September 18, 2006

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

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 60 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 Radiation Protection, Chapter 12, of Tier 2 of the ESBWR design control document (DCD), Revision 1. The RAI questions, with the exception of question 12.3-7, were sent to you via electronic mail on July 7, 2006, and were discussed with your staff during a telecon on August 18, 2006. Question 12.3-7 was sent to you via electronic mail on September 7, 2006, and you did not request a telecon to discuss this question. You agreed to respond to these RAI questions with the following schedule:

October 13, 2006: Questions 12.2-16 through 12.2-18, 12.3-2 through 12.3-3, 12.3-6, 12.3-8 through 12.3-9, 12.4-2 through 12.4-3, 12.4-10, 12.4-12, 12.4-21, 12.4-27, 12.5-5, 12.7-3

November 22, 2006: Questions 12.2-19, 12.3-1, 12.3-4 through 12.3-5, 12.3-7, 12.3-10 through 12.3-12, 12.4-1, 12.4-4 through 12.4-9, 12.4-11, 12.4-13 through 12.4-20, 12.4-22 through 12.4-26, 12.4-28 through 12.4-33, 12.5-1 through 12.5-4, 12.5-6 through 12.5-8, 12.6-1 through 12.6-2, 12.7-1 through 12.7-2.

If you have any questions or comments concerning this matter, you may contact me at (301) 415-2007 or lnq@nrc.gov, or Amy Cubbage at (301) 415-2875 or aec@nrc.gov.

Sincerely,

/RA/

Lauren Quiñones, 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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Requests for Additional Information (RAIs)
ESBWR Design Control Document DCD, Chapter 12

RAI number	Reviewer	Question Summary	Full Text
12.2-16	Pedersen R	Discuss consideration of operational experience and design features provided to maintain doses received during normal power and shutdown operations ALARA.	DCD Tier 2, Section 12.1.2.1 refers to design features that resulted from the application of the as low as reasonably achievable (ALARA) considerations during plant design such that the ESBWR can be operated and maintained ALARA. However, the list of examples on the bottom of page 12.1-2 only refers to those features that assist in maintaining doses ALARA during decommissioning. Provide a description of the current operational experience considered and those general design features employed in the ESBWR design to maintain doses received during normal power and shutdown operations ALARA.
12.2-17	Pedersen R	Examples of transportation of equipment or components requiring servicing to a lower radiation area?	DCD Tier 2, Section 12.1.2.3.1, third bullet, refers to “transportation of equipment or components requiring servicing to a lower radiation area.” Provide examples of the application of this design feature.
12.2-18	Pedersen R	Examples of control panels in the lowest radiation zones practicable?	DCD Tier 2, Section 12.1.2.3.2 refers to “central control panels [in the] lowest radiation zones practicable.” and “When practicable for package units, separate highly radioactive components...” Provide examples of each.

RAI number	Reviewer	Question Summary	Full Text
12.2-19	Pedersen R	Provide the dose rates in the upper drywell for the worst case fuel bundle drop accidents.	DCD Tier 2, Section 12.1.2.3.2, second bullet, appears to indicate that the shielding around the reactor vessel is sufficient to allow personnel access to the upper drywell during fuel handling operations. Verify that the ESBWR design is intended to allow occupancy of the upper drywell during fuel movement/refueling. Provide the dose rates in the upper drywell for the worst case normal fuel handling. Include a description of radiation streaming through the shield penetration opening. Provide the dose rates in the upper drywell for the worst case drop accident where the fuel rests against the reactor vessel, and where the fuel comes to rest on the vessel flange/refueling pool seal diaphragm. Describe maintenance activities anticipated in the upper drywell (from elevation 9060mm and up) and personnel egress routes during a fuel drop event. Provide all analytical model input parameters, and assumptions, used to determine these doses include all input parameters necessary calculate the assumed fuel bundle source strength with the ORIGIN computer code.
12.3-1	Pedersen R	Provide the basis for the values given in these DCD Tier 2, Tables 12.2-5 through 12.2-14(b).	DCD Tier 2, Tables 12.2-5 through 12.2-14(b) provide isotopic source strength for several systems and components that present the major source of radiation exposure. Provide the basis for the values in these tables. Are the bases for these sources consistent with an operating offgas rate of 100,000 uCi/sec after a 30 minute delay? Table 12.2-5 also provides contact dose rates on control rod drive (CRD) mechanisms before and after cleaning. Provide the basis for these values. Discuss whether CRD cleaning is a ESBWR designed feature. Is this cleaning performed before or during CFR handling for maintenance?
12.3-2	Pedersen R	Discuss conformance to the guidance provided in ANSI N237.	Indicate whether, and if so how, the applicable guidance provided in ANSI N237, “Source Term Specification,” has been followed in the ESBWR design. If not followed, specify what alternative methods were used.

