Safety Evaluation Report With Open Items for the U.S. EPR

Chapter 11, "Radioactive Waste Management"

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No figures were included in the chapter.

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11 RADIOACTIVE WASTE MANAGEMENT

This chapter describes the results of the U.S. Nuclear Regulatory Commission (NRC) staff review of the U.S. EPR design basis and average radioactive source terms, and radioactive waste management systems (RWMS). The design basis source term is used to define the capability of the RWMS to process associated types of wastes and amounts of radioactivity, and establish operational programs for the effluent radiation monitoring system to control and monitor liquid and gaseous effluent releases. This source term provides the basis for shielding analyses and assessment of occupational radiation exposures to plant workers. The average source term is used to represent conditions characterizing radionuclide concentrations in primary and secondary coolants under normal operating conditions. The average source term is used to assess doses to members of the public due to liquid and gaseous effluent releases.

The radioactive waste management systems include the liquid waste management system (LWMS), gaseous waste management system (GWMS), solid waste management system (SWMS), and process and effluent radiological monitoring and sampling systems (PERMSS). The systems include the instrumentation used to monitor and control releases of radioactive effluents and wastes. The systems are designed for normal operations, including refueling outages, containment purging, routine maintenance, and anticipated operational occurrences (AOOs). As operational events, AOOs include unplanned releases of radioactive materials associated with equipment failures, operator errors, and administrative errors, with radiological consequences that are not considered accident conditions.

This report chapter provides information on plant structure, system, and component designs and operational programs used to meet the radiation protection standards of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20, "Standards for Protection Against Radiation"; 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities"; and Appendix I to 10 CFR Part 50, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low As is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

The staff evaluated the information in Chapter 11 of the U.S. EPR Final Safety Analysis Report (FSAR), Revision 1, against the guidance of Chapter 11, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants – LWR Edition" (hereafter referred to as NUREG-0800 or the SRP), March 2007. The SRP acceptance criteria provide the guidance for assuring that effluent releases and associated radiation exposures are controlled, monitored, and maintained within the limits of 10 CFR Part 20, "Standards For Protection Against Radiation," and meet as low as reasonably achievable (ALARA) and numerical guides and design objectives of Appendix I to 10 CFR Part 50. Compliance with these criteria provides assurance that radioactive liquid and gaseous effluents will be processed before being discharged into the environment, and radioactive wastes will be treated before being shipped for disposal or further treatment at licensed facilities. An applicant seeking a combined license (COL) must fully describe specific operational programs to control and monitor effluent releases and doses, conduct radiological environmental surveys within the environs of the proposed plant, and manage radioactive wastes in compliance with their respective requirements for shipping and disposal at licensed facilities. The operational readiness of these programs is

controlled by license condition, implemented before the initial loading of fuel into the reactor vessel.

11.1 Source Terms

The operation of the U.S. EPR will result in the generation of radioactive materials during normal operations, including anticipated operational occurrences. Radioactive materials generated during operation include fission, activation, and corrosion products, present in both primary and, to lesser extents, in secondary coolant. The radioactivity thus generated is modeled by two types of radioactive source terms, design basis and average. The design basis source term is used to determine and define the capability of the liquid, gaseous, and solid radioactive waste management systems to process associated types and amounts of radioactivity, and for the design of process and effluent radiation monitoring systems in controlling and monitoring releases. This source term serves as the basis for shielding analyses and evaluation of occupational radiation exposures to plant workers. The average source term is used to represent conditions characterizing radionuclide concentrations in primary and secondary coolants under normal operating conditions. The average source term is used in evaluating the impacts of liquid and gaseous effluent releases in the environment and assessing doses to members of the public due to associated effluent releases.

11.1.1 Introduction

Information needed for the review of radioactive waste management systems includes the type and quantities of radioactivity that are input into these systems for treatment of liquid and gaseous wastes. This includes consideration of parameters used to determine the amount of radioactive material from fission products released to the reactor coolant and the concentrations of all nonfission product radioactive isotopes in the reactor coolant. The source term analysis also determines bounding values of parameters to be used in evaluating radioactive waste system capacities and effluent monitoring systems and in analyzing the consequences of certain postulated accidents. Expected values for source term parameters are also principally determined from industry experience.

11.1.2 Summary of Application

FSAR Tier 1: There are no FSAR Tier 1 entries for the source term area of review.

FSAR Tier 2: The applicant has provided a system description in FSAR Tier 2, Section 11.1, "Source Terms," summarized here in part, as follows:

Two source terms for the primary and secondary coolant systems are developed: Design and realistic. The design basis source term is obtained by applying bounding assumptions, and this term serves as a basis for the design capacities and performance of the waste management systems, as well as for PERMSS. The design basis source term also provides the radionuclide inventory and coolant concentrations for the initial conditions for design basis accident consequence calculations. The realistic source term represents an expected average radionuclide concentration in the primary and secondary coolant under normal operating conditions. The basis for the realistic source term is industry experience at operating nuclear power plants.

The bounding design basis source term is based on a combination of Technical Specification (TS) limits for halogens and noble gases in the primary coolant. Activation product and tritium concentrations are derived from an industry standard, American National Standards Institute/American Nuclear Society (ANSI/ANS)-18.1-1999, "Radioactive Source Term for Normal Operation of Light Water Reactors." Since the activated corrosion products are independent of failed fuel fraction, design basis and realistic basis concentrations for corrosion products are assumed to be the same. Design basis values for the remaining fission product radionuclides are calculated based on a 1.0 percent failed fuel fraction. Design basis secondary coolant concentrations are based on the TS limit primary to secondary leak rate.

The realistic source term is developed using a model based on ANSI/ANS-18.1-1999, in which the reactor coolant radionuclide concentrations are based on observed radionuclide concentrations in currently operating reactors with adjustment for the design parameters of the U.S. EPR design.

FSAR Tier 2, Tables 11.1-1 through 11.1-7 provide parameters used to calculate the primary and secondary source term activity for both bounding and realistic cases and the results of these calculations. The tables also show a comparison of the U.S. EPR design with the plant design used in ANSI/ANS-18.1-1999. The resulting reactor coolant and secondary system source terms represent radioactive liquid and gaseous materials that may be transported or released to the environment by radioactive waste systems.

ITAAC: The inspections, tests, analyses, and acceptance criteria (ITAAC) associated with FSAR Tier 2, Chapter 11 are given in FSAR Tier 1, Section 2.9, "Radioactive Waste Management." There are no ITAAC items for the source term area of review.

Technical Specifications: There are no technical specifications for the source term area of review.

11.1.3 Regulatory Basis

The relevant requirements of NRC regulations for the source term area of review, and the associated acceptance criteria, are given in NUREG-0800, Section 11.1 and are summarized below. Review interfaces with other SRP sections can be found in NUREG-0800, Section 11.1.

1. 10 CFR Part 20 as it relates to determining the operational source term that is used in calculations associated with potential radioactivity in effluents released to unrestricted areas.

2. 10 CFR Part 50, Appendix I as it relates to determining the operational source term that is used in calculations associated with potential radioactivity in effluents considered in the context of numerical guides for design objectives and limiting conditions for operation to meet the criterion "as low as is reasonably achievable" for radioactive material in light-water cooled reactor (LWR) effluents.

3. General Design Criterion (GDC) 60, "Control of Releases of Radioactive Materials to the Environment," as it relates to determining the operational source term that is used in calculations associated with potential radioactivity in effluents released to unrestricted areas, such that a nuclear power unit design shall include means to control suitably the

release of radioactive materials in gaseous and liquid effluents provided during normal reactor operation, including anticipated operational occurrences.

Acceptance criteria adequate to meet the above requirements include:

1. Regulatory Guide (RG) 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors," March 1976, as it relates to the cost-benefit analysis for radioactive waste management systems and equipment.

2. RG 1.112, "Calculation of Releases of Radioactive Materials In Gaseous and Liquid Effluent from Light-Water-Cooled Power Reactors," March 2007, as it relates to the method of calculating release of radioactive materials in effluents from nuclear power plants.

3. 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," Revision 1, October 1971, as it relates to the design, testing, and maintenance of normal ventilation exhaust system air filtration and adsorption units at nuclear power plants.

11.1.4 Technical Evaluation

The staff evaluated the information in FSAR Tier 2, Section 11.1 against the guidance of SRP Section 11.1. The specific criteria sufficient to meet the relevant requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I, for a pressurized water reactor (PWR) as taken from SRP Section 11.1 are as follows:

1. All normal and potential sources of radioactive effluent from PWR gaseous wastes and liquid wastes as delineated in SRP Section 11.1 will be considered.

2. For each source of liquid and gaseous waste, the volumes and concentrations of radioactive material given for normal operation and anticipated operational occurrences should conform to those given in NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code), Revision 1."

3. Decontamination factors 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 should conform to those given in RG 1.140. The building mixing efficiency for containment internal cleanup should conform to NUREG-0017.

4. Decontamination factors for in-plant control measures used to reduce liquid effluent releases to the environment, such as filters, demineralizers and evaporators, should conform to those given in NUREG-0017.

5. Radwaste augments used in the calculation of effluent releases to the environment conform to the findings of a cost-benefit analysis, which may be performed using the guidance of RG 1.110. The provisions that require a cost-benefit analysis are stated in 10 CFR Part 50, Appendix I, Section II.D.

6. Effluent concentration limits at the boundary of the unrestricted area do not exceed the values specified in 10 CFR Part 20, Appendix B, Table 2.

7. The source terms result in meeting the design objectives for doses in unrestricted areas as set forth in 10 CFR Part 50, Appendix I.

8. For evaluating the source terms, the applicant should provide the relevant information in the safety analysis report (SAR) as required by 10 CFR 50.34, "Contents of applications; technical information," and 10 CFR 50.34a, "Design objectives for equipment to control releases of radioactive material in effluents - nuclear power reactors." This technical information should include all the basic data given in to RG 1.112, Appendix B (PWRs) calculate the releases of radioactive material in liquid and gaseous effluents (the source terms). An acceptable method for satisfying the criteria given in RG 1.112, and Criteria 1 through 5 above consists of using the Gaseous and Liquid Effluent (GALE) Computer Code and the source term parameters given in NUREG-0017 for PWRs. A complete listing of the GALE Computer Code for PWRs is given in NUREG-0017.

9. If the applicant's calculation technique or any source term parameter differs from that given in ANSI/ANS-18.1-1999 or NUREG-0017, then each such difference should be described in detail, and the bases for the methods and/or parameters used should be provided.

In reviewing the U.S. EPR design against the above criteria, the staff determined that some of the above criteria dealt with the source term, which is the subject of this section, while some dealt with the subjects to be discussed in Sections 11.2 through 11.5 of this report. The following is the staff's evaluation of the FSAR Tier 2, Chapter 11.1 information against the above criteria:

- The staff reviewed FSAR Tier 2, Table 11.2-3, "Liquid and Gaseous Effluent Input Parameters for the GALE Computer Code," and FSAR Tier 2, Sections 11.2, "Liquid Waste Management System," and 11.3, "Gaseous Waste Management Systems," and determined that all sources of radioactive effluents delineated in SRP Section 11.1, Subsection I were considered, and that the sources conform to those considered in NUREG-0017. Therefore, the staff determined that Criterion 1 is satisfied.

- FSAR Tier 2, Table 11.2-3 addresses the applicant's use of the PWR-GALE code as discussed in Criterion 8. The staff's review of the values used by the applicant in the PWR-GALE code verified that Criteria 2 through 4 are met with respect to the U.S. EPR design values conforming to the reference values given in NUREG-0017.

- The decontamination factors used for gaseous effluents and HEPA filter efficiency conform to RG 1.140, satisfying Criterion 3.

- FSAR Tier 2, Table 11.2-3 addresses Criterion 4. The staff reviewed this table and confirmed that the decontamination factors (DFs) for liquid effluents, such as filters, demineralizers, and evaporators, conform to NUREG-0017. Therefore, the staff determined that Criterion 4 is satisfied.

- Criterion 5 is addressed in FSAR Tier 2, Sections 11.2.4, "Liquid Waste Management System Cost-Benefit Analysis," and 11.3.4, "Gaseous Waste Management Systems

Cost-Benefit Analysis." Sections 11.2 and 11.3 of this report discuss the staff's review of the cost-benefit analyses for the liquid radwaste and gaseous radwaste systems.

- FSAR Tier 2, Table 11.2-7, "Comparison of Annual Average Liquid Release Concentrations with 10 CFR Part 20 Concentration Limits," and FSAR Tier 2, Table 11.3-6, "Comparison of Annual Average Gaseous Release Concentrations with 10 CFR 20 Concentration Limits," address Criterion 6. The staff's evaluation is included in Sections 11.2 and 11.3 of this report.

- FSAR Tier 2, Sections 11.2.3, "Radioactive Effluent Releases," and 11.3.3, "Radioactive Effluent Releases," address Criterion 7 regarding the doses in an unrestricted area, and meet 10 CFR Part 50, Appendix I. The staff's evaluation is included in Sections 11.2 and 11.3 of this report.

- FSAR Tier 2, Table 11.1-1, "Parameters Used to Calculate RCS Design Source Term Activity"; FSAR Tier 2, Table 11.1-3, "Parameters Used to Calculate Secondary Coolant Design Basis Source Terms"; FSAR Tier 2, Table 11.1-6, "Parameters Used to Calculate Realistic Source Terms"; and FSAR Tier 2, Section 11.1 address Criterion 8. The staff reviewed the parameters in these tables and confirmed that they conform to those given in ANSI/ANS-18.1-1999 and NUREG-0017. Therefore, the staff determined that Criterion 8 is satisfied.

- The applicant used the PWR-GALE computer code to calculate the gaseous and liquid effluent source terms and followed the guidance in RG 1.112, Appendix B in developing the inputs to the code. As discussed in FSAR Tier 2, Sections 11.2 and 11.3, both ANSI/ANS-18.1-1999 and the PWR-GALE code were used along with the NUREG-0017 source term parameters; therefore, the staff determined that Criterion 9 is satisfied.

Sections 11.2 and 11.3 of this report document the staff's evaluation of the potential radioactive wastes and the capability of the liquid waste management system and gaseous waste management system to keep radioactive effluents in unrestricted areas ALARA, in accordance with the requirements of 10 CFR Part 50, Appendix I. In addition, Sections 11.2 and 11.3 of this report document the staff's evaluation of compliance with 10 CFR 20.1302, "Compliance with dose limits for individual members of the public," which defines the criteria for radionuclide concentration limits in liquid and gaseous effluents released into unrestricted areas. Sections 11.2 through 11.5 of this report discuss compliance with GDC 60, as it relates to the design of the radioactive waste management systems to control releases of radioactive materials and to conform to the guidance in RGs 1.110 and 1.140. As discussed above, RG 1.112 is satisfied by meeting Criterion 9.

FSAR Tier 2, Section 11.1 describes the sources of radioactivity that are generated within the core and have the potential of leaking to the reactor coolant system (RCS) during normal plant operation, including anticipated operational occurrences, by way of defects in the fuel cladding. Three sets of source terms are presented for the primary and secondary coolant. Two of the sets of source terms are design basis coolant source terms and the third is a realistic coolant source term.

The first set of source terms is comprised of the primary and secondary coolant design basis source terms for radwaste system and normal effluents analyses, which assumes a design basis fuel defect level of one percent. Reactor coolant activity is determined based on

time-dependent fission product core inventories that are calculated by the ORIGEN-2.1 isotope generation and depletion code. The second set of source terms is comprised of the primary and secondary coolant design basis source terms for shielding analyses, which assumes a fuel defect level of 0.25 percent for nuclides other than radioiodines, bromines, and noble gases. The design basis coolant source terms are given in FSAR Tier 2, Tables 11.1-2, "RCS Design Basis Source Term," and 11.1-4, "Secondary Coolant Design Basis Source Term, Liquid Concentrations."

The third source term is a realistic source term which represents the expected average concentrations of radionuclides in the primary and the secondary coolant. These values are determined using the model in ANSI/ANS-18.1-1999 and the PWR-GALE code (NUREG-0017, Revision 1). The realistic source term provides the bases for estimating typical concentrations of the principal radionuclides, and is given in FSAR Tier 2, Table 11.1-7, "RCS and Secondary Coolant System Realistic Source Terms." This source term model reflects the industry experience at a large number of operating PWR plants.

The staff determined that the assumption of a one percent fuel defect level used for the U.S. EPR design basis source terms for radwaste systems and normal effluents analyses conforms to the standard fuel defect assumption of one percent given as guidance in SRP Sections 11.2 and 11.3 for the liquid and gaseous waste management systems, respectively.

The design basis coolant source terms for shielding analyses are conservatively based on 0.25 percent cladding defect for nuclides except for radioiodine, bromines, and noble gases. The radioiodine and bromines are set to the TS concentration limits, and the noble gases are based on the one percent failed fuel assumption discussed above. With the assumptions used, the radioiodine, bromine, and noble gas concentrations will be higher than if the 0.25 percent cladding defect assumption was used. The staff determined that these assumptions conform to the guidance on coolant source terms in SRP Section 12.2, "Radiation Sources," which states that shielding fission product source terms for PWRs are acceptable if developed using an assumption of 0.25 percent fuel cladding defects.

The staff performed confirmatory calculations with the ORIGEN-ARP isotope generation and depletion computer code to verify the applicant's core fission product isotopic inventory and ultimately to verify the applicant's design basis coolant source terms assuming one percent cladding defect. ORIGEN-ARP is a newer revision of the ORIGEN code than the applicant used. The core fission product isotopic inventory is discussed in FSAR Tier 2, Section 15.0.3.3.4, "Core Radionuclide Inventory Assumptions," and the core inventory is given in FSAR Tier 2, Table 15.0-14, "Design Basis Core Radionuclide Inventory."

In request for additional information (RAI) 17, Question 15.00.03-1, the staff requested that the applicant justify the continued use of the ORIGEN-2.1 code, because it is no longer maintained by the Oak Ridge National Laboratory. In RAI 17, Question 15.00.03-2, the staff requested that the applicant verify that the cross-section libraries used in the calculation of the core fission product inventory were applicable to the assumed maximum fuel burnup of 62 gigawatt-days per metric ton uranium (GWD/MTU). In RAI 17, Question 15.00.03-3, the staff requested that the applicant provide additional information on the assumptions regarding operating cycles used in the core radionuclide inventory calculations. In a July 16, 2008, response to RAI 17, Questions 15.00.03-1 through 15.00.03-3, the applicant satisfactorily addressed the staff's

questions on use of the ORIGEN-2.1 code and calculation of the core isotopic inventory. The staff's evaluation of the applicant's responses is discussed in Section 15.0.3 of this report.

The applicant has used an appropriate isotope generation and depletion code and has used appropriate input values to the code with reference to the U.S. EPR fuel design regarding the operating cycle length, burnup, and uranium enrichment in calculating the core isotopic inventory. The staff's independent calculations using the ORIGEN-ARP code and the applicant's design values for operating cycle length, burnup, and uranium enrichment confirmed the applicant's core fission product isotopic inventory as given in FSAR Tier 2, Table 15.0-14. Further discussion of the staff's review of the core inventory can be found in Chapter 15, "Transient and Accident Analyses," of this report.

The applicant applied a set of standard differential equations that accounts for the introduction of fission products from the cladding defect, radioactive decay, fission product escape, dilution, letdown, primary-to-secondary leakage, and decontamination to calculate the reactor coolant fission product source term and secondary coolant and steam fission product source terms.

The corrosion product inventory, tritium activity, and activation products are included in FSAR Tier 2, Table 11.1-2. The activities of corrosion products are independent of fuel defect and are based on existing plant data. The design basis tritium activity is based on both fission tritium leakage and activation of Boron-10 and the reactor coolant. The applicant also determined the amount of activation products in the coolant. The applicant determined the production of carbon-14, argon-41, and nitrogen-16 through activation of the coolant, using standard assumptions in conformance to NUREG-0017 and engineering practice at current operating reactors. The staff verified that these values are consistent with operating plant data and bounds the modeling in NUREG-0017.

FSAR Tier 2, Tables 11.1-1 and 11.1-3 list the parameters used to calculate the design basis fission product activities in the reactor coolant and the secondary coolant. The staff requested that the applicant answer the following questions on the inputs used to determine the TS coolant concentrations. In RAI 17, Question 11.01-1, the staff requested that the applicant provide clarification on which dose conversion factors from Federal Guidance Report No. 11 (FGR-11), Table 2.1 were used to calculate dose equivalent iodine-131 (DE I-131) coolant concentrations. In RAI 17, Question 11.01-2, the staff requested that the applicant provide clarification on which dose conversion factors from Federal Guidance Report No. 12 (FGR-12), Table III.1 were used to calculate dose equivalent xenon-133 (DE Xe-133) coolant concentrations. In RAI 17, Question 11.01-3, the staff requested that the applicant clarify whether or not the RCS primary coolant iodine and noble gas concentration values given in FSAR Tier 2, Table 11.1-2 and Table 15.0-15, "U.S. EPR Primary Coolant Bounding Concentrations," are adjusted to reflect the TS limits. In a July 16, 2008, response to these RAIs, the applicant satisfactorily addressed these questions. The applicant identified that the committed effective dose equivalent (CEDE) values in FGR-11, Table 2.1 were used in calculating DE I-131 and that effective dose equivalent (EDE) values in FGR-12, Table III.1 were used in calculating DE Xe-133. The staff determined that the use of the FGR-11 CEDE values and FGR-12 EDE values are acceptable and conform to the guidance in RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," July 2000, for calculation of doses. The applicant confirmed that the primary coolant concentrations used as input to the dose calculations are adjusted to reflect the TS limits for DE I-131 and DE Xe-133.

FSAR Tier 2, Section 11.1.3, “Reactor Coolant System and Secondary Coolant Realistic Source Terms,” and FSAR Tier 2, Table 11.1-6 list the parameters used by the applicant to calculate the realistic source terms given in FSAR Tier 2, Table 11.1-7. The applicant used the model and procedures in ANSI/ANS-18.1-1999 and NUREG-0017. Radionuclides expected in primary and secondary coolants are obtained from ANSI/ANS-18.1-1999 to estimate the releases of radioactivity in various effluent streams and to the environment. Radionuclide concentrations are calculated using adjustment factors with the methodology described in ANSI/ANS-18.1-1999, NUREG-0017, and RG 1.112 to account for power levels, flow rates, and fluid quantities that depart from the reference plant conditions and parameter values.

The staff determined that the applicant has used inputs that conform to the guidance in RG 1.112 and NUREG-0017; therefore, the design basis reactor coolant and secondary coolant source terms are acceptable.

11.1.5 Combined License Information Items

The staff did not identify any COL information items to be included in FSAR Tier 2, Table 1.8-2 for the source term.

11.1.6 Conclusions

Based on the above evaluation, the staff determined that the source terms described in FSAR Tier 2, Section 11.1 are acceptable. The staff determined the acceptability of the applicant’s proposed source terms based on the applicant’s conformance with the guidance given in SRP 11.1 and ANSI/ANS-18.1-1999. The staff further determined that use of these source terms in calculating liquid and gaseous effluents, and as design parameters for the waste management systems discussed in Sections 11.2 and 11.3 of this report, will meet the regulatory requirements of 10 CFR Part 20 and 10 CFR Part 50, with respect to offsite radiation dose limits and effluent concentration limits.

11.2 Liquid Waste Management System

11.2.1 Introduction

The liquid waste management system is designed to ensure that process fluid streams and liquid wastes produced during normal operation, including anticipated operational occurrences, are handled, processed, stored, and released or routed to their final destination in accordance with applicable regulatory guidance and relevant NRC regulations. Liquid wastes typically generated by pressurized water reactors consist of primary coolant processed to control boron concentration levels, leakage collected from equipment and floor drains in buildings housing equipment and components that contain radioactive fluids, steam generator blowdowns, demineralizer effluents, regenerant solutions, contaminated liquids from anticipated plant operations (such as resin sluices, filter backwashes, decontamination solutions, and sample station drains), and detergent wastes. Wastes associated with the treatment of liquid process streams include sludge, spent resins, spent filters, and concentrated wastes, among others. Such wastes are handled by the radioactive concentrates processing system, which is a subsystem of the solid waste management system.

The evaluation of the LWMS includes reviews of the design basis, design objectives, design criteria, methods of treatment, including system piping and instrumentation diagrams (P&IDs) and process flow diagrams showing methods of operation and factors that may influence waste treatment (e.g., system interfaces and potential bypass routes to nonradioactive systems). The evaluation addresses expected releases of radioactivity and associated concentrations and doses to members of the public; and methods, assumptions, and principal parameters used in calculating effluent source terms, releases of radioactive materials in liquid effluents, and associated doses to members of the public. The review considers methods and programs used to control and monitor releases of liquid effluents into the environment, such as radiation monitoring methods and use of filtration, adsorption media, and storage.

The staff evaluated the information provided against the guidance of NUREG-0800, Section 11.2, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants – LWR Edition," (hereafter referred to as NUREG-0800 or the SRP), March 2007. The SRP acceptance criteria provide the guidance for assuring that liquid effluent releases and associated radiation exposures are controlled, monitored, and maintained within the limits of 10 CFR Part 20 and meet ALARA and numerical guides and design objectives of Appendix I to 10 CFR Part 50.

11.2.2 Summary of Application

FSAR Tier 1: As stated in FSAR Tier 1, Section 2.9.1, "Liquid Waste Management System," there are no FSAR Tier 1 entries for the liquid waste management system.

