October 16, 2006

MEMORANDUM TO: Joseph Colaccino, Acting Chief
ESBWR/ABWR Projects Branch
Division of New Reactor Licensing
Office of Nuclear Reactor Regulation

FROM: Timothy J. Frye, Chief **/RA/**
Health Physics Branch
Division of Inspection and Regional Support
Office of Nuclear Reactor Regulation

SUBJECT: PRELIMINARY SAFETY EVALUATION REPORT (PSER) INPUT AND REQUEST FOR ADDITIONAL INFORMATION (RAI) FOR THE ESBWR DESIGN CERTIFICATION SECTION(S) 11.1 THROUGH 11.5

The Health Physics Branch (IHPB) has assembled the input to the preliminary safety evaluation report (enclosure 1) for Sections 11.1 through 11.5 of the Economic Simplified Boiling Water Reactor (ESBWR) design certification. As part of your review, please note:

1. Our review covered health physics topics and regulatory requirements of Sections 11.2 to 11.5 of the ESBWR design control document (DCD) Tier 2 for which IHPB is responsible. The requests for additional information (RAIs) identify technical information and clarifications that are necessary for IHPB to complete its input to the ESBWR safety evaluation report (SER).

2. Consistent with the ESBWR Reviewer's Guide, the RAIs generated by IHPB were submitted separately to the DNRL PM over the past few months and are included at the end of each section of the PSER. Accordingly, the RAIs are not included here again as a separate attachment.

3. The text and RAIs prepared by AADB for Section 11.1 are included in Enclosure 1 for the sake of completeness. However, AADB should be given an opportunity to review Section 11.1 in light of related RAIs generated by IHPB for Sections 11.2 and 11.3.

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4. Note that Enclosure 1 does not incorporate matters and RAIs that are being addressed by other technical branches, such as the Balance-of-Plant Branch (SBPB). For example, there is a need to incorporate, as needed, material and RAIs on the following technical issues:

   a. Plant system technology/hardware, instrumentation and controls, process flow diagrams, system interfaces, hydrogen/oxygen recombiner design, hydrogen combustible gas mixture control and monitoring, and system performance in processing liquid, gaseous, and solid wastes
   b. Civil engineering, structural evaluation, seismic qualification, etc.
   c. System designs and qualifications under applicable GDCs and provisions of Regulatory Guides 1.97, 1.140, and 1.143, among others
   d. System technical specifications
   e. Quality assurance and maintenance
   f. Acceptance and compliance review for systems and hardware
   g. Identification of ITAAC and COL action items

Enclosures:
As stated

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   b. Civil engineering, structural evaluation, seismic qualification, etc.
   c. System designs and qualifications under applicable GDCs and provisions of Regulatory Guides 1.97, 1.140, and 1.143, among others
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As stated

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ESBWR Design Control Document

(DCD Tier 2, Rev. 1)

RADIOACTIVE WASTE MANAGEMENT

Chapters 11.1 to 11.5

Preliminary Safety Evaluation Report

with

Requests for Additional Information

## 11.1 Source Terms

### 11.1.1 Regulatory Criteria

The following acceptance criteria are applicable:

- Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20, as it relates to limits on doses for members of the public in unrestricted areas
- 10 CFR Part 50, Appendix I, as it relates to the numerical guidelines for design objectives and limiting conditions for operation (LCOs) to meet the "as low as is reasonably achievable" (ALARA) criterion given in Appendix I
- 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 60, as it relates to radioactive waste management system designs to control releases of gaseous and liquid radioactive effluents, as well as to handle solid radioactive wastes, produced during normal operation

The relevant requirements of the regulations identified above are met by using the regulatory positions and guidance contained in the following NRC Regulatory Guides (RG) and industry standards:

- RG 1.110, as it relates to the cost-benefit analysis for radioactive waste management systems and equipment
- RG 1.112, as it relates to the method of calculating releases of radioactive materials in effluents from nuclear power plants
- RG 1.140, as it relates to the design, testing, and maintenance of air filtration and adsorption units of normal ventilation exhaust systems
- American National Standards Institute ANSI/ANS 18.1-1999, "Radioactive Source Term for Normal Operation of Light Water Reactors."

- NUREG-0016, “Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors” (BWR-GALE Code).

The specific criteria sufficient to meet the relevant requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I, are as follows:

- The parameters used to calculate concentrations of radioactive materials in primary coolant and steam are consistent with those given in NUREG-0016.

- All normal and potential sources of radioactive effluents are considered, as delineated in Subsection I, Section 11.1 of Standard Review Plan (SRP, NUREG-0800).

- For each source of liquid and gaseous wastes considered in Subsection I, Section 11.1 of the SRP, the volumes and concentrations of radioactive materials given for normal operation and anticipated operational occurrences (AOOs) are consistent with those given in NUREG-0016.

- Decontamination factors (DFs) for in-plant control measures used to reduce gaseous effluent releases to the environment, such as iodine removal systems and high-efficiency particulate air (HEPA) filters for building ventilation exhaust systems and containment internal cleanup systems, are consistent with those given in RG 1.140.

- DFs for in-plant control measures used to reduce liquid effluent releases to the environment, such as filters, demineralizers, and evaporators, are consistent with those in NUREG-0016.

- The use of mobile or portable waste processing systems not specifically described in the Design Control Document (DCD) will not impact estimates of liquid and gaseous effluent releases to the environment, and the use of mobile or portable waste processing systems are expected to be consistent with NUREG-0016 and the SRP.

- Effluent concentrations at the boundary of the unrestricted area do not exceed the limits specified in Table 2 of Appendix B to 10 CFR Part 20.

- The source terms result in meeting the design objectives for doses in an unrestricted area, as set forth in Appendix I to 10 CFR Part 50.

- The applicant provides in the DCD the relevant information required by 10 CFR 50.34a. This technical information should include all the basic data listed in Appendix A to RG 1.112 needed to calculate the releases of radioactive material in liquid and gaseous effluents. The Gaseous and Liquid Effluent (GALE) computer code, along with the source term parameters given in NUREG-0016, is an acceptable method to perform this calculation.

- If the calculational technique or any source term parameter differs from that given in NUREG-0016, the applicant should describe these differences in detail, as well as the bases for the method and parameters used.

11.1.2 Summary of Technical Information

The ESBWR radioactive waste management system (RWMS) controls the handling and treatment of liquid, gaseous, and solid radioactive wastes. The systems is comprised of the liquid waste management system (LWMS), the gaseous waste management system (GWMS), and the solid waste management system (SWMS). The sources of radioactivity processed by these radioactive waste treatment systems are described in Section 11.1 of the DCD Tier 2, Rev. 1.

DCD Section 11.1 defines the radioactive source terms in reactor coolant and steam as the design bases and under normal operation for the gaseous, liquid, and solid radioactive waste management systems. The sources of radioactivity are generated within fuel assemblies and have the potential of leaking to the reactor coolant system (RCS) during normal plant operation, including AOOs, by way of defects in the fuel cladding. The applicant describes two types of source terms for the reactor primary coolant and steam. The first addresses design basis, and the second one describes average concentrations in reactor coolant and steam anticipated over the life of a boiling water reactor (BWR). These source terms serve as a basis for RWMS design and shielding analysis. The source terms and supporting assumptions are given in DCD Tables 11.1-1 to 11.1-7.

The first is the design-basis noble gas source term, which assumes a design-basis fuel defect level to produce 0.1 curie per second (3700 MBq/s) of noble gases after 30-minute decay. The applicant has chosen the noble gas source term rate after 30-minute decay as a measure of the fuel defect leakage rate, because it is readily measurable and historically consistent with the nominal 30-minute offgas holdup system designed and provided to current operating BWRs by General Electric. The radioiodine source term is associated with leakage from failed fuel. The presence of radioiodines is based on a leak rate of 700 uCi per second (26 MBq/s) from the fuel. The ratio of the concentration of radioiodines in coolant to that of reactor steam was assumed to be 0.02 using ANSI/ANS 18.1-1999. The fission products source term includes all other radionuclides, other than noble gases and radioiodines. The presence of fission products is based on ANSI/ANS 18.1-1999, and includes transuranics. The ratio of the concentration of fission products in reactor coolant to that of reactor steam was assumed to be 0.001 using ANSI/ANS 18.1-1999. The last category of source terms includes coolant activation products, non-coolant activation products, tritium, and argon. Coolant activation products include N-16 and tritium. The concentrations of N-16 and tritium are based on ANSI/ANS 18.1-1999. The presence of N-16 is associated with the activation of naturally occurring O-16. The presence of tritium in coolant is primarily due to the activation of naturally occurring deuterium in water and as a fission product in fuel to a lesser extent. The reactor coolant, process water, and steam are assumed to have a common tritium concentration, as tritium is not reduced by coolant cleanup systems or liquid waste treatment systems. The source term for Ar-41, an activation product of naturally occurring Ar-40, is based on NUREG-0016, but adjusted to a thermal power level of 4500 MWTh. The level of Ar-41 in coolant is primarily dependent on air in-leakage into the primary coolant system.

The second source term is the expected average concentrations of the principal radionuclides in the reactor coolant and steam that may be anticipated over the life of a BWR. The applicant assumed a realistic design basis fuel defect level of 0.02 curie per second (740 MBq/s) of noble gases release after 30-minute decay. For radioiodines, the release rate is estimated to be 100 uCi per second (3.7 MBq/s). The applicant has not provided average concentrations of the principal radionuclides in reactor coolant and steam based on fuel defect level of 0.02 curie per second (740 MBq/s) of noble gases after 30-minute decay. These values are determined using the model in ANSI/ANS 18.1-1999 and NUREG-0016.

11.1.3 Staff Evaluation

The staff has reviewed the DCD Tier 2, Rev. 1, Section 11.1, "Source Terms," in accordance with the guidance and acceptance criteria in Section 11.1, "Source Terms," of the SRP. The staff evaluates the potential radioactive wastes and the capability of the liquid and gaseous radioactive waste management systems to keep radioactive effluents in unrestricted areas ALARA, in accordance with the requirements of 10 CFR Part 50, Appendix I. In addition, the staff also evaluates compliance with 10 CFR Part 20.1302, which defines the criteria for radionuclide concentration limits in liquid and gaseous effluents released into unrestricted areas. The effluent concentration limits are defined in Table 2 of Appendix B to Part 20. Finally, the review also addresses compliance with GDC 60, as it relates to the design of the radioactive waste management systems to control and monitor releases of radioactive materials using the guidance of RGs 1.110 and 1.140.

The ESBWR DCD Tier 2, Rev. 1 did not use the methods and parameters described in NUREG-0016 and Regulatory Guide 1.112. Rather, the radioactive source terms defined in the DCD are based on ANSI/ANS 18.1-1999. The standard defines expected long-term radionuclide concentrations in the coolant and steam of BWRs. The standard provides a uniform approach in developing concentrations of principal radionuclides for a reference BWR plant and provides a method to adjust radionuclide concentrations to a specific plant design. The data defining the reference plant reflect industry experience at operating BWR plants. The adjustment of radionuclide concentrations from the reference plant to a specific plant design requires information for various plant system parameters. The major parameters include plant thermal power, mass of water in reactor vessel, cleanup demineralizer flow rate, steam flow rate, and ratio of condensate demineralizer to steam flow rate. Other parameters address factors characterizing the types of systems used to purify reactor coolant and cleanup efficiencies of such systems by class of radionuclides.

The source terms provide the bases for estimating typical concentrations of the principal radionuclides for operating BWR plants and, in part, it is used in Sections 11.2 and 11.3 of the DCD to calculate the quantity of radioactive materials released annually in liquid and gaseous effluents during normal plant operation, including AOOs, to demonstrate compliance with 10 CFR Part 20, Appendix B, Table 2, effluent concentration limits, 10 CFR Part 20.1302 dose limits to members of the public, and the ALARA design objectives of Appendix I to 10 CFR Part 50.

In reviewing the ESBWR design against the above criteria, the staff found that some of the above criteria dealt with the source terms, which are the subject of this section, while some dealt with subjects discussed in Sections 11.2 through 11.5 of this report. In requesting additional information (RAI No. 11.1-1), the staff asked the applicant to identify the relevant

DCD Tier 2, Rev. 1 sections that address the above criteria. In RAIs No. 11.1-2 and RAI No. 11.1-3, the staff asked the applicant to provide the expected average concentrations of the principal radionuclides in reactor coolant and steam that may be anticipated over the life of an ESBWR, complete with all calculational parameters used in the analysis.

The following presents the staff's RAIs, the applicant's responses to the RAIs, and the staff's evaluation of these responses.

RAI No. 11.1-1 Please identify the relevant DCD Tier 2, Rev. 1, sections that address the following criteria:

a. The parameters used to calculate concentrations of radioactive materials in primary and secondary coolant are consistent with those given in NUREG-0016.

b. All normal and potential sources of radioactive effluents delineated in Subsection I of SRP Section 11.1 are considered.

c. For each source of liquid and gaseous waste considered in Subsection I of SRP Section 11.1, the volumes and concentrations of radioactive material given for normal operation and AOOs are consistent with those given in NUREG-0016.

d. Decontamination factors (DFs) for in-plant control measures used to reduce gaseous effluent releases to the environment, such as iodine removal systems and HEPA filters for building ventilation exhaust systems and containment internal cleanup systems, are consistent with those given in RG 1.140. The building mixing efficiency for containment internal cleanup is consistent with that in NUREG-0016.

e. DFs for in-plant control measures used to reduce liquid effluent releases to the environment, such as filters, demineralizers, and evaporators, are consistent with those in NUREG-0016.

f. Effluent concentrations at the boundary of the unrestricted area do not exceed the limits specified in Table 2 of Appendix B to 10 CFR Part 20.

g. The source terms result in meeting the design objectives for doses in an unrestricted area, as set forth in Appendix I to 10 CFR Part 50.

h. The applicant provides in the DCD the relevant information required by 10 CFR Part 50.34a. This technical information should include all the basic data listed in Appendix A to RG 1.112 needed to calculate the releases of radioactive material in liquid and gaseous effluents. The GALE computer code, along with the source term parameters given in NUREG-0016, is an acceptable method to perform this calculation.

i. If the calculational technique or any source term parameter differs from that given in NUREG-0016, the applicant should describe these differences in detail, as well as the bases for the method and parameters used.

RAI No. 11.1-2 Please provide the realistic source term for fission, activation, and corrosion products in reactor water and steam used to demonstrate compliance with:

a. 10 CFR Part 20, as it relates to limits on doses for persons in unrestricted areas and,

b. 10 CFR Part 50, Appendix I, as it relates to the numerical guidelines for design objectives and limiting conditions for operation to meet the ALARA criterion given in Appendix I.

The realistic source term is the expected average concentrations of the principal radionuclides in the primary reactor coolant and steam that may be anticipated over the life of a BWR.

RAI No. 11.1-3 Please provide all calculational parameters used to determine the realistic source term provided in RAI No. 11.1-2 above.

11.1.4 Conclusions

- **Later** -

11.2 Liquid Waste Management System

11.2.1 Regulatory Criteria

The following acceptance criteria are applicable:

- 10 CFR Part 20.1302, as it relates to limits on doses to persons in unrestricted areas
- 10 CFR Part 20.1406, as it relates to facility design and operational procedures for minimizing the contamination of the facility and generation of radioactive waste

- 10 CFR Part 50.34a, as it relates to the inclusion of sufficient design information to demonstrate the design objectives for equipment necessary to control releases of radioactive effluents to the environment

- 10 CFR 50, Appendix I, Sections II.A and II.D, as they relate to the numerical guidelines for dose design objectives to meet the ALARA criterion

- GDC 60, as it relates to the design of liquid waste management systems to control releases of liquid radioactive effluents

- GDC 61, as it relates to the design of liquid waste management systems to ensure adequate safety under normal and postulated accident conditions

The relevant requirements of the regulations identified above are met by using the regulatory positions and guidance contained in the following RGs:

- RG 1.109, as it relates to demonstrating compliance with the numerical guidelines for dose design objectives and the ALARA criterion of Appendix I to 10 CFR 50

- RG 1.110, as it relates to performing a cost-benefit analysis for reducing cumulative dose to the population by using available technology

- RG 1.143, as it relates to the seismic design and quality group classification of components used in the liquid waste management system and structures housing this system, as well as the provisions used to control leakages

11.2.2 Summary of Technical Information

DCD Tier 2, Rev. 1, Section 11.2 describes the design of LWMS and its functions in controlling, collecting, processing, storing, and disposal of liquid radioactive waste generated as a result of normal operation, including AOOs. The LWMS does not normally process non-radioactive secondary system effluent. Sections 9.2 and 10.4 of the DCD describes the origins and discharges of non-radioactive effluents. The LWMS, shown in DCD Figures 11.2-1 and 11.2-2, consists of tanks, chemical injection and neutralization units, valves, and pumps. The components of the LWMS (drain tanks, sample tanks, and chemical injection tank, etc.) are located in the radwaste building. The other components, such as ion exchangers, filters, degasifier, pumps, valves, and heat exchangers, are also in the radwaste building. All LWMS tank overflows are routed to building sumps and drains, which are pumped to their respective drain tanks.