RAI number	Reviewer	Question Summary	Full Text
12.3-3	Pedersen R	Discuss the basis for assuming that the startup source will remain intact, within the reactor, over the lifetime of the facility.	DCD Tier 2, Section 12.2.1.1.2 states that the startup source resides in the reactor for its lifetime, and no special shielding is needed after reactor operation. Provide a description of the startup source (including the radioactive isotopes, source strength, half lives, and physical form). Discuss the basis for assuming that the startup source will remain intact, within the reactor, over the lifetime of the facility.
12.3-4	Pedersen R	Provide the maximum source strength for the filtering media, and any adsorption media (such as activated charcoal) used to determine the need for shielding.	DCD Tier 2, Section 12.2.1.2.1 states that "[t]he HEPA train is capable of removing all large particulate releases and up to 70 percent of the small particulate releases. As such, no significant radioactive contamination of the HEPA train is expected." Clarify this statement, as HEPA filters are high efficiency, generally removing 99.97 percent of the most penetrating sized particles. Provide the maximum source strength for the filtering media, and any adsorption media (such as activated charcoal) used to determine the need for shielding (or whether the system design allows media change out without unnecessary radiation exposure) for each HVAC system that services contaminated or potentially contaminated areas of the plant.
12.3-5	Pedersen R	Discuss how BWR operational experience with hydrogen water chemistry and noble metal injection was factored into this estimated source term.	Describe the basis for the N–16 source strength in the steam and condensate systems used for plant shielding design. Discuss how the operational experience of current BWRs with hydrogen water chemistry and noble metal injection was factored into this estimated source term. Provide an estimate of the contribution to the dose to an individual at a typical site boundary distance from N–16 skyshine.

RAI number	Reviewer	Question Summary	Full Text
12.3-6	Pedersen R	Verify that deposition of activated corrosion and wear products was considered in the ESBWR plant layout and shielding design.	DCD Tier 2, Sections 12.2.1.1 and 12.2.1.2, state that the sources described for the containment and reactor building do not consider the deposition of corrosion or fission products in contained systems and components. Verify that the deposition of activated corrosion and wear products was considered in the ESBWR plant layout and shielding design. Justify why current operating experience does not provide an adequate basis for determining the nominal values for these expected sources, or provide a description of these sources.
12.3-7	Pedersen R	Provide location of sources described in DCD Tier 2, Section 12.2.1 and provide quantitative parameters.	Provide the location within the plant of each source described in DCD Tier 2, Section 12.2.1, Revision 1 including all pertinent and necessary quantitative source parameters (i.e., dimensions, volumes, material, equipment self-shielding, etc.).
12.3-8	Pedersen R	Explain the before and after decontamination CRD dose rates given in DCD Tier 2, Table 12.2-5.	DCD Tier 2, Table 12.2-5 provides dose rates for various components of the control rod drive (CRD) system before and after cleaning. Explain how both dose rates are factored into the ESBWR design. Does the ESBWR design provide for routine cleaning of these CRD system components?
12.3-9	Pedersen R	Describe all sources (such as calibration sources) needed to construct and operate an ESBWR.	Provide a description of any sources (such as calibration sources) needed to construct and operate an ESBWR plant or provide justification why this should be left to the COL applicant.
12.3-10	Pedersen R	Provide the source term assumptions used in determining the dose rates indicated on the post-accident radiation zone maps.	Verify that the source term assumptions in NUREG-1465, and the associated dose criteria in GDC 19, were used to determine the in-plant post accident source terms and resultant doses to plant personnel. Provide the source term assumptions used in determining the dose rates indicated on the post-accident radiation zone maps (DCD Tier 2, Figures 12.3-43 through 12.3-51).