FSAR Tier 2: The applicant has provided a FSAR Tier 2 system description in FSAR Tier 2, Section 11.2, summarized here in part, as follows:

FSAR Tier 2, Section 11.2 describes the design of the LWMS and its functions in controlling, collecting, processing, storing, and disposing of liquid radioactive waste generated as a result of normal operation, including AOOs.

The LWMS, located in the Radioactive Waste Processing Building (RWB), is a non-safety-related system and serves no safety functions, except for the isolation of radioactive releases during planned discharges. Failure of the LWMS does not compromise safety-related systems or components and does not prevent the safe-shutdown of the plant. FSAR Tier 2, Section 3.2, "Classification of Structures, Systems, and Components," describes the seismic and quality group classification and corresponding codes and standards that apply to the design of the LWMS components and piping and structures housing the system. RWMS structures, systems, and components are designed to the seismic criteria of RG 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light Water Cooled Nuclear Power Plants," Revision 2, November 2001, as Class RW-IIa, and categorized as "radwaste seismic." Waste collection and processing tanks have level-indication gauges and provisions for high level alarms, with local indications and controls displayed in the RWB control room. FSAR Tier 2, Figures 11.2-1 to 11.2-3 present design details for each subsystem. FSAR Tier 2, Table 11.2-1, "Liquid Waste Management System Design Parameters," provides information characterizing volumetric capacities and processing flow rates for major components; FSAR Tier 2, Table 11.2-2, "Liquid Waste Management System Component Data," lists major components of the LWMS and operating features; and FSAR Tier 2, Table 11.2-12, "Liquid Waste Storage System Tank Level Indication, Alarms, and Overflows," describes design provisions in monitoring levels of wastes in tanks and vessels and

functions and locations of alarms. FSAR Tier 2, Figure 11.5-1 depicts the process flow from the LWMS to the point of release. FSAR Tier 2, Figures 1.2-18 to 1.2-27 present the general arrangement of the RWB in which the LWMS is located. FSAR Tier 2, Sections 9.3, "Process Auxiliaries," 9.2, "Water Systems," and 10.4, "Other Features of Steam and Power Conversion System," describe the equipment and floor drain drainage systems, and origins and discharges of nonradioactive effluents. The LWMS does not normally process nonradioactive secondary system effluent and has no interconnections with the potable and sanitary water systems (FSAR Tier 2, Section 9.2.4), raw water supply system (FSAR Tier 2, Section 9.2.9), and demineralized water distribution system (FSAR Tier 2, Section 9.2.3). The plant design places all LWMS tanks indoors, with no tanks located in yard areas outside of buildings based on the information presented in FSAR Tier 2, Section 9.2.

The LWMS is comprised of two subsystems: A storage system and a processing system. The storage system collects and holds radioactive process fluids in waste storage tanks. The processing system applies filtration, evaporation, centrifugal separation, and demineralization as treatment methods to remove and segregate radioactive materials collected from various process streams. The LWMS includes five liquid waste storage tanks with a capacity of about 74.2 m^3 (19,600 gal) each, three concentrate tanks with a capacity of about 36 m^3 (9,500 gal) each, two monitoring tanks with a capacity of about 74.2 m^3 (19,600 gal) each, and four chemical tanks with a capacity of about 606 l (160 gal) each. In addition to instrumentation and controls, the major components include feed, recirculation, and discharge pumps; sludge and concentrate pumps; distillate, sludge, and activity measurement tanks; and pre-heaters and heaters, coolers, separators, compressors, and decanters. The LWMS includes provisions for the use of optional skid-mounted processing equipment in conjunction with the operation of permanently installed liquid waste processing subsystems.

Operationally, the applicant has classified liquid wastes into three groups:

- Group I liquid wastes are those that include primary coolant characterized with higher levels of radioactivity, with boron and no organic substances. The major input streams include liquid from the spent fuel pool and pool purification system, treated waste returned from the centrifugal separator and evaporator, wastes from concentrate tanks, equipment drains and sumps and floor drains, and liquid wastes from sampling systems.

- Group II liquids include process wastes with lower levels of radioactivity, suspended solids, and some amounts of organic and inorganic substances. The major sources of such wastes include that from floor drains and sumps, steam generator blowdowns, distillates from the reactor coolant treatment systems, liquids from sanitary facilities located in controlled areas, and drains and sumps from the radiochemical laboratory.

- Group III liquid wastes include very little or no radioactivity, solids, and some organic and inorganic substances. Such wastes originate from nonradioactive equipment and floor drains and sumps, and steam generator blowdowns.

The LWMS has the capacity to process and store volumes of wastewater on the order of 49.2 m^3/wk (13,000 gal/wk) of Group I wastes, 71.9 m^3/wk (19,000 gal/wk) of Group II wastes, and about 64.4 m^3/wk (17,000 gal/wk) of Group III wastes. The design processing capacity of the evaporator is estimated to be about 3,975 l/hr (1,050 gal/hr). The process capacity of the centrifuge system is about 4,920 l/hr (1,300 gal/hr), and about 9,085 l/hr (2,400 gal/hr) for the demineralizer and filtration subsystem. Liquid wastes with low levels of organic substances are

processed by evaporation. Liquid wastes with high levels of organic substances and suspended solids are processed by centrifuge.

Design features are provided to control and collect radioactive material spills from liquid waste tanks and process equipment. Tanks are housed in radiologically controlled rooms with drains and sumps to collect spills and leaks and prevent uncontrolled and unmonitored releases to the environment. Tanks, vessels, and rooms are vented to the RWB ventilation system and gaseous releases are monitored for radioactivity via the plant vent stack. Tanks, vessels, and equipment are located in shielded enclosures to minimize exposure of plant workers during operation, inspection, and maintenance. The LWMS will be subjected to preoperational inspections and testing by the COL holder to ensure that all subsystems are operationally ready, meet their design basis and performance characteristics, and that all automatic control functions are fully operational, including the automatic termination and isolation of radioactive releases upon the detection of a high radiation signal from the liquid effluent radiation monitor. The COL holder will develop administrative procedures governing the operation of all subsystems, control the treatment of various process and waste streams, and avoid accidental discharges into the environment.

Radioactive materials present in waste streams are processed with an evaporator, a centrifuge, an evaporator in series with a demineralizer, a centrifuge in series with a demineralizer, or a demineralizer system alone. A feature of the design includes the use of aerobic bacteria, chelating and anti-foaming agents as chemical additives in treating some types of radwastes and for removing encrusted solids from evaporator internals. Waste concentrates are sent to concentrate tanks for further treatment and processing, including separating solids and sludge and processing them as solid wastes by the solid waste management system. Once segregated and treated, liquid wastes are then discharged in batches via monitoring tanks.

In monitoring tanks, the wastewater is chemically adjusted to an optimum pH and samples are collected and analyzed for radioactivity prior to its discharge from the plant. The levels of radioactivity in liquid wastes are monitored continuously during discharges via dual radiation monitors. If radioactivity exceeds allowable NRC effluent concentration limits, the discharge valves close on a high radiation signal, and the content of the monitoring tanks is sent back to the processing system for further treatment. Discharges from the LWMS are further diluted by mixing with other plant blowdowns and water in the discharge canal before reaching the plant outfall and unrestricted areas. The amount of dilution varies with the operating status of the plant. Additional dilution occurs when the plant's water outfall is further mixed with receiving surface water bodies, rivers, or tidal shorelines.

In assessing the radiological impacts associated with radioactive effluent discharges, FSAR Tier 2, Tables 11.2-4 to 11.2-7 present information supporting the development of the liquid effluent source term, and compliance with 10 CFR Part 20 (Appendix B, Table 2, Column 2) effluent concentration limits, 10 CFR 20.1301(e) insofar as it required meeting the U.S. Environmental Protection Agency (EPA) environmental radiation protection standards of 40 CFR Part 190, and the design objectives of Appendix I to 10 CFR Part 50. The results indicate that expected annual releases of radioactivity and liquid effluent concentrations in unrestricted areas and associated doses to members of the public comply with NRC regulations and conform to regulatory guidance. As discussed below, the results also demonstrate compliance with the ALARA requirements of Appendix I to 10 CFR Part 50 and SRP acceptance criteria for the evaluation of a postulated failure of a LWMS tank containing radioactive liquids.

ITAAC: The ITAAC associated with FSAR Tier 2, Chapter 11 are given in FSAR Tier 1, Section 2.9. There are no ITAAC identified for the LWMS.

Technical Specifications: There are no technical specifications for the LWMS.

11.2.3 Regulatory Basis

The relevant requirements of NRC regulations for the liquid waste management system and the associated acceptance criteria are given in SRP Section 11.2 of NUREG-0800 and are summarized below. Review interfaces with other SRP sections can be found in NUREG-0800, Section 11.2. The following acceptance criteria are applicable:

1. 10 CFR 20.1302, "Compliance with dose limits for individual members of the public," as it relates to limits on doses to members of the public and liquid effluent concentrations in unrestricted areas.

2. 10 CFR 20.1406, "Minimization of Contamination," as it relates to facility design and operational procedures for minimizing facility contamination and the generation of radioactive waste.

3. 10 CFR 50.34a, as it relates to the inclusion of sufficient design information in demonstrating compliance with the design objectives for equipment necessary to control releases of radioactive effluents to the environment.

4. 10 CFR Part 50, Appendix I, Sections II.A and II.D as they relate to numerical guidelines and design objectives and limiting conditions for operation in meeting dose criteria and the criterion of "as low as is reasonably achievable" of Appendix I.

5. 10 CFR Part 50, Appendix A, GDC 60 as it relates to the design of LWMS to control releases of liquid radioactive effluents.

6. GDC 61, "Fuel Storage and Handling and Radioactivity Control," as it relates to the design of the LWMS in ensuring adequate safety under normal operations and postulated accident conditions.

7. 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations" (the EPA generally applicable environmental radiation standards), as implemented under 10 CFR 20.1301(e), as it relates to controlling doses within EPA generally applicable environmental radiation standards.

8. 10 CFR 52.47(b)(1), "Contents of applications; technical information," which requires that applications for design certifications contain the proposed inspections, tests, analyses, and acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built, will operate in accordance with the design certification and provisions of the Atomic Energy Act and NRC regulations.

The following RGs contain the regulatory positions and guidance for meeting the relevant requirements of the regulations identified above:

1. RG 1.109, “Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I,” as it relates to demonstrating compliance with the numerical guidelines for dose design objectives and the ALARA criterion of 10 CFR Part 50, Appendix I.

2. RG 1.110, as it relates to performing a cost-benefit analysis for reducing cumulative doses to populations by using available technology.

3. RG 1.113, “Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I,” April 1977, as it relates to the use of acceptable methods for estimating aquatic dispersion and transport of liquid effluents in demonstrating compliance with 10 CFR Part 50, Appendix I dose objectives.

4. RG 1.143, “Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants,” as it relates to the seismic design and quality group classification of components used in the LWMS and the structures housing this system, as well as provisions used to control leakage.

5. RG 1.33, “Quality Assurance Program Requirements (Operation),” Revision 2, February 1978, as it relates to quality assurance for the operation of the LWMS provisions for the sampling and monitoring of radioactive materials in process and effluent streams and control of radioactive effluent releases to the environment.

6. RG 4.21, “Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning,” June 2008, as it relates to minimizing the contamination of equipment, plant facilities, and environment, and minimizing the generation of radioactive waste during plant operation.

7. SRP Section 11.2, Branch Technical Position (BTP) 11-6, “Postulated Radioactive Releases Due to Liquid-Containing Tank Failures,” as it relates to the assessment of radiological impacts associated with the assumed failure of an LWMS tank.

8. NRC IE Bulletin 80-10, “Contamination of Nonradioactive System and Resulting Potential for Unmonitored, Uncontrolled Release of Radioactivity to Environment,” May 6, 1980, as it relates to methods and procedures used in avoiding the cross-contamination of nonradioactive systems and unmonitored and uncontrolled releases of radioactivity.

11.2.4 Technical Evaluation

The staff reviewed the LWMS using the guidance and acceptance criteria of NUREG-0800, SRP Section 11.2. The staff reviewed the LWMS to determine whether it complies with the requirements of 10 CFR 50.34a and GDC 60 and GDC 61. Under the requirements of 10 CFR 50.34a, the applicant must provide sufficient design information to demonstrate that it has met the design objectives for equipment necessary to control releases of radioactive effluents to the environment. GDC 60 requires that the LWMS is designed to control releases of liquid radioactive effluents, and GDC 61 stipulates that the LWMS is designed to ensure adequate safety under normal operations and postulated accident conditions. Relevant guidance includes RG 1.143, which addresses the design and construction methods, materials specifications, welding, and inspection and testing standards for LWMS components and piping.

The COL holder is responsible for testing all liquid waste processing subsystems installed in the plant, as described in FSAR Tier 2, Chapter 14, “Initial Test Program and ITAAC.”

The staff reviewed the system construction standards; system process flow outlines and descriptions; sources of liquid wastes and volumes; collection points of liquid waste; flow paths of liquids through subsystems, including potential bypasses; provisions for monitoring radioactivity levels in effluent releases; and the point of release of liquid effluents to the environment. The LWMS design includes provisions for sampling at specific process points and protecting against accidental discharges by the detection and alarms signaling of abnormal conditions. The system incorporates design and operational flexibility by providing redundancy in processing wastes through cross-connections to route process fluids among subsystems and provides sufficient storage capacity using multiple collection and sample tanks. The LWMS does not normally process nonradioactive system effluents. The LWMS has no interconnections with the potable and sanitary water systems, as described in FSAR Tier 2, Section 9.2.4. Similarly, the potable and sanitary water systems have no connections with other process auxiliaries and secondary systems with origins and discharges of nonradioactive effluents, as described in FSAR Tier 2, Sections 9.3 and 10.4. The definition of the LWMS processing and release path, including specifying the location of the discharge point, is a COL information item and is addressed in FSAR Tier 2, Section 11.5, “Process and Effluent Radiological Monitoring and Sampling Systems.” A LWMS process diagram depicting all subsystems is provided in FSAR Tier 2, Figures 11.2-1, “Liquid Waste Storage System,” to 11.2-3, “Liquid Waste Processing, Demineralizer System.” FSAR Tier 2, Figure 11.5-1, “Radioactive Effluent Flow Paths with Process and Effluent Radiation Monitors,” presents an overview of the process flow from the LWMS to the point of release.

FSAR Tier 2, Figures 1.2-18, “Radioactive Waste Processing Building General Arrangement Plan View Elevation -31'-6",” to 1.2-27, “Radioactive Waste Processing Building General Arrangement Section B-B,” present the general arrangement of the RWB in which the LWMS is located. FSAR Tier 2, Section 12.3, Figures 12.3-52, “Radioactive Waste Building -32 Ft Elevation Radiation Zones,” through 12.3-58, “Radioactive Waste Building +36 Ft Elevation Radiation Zones,” present floor plans and associated radiation zones in RWB areas where liquid wastes will be processed by the LWMS. FSAR Tier 2, Table 11.2-1 provides information charactering volumetric capacities and processing flow rates for major components, FSAR Tier 2, Table 11.2-2 provides a listing of LWMS components and their design features, and FSAR Tier 2, Table 11.2-12 describes design provisions in monitoring levels of wastes in tanks and vessels, and functions and locations of alarms.

The LWMS is not a safety-related system and serves no safety functions, except for the isolation of radioactive releases during planned discharges. Failure of the LWMS does not compromise safety-related systems or components and does not prevent the safe shutdown of the plant. FSAR Tier 2, Section 3.2, Table 3.2.2-1, “Classification Summary,” and FSAR Tier 2, Section 11.2.1, “Design Basis,” describe the seismic and quality group classification and corresponding codes and standards that apply to the design of LWMS components and piping, and structures housing the system. The LWMS structure, systems, and components are designed to the seismic criteria of RG 1.143, Table 1, as Class RW-IIa, and categorized as “radwaste seismic.”

The LWMS components, equipment, and piping were determined to be designed to Quality Group D of RG 1.143, Table 1 and radwaste-seismic (RS) criteria. Specifically, RG 1.143 addresses the design and construction methods, materials specifications, welding, and

inspection and testing standards for the LWMS pumps and piping. The COL holder is responsible for testing all permanently installed liquid waste processing subsystems and installation of any temporary additional liquid waste processing skid-mounted equipment, as described in FSAR Tier 2, Chapter 14. The COL holder is responsible for testing any additional skid-mounted liquid waste processing systems installed in the plant. The staff determined that the design is acceptable with respect to meeting the criteria of 10 CFR 50.34a "Design objectives for equipment to control release of radioactive material in effluents – nuclear power reactors," GDC 60, GDC 61, and the guidance of RG 1.143 and quality assurance (QA) program described in Chapter 17 "Quality Assurance." The QA requirements address the design, fabrication, procurement, installation and testing of permanently installed liquid waste processing systems, including the combined use of skid-mounted processing equipment. A COL applicant referencing the U.S. EPR certified design should describe those aspects of the QA Program associated with the design and procurement, and construction and operational phases of the LWMS. This requirement is noted in COL Information Item 17.2-1, as identified in FSAR Tier 2, Table 1.8-2. The staff's evaluation of the scope and implementation of a QA program and the adequacy of the preoperational testing program are addressed in Chapter 17, and Chapter 14, "Verification Programs," of this report.

Based on the assigned RG 1.143 classification of RW-IIa, the design of the LWMS incorporates features to prevent spills and leaks, and to collect leaks and spills from LWMS tanks if they occur. Storage tanks are housed in rooms or cubicles with drains to contain any potential spills and prevent uncontrolled releases to the environment. Drains are directed to the LWMS. The tank rooms have no doors that directly connect to the outside environment. The LWMS design includes provisions for sampling at specific process points and protect against accidental discharges by the detection and alarm of abnormal conditions. The design includes provisions for periodic inspection of major components to ensure the operational readiness and integrity of LWMS subsystems. The LWMS system receives and holds degasified liquids in storage tanks, which are continuously vented to the RWB ventilation system and monitored at the plant vent stack with plant operators taking specific actions if alarms are activated. Thus, no significant levels of airborne radioactivity from a liquid waste system component leak or failure are expected. The LWMS is housed in a reinforced concrete structure that provides adequate shielding and minimizes radiation exposures to personnel during operation and maintenance. These design criteria and design provisions were compared to RG 1.143, based on the system description as it relates to liquid wastes produced during normal operation and AOOs. The staff determined that the design is acceptable with respect to meeting the guidance of RG 1.143 and, accordingly, meets the requirements of 10 CFR 50.34a, GDC 60 and GDC 61.

The staff evaluated the capability of the LWMS to process expected quantities of liquid wastes and radioactivity levels with respect to SRP Section 11.2, which states that provisions for standby equipment, alternate processing routes, and/or interconnections between subsystems are needed in order to evaluate the overall system capability to meet anticipated demands imposed by processing equipment downtime and waste volume surges resulting from anticipated operational occurrences. The processing capability of the LWMS depends on storage capacity, number of storage tanks and their volumes, and treatment methods. According to the information presented in FSAR Tier 2, Tables 11.2-1 and 11.2-2, the LWMS tankage and processing methods include:

- A storage system with five liquid waste storage tanks, each with a gross volume of 74,200 l (19,600 gal). There are two tanks each for Groups I and II wastes, and one for

Group III wastes. The system includes three concentrate tanks 36,000 l (9,500 gal) each and two monitoring tanks 74,200 l (19,600 gal) each.

- Processing subsystems consisting of an evaporator system, a demineralizer system and its ultra-filtration system, and a centrifuge system. The processing rates are stated to be about 3,975 l/hr (1,050 gal/hr) for the evaporator, about 4,920 l/hr (1,300 gal/hr) for the centrifuge, and about 9,085 l/hr (2,400 gal/hr) for the filter and demineralizer unit.

The capability of the system to process waste streams and produce effluent streams that meet NRC regulations depends on the performance of the evaporator system, the demineralizer system and its ultra-filtration system, and the centrifuge system. The applicant expects the generation of approximately 49,210 l/wk (13,000 gal/wk) of Group I wastes, 71,920 l/wk (19,000 gal/wk) of Group II wastes, and 64,350 l/wk (17,000 gal/wk) of Group III wastes. The expected weekly total waste generation or input rate to the LWMS is estimated to be about 185 m^3 (49,000 gal). The estimated storage capacity of the LWMS is about 370 m^3 (98,000 gal), with a processing rate of about 18 m^3/hr (4,800 gal/hr). The processing systems can be operated in series, or by using the demineralizer and ultra-filtration system alone. The estimated time needed to process the maximum anticipated flow rate varies from about 8 days of holdup for floor drains to near immediate collection for blowdowns.

The above volumetric capacities and expected processing rates indicate that the storage system is sized to store a volume of wastewater equivalent to the average quantity of liquid wastes produced in about 2 weeks. In Groups I and II wastes, the tanks can store more than 2 weeks of average expected waste volumes, with Group III waste tanks sized for approximately 1 week's worth of waste production. The liquid waste processing system has the capacity to process the average weekly discharge quantity of liquid waste in less than half a week. 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. However, for events occurring at low frequencies, or producing effluents not compatible with currently used processing equipment, temporary processing equipment may be brought into the RWB. Therefore, the LWMS can be unavailable for about 3 days and the temporary equipment can still process the expected influent while meeting NRC regulations. This satisfies the SRP criterion that processing equipment should be assumed to be unavailable for 2 consecutive days per week. In view of the above, the staff determined that the equipment sizing and processing rates are adequate for the LWMS.

The LWMS and RWB have provisions for connecting skid-mounted or vendor-supplied waste processing equipment. These connections allow for the use of skid-mounted equipment applied in series with or parallel to installed equipment as an alternative to returning treated liquid wastes to the LWMS. The connections also allow the use of skid-mounted or mobile equipment as a pumping point into tanks for shipment, treatment, and disposal by third-party waste processors on behalf of the COL holder. If used, temporary equipment and its connections to permanently installed equipment would be subjected to hydrostatic testing using guidelines described in SRP Section 11.2 and the technical guidance of RG 1.143. The design of skid-mounted waste processing systems that are used by contractors to process liquid wastes of a COL holder is not within the scope of the U.S EPR certification. The COL holder is responsible for confirming that the use of any additional processing equipment complies with the FSAR design bases, meets NRC regulations governing discharges of liquid effluents and dose limits for members of the public, and protects workers during the operation and maintenance of additional processing equipment. This feature is an option for consideration by COL applicants

or COL holders in augmenting the existing provisions of the LWMS. The staff determined that such an approach is acceptable in expanding the processing capability of the LWMS. However, this option is not part of the design certification, and this feature is not evaluated by the staff, since the application does not provide information on the types of liquid waste treatment augmentations that would be considered, nor does it include specific design details on the interface with the LWMS and plant services.

The overall performance of LWMS subsystems operating in tandem is expressed as DFs in removing radioactive materials from specific process streams. The radioactivity may be present as dissolved solids and salts and suspended solids, in both organic and inorganic forms. Treatment results in the generation of byproduct materials, such as wet waste concentrates, sludge, spent resins, and spent filtration media. FSAR Tier 2, Table 11.2-3 lists DFs by types of generic process streams and types of processing methods.

The DFs were determined to generally conform to the NRC guidance, as assigned to each type of treatment method with adjustments made for treatment methods not described in NRC guidance documents such as NUREG-0017. The DFs were used to derive yearly average estimates of liquid effluents released to the environment during routine operations. The staff applied the DFs to conduct an independent confirmation of estimated yearly releases and determined the results acceptable using the PWR-GALE code (1986 update). Release of dissolved gases from process fluids and water vapor generated during processing and contained in tanks and vessels are vented to the RWB ventilation system and discharged and monitored via the plant vent stack. The staff's evaluation of ventilation systems servicing radiologically controlled areas and systems and components containing radioactivity is addressed in Sections 9.4, 11.3, 11.5, and 12.3 of this report.

All LWMS discharges are made as batch releases through a single liquid waste discharge line and canal to the environment. Treated liquid wastes with reduced levels of radioactivity are transferred to monitoring tanks before being discharged. Radioactivity concentration levels present in liquid effluents are further reduced by mixing with other plant process blowdowns and discharge canal flow rate, and by dilution in receiving water bodies. In monitoring tanks, the water is chemically adjusted and checked for radioactivity prior to its discharge from the plant. The radiation monitor system, located on the common discharge line downstream of both monitor tanks, is used to confirm and record compliance with 10 CFR Part 20 (Appendix B, Table 2, Column 2) concentration limits for radionuclides present in liquid effluents and discharged into unrestricted areas. The system has a locked-closed valve that isolates the liquid waste storage system release line, as described in FSAR Tier 2, Section 11.5.3, "Effluent Monitoring and Sampling." Administrative controls preclude unlocking the valve until radioactivity measurements of liquid wastes held in monitoring tanks to verify that their concentrations are below the concentration limits of 10 CFR Part 20 at the point of discharge to unrestricted areas. Waste activity is continuously monitored during discharges. If radioactivity levels exceed allowable NRC limits, a high radiation signal closes the discharge valves at the discharge line outlet and terminates the release. When this occurs, the content of the monitoring tanks is sent back to the processing system for further evaluation and treatment.

