October 8, 2006

Mr. David H. Hinds, Manager, ESBWR
General Electric Company
P.O. Box 780, M/C L60
Wilmington, NC 28402-0780

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 73 RELATED TO ESBWR DESIGN CERTIFICATION APPLICATION

Dear Mr. Hinds:

By letter dated August 24, 2005, General Electric Company (GE) 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. This RAI concerns NEDO-33201, Revision 1, ESBWR Probabilistic Risk Assessment.

RAIs: 19.1-42 through 19.1-65

To support the review schedule, you are requested to respond to this RAI by November 22, 2006.

If you have questions or comments concerning this matter, please contact me at (301) 415-0224 or tak@nrc.gov or you may contact Amy Cubbage at (301) 415-2875 or aec@nrc.gov.

Sincerely,

/RA/

Thomas A. Kevern, Senior Project Manager
ESBWR/ABWR Projects Branch
Division of New Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 52-010

Enclosure: As stated

cc: See next page

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ACCESSION NO. ML062770062

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DATE	10/05/2006	10/08/2006

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Requests for Additional Information (RAIs)
NEDO-33201, Revision 1, "ESBWR Probabilistic Risk Assessment"

RAI Number	Reviewer	Question Summary	Full Text
19.1-42	Saltos N	Provide a complete list of systems/ subsystems and corresponding designators used in the PRA.	The submitted PRA contains a large number of references to "designators" of systems, subsystems and functions, such as B21 for the Automatic Depressurization System (ADS) and E50 for the Gravity-Driven Cooling System (GDCS). The repeated use of these designators in the PRA document, instead of the name of the system, subsystem or function they represent, is confusing. In addition, the list of Table 4.0-1 is not complete. For example, some of the designators mentioned in the text, such as C31 and H23, are not listed in Table 4.0-1, while others, such as C71, are listed but not defined. Please revise Table 4.0-1 accordingly and include the system, subsystem or function names together with their designator (e.g., designators in parentheses) in Chapter 4 of the PRA .
19.1-43	Saltos N	Provide cutsets for each fault tree diagram reported in Chapter 4 Appendices.	Please provide tables of cutsets for each of the fault tree diagrams reported in Chapter 4 of the PRA. Include up to four term cutsets or top 100, whichever is less. This information will be very useful to the staff's efficient review of the PRA.
19.1-44	Saltos N	Modeling of Inter-system Common Cause Failures	No intersystem Common Cause Failures (CCFs) appear to be modeled in the PRA. Please discuss the potential for such CCFs and what ESBWR design features are in place that prevent or minimize inter-system CCFs.
19.1-45	Saltos N	Simplified block diagrams for the signal generating portion of I&C, including element descriptions and important assumptions.	For each system modeled in the PRA, please provide simplified block diagrams for the signal generating portion of I&C (which is not discussed in Section 4.5 of the ESBWR PRA) supporting the fault trees provided in the Sections of Appendix B. Please include a description of each element (including basic events) and important assumptions made in the PRA model.

Enclosure

19.1-46	Saltos N	Clarify how certain potential failures of the Automatic Depressurization System were modeled in the PRA.	Additional information in the following areas (Section 4.1 of the PRA) is required to determine whether certain potential failures of the automatic and manual control of the Automatic Depressurization System (ADS) were identified and modeled in the PRA: (A) Please explain whether and how hardware failures associated with SRV solenoid operated valves and the configuration of load drivers are modeled in the PRA (for both automatic and manual actuation). (B) Please explain whether and how hardware failures associated with DPV firing circuits (two initiators and one booster), load drivers, and the two timers (i.e., the main ADS timer and the high drywell pressure bypass timer) are modeled in the PRA (for both automatic and manual actuation). (C) Please explain the purpose, the function and the operation of the main ADS and high drywell pressure bypass timers, including a discussion on how these timers impact plant response, with reference to accident sequences modeled in the PRA. Were beyond design basis conditions, such as those encountered in PRA accident sequences, considered in the design of these timers? (D) It is stated that each ADS SRV line to the suppression pool *"incorporates redundant vacuum breakers....[which] prevent waterhammer and pressure instability conditions in the SRV discharge line."* Please explain how the failure of these vacuum breakers was treated in the PRA? (E) ADS SRVs and DPVs must open following a small LOCA inside containment to allow operation of the low pressure core cooling systems. Since these valves are located inside the containment, they will have to open in a harsh environment. Studies and operational experience suggest that there is a potential for failure of power and control cables operating in harsh environments, which was not addressed in the ESBWR PRA. Please discuss.