RAI number	Reviewer	Question Summary	Full Text
12.3-11	Pedersen R	What is the radiation source term associated with the combined AFIP/LPRM assembly? Discuss provisions to facilitate removal, storage and disposal of these activated assemblies.	Chapter 12 of the DCD Tier 2, notes that the conventional BWR traversing in-core probe (TIP) system has been replaced in the ESBWR with a fixed in-core detector (AFIP) system for calibrating the local power range monitors (LPRMs) in the reactor. This eliminates the TIPs as an in-plant radiologic hazard. However, DCD Tier 2, Section 1.2 states that the "AFIP sensors in an LPRM assembly are replaced together with the LPRM detectors when the whole LPRM assembly is replaced." What is the expected frequency of AFIP/LPRM assembly replacement? What is the radiation source term associated with the combined AFIP/LPRM assembly? What provisions are made in the ESBWR design to facilitate removal the reactor, storage and disposal of these activated assemblies?
12.3-12	Pedersen R	Provide the nominal airborne concentrations of radionuclides in each building for normal power and shutdown operations.	DCD Tier 2, Section 12.2.2 only addresses airborne radioactivity for environmental considerations. Provide the nominal airborne concentrations of radionuclides in each building for normal power and shutdown operations. Provide the assumptions made at arriving at these quantitative values sufficient to demonstrate that airborne concentrations in frequently occupied areas of the plant will be a small fraction of the inhalation values of Table 1 in 10 CFR 20 Appendix B. Tabulated values should reflect the nominal leakage values for typical equipment within the buildings, ventilation flow rates and building volumes, and be consistent with the values and assumptions used to evaluate plant ventilation system effluents.
12.4-1	Pedersen R	Identify which of the radiation protection design provided in the DCD are not "final design."	DCD Tier 2, Section 12.3.1, first paragraph refers to a two-step design process, stating that the COL applicant will provide the final design. Identify which of the radiation protection design provided in the DCD are not "final design," and discuss the impact on radiation protection from changing these features.

RAI number	Reviewer	Question Summary	Full Text
12.4-2	Pedersen R	Discuss provisions for routing radioactively contaminated piping through shielded pipe chases, in lieu of embedding in concrete, to the maximum extent practicable.	DCD Tier 2, Section 12.3.1.2.4, states that "piping containing radioactive fluids is routed through shielded pipe chases, shielded equipment cubicles, or *embedded in concrete walls and floors* [emphasis added]." In addition the statement that radioactive piping is embedded in concrete, is made several places in the DCD. Embedding radioactive piping in concrete is a good ALARA measure; however, it does not facilitate dismantlement of the system nor decommissioning of the facility, as required by 10 CFR 20.1406. Verify that the ESBWR design provides for the routing of radioactively contaminated piping through shielded pipe chases, in lieu of embedding in concrete, to the maximum extent practicable.
12.4-3	Pedersen R	Discuss features of HCU/CRD arrangement to prevent activated corrosion and wear products in the CRDs from settling (by gravity) into the HCUs.	The ESBWR design has the hydraulic control units (HCU) located on an elevation lower than the level of the control rod drives (CRD). What design features have been incorporated into this HCU/CRD arrangement to prevent activated corrosion and wear products in the CRDs from settling (by gravity) into the HCUs, essentially making them crud traps?
12.4-4	Pedersen R	Identify (on zone maps) all VHRAs, all areas of the plant with dose rates >100 rads/hr during normal operations and AOOs, or that provide access to the spent fuel transfer tube.	Radiation zones defined in Section 12.3.1.3 of the DCD Tier 2, classify all areas of >100 mr/hr as Zone F. Identify on the Zone Maps provided, all areas of the plant with dose rates >100 rads/hr during normal operations and anticipated operational occurrences, or that provide access to the spent fuel transfer tube. Identify each area of the plant that meets the definition of a Very High Radiation Area (VHRA) in 10 CFR 20. For each area identified, discuss the design features that ensure that personnel are not able to gain unauthorized or inadvertent access to the area.
12.4-5	Pedersen R	Identify the personnel access and egress routes of the plant.	Identify the personnel access and egress routes of the plant (as depicted in DCD Tier 2, Figures 12.3-1 through 12.3-22) during normal power operations and shutdown conditions. Provide layout drawings of the Health Physics facilities (including men's and women's changing rooms, and decontamination facilities) and show their relationship to plant access/egress traffic patterns.