The LWMS is comprised of two types of systems, permanently installed equipment, and mobile treatment systems connected to permanently installed equipment. The mobile treatment systems are designed to process wastes from equipment drains and floor drains, and chemical and detergent wastes. The mobile treatment systems rely on demineralizers, charcoal and hollow fiber filters, reverse osmosis, and organic and neutralization treatments. The mobile systems use plant service utilities for their operations, such as compressed air, water, electricity, ventilation, radiation monitoring, etc.

The descriptions and design data for these systems are listed in DCD Tables 11.2-1 to 11.2-4 and depicted in Figure 11.2-1. Additional design details are provided in DCD Section 9.3.3. The associated process and effluent radiological monitoring and sampling systems are described in DCD Section 11.5. Estimates of liquid effluent radionuclide concentrations and average annual releases are presented in DCD Section 12.2.2.3 and associated doses to the maximally exposed individual are described in DCD Section 12.2.2.4.

The LWMS processes four major categories of radioactive wastes, including:

(1) equipment drains from various sources within the plant

(2) floor drains from various sumps in the reactor, turbine, and radwaste buildings

(3) chemical drains from the laboratory and other relatively small volume sources

(4) detergent drains from laundry and personnel decontamination, and decontamination waste water from the reactor and turbine buildings

The equipment drain subsystem processes liquid wastes (high purity) from the reactor water cleanup and shutdown cooling system, fuel auxiliary pools cooling system, condensate demineralizer, and from equipment drains located in the reactor building, turbine building, and radwaste building. This subsystem can also receive liquid waste from the floor drains subsystem. The permanently installed equipment include three collection tanks, each with a capacity of about 140,000 liters (37,000 gallons), and two sample tanks each with the same capacity. The associated mobile treatment system consists of pre-and main filters, pre-treatment and polishing resin ion-exchangers, a chemical injection unit, and an intermediate storage tank. The subsystem's processing capacity is rated at about 330 liters per minute (88 gallons per minute).

The floor drain subsystem processes liquid wastes (low purity) from the reactor drywell, and from floor drains located in the reactor building, turbine building, and radwaste building. This subsystem can also receive liquid waste from the equipment drain, chemical drain, or detergent drain subsystems. The permanently installed equipment include two collection tanks, each with a capacity of about 130,000 liters (34,000 gallons), and two sample tanks each with the same capacity. The associated mobile treatment system consists of pre-and main filters, a reverse osmosis unit, pre-treatment and polishing resin ion-exchangers, and an intermediate storage tank. The subsystem's processing capacity is rated at about 250 liters per minute (66 gallons per minute).

The chemical drain subsystem processes liquid wastes from the reactor building, turbine building, and radwaste building. This subsystem can also receive liquid waste from the detergent drain subsystem. The permanently installed equipment include one collection tank with a capacity of about 4,000 liters (1,060 gallons) and no sample tanks. Chemicals are added to the tank for pH control or other chemical adjustments, as needed. The associated mobile treatment system consists of a chemical neutralization unit.

The detergent drain subsystem processes liquid wastes from the hot-laundry and hot-shower facilities, and decontamination drains from the reactor building, turbine building, and radwaste building. This subsystem can also receive liquid waste from the chemical drains subsystem.

The permanently installed equipment include two collection tanks, each with a capacity of about 15,000 liters (4,000 gallons) and two sample tanks with the same capacities. The associated mobile treatment system consists of an organic pre-treatment unit, pre-and main cartridge and charcoal filters, with a rated processing capacity of about 33 liters per minute (9 gallons per minute).

When liquid wastes are processed, the treated waste is returned to the LWMS for eventual discharge to the environs. Liquid wastes that cannot be discharged are returned to their specific collection tanks for reprocessing or reuse in plant systems. If any liquid waste cannot be treated onsite, they are placed in tanks or containers and shipped for offsite processing and disposal. Process discharge is normally aligned to one of the subsystem sample tanks. Prior to discharge, liquid wastes are sampled for radiological analysis and compliance with local requirements for non-radioactive contaminants. DCD Sections 9.3.2 and 11.5.5 describe the features of the process sampling system for the LWMS.

All LWMS discharges are made through a single liquid waste discharge line to the discharge canal. The release of processed liquid wastes from any sample tank to the environs is permitted only when the analysis of the tank's contents indicates that such a release is permissible under 10 CFR 20 and Appendix I to 10 CFR 50. During discharges, liquid wastes are mixed with and diluted by the discharge canal, with a flow rate of about 20,000 liters per minute (5,300 gallons per minute). The discharge flow rate from the LWMS is controlled to ensure that radionuclide concentration levels in unrestricted areas are in compliance with the 10 CFR 20, Appendix B, Table 2, Column 2 concentration limits.

All discharges from the LWMS are monitored by the liquid radwaste discharge radiation monitor prior to dilution and released to the discharge canal. The monitor is located on the common discharge line downstream of the LWMS sample tanks. The radiation monitor provides a signal to terminate liquid waste releases before discharge concentrations exceed predetermined set-points, based on 10 CFR Part 20, Appendix B, Table 2 effluent limits. The radiation monitor used in controlling and monitoring releases of radioactive materials present in liquid effluents to unrestricted areas, as required by GDC 60 and 64.

The applicant calculated the amounts of radioactivity contained in liquid effluents using the methodology of NUREG-0016, but not the BWR-GALE Code itself. The methods, major assumptions, and parameters are described in DCD Section 12.2.2.3, and the relevant parameters are listed in Tables 11.2-3 and 12.2-19a. Table 11.2-3 lists the decontamination factors assigned by types of liquid waste streams and treatment systems. DCD Table 12.2-19a lists needed parameters using, in part, the methodology of NUREG-0016. The parameters characterize plant features, and processing parameters for each of the four liquid waste subsystems, equipment drain, floor drain, chemical drain, and detergent drain. The specific parameters are waste flow rates, fraction of reactor coolant activity, radionuclide decontamination factors, liquid waste collection and discharge times, and fraction released to the discharge canal. The estimates of average annual effluent concentrations and radioactivity levels discharged yearly are listed in Table 12.2-19b.

11.2.3 Staff Evaluation

Design and operational flexibility is incorporated by providing redundancy in processing wastes via cross-connections to route effluents among subsystems, and sufficient storage capacity

using multiple collection drain and sample tanks. The use of mobile systems is expected to result in more efficient liquid waste processing by matching optimum treatment methods against waste streams. Table 12.2-3 of the DCD presents decontamination factors assigned by types of liquid wastes. The decontamination factors are consistent with those presented in NUREG-0016 for general purpose ion-exchange resins and adsorbent media.

Based on DCD Table 11.2-1, the combined normal generation rate of liquid wastes serviced by the four subsystems is estimated to be about 83,000 liters per day (21,900 gallons per day). The maximum flow rate is estimated to be about 240,000 liters per day (63,400 gallons per day). The time needed to process the maximum anticipated flow rate is estimated to vary from 6.7 hours for the floor drain subsystem to 0.2 hour for the chemical drain subsystem. The combined storage capacity and processing rates are expected to provide an adequate margin for handling surges in the generation of liquid wastes serviced by these subsystems.

The results presented in DCD Table 12.2-19b compare liquid effluent radionuclide concentrations in unrestricted areas to their respective liquid effluent concentration limits of 10 CFR 20, Appendix B, Table 2, Column 2.

DCD Section 12.2.2.4 describes the method used to calculate doses to the maximally exposed individual associated with liquid effluent releases. Doses were calculated using the guidance of RG 1.109 (Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I) and the LADTAP II computer code, as described in NUREG/CR-4013 (LADTAP II - Technical Reference and User Guide). The key assumptions and parameters used in the calculations are listed in DCD Table 12.2-20a, with dose results presented in DCD Table 12.2-20b.

The DCD, however, does not present an assessment of population collective doses using the guidance of RG 1.110. A COL applicant referencing the ESBWR certified design should provide a site-specific cost-benefit analysis to address the requirements of 10 CFR Part 50, Appendix I, regarding population doses resulting from the release of liquid effluents. The COL applicant will also demonstrate conformance with RG 1.110, as it relates to performing a site-specific cost-benefit analysis in reducing collective doses. This is COL Action Item 11.2- **later**, as identified in DCD Table - **later**.

The dilution factor used to calculate doses, in part, is site dependent and will be provided by the COL applicant. A COL applicant referencing the ESBWR certified design should identify its planned discharge flow rate for all liquid wastes taking into account expected or actual dilution flow rates both before and beyond the point of discharge. This is COL Action Item 11.2-**later**, as identified in DCD Table - **later**.

The staff will review the operational set-points of the liquid radwaste discharge radiation monitor on a plant-specific basis for each COL application. A COL applicant referencing the ESBWR certified design should identify in its plant-specific offsite dose calculation manual (ODCM) operational set-points for the LWMS radiation monitor, and standard radiological effluent controls in monitoring and controlling releases of radioactive materials into the environment, thus eliminating the potential for unmonitored and uncontrolled release. This is addressed as a COL Action Item in Chapter 11.5 of this PSER.

A COL applicant referencing the ESBWR certified design should identify the ion-exchange resins and adsorbent media it plans to use for ion exchangers and charcoal filters depending upon the specific characteristics of the liquid radwaste to be processed. This is ITAAC/DAC Action Item 11.2-**later**, as identified in DCD Table - **later**.

The LWMS is designed to handle most liquid effluents and other anticipated events using installed and mobile equipment. However, for surge events occurring at a very low frequency, or producing effluents not compatible with the installed or mobile equipment, temporary or additional equipment may be used in the radwaste building. Connections are provided to and from the liquid waste subsystems to facilitate connections with mobile equipment. This allows mobile equipment to be used in series or parallel with installed equipment, as an alternative method in treating liquid wastes. The staff will review any mobile processing equipment that may be used for processing liquid radwaste on a plant-specific basis for particular COL applications using the guidelines of RG 1.143. The COL applicant should discuss how any mobile processing equipment intended for use in treating liquid radwaste meets the guidelines of RG 1.143. This is ITAAC/DAC Action Item 11.2- **later**, as identified in DCD Table - **later**.

A COL applicant referencing the ESBWR certified design should describe the quality assurance (QA) program for design, fabrication, procurement, construction of structures, and installation of permanent or mobile LWMS systems and components in the plant in accordance with its overall QA program. The staff will review and evaluate the COL applicant's QA program in meeting the QA guidance specified in RG 1.21, 1.33, 1.143, and 4.15. This is COL Action Item 11.2- **later**, as identified in DCD Table - **later**.

The following presents the staff's RAIs, the applicant's responses to the RAIs, and the staff's evaluation of these responses. The RAIs address technical issues associated with this section of the DCD and those that are supportive of the design bases and descriptions but that are located in other sections of the DCD. The RAIs are:

RAI No. 11.2.3-1 The decontamination factors (DF) listed in DCD Tier 2, Rev. 1, Table 11.2-3 are not consistent with NUREG-0016. No DF value is given for tritium. See related RAI No. 12.2-4. Without this information, the staff cannot independently confirm the annual doses reported in DCD Table 12.2-20.

RAI No. 11.2.3-2 The text does not state which sets of decontamination factors were used to assess doses from liquid releases. The text states that the values listed in DCD Tier 2, Rev. 1, Table 11.2-3 are conservative and consistent with NUREG-0016, but does not specify whether the "Total DF" values were used given that (i) the use of a second ion-exchanger in series is optional by NUREG-0016, (ii) if the use of a second ion-exchanger was applied in calculating doses, and (iii) whether an aggregate DF (weighted by liquid waste volume estimates from Table 11.2-4) was derived and applied in calculating doses. See related RAI No. 12.2-4. Without this information, the staff cannot independently confirm the annual doses reported in DCD Table 12.2-20.

RAI No. 11.2.5-1 The text describing instrumentation used to monitor liquid effluent releases is inconsistent with that of DCD Tier 2, Rev. 1, Section 11.5.3.2.6. It does not refer to the use of a continuous radiation monitoring system. Update DCD text accordingly.

RAI No. 11.2.5-2 The presence of the continuous liquid effluent radiation monitor is not discussed in the text, nor shown in DCD Tier 2, Rev. 1, Figure 11.2-1. Provide an updated figure showing the placement of the liquid effluent radiation monitor.

RAI No. 11.2.2-4 The text does not state which sets of decontamination factors were used to assess doses from liquid radioactive releases. The text states that the values listed in DCD Tier 2, Rev. 1, Table 12.2-19 are bounding and consistent with NUREG-0016, but does not specify which decontamination factors (DF) listed in Table 11.2-3 were used in deriving the annual activity inventories of Table 12.2-19. A cursory check of the information presented in Table 12.2-19 indicates that a DF of 100 was used in estimating liquid effluent concentrations of I-131, Co-60, Cs-137, Ba-140, and Np-239. Also, it was noted that a DF of 100 was used for tritium, which is contrary to the DF (value of 1) prescribed in NUREG-0016. Note that the application of a DF of 1 for tritium is expected to result in liquid effluent discharge concentrations that are about twice the limit of Appendix B (Table 2, Column 2) of Part 20. See related RAI No. 11.2.3-1.

RAI No. 11.2.2-5 The text cites the use of a liquid waste dilution factor of 10 prior to the point of release that is closest to the public, but no rationale is given for this value. The discussion does not state if a dilution factor was applied beyond the point of release in assessing doses to hypothetical receptors listed in DCD Tier 2, Rev. 1, Table 12.2-20. Provide the rationale for the dilution factor of 10 and address whether additional dilution factors were used to calculate doses to the hypothetical receptors listed in DCD Table 12.2-20.

RAI No. 11.2.2-6 DCD Tier 2, Rev. 1, Table 12.2-19 presents estimated liquid effluent concentrations for comparison against the limits of Appendix B to Part 20. A review of the listed limits indicate that they are based on the 1993 edition of Part 20 instead of the current Part 20. It should be noted that compliance with liquid effluent limits of the current Part 20 is required. For comparison note that the effluent limits listed in DCD Table 12.2-17 are based on the current Part 20, Appendix B criteria. Provide an updated version of DCD Table 12.2-19 listing liquid effluent concentration limits based on current NRC criteria.

RAI No. 11.2.2-7 The listing of radionuclides in DCD Tier 2, Rev. 1, Table 12.2-19 is inconsistent with that of Table 12.2-17. Table 12.2-19 includes Co-57 but

Table 12.2-17 does not. Table 12.2-19 includes Pr-143 but Table 12.2-17 lists Pr-144 instead. Provide updated versions of DCD Tables 12.2-19 and 12.2-17.

RAI No. 11.2.2-8 The evaluation of doses associated with liquid effluent releases is stated as being based on the methodology presented in NUREG-0016 and NUREG/CR-4013. The text does not present any discussion of the assumptions used in describing offsite dose receptor locations, rationale for the exposure pathways listed in DCD Tier 2, Rev. 1, Table 12.2-20, and a listing of all model parameters used in calculating doses. Without this information, the staff cannot independently confirm the annual doses reported in DCD Table 12.2-20.