			(F) Please explain the assumptions and associated bases made in estimating the common cause failure (CCF) factors for the ADS DPVs. The staff notes that there is no actual operational experience with the type and size of squib valves used in the ESBWR design. The estimated CCF factor for a set of four or more squib valves by the approach recommended in ALWR Utility Requirements Document (ESBWR PRA Reference 5-1) is 4.2E-2, which is significantly higher than the 5E-3 value used in the ESBWR PRA. Please discuss. The staff believes that there is significant uncertainty associated with the CCF probability of DPVs and the impact of this uncertainty on the results and insights of the PRA should be investigated by sensitivity studies.
19.1-47	Saltos N	Clarify how certain aspects of the Isolation Condenser System were modeled in the PRA.	The staff needs additional information related to Section 4.2 Isolation Condenser System (ICS) in the following areas: (A) One of the functions, of the ICS stated in Section 4.2 (page 4.2-1, second paragraph) of the PRA, is “to provide the means for initial depressurization of the reactor before ADS initiation from a low reactor water level.” Please explain whether and how was the success or failure of this function modeled in the PRA. (B) Clarify the description of the ICS initiation signals that are related to MSIV closure, documented in Section 4.2.4, and their modeling in the PRA: (1) Define the terms “position switch” and ‘limit switch” and their relationship to the operation of MSIVs, (2) Define failures and failure modes associated with the initiation signal(s), (3) clarify the success criteria for generating an ICS initiation signal, (4) Explain why no CCFs were considered for the groups of nitrogen and air operated MSIVs (operate to de-energized position), (5) Explain the basis of the MSIV failure data used (for the applicable failure mode), (6) Explain whether and how the manual initiation of ICS was modeled. (C) It is stated that “the isolation condenser and drain piping are filled with condensate, which is maintained at a subcooled temperature by the pool water during normal water operation.” Has the potential failure to maintain the condensate subcooled, and its impact on the ICS capability, been investigated? What features prevent the formation of a two-phase (water-vapor) mixture or single-phase (vapor) that could degrade the performance of the ICS? Please discuss.

			(D) It appears that not all CCF combinations of the nitrogen-operated condensate return bypass valves (ICS-F006A,B,C,D) have been modeled in the PRA. Table 4.2-5 lists only one CCF event for these valves (event B32-ACV-CF-2IABCD). Please clarify. (E) No common cause failure (CCF) to remain open was considered among the steam line motor-operated isolation valves F001A,B,C,D and F002A,B,C,D and the condensate line motor-operated isolation valves F003A,B,C,D and F004A,B,C,D. Please clarify. (F) It appears that no failures of the vent lines (to the suppression pool) and the purge lines (to the main steam lines) were modeled in the PRA. Please clarify. Also, no discussion is provided for the potential failure or degradation of the ICS due to hydrogen buildup and air entrainment that could blanket with non-condensables the ICS condensate lines. Was this potential failure and its impact on the ICS capability investigated? What features prevent non-condensables from getting entrained into the ICS condensate lines? Please discuss. (G) Please explain the assumptions and associated bases for estimating the CCF factors for ICS air-operated valves (AOVs) and motor-operated valves (MOVs). The staff notes that only five operating BWRs have isolation condensers and there are significant differences with the ESBWR ICS design. The estimated CCF factors for both MOVs and AOVs appear to be significantly lower than estimates obtained by the approach recommended in ALWR Utility Requirements Document. Please discuss. The staff believes that there is significant uncertainty associated with the CCF probability of AOVs and MOVs and the impact of this uncertainty on the results and insights of the PRA should be investigated by sensitivity studies.
19.1-48	Saltos N	Justify and/or clarify assumptions or potential missing information in modeling the Control Rod Drive System in the PRA.	The staff needs additional information related to Section 4.3 Control Rod Drive System (CRDS) in the following areas: (A) Suction manual valves F013A&B, F015A&B, F003A&B and injection manual valves F021A&B are assumed normally open. The only failure modeled is single “manual valve mis-positioning” following maintenance. Please explain why no common cause failure (CCF) of combinations of two or more manual valves, due to mis-positioning, was considered. Also, explain why CCF of orifices D007A&B (plug) was not considered.