RAI number	Reviewer	Question Summary	Full Text
12.4-6	Pedersen R	Composition and thickness of each radiation shield?	Provide the composition and thickness of each radiation shield depicted in DCD Tier 2, Figures 12.3-1 through 12.3-22.
12.4-7	Pedersen R	Provide the expected dose rates associated with the Radwaste piping galleries.	DCD Tier 2, Figures 12.3-3 and 12.3-12 depict subterranean radwaste piping galleries from the Rector Building (RB) and Turbine Building (TB) respectively. Provide the expected dose rates in areas above and adjacent to the galleries during transfer of radioactive wastes and resins.
12.4-8	Pedersen R	Provide the dose rates in assessable areas, adjacent to radwaste piping routes in the plant.	Describe the routing of radwaste lines from the points of origin (i.e., the condensate demineralizers in the Turbine Building and filter/demineralizers for the reactor water cleanup (RWCU) and fuel and auxiliary pool cooling system (FAPCS) in the Reactor Building) to the radwaste pipe chases. Provide the dose rates in assessable areas, adjacent to these piping routes. The response should specifically address, but not be limited to, the shielded pipe chase above the entrance to elevator (2192) on the -11500 mm elevation, and the dose rates in the passageway below during radwaste/resin transfer operations.
12.4-9	Pedersen R	Identify which components are referenced in the foot notes on DCD Tier 2, Figures 12.3-3, 4, and 5.	DCD Tier 2, Figures 12.3-3, 12.3-4, and 12.3-5 indicate two equipment hatches (near RD/R1) that according to the associated foot notes are used for the transfer of “high activity components.” Identify which components are referenced in the foot notes and discuss the anticipated frequency of such transfers.
12.4-10	Pedersen R	Indicate whether rooms and areas are designed for continuous access, infrequent access or inaccessible during power and shutdown operations.	It is difficult to determine the accessibility of several areas/rooms depicted on the plant layout drawings (DCD Tier 2, Figures 12.3-1 through 12.3-22). For example, are the HCU rooms (rooms 1110-1140) designed to be accessed during power or shutdown operations? For each room and area depicted on the layout drawings, indicate whether they are designed for continuous access, infrequent access or inaccessible during power and shutdown operations.

RAI number	Reviewer	Question Summary	Full Text
12.4-11	Pedersen R	Discuss the design features employed to minimize the spread of contamination from the “wash down bays” in the fuel building equipment entry facility.	DCD Tier 2, Figures 1.1-1 and 12.3-4 indicate “wash down bays” in the fuel building equipment entry facility. Identify what equipment is intended to be washed down in this facility. If contaminated or potentially contaminated equipment is to be washed down in this facility, discuss the design features employed to minimize the spread of contamination (including the provision for collecting and disposal of wash down fluids).
12.4-12	Pedersen R	Specify any deviations from this guidance and describe the alternative criteria and methods applied to the shielding design.	Indicate whether, and if so, how, the guidance in Regulatory Guide 1.69,”Concrete Radiation Shields for Nuclear Power Plants,” ANSI/ANS 6.4, “Nuclear Analysis and Design of Concrete Shielding for Nuclear Power Plants,” and ANSI/ANS 6.4.2, “Radiation Shielding Materials,” were followed in the design of the ESBWR radiation shielding. Specify any deviations from this guidance and describe the alternative criteria and methods applied to the shielding design.
12.4-13	Pedersen R	Discuss consideration of dose rates from SLC tank A in the designed wall thicknesses for room 1713 on DCD Tier 2, Figure 12.3-7.	Room number 1713 on DCD Tier 2, Figure 12.3-7 contains the standby liquid control (SLC) tank A. What is the potential for this tank to become radiologically contaminated during the life of the plant? What dose rates from this tank were considered in the designed wall thicknesses for room 1713?
12.4-14	Pedersen R	Dose rates expected in the lay down area the vessel head in removed from reactor vessel?	DCD Tier 2, Figure 12.3-9, Note 2, states “zoning increase [of the vessel head lay down area] in the presence of the vessel head,” however, no indication of the magnitude of the dose is provided. What dose rates are expected to be accessible to plant staff in this area with the vessel head stored in the lay down area (Elevation 34000 mm)? What design considerations have been implemented to ensure that the dose to plant workers will be ALARA?