RAI No. 12.2-10 The annual radionuclide source term estimates presented in DCD Tier 2, Rev. 1, Table 12.2-19b could not be duplicated using the information presented in Tables 12.2-19a, 12.2-20a, 11.2-3, 11.2-4, 11.1-3, and 9.3-2, using the BWR-GALE Code (NUREG-0016). Please address the following and update DCD Tables 12.2-19a, 12.2-19b, and 12.2-20a, and DCD Section 12.2.4 accordingly:

In DCD Table 12.2-19a:

a. The values for the total steam flow rate and mass of water in reactor vessel are inconsistent with that of DCD Table 11.1-3, once unit conversions are made.

b. Confirm the value given for the fraction of reactor coolant activity in low purity waste stream (0.11 vs 0.101).

c. This table includes a waste stream (regenerant waste) that is not listed in DCD Section 11.2.2 and DCD Tables 11.2-3 and 9.3-2.

d. The entry for detergent waste is not supported with the corresponding set of parameters and data.

e. Update the DCD table to include parameters corresponding to input data cards no. 20 to 28 to the BWR-GALE code.

In DCD Table 12.2-19b:

f. Explain differences in the listing of radionuclides, deletion of 14 nuclides and additions of 6 nuclides, as compared to its prior version.

In DCD Table 12.2-20a:

g. Reconcile inconsistency between a liquid effluent discharge rate of 20,000 L/min from the liquid waste management system (LWMS) against the value of 83,000 L/day as an estimate of the input to the LWMS - see DCD Table 11.2-4.

In DCD Section 12.2.4:

h. Update list of references to include all those cited in the DCD text.

RAI No. 12.2-10 Followup The estimates of total annual liquid effluent releases presented in DCD Tier 2, Rev. 1, Table 12.2-19b could not be duplicated using the information contained GE responses to RAI No. 12.2-10 (dated July 21, 2006) and RAIs No. 11.1-1 and 11.1-2 (dated July 19, 2006) and the BWR-GALE Code (NUREG-0016). For example, the staff's analyses show results that are inconsistent even after making specific adjustments to results, such as for the assumed primary coolant radionuclide concentrations and plant capacity factor. Please address the following:

a. Since the BWR-GALE Code was not used by GE in deriving total annual effluent releases, provide a description of the alternate method used, including adjustments made to address specific plant processes and/or radionuclides.

b. Provide technical discussions describing differences between the method used by GE and NUREG-0016. Include sufficient details in the response to facilitate the staff's review in comparing sources of differences.

RAI No. 12.2-13 The estimated annual doses to the thyroid associated with the drinking pathway presented in DCD Tier 2, Rev. 1, Table 12.2-20b could not be duplicated using the information presented in DCD Tables 12.2-19b and 12.2-20a and LADTAP II Code (NUREG/CR-4013). Review and update DCD Table 12.2-20a to include any other assumptions used in the analysis but not listed in this table.

RAI No. 12.2-14 The exposure pathway associated with the consumption of irrigated foods is not included in DCD Tier 2, Rev. 1, Table 12.2-20b. The omitted pathways are the consumption of vegetables, leafy vegetables, meat, and milk for the maximum exposed individual. Expand the analysis to include doses associated with the consumption of irrigated foods and update DCD Table 12.2-20b in presenting all associated results. Update DCD Table 12.2-20a in describing all related model parameters and their assumed values used in the revised analysis.

RAI No. 12.2-15 The dose model parameter describing the transit time of effluents from the point of discharge to the location of exposure (maximum exposed

individual) is not listed in DCD Tier 2, Rev. 1, Table 12.2-20a. Update DCD Table 12.2-20a to include this model parameter and its assumed value used in the analysis.

RAI No. 9.2-5 Although references are cited in the text, the full citations are missing in this subsection. Update the list of DCD references to include the applicable Hydraulic Institute Testing standard.

RAI No. 9.3-2 This section describes equipment and floor drainage systems that may become contaminated. A review of this section and Figure 11.2-1 indicates that Drywell HCW/LCW discharges are not included in the descriptions of the listed systems. Revise the text and tables of DCD Tier 2, Rev. 1, Sections 9.3.3.2 and 11.2 to include the subsystems identified in Figure 11.2-1 as input to the Liquid Waste Management System. Also, update and provide supporting DCD system flow diagrams, as needed.

11.2.4 Conclusions

- **Later** -

11.3 Gaseous Waste Management System

11.3.1 Regulatory Criteria

The following acceptance criteria are applicable:

- 10 CFR Part 20.1302, as it relates to limits on doses to persons in unrestricted areas
- 10 CFR Part 20.1406, as it relates to facility design and operational procedures for minimizing the contamination of the facility and generation of radioactive waste
- 10 CFR Part 50.34a, as it relates to providing sufficient design information to demonstrate the effectiveness of design objectives for equipment necessary to control releases of radioactive gaseous effluents to the environment
- GDC 3, as it relates to protecting gaseous waste handling and treatment systems from the effects of an explosive mixture of hydrogen and oxygen
- GDC 60, as it relates to the design of radioactive waste management systems to control releases of gaseous radioactive effluents
- GDC 61, as it relates to the control of radioactivity in the GWMS and the ventilation systems associated with fuel storage and handling areas
- 10 CFR 50, Appendix I, Sections II.B, II.C, and II.D, as they relate to the numerical guidelines for dose design objectives to meet the ALARA criterion

The relevant requirements of the regulations identified above are met by using the regulatory positions and guidance contained in the following RGs:

- RG 1.109, as it relates to demonstrating compliance with the numerical guidelines for dose design objectives and the ALARA criterion of Appendix I to 10 CFR 50
- RG 1.110, as it relates to performing a cost-benefit analysis for reducing cumulative dose to the population by using available technology
- RG 1.140, as it relates to the design, testing, and maintenance of normal ventilation exhaust systems at nuclear power plants
- RG 1.143, as it relates to the seismic design and quality group classification of components used in the gaseous waste management system and the structures housing this system, as well as the provisions used to control leakage
- SRP Branch Technical Position Effluent Treatment Systems Branch (BTP ETSB) 11-5, as it provides guidelines to analyze postulated radioactive releases as a result of postulated leakage or failure of a waste gas charcoal delay systems

11.3.2 Summary of Technical Information

DCD Tier 2, Rev. 1, Section 11.3 describes the Gaseous Waste Management System (GWMS) and its Offgas System (OGS) used to control, collect, process, hold for decay, and discharge gaseous radioactive wastes generated during normal operation, including AOOs. The primary function of the GWMS is to process offgases containing radiolytic hydrogen and oxygen and use recombination to reduce hydrogen concentrations in downstream process components. Because there exists a potential for a buildup of explosive mixtures of hydrogen and oxygen, the GWMS and OGS should be designed to either withstand the effects of a hydrogen explosion, or have design features to preclude the formation or buildup of explosive gas mixtures in accordance with SRP Section 11.3 guidelines. The OGS must be designed to be detonation and seismic resistant and meet the requirements of RG 1.143.

The major input to the GWMS are offgases from the main condenser evacuation system, which is described in DCD Tier 2, Rev. 1, Section 10.4.2. The flow through the OGS consists of hydrogen and a carrier gas (air from in-leakage), fission and activation gases, and water vapors. For each train, gaseous influents flow through the following six stages of the OGS:

(1) a preheater, which preheats gases for improving recombiner efficiency;

(2) an hydrogen/oxygen recombiner, which recombines radiolytic hydrogen and oxygen into water;

(3) a cooler, which cools effluent gases out of the recombiner;

(4) a cooler/condenser, which removes moisture from cooled gases to protect the charcoal beds;

(5) a dryer, which removes residual moisture from gases out of the cooler/condenser;

(6) a charcoal guard bed, which protects the delay beds from abnormal moisture carryover, or chemical contaminants, by removing them from the gas stream; and

(7) two charcoal trains consisting each of four 100-percent capacity beds, which adsorb and retain radioactive isotopes of krypton, xenon, nitrogen, oxygen, and iodines.

The components of the OGS system are shown in DCD Figure 11.3-1 and described in Table 11.3-2. The charcoal vault, located in the turbine building, is temperature monitored and controlled. The major components include preheaters, recombiners, cooler/condensers, dryers, activated charcoal beds, and associated valves, pumps, and instrumentation. The recombiner-dryer portion of the system consists of two trains (Trains A and B) which are connected to charcoal beds. The charcoal vault houses two charcoal guard beds, and two trains of four charcoal beds each. Each guard bed contains about 7,500 kg (16,500 lbs) of charcoal and each adsorber bed contains about 27,750 kg (61,180 lbs) of charcoal. The design includes provisions to bypass the charcoal beds in the event of a fire, when excessive moisture is present, and during plant pre-operational testing and startup. A nitrogen purge line and an air supply line connection is provided to the first charcoal bed. A nitrogen purge would be used if a fire were detected in charcoal beds. The air supply line would be used to dry the charcoal bed if it were to become saturated with moisture. A nitrogen line is also provided in servicing the main charcoal beds. The OGS system includes various types of instrumentation, including oxygen and hydrogen analyzers, flow, temperature, and pressure measurements, radiation monitoring, and provisions for gas sampling. Control and monitoring are performed locally and remotely in the plant's control room. Liquid waste generated by the coolers, condensers, and dryers are processed by the LWMS.

The GWMS minimizes and controls releases of radioactive materials by delaying the flow of gases using activated charcoal adsorber beds. The charcoal adsorber beds retain radioactive isotopes of krypton, xenon, nitrogen, oxygen, and iodines via dynamic adsorption, resulting in significant delays during their transit through the beds. The holdup time for xenon radioactive gases in charcoal beds is estimated to be about 60 days and -**later**- days for radioactive krypton gases. Radioiodines are adsorbed and retained on the charcoal beds. Radioactive particles are removed either via condensation by the system's cooler and condenser components or retained in the charcoal beds. DCD Table 11.3-1 describes the operational parameters of the GWMS and OGS.

The turbine gland steam sealing system (TGSS) exhaust and the condenser air removal system (CARS) exhaust are routed to a common header that discharges to the environs via the Turbine Building Compartment Exhaust subsystem and plant stack. The exhaust from the plant stack is monitored for the presence of radioactivity. The TGSS uses clean steam from the auxiliary boiler or gland steam evaporator, with main steam used as a backup supply of steam. At startup, the CARS exhaust is routed to the Turbine Building Compartment Exhaust subsystem. During plant operation, the CARS exhaust is discharged to the GWMS/OGS where it is processed, as discussed earlier.

Discharges from the GWMS are routed to the plant stack where gaseous effluents are monitored by the PRMS, described in DCD Section 11.5. DCD Section 11.3.7 presents an analysis of the radiological impact of a postulated accident. DCD Tables 11.3-3 to 11.3-7 present the assumptions and system parameters used in the analysis, and also provides the results in assessing the consequences of the postulated accident, as specified in Branch Technical Position ESTB 11-5 of SRP Section 11.3.

Airborne radioactive materials present in buildings associated with process leakage and steam discharges are handled via each building's ventilation system. These releases are in addition to that from the GWMS' offgas system. With the exclusion of ventilation systems servicing clean areas of the plant, radioactive materials are released from the following buildings and systems:

- Reactor Building - Reactor Building HVAC System, consisting of the Reactor Building Contaminated Area HVAC, Refueling and Pool Area HVAC, and the Reactor Building HVAC Purge Exhaust.

- Turbine Building - Turbine Building HVAC System, consisting of Turbine Building Exhaust, Turbine Building Compartment Exhaust, and the Turbine Building Decontamination Room Exhaust.

- Fuel Building - Fuel Building HVAC System, consisting of the Fuel Building General Area HVAC, and the Fuel Building Fuel Pool Area.

- Radwaste Building - Radwaste Building HVAC System, consisting of the Radwaste Building General Area HVAC.

Although plant building exhaust systems are not normally filtered prior to their release, the ventilation systems servicing the reactor building and refueling building incorporate design features that provide automatic isolation and filtration of exhaust flows, prior to their release, under certain circumstances. Specifically, a high-radiation signal from specific monitors located in or next to exhaust ducts will result in isolation of the normal supply and (unfiltered) exhaust ducts to the affected area and will route the respective ventilation exhausts to the Reactor Building HVAC purge exhaust where it is filtered before being discharged via the plant vent. The exhaust of the radwaste building is filtered. Releases from these buildings as well as from the turbine building and radwaste building are conducted through the plant stack. The design bases, operation, and monitoring of such ventilation systems are described in DCD Sections 9.4.2, 9.4.3, 9.4.4, and 9.4.6. The monitoring and control of gaseous and particulate releases are provided by the plant radiation monitoring system (PRMS), as discussed in DCD Section 11.5.

11.3.3 Staff Evaluation

The applicant provided a waste gas system leak or failure analysis, as well as the justification for the assumptions used in that analysis. The analysis was performed to demonstrate that the GWMS design meets the applicable guidelines of BTP ETSB 11-5. This BTP stipulates that the total body dose at the exclusion area boundary (EAB), as a result of the release of radioactivity for two hours from a postulated failure of the GWMS, should be calculated in accordance with the BTP assumptions, and should not exceed 2.5 rem. The applicant analyzed the accident using a short-term (0–2 hours) atmospheric dispersion $\chi/Q$ of $1.0 \times 10^{-3}$ second per cubic meter

(sec/$m^3$) at the EAB, a release duration of 1 hour instead of 2 hours, as suggested by the BTP, and other supporting assumptions. The applicant assumed a release duration of 1 hour as being consistent with the isolation time of the ESBWR design. The applicant calculated a total body dose of 0.31 rem (3.1 mSv). The analysis, supporting assumptions, and results are presented in DCD Section 11.3.7.

The applicant calculated the amounts of radioactivity contained in gaseous effluents using the methodology of NUREG-0016, but not the BWR-GALE Code itself. The methods, major assumptions, and parameters are described in DCD Section 12.2.2.1, and the relevant parameters are listed in DCD Tables 11.3-1 and 12.2-15. The tables list some of the parameters related, in part, to the methodology of NUREG-0016. The parameters characterize design plant features, and plant parameters, dynamic adsorption coefficients for noble gases, atmospheric dispersion and deposition parameters, and amounts of charcoal contained in the charcoal adsorber beds. The estimates of average annual effluent concentrations and radioactivity levels discharged yearly are listed in DCD Tables 12.2-16 and 12.2-17.

DCD Table 12.2-17 presents gaseous effluent radionuclide concentrations in unrestricted areas and compares them to their respective gaseous effluent concentration limits of 10 CFR 20, Appendix B, Table 2, Column 1.

DCD Section 12.2.2.2 describes the method used to calculate doses to the maximally exposed individual due to gaseous effluent releases. Doses were calculated using the guidance of RG 1.109 (Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I) and the GASPAR II computer code, as described in NUREG/CR-4653 (GASPAR II - Technical Reference and User Guide). The key assumptions and parameters used in the calculations are listed in DCD Table 12.2-18a, with dose results presented in DCD Table 12.2-18b.

The DCD, however, does not present an assessment of population collective doses using the guidance of RG 1.110. A COL applicant referencing the ESBWR certified design should provide a site-specific cost-benefit analysis to address the requirements of Appendix I to 10 CFR 50 regarding population doses due to releases of gaseous effluents. The COL applicant will also demonstrate conformance with RG 1.110, as it relates to performing a site-specific cost-benefit analysis in reducing collective doses. This is COL Action Item 11.3-**later**, as identified in DCD Table - **later**.

The atmospheric dispersion and deposition parameters are dependent on site-specific features and will be provided by the COL applicant. A COL applicant referencing the ESBWR certified design should identify the location of the plant stack and distances to the EAB and locations to all appropriate offsite dose receptors and exposure pathways. For each location, the COL is responsible for developing the relevant long-term annual average atmospheric dispersion and deposition parameters. This is COL Action Item 11.3- **later**, as identified in DCD Table - **later**.

A COL applicant referencing the ESBWR certified design should identify in its plant-specific offsite dose calculation manual (ODCM) operational set-points for its GWMS radiation monitors, and standard radiological effluent controls (SREC) in monitoring and controlling the release of radioactive materials into the environment, thus eliminating the potential for unmonitored and uncontrolled release. The staff will review the operational set-points of gaseous effluent

radiation monitoring systems (RMS) on a plant-specific basis for each COL application, including the following:

- Plant stack RMS
- Reactor building HVAC exhaust RMS and its subsystems
- Containment purge exhaust RMS
- Turbine building combined ventilation exhaust RMS and its subsystems
- Radwaste building ventilation exhaust RMS
- Fuel building combined ventilation exhaust and its RMS subsystems

This is addressed as a COL Action Item in Chapter 11.5 of this PSER.