			(B) Fault trees and Table 4.3-7 (System Basic Events) refer to manual valves F018A&B which are not mentioned in the text or shown in the CRDS flow diagram. Instead, manual valves F003A&B are shown in the flow diagram. Are they the same? Please clarify. (C) A CCF to open basic event (C12-MOV-CF-OPEN) for motor operated valves (MOVs) was considered. Since there are two pairs of MOVs (F014A&B and F020A&B) that can fail to open due to common cause, the definition of event C12-MOV-CF-OPEN is nor clear. Please clarify. (D) The flow diagram and text (page 4.3-3) refer to one valve F023 and one valve F024 while Table 4.3-2 lists valves F023A&B and valves F024A&B. Please clarify. (E) It is stated (page 4.3-2) that *"Upon receipt of a reactor water level 2 signal, the CRD shifts to the water injection mode of operation. The standby pump starts, the purge water header valve F012 and the charging water header valve F030 close ....."* However, the failure (both single and common cause) of valves F012 and F030 to close is not modeled. Please explain. (F) The flow diagram shows valves F01T and CV01T on the line from the Condensate and Feedwater. However, these valves are modeled in the fault trees as being on the line from the Condensate Storage Tank (CST). Please clarify. Also, provide the basis for the assumption that the source of water from the Condensate and Feedwater is adequate for the mission time and for all sequences where the CRDS is credited. (G) Please provide the basis for the assumed unavailability of one train of the CRDS due to maintenance (3E-3). What are the technical specifications for this system? (H) It is stated (page 4.3-2) that *"...no room cooling for the CRDS compartment is required for the first 24 hours of the accident."* Are there any accident sequences for which the CRDS is needed, as modeled in the PRA, for longer times (i.e., beyond 24 hours)? Please explain. (I) It is stated that *"Initiation of the CRDS automatically generates the automatic opening and closing of valves F023 and F024, respectively."* Please clarify whether valve F024 is normally closed (as shown in the flow diagram) or open as the above statement implies. If it is normally open, then, its failure to close has to be modeled in the PRA.

19.1-49	Saltos N	Clarify/explain how certain aspects of the Standby Liquid Control System were modeled in the PRA.	The staff needs additional information related to Section 4.4 Standby Liquid Control System (SLCS) in the following areas: (A) It is stated (page 4.4-1) that *"no maintenance is expected to occur during power operation that makes either train of the SLCS unavailable."* This statement implies that no preventive maintenance and no system outage for testing is expected. However, corrective maintenance may be needed that could impact the availability of one train during operation at power. As stated on page 4.4-4, *"...the SLCS can be maintained while the plant is in normal operation, subject to technical specification requirements and limitations."* Please explain why no unavailability due to test and maintenance was considered. (B) It is stated (page 4.4-9) that *"The SLC system and components shall be designed such that they can be maintained with relative ease and minimum maintenance time."* This statement implies that the SLCS is not yet designed. Please clarify. Does this statement refer to both preventive and corrective maintenance? Please list the features that the system has to possess to ensure minimum maintenance time. (C) It appears that the system has four manual valves which are locked open during operation at power (F001A&B and F006A&B). It is stated (page 4.4-4) that *"Mispositioning of valves F001A, F001B, F006A and F006B is not considered an error because they are checked periodically. All normally-open manual isolation valves are subject to being left in the closed position following maintenance. The probability of this is included in the analysis."* It appears that the second sentence negates the first sentence. Regarding the third sentence, the staff could not find documentation on how the subject failure was included in the analysis. Please clarify and state how and how often these valves are checked. (D) Table 4.4-3 indicates that manual valves F006A&B are tested quarterly while manual valves F001A&B are tested during plant outages. Please state the reason for the different testing intervals and explain whether and how these intervals were modeled in the PRA. (E) It is stated (page 4.4-3) that *"Following firing of the squib valves....When each tank reaches a set low value, local instrumentation closes the respective motor-operated valves F002A and B to prevent the injection of nitrogen into the RPV. The same signal ....opens the diverse accumulator depressurization valves F507A and B and F508A and B after a delay."* Is the failure of these valves to change status modeled in the PRA? Please explain.