The determination of appropriate liquid waste discharge rates and alarm settings of radiation monitors will be determined by the COL holder using the methodology described in the offsite dose calculation manual (ODCM). FSAR Tier 2, Section 11.5.3.2, "Liquid Effluents," commits to the use of the ODCM in controlling and monitoring all liquid effluent releases. The use of an ODCM is under the operational programs described in FSAR Tier 2, Section 13.4, "Operational

Program Implementation." The program addresses radiological effluent controls in monitoring and controlling releases of radioactive materials to the environment and eliminating the potential for unmonitored and uncontrolled releases, and the development of a site-specific radiological environmental monitoring program. The staff will review the operational set-points of the radiation monitor on a plant-specific basis for each COL application. A COL applicant referencing the U.S. EPR certified design should identify the planned operational set-points for its LWMS radiation monitor in a plant-specific ODCM. As part of this requirement, the COL applicant will be responsible for demonstrating, using the ODCM, compliance with 10 CFR 20.1301(e) which requires satisfaction of EPA environmental radiation protection standards of 40 CFR Part 190 for facilities within the fuel-cycle, which include nuclear power reactors. This is COL Information Item 11.5-1, as identified in FSAR Tier 2, Table 1.8-2. This process, along with the use of the ODCM in controlling liquid effluent discharges, satisfies GDC 60 and 10 CFR Part 50, Appendix I requirements, as they relate to provisions for controlling releases of radioactive materials in liquid effluents to the environment during normal operation and AOOs. These provisions are credited, in part, in accordance with the SRP guidance related to minimizing contamination of the facility and the environment under 10 CFR 20.1406. This goal is accomplished by means of design features that reduce leakage of liquid waste or discharges of radioactive materials in liquid effluents and avoid uncontrolled and unmonitored releases to the environment.

The staff's evaluation of the applicant's proposed ODCM is addressed in Section 11.5 of this report.

Design Considerations

In reviewing FSAR Tier 2, the staff could not confirm that some aspects of the LWMS design conform to NRC regulatory requirements and guidance. These aspects include inconsistencies in system interfaces shown in drawings, differences between system descriptions and drawings to which system descriptions referred to as information, and lack of details describing system capacities or flow rates. The staff requested that the applicant provide additional information, as requests for additional information (RAIs). The RAIs requested that the applicant provide clarifications for technical completeness, provide details supporting design bases and design descriptions in demonstrating compliance with regulatory requirements, revise and update system drawings for consistency with system descriptions, revise technical and regulatory references, and provide information for the staff to conduct independent evaluations of results presented in the application. Depending on the response from the applicant, the RAIs are either listed as satisfactory responses and resolved by the staff, or left open pending the receipt of responses or issuance of follow-up RAIs. The following subsections present the results of the staff's evaluation and, when necessary, list follow-up RAIs to the applicant.

A review of FSAR Tier 2, Revision 0, indicated that the description was not of sufficient detail to demonstrate that the LWMS had sufficient redundancy in pumping systems for liquids and excess capacity in holdup tanks to account for expected downtime for maintenance. In RAI 105, Question 11.02-1, the staff requested that the applicant provide additional clarification as to how the applicant met the design objectives delineated in 10 CFR 50.34a, with respect to processing capacity. In a November 5, 2008, response to RAI 105, Question 11.02-1, the applicant provided additional information to address the question, but it did not propose any changes to FSAR Tier 2. The additional information describes the operation of the system via two process flow paths, one to the evaporator and one to the demineralizer. In both instances, the subsystems are expected to have the capacity to remove suspended solids and sludge from

each process stream to avoid any flow obstructions. The description of the capabilities of the systems and expected processing load was sufficient to conclude that the capacity was adequate to address the staff's initial concern. The staff found that this additional information sufficiently clarified how the design objectives of 10 CFR 50.34a are being met. Therefore, the staff considers RAI 105, Question 11.02-1 resolved based on a review of FSAR Tier 2, Revision 1.

In RAI 105, Question 11.02-3, the staff requested that the applicant verify that all tanks have the proper instrumentation based on the guidance of RG 1.143, which calls for tanks to have fluid level indicators. In a November 5, 2008, response to RAI 105, Question 11.02-3, the applicant agreed to revise the information in FSAR Tier 2, Section 11.2 in accordance with the guidance contained in RG 1.143. The staff reviewed the revised section and table attached to the applicant's response and determined the information on tank level instrumentation conformed to RG 1.143. The additional information includes details on the type and location of tank level indications, types of alarms, and where tank overflows are routed in such events. The staff confirmed that Revision 1 of the U.S. EPR FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 105, Question 11.02-3 resolved.

In FSAR Tier 2, Section 11.2.1, the FSAR describes the design basis of the LWMS. However, a review indicates that the design basis does not acknowledge applicable SRP acceptance criteria, such as NRC Bulletin 80-10, and industry standards. In RAI 273, Question 11.02-4, the staff requested that the applicant review SRP Section 11.2 and confirm that the FSAR design basis conforms to all SRP criteria and RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," guidance, and, if not, provide the justification that the alternate approach provides acceptable methods of compliance with NRC regulations. In a November 6, 2009, response to RAI 273, Question 11.02-4, the applicant agreed to provide additional information in FSAR Tier 2, Section 11.2.1 and AREVA Technical Report ANP-10292, "U.S. EPR Conformance with Standard Review Plan (NUREG-0800) Technical Report," (Revision 1) to identify additional commitments with SRP acceptance criteria. The information includes references and technical aspects identified in NUREG-0800, SRP 11.2; BTP 11-6, "Postulated Radioactive Releases Due to Liquid-containing Tank," Revision 3, March 2007; RG 1.206; RG 1.112; RG 1.113; and NRC Bulletin 80-10. The staff finds the response and additional information acceptable. **RAI 273, Question 11.02-4, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Sections 11.2.2.1.3, "Chemical Addition," 11.2.2.1.6, "Monitoring and Discharge," and 11.2.2.2.3, "Demineralizer System," state that aerobic bacteria, chelating and anti-foaming agents will be used as chemical additives in treating some types of radwastes and for removing encrusted solids in the evaporator. Distillate discharges from the evaporator may be sent to the demineralizer system for further processing in removing radioactivity. The introduction of such chemical additives does not address NRC concerns on the generation of explosive gas mixtures (e.g., hydrogen and methane) and the possibility of chelating and antifoaming agents causing exothermic reactions when coming in contact with ion-exchange resins. For example, NRC Information Notices 83-14, "Dewatered Spent Ion Exchange Resin Susceptibility to Exothermic Chemical Reaction," 84-72, "Clarification of Conditions For Waste Shipments Subject To Hydrogen Gas Generation," 88-08, "Chemical Reactions with Radioactive Waste Solidification Agents," and 90-50, "Minimization of Methane Gas in Plant Systems and Radwaste Shipping

Containers," and NUREG/CR-4601, "Technical Considerations Affecting Preparation of Ion-Exchange Resins for Disposal," caution power plant operators and waste generators about the introduction of microbial organisms and organic chemicals in waste streams that would come in contact with ion-exchange resins. The introduction of chemical agents may reduce ion-exchange capacity and decontamination factors of ion-exchange resins; thereby, resulting in higher discharges of radioactivity levels. In RAI 273, Question 11.02-5, the staff requested that the applicant revise the description of this operational concept and acknowledge prior NRC information notices; identify measures that will be implemented in avoiding the inadvertent generation of explosive gas mixtures, monitoring system overpressures, and temperature rises before exothermic reactions compromise the integrity of LWMS subsystems; and identify related operational requirements for consideration by COL applicants and holders. **RAI 273, Question 11.02-5, which is associated with the above request, is being tracked as an open item.**

FSAR Tier 2, Section 11.2.2, "System Description," states that the radwaste processing building has spare space for the optional use of vendor-provided mobile waste processing equipment. A review of FSAR Tier 2, Figures 11.2-1 to 11.2-3 reveals that there are no connection points into existing LWMS subsystems to which mobile or skid-mounted processing equipment would be connected in augmenting the processing capacity of the LWMS. In RAI 273, Question 11.02-6, the staff requested that the applicant review LWMS drawings and determine whether such connections should be shown or footnoted in the appropriate subsystem drawings. In addition, the staff requested that the discussion be expanded to address connections for support services (e.g., compressed air, water, radwaste ventilation, etc.), contamination controls in the context of NRC Bulletin 80-10, 10 CFR 20.1406 and RG 4.21, and the need for the use of permanent or temporary radiation shielding in keeping ambient radiation exposure rates ALARA. In a November 6, 2009, response to RAI 273, Question 11.02-6, the applicant agreed to remove the partial description of mobile site-specific processing equipment from the description of the LWMS. The deletion does not detract from the given features of the LWMS, which relies on the use of permanently installed equipment as described in the FSAR. The staff finds the applicant's response to RAI 273, Question 11.02-6 acceptable and the staff will confirm that the proposed change is incorporated in a future revision of the FSAR. **RAI 273, Question 11.02-6, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC. A COL applicant still has the option of using vendor-supplied mobile processing equipment and would be required to describe any additional processing equipment in its COL application.

FSAR Tier 2, Section 11.2.2.3, "Sampling," describes a process by which radioactive process and effluent samples will be collected from various segments of the LWMS. However, a review of FSAR Tier 2, Figures 11.2-1 to 11.2-3 revealed that there were no sampling points identified in LWMS subsystems. A review of FSAR Tier 1, Figure 1.3-1, "Functional Arrangement Symbol," Legend and FSAR Tier 2, Figure 1.7-1, "P&ID Symbol Legend," indicated that there were no Piping and Instrumentation Diagram (P&ID) symbols for sampling points. In RAI 273, Question 11.02-7, the staff requested that the applicant include the locations and identification of sampling points in all associated LWMS subsystems, and add legends for sampling points in FSAR Tier 1 and 2 figures. In a November 6, 2009, response to RAI 273, Question 11.02-7, the applicant agreed to revise FSAR Tier 2, Figures 11.2-1 and 11.2-2, "Liquid Waste Processing System, Evaporator System," by identifying local grab sampling points within the LWMS. The staff determined the applicant's response to RAI 273, Question 11.02-7 acceptable, and the staff will confirm that the proposed change is incorporated in a future revision of the FSAR.

RAI 273, Question 11.02-7, is being tracked as a confirmatory item and will be evaluated when the next revision to the FSAR is submitted to the NRC.

In FSAR Tier 2, Section 11.2.2.2.3 and FSAR Tier 2, Figure 11.2-3 describe the demineralizer subsystem and state that the inlet to the subsystem is equipped with prefilters to remove resin fine particles. A review of the drawing indicated that there were no filters to remove resin fines out of the demineralizers before sending process waste streams to the monitoring tanks for release to the discharge canal. Without resin traps in the outlet stream of the demineralizer, there would be the possibility that high radioactivity resin fines could be discharged to the environment. In RAI 273, Question 11.02-8, the staff requested that the applicant review the design and consider the installation of resin traps on the discharge line after the last demineralizer column. In a November 6, 2009, response to RAI 273, Question 11.02-8, the applicant agreed to revise FSAR Tier 2, Section 11.2.2.2.3 and FSAR Tier 2, Figure 11.2-3 by adding a resin filter trap after the demineralizer system. The staff finds the applicant's response to RAI 273, Question 11.02-8 acceptable, and the staff will confirm that the proposed change is incorporated in a future revision of the FSAR. **RAI 273, Question 11.02-8, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Section 11.2.2.4, "Component Description," provides a description of LWMS subsystem components. A review of the discussions indicated that the text did not match the details in the corresponding subsystem figures. In RAI 273, Question 11.02-9, the staff requested that the applicant review and address, at a minimum, the following:

- The liquid radwaste storage tanks are described as having connections to the radwaste building ventilation system, but the drawing does not show such connections for any of the tanks. In contrast, the drawing for the evaporator does show a connection to the radwaste building ventilation system (see "KLF" point).

- The drawing for the concentrate tanks shows two connections to the tank while the text states that there are nine connections, four on the top, four on the side, and one at the bottom.

- The drawing for the centrifuge shows that two tanks are connected to the system for the collection of solids and sludge, but the text refers to drums being used for that purpose. The drums or connections to replaceable drums are not shown in the drawing.

- The level of detail and description of components for the demineralizer system is inconsistent with the corresponding drawings for the other subsystems. The drawing shows components that are not described in the text (e.g., chemical additive system), and the text describes components that are not shown in the drawing (e.g., spent resin drying subsystem).

- The description of the distillate tank, evaporator system, states that "… the distillate tank is treated waste water with little or no contamination." This statement is incorrect, since the evaporator removes only radioactive materials suspended in particulate forms, while the presence and concentration of tritium in the collected distillate remains unchanged as compared to initial concentrations of influent streams to the evaporator.

In a November 6, 2009, response to RAI 273, Question 11.02-9, the applicant agreed to revise FSAR Tier 2, Section 11.2.2.4.1, "Liquid Waste Storage System Components," and FSAR Tier 2, Figures 11.2-1 and 11.2-2 by showing system vent connections to the RWB ventilation system, deleting descriptions of the types and number of tank connections, revising the drawing in differentiating between drums and tanks receiving sludge from the centrifuge, and clarifying that evaporator distillates may contain little or no radioactivity but that tritium concentrations are expected to remain essentially unchanged. The response relies on the response to RAI 273, Question 11.02-15 in providing further details describing the demineralizer system. The staff finds the applicant's response to RAI 273, Question 11.02-9 is acceptable since it addresses the identified inconsistencies. **RAI 273, Question 11.02-9, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Section 11.2.2.4 describes two design features that the staff identified as not having been evaluated as to the potential for radioactive cross contamination of nonradioactive systems and the possibility for unmonitored and uncontrolled releases. The first design features are associated with spargers in liquid radwaste storage tanks designed to introduce compressed air into liquid radwaste. The second instance is associated with the evaporator vapor compressor shaft liquid sealing system where seal water from the shaft seal may be recycled to the demineralizer water distribution system or discharged to the distillate tank. In RAI 273, Question 11.02-10, the staff requested that the applicant acknowledge NRC concerns identified in NRC Bulletin 80-10, requirements of 10 CFR 20.1406, and guidance of RG 4.21 in preventing nonradioactive systems from becoming contaminated and avoiding unmonitored and uncontrolled releases. The staff requested that these design features should be evaluated and the FSAR should describe system features that would prevent the compressed air and demineralizer supply systems from becoming contaminated by liquid radwaste or radioactive gases contained in tanks and vessels. In an October 14, 2009, response to RAI 273, Question 11.02-10, the applicant provided additional details describing protective features that would make the cross-contamination of demineralizer water distribution system unlikely. These features include the use of differential pressures on the demineralized water distribution system and multiple barriers, such as isolating valves, check valves, air gaps, and anti siphons that would prevent backflow. For the compressed air distribution system, the working air pressure of the system is higher than that of liquid wastes held in tanks and vessels, with control valves acting as physical barriers. The staff finds the response and explanation to be acceptable. Therefore, the staff considers RAI 273, Question 11.02-10 resolved.

FSAR Tier 2, Section 11.2.2.5.2, "Pre-operational Inspection," lists a number of items associated with the pre-operational inspection program. Among others, one item given addresses "demineralizer resin bed loading capacity." The resin capacity is dependent on the installation of specified sizes of demineralizer columns, a step which should be confirmed as part of the post-construction inspection and system turnover. The staff determined that an equally important inspection step was not given, ensuring that the proper types and amounts of adsorption and filtration media have been initially loaded in each ion-exchange column. In RAI 273, Question 11.02-11, the staff requested that the applicant update the listing and include a step ensuring that the proper types and amounts of adsorption media have been initially added to each LWMS subsystem. The staff requested that the listing include similar provisions for portions of LWMS subsystems that rely on pre- and main filters and ultra-filtration media. In an October 14, 2009, response to RAI 273, Question 11.02-11, the applicant agreed to make the correction and provided proposed changes modifying the listing to include steps that would ensure that the proper types and amounts of adsorption and filtration media will be initially

loaded in each demineralizer bed and filter housing. The staff finds the applicant's response to RAI 273, Question 11.02-11 acceptable. **RAI 273, Question 11.02-11, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Table 11.2-1 provides estimates of processing rates for LWMS subsystems. A review of the discussion presented in FSAR Section 11.2.1.2.3, "Controlled Releases of Radioactivity," indicate that one operational option was to wait for "…natural radioactive decay…" to reduce activity level below release limits. Given that most of the radioactivity present in liquid radwaste is associated with long-lived radionuclides, the staff determined that the processing rates described in FSAR Tier 2, FSAR Tier 2, Table 11.2-1 should be qualified as to whether radioactive decay is being considered for specific waste streams and reflected in the stated processing rates of FSAR Tier 2, Section 11.2.1.2.1, "Capacity," and FSAR Tier 2, Table 11.2-1 and applied as input rates for the GALE code analysis described in FSAR Tier 2, Table 11.2-3 in assessing offsite releases and doses to members of the public. In RAI 273, Question 11.02-12, the staff requested that the applicant consider the practical considerations of waiting for radioactive decay in managing process and effluent streams, and in generating conservative estimates of doses to members of the public. In a November 6, 2009, response to RAI 273, Question 11.02-12, the applicant agreed to revise FSAR Tier 2, Section 11.2.1.2.3 by deleting the discussion about relying on radioactive decay as a means to reduce radioactivity levels for the purpose of complying with NRC regulations. The staff finds the applicant's response to RAI 273, Question 11.02-12 acceptable. **RAI 273, Question 11.02-12, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Section 11.2.2.4.1 states that the activity measurement tank, containing two radiation detectors, is located downstream of the release isolation valves. However, a review of FSAR Tier 2, Figure 11.2-1 indicates that two radiation detectors are located before the two isolation valves and not after. The figure does not show the "activity measurement tank." In RAI 273, Question 11.02-13, the staff requested that the applicant address these inconsistencies and reconcile the descriptions of this portion of the system and figure depictions. In a November 6, 2009, response to RAI 273, Question 11.02-13, the applicant agreed to revise FSAR Tier 2, Section 11.2.2.4.1 and Figure 11.2-1 by updating the description and placement of radiation detectors on the LWMS discharge line. The revision ensures that the description and drawing present consistent information on that function of the LWMS system. The staff finds the applicant's response to RAI 273, Question 11.02-13 acceptable. **RAI 273, Question 11.02-13, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

A review of FSAR Tier 2, Table 11.2-2 and FSAR Tier 2, Figures 11.2-1 to 11.2-3 indicate that the listing of components in FSAR Tier 2, Table 11.2-2 was inconsistent with system descriptions. For example, FSAR Tier 2, Table 11.2-2 did not list components for the demineralizer system. Similarly, FSAR Tier 2, Table 12.2-2 listed components that are not shown in related drawings (e.g., the activity measurement tank). In RAI 273, Question 11.02-15, the staff requested that the applicant review text, tables, and figures and update them to include a complete and consistent presentation of the information for each LWMS subsystem. **RAI 273, Question 11.02-15, which is associated with the above request, is being tracked as an open item.**

A review of FSAR Tier 2, Section 11.2.3.8 indicated that the quality assurance program for the design, fabrication, procurement, and installation of the LWMS meets the guidance of RG 1.143. The commitment refers to FSAR Tier 2, Chapter 17 for a description, which in turn refers to AREVA Topical Report ANP-10266A, AREVA NP, Inc., "Quality Assurance Plan (QAP) for Design Certification of the U.S. EPR, Rev.1, April 2007." A review of FSAR Tier 2, Section 17.2 indicated that the construction phase and operations of the U.S. EPR are not applicable in the context of its design certification; FSAR Tier 2, Section 17.4 is devoted to the reliability program; and FSAR Tier 2, Section 17.5 relies on the AREVA Topical Report in describing the quality assurance program. A review of AREVA Topical Report, Appendix B, "Regulatory Commitments: Compliance with Applicable Regulatory Guides, Generic Letters, and Standards," indicated that RG 1.143 is not listed among the cited documents. Note that although AREVA Topical Report, Appendix B refers to RGs 1.26 and 1.29, these two RGs do not apply to radioactive waste management systems, as stated in both RGs. Given the above, the staff concluded that FSAR Tier 2, Section 11.2.3.8 makes a design commitment for the LWMS that is not supported by FSAR Tier 2, Sections 11.2 and 17.2 and AREVA Topical Report ANP-10266A. In RAI 359, Question 11.02-18, the staff requested that the applicant consider the following and make appropriate revisions to the FSAR Tier 2, Sections 11.2 and 11.7. Specifically:

- revise AREVA Topical Report ANP-10266A, Appendix B of by including RG 1.143 in the list of documents

- describe in FSAR Tier 2, Section 11.2.3.8 the elements of the QAP and identify related COL information item(s) that address the design, fabrication, procurement, and installation of the LWMS based on the guidance of RG 1.143

- make the corresponding changes to the QA discussion of FSAR Tier 2, Section 11.3.3.7 for the GWMS

- add a new subsection containing the corresponding commitment to FSAR Tier 2, Section 11.4 for the SWMS, as FSAR Tier 2, Section 11.4 has no parallel QA discussion that address the fabrication, procurement, and installation of the SWMS based on the guidance of RG 1.143

RAI 359, Question 11.02-18, which is associated with the above request, is being tracked as an open item.

Development of Liquid Effluent Source Term and Compliance with Effluent Concentration Limits

In assessing the radiological impacts associated with radioactive effluent discharges, FSAR Tier 2, Tables 11.2-3 to 11.2-7 present information supporting the development of the liquid effluent source term, and compliance with 10 CFR Part 20 (Appendix B, Table 2, Column 2) effluent concentration limits and design objectives of 10 CFR Part 50, Appendix I. The applicant calculated the annual liquid effluent releases (shown in FSAR Tier 2, Table 11.2-7) using the PWR-GALE code methodology, as described in NUREG-0017. FSAR Tier 2, Table 11.2-3 provides input parameters used in running the computer program in estimating expected primary and secondary coolant radionuclide concentrations and liquid effluents. Other parameters are noted as default values taken from NRC guidance in NUREG-0017. FSAR Tier 2, Table 11.2-4, "Releases to Liquid Effluent Discharge Point (Ci/yr)

Calculated by GALE Code," provides estimates of yearly releases calculated using the PWR-GALE code (1986 update). Using the results of the analysis, FSAR Tier 2, Table 11.2-7 provides a comparison of liquid effluent concentrations relative to 10 CFR Part 20 limits. FSAR Tier 2, Table 11.2-8 presents the results of an evaluation postulating the failure of a LWMS tank containing radioactive liquids, and FSAR Tier 2, Tables 11.2-9 to 11.2-11 present information on the cost-benefit analysis in demonstrating compliance with the requirements of Section II.D in Appendix I to 10 CFR Part 50. Regarding the approach used for the cost-benefit analysis, the applicant used an alternate method to RG 1.110 in demonstrating compliance with the cost-benefit ratio of 10 CFR Part 50, Appendix I, Section II.D. The applicant's results indicate that expected annual releases of radioactivity and liquid effluent concentrations in unrestricted areas comply with NRC regulations using NRC methodology and guidance.

The staff performed independent assessments of the results presented for the liquid effluent source terms, compliance with effluent concentration limits in unrestricted areas under 10 CFR Part 20, doses to a maximally exposed individual located in an unrestricted area, and the cost-benefit ratio of 10 CFR Part 50, Appendix I. The staff evaluated the information and supporting statements of compliance with NRC regulations and guidance using the PWR-GALE code methodology, as described in NUREG-0017. While the NRC endorsed the use of a calculation methodology and has issued relevant NRC guidance, there are no specific regulatory requirements governing the development of annual liquid effluent source terms. The staff confirmed the results presented for the liquid effluent source term and effluent concentrations in unrestricted areas and determined the results to be acceptable, with differences on the order of about 10 percent. However, the evaluation identified a number of inconsistencies associated with assumptions and parameters used in calculations for which the staff requested the applicant to provide corrections and technical clarifications in RAI 299, Question 11.02-16. The observations included:

- FSAR Tier 2, Table 11.2-3 – The table should state that the basis of the source term assumes an 80 percent capacity factor, being the default value in the PWR-GALE code, and provide the expected capacity factor for the U.S. EPR. In qualifying the expected capacity factor for the U.S. EPR, the discussion should acknowledge that the current fleet of operating reactors is operating at factors in excess of 90 percent, and discuss the rationale as to whether the estimated radioactive liquid effluent releases (Ci/yr) and offsite concentrations (μCi/ml) need to be scaled up in light of an expected higher capacity factor.

- FSAR Tier 2, Table 11.2-3 – The table should note that the cited mass of primary coolant does not include the mass of coolant contained in the pressurizer.

- FSAR Tier 2, Table 11.2-3 – A review of the FSAR indicates that there are three values for the total steam flow rate: 9.39E+06 kg/hr (2.07E+07 lbs/hr) in Table 11.1-3; 8.62E+06 kg/hr (1.9E+07 lbs/hr) in FSAR Tier 2, Table 11.1-6; and 9.85E+06 kg/hr (2.171E+07 lbs/hr) in FSAR Tier 2, Table 11.2-3. Provide a justification for the use of 9.85E+06 kg/hr (2.171E+07 lbs/hr) in FSAR Tier 2, Table 11.2-3.

- FSAR Tier 2, Table 11.2-3 – The table applies a value of 9.91E+04 kg/hr (2.184E+05 lbs/hr) as the steam generator (SG) blowdown rate. FSAR Tier 2, Table 11.1-6 lists a value of 8.62E+04 kg/hr (1.9E+05 lbs/hr) and Table 11.1-3 lists a value of 9.43E+04 kg/hr (2.08E+05 lbs/hr). Provide a justification for the use of 9.91E+04 kg/hr (2.184E+05 lbs/hr) in FSAR Tier 2, Table 11.2-3.

- FSAR Tier 2, Table 11.2-3 – The table applies a value of 0.33 as the fraction of condensate flow going to the condensate demineralizer. In Table 11.1-6, this fraction is given as zero, and in FSAR Tier 2, Table 11.1-3, it is shown as 100 percent of the condensate. Provide a justification for the use of 0.33 in FSAR Tier 2, Table 11.2-3.

