, Section 4.7 describes the FAPCS interface with the high pressure RWCU/SDC system (for flow in LPCI mode). This description is not consistent with that provided in DCD, Tier 2, Revision 4, Figure 9.1-1, "FAPCS Schematic Diagram" (i.e., Figure 9.1-1 shows two parallel FAPCS check valves F335A/B that interface with RWCU/SDC, which are not included in the ESBWR PRA). The staff requests that GEH clarify this discrepancy.
19.1-165	Kelly G	Discuss hurricane risk assessment sensitivity study	Please describe what risk assessment sensitivity studies were performed for hurricanes in the high winds risk assessment, and what the results and insights were. If sensitivity studies were not performed, please explain the basis for not performing any?
19.1-166	Kelly G	Discuss existence of above-ground tanks that could pose a flooding hazard	Please explain whether there are above-ground, outdoor tanks or other structures holding significant quantities of liquids, such as water or oil that if failed or damaged could cause a flooding issue for other important equipment on site (e.g., pumps, transformers)? If so, please describe the tank(s) including whether they are protected by Seismic Category 1 or Category 2 structures, and any flooding mitigative features on the ESBWR site that would reduce the probability or consequences of undesirable events.
19.1-167	Kelly G	Discuss how the ESBWR PRA modeled effects of tornado missiles on Seismic Category 2 and RTNSS structures	Please describe specifically how the effects of tornado missiles on Seismic Category II and RTNSS structures were accounted for in the ESBWR high winds PRA. If such effects were not modeled, explain the reason(s)/justification for not performing the evaluation.

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19.1-168	Kelly G	Discuss the credit taken for the fire water system in the PRA during high winds events	In discussions with GEH, it was indicated that the ESBWR high winds PRA does not model damage to unprotected equipment in the area surrounding plant structures (e.g., fire hydrants) during hurricane and tornado events. GEH also stated that some credit is taken in the high winds PRA for use of the fire water system to cool the core or refill water tanks at the top of containment in hurricane and tornado loss of preferred power events. Please provide the effect on CDF, as well as risk insights, if no credit is given for the use of the fire water system (in whole or in part) to cool the core or refill tanks following a tornado or hurricane event?
19.1-169	Kelly G	Discuss why it is assumed hurricanes and tornados cannot damage Seismic Category 1 and 2 structures	Please explain the basis for assuming in the high winds risk assessment that no hurricane or tornado will significantly damage any ESBWR Seismic Category 1 or Category 2 structure.
19.1-170	Kelly G	Discuss the bounding aspects of the high winds risk assessment	If it is assumed that the tornado and hurricane high winds risk assessments are bounding for all or most proposed ESBWR sites, please explain the manner in which the assessments bound site-specific assessments that would be associated with plants sited on the coast of the U.S. or in the central or south-east portions of the U.S.
19.2-86	Xu J	Based on DCD, Tier 2, Revision 4 19B analysis results, justify how the containment Level C pressure capacity meets 10 CFR 50.44 (c)(5) requirement	The new ABAQUS/ANACAP-U analysis result as presented in DCD, Tier 2, Revision 4, Appendix 19B, showed that at an internal pressure of 0.987 MpaG (MWR pressure), or $3.18P_d$, the strain in the liner of the upper drywell wall at the connection with the top slab reached 0.72%, which exceeded the factored load limit for liners (0.3% tensile membrane strain, ASME Section III, Div 2, CC-3720). Based on Figure 19B-5 of DCD, Tier 2, Revision 4, Appendix 19B, the staff estimated that the containment Level capacity slightly less than 2.5 P_d with respect to the Code Allowable, controlled by the failure mode of the liner strain at Location A. Therefore, the requirement of 10 CFR 50.44(c)(5) is not met. The staff also disagrees with the characterization of DCD, Tier 2, Revision 4, Appendix 19B that the