A COL applicant referencing the ESBWR certified design should identify the types of adsorbent media it plans to use for the main eight charcoal beds and two guard charcoal beds, and for the charcoal filters used in building ventilation exhaust systems, depending upon plant-specific design features of the GWMS/OGS and building HVAC systems. This is COL Action Item 11.3 - **later**, as identified in DCD Table - **later**.

The components of the GWMS (preheaters, recombiner, cooler/condenser, dryer, and hydrogen and oxygen analyzers) are located in the turbine building. The GWMS condenser drains are routed to the LWMS, which located in the radwaste building.

A COL applicant referencing the ESBWR certified design should describe the quality assurance (QA) program for design, fabrication, procurement, construction of structures, and installation of permanent or mobile GWMS systems and components in the facility in accordance with its overall QA program. The staff will review and evaluate the COL applicant's QA program in meeting the QA guidance specified in RG 1.21, 1.33, 1.143, and 4.15. This is COL Action Item 11.3 - **later**, as identified in DCD Table - **later**.

In DCD Sections 9.4.2, 9.4.3, 9.4.4 and 9.4.6, the applicant provided discussions of how HEPA filters meet the guidelines of RG 1.140, "Design, Testing, and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light Water Cooled Nuclear Power Plants." Similarly, DCD Sections 9.4.2, 9.4.3, 9.4.4, and 9.4.6 state that the exhaust filtration units of the fuel building, radwaste building, turbine building, and reactor building are designed and tested in accordance with American Society of Mechanical Engineers (ASME) Standards N-509-1989 and N-510-1989. These ASME standards discuss the instrumentation necessary for the periodic inspection and verification of system airflow rates, air temperatures, and filter pressure drops. Based on the above, the GWMS must comply with GDC 61, as it relates to radioactivity control in the GWMS and the ventilation systems associated with fuel storage and handling areas. A COL applicant referencing the ESBWR certified design should describe the program used in demonstrating how the guidance of RG 1.140 and ASME standards were used in installing and testing exhaust filtration units of the fuel building, radwaste building, turbine building, and reactor building. The staff will review and evaluate the

COL applicant's program in meeting the guidance described in RG 1.140 and ASME standards. This is COL Action Item 11.3 - **later**, as identified in DCD Table - **later**.

The following presents the staff's RAIs, the applicant's responses to the RAIs, and the staff's evaluation of these responses. The RAIs address technical issues associated with this section of the DCD and those that are supportive of the design bases and descriptions but that are located in other sections of the DCD. The RAIs are:

RAI No. 12.2.2-1 The evaluation of doses associated with airborne effluent releases is based on assumed atmospheric dispersion parameters given in DCD Tier 2, Rev. 1, Table 12.2-15. The text does not present any discussion about the assumptions used in developing the dispersion parameters at the stated distance of 800 m. A review of DCD Section 2.3.5 (Long-Term Diffusion Estimates) of the Design Control Document indicates that the parameters were derived using NRC guidance (NUREG-0800 and NUREG- 0324), but no details are provided on the assumptions used. It should noted that NUREG-0324 (Sept. 1977) has been superseded by NUREG/CR-2919 (Sept. 1982). Without this information, the staff cannot independently confirm the adequacy of the values given for the dispersion and deposition parameters used and resulting annual doses reported in DCD Table 12.2-18.

RAI No. 12.2.2-2 DCD Tier 2, Rev. 1, Table 12.2-16 presents anomalous radioactivity release inventories for Kr-87 and Xe-135 from the Offgas System. In both instances, the listed annual releases appear to be unrealistically low by orders of magnitude. Without a clarification, the staff cannot independently confirm the annual doses reported in DCD Table 12.2-18.

RAI No. 12.2.2-3 The evaluation of doses associated with airborne effluent releases is stated as being based on the methodology presented in NUREG-0016 and NUREG/CR-4653. The text does not present any discussion of the assumptions used in describing offsite dose receptor locations, rationale for the exposure pathways listed in DCD Tier 2, Rev. 1, Table 12.2-18, and a listing of all model parameters used in calculating doses. Without this information, the staff cannot independently confirm the annual doses reported in DCD Table 12.2-18.

RAI No. 12.2-9 The estimates of annual airborne activity releases presented in DCD Tier 2, Rev. 1, Table 12.2-16 could not be duplicated using the information presented in DCD Tables 12.2-15, 11.1-1, 11.3-1, 10.4-2, and 9.4-1, using the BWR-GALE Code (NUREG-0016). Please address the following in DCD Table 12.2-15:

a. Provide the basis for the offgas system flow rate or refer to the appropriate DCD section that presents this information. Reconcile different flow rates for this system, 54 vs 51 $m^3$/hr - see DCD Table 11.3-1.

b. Update DCD table to include parameters corresponding to input data cards no. 20 to 28 and 32 to the BWR-GALE Code.

c. Regarding input cards no. 23 to 24, confirm that the use of charcoal and HEPA filters are consistent with HVAC system descriptions of DCD Section 9.4 and Tables 9.4-3 to 9.4-11.

d. Regarding input card no. 32, update DCD entries on mass of charcoals to indicate whether the total amounts are for each operating train and state if only one or both trains will be used in parallel during routine operations.

e. Regarding input cards no. 20 to 21 and 25, confirm whether the steam used for the gland seal system is clean steam or main turbine steam. DCD Section 10.3.1 states that main turbine steam is used, but DCD Section 10.4.3 states that clean steam is used. Update DCD table to include the gland seal holdup time and iodine partition factor.

f. Reconcile the basis for noble gas release rate, 740 MBq/sec in DCD Table 12.2-15 vs 3700 MBq/sec in DCD Table 11.3.-1 as the average annual or normal operational release rates. Check for consistency with DCD Table 11.1-1

In DCD Table 10.4-2:

g. Update DCD table to include the air ejector holdup time and iodine partitioning factor.

In DCD Table 11.3-1:

h. Provide the basis of the major offgas maximum permissible concentrations and its applicability to the analysis.

Update DCD Tables 12.2-15, 10.4-2, and 11.3-1 accordingly.

RAI No. 12.2-9 Followup

The estimates of total annual airborne effluent releases presented in DCD Tier 2, Rev. 1, Table 12.2-16 could not be duplicated using the information contained GE responses to RAI No. 12.2-9 (dated July 21, 2006) and RAIs No. 11.1-1 and 11.1-2 (dated July 19, 2006), and the BWR-GALE Code (NUREG-0016). For example, the staff's analyses show results that are inconsistent even after making specific adjustments to results, such as for the assumed primary coolant radionuclide concentrations and plant capacity factor. Please address the following:

a. Since the BWR-GALE Code was not used by GE in deriving total annual effluent releases, provide a description of the alternate

method used, including adjustments made to address specific plant processes and/or radionuclides.

b. Provide technical discussions describing differences between the method used by GE and NUREG-0016. Include sufficient details in the response to facilitate the staff's review in comparing sources of differences.

RAI No. 12.2-9 Followup A review of DCD Tier 2, Rev. 1, Section 11.3.7 indicates that the radiological consequences of the postulated failure of the charcoal delay bed (Offgas system) were evaluated using the technical guidance of Branch Technical Position ESTB 11-5, as described in SRP Section 11.3.II. The method described in ESTB 11.5 requires the use of the BWR-GALE Code (NUREG-0016). However, a review of GE's response to NRC RAI No. 12.2-9(b) (GE letter of July 21, 2006, MFN 06-212) states that BWR-GALE Code was not used in the analysis providing an estimate of annual airborne effluent releases. Accordingly, reconcile this inconsistency, update the methodology described in DCD Section 11.3.7, update the analytical parameters listed in DCD Tables 11.3-4 to 11.3-7, and revise doses if the analysis is updated. Without this clarification and updated information, the staff cannot independently confirm the approach and dose results presented in DCD Section 11.3.7.

RAI No. 12.2-11 The estimated annual beta air dose and annual gamma air dose due to airborne releases presented in DCD Tier 2, Rev. 1, Table 12.2-18b could not be duplicated using the information presented in DCD Tables 12.2-15, 12.2-17, and 12.2-18a and the GASPAR II Code (NUREG/CR-4653). Please address the following and update DCD Table 12.2-18b accordingly:

a. Review and update the listed beta and gamma air doses, ordescribe and provide any modifiers applied in adjusting code results and update DCD Table 12.2-18a.

b. Confirm the radiological unit used to report the beta and gamma air doses, either as mrad/year or mGy/year given that the rest of the data presented in the table are expressed in SI units.

RAI No. 12.2-12 The estimated annual average doses from airborne effluents listed in DC Tier 2, Rev. 1, Table 12.2-18b for the milk pathway do not specify whether the results are for cow milk or goat milk consumption. Insert a qualifier to DCD Table 12.2-18a or 12.2-18b stating the basis for the milk exposure pathway. Update either DCD table accordingly.

11.3.4 Conclusions

- **Later** -

## 11.4 Solid Waste Management System

### 11.4.1 Regulatory Criteria

The following acceptance criteria are applicable:

- 10 CFR Part 20.1302, as it relates to radioactive materials released in gaseous and liquid effluents to unrestricted areas. These criteria apply to releases resulting from SWMS operation during normal plant operations and anticipated operational occurrences.

- 10 CFR Part 20.1406, as it relates to facility design and operational procedures for minimizing the contamination of the facility and generation of radioactive waste

- 10 CFR Part 20.2006 and Appendix G to Part 20, as they relate to the transfer and manifesting of radioactive waste for disposal at licensed land disposal facilities

- 10 CFR Part 50.34a, as it relates to providing adequate system design information being provided to demonstrate that design objectives for equipment necessary to control releases of radioactive effluents to the environment resulting from SWMS operation have been met

- GDC 60, as it relates to the design of the SWMS incorporating means to handle solid wastes produced during normal plant operation, including AOOs

- GDC 63 and 64, as they relate to the design of the radioactive management system to control and monitor radiation levels and releases of radioactivity

- 10 CFR Part 61, as it relates to the classification, processing, and disposal of solid radioactive wastes

- 10 CFR Part 71, as it relates to the packaging of radioactive materials

- 49 CFR Parts 171 - 180, as they relate to the packaging of waste, labeling of waste containers, placarding of waste shipments, and transportation of radioactive materials

Specific acceptance criteria for the relevant requirements identified above are as follows:

- The development of a plant-specific process control program (PCP) should meet the provisions of Generic Letter 89-01 (Supplement No. 1) and guidance of NUREG-1302 for BWR plants.

### 11.4.2 Summary of Technical Information

DCD Tier 2, Rev. 1, Section 11.4 describes the Solid Waste Management System (SWMS) used to control, collect, handle, process, package, and temporarily store wet and dry solid

radioactive waste prior to shipment. Radioactive wastes will be generated during normal operation and AOOs. The SWMS is located in the radwaste building. The SWMS system process wastes from the LWMS, reactor water cleanup/shutdown cooling system, fuel and auxiliary pools cooling system, and condensate purification system. The SWMS is a non-safety-related system and has no accident mitigation functions. The SWMS is comprised of the following four subsystems:

(1) wet solid waste collection subsystems;

(2) mobile wet solid waste processing subsystem;

(3) dry solid waste accumulation and conditioning subsystem; and

(4) container storage subsystem.

The components of the SWMS are shown in DCD Figure 11.4-1 and described in DCD Table 11.4-1. The permanently installed equipment include six holdup tanks, recirculation and decant pumps, valves, piping, vents, control panels, and instrumentation. The high activity tank and the low activity tank have a nominal capacity of about 70,000 liters (18,500 gallons) each, and the two low activity low-phase separator tanks have a nominal capacity of about 55,000 liters (14,500 gallons) each. This system is equipped with two decant pumps each, with a nominal flow rate of about 330 liters per minute (88 gallons per minute) each; two resin transfer pumps with a nominal flow rate of about 380 liters per minute (100 gallons per minute); and three circulation pumps with nominal flow rates of about 3,330 liters per minute (880 gallons per minute). The condensate resin holdup tank has a nominal capacity of about 70,000 liters (18,500 gallons). The condensate resin system is equipped with a circulation pump with a nominal flow rate of about 3,330 liters per minute (880 gallons per minute) and a resin transfer pump with a nominal flow rate of about 379 liters per minute (100 gallons per minute). The concentrated waste tank has a nominal capacity of about 60,000 liters (15,800 gallons). This system is equipped with two pumps with a nominal flow rate of about 1,330 liters per minute (350 gallons per minute) each.

The SWMS system can be operated from local panels and from the radwaste control room. The instrumentation monitors tank levels, process flow rates, radiation levels, etc. There are no provisions to release liquid wastes from the SWMS system. Releases of liquid wastes are conducted through the LWMS.

The design and operation of the SWMS is characterized by the use of mobile processing subsystems to process wet and solid wastes. The wastes originate from the wet solid waste collection system, including the high and low activity resin holdup tanks, low activity sludge phase separator tanks, condensate resin tanks, and the floor drain concentrate waste tank. Each mobile waste processing subsystem has provisions to return waste to permanently installed plant equipment, including to the high activity resin holdup tank, the low activity phase separator, and the floor drain collection tank. The major components of the mobile waste processing subsystems include dewatering fill heads, feed tanks, feed and return pumps, thermal dryer, waste sorting tables, and waste conditioning and packaging modules.

The container storage subsystem is designed to process solid wastes. Solid wastes include spent filter cartridges, HEPA filters, paper, rags, plastics, protective clothing, tools, and

contaminated equipment generated during plant operations and refueling and maintenance outages. DCD Figure 11.4-1 provides a conceptual description of the process used in handling dry solid and wet wastes.

Spent activated charcoal from the GWMS/OGS is not expected to be routinely disposed of as radioactive waste. Rather, the spent activated charcoal will be regenerated in place by the OGS. In the event that activated charcoals contained in the guard or main beds become contaminated with chemicals or saturated with water, the replacement of the charcoals in affected beds will be addressed under operational procedures.

The expected amounts of radioactive waste generated yearly are listed in DCD Table 11.4-2. The estimates include about 363 cubic meters (12,830 cubic feet) for dry active solid waste (DAW) and 111 cubic meters (3,920 cubic feet) for wet solid wastes. Dry solid waste include combustible and compactable, and other unspecified waste forms. Wet solid wastes are comprised of spent resins, filter sludge, and waste concentrates from the LWMS. The early generated amounts are estimated to be about 55 cubic meters (1,940 cubic feet) for spent resins, about 6 cubic meters (210 cubic feet) for filter sludge, about 50 cubic meters (1,770 cubic feet) for waste concentrates.

Onsite storage capacity is designed for 6 months of waste generation, as packaged waste. Waste packaging includes 55-gallon drums (210 liters), high-integrity containers (HIC), shielded filter containers, etc. The specific design features of the solid waste processing subsystem are not described and are left to the COL applicant to define the specifications and procurement through qualified vendors. The services may include truck-mounted waste treatment systems and the use of offsite waste processing services, such as for waste compaction, treatment, decontamination, etc.

The SWMS is serviced by the exhaust system of the radwaste building, which includes a HEPA filtration system. Releases from this building are conducted and monitored via the plant stack. The design bases, operation, and monitoring of the radwaste building ventilation system are described in DCD Section 9.4.3. The monitoring and control of gaseous and particulate releases from the plant stack are provided by the plant radiation monitoring system (RMS), as discussed in DCD Section 11.5. The plant systems used to process and treat liquid and gaseous effluents, and assessment of doses to members of the public associated with effluent releases from the SWMS are described in DCD Sections 11.2 and 11.3, and 12.2.2, respectively.