- FSAR Tier 2, Table 11.2-3 – The table applies a value of 416 l/d (110 gpd) as the shim bleed flow rate. Table 11.1-6 lists a value of 227 kg/hr (500 lbs/hr), which is equivalent to a flow rate of 7,778 l/d (2,055 gpd) using the specific volume of FSAR Tier 2, Table 11.1-1. Provide a justification for the use of 416 l/d (110 gpd) in FSAR Tier 2, Table 11.2-3.

- FSAR Tier 2, Table 11.2-3 – The table applies a value of 6,540 l/d (1,728 gpd) for the equipment drain input and 3.57E+04 l/d (9,428 gpd) for the clean waste input. However, these input rates could not be inferred from the design values given in FSAR Tier 2, Table 11.2-1 or Group I, II, and III waste streams. Provide the basis and justification for these two input rates.

- FSAR Tier 2, Table 11.2-3 – The table applies a DF of 10^7 for cesium and other nuclides for the processing of shim bleed and equipment drain. However, these DFs could not be inferred from the values given in NUREG-0017. Provide the basis and justification for the use of a DF of 10^7.

- FSAR Tier 2, Table 11.2-3 – The table applies a value of 27.7 days as the holdup time for xenon and 1.67 days for krypton, with the values being imported from FSAR Tier 2, Table 11.3-1. See staff comments on FSAR Tier 2, Table 11.3-1 about holdup times. These comments are discussed in Section 13.3, "Emergency Planning," of this report. Update FSAR Tier 2, Table 11.2-3 accordingly in light of the resolution of comments generated on this topic for FSAR Tier 2, Table 11.3-1.

- FSAR Tier 2, Table 11.2-3 –The table applies a value of 116 m^3/m (4,100 cfm) for the containment internal cleanup rate and 84.1 m^3/m (2,970 cfm) for the containment low volume purge rate. However, these input rates could not be found in FSAR Tier 2, Section 9.4, "Air Conditioning, Heating, Cooling and Ventilation Systems," Revision 1. FSAR Tier 2, Table 12.2-19, "Parameters and Assumptions for Calculating Airborne Radioactive Concentrations," provides values of 90.9 m^3/m (3,210 cfm) for the normal operation purge flow rate and 116 m^3/m (4,100 cfm) for the equipment area recirculation flow rate, and FSAR Tier 2, Section 6.5.1.3, "Design Evaluation," provides only operational ranges. Provide the basis and justification for the values used in FSAR Tier 2, Table 11.2-3.

- A review of FSAR Tier 2, Section 11.2.2.1.1, "Waste Input Streams," Revision 1, and FSAR Tier 2, Table 11.2-4 indicates that the grouping of liquid effluent streams given in FSAR Tier 2, Table 11.2-4 is inconsistent with that of FSAR Tier 2, Section 11.2.2.1.1. For example, Turbine Building floor drain, miscellaneous wastes, and shim bleed waste inputs shown in FSAR Tier 2, Table 11.2-4 are not given in FSAR Tier 2, Section 11.2.2.1.1. Similarly, the category of "Misc. Wastes" shown in FSAR Tier 2, Table 11-2-4 is not explained as to which waste input streams it includes given in the grouping scheme of FSAR Tier 2, Section 11.2.2.1.1. Review and revise for consistency the information presented in FSAR Tier 2, Section 11.2.2.1.1 and FSAR Tier 2,

Table 11.2-4. Also, provide in FSAR Tier 2, Table 11.2-4 appropriate notations describing how the grouping scheme of FSAR Tier 2, Section 11.2.2.1.1 was translated into the one shown in Table 11.2-4.

- A review of FSAR Tier 2, Section 11.2.3.5, "Maximum Release Concentrations," Revision 1, and FSAR Tier 2, Table 11.2-7 indicates that the basis of the adjustment factor applied in estimating releases characterized by maximum fuel defects is not described in FSAR Tier2, Section 11.2.3.5. A review of the results presented in FSAR Tier 2, Table 11.2-7 indicates that the scaling factor (max/normal) ranges from 1 to 10^3. For example, the results for corrosion and activation products and tritium are greater than one, which should not be the case, since their production is insensitive to the assumed fraction of failed fuel. The scaling factor is presumed to be four, (i.e., 1.0 percent vs. 0.25 percent) assumed failed fuel fraction given the information presented in FSAR Tier 2, Section 11.1. However, the factors were determined to be much higher and variable in many instances. For example, the ratio is 3.8 for H-3, 131 for Mo-99, 1,000 for Rh-103 m, 69 for Te-129 m, 35 for I-131, 1.9 for I-132, 16.7 for I-133, 4.4 for I-135, and 96 for Cs-137, among others. Review and revise the basis of the scaling factor and describe the rationale and application of the scaling factor in FSAR Tier 2, Section 11.2.3.5 and presentation of the results in FSAR Tier 2, Table 11.2-7.

RAI 299, Question 11.02-16, which is associated with the above request, is being tracked as an open item.

With respect to liquid effluent releases, the requirements of 10 CFR 20.1302 permit an applicant to demonstrate compliance with applicable dose limits of 10 CFR 20.1301, in part, by showing that the annual average concentrations of radioactive materials in liquid effluents released in unrestricted areas do not exceed the limits specified in 10 CFR Part 20 (Appendix B, Table 2, Column 2). FSAR Tier 2, Table 11.2-7 demonstrates that radionuclide sum-of-the-ratios of liquid effluents released during normal operation in unrestricted areas to their respective liquid effluent concentration limits of 10 CFR Part 20 are less than unity, about 0.12. The results for the given radionuclides are well below 10 CFR Part 20 Appendix B (Table 2, Column 2) liquid effluent concentration limits, while tritium, by itself, is about 10 percent of its limit. The results derived using maximum fuel defects comply as well with effluent concentration limits with a higher sum-of-the-ratios, about 0.62. The staff confirmed these results based on its own independent analysis and determined the results to be acceptable, with values of the sum-of-the-ratios of about 0.12 and 0.64, respectively for normal operation and maximum fuel defects.

With respect to the evaluation of offsite impacts due to a postulated failure of a LWMS waste tank, the applicant presents the results of its analysis in FSAR Tier 2, Table 11.2-8. The assessment considers the impacts of the release of radioactive materials on the nearest potable water supply located in an unrestricted area using the guidance of BTP 11-6 in SRP Section 11.2 (NUREG-0800). The applicant assumed a distance of about 366 m (1,200 ft) from the building to the unrestricted area, and a travel rate of about 0.037 cm/day (0.0012 ft/day) for cesium and strontium, and about 2.5 cm/day (0.083 ft/day) for nuclides other than cesium and strontium. Results are included for three radionuclides, tritium, Fe-55, and Co-60 in demonstrating compliance with liquid effluent concentration limits of 10 CFR Part 20 (Appendix B, Table 2, Column 2). FSAR Tier 2, Table 11.2-8 demonstrates that the sum-of-the-ratios for these three radionuclides is less than unity and FSAR Tier 2,

Section 11.2.3.7, “Postulated Radioactive Releases due to Liquid-Containing Tank Failures,” presents specific assumptions used in the analysis. FSAR Tier 2, Table 11.2-8 indicates that tritium and Co-60 when summed would not exceed 40 percent of the 10 CFR Part 20, Appendix B limit, and that Fe-55 would contribute less than 0.01 percent to the sum-of-the-ratios. The staff’s review indicates that there is not enough information provided in the FSAR to conduct an independent evaluation. In RAI 301, Question 11.02-17(5), the staff requested that the applicant provide further information and technical clarifications. The applicant was requested, at a minimum, to describe the radioactive source term contained in the LWMS tank assumed to have failed; explain why other long-lived radionuclides (e.g., Cs-137, Sr-90, etc.) and environmentally mobile radionuclides (e.g., C-14, Tc-99, I-129, etc.) were not considered in the analysis; describe the application of design features, if any, used in mitigating such releases; and provide information describing the ground water flow regime characterizing the movement, retardation, and dilution of the release of radioactivity from the selected tank and plant building location to the unrestricted area and point of water use. **RAI 301, Question 11.02-17(5), which is associated with the above request, is being tracked as an open item.**

Compliance with Liquid Effluent Dose Limits for Members of the Public

Under the requirements of 10 CFR Part 50, Appendix I, Sections II.A and II.D to an applicant is responsible for addressing the requirements of 10 CFR Part 50, Appendix I dose objectives in controlling doses to a hypothetical maximally exposed member of the public and populations living near the proposed nuclear power plant. The requirements define dose objectives for liquid effluents, and require a cost-benefit analysis in justifying installed processing and treatment equipment of the LWMS, including any augmentation to the design in complying with 10 CFR Part 50, Appendix I. FSAR Tier 2, Section 11.2.4 states that a COL applicant will confirm that the FSAR analysis for a typical site is applicable and, if not, conduct its own site-specific cost benefit analysis instead. This is COL Information Item 11.2-1, as identified in FSAR Tier 2, Table 1.8-2. The staff determined that the inclusion of COL Information Item 11.2-1 is acceptable as it addresses the requirements of 10 CFR Part 50, Appendix I, Sections II.A and II.D.

Regarding doses to the maximally exposed offsite individual, the applicant demonstrates compliance with the numerical and design objectives of 10 CFR Part 50, Appendix I to using NRC guidance and methodology, namely the LADATP II computer code documented in NUREG/CR-4013, “LADTAP II − Technical Reference and User Guide.” The applicant estimates an annual dose of 0.0218 mSv (2.18 mrem) to the total body and an infant thyroid dose of 0.0483 mSv (4.83 mrem). The corresponding numerical and design objectives of 10 CFR Part 50, Appendix I, are 0.03 and 0.10 mSv (3 and 10 mrem) per year to the total body and limiting organ, respectively. By comparison, the results demonstrate compliance with 10 CFR 20.1301(e) in meeting EPA environmental radiation protection standards of 40 CFR Part 190 for facilities within the fuel-cycle, including nuclear power reactors. The EPA standards specify annual dose limits of 0.25 mSv (25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid, and 0.25 mSv (25 mrem) for any other organ for members of the public exposed to planned discharges of radioactive materials. The staff performed an independent evaluation of the parameters and methodology used in calculating doses. In its evaluation, the staff determined that it could not confirm the results, with differences of over 20 percent, using the assumptions and parameters presented in FSAR Tier 2, Tables 11.2-6, “Dose Commitment Due to Liquid Effluent Releases,” and 11.2-10, “Obtainable Dose Benefits

for Liquid Waste System Augment." In RAI 301, Question 11.02-17, the staff requested that the applicant provide corrections and technical clarifications. The staff observations included:

- A review of FSAR Tier 2, Table 11.2-5, "Input Parameters for LADTAP II Computer Code," indicates that a number of parameters used in the LADTAP II code are not given. While the FSAR references LADTAP II as a source of information, the applicant is responsible for documenting and justifying all input parameters in calculating doses. At a minimum, the staff requested that the applicant expand the tabulation to include the following parameters for the ALARA analysis: (1) Dilution factors for the following exposure pathways: Aquatic food, boating, swimming, shoreline, and drinking water for the maximum individual; and (2) transit times for drinking water, and "other pathways," as a category. Similarly for the irrigated food pathways, the tabulation should include: (1) The fraction of animal feed and water provided from non-contaminated irrigation water as they relate to the meat and milk exposure pathways; and (2) water usage transit times for the leafy vegetables, vegetables, milk, and meat exposure pathways.

- A review of FSAR Tier 2, Table 11.2-5 indicates that the results are based on a discharge flow rate of 2.83 m^3/s (100 ft^3/s). In demonstrating compliance with the effluent concentration limits of 10 CFR Part 20, Appendix B, FSAR Tier 2, Section 11.2.3.5 applies a dilution flow rate of 0.56 m^3/s (20 ft^3/s). In calculating population doses for the same effluents and discharge path, FSAR Tier 2, Table 11.2-9 uses a discharge flow rate of 1.11 m^3/s (39.3 ft^3/s). The applicant is requested to describe in the FSAR the underlying assumptions and justify the use of different values in estimating doses from the same effluent and discharge path.

- A review of FSAR Tier 2, Table 11.2-6 indicates that dose results are presented only for the total body and thyroid, with only one reference identifying the infant as the critical age group for thyroid exposure. Also, the age group is not specified for the reported total body dose given in the table. It is not possible from this information to compare doses among the four age groups of RG 1.109 and confirm that the infant is the limiting age group for the thyroid and that no other age group and organ are limiting. The applicant is requested to expand the presentation of the results in FSAR Tier 2, Table 11.2-6 to include all four age groups and eight organs of RG 1.109, and provide a summation of doses given that the LADTAP II code automatically provide all such results.

- A review of FSAR Tier 2, Table 11.2-9 indicates that a number of parameters used in the LADTAP II code are presented without any supporting assumptions and justifications. For example, FSAR Tier 2, Table 11.2-9 lists values for population distributions, time spent as recreational activities in surrounding locations impacted by liquid effluent releases, commercial and sport fishing production rates, and other supporting parametric values. While the FSAR references LADTAP II as a source of information, the applicant is responsible for documenting and justifying all input parameters in calculating doses. The applicant is requested to describe in the FSAR the underlying assumptions and justify the use of different values in estimating population doses. Note that the information on population doses is needed by the staff in confirming the results of the cost-benefit analysis presented in FSAR Tier 2, Section 11.2.4. At a minimum, the staff requested that the applicant:

- Provide justifications and references supporting the values given in FSAR Tier 2, Table 11.2-9.

- Explain the rationale for applying a “saltwater site” (see FSAR Tier 2, Table 11.2-9) in estimating population doses and using a “freshwater site” (see FSAR Tier 2, Table 11.2-5) in estimating individual doses for 10 CFR Part 50, Appendix I compliance. Provide descriptions of exposure pathways and usage or consumption parameters that would characterize a saltwater site.

- Explain the basis for a single dilution value of 365, given in FSAR Tier 2, Table 11.2-9, in estimating population doses. Confirm that a single dilution factor is adequate in characterizing exposures for the various given activities, including shoreline, boating, swimming, commercial fishing (fish and invertebrate), and sport fishing (fish and invertebrate).

- Provide the transit times for the given activities, including shoreline, boating, swimming, commercial fishing (fish and invertebrate, if different), and sport fishing (fish and invertebrates, if different).

RAI 301, Question 11.02-17, which is associated with the above request, is being tracked as an open item.

In the context of complying with 10 CFR Part 50, Appendix I, Section II.D, ALARA cost-benefit analysis (CBA) for the LWMS, FSAR Tier 2, Section 11.2.4 and FSAR Tier 2, Tables 11.2-10 and 11.2-11 present the results of a cost-benefit analysis in justifying that no system augmentation is needed given the cost-benefit ratio of $100,000 per person-sievert ($1,000 per person-rem) 10 CFR Part 50, Appendix I. Collective doses are reported to be 0.00177 person-sievert (0.177 person-rem) for the total body and 0.00682 person-sievert (0.682 person-rem) for the thyroid.

A review of the method applied indicated that an alternate approach and assumptions to RG 1.110 were used for the analysis. The analysis assumes a 60-year life-cycle for the selected radwaste processing equipment, while RG 1.110 applies a 30-year life cycle. Given the heavy duty operational cycle of such equipment, the CBA should provide the technical justification for an expected operational life of 60 years. In addition, the CBA should provide the processing capacity rate of the supplemental demineralizer subsystem. In RAI 273, Question 11.02-14 and RAI 301, Question 11.02-17(4), the staff requested that the applicant provide a technical justification for the approach used and provide sufficient information for the staff to conduct an independent evaluation. **RAI 273, Question 11.02-14 and RAI 301, Question 11.02-17(4), which are associated with the above request, are being tracked as open items.**

In addition, the staff confirmed that a COL applicant will be responsible for determining if the CBA presented in FSAR Tier 2, Section 11.2.4 is applicable or bounding for the site location and, whether the COL applicant has conducted a plant-and site-specific analysis to update the results presented in the FSAR. A COL applicant referencing the U.S. EPR design will be responsible for demonstrating, through the ODCM, compliance with 10 CFR 20.1301(e), which incorporates by reference the EPA environmental radiation protection standards in 40 CFR Part 190 for facilities within the nuclear fuel-cycle, including nuclear power plants.

Minimization of Contamination

FSAR Tier 2, Section 12.3.6, "Minimization of Contamination," addresses compliance with 10 CFR 20.1406, as it relates to facility design and operational procedures for permanently installed subsystems in minimizing the contamination of the facility and generation of radioactive waste. FSAR Tier 2, Section 12.3.6, discusses features of structures, systems, and components (SSCs) intended to minimize contamination.

This section states that the principles embodied in the philosophy include preventing unintended releases and early detection of unintended contamination. The LWMS is designed to reduce volumes of liquid wastes held in subsystems and, to the extent practicable, minimize contamination to the facility and environment, and facilitate eventual decommissioning under 10 CFR 20.1406.

In its review of the LWMS, the staff noted that the design basis and descriptions of structures, systems, and components did not always acknowledge NRC concerns identified in NRC Bulletin 80-10 and the guidance of RG 4.21 in preventing nonradioactive systems from becoming contaminated and avoiding unmonitored and uncontrolled releases of liquid effluents. These design features should be evaluated, and the FSAR should describe system features that would prevent spills and leaks, and radioactive contamination of nonradioactive support systems. For example, such support systems include compressed air and demineralized water supply systems, which might potentially become contaminated by liquid radwaste or radioactive gases contained in tanks and vessels of the LWMS. While specific RAIs were submitted to the applicant to address such concerns in FSAR Tier 2, Section 11.2, the staff's evaluation of the applicant's responses and closure of such RAIs are addressed in Section 12.3 of this report.

FSAR Tier 1 Information

In FSAR Tier 2, Section 14.3.2, "Chapter 2, System Based Design Descriptions and ITAAC," and FSAR Tier 2, Table 14.3-8, "ITAAC Screening Summary"; FSAR Tier 2, Section 11.2; and FSAR Tier 1, Section 2.0, "System Based Design Descriptions and ITAAC," the applicant indicates that the treatment of ITAAC has been divided in two groups: Certified design material (CDM), and ITAAC. The applicant states further: CDM binds the design commitment of structures, systems, and components for the lifetime of the facility; and ITAAC are used to verify the as-built features of the plant. FSAR Tier 2, Section 14.3.2 assigns ITAAC based on (1) the classification of systems and equipments, and (2) on systems identified during key safety and integrated plant safety analyses for the purpose of preserving specific design features in the as-built facility. Systems described in FSAR Tier 2 sections that have no safety significant features or that were not identified as part of the "key safety and integrated plant safety analyses" process are given in FSAR Tier 1 as, "No entry for this system."

Although the selection process identifies pertinent NRC regulations for safety-related design features, FSAR Tier 1, with the exception of Section 2.9.4, "Sampling Activity Monitoring System," FSAR Tier 1. Section 2.9 does not identify ITAAC associated with plant systems and components used to monitor and/or control radioactivity releases in the environment in demonstrating compliance with 10 CFR Part 20 (Appendix B, Table 2, Column 2) liquid effluent concentration limits; and doses to members of the public under 10 CFR 20.1301, "Dose limits for individual members of the public," and 10 CFR 20.1302, as well as avoiding unmonitored and uncontrolled radioactive releases to the environment in response to 10 CFR 20.1406(b). FSAR Tier 1, Section 2.9.4 includes ITAAC in confirming that instrumentation will indicate the

presence of elevated levels of radioactivity in the plant vent stack and main control room air intake and the isolation of the intake air supply system. Specific RAIs were submitted to the applicant to address such concerns for the LWMS as part of the review of FSAR Tier 2, Section 14.3, "Inspection, Test, Analysis, and Acceptance Criteria." The staff's evaluation of the applicant's responses and closure of such RAIs are addressed in Section 14.3 of this report.

ITAAC Information

FSAR Tier 2, Chapter 14, Table 14.3-8, (Sheet 5 of 8), states that the LWMS is within the scope of FSAR Tier 1; however, FSAR Tier 1, Section 2.9.1 states that there are no FSAR Tier 1 entries for the LWMS. The LWMS is relied upon to maintain concentrations of radioactive wastes released to the environment below the exposure limits of 10 CFR Part 20. In addition, 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," states that significant plant systems and component parameters should be included in FSAR Tier 1 entries. The ability to maintain concentrations below 10 CFR Part 20 limits and doses to members of the public depends upon the LWMS process, including the number and sizing of storage tanks, processing equipment, effluent radiological monitoring and sampling systems, automatic control features in terminating releases that exceed alarm set-points, and process dilution before release into the environment. It was determined that ITAAC should be included to confirm, with respect to FSAR Tier 2 design features, the initial introduction of the proper types and amounts of adsorbent and filtration media in LWMS subsystems that rely on such media to successfully process and treat liquid wastes before being discharged to the environment. For example, if the LWMS were properly built with all mechanical components in place, but without confirming the initial introduction of the proper types and amounts of filtration and adsorbent media, the LWMS would be ineffective and would fail to meet the performance parameters stated in FSAR Tier 2, Section 11.2.1 and decontamination factors given in FSAR Tier 2, Table 11.2-3. As a result, liquid effluent releases could exceed the concentration limits of 10 CFR Part 20 (Appendix B, Table 2, Column 2). In view of the above, under FSAR Chapter 12, "Radiation Protection" (RAI 105, Question 11.02 02), and Chapter 14 (RAI 292, Question 14.03.07-33), the staff requested that the applicant, identify the rationale for screening out LWMS subsystems from FSAR Tier 1 entries given that subsystems are used to demonstrate compliance with 10 CFR Part 20 regulations. The staff requested that the applicant address such concerns for the LWMS in FSAR Tier 2, Section 14.3. The staff's evaluation of the applicant's responses and closure of such RAIs are addressed in Section 14.3 of this report.

Technical Specifications

Review of FSAR Tier 2, Chapter 16, "Technical Specifications," shows that there are no TS directly associated with liquid waste storage and processing. However, FSAR Tier 2, Chapter 16, TS 5.5.1, "Offsite Dose Calculation Manual," and FSAR Tier 2, Chapter 16, TS 5.5.3, "Radioactive Effluent Controls Program," provide directions in managing releases of radioactive effluents and the control and handling of concentrated wastes for disposal. The proposed TS requirements of FSAR Tier 2, Chapter 16, TS 5.5.11, "Gaseous Waste Processing System Radioactivity Monitoring Program," on specifying limits on the amounts of radioactivity in tanks located outdoors does not apply to the U.S. EPR, since the refueling water storage tank is located in the reactor containment.

However, the TS states that if outdoor liquid radwaste tanks are used, the COL applicant or COL holder is responsible for modifying this program by introducing maximum limits on the amounts of radioactivity that would be contained in such tanks. FSAR Tier 2, Chapter 16,

TS 5.6.1, “Annual Radiological Environmental Operating Report,” and TS 5.6.2, “Radiological Effluent Release Report,” specify annual reporting requirements in describing the results of the radiological monitoring program and provide summaries of the quantities of radioactive liquid effluents released in the environment. As stated in TS 5.5.1, COL initiated changes to the ODCM must be justified by calculation, and changes will maintain levels of radioactivity in effluent in compliance with the requirements of 10 CFR 20.1302; 40 CFR Part 190; 10 CFR 50.36a, “Technical specifications on effluents from nuclear power reactors”; and 10 CFR Part 50, Appendix I. Technical specifications would also require the radioactive effluent controls program, which is contained in the ODCM, to include instrumentation to monitor and control liquid effluent discharges; meet limits on effluent concentrations released to unrestricted areas; monitor, sample, and analyze liquid effluents before and during releases; set limitations on annual and quarterly dose commitments to a member of the public; and assess cumulative doses from radioactive liquid effluents. The use of an ODCM is under the operational programs described in FSAR Tier 2, Section 13.4.

The staff determined these proposed TS requirements acceptable, and the implementation of such programs will be addressed in a plant and site-specific ODCM under COL Information Item 11.5-1, as described in FSAR Tier 2, Table 1.8-2. The staff’s evaluation of the applicant’s proposed ODCM is addressed in Section 11.5 of this report.

Preoperational Testing

FSAR Tier 2, Section 14.2.12, “Individual Test Descriptions,” describes individual test abstracts to be conducted on identified plant systems and components. There are four tests identified for the LWMS. They are Test No. 095 for the LWMS processing system; Test No. 144, “Process and Effluent Radiological Monitoring System,” for the process and effluent radiological monitoring system, which includes the radiation monitor located on the LWMS discharge line; Test No. 215 for the liquid storage and processing systems; and Test No. 090, “Plant Laboratory Equipment,” for laboratory radio-analytical equipment which will be used for the analysis of effluent samples and to determine if radionuclide concentrations in monitoring tanks comply with NRC effluent concentration limits of 10 CFR Part 20, and whether they can be discharged to the environment. Test No. 095 (liquid waste processing system) describes the startup tests for the LWMS, including the operational status of key design features, such as isolation of a discharge on a high-radiation signal along with other alarms and interlocks. Test No. 215 is similar to Test No. 095, but it is performed during plant operations at plant power levels above 75 percent. The staff reviewed these tests and generated specific RAIs on the information presented in FSAR Tier 2, Section 14.2.12. The evaluation of the applicant responses to and closure of these RAIs are addressed in Section 14.2 of this report.

11.2.5 Combined License Information Items

Table 11.2-1 provides a list of LWMS-related COL item numbers and descriptions from FSAR Tier 2, Table 1.8-2:

Table 11.2-1 U.S. EPR Combined License Information Items

Item No.	Description	FSAR Tier 2 Section
11.2-1	A COL applicant that references the U.S. EPR design certification will confirm that the liquid waste management system cost-benefit analysis for the typical site is applicable to their site; if it is not, provide a site-specific cost-benefit analysis.	11.2.4

The staff concludes the above list of COL information items to be complete and adequately describes the actions necessary for the COL applicant or holder.