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			containment Level C pressure capacity can be estimated using 99-percentile fragility value, because the Level C allowable is a design parameter that was not derived on a fragility basis. GEH further qualitatively justified that the liner strain could be reduced to within the factored load limit by accounting for the thermal induced strain, which is not consistent with the requirement of R.G. 1.7. Also, based on Figure 19B-5 of DCD, Tier 2, Revision 4, Appendix 19B, the excess liner strain appears to be a localized phenomenon (designated as location A in the figure). To facilitate the staff's evaluation, please provide: a) whether the strain at location A of Figure 19B-5 was calculated based on membrane or membrane plus bending (if the strain is due to membrane plus bending, the code allowable factored load limit is 1%); b) time histories of pressure and temperature on the liner due to WMR and a summary of thermal analysis which reduces the strain induced by the internal pressurization; c) SRP 3.8.1, II, SRP Acceptance Criteria 4.K.i for computing ultimate pressure capacity of concrete containment states that "One acceptable methodology for cylindrical reinforced concrete containment is to estimate the capacity based on attaining a maximum global membrane strain away from discontinuities of 1 percent." Please assess if there could be a change in failure mode if 1% strain is used as the failure criteria for liners in place of Table 19C-5 of DCD, Tier 2, Revision 4, Appendix 19C.

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19.2-87	Xu J	Provide Justification of including safety factor for SSI and incoherency effect in absence of any discussion regarding site conditions	NEDO-33201, Revision 2, Chapter 15, Table 15-2 thru 15-6 provided various factor of safety and associated uncertainty estimates for seismic fragility calculations, which included SSI effect and ground motion incoherency effect. Since no discussion was made with respect to the site conditions (soil vs. rock), the staff could not determine how and why the SSI and incoherency effects are included in the analysis (SSI effect only pertains to soil site). Please provide a justification of including the safety factor for SSI and incoherency effects in absence of any discussion regarding the site conditions.
19.2-88	Xu J	Incorporate in DCD a COL holder commitment to ensure that the mode of failure due to differential building displacement has a capacity no less than the required margin of 1.67*CSDRS	In NEDO-33201, Revision 2, Section 15.3.3, the structural fragility analysis assumed that the mode of failure due to differential building displacement has a capacity no less than the required margin of 1.67*SSE. Since this statement was made in the context of ESBWR certified design, the staff requests that the DCD be revised to clarify that SSE means CSDRS.
19.2-89	Xu J	Clarification for HCLPF capacity calculations for RCCV and RPV Pedestal	NEDO-33201, Revision 2, Section 15.3.3.2 describes the HCLPF calculation for RCCV and RPV Pedestal, using Appendix N of EPRI NP-6041-SL. It is unclear how the non-seismic loads were considered in the calculation. Further, given the tall structure of RCCV, discuss how the seismic induced local bending was considered in the HCLPF calculation for RPV pedestal.
22.5-6S01	Shams M	Provide a complete listing for RTNSS structures and address performance incompatibility between IBC and the required functional performance under SSE for RTNSS Criterion B structures	As stated by the applicant, structures that house Criteria B1 and B2 RTNSS systems are designed to the augmented standards of DCD, Section 19A.8.3. With regard to IBC seismic provisions proposed by the applicant for the design of RTNSS SSCs meeting Criterion B2, the staff noticed that these seismic provisions utilize a 2500-year event as the “Maximum Considered Earthquake”. This ground motion is then reduced by a factor of two-thirds to produce the “design” ground motion. Such ground motion may have a

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		and systems	return period varying from approximately 500 to 1,500 years, depending on the regional seismicity. The design seismic demands are further modified (generally reduced) in the design calculations to account for earthquake energy absorption through nonlinear behavior, i.e. component cracking and yielding. Structures classified as IBC Occupancy Category IV are designed as Seismic Use Group III and are expected to achieve the Immediate Occupancy performance level at the "design" level ground motion. Based on the *2003 NEHRP Recommended Provisions for Seismic Regulations of New Buildings and Other Structures* (FEMA 450, 2004), which forms the technical bases for the IBC seismic provisions, Immediate Occupancy is a performance level below an operational or a "functional" level. FEMA 450 further states that at the Immediate Occupancy level, damage to the structural systems is very slight and the structure remains safe to occupy; however, some repair is probably required before the structure can be restored to normal service. Equipment housed in such structures, on the other hand, is expected to experience more damage. In particular, utilities necessary for normal function of systems are not expected to be available. Also, some equipment and systems may experience internal damage due to shaking of the structure. Ultimately, minor structural repairs are required; however, significant nonstructural repair and cleanup are probably required before normal function of the structure can be restored. Based on the above, the staff believes that the IBC 2003 seismic provisions are not adequate to ensure that the post-72 hour systems, structures and components can withstand the effects of a safe-shutdown earthquake (SSE) without the loss of capability to perform their required functions. The staff requests the following: 1. Identify in the DCD all non-safety-related, non-seismic structures that house/support RTNSS systems meeting Criteria B1 and B2. 2. Provide the technical rationale to support GEH's assertion that IBC seismic provisions will achieve functional performance under an SSE level earthquake.