11.4.3 Staff Evaluation

The specific design features of each mobile subsystem are not described and are left to the COL applicant in defining specifications and procurement of each subsystem through qualified vendors. The design of subsystems and components of mobile waste processing subsystems that are used by contractors offsite on behalf of the applicant to process wet solid wastes and chemical wastes are not within the scope of the ESBWR standard design. The selection of mobile processing subsystems is expected to consider most effective treatment technologies, based on chemical and radiological properties of the wastes to be processed over the life of the plant. DCD Section 11.4.1 states that design of the SWMS meets the requirements identified in RG 1.143, as they relate to the seismic design and quality group classification of the components and structures housing this system, as well as the provisions to control leakage.

The staff will review, on a plant-specific basis, the mobile waste processing subsystems and associated operating procedures proposed by the COL applicant against the guidelines of RG 1.143, IE Bulletin 80-10, BTP ETSB 11-3, and 10 CFR Part 20.1406.

A COL applicant referencing the ESBWR certified design should discuss how any mobile processing equipment intended for use in the processing of solid and wet radwaste meets the guidelines of RG 1.143, IE Bulletin 80-10, BTP ETSB 11-3, and 10 CFR Part 20.1406. It should also include a discussion of the use of mobile equipment containing wet solid wastes in non-seismic temporary facilities and structures. This is ITAAC/DAC Action Item 11.4 - **later**, as identified in DCD Table - **later**.

Section 11.4 of the DCD does not present an assessment of population collective doses from liquid and gaseous effluent releases associated with the operation of SWMS. A COL applicant referencing the ESBWR certified design should provide a site-specific cost-benefit analysis, using the guidance of RG 1.110, to address the requirements of Appendix I to 10 CFR 50 regarding population doses due to releases of liquid and gaseous effluents. Alternatively, the cost-benefit analysis may be incorporated in the analysis supporting the cost-benefit evaluation of the LWMS described in DCD Section 11.2 for liquid wastes generated by the SWMS, and GWMS described in DCD Section 11.3 for gaseous wastes generated by the SWMS. The COL applicant will demonstrate conformance with RG 1.110, as it relates to performing a site-specific cost-benefit analysis in reducing collective doses. This is COL Action Item 11.4 -**later**, as identified in DCD Table - **later**.

A COL applicant referencing the ESBWR certified design should describe the quality assurance (QA) program for the design, fabrication, procurement, construction of structures, and installation of SWMS components and operational interface of mobile waste processing subsystems in the facility in accordance with its overall QA program. The staff will review and evaluate the COL applicant's QA program in meeting the QA guidance specified in RG 1.21, 1.33, 1.143, and 4.15. This is COL Action Item 11.4- **later**, as identified in DCD Table - **later**.

DCD Section 11.4.6 states that the packaging and disposal of dry, solid and wet wastes will observe the requirements of 10 CFR Parts 61.55 and 61.56, Appendix G to 10 CFR 20, 40 CFR Part 190, and relevant DOT regulations. The verification of waste characteristics, waste packaging, and waste disposal are within the responsibility of the COL applicant. Similarly, the staff expects that the COL applicant will develop and maintain a process control program (PCP) in compliance with 10 CFR Part 61, which identifies the operating procedures (i.e., boundary conditions for a set of process parameters, such as settling time, drain time, drying time, etc.) for processing wet solid wastes. Therefore, for each COL application, the staff will review the PCP, including dewatering and solidification, and determine whether the COL application demonstrates that the SWMS complies with the requirements of 10 CFR Part 61.55, 10 CFR Part 61.56, 10 CFR Part 71, and relevant DOT shipping regulations under 49 CFR Part 171 - 180.

A COL applicant referencing the ESBWR certified design should submit a PCP that identifies the operating procedures for processing wet solid wastes meeting the provisions of Generic Letter 89-01 (Supplement No. 1), and guidance of NUREG-1302 for BWR plants, and should address the issues raised in Generic Letters (GLs) 80-009 (Low Level Radioactive Waste Disposal) and GL 81-039 (NRC Volume Reduction Policy). The PCP (or sections of the PCP) for mobile waste processing systems should include discussions on conformance with

RG 1.143, IE Bulletin 80-10, BTP ETSB 11-3, and 10 CFR Part 20.1406. Collectively, these items are included as COL Action Item 11.4- **later**, as identified in DCD Table - **later**.

In GL 81-38, "Storage of Low-Level Radioactive Wastes at Power Reactor Sites," the staff provided guidance to licensees on the addition of onsite storage facilities for low-level radioactive wastes generated onsite. The staff recognizes that the need for additional onsite storage capacity for low-level radioactive wastes, beyond what has been provided in the ESBWR standard design, are site-specific and depend on regional considerations addressing the disposal of low-level radioactive wastes. This need will depend upon the regional availability of offsite low-level waste storage space or disposal capacity for the plant's wastes. Therefore, when such a need is identified, the COL applicant should submit the details of any proposed onsite, low-level radioactive waste storage facility to the NRC. The staff will evaluate the design of the proposed additional site-specific storage facility against the guidelines in GL 81-38, which is similar to the guidance in Appendix 11.4-A to SRP Section 11.4. At this time, the staff did not find it necessary to create a COL action item regarding the issues raised in GL 81-38 and, instead, the staff asked the applicant in RAI No. 11.4-3 to address them. In response, the applicant revised DCD Section 11.4.6 to identify Appendix 11.4-A to SRP Section 11.4 as a COL Action Item. The staff finds the revision to DCD Section 11.4.6 to be acceptable.

The DCD states that spent activated charcoal from the GWMS/OGS is not expected to be routinely disposed of as radioactive waste. Rather, spent activated charcoals will be regenerated in place by the OGS. The replacement of unusable charcoals in affected beds of the OGS will be addressed under an operational program and procedures. The staff will review and evaluate the COL applicant's program and procedures for the handling and disposal of spent charcoal in the context of the PCP. This is COL Action Item 11.4- **later**, as identified in DCD Table - **later**.

The following presents the staff's RAIs, the applicant's responses to the RAIs, and the staff's evaluation of these responses.

RAI No. 11.4-1 DCD Tier 2, Rev. 1, Section 11.4 states that the four subsystems of the solid waste management system (SWMS) are depicted in Figure 11.4-1. A review of Figure 11.4-1 indicates that the container storage subsystem is not shown in this figure. Update DCD text and figure accordingly.

RAI No. 11.4-2 The design bases section (DCD Tier 2, Rev. 1) Section 11.4.1 does not acknowledge the acceptance criteria of SRP Chapter 11.4.II. The following criteria are not listed nor addressed: Part 20.1302; Part 20, Appendix B effluent concentrations; Part 20 Appendix G; Part 20.1406; Part 50.34a; Part 50.36a; Part 50 Appendix A GDC 60, 61, 63, and 64; Parts 61.55 and 61.56; SRP BTP (ESTB) 11-3; SRP Appendix 11.4-A; 40 CFR Part 190; Regulatory Guide 8.10; IE Bulletin No. 80-10; and Process Control Program (see Generic Letter 89-01, Suppl. 1 and NUREG-1302). Address the applicability of these criteria either as part of the design of structures, systems, and components (SSC), or as the responsibility of the COL applicant. Revise DCD Section 11.4.1 to include applicable design criteria, update descriptions of associated SSCs in DCD Section 11.4.2; update the safety evaluation of DCD Section

11.4.3; revise testing and inspection requirements of DCD Section 11.4.4; update instrumentation requirements of DCD Section 11.4.5; and identify information to be provided by the COL applicant in DCD Section 11.4.6. Update references in DCD Section 11.4.7 accordingly.

RAI No. 11.4-3 The provision for onsite storage of radwaste stated in DCD Tier 2, Rev. 1, Section 11.4.1 is inconsistent with SRP 11.4.II and SRP Appendix 11.4-A. The SRP refers the need to consider radwaste storage capabilities for several years (up to 5 years). The guidance places emphasis on the future availability or accessibility to low-level waste disposal sites, and safety considerations in the storing, handling and eventual disposition of radwaste. Accordingly, describe the design features of the SWMS facility with a provision for storing radwaste up to 5 years. Alternatively, state whether the design and construction of a long-term radwaste storage facility is the responsibility of the COL applicant. Update the provision for onsite storage of radwaste stated in DCD Section 11.4.1 to be consistent with SRP 11.4.II and SRP Appendix 11.4-A.

RAI No. 11.4-4 Part 20.1406 describes requirements on how design features and operational procedures will minimize, to the extent practicable, contamination of the facility and the environment, facilitate decommissioning, and minimize the generation of radioactive wastes. A review of DCD Tier 2, Rev. 1, Section 12.6 indicates that design features and operational procedures described there focus on permanently installed systems. However, this discussion should describe how design features and operational procedures will be implemented with mobile and portable SWMS systems. Update DCD Section 11.4.1 to describe design features addressing the requirements of Part 20.1406 as they apply to the installation and use of portable/mobile SWMS and describe in DCD Section 11.4.6 the information to be provided by the COL applicant.

RAI No. 11.4-5 DCD Tier 2, Rev. 1, Section 11.4.2.1 notes that there will be no liquid discharges from the plant, but Section 11.2.2 assumes that such discharges will occur and provides dose estimates based on liquid effluent discharge rates. Reconcile this internal inconsistency by clarifying whether such types of liquid wastes will be routinely discharged or processed and reused, as discussed in DCD Section 11.2.3. Update the text in DCD Sections 11.4.2.1, 11.2.2, and 12.2.3, accordingly.

RAI No. 11.4-6 A review of DCD Tier 2, Rev. 1, Section 11.4.2.2 describing the operations of the dry waste accumulation and conditioning subsystem indicates that compaction is not considered as a mean of reducing the volumes of compressible and compactible dry active wastes. SRP BTP ETSB 11-3 and Appendix 11.4-A recommend the use of waste volume reduction methods to reduce the amounts of waste shipped offsite for disposal and maximize the utilization of space at onsite radwaste storage facilities. Provide a discussion on the use of waste volume reduction technologies by types of radwastes and how such methods will be incorporated in the design of the radwaste building and facility operations

in controlling effluent releases and occupational exposures. Update equipment descriptions in DCD Table 11.4-1 and revise DCD Table 11.4-2 projected radwaste volumes to the reflect the application of waste volume reduction technologies.

RAI No. 11.4-7 DCD Tier 2, Rev. 1, Section 11.4.2.2 does not address the waste classification requirements of Part 61.55 and waste characteristics of Part 61.56 for disposal. Provide a discussion addressing the expected distribution of Class A, B, C, and greater-than-Class C wastes expected to be generated under the provisions of Part 61.55. Provide a discussion of the expected waste characteristics shipped for disposal under the provisions of Part 61.56. Provide a discussion on how waste acceptance criteria of radwaste disposal facilities will be met using SWMS subsytems and update DCD Section 11.4.2.2 accordingly.

RAI No. 11.4-8 DCD Tier 2, Rev. 1, Section 11.4.2.2 does not address the waste classification guidance of RG 1.143 in designing radwaste systems. Provide a discussion addressing how the three safety classes or classifications for radwaste management facilities were addressed in the proposed design of the SWMS and update DCD Section 11.4.2.2 accordingly.

RAI No. 11.4-9 A review of the types of dry wastes described in DCD Tier 2, Rev. 1, Section 11.4.2.2 indicates that spent charcoal is not included in the description. The proposed design of the charcoal vault (See DCD Section 11.3) indicates that over 30,000 kg of charcoal will be contained in tanks. Given that the spent charcoal will be periodically replaced, provide an estimate the amounts of spent charcoal that will be generated yearly as radwaste from the turnover of the guard beds (2 tanks) and main parallel trains (8 tanks), and describe the provisions that will be used to manage and ship spent charcoal for disposal. Update equipment descriptions in DCD Table 11.4-1 and revise DCD Table 11.4-2 to include an annual estimate of the projected amounts of spent charcoal shipped as radwaste.

RAI No. 11.4-10 A review of DCD Tier 2, Rev. 1,Table 11.4-2 indicates that the basis of a waste volume reduction factor is missing. Provide the basis for the stated waste volume reduction factor of two for the “LWMS Concentrated Waste” stream. Describe the type of waste volume reduction technology that would be used to achieve such a volume reduction. Update DCD Table 11.4-2 accordingly.

RAI No. 11.4-11 A review of DCD Tier 2, Rev. 1, Section 11.4.3 indicates that the text does not identify provisions, systems, or procedures addressing the detection of radioactivity in non-radioactive systems (as interface) to prevent unmonitored and uncontrolled releases of radioactive materials in the environment. See regulatory positions from RG 1.143 and IE Bulletin No. 80-10 for details. Describe system design features and operational procedures to ensure that inter connections between plant systems and

mobile processing equipment will avoid the contamination of non-radioactive systems or uncontrolled and/or unmonitored releases of radioactivity in the environment. Update DCD Section 11.4-3 accordingly.

RAI No. 14.16 A review of the types of radioactive wastes described in DCD Tier 2, Rev. 1, Section 11.4.2.2 indicates that there is no discussion on the generation of mixed wastes and how mixed wastes (with chemical and radiological hazards) will be processed. Provide a description of permanently installed or mobile treatment systems (processing equipment, tanks, pumps, etc.) that will be used to process, handle, and package and ship mixed wastes. Describe information and operational considerations that would be addressed by the COL applicant in the process control program. Update equipment descriptions in DCD Table 11.4-1 and revise DCD Table 11.4-2 to include an annual estimate of the projected amounts of mixed wastes.

RAI No. 14.17 A review of the types of radioactive wastes described in DCD Tier 2, Rev. 1, Section 11.4.2.2 indicates that there is no discussion on how large items, such as vessels, tanks, pumps, core components, etc. will be handled. Provide a description of equipment (cranes, decon equipment, etc.) and features of the radwaste building (shielding, staging areas, etc.) that will be used to process, handle, and package and ship large plant components. Describe information and operational considerations that would be addressed by the COL applicant in the process control program. Update equipment descriptions in DCD Table 11.4-1 and revise DCD Table 11.4-2 to describe the types and numbers, or projected amounts of such wastes.

11.4.4 Conclusions

- **Later** -

11.5 Process Radiation Monitoring System

11.5.1 Regulatory Criteria

The following acceptance criteria are applicable:

- 10 CFR Part 20.1302, as it relates to radioactivity monitoring of effluents released to unrestricted areas
- 10 CFR Part 20.1406, as it relates to facility design and operational procedures for minimizing the contamination of the facility and generation of radioactive waste
- 10 CFR Part 50, Appendix A, GDC 19, as it relates to provisions used in controlling radiation exposures and doses to control room operators during normal operations and postulated accident conditions

- 10 CFR Part 50, Appendix A, GDC 60, as it relates to controlling releases of radioactive materials to the environment

- 10 CFR Part 50, Appendix A, GDC 63, as it relates to the monitoring of fuel and waste storage

- 10 CFR Part 50, Appendix A, GDC 64, as it relates to monitoring radioactive releases from the containment and effluent discharge pathways in plant environs

- 10 CFR Part 50.34a, as it relates to the design of equipment and procedures to control releases of radioactive materials to the environment within the numerical guidance provided in Appendix I to 10 CFR Part 50

- Appendix I to 10 CFR Part 50, as it relates to numerical guides for design objectives to meet the requirements of Part 50.34a and Part 50.36a, which specify that radioactive effluents released to unrestricted areas will be kept ALARA

- 10 CFR Part 50.34(f)(2)(xvii) and 10 CFR Part 50.34(f)(2)(xxvii), as they relate to monitoring radiation and radioactivity levels for routine operating and accident conditions, consistent with the requirements of GDC 63 and 64

- 10 CFR Part 50.34(f)(2)(xxviii), as it relates to monitoring radiation and radioactivity levels and control room habitability, consistent with the requirements of GDC 19

The relevant requirements of the regulations identified above are met by using the regulatory positions and guidance contained in the following RGs and industry standards:

- The design of systems should meet the provisions of the applicable regulatory positions given in RG 1.21, RG 1.33, RG 1.97, and RG 4.15, and guidance from Appendix 11.5-A of SRP Section 11.5
- The gaseous and liquid process streams, or effluent release points, should be monitored and sampled according to Tables 1 and 2 of SRP Section 11.5

- The design of aerosol sampling systems should follow the guidance of ANSI/HPS N13.1-1999

- The design of continuous radiation monitoring systems should follow the guidance of ANSI N42.18-1980

- The design of the instrumentation and sampling systems used in the event of a postulated accident should meet the provisions of SRP Sections 9.3.2, 11.2, and 11.3

- The development of the plant's standard radiological effluent controls (SREC), offsite dose calculation manual (ODCM), and the radiological environmental monitoring program (REMP) should meet the provisions of Generic Letter 89-01 (Supplement No. 1), Radiological Assessment Branch Technical Position (Rev.