11.2.6 Conclusions

Except for the open items identified below, the staff concludes that the LWMS, as a permanently installed system, includes the equipment necessary to collect, process, handle, store, and dispose of liquid radioactive wastes generated as a result of normal operation and AOOs. The applicant provided sufficient design information to demonstrate that it has met the requirements of 10 CFR Part 50.34a; GDC 60 and GDC 61 of 10 CFR Part 50, Appendix A; and NRC guidance and acceptance criteria. This conclusion is based on the following:

- The U.S. EPR design demonstrates compliance with 10 CFR 50.34a, as it relates to the inclusion of sufficient design information and system design features that are necessary for collecting, storing, processing, and controlling and monitoring the safe discharges of liquid wastes. The design conforms to the guidelines of SRP Section 11.2.

- The U.S. EPR design meets the requirements of GDC 60 with respect to controlling releases of liquid effluents by monitoring LWMS discharges through a single discharge line. All LWMS releases are monitored by a radiation monitor, which will generate a signal to terminate liquid waste releases before discharge concentrations exceed a predetermined instrumentation set point. The COL applicant is responsible for determining the operational set-point for its LWMS radiation monitors in a plant and site-specific offsite dose calculation manual (ODCM) under COL Information Item 11.5 1, as described in FSAR Tier 2, Table 1.8-2. As part of this commitment, the COL applicant will be responsible for demonstrating compliance with 10 CFR Part 20 (Appendix B, Table 2, Column 2) and dose limits for members in 10 CFR 20.1301 before releasing radioactive materials in unrestricted areas. As part of this commitment, the COL applicant will be responsible for demonstrating, through the ODCM, compliance with 10 CFR 20.1301(e), which incorporates by reference 40 CFR Part 190 for facilities within the nuclear fuel cycle, including nuclear power plants.

- The U.S. EPR demonstrates compliance with the requirements of GDC 61 by meeting the guidelines of RG 1.143 by using providing sufficient storage space and treatment capacity to assure adequate safety under normal operation, AOOs, and postulated accident conditions. This commitment fulfills the requirements of 10 CFR 20.1406 and guidance of RGs 4.21 and 1.143 in minimizing the contamination of the facility and generation of radioactive waste and concerns of NRC Bulletin 80-10 in avoiding the cross-contamination of nonradioactive systems and unmonitored and uncontrolled radioactive releases to the environment.

- A COL applicant referencing the U.S. EPR certified design will demonstrate compliance with 10 CFR Part 50, Appendix I, Section II.D design objectives for offsite individual doses and population doses resulting from liquid effluents by preparing a site-specific cost-benefit analysis using NRC guidance under COL Information Item 11.2-1, as described in FSAR Tier 2, Table 1.8 2.

- The U.S. EPR design provides sufficient information and design features satisfying the guidance of RG 1.143 for radioactive waste processing systems in establishing the seismic and quality group classifications for system components and structures housing LWMS components.

For the following open items, tracked under **RAI 273, Question 11.02-5; RAI 273, Question 11.02-15; RAI 359, Question 11.02-18; RAI 299, Question 11.02-16; RAI 301, Question 11.02-17(5); RAI 301, Question 11.02-17; RAI 273, Question 11.02-14; and RAI 301, Question 11.02-17(4)**, the staff concludes, using the information presented in the application, that the applicant has not fully demonstrated compliance with NRC regulations and guidance controlling radioactive releases to the environment and associated doses to members of the public. The regulations are contained in 10 CFR 20.1301 and 20.1302; Appendix B (Table 2, Column 2) to 10 CFR Part 20; 10 CFR Part 50, Appendix I, Sections II.A and II.D design objectives; and requirements of 40 CFR Part 190 as referenced in 10 CFR 20.1301(e). The guidance is contained in RGs 1.109, 1.110, and 1.143, and SRP Section 11.2.

11.3 Gaseous Waste Management Systems

11.3.1 Introduction

During plant operation, fission product gases, radioactive particulates and vapors, and radiolytic decomposition gases (e.g., hydrogen and oxygen) are generated and conveyed by system processes to various plant systems. In pressurized water reactors, gaseous wastes and process vents are characterized by the presence of noble gases, radioiodines, particulates, carbon-14, and tritium, among others. Process gases originate from primary coolant degasification systems, venting of tanks and vessels, the steam generator blowdown flash tank, and the main condenser evacuation system, among others. Other sources of gaseous radioactivity include containment purges and radioactivity captured by various building ventilation systems, including those of the Fuel, Auxiliary, Radwaste, Turbine, and Containment Buildings. The gaseous waste management system is designed to collect, process, store, monitor, and control releases of radioactive gases generated during plant operation and maintenance. For process streams containing radioactivity, treatment methods include the use of HEPA and charcoal filters, gas decay tanks filled with activated charcoals, and detectors monitoring radiation and radioactivity levels. Fission product gases (e.g., krypton and xenon)

are dynamically absorbed by activated charcoal media in decay tanks, allowing for radioactive decay before being discharged to the environment via a building or plant vent stack. For process streams that contain hydrogen and oxygen, in addition to radioactive materials, the treatment methods include the use of hydrogen and oxygen recombiners, instrumentation to control hydrogen and oxygen levels, gas driers and coolers, and waste gas compressors. The purpose of this system is to control and avoid the generation of potentially explosive gas mixtures. Airborne radioactive materials present in buildings are handled via each building's ventilation exhaust system using HEPA and charcoal filters. The sources of radioactivity for such systems include process leakage, steam discharges, and work being conducted in radiologically controlled work areas where open systems are being maintained.

The evaluation of the GWMS includes reviews of the design basis, design objectives, design criteria, methods of treatment, and system piping and instrumentation diagrams and process flow diagrams showing methods of operation and factors that influence waste treatment (e.g., system interfaces and potential bypass routes to nonradioactive systems). The evaluation addresses expected releases of radioactivity and associated concentrations and doses to members of the public, and methods, assumptions, and principal parameters used in calculating effluent source terms, releases of radioactive materials in gaseous effluents, and associated doses to members of the public. The review considers methods and programs used to control and monitor releases of gaseous effluents into the environment, such as radiation monitoring methods and use of filtration and adsorption media, and decay tanks.

The staff evaluated the information against the guidance of NUREG-0800, Section 11.3, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants – LWR Edition", March 2007. The SRP acceptance criteria provide the guidance for assuring that gaseous effluent releases and associated radiation exposures are controlled, monitored, and maintained within the limits of 10 CFR Part 20 and meet ALARA and numerical guides and design objectives of 10 CFR Part 50, Appendix I.

11.3.2 Summary of Application

FSAR Tier 1: As stated in FSAR Tier 1, Section 2.9.3, "Gaseous Waste Management System," there are no FSAR Tier 1 entries for the gaseous waste management system.

FSAR Tier 2: The applicant has provided a system description in FSAR Tier 2, Section 11.3, summarized here in part, as follows:

FSAR Tier 2, Section 11.3 describes the design of the GWMS and its functions in controlling, collecting, processing, storing, and disposing of radioactive gases generated as a result of normal operation, including anticipated operational occurrences. The GWMS collects gas mixtures containing hydrogen and oxygen, noble gas fission products, and radioiodines and radioactive particulates, among others. The GWMS, located in the Nuclear Auxiliary Building (NAB), is a non-safety-related system and serves no safety functions, except for the isolation of radioactive releases. A secondary safety-related function of the GWMS includes the isolation of system piping that penetrates the Reactor Building. A failure of the GWMS does not compromise safety-related systems or components and does not prevent the safe-shutdown of the plant. FSAR Tier 2, Section 3.2 describes the seismic and quality group classification and corresponding codes and standards that apply to the design of the GWMS components and piping and structures housing the system. RWMS structures, systems, and components are designed to the seismic criteria of RG 1.143, as Class RW-IIa, and categorized as "radwaste

seismic." Depending on location, some portions of the piping and isolation valves are classified as safety-related and built to American Society of Mechanical Engineers (ASME) Class 2 code standards. The GWMS is housed in a reinforced concrete structure to provide adequate shielding and minimize radiation exposures to personnel during operation and maintenance.

FSAR Tier 2, Figures 11.3-1, "Gaseous Waste Processing System - Normal Operation," and 11.3-2, "Gaseous Waste Processing System - Gaseous Waste Sources," present an overall process flow diagram of the system and specific design details for each subsystem of the GWMS. FSAR Tier 2, Table 11.3-1, provides a listing of operating parameters, including pressure, temperature, and flow rates, among others. FSAR Tier 2, Table 11.3-2, "Gaseous Waste Processing System Component Data," provides a listing of system components and information characterizing volumetric capacities and processing flow rates of major components. FSAR Tier 2, Figures 1.2-10, "Nuclear Auxiliary Building General Arrangement, Plan Elevation +34 Feet," and 1.2-11, "Nuclear Auxiliary Building General Arrangement, Plan Elevation +50 Feet," and Figures 1.2-15, and 1.2-16, "Nuclear Auxiliary Building General Arrangement, Section B-B," present the general arrangement of the NAB in which the major components of the GWMS are located.

FSAR Tier 2, Section 9.4 presents design information on ventilation systems servicing buildings where radioactive systems are located, as well as systems used to collect gases vented from tanks and vessels. FSAR Tier 2, Figures 11.5-1, 12.3-72, "Main Control Room Airborne Monitoring," and 12.3-73, "Reactor and Fuel Buildings Airborne Monitoring," present an overview of the process flow from the GWMS to the point of release via the plant vent stack. The discharge point of the plant vent stack is located at an elevation of 64 m (211 ft) above local grade, which is about 2 m (7 ft) above the top of the Reactor Building.

The GWMS consists of processing equipment, and its associated monitoring instrumentation and control components. The GWMS treats waste gases in two ways. The first method reduces the volume of the gases by recombining of hydrogen and oxygen into water. The recombination reduces the explosion potential within the GWMS. The water is removed and returned for process use, which protects charcoal delay beds and gel drier from being moisture saturated. Because a buildup of explosive mixtures of hydrogen and oxygen is possible, the GWMS must be designed either to withstand the effects of a hydrogen explosion, or to have design features that preclude the buildup of explosive gas mixtures in accordance with SRP Section 11.3 guidelines. The U.S. EPR is designed to preclude the generation and accumulation of explosive gas mixtures.

The second method for treating removed gases is to provide the means to store and hold waste gases long enough for radioactive decay. The holdup allows time for the decay of radioactive materials in waste gases and provides the means to confirm that radioactivity levels released to the environment meet regulatory requirements.

The major components of the GWMS include:

- Piping and valves used to collect and direct gases to and from systems serviced by the GWMS
- Waste gas compressors
- Purge gas driers

- Purge gas reducing stations
- Gas coolers
- Recombiner
- Gel drier
- Nitrogen purge
- Charcoal delay beds
- Gas filters
- Radiation monitors
- Sampling points
- Oxygen and hydrogen measurement cabinets

The charcoal delay beds consist of three vessels and a gel drier with dessicant. The design includes provisions to bypass the charcoal delay beds in the event of a fire, when excessive moisture is present, and during plant startup. A nitrogen purge line is provided to the charcoal delay beds and would be used if a fire were detected in charcoal beds or to dry charcoal beds if saturated with moisture. The GWMS includes various types of instrumentation, including oxygen and hydrogen analyzers; flow, temperature, and pressure measurement sensors; and radiation monitoring and gas sampling equipment. Control and monitoring occur locally and remotely in the plant's control room. Liquid waste generated by the coolers, condensate tanks, and dryers is processed by the LWMS. Plant operators can isolate functional groups or single units to respond to operational needs, maintenance, or equipment malfunctions, while ensuring the proper treatment of processed gases before being released to the environment.

The major process gaseous streams to the GWMS are radioactive fission product gases collected from the pressurizer relief tank, the reactor coolant drain tank, and the volume control tank. The primary source of radioactive gases is the coolant degasification system, which extracts both hydrogen and fission product gases from the reactor coolant. The sources of gases that leak into these systems originate from pump seals and valve packing, and gases that become entrained in solution. The system provides the means to recycle some of the process gases, which reduces the amount of gases that must be directed to the delay bed system. The recycle system includes waste gas compressors and purge gas processing equipment, with nitrogen used for the purge. The design uses redundant, cross-connected flow paths to ensure availability of the system during maintenance or malfunction of a component. The three charcoal delay beds provide an estimated hold time of about 28 days for xenon and about 40 hours for krypton gases. Radioiodines are adsorbed and retained in charcoal delay beds or captured by moisture collected in condensers and drained to the LWMS.

Airborne radioactive materials present in buildings are associated with process leakage and steam discharges and are handled through each building's exhaust ventilation system. These releases are in addition to those from the GWMS. Ventilation systems servicing clean areas of the plant do not contain radioactive materials and were not considered in the design of the

GWMS. The evaluation of these systems are described in Section 9.4 of this report. Airborne and gaseous radioactive materials are processed from the following buildings and released via the plant vent stack:

- Fuel Building ventilation system (FBVS)
- Nuclear Auxiliary Building ventilation system (NABVS)
- Safeguard building controlled-area ventilation system (SBVS)
- Containment Building ventilation system (CBVS)
- Containment Annulus ventilation system (CAVS)
- Radioactive Waste Building ventilation system (RWBVS)
- Access Building Ventilation system (ABVS)

The turbine building ventilation system does not include provisions for controlling and monitoring radioactive releases, since noncondensable gases from the main condenser evacuation system and turbine gland sealing system, which are the only sources of radioactive gases in the turbine building, are released through the plant vent stack via the nuclear auxiliary building exhaust (NABE).

Exhaust flows from the major plant buildings are filtered before being released to the environment and the filtration systems incorporate design features that provide automatic isolation and filtration of exhaust flows before their release under certain circumstances. A high-radiation signal from radiation monitors or sampling systems will result in the isolation of the normal supply and exhaust ducts to affected areas, and route the respective ventilation exhausts to appropriate filter trains equipped with HEPA and charcoal filtration systems. Releases from these buildings are conducted through the plant vent stack. FSAR Tier 2, Sections 6.2.3, “Secondary Containment Functional Design,” 9.4.2, 9.4.3, 9.4.4, 9.4.5, 9.4.7, 9.4.8, and 9.4.14 describe the design bases, operation, and monitoring of such ventilation systems. The PERMSS provides for the monitoring and control of gaseous and particulate releases, as discussed in FSAR Tier 2, Section 11.5.2, “System Description.” FSAR Tier 2, Table 11.5-1, “Radiation Monitor Detector Parameters,” describes the sampling and operational characteristics of the related radiation monitors, including those servicing the plant vent stack.

In assessing the radiological impacts associated with radioactive gaseous effluent discharges, FSAR Tier 2, Tables 11.3-3 to 11.3-9 present information supporting the development of the gaseous effluent source term, and compliance with 10 CFR Part 20 (Appendix B, Table 2, Column 1) effluent concentration limits, 10 CFR 20.1301(e) in meeting EPA environmental radiation protection standards of 40 CFR Part 190, and design objectives of 10 CFR Part 50, Appendix I. As discussed below, the results indicate that expected annual releases of radioactivity and gaseous effluent concentrations in unrestricted areas and associated doses to members of the public comply with NRC regulations and conform to regulatory guidance. The results also demonstrate compliance with the ALARA requirements of 10 CFR Part 50, Appendix I and SPR acceptance criteria for the evaluation of a postulated leak of radioactivity from a GWMS component.

ITAAC: The ITAAC associated with FSAR Tier 2, Chapter 11 are given in FSAR Tier 1, Section 2.9. There are no ITAAC identified for the gaseous waste management systems.

Technical Specifications: There are no technical specifications for the gaseous waste management systems.

11.3.3 Regulatory Basis

The relevant requirements of NRC regulations for the gaseous waste management systems, and the associated acceptance criteria, are given in SRP Section 11.3 of NUREG-0800 and are summarized below. Review interfaces with other SRP sections can be found in NUREG-0800, Section 11.3.

1. 10 CFR 20.1302, as it relates to limits on doses to members of the public and gaseous effluent concentrations in unrestricted areas.

2. 10 CFR 20.1406, as it relates to facility design and operational procedures for minimizing facility contamination and the generation of radioactive waste.

3. 10 CFR 50.34a, as it relates to the inclusion of sufficient design information to demonstrate compliance with the design objectives for equipment necessary to control releases of radioactive gaseous effluents to the environment.

4. 10 CFR Part 50, Appendix I, Sections II.C, II.B, and II.D as they relate to numerical guidelines and design objectives and limiting conditions for operation in meeting dose criteria and the criterion of “as low as is reasonably achievable” in Appendix I.

5. 10 CFR Part 50, Appendix A, GDC 60, as it relates to the design of GWMS to control releases of gaseous radioactive effluents.

6. GDC 3, “Fire Protection,” as it relates to protecting the gaseous waste handling and treatment systems from the effects of a detonation of explosive hydrogen and oxygen gas mixtures.

7. GDC 61, as it relates to the design of the GWMS to ensure adequate safety under normal operations and postulated accident conditions.

8. 40 CFR Part 190 (the EPA generally applicable environmental radiation standards), as implemented under 10 CFR 20.1301(e), as it relates to controlling doses within EPA generally applicable environmental radiation standards.

9. 10 CFR 52.47(b)(1), which requires that applications for design certification contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built, will operate in accordance with the design certification and provisions of the Atomic Energy Act and NRC regulations.

The following RGs contain the regulatory positions and guidance for meeting the relevant requirements of the regulations identified above:

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

2. RG 1.110, as it relates to performing a cost-benefit analysis for reducing cumulative doses to populations by using available technology.

3. RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," July 1977, it relates to the modeling and derivations of atmospheric dispersion and deposition parameters in demonstrating compliance with the numerical guidelines and ALARA criterion of 10 CFR Part 50, Appendix I.

4. RG 1.140, as it relates to the design, testing, and maintenance of normal ventilation exhaust systems at nuclear power plants.

5. RG 1.143, as it relates to the seismic design and quality group classification of components used in the GWMS and the structures housing this system, as well as provisions used to control leakages.

6. RG 1.33, as it relates to quality assurance for the operation of the GWMS provisions for the sampling and monitoring of radioactive materials in process and effluent streams and control of radioactive effluent releases to the environment.

7. RG 4.21, as it relates to minimizing the contamination of equipment, plant facilities, and environment, and minimizing the generation of radioactive waste during plant operation.

8. BTP 11-5, "Postulated Radioactive Releases Due to a Waste Gas System Leak or Failure," as it relates to the assessment of radiological impacts associated with the failure of a GWMS component.

9. NRC IE Bulletin No. 80-10, as it relates to methods and procedures used in avoiding the cross-contamination of nonradioactive systems and unmonitored and uncontrolled releases of radioactivity.

11.3.4 Technical Evaluation

The staff reviewed the GWMS in accordance with the guidance of SRP Section 11.3. The staff reviewed the GWMS to determine whether it complies with the requirements of 10 CFR 50.34a and GDC 3, GDC 60, and GDC 61. Under the requirements of 10 CFR 50.34a, the applicant must provide sufficient design information to demonstrate that the design objectives of equipment necessary to treat and control releases of radioactive effluents into the environment have been met. GDC 3 requires that the design of SSCs important to safety, including the gaseous waste handling and treatment systems from the effects of a detonation of explosive hydrogen and oxygen gas mixtures. GDC 60 requires that the GWMS is designed to control releases of gaseous radioactive effluents, and GDC 61 stipulates that the GWMS is designed to ensure adequate safety under normal operations and AOOs. The relevant requirements of GDC 60 and GDC 61 are met by using the regulatory positions contained in RG 1.143, as it relates to the seismic design, quality group classification of components used in the GWMS and structures housing the systems, provisions used to control leakage, and definitions of discharge paths beginning with interfaces with plant primary systems and terminating at the point of

controlled discharges to the atmosphere via the plant vent stack. Other relevant aspects of RG 1.143 address design and construction methods, materials specifications, welding, and inspection and testing standards for GWMS components and piping. The COL holder is responsible for testing all gaseous waste processing subsystems installed in the plant, as described in FSAR Tier 2, Chapter 14.

The staff reviewed the system construction standards; system process flow outlines and descriptions; sources of waste gases; sampling collection points; flow paths of gases through subsystems, including potential bypasses; and provisions for monitoring radioactivity levels or concentrations in process streams and before being released via the plant vent stack. The review addressed system construction standards, seismic design, and quality group classification of components. The evaluation addressed provisions to control waste gas and purge gas flows as part of the subsystem used for the analysis of combustible gas mixtures, and automatic control functions to preclude the buildup of explosive mixtures in complying with GDC 3 and acceptance criteria of SRP Section 11.3.

An overall process flow diagram depicting major subsystems and sources of radioactivity is provided in FSAR Tier 2, Figure 11.3-2, and FSAR Tier 2, Figure 11.3-1 presents a flow diagram showing process system components and flow paths. FSAR Tier 2, Table 11.3-1 provides a listing of operating parameters, including pressure, temperature, and flow rates, among others. FSAR Tier 2, Table 11.3-2 provides a listing of system components and information charactering volumetric capacities and processing flow rates of major components. FSAR Tier 2, Figures 1.2-10, 1.2-11, 1.2-15, and 1.2-16 present the general arrangement of the NAB in which the major components of the GWMS are located. FSAR Tier 2, Sections 6.2.3 and 9.4 provide information on the design of ventilation system servicing buildings where radioactive systems are located, including features to collect gases vented from tanks and vessels.

Airborne radioactive materials present in buildings are associated with process leakage and steam discharges and are handled through each building's exhaust ventilation system. These releases are in addition to those from the GWMS. FSAR Tier 2, Sections 6.2.3, 9.4.2, 9.4.3, 9.4.4, 9.4.5, 9.4.7, 9.4.8, and 9.4.14 describe the design bases, operation, and maintenance of such ventilation systems. FSAR Tier 2, Figures 12.3-72 and 12.3-73 present process flows, location of filter trains, placement of radiation detectors, and discharge paths to the plant vent stack. Exhaust flows from plant buildings are filtered before being released to the environment and incorporate design features used in isolating the normal air supply and exhaust ducts to affected areas, and diverting process flows to their respective exhaust filter trains, which are equipped with HEPA and charcoal filtration systems. For these systems, the staff's review evaluated how designs considered and incorporated the guidance of RG 1.140 and industry standards, as related to the design, testing, and maintenance of normal ventilation exhaust system air filtration and adsorption units.

The radiological impacts associated with radioactive gaseous effluent discharged via the GWMS are described in FSAR Tier 2, Tables 11.3-3, "Gaseous Release (Ci/yr) Calculated by GALE Code," to 11.3-9, "Gas Waste Management Cost-Benefit Analysis." The information describes the gaseous effluent source term, and, as described in more detail below, demonstrates compliance with 10 CFR Part 20 (Appendix B, Table 2, Column 1) effluent concentration limits, and the design objectives of 10 CFR Part 50, Appendix I. The information includes the results of a cost-benefit analysis demonstrating compliance with the ALARA requirements of 10 CFR Part 50, Appendix I. The cost-benefit analysis concludes that an augmentation of the

GWMS design is not warranted, based on the cost-benefit ratio of 10 CFR Part 50, Appendix I, Section II.D.

FSAR Tier 2, Figure 11.5-1 depicts the process flow from the GWMS to the point of release via the plant vent stack, located at an elevation of 64 m (211 ft) above local grade and about 2 m (7 ft) above the top of the Reactor Building. The PERMSS provides the means to monitor and control gaseous and particulate releases, as discussed in FSAR Tier 2, Section 11.5.2. FSAR Tier 2, Table 11.5-1 describes sampling and operational characteristics of the related radiation monitors, including those servicing the plant vent stack. FSAR Tier 2, Section 12.3.1.4, "Nuclear Auxiliary Building," states that GWMS components are shielded by 0.9 m (3 ft) thick walls inside the Nuclear Auxiliary Building, and that this thickness of shielding results in a dose rate on the outside of the walls of less than 0.01 mSv/hr (1 mrem/hr).

The GWMS is a once-through, activated carbon delay and filtration system, with the capability to hold up for decay, recycle for reuse, or recirculate waste gases that warrant additional processing. The recycling provision reduces the amount of gas that must be processed and discharged through the system. The system includes a gas drier, a hydrogen and oxygen recombiner, a gas cooler, waste gas compressors, gel drier, and activated charcoal in delay beds. During normal plant operation, components in the reactor coolant systems continuously generate and deliver radioactive gases and hydrogen to the processing system for removal by recombination with oxygen. The GWMS operates in two modes, delay mode and surge gas mode. The delay mode is normally used during normal operation when small quantities of waste gas are generated and most of the gas is recycled. When large amounts of waste gases are generated, during startup and shutdown, the system automatically shifts to the surge gas mode. In this mode, the system stops the flow from the delay beds to the NABVS until delay bed pressures and residence times are adjusted to achieve the desired residence times for fission gases. The recycle (purge) system includes waste gas compressors and purge gas processing equipment, with nitrogen as the purge gas. A nitrogen purge is initiated if the compressor were to fail or if the recombiner has to be bypassed to prevent the ingress of atmospheric oxygen and formation of explosive hydrogen and oxygen gas mixtures. Plant operators can isolate functional groups or single units to respond to operational needs, maintenance, or equipment malfunctions, while ensuring the proper treatment of the processed gas before it is released to the environment. The design includes provisions to bypass the charcoal delay beds in the event of a fire, when excessive moisture is present, and during plant startup.