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			3. Given the lower hazard level and performance level of the IBC as compared to the SSE hazard level with a functional performance level, explain how GEH will ensure availability and reliability of RTNSS B2 systems and their surrounding/supporting structures. In the event of an SSE, explain in the DCD how RTNSS B1 and B2 systems are protected against adverse interaction due to the failure of adjacent non-safety related, non-seismic structural and non-structural components that are designed to the IBC seismic provisions.
22.5-7S01	Shams M	Address inadequacy of IBC to provide the required performance goal for RTNSS Criterion B2 SSCs and discuss any proposed improvements to IBC provisions.	Based on the staff's understanding of the IBC code, the augmented seismic design criteria, as delineated in GEH's response, will allow Criterion B2 RTNSS SSCs to achieve Immediate Occupancy performance level at two-thirds SSE. In accordance with FEMA 450, this is a state of some level of damage (lower for the structure and higher for the equipment) at two-thirds SSE. This is not sufficient to provide reasonable assurance that Criterion B2 SSCs will function after an SSE event. The staff requests the following: 1. Provide a detailed explanation for GEH's assertion that an Immediate Occupancy performance level at two-thirds SSE will provide reasonable assurance that Criterion B2 SSCs will function after an SSE event. 2. If applicable, provide in the DCD GEH's specific modifications to the IBC provisions in order to improve the performance criteria for RTNSS Criterion B2 SSCs to functional performance level at an SSE event level.
22.5-20	Shams M	In Section 19A.3.2, replace reference to Section 19.2.3.5 with Section 19.2.3.2.4.	In DCD, Revision 4, Section 19A.3.2, GEH stated that the seismic margins analysis is described in DCD, Section 19.2.3.5. This reference appears to be incorrect since the DCD does not include such section. The staff requests GEH to confirm that the correct reference to the description of the seismic margins analysis should be to DCD Section 19.2.3.2.4 or to provide the correct reference. Also, the staff requests GEH to update the DCD as necessary.

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22.5-21	Shams M	Identify design standards for RTNSS Criterion B SSCs designated as Regulatory Treatment "Support".	DCD, Revision 4, Section 19A.8.3 states that the augmented design standards are applied to High and Low Regulatory Oversight systems that meet Criterion B. Several RTNSS systems meeting Criterion B in DCD, Table 19A-2 are designated as Regulatory Treatment "Support". The staff requests GEH to identify in the DCD the standards used to design these systems and the structures that house/support them.
19.1-171	Radlinski R	Revise definition of fire protection defense in depth (NEDO-33201 Section 12.3.1)	NEDO-33201 Section 12.3.1, Separation Criteria, includes a statement of the defense in depth criteria for fire protection of a nuclear plant. The third component of this statement is not consistent with the defense in depth description in the DCD and is not consistent with regulatory guidance. Refer to ESBWR DCD Section 9.5.1.1, Power Generation Design Bases, for an acceptable version of the defense in depth criteria. Please revise the definition of fire protection defense in depth (NEDO-33201, Section 12.3.1)
19.1-172	Radlinski R	Revise description of the criteria for 3-hour fire barrier separation (NEDO-33201 Section 12.3.1)	NEDO-33201 Section 12.3.1, Separation Criteria, includes the criteria for where 3-hour rated fire barriers will be provided in the plant that is inconsistent with the description in Tier 1, Section 2.16.3.1, of the DCD. Please revise NEDO-33201 to be consistent with the DCD.
19.1-173	Radlinski R	Reconcile statements that ESBWR design will prevent spurious actuations with the identification of specific spurious actuations in Table 4-2 of NEDE-33386, Rev 0 (NEDO-33201 Section 12.5, etc.)	NEDO-33201 Section 12.5, Cable Selection, as well as sections of the DCD, states that the ESBWR digital instrument and control system designs will prevent spurious actuations. Table 4-2, The Cable Routing Report, of NEDE-33386, Rev 0, identifies a number of postulated spurious actuations. Please explain how the statement that spurious actuations are prevented is reconciled with the postulation of multiple spurious actuations? In addition, please clarify whether the multiple spurious actuations are assumed to occur one at a time or simultaneously and provide the basis for the approach taken. (See also RAI 19.1-150, Supplement No. 1)

DC GE - ESBWR Mailing List (Revised 1/3/08)

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