1, Nov. 1979), and guidance of NUREG-1302 for BWR plants and NUREG-0133.

11.5.2 Summary of Technical Information

DCD Tier 2, Rev. 1, Sections 11.5.1 and 11.5.2 list the design bases and criteria of the process radiation monitoring system (PRMS). The PRMS is used to measure and control releases of radioactive materials in plant process streams and liquid and gaseous effluents. The design objectives and criteria of the PRMS are based on requirements that address:

- Radiation monitoring instrumentation required for plant safety
- Radiation instrumentation required for monitoring and plant operation

The PRMS consists of skid-mounted and permanently installed sampling and monitoring equipment designed to indicate operational radiation levels and releases of radioactive materials, equipment or component failures, and system malfunctions or improper operation. The PRMS generates signals to initiate the operation of certain safety-related equipment to control radioactive releases under normal and abnormal operations, and accident conditions.

In the ESBWR design, the PRMS includes subsystems designed for safety and protection. The following PRMS subsystems provide signals and initiate automatic safety functions:

- Reactor building heating, ventilating, and air conditioning (HVAC) exhaust radiation monitoring subsystem (RMS)
- Refuel handling area HVAC exhaust RMS
- Control building air intake HVAC RMS
- Drywell sumps low conductivity waste/high conductivity waste (LCW/HCW) discharge RMS
- Isolation condenser vent exhaust RMS
- Fuel building main area HVAC RMS
- Containment purge exhaust RMS

The other subsystems of the PRMS monitor plant operations and provide information on levels of radioactivity present in process streams and liquid and gaseous effluents. The following PRMS subsystems provide signals and initiate automatic isolation functions and provide the means to collect process and effluent samples for radiological analysis:

- PRMS subsystems for gaseous effluents
  - Plant stack RMS
  - Turbine building normal ventilation air HVAC RMS
  - Turbine building compartment area air HVAC RMS
  - Radwaste building ventilation exhaust RMS
  - Main turbine gland seal steam condenser exhaust RMS

- Fuel building combined ventilation exhaust RMS
- Turbine building combined ventilation exhaust RMS
- Fuel building ventilation exhaust air handling unit (AHU) RMS

• PRMS subsystems for liquid effluents

- Liquid radwaste discharge RMS

• PRMS subsystems for gaseous process streams

- Main steamline RMS
- Offgas pre-treatment RMS
- Offgas post-treatment RMS
- Charcoal vault ventilation RMS
- Drywell fission product RMS

• PRMS subsystems for liquid process streams

- Reactor component cooling water intersystem leakage RMS

• PRMS subsystems for gaseous intake streams

- Technical support center HVAC air intake RMS

DCD Sections 11.5.5, 9.3.2, and 7.5.2 describe the features of the process monitoring and sampling. DCD Tables 11.5-1, 11.5-2, 7.5-2, and 9.3.1describe the design for monitoring and sampling these process and effluent streams. The system consists of permanently installed sampling lines, sampling panels with analyzers and associated sampling equipment, provisions for local sampling, and permanently installed radiation shielding. The descriptions include a listing of process and effluent systems with such features, selection of locations for the placement of RMS monitors, number of RMS channels, provisions for grab sampling, and expected radiation levels, and types of alarms and trips. Sampling stations or points are provided for the following systems:

• Reactor building

- Reactor water cleanup/shutdown cooling system (RWCU/SDC)
- Control rod drive system
- Fuel and auxiliary pool cooling system (FAPCS)

• Turbine building

- Condensate and feedwater system
- Moisture separator and reheater system
- Heater drain and vent system
- Generator cooling system
- Turbine main steam system

• Condensate polishing

- Condensate and feedwater system
- Condensate purification system

- Condenser
  - Main condenser and auxiliaries
- Radwaste building
  - Equipment and floor drain input
- Auxiliary Boiler

Local grab sampling stations are provided for the following systems:

- Reactor component cooling water system
- Turbine component cooling water system
- Plant service water system
- Chilled water system
- Circulating water system
- Standby liquid control system

For gaseous effluents, the system provides for continuous and representative sampling of radioactive airborne particulates, radioiodines, and noble gases from the plant vent. The system also provides for grab sampling for noble gases, radioiodines, particulates, and tritium for the gaseous radwaste system discharge. For liquid process and effluent streams, the system provides grab sampling and analysis capability for gross radioactivity determination, identification of principal radionuclides and alpha emitters, and measurement of their concentrations. DCD Sections 7.5.2, 7.5.3, and 9.3.2 describe the features of the post-accident sampling system and process sampling system.

11.5.3 Staff Evaluation

The primary purpose of the PRMS is to provide information characterizing the types and amounts of radioactivity contained in process streams and liquid and gaseous effluents. Another objective is to alert the control room of abnormal levels of radioactivity in process streams and liquid and gaseous effluents, and provide signals that initiate automatic safety functions, isolate process streams, and terminate effluent discharges if pre-determined radioactivity levels or release rates exceed alarm set-points. Another function of the PRMS is to provide the means to collect samples from process and effluent streams for radiological analysis.

DCD Tier 2, Rev. 1, Section 11.5.3 provides descriptions of the operational features of each subsystems of the PRMS. DCD Section 11.5.4 presents a regulatory evaluation of the PRMS addressing the basis of the selection for the locations of subsystem components, expected radiation or radioactivity levels, instrumentation and sample collection, and requirements for establishing alarm or trip instrumentation set-points. The PRMS system include beta and gamma radiation sensitive detectors working in redundant channels as required for each

subsystem. The radiation detectors are capable of detecting the types and energies of radiation emitted from fuel, radioactive wastes, and process and effluent streams. A local readout and alarm module are located at specific areas to provide information on the radiological status of plant systems and alert personnel of abnormal or accident conditions.

DCD Figure 11.5-1 and Table 11.5-3 provide information about the locations of PRMS subsystems by plant systems and within plant buildings. DCD Table 11.5-1 provides information on plant processes that are monitored, number of RMS channels, and operational range of each subsystem. DCD Table 11.5-2 describes the operational features of each gaseous and airborne PRMS subsystems, including the configuration, dynamic detection ranges, principal radionuclides measured, and types of alarm functions. DCD Table 11.5-4 describes the operational features of the liquid process and liquid effluent PRMS subsystems, including the configuration, dynamic detection ranges, principal radionuclides measured, and types of alarm functions. DCD Tables 11.5-5 and 11.5-6 present summary descriptions of radiological analyses for liquid and gaseous process samples, including types of samples, sampling frequency, type of radiological analyses, analytical sensitivity, and purpose. DCD Tables 11.5-7 and 11.5-8 provide descriptions of radiological analyses for liquid and gaseous effluent samples, including types of samples, sampling frequency, types of radiological analyses, analytical sensitivity, and purpose.

DCD Section 11.5.2.1 indicates that the PRMS subsystems required for safety incorporate the following major design requirements: capable of withstanding the effect of natural phenomena without the loss of operational function; perform safety functions during normal and abnormal conditions, meet the reliability, testability, independence, and failure mode requirements of engineered safety systems; use redundant channels satisfying the separation and single failure criteria for the initiation of safety functions; provide compatibility with expected radiation levels and ranges under normal operation, and abnormal and accident conditions; provide the means for checking the availability and operational status of each RMS channel and calibration and functional checks; provide continuous RMS output and alarms levels in the plant's control room; and register full scale when radiation detection levels exceed the operational range of each subsystem.

DCD Section 11.5.2.2 states that the PRMS subsystems required for plant operation incorporate the following major functional requirements: provide continuous RMS output and alarms levels in the plant's control room; register full scale when radiation detection levels exceed the operational range of each subsystem; provide self-diagnosis for instrumentation malfunctions, with annunciation provided in the plant's control room and isolation of effluent discharges; ensure compatibility with expected radiation levels and ranges under normal operation, and abnormal and accident conditions; monitor a representative sample of bulk stream or volume of process and effluent streams; and incorporate provisions for instrumentation calibration and functional checks.

DCD Section 11.5.6 describes the requirements for the calibration, inspection, testing, and maintenance of the PRMS. The PRMS system includes provisions for self-diagnosis and online calibrations of process monitors that operate continuously. Each monitor channel has provisions to conduct periodic calibrations using standard radiation sources or electronic test signals. The PRMS system includes design features to facilitate the maintenance using modules that can be removed for repairs or replacement. At this time, the derivation of each system's lower dynamic range and sensitivity (lower limit of detection) are left to the COL

applicant based on site-specific conditions, type of RMS installed, and operating characteristics of each installed subsystem.

DCD Sections 11.5.3.1.3 and 11.5.3.2.13 describe the designs of the PRMS subsystems use to monitor the air intakes of the control building and technical support center, respectively, as being compliant with GDC 19 of Appendix A to 10 CFR Part 50. Each RMS subsystem includes provisions to initiate the isolation of the outside air intake and exhaust dampers and startup of the emergency air filtration system when doses to control room operators and occupants of the technical support center are expected to exceed 0.05 Sv (5 rem), as total effective dose equivalent for the duration of a postulated accident.

In complying with the numerical objectives in 10 CFR Part 50, Appendix I, for offsite doses resulting from gaseous and liquid effluents during plant operation and abnormal operational occurrences, COL holders will need to limit annual and quarterly offsite doses. Additionally, if an applicant proposes to use permanent or mobile treatment systems described in DCD Section 11.2 (liquid waste) and Section 11.3 (gaseous waste), the requirements for this design objective will be deemed in compliance if annual doses are not greater than 3 millirem (0.03 mSv) for liquid effluents and 5 millirem (0.05 mSv) for gaseous effluents, using the guidance of RG 1.109 in defining effluent release pathways and exposure pathways for members of the public located in unrestricted areas. The COL applicant will implement the items described above in a plant-specific offsite dose calculation manual (ODCM). DCD Section 11.5.7 states that the COL applicant is responsible for addressing 10 CFR Part 50, Appendix I guidelines for offsite individual doses and population doses via liquid and gaseous effluents. This is COL Action Item 11.5- **later**, as identified in DCD Table - **later**.

Additionally, a COL applicant will be required to limit average annual effluent concentrations from the LWMS and GWMS to comply with 10 CFR Part 20.1302, which defines dose criteria and radionuclide concentration limits in liquid and gaseous effluents. A COL applicant will provide the associated set-points for the applicable PRMS subsystems in a plant-specific ODCM.
The staff will review the operational set-points of liquid and gaseous effluent radiation monitoring systems (RMS) on a plant-specific basis for each COL application, including the following:

- Plant stack RMS
- Reactor building HVAC exhaust RMS and its subsystems monitoring specific HVAC areas of the reactor building
- Containment purge exhaust RMS
- Turbine building combined ventilation exhaust RMS and its subsystems monitoring specific HVAC areas of the turbine building
- Radwaste building ventilation exhaust RMS
- Fuel building combined ventilation exhaust and its RMS subsystems monitoring specific HVAC areas of the fuel building
- Liquid radwaste discharge RMS
- Liquid discharges from the drywell sump low conductivity waste/high conductivity waste RMS

Properly designated set-points, in conjunction with automatic control features of the applicable PRMS subsystems (e.g., termination of discharges), will ensure that the response of effluent

monitors comply with the requirements of 10 CFR Part 20.1302 and GDC 60 and 64 of Appendix A to 10 CFR Part 50. This is COL Action Item 11.5- **later**, as identified in DCD Table - **later**.

The COL application will develop a plant and site-specific ODCM, containing the plant's standard radiological effluent controls (SREC), and the radiological environmental monitoring program (REMP). The ODCM should describe programs and identify procedures used in implementing effluent discharges, define effluent discharge flow rates, provide the basis for liquid effluent dilution factors and atmospheric dispersion and deposition parameters for gaseous effluents, and identify exposure pathways and dose receptors using data from local land-use census. The ODCM should contain the methodology and parameters used for calculating offsite doses to members of the public due to gaseous and liquid effluents for the purpose of demonstrating compliance with the numerical objectives Appendix I to 10 CFR Part 50, dose and effluent concentration limits of 10 CFR Part 20.1302, and environmental radiation standards of 10 CFR Part 20.1301(e). The ODCM should present methods and parameters used in determining operational set-points for effluent radiation monitors in limiting releases of radioactive materials to the environment within the liquid and gaseous effluent concentration limits of Table 2 of Appendix B to 10 CFR Part 20. The ODCM should also provide instructions in identifying and eliminating the potential for unmonitored and uncontrolled releases. The ODCM, SREC, and REMP should be based on the guidance of NUREG-1302 for BWR plants; NUREG-0133; Regulatory Guides (RG) 1.21, 1.33, and 4.15; ANSI/HPS N13.1-1999 and ANSI N42.18-1980; Appendix 11.5-A (Section 11) of the Standard Review Plan (NUREG-0800; Generic Letter 89-01 (Supplement No. 1); and Radiological Assessment Branch Technical Position (Rev. 1, Nov. 1979). Collectively, these items are included as COL Action Item 11.5- **later**, as identified in DCD Table - **later**.

Regarding the habitability of the control building and technical support center, a COL applicant will be required to monitor, control, and initiate the automatic closure of outside air intakes and exhaust dampers, and startup the emergency air filtration system upon the detection of elevated levels of radioactivity in the normal outdoor air supply. A COL applicant will provide the associated set-points for the applicable PRMS subsystems demonstrating compliance with 10 CFR Part 20.1201 and GDC 19 of Appendix to 10 CFR Part 50. The staff will review the operational set-points of the associated radiation monitoring systems (RMS) on a plant-specific basis for each COL application, including the:

- Control building air intake HVAC RMS
- Technical support center HVAC air intake RMS

This is COL Action Item 11.5- **later**, as identified in DCD Table - **later**.

The operational procedures of the post-accident sampling system and operational range of each process radiation monitoring system (PRMS) will be evaluated by the staff to ensure that they are consistent with the requirements of 10 CFR Parts 50.34(f)(2)(xvii), 50.34(f)(2)(xxvii), and 50.34(f)(2)(xxviii), and guidance of RG 1.97 and NUREG-0737 TMI-related Item II.F.1 (Attachments 1 and 2). The evaluation will address the following PRMS subsystems:

- Reactor building HVAC exhaust RMS
- Refuel handling area HVAC exhaust RMS
- Drywell sumps (LCW/HCW) discharge RMS

- Isolation condenser vent exhaust RMS
- Fuel building main area HVAC RMS
- Containment purge exhaust RMS
- Control building air intake HVAC RMS
- Plant stack RMS
- Liquid radwaste discharge RMS

Collectively, these items are included as COL Action Item 11.5- **later**, as identified in DCD Table - **later**.

A COL applicant referencing the ESBWR certified design should describe the quality assurance (QA) program for design, fabrication, procurement, and installation of PRMS subsystems and components in the facility in accordance with its overall QA program. The staff will review and evaluate the COL applicant's QA program in meeting the QA guidance specified in RG 1.21, 1.33, 1.143, and 4.15. This is COL Action Item 11.5- **later**, as identified in DCD Table - **later**.

The following presents the staff's RAIs, the applicant's responses to the RAIs, and the staff's evaluation of these responses. The RAIs address technical issues associated with this section of the DCD and those that are supportive of the design bases and descriptions but that are located in other sections of the DCD. The RAIs are:

RAI No. 11.5.3-1 The operational ranges of radiation monitoring systems listed in DCD Tier 2, Rev. 1, Tables 11-5.1 and 11.5-2 are inconsistently presented in terms of expected activity levels or dynamic ranges. For example, the dynamic response ranges of stack vent instrumentation of the Radwaste, Turbine, and Spent Fuel ventilation systems given in Table 11.5-1 are different than shown in Table 11.5-2. Also, the reported activity levels given in Table 11.5-2 for the Plant Stack are beyond the dynamic detection range, i.e., the expected activity levels are lower than the lowest dynamic range by 3 to 5 orders of magnitude. Confirm whether the stated dynamic range of the instrumentation is correct as indicated.