			(F) The failure of long-term boration during ATWS (top event GC-0001__1) is modeled in the fault tree (page 1 of App. B.4.4) with an AND gate and requires the failure to inject boron by both SLCS loops and the failure of boration through the "working inventory make-up systems." The means of providing boration through the "working inventory make-up systems" is not discussed in Section 4.4. Please discuss how boron make-up is provided and how its failure is modeled (e.g., events C41-XHE-FO-INISL-CS and C41-SYS-FF-MAKEUP and associated failure probabilities). (G) It appears that no common cause failures (CCFs) between similar components of the two SLCS loops were considered. Please explain. (H) Check isolation valves F004A&B and F005A&B are tested during plant outages. Their failure to open probability is assumed to be 1.6E-3. Please discuss under what conditions these valve operate (e.g., differential pressures during normal plant operation) and explain how their failure probability was calculated. (I) Please explain how the CCF probability of squib valves (1.5E-4) was calculated. Also, please discuss how and how often the squib valve actuators are tested. (J) It is stated (page 4.4-4) that *"The system fault tree analysis is based on a test interval of two years for all SLCS equipment except valve F010, which are tested every 90 days."* This statement seems to contradict the information provided in Table 4.4-3. Also, the staff could not find any reference to valve F010 in the failure data tables or the simplified line diagram. Please clarify.
19.1-50	Saltos N	Clarify/explain how certain aspects of the Gravity-Driven Cooling System were modeled in the PRA.	The staff needs additional information, related to Section 4.6 Gravity-Driven Cooling System (GDCS) in the following areas: (A) There is an inconsistency between assumptions #2 and #3 on page 4.6-1. Assumption #2 implies that there are three 8-inch lines (one taking suction from pools A and C) and two taking suction from pool B. Assumption #3 refers to four 8-inch lines. Please clarify. (B) It is stated (at the bottom of page 4.6-1) that *"Information regarding alarms and instrumentation is preliminary."* The staff expects GE to point out any changes to this important information before the final design certification review.

			(C) Please provide the basis, including major assumptions, for the success criteria associated with GDCS operation (both short term and long term cooling). Are the criteria valid for all conditions and configurations modeled in the PRA accident sequences? Please discuss. (D) It is stated (page 4.6-2) that *"The check valves prevent gross reverse back flow to the pools after the squib valves are actuated if the vessel pressure is still higher than the pool pressure plus its gravity head."* In this case the check valves can fail to open (even common cause) once the vessel pressure decreases. It appears that no failure to open (individual or common cause) of check valves has been considered. Please explain. (E) Provide the basis for not considering unavailability of one or more GDCS lines due to test and maintenance (preventive or corrective). Discuss in terms of the technical specification requirements for this system. (F) Please explain how the probability (1.75E-3) for the failure of a check valve (to remain open or plug) was obtained. Also, provide the basis for not considering common cause failures among the various GDCS injection and equalizing line check valves (to remain open or plug). Please discuss. (G) Please explain the assumptions and associated bases in estimating the common cause failure (CCF) factors for the GDCS squib valves. The staff notes that there is no actual operational experience with the type and size of squib valves used in the ESBWR design. The estimated CCF factor for a set of four or more squib valves by the approach recommended in ALWR Utility Requirements Document (ESBWR PRA Reference 5-1) is 4.2E-2, which is significantly higher than the 5E-3 value used in the ESBWR PRA. Please discuss. The staff believes that there is significant uncertainty associated with the CCF probability of squib valves and the impact of this uncertainty on the results and insights of the PRA should be investigated by sensitivity studies. (H) Please explain the assumptions and associated bases in estimating the CCF factors for orifices in the GDCS injection and equalizing lines (1.44E-5) and the various I&C components supporting GDCS squib valve actuation, such as pressure and level transmitters and detectors.

19.1-51	Saltos N	Provide a simplified diagram of the Fire Protection System and discuss failure probabilities and support system dependencies.	Additional information is needed on the modeling of the Fire Protection System (FPS) in the PRA. Please provide a simplified diagram for the entire system and explain how the assumed failure probabilities (events U43-SYS-FF-LPCI and U43-SYS-FF-YARD) for FPS hardware failure were calculated. Was credit taken for all three fire water pumps? Why were no CCFs considered? What testing and maintenance assumptions were made? What are the system's dependencies on support systems? Please explain.
19.1-52	Saltos N	Clarify/explain how certain aspects of the Fuel and Auxiliary Pools Cooling System were modeled in the PRA.	The staff needs additional information related to Section 4.7 Fuel and Auxiliary Pools Cooling System (FAPCS) in the following areas: (A) It is stated (page 4.7-2) that *"When the FAPCS operates in the cooling mode, water is drawn from the pools listed in 4.7.1 "a" through "e" using surface level skimmers."* This information is not shown in the simplified diagram (Figure 4.7-1) and the pools listed in 4.7.1 are numbered from "e" to "l." Please clarify. Also, please verify that no water can be diverted to these pools when the system is actuated for reactor pressure vessel injection operation or for suppression pool cooling operation. (B) Please explain what components are included in common cause failure (CCF) events G21-MOV-CF-CLOSEA, G21-MOV-CF-OPENA/B and G21-ACV-CF-SUCTION and discuss how the associated probabilities were calculated. It appears that not all combinations of motor-operated valves were considered and the air operated valves are in series. (C) Assumption #2 (page 4.7-2) states that *"...the necessary measures will be taken to make air operated valves not dependent from the Instrument Air System on emergency situation."* The staff needs more detailed information about the measures that will be taken to ensure proper modeling in the PRA fault trees. (D) Explain how the probability of 3E-3 for the unavailability of one FAPCS train, due to test and maintenance, was calculated. This probability assumes that, on average, each train will be unavailable only one day per year. This is an optimistic assumption (based on operating reactor experience), especially since there are no technical specification requirements for this system. Furthermore, since the FAPCS is not made up of two completely independent trains, the single unavailability of some components (e.g., air-operated gate valve F332 in the LPSI injection line and motor-operated valve F306 in the suppression pool cooling line) cause the whole system to be unavailable. Please discuss.