A nitrogen purge line is provided to the charcoal delay beds, and it would be used if a fire were detected in charcoal beds. The design includes a sealing liquid tank to separate gaseous and liquid phases in reducing leakage of gaseous waste or discharges of radioactivity in gaseous effluents, and avoid uncontrolled and unmonitored releases to the environment. GWMS instrumentation includes oxygen and hydrogen analyzers, flow, temperature, and pressure measurements, and provisions for gas sampling. Control and monitoring occur locally and remotely via the main control room.

The principal feature of the GWMS used to reduce radioactive releases is the delay bed system, which includes a gel drier, delay bed, and gas filter. The gel drier remove residual moisture not fully removed by the pre-drier. The charcoal adsorber beds retain radioactive gases (krypton, xenon, and radioiodines) resulting in delays and decay during their transit through the beds. The gas filter removes suspended particulates that may be entrained out of the delay beds. The charcoal delay beds consist of three tanks, each with nominal volume of about 5.3 m^3 (187 ft^3)

and capacity to hold about 2,470 kg (5,440 lbs) of charcoal, for a total amount of about 7,400 kg (16,320 lbs) for the three beds. The gel drier vessel has a nominal volume of about 0.09 m^3 (3.2 ft^3) and capacity to hold about 15 kg (33 lbs) of dessicant. The estimated holdup time for xenon radioactive gases in charcoal beds is about 28 days, and about 40 hours for krypton. Radioiodines are removed by various moisture separation systems. Radioactive particles are removed either via condensation by the system's cooler and condenser components or retained in charcoal beds. Liquid wastes generated by the coolers, condensate tanks, and dryers are processed by the LWMS. The GWMS system includes radiation monitoring instrumentation that is used to control discharges from the system to the atmosphere, via the plant vent stack. The GWMS design includes provisions for sampling at specific process points and protecting against accidental discharges by the detection and signaling of abnormal conditions. There are provisions for periodic inspection of major components to ensure the operational readiness and integrity of the subsystems. As a result, the GWMS satisfies GDC 60, as it provides sufficient means for the treatment and retention of waste gases, and for control of radioactive gaseous effluent releases.

In preventing potentially explosive hydrogen and oxygen mixtures, the GWMS includes measurement cabinets with gas analyzers to measure hydrogen and oxygen concentrations in the purge gas to the gas drier and upstream of the recombiner. The hydrogen and oxygen sensors have interlocks and quick-closing valves to isolate potentially explosive gas mixtures. The interlocks actuate when hydrogen concentrations exceed four percent by volume, or when oxygen concentrations exceed two percent. The piping and components are not designed to withstand an explosion, but the system is designed to prevent the accumulation of explosive gas mixtures. Other design features include redundant hydrogen and oxygen gas supply control valves so that a failure of one valve does not prevent injection of either gas in avoiding explosive gas mixtures. The gas supply is equipped with an air operated, quick-closing, isolation valve that responds to an interlock signal to stop injection of hydrogen and oxygen. If the potential for hydrogen and oxygen explosive mixtures exists, or an analyzer detects an out of specification reading or malfunction, it will annunciate an alarm in the main control room and simultaneously send a signal that closes all injection valves. The sensors are interlocked with nitrogen blanket supply valves to connected components that generate the most hydrogen, and the sensors can shut down the recombiner. If the waste gas compressors were to fail or if the recombiner needs to be bypassed, the purge gas return line is blanketed with nitrogen to prevent the accumulation of explosive gas mixtures.

The GWMS incorporates redundant components in order to provide adequate system tolerance to single component failures. The GWMS design has two gas analyzers upstream and one gas analyzer downstream of the recombiner. These components include redundant waste gas compressors, redundant isolation valves at reducing stations, hydrogen and oxygen supply isolation valves, containment isolation valves, and spare measuring gas compressors. In addition, paired sensors are used for monitoring essential process parameters for the purpose of generating alarm signals and activating valves and interlocks. The staff concludes that the requirements of GDC 3 relative to minimizing the generation and accumulation of explosive gas mixtures and acceptance criteria of SRP Section 11.3 are met and the GWMS design is acceptable.

Radiation detectors in the gaseous waste discharge line monitor and alarm in the event of an equipment malfunction or operator error. Radiation detectors in the plant vent stack continuously monitor exhaust gases released from the GWMS via the nuclear auxiliary building

ventilation system. The process radiation monitoring system provides monitoring and control of gaseous and particulate releases, as discussed in FSAR Tier 2, Section 11.5.3. FSAR Tier 2, Table 11.5-1 provides the operating parameters of the related detectors of the PERMSS. In light of the above discussion, the staff concludes that the GWMS complies with GDC 60 and GDC 61, as they relate to monitoring and controlling radioactivity releases.

GDC 61 requires that the GWMS be designed to assure adequate safety under normal and postulated accident conditions. FSAR Tier 2, Table 3.2.2-1 describes the quality group and seismic design classification assigned to the GWMS. Most GWMS components, equipment, and piping were determined to be designed to Quality Groups B and D. The only portions of the GWMS system that are Quality Group B are the containment isolation piping and valves, and the containment penetration test connection isolation valve. The Group B equipment is Safety Classification S, Seismic Class I and subject to 10 CFR Part 50, Appendix B. Quality Group D applies to non-safety portions of systems and components that may contain radioactive material. The Group D portions of the system are classified as Radwaste Seismic and RG 1.143 RW-IIa (high hazard), which result in designs that can withstand seismic loadings equivalent to one-half of the loading of the safe-shutdown earthquake (SSE). The GWMS was determined to perform no safety related function except for the monitoring of the containment isolation valves. In view of the above, the staff determined that the quality group classification of the GWMS conforms to RG 1.143 and is, therefore, acceptable. A COL applicant referencing the U.S. EPR certified design should describe those aspects of the QA Program associated with the design, procurement, construction, and operational phases of the GWMS. This requirement is noted in COL Information Item 17.2-1, as identified in FSAR Tier 2, Table 1.8-2.

The COL holder will subject the GWMS to preoperational tests and conduct periodic inspections of major components to ensure operational readiness and integrity of its subsystems. The COL holder will be responsible for ensuring that the initial installation complies with the requirements of 10 CFR 20.1406 and conforms to the guidance of NRC Bulletin 80-10 and RG 4.21 for the purpose of avoiding the cross contamination of nonradioactive systems and unmonitored and uncontrolled radioactive releases into the environment, and minimizing the contamination of the facility and environment. Adsorbent media introduced in driers and delay beds will be inspected to confirm that they are of appropriate types and of sufficient quantities to achieve the desired minimum performance specifications. Section 14.2 of this report addresses the adequacy of the preoperational testing program for the GWMS and associated QA tests using the guidance in RG 1.143 and the QA program described in FSAR Tier 2, Chapter 17. The QA measures address the design, fabrication, procurement, and installation and testing of permanently installed GWMS processing subsystems.

The GWMS generates a liquid radioactive waste phase from the associated coolers/condensers, where the liquid phase can potentially cross contaminate nonradioactive systems and result in unmonitored and uncontrolled radioactive releases. In FSAR Tier 2, Sections 11.3.1, “Design Basis,” the applicant states that the design of the GWMS complies with the requirements of 10 CFR 20.1406. The design includes drains and vents to route radioactive process or waste streams and avoid interconnections between plant systems that could become radioactive through improper interfaces with radioactive systems. The liquid phases from coolers and condensers are routed to the LWMS. The staff determined that such design features are acceptable and in compliance with the requirements of 10 CFR 20.1406 and conform to the guidelines of NRC Bulletin 80-10 and RG 4.21. FSAR Tier 2, Section 12.3.6 outlines programmatic aspects and describes design concepts and features to address such

concerns using the guidance of RG 4.21. Section 12.3 of this report presents the staff's evaluation in complying with the requirements of 10 CFR 20.1406 and guidelines of NRC Bulletin 80-10 and RG 4.21.

FSAR Tier 2, Sections 9.4.1, 9.4.2, 9.4.3, 9.4.5, 9.4.7, 9.4.8, and 9.4.14 indicate that the respective exhaust ventilation systems conform to the guidelines of RG 1.140, by providing filtration via HEPA and charcoal filters and diversion of contaminated exhausts to filter trains upon detection of elevated levels of radioactivity. The air filtration units are designed and tested in accordance with NRC guidance and industry standards, as described in FSAR Tier 2, Section 9.4. The standards address the installation, inspection, and verification of system airflow rates, air temperatures, and filter pressure drops. The staff's evaluation of building ventilation systems design bases is presented in Section 9.4 of this report. In the context of GDC 61, SRP Section 11.3 acceptance criteria, and the guidelines of RG 1.143, the staff determined that the building ventilation systems provisions are acceptable as they relate to normal ventilation exhaust systems and design features to control releases of radioactivity via the plant vent stack.

The main control room has a separate ventilation system to protect control room operators from airborne radioactivity that may be entrained in the air intake during an accident. This system is not interconnected with the GWMS, and its evaluation is addressed in Section 6.4 of this report.

FSAR Tier 2, Section 11.5.3.2 commits to the use of the ODCM in controlling and monitoring all gaseous and airborne effluent releases and eliminating the potential for unmonitored and uncontrolled releases. The use of an ODCM is under the operational programs described in FSAR Tier 2, Section 13.4. The operational program addresses the development of a site-specific radiological environmental monitoring program, meeting the provisions of Generic Letter (GL) 89-01, "Implementation of Programmatic and Procedural Controls for Radiological Effluent Technical Specifications," Supplement No. 1, November 14, 1990; Radiological Assessment Branch Technical Position (Revision 1, November 1979) included as Appendix A in NUREG-1301, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors," April 1991, as ODCM guidance for PWR plants; and the guidance in NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978. Alternatively, a COL applicant may use Nuclear Energy Institute (NEI) ODCM Template 07-09A (Revision 0, March 2009) to meet this regulatory milestone until a plant and site-specific ODCM is prepared, before fuel load, under the requirements of a license condition described in FSAR Tier 2, Section 13.4 of COL applications. The staff has reviewed NEI ODCM Template 07-09A and determined it is acceptable. The NEI ODCM Template 07-09A is available in ML091050234. The staff evaluation of the applicant's proposed ODCM is addressed in Section 11.5 of this report. The staff will review this information on a plant specific basis for each COL application as it relates to the following:

- Gaseous waste management system effluent (plant vent stack via the NABVS)
- Main condenser evacuation system and turbine gland sealing system (plant vent stack via the NABVS)
- Sampling activity monitoring system (plant vent stack)
- Containment building ventilation system

- Low flow purge subsystem to the plant vent stack via the FBVS
- Full flow purge subsystem to the plant vent stack via the NABVS or SBVS

- Nuclear Auxiliary Building ventilation system (exhaust to plant vent stack)
- Fuel Building ventilation system (exhaust to plant vent stack)
- Radioactive Waste Processing Building ventilation system (exhaust to plant vent stack)
- Safeguard Building controlled area ventilation system
  - Operational air exhaust mode to the plant vent stack via the NABVS filter train
  - Accident exhaust mode to plant vent stack via the FBVS filter train
- Annulus ventilation system (exhaust to plant vent stack via AVS filter train system or NABVS)

The turbine building ventilation system does not include provisions for controlling and monitoring radioactive releases. The turbine building air removal system captures the exhausts from the main condenser evacuation system and turbine gland sealing system, which are the only sources of radioactive gases in the turbine building, and directs both to the plant vent stack via the NABVS.

Design Considerations

In reviewing FSAR Tier 2, the staff could not confirm that some aspects of the GWMS design comply with NRC regulatory requirements and conform to guidance. These aspects included inconsistencies in system interfaces shown in drawings, differences between system descriptions and drawings to which the system descriptions referred to for information, and lack of details describing system capacities or flow rates. Consequently, the staff requested in RAIs that the applicant provide clarifications for technical completeness, provide details supporting design bases and design descriptions to demonstrate compliance with regulatory requirements, revise and update system drawings for consistency with system descriptions, revise technical and regulatory references, and provide information for the staff to conduct independent evaluations of results presented in the application. Depending on the response from the applicant, the RAIs are either listed as satisfactory responses and resolved by the staff, or left open pending the receipt of responses or issuance of follow-up RAIs. The following subsections present the results of the staff evaluation and, when necessary, list follow-up RAIs to the applicant.

Based on a review of FSAR Tier 2, Revision 0, Section 11.3.2.3.9, in RAI 105, Question 11.03-1, the staff requested that the applicant provide additional information on calculations and results supporting the holdup times for the various constituents of waste gases processed by the GWMS. In a December 5, 2008, response to RAI 105, Question 11.03-1, the applicant provided additional information supporting the basis of delay bed residence times, variations in the input variables for the computer coding used in FSAR Tier 2, Sections 11.1 and 11.3 and GALE code input parameters for the GWMS. The applicant committed to update FSAR Tier 1, Section 1.2.5, “Rated Reactor Core Thermal Power,” in correcting the stated

thermal power level upon which the applicant's calculations were based. The staff determined the above information and proposed correction are acceptable. The staff confirmed that Revision 1 of the U.S. EPR FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 105, Question 11.03-1 resolved.

FSAR Tier 2, Revision 0, Section 11.3 described several design provisions of the GWMS to reduce the generation of explosive gas mixtures. However, the FSAR did not describe any provisions for isolation of continuous gaseous leakage paths in the event that an explosion was to occur, given the acceptance criteria of SRP Section 11.3. Specifically, SRP Acceptance Criteria 3 states, "The design should include precautions to stop continuous leakage path in the event of an explosion due to gaseous wastes produced during normal operation and anticipated operation occurrences." In RAI 105, Question 11.03-2, the staff requested that the applicant verify in FSAR Tier 2, Section 11.3 that such provisions are included in the design of the GWMS. In a December 5, 2008, response to RAI 105, Question 11.03-2, the applicant provided additional information regarding leak detection and assessment of vulnerabilities. The applicant committed to revise FSAR Tier 2, Section 11.3.3.6 and provided a markup copy of the proposed revision. The staff determined the above information acceptable in confirming that protection against internal explosions conforms to SRP Acceptance Criterion 3, as noted above. The staff confirmed that Revision 1 of the U.S. EPR FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 105, Question 11.03-2 resolved.

FSAR Tier 2, Revision 0, Section 11.3.1 described the design basis of the GWMS. However, the staff determined that the design basis did not fully acknowledge applicable SRP acceptance criteria, such as RG 1.140 and NRC Bulletin 80-10. In RAI 273, Question 11.03-4, the staff requested that the applicant review SRP Section 11.3 and RG 1.206 and confirm that the design basis conforms to all SRP criteria and, if not, provide the justification that the alternate approach provides acceptable methods of compliance with NRC regulations. In a November 6, 2009, response to RAI 273, Question 11.03-4, the applicant agreed to provide additional information in FSAR Tier 2, Sections 11.3.1 and 11.3.2.3.15, "Measurement Cabinets," and AREVA Technical Report ANP-10292 (Revision 1) to identify additional commitments to conform to SRP acceptance criteria. The information includes references and technical aspects identified in NUREG-0800 SRP 11.3, BTP 11-5; RGs 1.109, 1.110, 1.111, 1.112, 1.140, and 4.21; and NRC Bulletin 80-10. The staff determined that the applicant's response to RAI 273, Question 11.03-4 and the proposed revisions to the FSAR and topical report are acceptable because they include the appropriate references to confirm that the design basis conforms to the applicable SRP criteria. **RAI 273, Question 11.03-4, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

In FSAR Tier 2, Section 11.3.2.3, "Component Description," the applicant describes the various components of the GWMS. However, a review of FSAR Tier 2, Figures 11.3-1 and 11.3-2 revealed that there are no sampling points identified in the GWMS subsystems. A review of FSAR Tier 1, Figure 1.3-1 and FSAR Tier 2, Figure 1.7-1 indicates that there are no P&ID symbols for sampling points. In RAI 273, Question 11.03-5, the staff requested that the applicant revise the GWMS P&IDs and supporting legends in FSAR Tier 1 and 2 figures to include the locations and identification of sampling points in all associated GWMS subsystems. In a November 6, 2009, response to RAI 273, Question 11.03-5, the applicant agreed to revise FSAR Tier 2, Figure 11.3-1 by showing the locations of sampling points and drain connections

from process coolers. The staff determined that the applicant's response to RAI 273, Question 11.03-5 and proposed revisions to the FSAR are acceptable. **RAI 273, Question 11.03-5, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Section 11.3.2.3 describes the gas drier and states that the drier is followed by a gas filter. However, a review of FSAR Tier 2, Figure 11.3-1 reveals that the filter is a liquid filter instead. Note that the same observation was made for the filter (shown as a liquid filter in the drawing) located after the recombiner cooler. In RAI 273, Question 11.03-6, the staff requested that the applicant review and revise descriptions and details of the figure for consistency as to the exact type of filter being used in that segment of the GWMS subsystem. In an October 14, 2009, response to RAI 273, Question 11.03-6, the applicant provided additional details for these filters and their intended functions. Both filters are basket-type designs provided in the system in anticipation that particulate matter may be present in the influent stream to the filter. In addition, the design considers the potential presence of moisture, condensed from the gas drier or recombiner. As a result, the filters are equipped with drains to route condensate to the nuclear island drain and vent system for proper treatment and disposition. In depicting these types of filters in drawings, the design applies the symbol which is most representative of the function of the filter; hence, the use of a symbol for a liquid filter. The staff finds the response and explanation acceptable and, therefore, the staff considers RAI 273, Question 11.03-6 resolved.

A review of FSAR Tier 2, Section 11.3.2.3 and FSAR Tier 2, Table 11.3-2 indicated that while some equipment are described in the text, some are not given in FSAR Tier 2, Table 11.3-2. In RAI 273, Question 11.03-7, the staff requested that the applicant review and expand the listing of important components shown in FSAR Tier 2, Table 11.3-2, such as the O_2 and H_2 measurement cabinets as they perform essential functions in preventing the accumulation of explosive gas mixtures in GWMS subsystems. In an October 14, 2009, response to RAI 273, Question 11.03-7, the applicant agreed to provide additional details in FSAR Tier 2, Table 11.3-2 describing the hydrogen and oxygen analyzers and radiation monitors in proposed marked-up pages of Revision 2 of the FSAR. The information includes the number of units, operating pressures, temperatures, and nominal design flow rates. The staff determined that the applicant's response to RAI 273, Question 11.03-7 and proposed revisions to the FSAR provide the requested information and are, therefore, acceptable. Also, in the November 6, 2009, response to RAI 273, Question 11.03-4, the applicant agreed to provide an update of the hydrogen and oxygen analyzer description in FSAR Tier 2, Section 11.3.2.3.15, "Measurement Cabinets," stating that the related instrumentation relies on non-sparking gas analyzers to conform to the SRP acceptance criteria. **RAI 273, Questions 11.03-4 and 11.03-7, are being tracked as confirmatory items** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Section 11.3.2.3 describes the various components of the GWMS. However, a review of FSAR Tier 2, Figures 11.3-1 and 11.3-2 revealed that there are no connections from cooler condensers drains to the LWMS. In RAI 273, Question 11.03-8, the staff requested that the applicant review and update system drawings to identify such connections in ensuring that there are no unmonitored and uncontrolled releases of radioactive materials and that the design complies with the requirements of 10 CFR 20.1406 and conforms to guidance of RG 4.21. In a November 6, 2009, response to RAI 273, Question 11.03-8, the applicant presented additional information on methods used to prevent contamination and backflows from the nuclear island

drain and vent system and agreed to revise FSAR Tier 2, Figure 11.3-1. The additional information describes design features that include water locks, process filters, drain lines, balancing of operating pressures, and ball and float check valves. FSAR Tier 2, Figure 11.3-1 will be revised to show the location and routing of drains from process coolers to the nuclear island drain and vent system. The staff determined that the applicant's response to RAI 273, Question 11.03-8 and proposed revisions to the FSAR are acceptable. **RAI 273, Question 11.03-8, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Section 11.3.2.3 describes design features of the nitrogen purge gas and O_2 and H_2 supply systems. In either case, the design should acknowledge NRC concerns identified in NRC Bulletin 80-10, requirements of 10 CFR Part 20.1406, and guidance of RG 4.21 in preventing nonradioactive systems from becoming contaminated and avoiding unmonitored and uncontrolled releases. In RAI 273, Question 11.03-9, the staff requested that the applicant review design features and include system features that would prevent such gas supply systems from becoming contaminated by the GWMS. In an October 14, 2009, response to RAI 273, Question 11.03-9, the applicant provided additional information on the operational features of the GWMS and agreed to provide additional design details in FSAR Tier 2, Section 12.3.6.5.4 (provided separately in response to RAI 228, Question 12.03-12.04-9, Part 3) describing mechanical barriers and direction of process flows. The information states that the GWMS operates at a negative pressure preventing outward leaks or flowing into the nitrogen or oxygen supply system. The staff determined that the applicant's response to RAI 273, Question 11.03-9 and proposed revisions to the FSAR are acceptable. **RAI 273, Question 11.03-9, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

In FSAR Tier 2, Section 11.3.2.3, the applicant describes design features of the gas delay beds, which include three vessels each with a capacity of about 2,449.4 kg (5,400 lbs) of charcoal, and a gel drier, with a capacity of about 0.09 m^3 (3.2 ft^3). However, the staff noted that the description did not address operational considerations for the periodic removal and disposal of contaminated or water-saturated gel and charcoal or the use of in-place charcoal regeneration. In RAI 273, Question 11.03-10, the staff requested that the applicant review the descriptions of the delay beds and gel drier and expand the description to include such operational considerations. In an October 14, 2009, response to RAI 273, Question 11.03-10, the applicant provided additional information on the operational features of the delay beds and gel drier and agreed to provide additional details in FSAR Tier 2, Sections 11.3.2.3.8 and 11.3.2.3.9 describing provisions for the disposal of spent charcoal and dessicant via the solid waste management system (SWMS). The information states that design features, such as locations of delay beds relative to other GWMS components, and interlocks, prevent the introduction of water or moisture into delay beds. The chemical contamination of delay beds are protected by the use of high integrity leak tightness and mechanical barriers, such as valves and interlocks. Similar design features protect the gel drier and its dessicant bed. The proposed revisions include the correction of a typographical error in FSAR Tier 2, Table 1.1-1, "U.S. EPR FSAR Acronyms and Descriptions," for the SWMS entry. The staff determined that the applicant's response to RAI 273, Question 11.03-10 and proposed revisions to the FSAR are acceptable. **RAI 273, Question 11.03-10, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Section 11.3.2.5.2, "Preoperational Inspection," describes aspects of the preoperational inspection program. Among others, one item addresses the loading of media in the gel drier and delay beds. The staff determined that an important inspection step, not given, is ensuring that the proper types and amounts of adsorption media have been initially loaded in the gel drier and delay beds. In RAI 273, Question 11.03-11, the staff requested that the applicant revise the preoperational inspection discussion by including a step to ensure that the proper types and amounts of adsorption media will be initially added to the GWMS subsystems in order to meet radionuclide residence times and effluent concentration limits of 10 CFR Part 20, Appendix B and criteria of 10 CFR Part 50, Appendix I, as stated in SRP Section 11.3. In an October 14, 2009, response to RAI 273, Question 11.03-11, the applicant refers to FSAR Tier 2, Section 11.3.2.5.2 addressing preoperational inspections. The response notes that the inspection procedure will confirm that sufficient media are loaded in the gel drier and delay beds to achieve minimum performance. The staff finds the response and information acceptable and, therefore, the staff considers RAI 273, Question 11.03-11 resolved.

Development of Airborne Effluent Source Term and Compliance with Effluent Concentration Limits

The applicant calculated annual gaseous effluent releases (shown in FSAR Tier 2, Table 11.3-3) using the PWR-GALE code methodology, as documented in NUREG-0017. FSAR Tier 2, Table 11.2-3 presents a common set of input parameters to the PWR-GALE code that is used in the development of gaseous effluent source terms. Other parameters are noted as default values taken from NRC guidance, NUREG-0017. While the NRC-endorsed the use of a calculation methodology and has issued relevant NRC guidance, there are no specific regulatory requirements governing the development of annual gaseous effluent source terms.

As described below, compliance with 10 CFR Part 20 (Appendix B, Table 2, Column 1), gaseous effluent concentration limits is demonstrated in FSAR Tier 2, Table 11.3-6. FSAR Tier 2, Table 11.3-3 provides estimates of yearly releases calculated for the Reactor, Auxiliary, and Turbine Buildings and for continuous gas stripping and air ejector exhaust. Using the results of FSAR Tier 2, Table 11.3-6, the applicant provides a comparison of gaseous effluent concentrations relative to the limits of 10 CFR Part 20 (Appendix B, Table 2, Column 1). FSAR Tier 2, Tables 11.3-7 to 11.3-9 present information on the cost-benefit analysis in demonstrating compliance with the requirements of 10 CFR Part 50, Appendix I, Section II.D. The applicant's results indicate that expected annual releases of radioactivity and gaseous effluent concentrations in unrestricted areas comply with NRC regulations using NRC methodology and guidance. FSAR Tier 2, Section 11.3.3.6 presents the results of an evaluation postulating an operator error leading to the release of radioactivity from the GWMS via an inadvertent bypass. Regarding the approach used for the cost-benefit analysis, the applicant used an alternate method to RG 1.110 in demonstrating compliance with the cost-benefit ratio of 10 CFR Part 50, Appendix I, Section II.D.

The staff performed independent assessments of the results presented for the gaseous effluent source terms, compliance with effluent concentration limits in unrestricted area under Appendix B to 10 CFR Part 20, doses to a maximally exposed individual located in unrestricted area, and cost-benefit ratio of Appendix I to 10 CFR Part 50.