RAI No. 11.5.3-2 The radiological units of the Turbine Building Vent Exhaust (Normal Vent and Area Exhausts) and Turbine Building HVAC Vent monitoring systems given in DCD Tier 2, Rev. 1, Table 11-5.1 are expressed in "mSv/h" but listed as "MBq/$m^3$" in DCD Table 11.5-2. Provide DCD tables with updated information.

RAI No. 11.5.3-3 This section refers to DCD Tier 2, Rev. 1, Table 11.5-3 and Figure 11.5-1 for information about the designation and ID codes of radiation monitoring systems. A review of instrumentation ID codes indicates that the numbering system is inconsistent for ID No. 21, 22 and 23. The system identified as No. 21 on Figure 11.5-1 is not listed in Table 11.5-3 and its designation ("#21, COPS") and function are not described in the Section. As a result, ID codes No. 21 and 22 presented in Table 11.5-3 are not consistent with those shown in Figure 11.5-1. Also, instrument ID code No. 23 is missing in Table 11.5-3, but is included in Figure 11.5-1. Provide figures and tables (and text as needed) with updated information.

DCD Figure 11.5-1 - Location of Radiation Monitors:

a. Provide an explanation (footnote) as to how and where do discharges from the Isolation Condenser Vent Exhaust system tie into the Reactor Building HVAC system.

b. Update drawing to show that the Offgas Post-Treatment RMS is equipped with an isokinetic probe - such as shown for the Turbine Building, Fuel Building, Radwaste Building, and Plant Stack.

RAI No. 11.5-4 The PRMS subsystems listed on page 11.5-2 of the DCD Tier 2, Rev. 1, are not consistent with those listed in Table 11.5-3 of the DCD. Confirm whether the Containment Overpressure Protection System Discharge RMS is a relevant system. Update DCD text accordingly.

Section 11.5.1.1.1 - Radiation Monitors Required for Safety and Protection. The section identifies seven PRMS subsystems that provide or initiate automatic safety functions. A review of the listing indicates that three systems are missing: Offgas Post-treatment, Main Steam Line, and Liquid Radwaste Discharge. This is contrary to the discussion and listed systems addressing the implementation of GDC 60 in Section 11.5.5.2. Correct or clarify accordingly here and in DCD Section 11.5.5.2, as needed.

RAI No. 11.5-5 The list of applicable design bases criteria provided in DCD Tier 2, Rev. 1, Section 11.5.2 is not consistent with Section 11.5.II of the Standard Review Plan (SRP). The design bases fail to identify design criteria to monitor non-radioactive systems for potential cross-contamination through interfaces with radioactive systems. The text omits references to Regulatory Guide 4.15, and Part 50.34a and Part 50.36a, and Appendix B to Part 20. Also, note that throughout DCD Section 11.5, the text either lacks references for or improperly refers to Appendix B, Table 2 (Column 1 and Column 2) criteria. For example, citations to Table 2 (including Column 1 and Column 2) are omitted or are inconsistent with the topics being discussed in the text or with the current Part 20. Update text in DCD accordingly.

DCD Section 11.5.2.2 - Radiation Monitors Required for Plant Operation. The section does not identify provisions, systems, or procedures addressing the detection of radioactivity in non-radioactive systems to prevent unmonitored and uncontrolled releases of radioactive materials in the environment. Correct or clarify text in DCD accordingly.

RAI No. 11.5-6 The listing of Process Radiation Monitoring System (PRMS) subsystems described in Section 11.5.3 of the DCD Tier 2, Rev. 1, is not consistent with those listed in Table 11.5-3 of the DCD. Descriptions of the following subsystems are not included in this section: Plant Stack; and Fuel Building Ventilation Stack. Update text in DCD accordingly.

DCD Section 11.5.3.1.5 - Isolation Condenser Vent Exhaust RMS. In its description and functions, the discussion does not indicate where discharges from the Isolation Condenser Vent Exhaust goes into. A review of Chapter 9.4 does not indicate how the Reactor Building HVAC Exhaust system capture discharges from the Isolation Condenser Vent Exhaust. Correct or clarify text in DCD accordingly.

DCD Section 11.5.3.1.6 - Fuel Building Main Area HVAC RMS. The description of the Fuel Building Main Area HVAC RMS is incomplete as it does not include a discussion about whether the associated radiation monitor initiates isolation and closure functions as part of automatic safety functions. Correct or clarify accordingly.

DCD Section 11.5.3.2.2 - Offgas Pre-Treatment RMS. The dynamic response of the Offgas Pre-Treatment RMS is based on a gas release rate ranging from 3.7 MBq/sec to 3.7E+05 MBq/sec. Given the source term basis parameters of Chapter 11.1 (Tables 11.1-1 and 11.1-3) and SRP Chapter 11.3 guidance (3.7 MBq/sec per MWt), it is not clear how this dynamic range was derived. Provide the basis of this dynamic range in light of Chapter 11.1 assumptions. Confirm that the basis of this range is also consistent with the dynamic range given for the Offgas Post-Treatment RMS described in the following subsection.

DCD Section 11.5.3.2.3 - Offgas Post-Treatment RMS:

a. Confirm and describe the functions of Skid A and Skid B, as is noted in DCD Table 11.5-1.

b. The fourth paragraph refers to an incorrect section of Part 20. Change “20.1203" to read “20.1302" instead. Note that this error appears throughout the DCD chapter; check and correct accordingly.

c. Although the system description refers to sampling in accordance with ANSI/HPS 13.1-1999, the supporting DCD figure (Figure 11.5-1) does not indicate the presence of an isokinetic probe on that part of the Offgas Post-Treatment System. Correct or clarify accordingly.

DCD Section 11.5.3.2.7 - Reactor Component Cooling Water Intersystem Leakage RMS:

a. The description of the Reactor Component Cooling Water Intersystem Leakage RMS does not refer to separate trains, A and B, each with its own radiation monitor. Correct or clarify the DCD text accordingly.

b. The description of the Reactor Component Cooling Water Intersystem Leakage RMS does not refer to built-in radioactive

check sources to check the operability of the system. Confirm that this feature is consistent with the description given in DCD Section 11.5.6.1.

DCD Section 11.5.3.2.12 - Drywell Fission Product RMS. The description of the Drywell Fission Product RMS does not refer to built-in radioactive check sources to check the operability of the system. Confirm that this feature is consistent with the description given in DCD Section 11.5.6.1.

DCD Section 11.5.3.2.14 - Plant Stack RMS. The description of the Plant Stack RMS does not refer to built-in radioactive check sources to check the operability of the system. Confirm that this feature is consistent with the description given in DCD Section 11.5.6.1.

DCD Section 11.5.3.2.15 - Fuel Building Ventilation Exhaust Air Handling Unit (AHU) RMS. The description of the radiation monitoring system refers to alternatively to two different number of channels for the same system. In the first instance, it states "... consists of a total of four channels that monitor the radiation level of the air entering the Fuel Handling Ventilation (FVH) unit area exhaust AHUs." In the second instance, it states "Two channels provide the monitoring." Correct or clarify DCD text accordingly.

DCD Section 11.5.3.2.16 - Fuel Building Combined Ventilation Exhaust RMS. The description of the Fuel Building Combined Ventilation Exhaust RMS does not refer to built-in radioactive check sources to check the operability of the system. Confirm that this feature is consistent with the description given in DCD Section 11.5.6.1.

DCD Section 11.5.4.3 - Instrumentation. The tables cited for where information on instrumentation can be found should be changed to include DCD Table 11.5-8, as it is not included here.

RAI No. 11.5-7 The descriptions of isokinetic sampling systems in DCD Tier 2, Rev. 1, Section 11.5.3 are inconsistent among the Turbine Building Ventilation Stack and Radwaste Building Ventilation Exhaust, and missing for the Plant Stack and Fuel Building Ventilation Stack. Given that a new approach is used in the revised ANSI/HPS N13.1-1999 standard, confirm that the design bases for all relevant sampling systems used to monitor effluent releases will comply with the performance-based approach of the standard. For example, the standard no longer relies on prescriptive rules used for selecting sampling locations, but relies on criteria defining locations with acceptable flow mixing from which representative samples can be extracted. Update text and design bases in DCD accordingly.

RAI No. 11.5-8 The dynamic detection ranges listed in DCD Tier 2, Rev. 1, Table 11.5-2 for gaseous effluent instrumentation should be qualified given the competing objectives of Regulatory Guides 1.21 and 1.97. For example, the reported dynamic range for the Plant Stack is stated to cover 13

orders of magnitude. This instrumentation is required to confirm compliance as well with airborne effluent limits of Appendix B to Part 20. As is stated in Regulatory Guide 1.97, it is recognized that a single instrument is not expected to cover the entire expected response range, but nevertheless the accuracy of the system must still be adequate in demonstrating compliance with regulatory limits. Accordingly, confirm how instrumentation selected to routinely monitor gaseous effluent releases will provide the appropriate level of accuracy in demonstrating compliance with 10 CFR Part 20 Appendix B limits over the stated operational ranges. Update the text in DCD and revise DCD Tables 11.5-1 and 11.5-2 accordingly.

DCD Table 11.5-1 - Process and Effluent Radiation Monitoring Systems:

a. The radiological units used to express display channel ranges are inconsistent with those presented in DCD Table 11.5-2 for the same systems and functions. This table uses mSv/h while the other uses $MBq/m^3$. Also, some of the stated ranges are inconsistent with expected activity levels under accident or abnormal plant conditions, e.g., up to 1 mSv/h for the Isolation Condenser Vent Exhaust, among other systems. Check all listed monitoring systems and correct or clarify all display channels accordingly in both DCD tables.

b. There are two entries for the Turbine Building Combined Ventilation Exhaust, with one showing the sampling line coming from the drywell. Check all listed systems and correct or clarify DCD text accordingly.

c. Confirm the number of channels and values stated for the display channel ranges between Skid A and Skid B of the Offgas Post-treatment and Offgas Pre-Treatment monitoring systems in light of the information provided in DCD Sections 11.5.3.2.2 and 11.5.3.2.3. Correct or clarify accordingly.

d. Confirm the number of channels for the display channel ranges for the Fuel Building Ventilation Exhaust AHU in light of the information provided in DCD Section 11.5.3.2.15. Correct or clarify accordingly.

DCD Table 11.5-2 - Process Radiation Monitoring System (Gaseous and Airborne Monitors):

a. The radiological units used to express detection ranges are inconsistent with those presented in DCD Table 11.5-1 for the same systems and functions. This table uses $MBq/m^3$ while the other uses mSv/h. Also, this table uses units of $MBq/m^3$ in describing the response range of the Main Steam Line RMS.

Check all listed monitoring systems and correct or clarify accordingly throughout in both set of tables.

b. Confirm that all stated detection ranges are correctly estimated in light of the potential for radioactivity for each system. For example, the upper range given for the Refuel Handling Area HVAC Exhaust is "7.3E+06 Bq/$m^3$" versus a value of "8.0E+05 MBq/$m^3$" for the Control Building Air Intake HVAC RMS. Review and correct all effluent concentration detection ranges (MBq/$m^3$ vs Bq/$m^3$).

c. Provide the basis of the estimates given for the dynamic detection ranges.

RAI No. 11.5-9 The data presentation in DCD Tier 2, Rev. 1, Table 11.5-2 is inconsistent and incomplete. In describing instrument detection ranges and expected activity concentrations, the table applies inconsistent use of exponential notations. For example, mixed notations are used for the detection range of the Turbine Building HVAC Exhaust and Turbine Building Compartment Area Exhaust. Also, it is not clear as whether the lower values of the cited range are expressed as a negative or positive exponents. The concentrations reported as "Expected Activity" are expressed as "0" and "negligible" in several instances. It is not clear if such designations refer to undefined lower limits of detection or other undefined instrument threshold values. The footnotes (* and **) for the "Dynamic Detection Range" and "Expected Activity" headers qualify the entries as being "typical," "estimated," or "will be updated on a plant specific basis." Given that Chapter 12 of the Design Control Document (DCD) presents expected gaseous source terms and process and effluent stream concentrations, there is a need to reconcile "Expected Activity" levels with those presented in DCD Section 12.2.2 for the nuclides listed in DCD Table 11.5-2. There is a need to provide a legend for each descriptor listed under the "Alarms and Trips" column. Provide legends and criteria defining "DNSC," "High," "High-High," "INOP," and "Abnormal Flow." Update table and text in DCD accordingly.

RAI No. 11.5-10 Update DCD Tier 2, Rev. 1,Table 11.5-3 appropriately given the specific resolution of each applicable comment noted the above RAI.

DCD Table 11.5-3 - Key to Radiation Monitors Shown in Figure 11.5-1:

a. Confirm and update DCD Table 11.5-3 to indicate that the Reactor Component Cooling Water Intersystem Leakage has two trains, A and B.

b. Confirm and update DCD Table 11.5-3 to indicate that the Offgas Post-Treatment RMS is equipped with two skids, Skid A and Skid B.

RAI No. 11.5-11

The data presentation in DCD Tier 2, Rev. 1, Table 11.5-4 is inconsistent and incomplete. In describing instrument detection ranges and expected activity concentrations, the table applies inconsistent use of exponential notations. For example, mixed notations are used for the detection range of the Liquid Radwaste Discharge subsystem. Also, it is not clear as to whether the lower value of the cited range is expressed as a negative or positive exponent. The footnotes (* and **) for the "Dynamic Detection Range" and "Expected Activity" headers qualify the entries as being "typical," "estimated," or "will be updated on a plant specific basis." Given that DCD Section 12 presents expected gaseous source terms and process and effluent stream concentrations, there is a need to reconcile "Expected Activity" levels with those presented in DCD Section 12.2.2 for radionuclides listed in DCD Table 11.5-4. There is a need to provide a legend for each descriptor listed under the "Alarms and Trips" column. Provide legends and criteria defining "DNSC," "High," "High-High," "INOP," and "Abnormal Flow." Update table and text in DCD accordingly.

DCD Table 11.5-4 - Process Radiation Monitoring System (Liquid Monitors)

a. Confirm and correct the DCD-stated dynamic detection range for the Liquid Radwaste Discharge RMS. The lower and upper ranges have the same values, "2.1E+03 MBq/$m^3$".

b. Provide the basis of the estimates given for the dynamic detection ranges in the DCD.

RAI No. 11.5-12

DCD Tier 2, Rev. 1, Table 11.5-5 lists "evaporator bottoms" as a liquid sample processing stream, however, the use of an evaporator is not described in DCD Section 11.2.2. The footnote (*) defining the frequency of daily grab sample collection should be revised from "5 times per week" to 7 times per week. A comparison of the types of analyses listed in DCD Table 11.5-5 is not consistent with that shown in DCD Table 11.5-7, e.g., gross alpha, Sr-89, Sr-90, tritium, and fission gases are not included. Update text in DCD accordingly.

DCD Table 11.5-5 - Radiological Analysis Summary of Liquid Process Samples:

a. The listed types of analysis are not consistent with SRP Chapter 11.5, Table 2. For example, the analyses listed for the LCW and HCW tanks do not include all required analyses, such as "S&A" and "H-3" are not listed as part of the suite of radiological analyses described in DCD Table 11.5-5. The suite of analyses defined in SRP Table 2 as "S&A" in the SRP includes "Sampling and analysis of radionuclides, to include gross radioactivity, identification and concentration of principal radionuclides and concentration of alpha emitters." The requirements for tritium (H-3) are addressed separately in Table 2

of SRP Chapter 11.5. Check all entries and correct or clarify accordingly for all listed systems.

b. The table does not provide any explanation as to the basis of the stated instrumentation sensitivity. Check entries and correct or clarify accordingly.

c. One line entry on the second page of the table lists an unidentified system collection and sample tanks with no details being provided for gab sample frequency, analysis, sensitivity, and purpose. Check and correct accordingly.

d. The table does not include sample collection criteria for the Chemical Drain Subsystem. Correct or clarify accordingly.