			(E) It is indicated (Table 4.7-3) that active valves will be tested quarterly and maintenance valves every 24 months. Please list the maintenance valves that are modeled in the PRA and explain how the failure probabilities of these valves were calculated. Also, explain the basis of the monthly rotation assumption between trains and how this assumption impacts the PRA results. (F) Provide justification for assuming zero probability of mispositioning manual valves F308 and F320.
19.1-53	Saltos N	Clarify/explain how certain aspects of the Reactor Water Cleanup/Shutdown Cooling System were modeled in the PRA.	The staff needs additional information related to Section 4.8 Reactor Water Cleanup/ Shutdown Cooling System (RWCU/SDCS) in the following areas: (A) It is stated that one of the system purposes (third bullet on page 4.8-1) is *"To provide high-pressure cooling of the primary coolant...."* It is also stated (page 4.8-2): *"During emergency plant conditions, the system is used in the SDC mode to relieve the Isolation Condenser System (ICS) load, that is, the standby train is aligned, and its pump is started."* It appears that these statements do not completely reflect the system function modeled in the PRA event trees. In the event trees, the RWCU/SDCS is used for decay heat removal following successful passive low pressure injection. Please clarify. (B) It appears that there are four designators used for the three air-operated containment isolation valves (F005A&B, F006A&B, F007A&B and F3A&B). Please clarify this information in the text, the tables and the simplified flow diagram. (C) Assumption #2 (page 4.8-1) states that *"...the relevant measures will be taken so that the air-operated valves do not depend on the Instrument Air System in an emergency situation."* The staff needs more detailed information about the measures that will be taken to ensure proper modeling in the PRA fault trees. (D) Please explain what components are included in the common cause failure (CCF) events G31-MOV-CF-OPENA/B, and G31-ACV-CF-DEENERGA/B and discuss how the associated probabilities were calculated. It appears that not all combinations of motor-operated valves and air operated valves, respectively, between trains were considered. In addition, explain why no CCF of air operated valves to open (e.g., F007A&B) and no CCF of check valves to open following loss of offsite power (e.g., F017A&B) were considered.

			(E) Explain how the probability of 3E-3 for the unavailability of one RWCU/SDCS train, due to test and maintenance, was calculated. This probability assumes that, on average, each train will be unavailable only one day per year. This is an optimistic assumption (based on operating reactor experience), especially since there are no technical specification requirements for this system. (F) It is indicated (Table 4.8-3) that active valves will be tested quarterly and maintenance valves every 24 months. Please list the maintenance valves that are modeled in the PRA and explain how the failure probabilities of these valves were calculated. Also, explain the basis of the monthly rotation assumption between trains and how this assumption impacts the PRA results. (G) Please explain why no failure of the flow control valves F002A&B and F004A&B was considered.
19.1-54	Saltos N	Clarify/explain how certain aspects of the Feedwater and Condensate System were modeled in the PRA.	The staff needs additional information related to Section 4.9 (Feedwater and Condensate), in the following areas: (A) Please explain how turbine bypass fails and how the probability of basic event N21-SYS-FF-BYPASS (1E-2) was calculated. (B) It is stated that the air operated valve F018 fails to remain open on a loss of air supply. This failure, which fails both the power conversion system and the high pressure injection through the feedwater lines top events, was not modeled. Please explain. (C) Please explain how the failure to open probabilities (both single and common cause) for the air-operated valves F023 and F026 were calculated. (D) Please define the common cause failure basic event XXX-MP_-CR-SWS/CWS listed in Table 4.9-5B and explain how the probability was calculated.