RAI number	Reviewer	Question Summary	Full Text
12.4-15	Pedersen R	Provide the radiation zoning for all personnel access tunnels in the ESBWR design.	DCD Tier 2, Figure 12.3-11 indicates that the access tunnel between the Reactor Building (RB) and the Control Building (CB) is (in cross section) Zone A. Provide the radiation zoning for all other access tunnels (Electrical Building Access, CB-RB Access, Radwaste Building Access, etc) for normal operations, anticipated operational occurrences and accident conditions.
12.4-16	Pedersen R	Describe the electrical equipment located in the radwaste piping galleries.	DCD Tier 2, Figure 12.3-12 indicates that the radwaste piping gallery between the Turbine Building and the Radwaste Building also contains electrical equipment. Describe this electrical equipment, including the anticipated frequency of maintenance associated with it. Is shielding provided between the piping carrying radioactive fluids and this electrical equipment? If not, provide a justification why the current design is ALARA.
12.4-17	Pedersen R	Provide the designed zones for all rooms and corridors in the Radwaste Building, and provide detailed information on design of shielding for incoming radwaste piping.	DCD Tier 2, Figure 12.3-20 is missing radiation zone designations for several room in the -2350 mm elevation of the Radwaste Building. Provide the designed zones for all rooms and corridors. Provide detailed drawings of the access corridor (between sections WC-WD near section W4) showing the radiation shielding provided for the radwaste pipes coming into the Radwaste Building from the combined TB & RB radwaste piping gallery. Provide the analysis input parameters and assumptions used in this shield design (including the maximum source strength, pipe dimensions shielding thickness, etc.).
12.4-18	Pedersen R	For sump pumps identified in Figure 12.3-1, identify associated systems and radiation source strength	DCD Tier 2, Figure 12.3-1 depicts a room (near RE/R7), with substantially shielded walls, containing two “sump pumps.” Identify the system these sump pumps are associated with, and associated radiation source strength.

RAI number	Reviewer	Question Summary	Full Text
12.4-19	Pedersen R	Provide detailed radiation shielding calculations showing peak dose rates for each area adjacent to the incline fuel transfer tube system.	DCD Tier 2, Figure 12.3-10 indicates that several low dose areas adjacent to the incline fuel transfer tube system, including several open corridors in the Fuel Building, become Zone F (>100 mrem/hr) during fuel transfer. Provide detailed radiation shielding calculations showing peak dose rates for each area adjacent to the incline fuel transfer tube system in the Reactor Building and Fuel Building during fuel transfer. Include all input parameters and assumptions used in the analytical model used for these calculations. Provide justification for not including added shielding for these areas in the ESBWR design.
12.4-20	Pedersen R	Discuss physical controls for rooms/areas through which the inclined fuel transfer tube transits, unshielded.	Identify all rooms or areas of the plant through which the inclined fuel transfer tube transits, unshielded, and any other room or area that is potentially accessible with radiation levels greater than 100 rads per hour. Provide a detailed description of the design features employed to ensure that no individual is able to gain unauthorized access to these areas. Specify if removable shielding is used to provide access to any of these areas.
12.4-21	Pedersen R	Revise references to “airborne limits” to concentrations considered an airborne area as defined in 10 CFR 20.	DCD Tier 2, Section 12.3.3.1, second bullet, states that concentrations of radionuclides in air will be “kept below the limits of 10 CFR 20 during normal power operation.” Revise this statement to indicate that they will be below the concentrations defined as an airborne area in 10 CFR 20, or state specifically which limits are referred to by this statement.
12.4-22	Pedersen R	Verify capacity of ventilation systems in infrequently accessed areas of the plant.	Verify that the ventilation system is capable of reducing the airborne concentrations in areas accessible only for maintenance or in-service inspections to below the concentrations considered an airborne area as defined in 10 CFR 20.