The staff evaluated the information supporting statements of compliance with NRC regulations and guidance and conducted its own independent evaluations, which are described below, including requests for additional information, as necessary. The staff confirmed the applicant's

results using PWR-GALE (1986 update) and determined that the results are acceptable. While the staff duplicated the estimates of yearly radioactive gaseous effluent releases (Ci/yr) and offsite concentrations (μCi/ml) within a few percent, the evaluation identified a number of inconsistencies associated with assumptions and parameters used in calculations. As a result, the staff requested that the applicant provide corrections and technical clarifications in RAI 299, Question 11.03-14. **RAI 299, Question 11.03-14, which is associated with the above request, is being tracked as an open item.** The observations include:

- A review of FSAR Tier 2, Revision 1, Section 11.3.3.5, "Maximum Release Concentrations," indicates that the discussion and results do not include the sum-of-the-ratios in demonstrating compliance with 10 CFR Part 20, (Appendix B, Table 2, Column 1) concentration limits for both types of gaseous effluent releases, normal and maximum failed fuel. In contrast, compliance with 10 CFR Part 20, Appendix B, Table 2, sum-of-the-ratios was provided for liquid effluent releases in FSAR Tier 2, Section 11.2.3.5. The staff requested that the applicant provide this information for gaseous effluent releases in a revision of FSAR Tier 2, Table 11.3-6.

- FSAR Tier 2, Table 11.3-1 – The table applies a value of 27.7 days as the holdup time for xenon and 1.67 days for krypton. The basis for these values is presented in FSAR Tier 2, Table 11.2-3. First, it is noted that the values for dynamic adsorption coefficients of Xe and Kr are reversed in FSAR Tier 2, Table 11.3-1, given that the FSAR adopts the default values of NUREG-0017. Second, the staff was unable to confirm these holding times using a design flow rate of 34.7 g/sec (0.0765 lbs/sec) [about 1.73 m^3/min (61.1 ft^3/min) assuming normal temperature and pressure] and a charcoal mass of 7,402.6 kg (16,320 lbs), as given in FSAR Tier 2, Table 11.3-1. The staff requested that applicant confirm the above findings, provide the basis and justification for these holdup times, and revise FSAR Tier 2, Table 11.3-1 accordingly.

- FSAR Tier 2, Table 11.3-2 − A review of FSAR Tier 2, Tables 11.3-1 and 11.3-2 indicates that the useable volume of charcoal is about 89 percent of the actual volume of each charcoal delay bed. The inventory of charcoal in each delay bed is reported to be 2,467.5 kg (5,440 lbs). However, it is not clear if this inventory reflects the actual or useable volume of each delay bed. The applicant was requested to confirm the basis of the amount of charcoal in each delay bed, qualify the value presented in FSAR Tier 2, Table 11.3-1 as to whether the amount of 2,467.5 kg (5,440 lbs) reflects the useable volume of charcoal, and revise the Xe and Kr holdup times as needed in FSAR Tier 2, Table 11.3-1.

- A review of FSAR Rev 1, Tier 2, Section 11.3.3.5 and FSAR Tier 2, Table 11.3-6 indicates that the basis of the adjustment factor applied in estimating releases characterized by maximum fuel defects is not described in Section 11.3.3.5. A review of the results presented in FSAR Tier 2, Table 11.3-6 indicates that the scaling factor (max/normal) ranges from 0.8 to 10^3. For example, the results for corrosion and activation products and tritium are greater than one, which should not be the case as their production is insensitive to the assumed fraction of failed fuel. The scaling factor is presumed to be four (i.e., 1.0 percent vs. 0.25 percent) assumed failed fuel fraction given the information presented in FSAR Tier 2, Section 11.1. However, the factors were determined to be much higher and variable in many instances. For example, the ratio is 4 for H-3, 1.8 for Kr-87, 2.8 for Kr-88, 1,000 for Sr-90, 36 for I-131, 16 for I-133,

and 1,000 for Cs-137, among others. The staff requested that the applicant review and revise the basis of the scaling factor and describe the rationale and application of the scaling factor in FSAR Tier 2, Section 11.3.3.5 and presentation of the results in FSAR Tier 2, Table 11.3-6.

With respect to gaseous effluent releases, the requirements of 10 CFR 20.1302 permit an applicant to demonstrate compliance with applicable dose limits of 10 CFR 20.1301, in part, by showing that annual average concentrations of radioactive materials in gaseous effluents released in unrestricted areas do not exceed the limits specified in 10 CFR Part 20, Appendix B, Table 2, Column 1. FSAR Tier 2, Table 11.3-6 demonstrates that radionuclide concentrations released during normal operation in unrestricted areas are less than their respective gaseous effluent concentration limits of 10 CFR Part 20 (Appendix B, Table 2, Column 1). The staff's analysis concludes that the sum-of-the-ratios is less than unity, about 0.02 for normal effluent releases, and 0.1 for releases associated with maximum fuel defects. The staff confirmed these results based on its own independent analysis and determined that the results are acceptable and in compliance with the 10 CFR Part 20 (Appendix B, Table 2, Column 1) effluent concentration limits.

With respect to the evaluation of offsite impacts associated with an operator error leading to an inadvertent release of radioactivity from GWMS via a bypass, the staff's evaluation revealed that there is not enough information with which to conduct an independent confirmation of the results. The applicant concludes that for the duration of the event, the associated dose for a receptor located at the Exclusion Area Boundary (EAB) conforms to the acceptance criteria of SRP Section 11.3, BTP 11-5 of NUREG-0800. A review of FSAR Tier 2, Sections 11.3.2.4, "Failure Tolerance," and 11.3.3.6, indicates that for each type of failure or event identified, the discussion does not address the associated radiological consequences, such as the potential for radioactive releases, system or facility contamination, unmonitored releases to the environment, etc. Moreover, the analysis should identify an event associated with the failure of the GWMS radiation monitoring system and detectors located before and after the charcoal delay beds given that they have different radiation response characteristics, and one involving an operator error that includes an estimate of the duration of the event and mitigating measures applied in terminating the event to a safe end point. The staff requested the applicant to provide further information and technical clarifications in RAI 273, Question 11.03-13. **RAI 273, Question 11.03-13, which is associated with the above request, is being tracked as an open item.**

Compliance with Airborne Effluent Dose Limits for Members of the Public

Regarding doses to the maximally exposed offsite individual, as discussed below, the applicant demonstrates compliance with the numerical and design objectives of 10 CFR Part 50, Appendix I using NRC guidance and methodology, namely the GASPAR II computer code documented in NUREG/CR-4653, "GASPAR II—Technical Reference and User Guide." The results are presented in FSAR Tier 2, Tables 11.3-4, "Input Parameters for the GASPAR II Computer Code Used in Calculating Annual Offsite Doses to the Maximally Exposed Individual from Gaseous Releases," and 11.3-5, "Dose Commitment Due to Gaseous Effluent Releases." The applicant estimates an annual dose of 0.0103 mSv (1.03 mrem) to the total body, a skin dose of 0.0976 mSv (9.76 mrem), and an infant thyroid dose of 0.099 mSv (9.9 mrem). The corresponding numerical and design objectives of Appendix I to 10 CFR Part 50 are 0.05 mSv (5 mrem) per year to the total body, and 0.15 mSv (15 mrem) per year to the thyroid, skin, or other limiting organs. By comparison, the results demonstrate compliance with

10 CFR 20.1301(e), which requires satisfaction of EPA environmental radiation protection standards of 40 CFR 190 for facilities within the fuel-cycle, including nuclear power reactors. The EPA standards specify annual dose limits of 0.25 mSv (25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid, and 0.25 mSv (25 mrem) for any other organ for members of the public due to planned discharges of radioactive materials. The annual beta and gamma air dose rates at the EAB are estimated to be 0.133 and 0.0162 mGy or 13.3 and 1.62 mrad, respectively. The annual beta and gamma air dose rate limits at the EAB are 0.2 and 0.1 mGy (20 and 10 mrad), respectively.

The staff performed an independent evaluation of the parameters and methodology used in calculating doses, and dose results presented in FSAR Tier 2, Tables 11.3-4 and 11.3-5. In its evaluation, the staff duplicated the estimates of yearly doses to the maximally exposed individual (MEI) within five percent, but could not duplicate the results of population doses. The evaluation identified a number of inconsistencies in the presentation of the results and assumptions and parameters used in the calculations described in FSAR Tier 2, Sections 11.3.3.4, "Estimated Doses," and 11.3.4.1, "Calculation of Population Doses." In RAI 301, Question 11.03-15, the staff requested that the applicant provide corrections and technical clarifications. The staff observations include:

- A review of FSAR Tier 2, Table 11.3-4 indicates that a number of parameters used in the GASPAR II code are presented without supporting assumptions and justifications. For example, FSAR Tier 2, Table 11.3-4 list values for the atmospheric dispersion and deposition parameters, but does not specify the basis of the parameters, nor does it references FSAR Tier 2, Section 2.3.5, "Long-Term Atmospheric Dispersion Estimates for Routine Releases," on the development of long-term atmospheric dispersion estimates for routine airborne effluent releases. The types of exposure locations should be expanded to include the nearest residence. The reference of FSAR Tier 2, Table 11.2-4 for the airborne source term is wrong, since this table presents the source term for liquid effluents - the proper citation is FSAR Tier 2, Table 11.3-3. At a minimum, the staff requested that the applicant describe in the FSAR the underlying assumptions, provide all appropriate references or identify the source of the information within the FSAR for all parameters presented in FSAR Tier 2, Table 11.3-4, add the missing exposure location for the MEI, and provide the proper citation for the table listing the airborne effluent source term.

- While the staff duplicated the dose results presented in FSAR Tier 2, Table 11.3-5, a review indicates that results for the MEI are presented only for the total body and thyroid, with only one reference identifying the infant as the critical age group for thyroid exposure. Also, the age group is not specified for the reported total body dose given in the table. It is not possible from this information to compare doses among the four age groups of RG 1.109 and confirm that the infant is the limiting age group for the thyroid and that no other age group and organ are limiting. The applicant is requested to expand the presentation of the results in FSAR Tier 2, Table 11.3-5 to include all four age groups and eight organs of RG 1.109, and provide a summation of doses given that the GASPAR II code automatically provides all such results.

- A review of FSAR Tier 2, Table 11.3-7 indicates that a number of parameters used in the GASPAR II code are presented without supporting assumptions and justifications. In addition, the table and FSAR Rev 1, Section 11.3.4.1 do not include enough information

for the staff to conduct an independent evaluation of population dose results. For example, FSAR Tier 2, Table 11.3-7 list values for a population within an 80 km (50 mi) radius of the plant, an atmospheric dispersion parameter, and agricultural production data, but does not specify the basis for the parameters, nor does it reference the applicable FSAR Tier 2 sections on the development of these parameters. In addition, the entries for the average humidity and temperature are inconsistent with the code input requirements, as the code requires that the relative humidity (percent) be specified whenever a temperature value is inserted over the code default value. Finally, FSAR Tier 2, Section 11.3.4.1 and FSAR Tier 2, Table 11.3-7 do not provide any information as to how population data and agricultural production data were distributed against long-term atmospheric dispersion parameters by sectors in the 80 km (50 mi) radius. The staff requested that, at a minimum, the applicant describe in the FSAR the underlying assumptions, insert all appropriate references or identify the source of the information within the FSAR for all parameters presented in FSAR Tier 2, Table 11.3-7, provide the missing information for the staff to conduct its own analysis, revise the citation for the table referencing the basis of the airborne effluent source term, and change in FSAR Tier 2, Section 11.3.4.1 the table citation from 11.3-4 to 11.3-7 since FSAR Tier 2, Table 11.3-4 is for MEI doses and FSAR Tier 2, Table 11.3-7 is for population doses.

Note: The requested clarification on the basis of population doses is needed as well by the staff in order to confirm the results of the cost-benefit analysis presented in FSAR Tier 2, Section 11.3.4.2, “Dose Benefits and Augment Cost.”

RAI 301, Question 11.03-15, which is associated with the above request, is being tracked as an open item.

In the context of complying with 10 CFR Part 50, Appendix I, Section II.D, ALARA cost-benefit analysis for the GWMS, FSAR Tier 2, Section 11.3.4 and FSAR Tier 2, Tables 11.3-7 to 11.3-9 present the results of a CBA in justifying that no system augmentation is needed given the cost-benefit ratio of $100,000 per person-Sv ($1,000 per person-rem) of 10 CFR Part 50, Appendix I. Collective doses are reported to be 0.0552 person-Sv (5.52 person-rem) for the total body and 0.058 person-Sv (5.8 person-rem) for the thyroid. A review of the method applied indicated that an alternate approach and assumptions to RG 1.110 were used for the analysis. The analysis assumed a 60-year life-cycle for the selected radwaste processing equipment, while RG 1.110 applies a 30-year life cycle. Given the heavy duty operational cycle of such equipment, the CBA should provide the technical justification for an expected operational life of 60 years. The CBA should provide design details for the supplemental charcoal delay bed. As part of RAI 273, Question 11.03-12, the staff requested that the applicant provide a technical justification for the approach used and provide sufficient information for the staff to conduct an independent evaluation. **RAI 273, Question 11.03-12, which is associated with the above request, is being tracked as an open item.**

Under the requirements of 10 CFR Part 50, Appendix I, Sections II.B, II.C, and II.D, a COL applicant is responsible for addressing the requirements of 10 CFR Part 50, Appendix I dose objectives in controlling doses to a hypothetical maximally exposed member of the public and populations living near the proposed nuclear power plant. The requirements define dose objectives for gaseous effluents, require a CBA in justifying installed processing and treatment equipment of the GWMS, including any augmentation to the design in complying with 10 CFR Part 50, Appendix I.

In addition, the staff confirmed that a COL applicant will be responsible for determining if the CBA presented in FSAR Tier 2, Section 11.3.4 is applicable or bounding for the site location and, whether the COL applicant has conducted a plant-and site-specific analysis to update the results presented in the FSAR. A COL applicant referencing the U.S. EPR design will be responsible for demonstrating, through the ODCM, compliance with 10 CFR 20.1301(e), which incorporates by reference the EPA environmental radiation protection standards in 40 CFR Part 190 for facilities within the nuclear fuel-cycle, including nuclear power plants.

Minimization of Contamination

FSAR Tier 2, Section 12.3.6 addresses compliance with 10 CFR 20.1406, as it relates to facility design and operational procedures for systems in minimizing the contamination of the facility and generation of radioactive waste. FSAR Tier 2, Section 12.3.6, describes programmatic aspects and design features of SSCs intended to minimize contamination. This section states that the principles embodied in the philosophy include preventing unintended releases and early detection of unintended contamination. The GWMS is designed to reduce, through filtration and holdup for decay, radioactivity levels and concentration in gaseous wastes held in subsystems and, to the extent practicable, minimize contamination to the facility and environment, and facilitate eventual decommissioning under 10 CFR 20.1406.

In its review of the GWMS, the staff noted that the design basis and descriptions of structures, systems, and components did not always acknowledge NRC concerns identified in NRC Bulletin 80-10 and the guidance of RG 4.21 in preventing nonradioactive systems from becoming contaminated, and avoiding unmonitored and uncontrolled releases of gaseous effluents. These design features should be evaluated, and the FSAR should describe system features that would prevent leaks and radioactive contamination of nonradioactive support systems. For example, such support systems include instrumentation air and water seals, which might potentially become contaminated by radioactive gases and particulates contained in tanks and vessels of the GWMS. While specific RAIs were submitted to the applicant to address such concerns in FSAR Tier 2, Section 11.3, the staff's evaluation of the applicant's responses and closure of such RAIs are addressed in Section 12.3 of this report.

FSAR Tier 1 Information

In FSAR Tier 2, Section 14.3.2; FSAR Tier 2, Section 11.3; and FSAR Tier 1, Section 2.0, the applicant indicates that the treatment of ITAAC has been divided in two groups: Certified design material and ITAAC. The applicant states further: CDM binds the design commitment of structures, systems, and components for the lifetime of the facility, and ITAAC are used to verify the as-built features of the plant. FSAR Tier 2, Section 14.3.2 assigns ITAAC based on (1) the classification of systems and equipments, and (2) systems identified during key safety and integrated plant safety analyses for the purpose of preserving specific design features in the as-built facility. Systems described in FSAR Tier 2 sections that have no safety significant features or that were not identified as part of the "key safety and integrated plant safety analyses" process are given in FSAR Tier 1 as, "No entry for this system."

Although the selection process identifies pertinent NRC regulations for safety-related design features, FSAR Tier 1, with the exception of Section 2.9.4, Section 2.9 does not identify ITAAC associated with plant systems and components used to monitor and/or control radioactivity releases in the environment in demonstrating compliance with 10 CFR Part 20 (Appendix B, Table 2, Column 1) gaseous effluent concentration limits; and doses to members of the public

under 10 CFR 20.1301 and 10 CFR 20.1302, as well as avoiding unmonitored and uncontrolled radioactive releases to the environment in response to 10 CFR Part 20.1406(b). FSAR Tier 1, Section 2.9.4 includes ITAAC to confirm that instrumentation will indicate the presence of elevated levels of radioactivity in the plant vent stack and main control room air intake and the isolation of the intake air supply system. FSAR Tier 1, Section 2.4.22, "Radiation Monitoring System," includes ITAAC for the radiation monitoring system to confirm that its instrumentation will alarm on a high radiation signal from the containment high range monitor and initiate an isolation of the reactor building ventilation system.

ITAAC Information

FSAR Tier 2, Chapter 14, Table 14.3-8, (Sheet 5 of 8), states that the GWMS is within the scope of FSAR Tier 1; however, FSAR Tier 1, Section 2.9.3 states that there are no FSAR Tier 1 entries for the GWMS. The GWMS is relied upon to maintain concentrations of radioactive wastes released to the environment below the exposure limits of 10 CFR Part 20. The ability to maintain concentrations below the 10 CFR Part 20 limits depends upon the GWMS process, including the number and sizing of gas delay beds, processing equipment, effluent radiological monitoring and sampling systems, automatic control features in terminating releases that exceed alarm set-points, in-plant process dilution before release via the plant vent stack, and instrumentation used to monitor and prevent the accumulation of explosive gas mixtures.

It was determined that ITAAC should be included to confirm, with respect to FSAR Tier 2 design features, the proper initial introduction of charcoal absorbent and dessicant media in the system as it relies on such media to successfully process and treat gaseous wastes before they are discharged to the environment, and inclusion of H_2 and O_2 monitoring instrumentation given that the system is not designed to withstand the effects of internal detonations. For example, if the GWMS were properly built with all mechanical components in place, but without confirming the initial introduction of the proper types and amounts of adsorbent media, the GWMS would be ineffective and would fail to meet the performance parameters stated in FSAR Tier 2, Section 11.3.1 and xenon and krypton holdup times given in FSAR Tier 2, Table 11.3-1. As a result, gaseous effluent releases could exceed the concentration limits of 10 CFR Part 20 (Appendix B, Table 2, Column 1). Similarly, if the instrumentation used to monitor and control the presence of explosive gas mixtures were ineffective, the failure to detect explosive gas mixtures could compromise the integrity of the GWMS in the event of an internal detonation and result in releases of noble gases and radioiodines in excess of the concentration limits of 10 CFR Part 20 and dose limit of 10 CFR 20.1301 at the site boundary.

In view of the above, in RAI 105, Question 11.03-3, the staff requested that the applicant include appropriate FSAR Tier 1 entries for the GWMS. The FSAR Tier 1 items should include appropriate ITAAC entries for the GWMS to confirm functional arrangements of the system, quality group and seismic classifications, and controls for the release of radioactive materials. Where key system components (e.g., number, sizing, and connection of charcoal delay beds, and instrumentation for measuring explosive gas mixture concentrations) are not included in FSAR Tier 1, appropriate justifications for their exclusion should be provided in FSAR Tier 2, Section 14.3. In a December 5, 2008, response to RAI 105, Question 11.03-3, the applicant stated that the GWMS does not have safety significant features that warrant inclusion in FSAR Tier 1. The staff disagrees with the applicant's response to this RAI and formulation of FSAR Tier 1 screening criteria in determining which systems are included as a FSAR Tier 1 entry. While this issue has not yet been resolved to the staff's satisfaction given the absence of ITAAC

for the GWMS, the staff considers RAI 105, Question 11.03-3 resolved in the context of FSAR Tier 2, Section 11.3. **An RAI associated with FSAR Tier 2, Section 14.3.2, which is directly related to this issue, is being tracked as an open item.** The staff's evaluation of the applicant's responses and closure of RAIs on ITAAC are addressed in Section 14.3 of this report.

Technical Specifications

A review of FSAR Tier 2, Chapter 16 shows that TS 5.5.11 would require a program to control levels of potentially explosive gas mixtures in the GWMS, and limit the quantity of radioactivity contained in gas delay beds such that offsite doses would not exceed 5 mSv (500 mrem) in the event of a bed failure. In addition, FSAR Tier 2, Chapter 16, TS 5.5.1 and TS 5.5.3 provide direction in managing releases of radioactive effluents and the control and handling of concentrated wastes for disposal. FSAR Tier 2, Chapter 16, TS 5.6.1 and TS 5.6.2 specify annual reporting requirements for the submission of the results of the radiological monitoring program and summaries of the quantities of radioactive gaseous effluents released in the environment. As stated in TS 5.5.1, COL applicant initiated changes to the ODCM must be justified by calculation and these changes must maintain levels of radioactivity in effluent to meet the requirements of 10 CFR 20.1302, 40 CFR Part 190, 10 CFR 50.36a, and 10 CFR Part 50, Appendix I.

Technical specifications would address the radioactive effluent controls program, which is contained in the ODCM, to include instrumentation to monitor and control gaseous effluent discharges; meet limits on effluent concentrations released to unrestricted areas; to monitor, sample, and analyze gaseous effluents before and during releases; to set limitations on annual and quarterly dose commitments to a member of the public; and to assess cumulative doses from radioactive gaseous effluents. The use of an ODCM is under the operational programs described in FSAR Tier 2, Section 13.4. The staff determined these requirements acceptable and agreed that further implementation of such programs will be addressed in a plant and site specific ODCM under COL Information Item 11.5-1, as described in FSAR Tier 2, Table 1.8-2. The staff's evaluation of the applicant's proposed ODCM is addressed in Section 11.5 of this report.

Preoperational Testing

FSAR Tier 2, Section 14.2.12 presents descriptions of individual tests and test abstracts to be conducted on identified plant systems and components. For the GWMS, the tests include Test No. 099, "Gaseous Waste Processing System," to confirm the performance of GWMS subsystems. This test will verify flow paths, instrumentation, alarms, and proper equipment operation. The acceptance criteria for Test No. 099 include performance in accordance with FSAR Tier 2, Section 11.3, and radiation monitoring in accordance with FSAR Tier 2, Section 7.3.1, "Description." Test No. 216, "Gaseous Waste Processing System," will confirm the ability of the system to process and control radioactive gaseous wastes and potentially explosive gas mixtures during plant operation above 75 percent power. In addition, other tests will be conducted on peripheral systems, such as Test No. 011, "Coolant Purification System," Test No. 045, "Seal Water Supply System," to confirm interfaces and flows to and from the GWMS, and Test No. 090 "Plant Laboratory Equipment" for laboratory radio-analytical equipment which would be used to determine radionuclide concentrations in samples collected from the GWMS to determine if gaseous wastes meet NRC effluent concentration limits of 10 CFR Part 20 (Appendix B, Table 2, Column 1). The staff reviewed these tests and

generated specific RAIs on the information presented in FSAR Tier 2, Section 14.2.12. The evaluation of the applicant responses to and closure of these RAIs is addressed in Section 14.2 of this report.

11.3.5 Combined License Information Items

Table 11.3-1 provides a list of GWMS related COL item numbers and descriptions from FSAR Tier 2, Table 1.8-2:

Table 11.3-1 U.S. EPR Combined License Information Items

Item No.	Description	FSAR Tier 2 Section
11.3-1	A COL applicant that references the U.S. EPR design certification will confirm that the gaseous waste management system cost-benefit analysis for the typical site is applicable to their site; if not, provide a site-specific cost-benefit analysis.	11.3.4

The staff determined the above list of COL information items to be complete, and adequately describes the actions necessary for the COL applicant or holder.

11.3.6 Conclusions

Except for the open items identified below, the staff concludes that the GWMS, as a permanently installed system, includes the equipment necessary to collect, process, hold for decay, and control releases of radioactive materials in gaseous effluents generated as a result of normal operation and AOOs. The applicant provided sufficient design information to demonstrate that it has met the requirements of 10 CFR 50.34a; GDC 3, GDC 60, and GDC 61 of Appendix A to 10 CFR Part 50; and NRC guidance and acceptance criteria. This conclusion is based on the following:

- The U.S. EPR design demonstrates compliance with 10 CFR 50.34a, as it relates to the inclusion of sufficient design information and system design features that are necessary for collecting, processing, holding for radioactive decay, controlling, and monitoring safe discharges of gaseous wastes. The design conforms to the guidelines of SRP Section 11.3.

- The U.S. EPR design demonstrates compliance with the requirements of GDC 61, using the guidelines of RG 1.143, by providing sufficient treatment capacity, retention in charcoal delay beds, and holdup for radioactive decay in ensuring adequate safety under normal operation, AOOs, and postulated accident conditions. This commitment fulfills the requirements of 10 CFR 20.1406 and guidance of RGs 4.21 and 1.143 in minimizing the contamination of the facility and generation of radioactive wastes, and concerns of NRC Bulletin 80-10 in avoiding the cross-contamination of nonradioactive systems and unmonitored and uncontrolled radioactive releases to the environment.