19.1-55	Saltos N	Clarify/explain how certain aspects of the Reactor Component Cooling Water System were modeled in the PRA.	The staff needs additional information related to Section 4.10 Reactor Component Cooling Water System (RCCWS) in the following areas: (A) Assumption #4 (page 4.10-1) states that *"...relevant measures will be taken so that the air-operated valves do not depend on the Instrument Air System in an emergency situation."* The staff needs more detailed information about the measures that will be taken to ensure proper modeling in the PRA fault trees. (B) Assumption # 2 states that *"All components of train A are powered from division I and those of train B from division II."* However, in identifying common cause failure (CCF) of RCCWS pumps, failures referring to both trains and divisions are defined (e.g., event P21-MP_-CR-5ALL is defined as CCF to run of pumps in trains A and B while P21-MP_-CR-3A is defined as CCF of three pumps to run in division A). Please clarify the definitions of all CCFs listed in Table 4.10-5 for pumps. (C) The definition of CCFs listed in Table 4.10-5 for the flow rate regulating air-operated valves F022A&B and F025A&B is not clear. It appears that valves considered in the same CCF group have different failure modes. No CCF of valves in different trains but with same failure mode (e.g., F025A&B) was considered. In addition, no CCF events due to loss of heat sink, which would fail two or more heat exchangers, are considered. Please clarify. (D) It is not clear what assumptions were made in calculating the CCF probabilities listed in table 4.10-5. The information provided in Section 5 (Data Analysis) of the PRA is not detailed enough to answer the staff's questions regarding these probabilities. It appears that these CCF probabilities are significantly smaller than what one would calculate using the information provided in EPRI's "Utility Requirements Document" (ESBWR PRA Reference 5-1). Please explain. (E) Assumption #7 (page 4.10-1) states that room cooling is not required for the first 24 hours of the accident. Please provide the basis for this statement and explain whether room cooling has been modeled for cases where the system is required to operate for longer than 24 hours. (F) It is stated (page 4.10-9) that *"...the relevant train components are checked quarterly."* Please list the "relevant" train components.

			(G) It appears that the failure (to remain open) of the air-operated valve F063 in the common suction line was not modeled. Please explain. (H) Explain the basis for the probabilities of 2E-3 for the unavailability of a pump and 2.2E-3 for the unavailability of a heat exchanger. These probabilities assume unavailability of a single standby pump or heat exchanger of less than one day per year. This is an optimistic assumption (based on operating reactor experience), especially since there are two pairs of standby pumps and heat exchangers and no technical specification requirements for this system. In addition, the unavailability due to maintenance of two pumps or two heat exchangers is not unlikely. Please discuss.
19.1-56	Saltos N	Clarify/explain how certain aspects of the Plant Service Water system were modeled in the PRA.	The staff needs additional information related to Section 4.11 Plant Service Water (PSW) system in the following areas: (A) Assumption #1 (page 4.11-1) states *" The normal supply source for the pumps is the Cooling Tower Makeup System (Y41). Upon a malfunction of this system, the cooling water supply to the exchangers is supplied from the PSW pumps."* Please clarify this statement. A simplified flow diagram including both systems P41 and Y41 would be helpful. Assumption #1, also, states that *"The malfunction of the Y41 system is currently represented by special event P41-SYS-FF-3CTMP in the event that the flow from two pumps is required.....and by special event P41-SYS-FF-2CTMP in the event that the flow from two pumps is required..."* What is the reason for representing the failures of the Cooling Tower Makeup (CTM) system by special events? Please explain what do these special events include and how the assumed failure probabilities were calculated. (B) Assumption #4 (page 4.11-1) states that *"...the relevant measures will be taken so that the air-operated valves do not depend on the Instrument Air System in an emergency situation."* The staff needs more detailed information about the measures that will be taken to ensure proper modeling in the PRA fault trees." (C) It is stated in Table 4.11-3 that *"A periodic change ...is assumed such that the relevant train components are checked quarterly."* Please explain how this will be achieved and list the "relevant" train components. (D) It is not clear what assumptions were made in calculating the CCF probabilities listed in Table 4.11-5. The information provided in Section 5 (Data Analysis) of the PRA is not detailed enough to answer the staff's questions regarding these probabilities (e.g., why the CCF to run for 2 pumps is smaller than the case of 3 pumps?).