RAI number	Reviewer	Question Summary	Full Text
12.4-23	Pedersen R	Describe maximum radiation source term in the filter or adsorption media for ventilation systems designed to operate during accident conditions.	List the ESBWR ventilation systems designed to operate during accident conditions. Indicate their location on plant layout drawings. Describe the maximum radiation source term in the filter or adsorption media, and give associated radiation dose rates in adjacent areas. Describe design features to ensure that the radiation exposures resulting from maintenance (filter change out) of these systems is ALARA.
12.4-24	Pedersen R	Indicate location and maximum radiation source term in the filter or adsorption media, of Reactor Building, Radwaste Building, and Fuel Building filtration units.	Indicate the location of the filtration units for the Reactor Building, the Radwaste Building, and the Fuel Building, on plant layout drawings. Describe the maximum radiation source term in the filter or adsorption media, for each and give associated radiation dose rates in adjacent areas. Describe design features to ensure that the radiation exposures resulting from maintenance (filter change out) of these systems is ALARA.
12.4-25	Pedersen R	Clarify information provided for the ARM system.	DCD Tier 2, Sections 12.3.4.1 and 12.3.4.2 describe the ESBWR Area Radiation Monitoring (ARM) System. Tables 12.3-2 through 12.3-6 list the monitors with their locations provided on Figures 12.3-23 through 12.3-42. However, the information is unclear. Clearly indicate which Regulatory Guide (RG) 1.97 category and accident monitoring type variable, each ARMs is provided to meet, and show that the range of each monitor is consistent with RG 1.97. For those ARMs not provided for accident monitoring, clearly demonstrate that they meet the guidance in ANSI/ANS 6.8.1, or provide a justification for an alternative.
12.4-26	Pedersen R	Clarify information provided for the ARM system.	What is the “Aux. Units” column on DCD Tier 2, Tables 12.3-2 through 12.3-6? Is that the same as the “Local Alarms” column on Table 12.3-7? If not indicate which ARM is provided with a local alarm. Section 12.3.4.1 of the DCD states that ARMs with local alarms are provided in “selected” areas. Describe the selection criteria for providing a local alarm and why each ARM not provided with a local alarm is justified.
12.4-27	Pedersen R	Clarify numbering of ARM system.	Figure 12.3-23 indicates two ARMs numbered 18, please clarify.

RAI number	Reviewer	Question Summary	Full Text
12.4-28	Pedersen R	Verify that high range monitors in drywell and wetwell meet the criteria of NUREG-0737, Item II.F.1.	DCD Tier 2, Section 12.3.4, second bullet, indicates that two redundant high range monitors are provided in the drywell and two in the wetwell "as required by RG 1.97." Verify that these monitors meet the criteria of NUREG-0737, Item II.F.1, as required by 10 CFR 50.34(f)(xvii)(D). Indicate the location of these monitors on the plant layout drawings.
12.4-29	Pedersen R	Provide a description of the in-plant airborne radiation monitoring system.	DCD Tier 2, Section 12.3.4, third bullet, indicates that the description of radiation instrumentation to monitor airborne radioactivity is left to the COL applicant. Although the concentrations of airborne radionuclides in each room or cubicle is to be determined by ITAAC, the rooms and cubicles that have a potential for becoming significant airborne areas should be known at this design stage. Provide a description of the in-plant airborne radiation monitoring system. Monitors should be able to detect the time integrated change of the most limiting particulate and iodine species equivalent to those concentrations specified in Appendix B of 10 CFR Part 20 (one derived air concentration (DAC) in each monitored plant area within 10 hours (i.e., monitors should be sensitive enough to measure 10 DAC-hours)).
12.4-30	Pedersen R	Provide a description of the radiation monitors that either meet the requirements of 10 CFR 70.24(a)(1) or 10 CFR 50.68(b)(6).	DCD Tier 2, Section 12.3.4.3 indicates that "[c]riticality detection monitors are not needed to satisfy the criticality accident requirements..." Provide a description of the radiation monitors that either meet the requirements of 10 CFR 70.24(a)(1) or 10 CFR 50.68(b)(6).