RAI No. 11.5-13 Based on a review of DCD Tier 2, Rev. 1, Table 11.5-7 footnotes qualifying conditions for liquid waste sampling and analysis, it is not clear if releases will always be conducted on a batch basis and, as a result, continuous releases are excluded from the design basis. Confirm whether this is the intent of the design bases and, if so, state that the related provisions of Regulatory Guide 1.21 and Section 11.5.II of the SRP do not apply. Update text in this DCD table and DCD Section 11.5.1 accordingly.

RAI No. 11.5-14 DCD Tier 2, Rev. 1, Table 11.5-7 provides an incomplete listing of sources of liquid waste streams as compared to that described in DCD Section 11.2.2. The following streams are not listed: Chemical Drains, Equipment Drains, Floor Drains, and Drywell Sump LCW/HCW Discharge. The nomenclature of the “Liquid Radwaste Effluent” is different than that given in DCD Section 11.2.2. The types of analyses listed in DCD Table 11.5-7 are not consistent with that shown in DCD Table 11.5-5 - see prior comment. Provide a description of the proportional composite sampling system footnoted (**) in this table. Confirm that all tank liquid waste samples used for analysis will be taken as representative samples and that each tank volume will be re-circulated in accordance with the guidance of Section 11.5.II of the SRP. Update text in DCD accordingly.

DCD Table 11.5-7 - Radiological Analysis Summary of Liquid effluent Samples:

a. The table does not provide any explanation as to the basis of the stated instrumentation sensitivity. Clarify text in DCD accordingly.

b. One line table entry after the “Plant Stack” has no details. Insert system or delete entry if extraneous in DCD table.

RAI No. 11.5-15 DCD Tier 2, Rev. 1,Table 11.5-8 provides an incomplete listing of sources of gaseous waste streams as compared to that described in DCD Section

11.5.3. The following streams are not listed: Reactor Building HVAC Exhaust Vent, Fuel Building Ventilation Stack, Refueling Handling Area Air Exhaust, and Plant Stack. The nomenclature of the "Offgas Exhaust Discharge" system is different than that shown in DCD Section 11.5.3. Confirm whether the single asterisk (*) footnote correctly describes the "Control Building" as one source of gaseous radiological effluents. Update text in DCD accordingly.

RAI No. 11.5-16 DCD Tier 2, Rev. 1, Table 11.5-8 is inconsistent with Regulatory Guide 1.21 guidance for gaseous effluents as it does not differentiate between batch and continuous releases, nor address principal fission and activation gases. Also, this table does not provide the basis for the listed analytical sensitivities given the threshold levels cited in the regulatory guide. Update text in DCD accordingly and ensure consistency with the parallel information presented in DCD Table 11.5-6.

DCD Table 11.5-6 - Radiological Analysis Summary of Gaseous Process samples. The listed types of analysis are not consistent with SRP Chapter 11.5, Table 1. For example, the Containment Atmosphere Drywell does not include iodines and noble gases. The types of analyses identified as "NG" (noble gases) and "I" of SRP Table 1 are not included as part of the suite of radiological analyses described in DCD Table 11.5-6. The suite of analyses defined by "I" in the SRP includes "Iodine radioactivity, radioactivity of other radionuclides in particulate form, and alpha emitters." The requirements for tritium (H-3) are addressed separately in Table 1 of SRP Chapter 11.5. Check all entries and correct or clarify accordingly.

DCD Table 11.5-8 Radiological Analysis Summary of Gaseous Effluent Samples:

a. The table does not provide any explanation as to the basis of the stated instrumentation sensitivity. Clarify accordingly.

b. One line entry after the "Plant Stack" has no details. Clarify accordingly.

RAI No. 11.5-17 This comment is related to the RAI for DCD Tier 2, Rev. 1, Table 11.5-2 (see RAI No. 11.5-8 above). This RAI addresses the same concerns in ensuring that operational ranges and levels of accuracy of such instrumentation are adequate in confirm compliance with airborne effluent concentration limits of Appendix B to Part 20. Accordingly, the information presented in DCD Table 11.5-8 should be consistent with any revisions made to DCD Table 11.5-2 for instrumentation used to monitor continuous gaseous effluent releases.

RAI No. 11.5-18 The PRMS subsystems listed in DCD Tier 2, Rev. 1, Sections 11.5.5.2, 11.5.5.3, and 11.5.5.4 are not consistent with those shown in Section 11.5.3 and Table 11.5-3 of the DCD. For example, DCD Section

11.5.5.4 refers to the Containment Overpressure Protection Systems, which is not listed in Section 11.5.3, nor in Table 11.5-3. Also, the text uses different nomenclatures for the same subsystems. Update text in DCD accordingly. Note: These comments also apply to DCD Tables 11.5-1 to 11.5-8.

DCD Section 11.5.5.4 - Implementation of General Design Criteria 64. A review of the RMS system used to demonstrate compliance with GDC 64 indicates that: (i) the Liquid Radwaste Discharge RMS is omitted from the listing, and (ii) the Turbine Building Combined Ventilation Exhaust RMS is listed twice. Correct or clarify text in DCD accordingly.

RAI No. 11.5-19 The PRMS subsystems listed in DCD Section 11.5.6.1 are not consistent with those shown in DCD Section 11.5.3 and DCD Table 11.5-3. For example, the section refers to the Containment Overpressure Protection Systems, which is not listed in Section 11.5.3, nor in Table 11.5-3. Also, the text uses different nomenclatures for the same subsystems. Update text in DCD accordingly. Note: These comments also apply to DCD Tables 11.5-1 to 11.5-8.

DCD Section 11.5.6.1 - Inspection and Tests. The sentence introducing the second listing of monitoring systems (DCD page 11.5-17) should note that these systems also include, in addition to check sources, provisions for using test signals in checking system operability. Correct or clarify text in DCD accordingly.

RAI No. 11.5-20 The discussions of applicable PRMS calibration and quality assurance criteria in DCD Tier 2, Rev. 1, Section 11.5.6.2 are not fully consistent with SRP Section 11.5.II. The discussions fail to refer to calibration and quality assurance criteria of Regulatory Guides 1.21 and 4.15. Update text in DCD accordingly, and assess whether DCD Section 11.5.2 needs to be updated as well.

RAI No. 11.5-21 Although numerous references are cited in the text, their full citations are missing in DCD Tier 2, Rev. 1, Section 11.5.8. Among others, references are missing for ANSI N42.18-1980, ANSI/HPS N13.1-1999, NUREG-0737, General Design Criteria 60 and 64, and Regulatory Guides 1.21, 1.97, and 4.15. Update list of references in DCD accordingly.

RAI No. 11.5-22 A review of DCD Tier 2, Rev. 1, Section 1.9.2 (Applicability to Regulatory Criteria) revealed that it is inconsistent with DCD Section 11.5.7.3 addressing the implementation of site-specific radiological effluent monitoring programs by the COL applicant. Currently, DCD Table 1.9-21 does not include Regulatory Guide 4.15* in its listing of applicable guides to the ESBWR. Since Section 11.5.7.3 endorses the applicability of Regulatory Guide 4.15, it follows that it should be listed in DCD Table 1.9-21 (NRC Regulatory Guides Applicability to ESBWR). Clarify inconsistencies between DCD Sections 11.5 and 1.9.2, and update DCD Table 1.9-21 accordingly.

* Regulatory Guide 4.15 - Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment, Rev. 1, 2/79.

RAI No. 11.5-23

A review of DCD Tier 2, Rev. 1, Sections 10.4.2, 11.3, 11.5, 12.3.1, and 12.3.2 indicates that there is no discussion addressing plant design features to mitigate radiation exposures and doses to members of the public associated with the production of N-16 and sky-shine out of the turbine building in the context of 10 CFR Parts 20.1302 and 20.1301(e) and 40 CFR Part 190. Accordingly, provide:

a. a description of turbine building features (placement of main steam pipes, shielding, construction materials used for the turbine building walls and roof, etc.) that are designed to mitigate radiation fields and sky-shine in plant environs;

b. an estimate of the dose to a postulated member of the public located at or beyond the EAB (800 m) in complying with 10 CFR Parts 20.1302 and 20.1301(e) and 40 CFR Part 190; and

c. describe how site-specific conditions will be considered in assessing radiation exposures and doses to members of the public, and how such information and operational considerations would be addressed by the COL applicant in the offsite dose calculation manual.

RAI No. 11.5-24

A review of DCD Tier 2, Rev. 1, Sections 11.5 and 9.3.2 indicates that there are no discussions on whether the acceptance criteria and guidance of SRP Section 9.3.2.II (NUREG-0800) on the process sampling system and post-accident sampling system were considered in the design. The criteria include: General Design Criteria 1, 2, 13, 14, 26, 41, 60, 63, and 64; 10 CFR Part 20.1101(b); and 10 CFR Parts 50.34(f)(2)(viii) and 50.34(2)(xxvi). The guidance includes Regulatory Guides 1.21, 1.26, 1.29, 1.33, 1.56, 1.97, and 8.8; and ANSI/HPS 13.1-1999. Accordingly:

a. provide discussions addressing how the applicable requirements of SRP Section 9.3.2.II were met in DCD Sections 11.5.5 and 9.3.2 for gaseous/liquid process and effluent streams;

b. update the text of DCD Sections 11.5.5 and 9.3.2 and DCD Tables 11.5-1 and 9.3-1 to reflect the applicable criteria of SRP Section 9.3.2.II;

c. update the text in DCD Section 11.5.5 by adding internal cross-references to DCD Section 9.3.2; and

d. describe operational considerations that would be addressed by the COL applicant in DCD Sections 11.5.7 and 9.3.2.

RAI No. 11.5-25

DCD Tier 2, Rev. 1, Sections 9.4.2, 9.4.3, 9.4.4, and 9.4.6, and DCD Tier 2, Rev. 1, Tables 9.4-7 and 9.4-11 inconsistently describe the types of filtration systems (as prefilters, HEPA, or charcoal) used for mitigating and controlling gaseous effluents described in DCD Tier 2, Rev. 1, Sections 11.5 and 11.3. For example:

a. DCD Sections 9.4.2 and 9.4.6 and DCD Table 9.4-11 indicate that the exhaust flow out the reactor and fuel buildings may be diverted to the purge exhaust filter unit. The information does not describe the types of filters used in these subsystems. DCD Table 9.4-11 refers to "high efficiency and HEPA" and DCD Section 9.4.6 only refers to "filter units" or "filter unit." Update descriptions in DCD to clearly specify the exact make up of each "filter unit," i.e., equipped with prefilters, HEPA filters, and/or charcoal filters, or combination of these, for each subsystem.

b. DCD Section 9.4.4 states that HEPA filters are used for the turbine building exhaust subsystem, turbine building compartment exhaust subsystem, and turbine building decontamination room exhaust subsystem, but they are not listed in supporting DCD tables. Provide information and equipment descriptions in new tables for these subsystems - see details in DCD Table 9.4-7 as an example.

c. DCD Table 9.4-7 describes the filters for the radwaste building general area exhaust as "medium efficiency and HEPA" filtration units, while DCD Section 9.4.3 describes the system as "medium efficiency prefilter and HEPA filter." The designation of "prefilter" should be used consistently throughout this and other sections when prefilters are specified by the design. Update text and tables in DCD.

RAI No. 7.5-1

This section refers to DCD Tier 2, Rev. 1, Chapter 11.5 and Figure 7.5-2 for descriptions and information on the designations and ID codes of radiation monitoring systems. The numbering designations shown in Figure 7.5-2 are inconsistent for ID No. 21, 22, and 23. The system identified as No. 21 on Figure 7.5-2 is not listed in DCD Table 11.5-3 and its designation ("#21, COPS") and functions are not described in Chapter 11.5.3. As a result, ID codes No. 21 and 22 presented in Figure 7.5-2 are not consistent with those shown in Table 11.5-3. Also, instrument ID code No. 23 is included in Figure 7.5-2 but is not listed in Table 11.5-3. Provide an updated listing and designations of instrumentation systems that are consistent with Chapter 11.5 of the DCD Tier 2, Rev. 1.

RAI No. 7.5-2

This section refers to DCD Tier 2, Rev. 1, Chapter 11.5 and Figure 7.5-2 for descriptions and information of the radiation monitoring systems. A review of instrumentation systems listed on DCD page 7.5-14 and those shown in Figure 7.5-2 indicates that the listing of instrument systems

shown on this page is incomplete with that presented in DCD Chapter 11.5.3 and DCD Table 11.5-3. For example, the systems listed on page 7.5-14 is a partial listing (7 of 22 systems). Update the listing of instrumentation systems on DCD page 7.5-14 and ensure consistency with those listed in Chapter 11.5 of the DCD.

RAI No. 9.2-3 The RCCWS P&ID does not show the location of radiation monitor No. 15 (RCCW Inter-system Leakage) within this system. Please provide a drawing indicating the location of this radiation monitor. Note that "RE 104" and "RE 105" are shown on the P&ID but are not referenced in DCD Tier 2, Rev. 1, Chapter 11. Also, DCD Table 11.5-3 and DCD Figure 11.5-1 of the DCD do not indicate whether radiation monitor No. 15 is located on Train A or B of the RCCWS. Provide updated revisions of DCD Table 11.5-3 and Figure 11.5-1 that include Train A and B of the RCCWS.

RAI No. 9.2-4 The text notes that a provision for grab sampling from the RCCWS is provided for radiological analysis, but this provision is not included in DCD Tier 2, Rev. 1, Table 9.3-1 listing all process sampling systems. Provide an updated revision of Table 9.3-1 that includes the RCCWS.

RAI No. 9.4-1 The nomenclatures used to designate the Fuel Building HVAC System and Subsystems are not consistent with the corresponding designations used in the text, tables, and figures of DCD Tier 2, Rev. 1, Section 11.5. Update text, tables, and figures of both DCD sections for consistency.

RAI No. 9.4-2 The nomenclatures used to designate the Radwaste Building HVAC System and Subsystems are not consistent with the corresponding designations used in the text, tables, and figures of DCD Tier 2, Rev. 1, Section 11.5. The text (DCD page 9.4-16) describing system operations does not discuss what actions are initiated by the system once the exhaust radiation monitor (ID No. 17) detects high radiation levels. Update text, tables, and figures of both DCD sections for consistency.

RAI No. 9.4-3 The nomenclatures used to designate the Turbine Building HVAC System and Subsystems are not consistent with the corresponding designations used in the text, tables, and figures of DCD Tier 2, Rev. 1, Section 11.5. The text (DCD page 9.4-21) describing system operations does not discuss what actions are taken by the system once any of the exhaust radiation monitors (ID No. 5, 6, 7, 8, 9, or 14) detects high radiation levels. Update text, tables, and figures of both DCD sections for consistency. Confirm whether the Turbine Building Decontamination Room Exhaust Subsystem needs to added to the subsystems described in DCD Section 11.5. It is not clear from DCD Figure 9.4-8 (sheet 3) and DCD Figure 11.5-1 as to which radiation monitor (ID No. 5, 6, or 10?) services the discharge side of the Turbine Building Decontamination Room Exhaust Subsystem.

RAI No. 9.4-4 The nomenclatures used to designate the Reactor Building HVAC System and its subsystems are not consistent with the corresponding designations used in the text, tables, and figures of DCD Tier 2, Rev. 1, Section 11.5. Update text, tables, and figures of both DCD sections for consistency.

RAI No. 16.2-9 A review of DCD Tier 2, Rev. 1, Section 16.5.5.1.c. (Offsite Dose Calculation Manual (ODCM)) indicates that the requirements for the submission of the ODCM is inconsistent with its stated basis document (NUREG-1434, Vol. 1, Rev. 3.). As written, DCD Section 16.5.5.1.c of the DCD assumes that an ODCM already exists and that only changed portions of the ODCM specific to ESBWR design features would need to be submitted to the NRC for review. DCD Section 16.5.5.1.c should be revised to consider the possibility of an initial submission of an entirely new ODCM as the first submittal to the NRC. This change would make the commitments in this section consistent with NUREG-1434 on which Chapter 16 of the DCD is based. Update text in this DCD section accordingly.

11.5.4 Conclusions

- **Later** -