19.1-57	Saltos N	Revised Section 4.12 for Instrument Air System and Service Air System to remove errors, mislabeling of failures or lack of labeling of components.	The staff cannot submit detailed RAIs on Section 4.12 Instrument Air System (IAS) and Service Air System (SAS) for the following reasons: 1) It appears that no fault tree for IAS was included in Revision 1 of the PRA; 2) It appears that the designators P51 and P52 (for IAS and SAS, respectively), have been used for the wrong system in the SAS fault tree and the basic event designators; and 3) Components modeled in the SAS fault tree are not shown in the simplified flow diagram or discussed in the text (e.g., air-operated valves F0110C and F008A). Please revise Section 4.12 and related Appendix B4.12 to address these issues and provide a more detailed explanation of how the assumed common-cause failure probabilities were calculated.
19.1-58	Saltos N	Clarify/explain how certain aspects of the High Pressure Nitrogen Supply System were modeled in the PRA.	The staff needs additional information related to Section 4.13 High Pressure Nitrogen Supply System (HPNSS) in the following areas: (A) Assumption #1 (page 4.13-1) states *" Instrumentation logic for the actuation of valves located in the high pressure portion ....is used for SRV operation in both designs ..."* Please clarify this statement. Which are the two designs? (B) In Section 4.13.3.1 it is stated that *"[The HPNSS] Supplies nitrogen gas to essential safety-related systems inside the primary containment........the nitrogen is normally obtained from a non-safety-related gas supply..."* Is the HPNSS a safety-related system? Should not the nitrogen supply to safety-related systems be safety-related, also? Is the nitrogen supply from the Nitrogen Storage Tanks safety-related? Please discuss this issue with respect to operation of the essential safety-related systems supported by HPNSS. (C) The fault trees for loss of nitrogen supply to the high-pressure consumers (event GP54-0001_-1) and low pressure consumers (event GP54-0001_-2) do not include failures for many components shown in the simplified flow diagram or discussed in the text without any explanation (e.g., mispositioning of normally open manual valves F011 and F007A&B, failure of several check valves to remain open, failure of nitrogen bottle station valves). Please explain all important assumptions in developing the fault trees for HPNSS, such as testing, demand frequency and monitoring that are used to justify not modeling certain failures.

			(D) There are four pressure control valves and several combinations of common-cause failure are possible. Please define the group of pressure control valves that are included in the common-cause failure (event P54-CPV-CF-CONTROL) and explain how the CCF probability of 1.57E-4 was calculated. (E) Table 4.13-4 states that "Component maintenance has not been included in the model." Please explain the reason for not including unavailability of components due to test and maintenance. (F) It is stated (Section 4.13.11) that *"There are no changes to the model for operation for 72 hours other than the mission time."* The staff notes that the 72 hour mission time was not included in calculating probabilities. Please explain. (G) The staff needs more information about the automatic actuation of air-operated valve F005 and its modeling in the PRA. Please explain event E23-RMU-FC-P54F005 (ATM Valve F005 fails to trip).
19.1-59	Saltos N	Clarify/explain how certain aspects of the AC Electric Power System were modeled in the PRA.	The staff needs additional information, related to Section 4.14 (AC Power System), in the following areas: (A) It is stated (page 4.4-1, second paragraph) that *"The low voltage AC power System supplies electric power at 480V and consists of non-safety buses that are normally powered from the PG buses...."* This statement appears to contradict the statement made on page 4.14-2 that *"The safety-related portion of the low voltage system consists of four Distribution Panels ...."* Please clarify and explain what portion of the AC power is safety related and what that means in terms of modeling this system in the baseline PRA and the focused (RTNSS) PRA case. (B) It is stated that the four safety-related Distribution Panels (A31, B31, C31, D31) are provided with plug-in connections for transportable AC generators. Please clarify if this was credited in the PRA to support long-term cooling requirements, including the focused (RTNSS) PRA case.