RAI number	Reviewer	Question Summary	Full Text
12.4-31	Pedersen R	Provide complete post accident radiation zone maps.	The post accident radiation zones on DCD Tier 2, Figures 12.3-43 through 12.3-51 are incomplete. Layout drawings are only provided for the "Nuclear Island" and then only the dose rates in the vital areas and "access pathways" are provided. Although the legends on these drawings go up to Zone I (>100 Rem/hr), with the exception of one area on Figure 12.3-51, no area greater than Zone F (1 Rem/hr) is indicated on any of the figures. Provide a complete set of post accident radiation zone drawings. Identify on these drawings the location of: (1) those systems and components that contain post accident materials outside of the primary containment listed under Item II.D.3 of DCD Tier 2, Table 1A-1; (2) each specific area (not just the general room) requiring access to mitigate the consequences of an accident listed under Item II.B.2 of DCD Tier 2, Table 1A-1 (including technical support center and health physics facilities); and (3) the personnel access routes to, and egress routes from, these areas (not just a listing of the general rooms and stairs). Provide a detailed description of personnel actions to be taken in each area, the significant radiation sources associated with each, and an analysis of the radiation "mission" dose received (including dose from access and egress).
12.4-32	Pedersen R	Justify why radiation dose rates in the plant during accident conditions are no higher than dose rates in the plant during normal operations.	With the one exception noted above, DCD Tier 2, Figures 12.3-43 through 12.3-51 indicate that radiation dose rates in the vital area of the plant under design basis accident conditions are no higher than during normal operations as indicated by Figures 12.3-1 through 12.3-9. Justify this unexpected situation. Provide a complete description of the assumptions, input parameters, and models used to determine the radiation zones in ESBWR vital areas.
12.4-33	Pedersen R	Clarify statement concerning post accident zone map criteria.	DCD Tier 2, Section 12.3.6 states that the post accident zone maps "are design to reflect the criteria established in Subsection 3.1.2." Clarify this statement. Specify exactly which criteria are being referred to, and how they were used to establish the radiation zones in the vital areas of the plant.

RAI number	Reviewer	Question Summary	Full Text
12.5-1	Pedersen R	Provide a complete tabulated dose assessment with a scope and detail consistent with the guidance in RG 8.19.	Provide a complete tabulated dose assessment with a scope and detail consistent with the guidance in RG 8.19. Data should be presented in the format provided in RG 8.19 or an acceptable alternative. The analysis should clearly indicate the basis (i.e., based on recent BWR experience or calculated based on similar tasks in other industries) for the staff-hour and dose rate estimates assumed and show how each was adjusted to account ESBWR specific design features. Estimates on work activities similar to the Advanced Boiling Water Reactor (ABWR) design (i.e., control rod drive removal and maintenance) should be based on experience from operating ABWRs.
12.5-2	Pedersen R	Describe the maintenance and testing that require personnel access to the drywell during power operations.	DCD Tier 2, Section 12.4.1, second paragraph, states that "the drywell is inaccessible during full power operations except to perform testing and maintenance..." Describe the maintenance and testing referenced here. Provide the frequency of these activities, the locations in the drywell (including access and egress paths) that will be occupied, the anticipated dose rates in each, and the maximum dose to the individuals performing these activities.
12.5-3	Pedersen R	Clarify the third item under the first bullet on page 12.4-3.	Clarify the third item under the first bullet on Page 12.4-3 (DCD Tier 2, Section 12.4.1). If the feedwater line contributes half of what the recirculation lines contribute to the dose rates in the drywell, wouldn't removal of the recirculation lines result in a 2/3 decrease in dose rates?
12.5-4	Pedersen R	Clarify the discussion of the impact that the ESBWR "reduced radiation fluence."	Clarify the discussion of the impact that the ESBWR "reduced radiation fluence" has on corrosion product transport and plateout (middle of page 12.4-4 in DCD Tier 2, Section 12.4.1). Is this referring to neutron fluence, gamma fluence, or both? There is little indication (other than a reference to "lower stress experienced by materials") of how this will reduce the activation and transport of corrosion products.

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12.5-5	Pedersen R	Clarify the statement in the middle of page 12.4-7.	Clarify the statement in the middle of page 12.4-7 (DCD Tier 2, Section 12.4.4) that "[t]he material of construction for the condenser tubesheet is titanium which reduces leakage of corrosion products into the feedwater." Verify that the ESBWR main condensers will have titanium heat exchanger tubes. The performance advantage of titanium tubes over bronze tubes minimizes the introduction of impurities from the ultimate heat sink (in the circulating system) into the feedwater system and ultimately into the reactor.
12.5-6	Pedersen R	Justify the low dose rate assumed for work activities in the Radwaste Building.	DCD Tier 2, Rev 1, Section 12.4.5 indicates that the Radwaste Building work activities considered in the dose assessment include movement of casks and liner, activated filter handling, resin moving and the removal of mobile radwaste processing skids. However, DCD Tier 2, Rev 1, Table 12.4-1 indicates that the average dose rate of 2.5 mrem/hr was assumed for these radwaste activities. Justify this low dose rate for what are typically high dose jobs. Several of the entries in Table 12.4-1 are substantially lower in DCD Rev. 1 than DCD Rev. 0 (i.e., refueling hours decreased from 1000 person-hours annually to 250 person hours, the dose rate assumed for main steam isolation valve (MSIV) work decreased from an already low 9 mrem/hr to 4 mrem/hr, etc.). Provide the basis for each of the assumptions and parameters used in the dose assessment (see question 12.5-1 above).
12.5-7	Pedersen R	Justify the low dose rates assumed for work on the CRD and HCU units.	DCD Tier 2, Table 12.4-1 indicates that the dose rate assumed for ESBWR CRD HCU work was 4.5 mrem/hr. The ESBWR design has the HCUs located below the CRDs. Did the dose assessment of these units include the likely increased build up of activated corrosion and wear products from gravitational settling? Justify this low assumed dose rate.