			(C) It is stated (page 4.14-2) that *"The I&C Power Supply system is comprised of five subsystems.....Four of the subsystems are supplied by power center buses A31, B31, C31 and D31.....The fifth is supplied by power center DCIS swing bus C23..."* However, no further discussion of the I&C power Supply system is provided in Section 4.14 (with no mention that this system is discussed elsewhere). The staff notices that Section 4.15 discusses the Uninterruptible AC Power Supply System. Section 4.15, mentions four safety-related divisions and five non-safety-related "systems." This appears to contradict the Section 4.14 statement of five subsystems. Please clarify by revising the discussion provided in Sections 4.14 and 4.15, as necessary, and by using consistent terminology and designators. (D) Table 4.14-5 includes CCF basic events for the Reactor Component Cooling Water (RCCW) pumps. It appears that these CCF events were discussed in Section 4.10. Are these events different than those discussed in Section 4.10? Table 4.14-5 shows that the CCF to start probability for the RCCW train A pumps is about an order of magnitude lower than the train B pumps. Please clarify. In addition, the description of CCF basic events needs to be improved to make it clear what exact group of components are included in the CCF event (e.g., need to state what event(s) refer to 13.8 kV breakers and define which and how many 480V breakers are included in the CCF events). Also, no spurious opening CCF of 480V circuit breakers is included even though in the discussion of Section 4.14.8 it is stated that this failure is judged to be negligible only for 6.9 kV and 13.8 kV circuit breakers. (E) Please provide the basis for the assumed unavailability of the 230 kV switchyard due to test and maintenance.

19.1-60	Saltos N	Clarify/explain how certain aspects of the Uninterruptible AC Power Supply System were modeled in the PRA.	The staff needs additional information, related to Section 4.15 (Uninterruptible AC Power Supply System), in the following areas: (A) The staff could not find any lists of basic events and associated probabilities in Section 4.15 (Table 4.15-7 lists top events, instead of listing basic events). (B) It is stated (page 4.15-1) that *"There are five non-safety related ....supply systems......, while the other two receive 480 V AC and 125 V DC power and supply 120 V AC."* This information is not shown in the provided one-line simplified diagrams. Please explain. (C) It is stated (page 4.15-1) that *"In the systems that are a long distance away from the DC power system batteries, the uninterruptible power can be supplied by a modularized Uninterruptible Power Supply (UPS) that includes batteries and battery chargers."* Please provide a more detailed description of the modularized UPS and state whether and how was this modeled in the PRA.
19.1-61	Saltos N	Clarify/explain how certain aspects of the DC Power Supply System were modeled in the PRA.	The staff needs additional information, related to Section 4.17 (DC Power Supply System), in the following areas: (A) Design assumption #3 (page 4.17-1) states: *"It is assumed that adequate cooling is needed and available in battery charger room."* It appears that no failure to cool the battery charger rooms was modeled. Please explain. (B) It is stated (page 4.17-2): *"Battery rooms are served by a flow-through ventilation system....In case of loss of AC power, ...the ventilation is not needed."* The staff notices that no mechanical failure of the ventilation system is discussed or modeled. Please explain.

19.1-62	Saltos N	Document major steps and assumptions in calculating probabilities for risk significant common cause failure events.	The staff needs more detailed information about the assumptions that were made in calculating the common cause failure (CCF) probabilities listed in Table 5.3-1. The alpha factor method is used to calculate CCF probabilities and generic alpha parameters are used for basic events for which no information is available in the databases. The generic alpha parameters are taken from three different sources with no indication which source is used for each of the CCF probabilities listed in Table 5.3-1. It appears that in many cases the estimated CCF probabilities are significantly lower than the CCF probabilities used in the AP1000 design certification for similar components. Please provide the major steps and important assumptions used to calculate CCF probabilities for events associated with Risk Achievement Worth (RAW) values of 5 or greater and for events associated with Fussel-Vesely (F-V) values of 1 percent or greater. In addition to important assumptions, this additional information should clearly state the size of the CCF group and the corresponding CCF parameters (alpha factors). Uncertainties associated with CCF probabilities for risk significant components should be evaluated and addressed by appropriate sensitivity studies.
19.1-63	Saltos N	Justify the bounding probability values based on "engineering judgment."	Table 5.4-1 lists the probabilities of "special events" used in the PRA. A number of these probabilities are assumed to be bounding values and are based on "engineering judgment." The staff needs additional information showing that such values are indeed bounding.
19.1-64	Saltos N	Discuss "errors of commission" in the PRA.	It is stated (page 6.2-2) that "Errors of commission have not been included in the ESBWR design PRA." The staff believes that the omission of such errors needs to be justified by a systematic search to identify areas where errors of commission could occur and the introduction of appropriate design and operational features (if not already available) that essentially make such errors risk insignificant. Please discuss.
19.1-65	Saltos N	Discuss the values of several time windows in Table 6.3-4	Please explain the reason for not including the values of several time windows in Table 6.3-4. Also, discuss the robustness of the assumed time windows for operator action.

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