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12.5-8	Pedersen R	Justify the apparent low radiation worker utilization rates (only 34 hours per year of radiologically significant work).	DCD Tier 2, Table 12.4-1 gives an estimated total annual time of 33,131 person-hours, to complete the radiologically significant work to operate and maintain an ESBWR. Exposure data reported to the NRC, and summarized in Volume 26 to NUREG-0713, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and other Facilities," indicates that 35 US BWRs reported dose records for a total of 59,991 workers (33,948 that received an annual dose of greater than 100 mrem) for 2004. An average BWR in 2004 had about 970 workers performing radiologically significant work. Assuming that similar numbers of workers will be required to operate and maintain an ESBWR, and that all the work included in Table 12.4-1 was completed by workers that would have an annual dose greater than 100 mrem, that translates into a work rate of only about 34 (33,131 person-hours per year divided by 970 workers) hours of radiological work per year per ESBWR radiation worker. Justify what appears to be a very low estimate of person hours needed to maintain an operating ESBWR.
12.6-1	Pedersen R	Provide layout drawings depicting the health physics facilities in the Service Building.	DCD Tier 2, Section 12.5.2 discusses ESBWR facilities in the service building. Provide layout drawings (to the same scale as the other figures in DCD Tier 2, Section 12.3) of the Service Building, indicating the described facilities (including, but not limited to, the HP offices, control points, contamination control/monitoring stations, changing rooms (men's and women's), decontamination stations/showers, etc). Indicate the designed plant access and egress control through these facilities.
12.6-2	Pedersen R	Describe the radiation protection design considerations in the facilities included in the above answer.	DCD Tier 2, Section 12.5.2 states that shielded rooms are provided for radioactivity analysis and instrument calibration. Describe the radiation sources that these facilities are designed to contain, shielding provided and any other protective considerations in the design. Does the ESBWR design provide a low background facility for personnel bioassay? If so include a description with the above.

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12.7-1	Pedersen R	Describe to what extent each of the features addressed in NUREG/CR-3587, Section 5.2, were incorporated in the design ESBWR.	Section 5.2 of NUREG/CR-3587 lists several decommissioning facilitation techniques that are applicable during the design and construction phase of a commercial nuclear power light water reactor. Describe to what extent each of these features were incorporated in the ESBWR design, or describe why the recommendation is not practical. Provide illustrative examples.
12.7-2	Pedersen R	Describe how the ESBWR design minimizes the generation of radioactive waste during decommissioning operations.	The discussions of the systems (liquid, solid, and gaseous, waste management) provided in DCD Tier 2, Section 12.6.2 seem to be addressing minimization of effluents and solid waste from normal plant operation. Explain how the bulleted items (such as the segregation of wet and dry active waste for off-site shipment and burial) facilitate decommissioning operations. Describe how the ESBWR design minimizes the generation of radioactive waste during decommissioning operations.
12.7-3	Pedersen R	Describe prevention of acute leakage of radioactively contaminated fluids, minimization of chronic leakage, and leakage detection and capture to minimize contamination.	Identify ESBWR piping or components that have a potential for leaking radioactively contaminated fluids, and are is designed to be below the grade (ground level) of the plant site. Describe design features intended to prevent acute, and minimize chronic (over the life of the plant), leakage from these systems and components. Describe how leakage from these systems and components will be detected and captured to minimize contamination of the soil and/or ground water below the site. This description should include, but not be limited to, the spent fuel pool, Radwaste Building tanks and sumps, radwaste piping and drain lines between the Radwaste Building and other plant buildings (i.e., the Reactor and Turbine Buildings), and radwaste discharge lines.

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