- The U.S. EPR design meets the requirements of GDC 60 with respect to controlling releases of gaseous effluents by monitoring GWMS discharges through the plant vent stack. GWMS releases are monitored by a radiation monitor, which will generate a signal to terminate gaseous releases before discharge concentrations exceed a predetermined instrumentation set point. A COL applicant is responsible for determining the operational set-point for its GWMS radiation monitor in a plant and site-specific ODCM under COL Information Item 11.5-1, as described in FSAR Tier 2, Table 1.8-2. As part of this commitment, the COL applicant will be responsible for demonstrating, through the ODCM, compliance with 10 CFR 20.1301(e), which incorporates by reference 40 CFR Part 190 for facilities within the nuclear fuel cycle, including nuclear power plants.

- A COL applicant referencing the U.S. EPR certified design will demonstrate compliance with 10 CFR Part 50, Appendix I, Section II.D design objectives for offsite individual doses and population doses resulting from gaseous effluents by preparing a site-specific cost-benefit analysis using NRC guidance under COL Information Item 11.3-1, as described in FSAR Tier 2, Table 1.8 2.

- The U.S. EPR design demonstrates compliance with GDC 3, as it relates to sufficient information and design features necessary for processing and recombining radiolytic decomposition gases and instrumentation in controlling and monitoring potentially explosive gas mixtures in gaseous waste processing equipment.

- The U.S. EPR design provides sufficient information and design features satisfying the guidance of RG 1.143 for radioactive waste processing systems in establishing the seismic and quality group classifications for system components and structures housing components.

For the following open items, tracked under **RAI 273, Question 11.03-14; RAI 273, Question 11.03-13; RAI 299, Question 11.03-15; and RAI 301, Question 11.03-12,** the staff concludes, using the information presented in the application, that the applicant has not fully demonstrated compliance with NRC regulations and guidance controlling radioactive releases to the environment and associated doses to members of the public. The regulations are contained in 10 CFR Part 20, (Appendix B, Table 2, Column 1), dose limits for members of the public in 10 CFR 20.1301 and 20.1302; 10 CFR Part 50, Appendix I, Sections II.B, II.C, and II.D design objectives; and requirements of 40 CFR Part 190 as referenced in 10 CFR 20.1301(e). The guidance is contained in RGs 1.109, 1.110, and 1.143, and SRP Section 11.3.

11.4 Solid Waste Management Systems

11.4.1 Introduction

During plant operation, fission product gases and radioactive particulates and vapors are generated and distributed throughout various plant systems. In pressurized water reactors, radioactive process streams contain noble gases, radioiodines, particulates, carbon-14, and tritium, among other radionuclides. Radioactive materials present in plant systems are treated by the LWMS and GWMS. As part of the treatment process, various types of wet wastes, such as concentrates, sludge, spent adsorption media, and spent filters, are generated as byproduct materials during the operation of the LWMS and GWMS. Other plant operations, such as

refueling and routine maintenance, generate solid wastes in addition to wet wastes. Typical solid waste streams include paper, plastic, glass, metal scraps, wood, tools, etc. Other plant activities may generate both wet and solid wastes, such as during decontamination of plant facilities and equipment or refurbishing of major system components.

The solid waste management system is designed to process such types of radioactive wastes during normal operation and anticipated operational occurrences. The SWMS reduces the volume of radioactive wastes by various methods, including segregation, compaction, shredding, filtration, and evaporation and provides temporary storage of radioactive wastes prior to shipment to offsite licensed radioactive waste disposal or processing facilities. The major components of a SWMS typically include holding tanks, monitoring tanks, demineralizer and filtration units, drum and container drying units, and shredder and compactor units, besides valves, pumps, and instrumentation. Other necessary equipment include cranes, drum and container transport carts, shielded casks, and processing stations to measure radioactivity and radiation levels from waste containers before shipment.

The evaluation of the SWMS includes a review of design, design objectives, design criteria, system piping and instrumentation diagrams, process flow diagrams showing methods of operation, and factors that influence waste treatment (e.g., system interfaces and potential bypasses to nonradioactive systems and radiation monitoring). The review addresses methods used to segregate and treat wastes, estimates of annual waste generation rates and total radioactivity levels and assumptions applied in deriving these estimates, and methods applied to control process flows and reduce releases of liquid and gaseous effluents into the environment, such as with the use of filtration, adsorption, and storage for radioactive decay.

The staff evaluated the information in the application against the guidance of NUREG-0800, Section 11.4, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants – LWR Edition,” March 2007. The SRP acceptance criteria provide the guidance for assuring that radioactive wastes and associated radiation exposures are managed, controlled, monitored, and maintained within the limits of 10 CFR Part 20 and 10 CFR 50.34a and 10 CFR Part 50, Appendix I are satisfied. In the context of liquid and gaseous effluents generated during the operation of the SWMS, the evaluation of associated releases of effluents in the environment and doses to members of the public are addressed by the staff’s review of the LWMS and GWMS, since the SWMS does not directly discharge effluents into the environment.

11.4.2 Summary of Application

FSAR Tier 1: As stated in FSAR Tier 1, Section 2.9.2, “Solid Waste Management System,” there are no FSAR Tier 1 entries for the solid waste management systems.

FSAR Tier 2: The applicant has provided a system description in FSAR, Tier 2, Section 11.4, “Solid Waste Management Systems,” summarized here in part, as follows:

The SWMS, located in the Radioactive Waste Processing Building, is a non-safety-related system and serves no safety functions. A failure of the SWMS does not compromise safety-related systems or components and does not prevent the safe-shutdown of the plant. FSAR Tier 2, Section 3.2 describes the seismic and quality group classification and corresponding codes and standards that apply to the design of SWMS components, piping, and structures housing the system. Plant structures, systems, and components are designed to the

seismic criteria of RG 1.143, as Class RW-IIa, and categorized as “radwaste seismic.” The SWMS is housed in a reinforced concrete structure to provide adequate shielding and minimize radiation exposures to personnel during operation and maintenance. If leaks or tank overflows were to occur in rooms containing such equipment or wastes, floor drains capture the resulting spills and route them to appropriate sumps and storage tanks of the liquid waste storage system. The SWMS will be subjected to preoperational inspections and testing by the COL holder to ensure that all subsystems are operationally ready and meet their design basis and performance characteristics, and that all automatic interlock controls are fully operational.

FSAR Tier 2, Section 11.4 describes the design of the SWMS and its functions in collecting, processing, treating, storing, and preparing wet and solid radioactive wastes for shipment and disposal. The SWMS is comprised of two major subsystems:

- Solid waste processing and storage system, which treats and processes dry solid wastes

- Radioactive concentrates processing system, which treats wet solid wastes including spent ion exchange resins, filtration media, and sludge

The major components of the solid waste processing system include a sorting box for sorting wastes, a shredder and compactor for reducing the volume of compressible wastes, drum transport carts, shielding casks, cranes, and facilities to store radioactive wastes. Solid radioactive wastes include such items as paper, plastic, cloth, wood, metal parts, worn-out items, concrete, glass, electrical parts, stabilized spent-adsorption and filtration media from the LWMS and GWMS, and other discarded materials and items that are contaminated. Waste containers include plastic bags, drums, or bins which are placed in interim work areas and later brought to the RWB for processing and packaging. Containers used for shipping radioactive wastes include U.S. Department of Transportation (DOT)-approved drums, high integrated containers (HIC), steel boxes, and shipping containers. Once packaged, solid wastes can be stored at two locations: The tubular storage area with a capacity to hold about 200 drums, and the drum storage area with a capacity of about 350 drums. The tubular storage area is used for storing drums containing higher levels of radioactivity, such as spent filter cartridges and resins.

The major components of the radioactive concentrates processing system include a series of tanks, resin traps, three condenser drying units, vacuum unit, three drum drying stations, condensate buffer sluice, three condensate counters, transfer station, sampling box and device, drum handling device, and a drum capping, weighing, and measuring system. The tanks include a resin proportioning tank, concentrate buffer tank, condensate collection tank, and scrubber tank. Other components include valves, pumps, and associated process and control instrumentation, including radiation monitoring. For wet wastes, the radioactive concentrates processing system receives concentrates and sludge from other waste treatment systems. The system dries these waste streams to produce monolithic blocks of wastes, which are placed in drums. Evaporator concentrates from the concentrate tanks and contaminated sludge from the storage tanks of the liquid waste storage system are transferred to the concentrate buffer tank. From the concentrate buffer tank, liquid wastes are transferred into one of the drum drying stations where water vapors are condensed and sent to the condensate tank, while noncondensable gases are captured by the ventilation system. Radiation monitors are used to characterize radioactivity levels in drums for the purpose of identifying and quantifying radionuclide concentrations in processed and stabilized wastes. This information is used to confirm compliance with 10 CFR Part 61 concentrations limits and characteristics for Class A, B,

and C wastes, DOT shipping regulations for radioactive materials, and waste acceptance criteria of licensed disposal or storage facilities. Administrative procedures govern the operation of subsystems and control the treatment of various process streams in avoiding accidental discharges into the environment.

FSAR Tier 2, Figures 11.4-1 and 11.4-2 (latter provided separately in response to RAI 225, Question 11.04-5) present an overall process flow diagram of the system and specific design details for the radioactive concentrates processing system. **RAI 225, Question 11.04-5, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC. FSAR Tier 2, Table 11.4-1, "Estimated Solid Waste Annual Activity and Volume," provides an estimate of waste volumes and radioactivity levels expected in radioactive wastes. FSAR Tier 2, Tables 11.4-2, "Noncompressible DAW Annual Activity," to 11.4-13, "Mixed Waste Annual Activity," provide a characterization of radionuclide distributions and concentrations expected in radioactive waste streams and mixed wastes. FSAR Tier 2, Table 11.4-14, "Solid Waste Management System Component Data," lists the major components of the SWMS, and nominal values of operating parameters, including component capacities, operating pressures and temperature, flow rates, and material grades. FSAR Tier 2, Figures 1.2-18, "Radioactive Waste Processing Building General Arrangement Plan View Elevation -31'-6", through 1.2-27 present the general arrangement of the RWB in which the SWMS is located. FSAR Tier 2, Section 9.4.8, "Radioactive Waste Building Ventilation System," presents design information on ventilation systems servicing the RWB where SWMS subsystems are located, as well as systems used to collect gases vented from tanks and vessels. FSAR Tier 2, Section 11.2 presents design information on the processing of equipment and floor drains, including the collection of liquids from the SWMS.

FSAR Tier 2, Figure 11.5-1 presents an overview of the process flow from the SWMS through the GWMS to the point of release via the plant vent stack for gaseous effluents and via the LWMS discharge line for liquid effluents. As a result, the assessment of radiological impacts associated with all radioactive liquid and gaseous effluents generated during the operation of the plant, including those from SWMS, is addressed in FSAR Tier 2, Section 11.2 for the LWMS and FSAR Tier 2, Section 11.3 for the GWMS. Sections 11.2 and 11.3 of this report provide the results of the staff's evaluation of liquid and gaseous effluents released from the LWMS and GWMS.

The applicant states that the design features of the SWMS provide the means to process, treat, store, prepare for shipment, and ship radioactive wastes and materials in accordance with the requirements of 10 CFR Part 20 and 10 CFR Part 61 using the acceptance criteria of SRP Section 11.4 and associated regulatory guidance.

ITAAC: The ITAAC associated with FSAR Tier 2, Chapter 11 are given in FSAR Tier 1, Section 2.9. There are no ITAAC identified for the solid waste management systems.

Technical Specifications: There are no technical specifications for the solid waste management systems.

11.4.3 Regulatory Basis

The relevant requirements of NRC regulations for the radioactive waste system, and the associated acceptance criteria, are given in SRP Section 11.4 of NUREG-0800 and are

summarized below. Review interfaces with other SRP sections can be found in NUREG-0800, Section 11.4.

1. 10 CFR 20.1302 and 10 CFR 20.1301(e), as they relate to radioactive materials released in gaseous and liquid effluents to unrestricted areas.

2. 10 CFR 20.1406, as it relates to the design and operational procedures for minimizing contamination, facilitating eventual decommissioning, and minimizing the generation of radioactive wastes.

3. 10 CFR 50.34a, as it relates to providing sufficient information and design features to demonstrate that design objectives for equipment necessary to control releases of radioactive effluents from the SWMS to unrestricted areas are kept as low as reasonably achievable.

4. 10 CFR Part 50, Appendix I, Sections II.A, II.B, II.C, and II.D, as they relate to the numerical guides, design objectives, and limiting conditions for operation to meet the ALARA criterion for equipment installed to process and treat wet and solid radioactive wastes.

5. 40 CFR Part 190 (the EPA generally applicable environmental radiation standards), as implemented under 10 CFR 20.1301(e) and as it relates to controlling doses within EPA generally applicable environmental radiation standards.

6. GDC 60, as it relates to the design of the SWMS to control the release of radioactive materials in liquid and gaseous effluents from the SWMS and to handle wet and solid wastes produced during normal plant operation, including AOOs.

7. GDC 61, as related to the system design for solid radioactive waste systems and the ability of such systems containing radioactivity to assure adequate safety under normal and AOOs and suitable shielding for radiation protection.

8. GDC 63, “Monitoring Fuel and Waste Storage,” as it relates to the ability of solid radioactive waste systems to detect conditions that may result in excessive radiation levels and to initiate appropriate safety actions.

9. 10 CFR 52.47(b)(1), which requires that applications for design certification contain the proposed inspections, tests, analyses, and acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built, will operate in accordance with the design certification and provisions of the Atomic Energy Act and NRC regulations.

Regulatory guidance adequate to meet the above requirements includes:

1. NUREG-0800, SRP Section 11.4, BTP 11-3, “Design Guidance for Solid Waste Management Systems Installed in Light-Water Cooled Nuclear Power Plants,” Revision 3, March 2007.

2. NUREG-0800, SRP Section 11.4, Appendix 11.4-A, including updated guidance from SECY-93-323, “Withdrawal of Proposed Rulemaking to Establish Procedures and

Criteria for On-Site Storage of Low-Level Radioactive Waste After January 1, 1996," and SECY-94-198, "Review of Existing Guidance Concerning the Extended Storage of Low-Level Radioactive Waste," with respect to long-term onsite storage (e.g., for several years, but within the operational life of the plant).

3. RG 1.143 as it relates to the seismic design, quality group classification of components, general guidelines for design, construction, and testing criteria for radioactive waste systems; and general QA guidelines for radioactive waste management systems.

4. RG 4.21 as it relates to minimizing the contamination of equipment, plant facilities, and environment, and minimizing the generation of radioactive waste during plant operation.

5. GL 89-01 as it relates to the restructuring of the process control program (PCP) and radiological effluent technical specification (RETS). (Included in NUREG-1301).

6. NUREG-1301 as it relates to the development of a plant-specific process control program. Alternatively, a COL applicant may use NEI PCP Template 07-10A (Rev 0, March 2009) for the purpose of meeting this regulatory milestone until a plant-specific PCP is prepared, before fuel load, under the requirements of a license condition described in FSAR Tier 2, Section 13.4 of a COL application. The NEI PCP Template 07-10A has been determined to be acceptable by the staff, and the NEI PCP Template 07-10A is presented in ML091460627.

7. NRC Regulatory Issue Summary (RIS) 2008-32, "Interim Low Level Radioactive Waste Storage at Reactor Sites," December 30, 2008, as it relates to the use of NRC and industry guidance in addressing limited access to radioactive waste disposal facilities.

8. RG 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable," Revision 3, June 1978.

9. RG 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable," Revision 1-R, May 1977.

10. NRC IE Bulletin No. 80-10, as it relates to methods and procedures used in avoiding the cross-contamination of nonradioactive systems and unmonitored and uncontrolled releases of radioactivity.

11.4.4 Technical Evaluation

The staff reviewed the solid waste management system in accordance with the guidance of SRP Section 11.4. The staff reviewed the SWMS to determine whether it complies with the requirements of 10 CFR 50.34a, GDC 60, GDC 61, and GDC 63, and the guidance contained in RG 1.143, RG 8.8, and RG 8.10. GDC 60 requires that the SWMS is designed to control releases of liquid and gaseous radioactive effluents, GDC 61 stipulates that the SWMS is designed to ensure adequate safety under normal operations and AOOs, and GDC 63 requires equipment in waste storage areas to detect conditions that may result in excessive radiation levels and initiate appropriate safety actions. Under 10 CFR 50.34a, an applicant is required to provide sufficient design information to demonstrate that the design objectives have been met

as they relate to the inclusion of systems and components necessary to process radioactive materials and control releases of radioactive effluents into the environment.

The relevant requirements of GDC 60, GDC 61, and GDC 63 are met by using the regulatory positions contained in RG 1.143, as they relate to the seismic design, quality group classification of components used in the design of the SWMS and structures housing the systems, and provisions used to control leakage and minimize contamination. Other relevant aspects of RG 1.143 address design and construction methods, materials specifications, welding, and inspection and testing standards for SWMS components and piping. As NRC guidance, RGs 8.8 and 8.10 address design and operational features to ensure that ambient radiation levels result in occupational exposures that are ALARA. The COL holder is responsible for testing all solid and wet waste processing subsystems installed in the plant, as described in FSAR Tier 2, Chapter 14.

The staff reviewed proposed construction standards and methods; system process flow outlines and descriptions; anticipated operational programs, material specifications and potential leakage paths; sources of solid and wet wastes, expected waste volumes and radioactivity levels; sample collection points within process streams; flow paths of liquids through subsystems, including potential bypasses; and provisions for monitoring radioactivity levels in process streams and after wastes are containerized for storage or shipment.

An overall process flow diagram depicting major subsystems and sources of radioactivity is provided in FSAR Tier 2, Figure 11.4-1, and FSAR Tier 2, Figure 11.4-2 (latter provided separately in response to RAI 225, Question 11.04-5) presents a detailed flow diagram for the radioactive concentrates processing system. FSAR Tier 2, Table 11.4-1 provides estimates of the amounts of waste expected to be generated yearly and inventories of radioactivity. FSAR Tier 2, Tables 11.4-2 to 11.4-13 provides estimates of expected radionuclide distributions and concentrations in wet and solid wastes and mixed wastes.

FSAR Tier 2, Table 11.4-14 provides a listing of major system components and information charactering volumetric capacities, processing flow rates of major components, and operating conditions, such as pressure, temperature and material grades. FSAR Tier 2, Figures 1.2-18 to 1.2-27 present the general arrangement of the RWB in which the SWMS is located. FSAR Tier 2, Section 9.4.8 presents design information on ventilation systems servicing the RWB where SWMS subsystems are located, as well as systems used to collect gases vented from tanks and vessels. FSAR Tier 2, Table 12.3-4, “Airborne Radioactivity Detector Parameters,” lists the airborne radiation detectors, and FSAR Tier 2, Table 12.3-3, “Radiation Monitor Detector Parameters,” lists area radiation monitors for the RWB. FSAR Tier 2, Section 12.3, Figures 12.3-52 through 12.3-58 present floor plans and associated radiation zones in RWB areas where wastes will be processed and stored. FSAR Tier 2, Section 11.2 presents design information on the processing equipment and floor drains, including the collection of liquids from the SWMS. FSAR Tier 2, Figure 11.5-1 presents an overview of the process flow from the SWMS through the GWMS to the point of release via the plant vent stack for gaseous effluents and via the LWMS discharge line for liquid effluents.

The radiological impacts associated with the operation of the SWMS are addressed by the staff’s review of the LWMS and GWMS, since the SWMS does not release liquid and gaseous effluents directly to the environment. The staff’s evaluation is presented in Sections 11.2 and 11.3 of this report. The evaluation considers liquid and gaseous effluents generated during the processing of solid and wet wastes, and whether the equipment and design features are

acceptable and meet the requirements of 10 CFR 20.1302; effluent concentrations limits of 10 CFR Part 20 (Appendix B, Table 2, Columns 1 and 2); the requirements of 10 CFR 20.1406 to minimize the contamination of the facility and environment; design objectives of 10 CFR Part 50, Appendix I; and the requirements of 10 CFR 20.1301(e) to control doses within the EPA generally applicable environmental radiation standards under 40 CFR Part 190.

The SWMS consists of the solid waste processing and storage systems for treating dry solid wastes, and the radioactive concentrates processing system for the treatment of wet solid wastes. These subsystems provide the equipment and methods for the collection, handling, treatment, and storage of various forms of solid and wet radioactive waste. The SWMS reduces the volume of waste material through compaction, shredding, segregation, and evaporation of water contained in waste streams. The SWMS provides the means for the temporary storage of radioactive materials and packaged wastes prior to shipment to a licensed offsite storage or disposal facility.

Dry solid radioactive wastes typically consist of paper, plastic, cloth, wood, metal parts, concrete, glass, stabilized spent-charcoal and filtration media from the LWMS and GWMS, and other potentially contaminated discarded materials generated during normal, maintenance, and refueling operations. The wastes are collected, segregated, and treated based on their radiological, physical, and chemical properties. Solid wastes are initially classified as:

- Combustible
- Compressible
- Non-combustible and non-compressible

Combustible wastes are separated and compressible wastes are compacted to reduce their overall storage or disposal volumes. Other criteria may be used for segregating wastes, such as physical shapes and dimensions, types of materials, and chemical properties, among others. Wastes containing residual amounts of liquids and moisture are stored separately and treated to prevent decomposition of the waste, formation of combustible gas mixtures, and corrosion of containers. Non-combustible and compressible wastes are compacted in storage drums and held in temporary storage.

Combustible and non-compressible wastes are either segregated or fragmented and transferred into drums or other types of containers.

The other part of the SWMS is comprised of the radioactive concentrates processing system. This subsystem is used for the treatment of wet solid wastes, including concentrates, sludge, spent resins, backflush from the ultra-filtration system, among other wet wastes originating from other treatment systems. The major components of the radioactive concentrates processing system include tanks, resin traps, three condenser drying units, a vacuum unit, three drum drying stations, a condensate buffer sluice, three condensate counters, a transfer station, a sampling box and device, a drum handling device, and a drum capping, weighing and measuring system. The tanks include a resin proportioning tank, concentrate buffer tank, condensate collection tank, and scrubber tank. Other components include valves, pumps, and associated process and control instrumentation, including radiation monitoring. For wet wastes, the radioactive concentrates processing system receives concentrates and sludge and dries these waste streams to produce stabilized wastes. Evaporator concentrates from concentrate

tanks and sludge from the storage tanks of the LWMS are transferred to the concentrate buffer tank. From the concentrate buffer tank, liquid wastes are transferred into one of the drum drying stations, where water is extracted and condensed and routed to the condensate tank. Noncondensable gases generated during this process are captured by the ventilation system and monitored and released via the plant vent stack.

There are two basic options in treating such wastes: Placing the wastes in a HIC after confirming that the chemical and radiological properties of the waste comply with expected storage and disposal methods, or treating and packaging the wastes. Treatment would include dewatering, drying, removal of noncondensable and combustible gases, mixing, sampling and analysis of waste samples to confirm that waste products meet storage or disposal criteria, and radiological analyses via gamma-ray spectroscopy. The results of the radiological analyses would be used to determine radionuclide distributions and concentration levels for the purpose of classifying waste streams in accordance with the waste classification standards of 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," waste containers and packaging methods of 10 CFR Part 71, waste acceptance criteria of offsite disposal facilities or waste processors, and DOT shipping regulations. The DOT shipping regulations specify maximum allowable external radiation exposure rates from shipping containers and maximum levels of surface contamination on shipping containers, and identify requirements for the labeling of containers holding radioactive materials and placarding of trucks transporting radioactive materials.

The design of the SWMS includes provisions for connecting skid-mounted and vendor-supplied waste processing equipment to augment existing treatment options or capacity of the SWMS. FSAR Tier 2, Section 11.4.1.2.5, "Mobile Systems," states that the RWB has sufficient space and support services to accommodate the use of temporary processing equipment. If used, the temporary equipment and its connections to permanently installed equipment would be subjected to hydrostatic testing using guidelines described in BTP 11-3 of SRP Section 11.4 and the technical guidance of RG 1.143.

This feature is an option for consideration by COL applicants or COL holders in augmenting the processing capacity of the SWMS described in the design certification. However, this option is not part of the design certification, and this feature is not evaluated by the staff since the application does not provide information on the types of waste treatment augmentation that would be considered, nor does it include design details on the interface with the SWMS and plant services. The design of skid-mounted waste processing systems that are used by contractors to process wet and solid wastes and chemical wastes on behalf of a COL holder are not within the scope of the U.S. EPR design certification.

The staff reviewed the system and structure design according to the guidelines of RG 1.143, and SRP Section 11.4, BTP 11-3. As NRC guidance, RG 1.143 describes applicable design codes, seismic design criteria, quality assurance, safety classification, and natural phenomena and man-induced hazards design criteria for radwaste systems. In SRP Section 11.4, BTP 11-3 provides guidance on the processing of solid and wet wastes, criteria to ensure complete stabilization and dewatering of wastes, waste storage, use of portable processing systems, and general design features. A review of FSAR Tier 2, Section 11.4.1, "Design Basis," indicates that the design of the SWMS meets the guidance of RG 1.143 and acceptance criteria of SRP Section 11.4, BTP 11-3 (NUREG-0800). In conformance to the guidance of RG 1.143, the applicant has classified the SWMS as RW-IIa (High Hazard). FSAR Tier 2, Section 3.2 categorizes the SWMS as radwaste seismic and Quality Group D. Based on the evaluation of

seismic, quality, and structural and system material standards cited by the applicant, the staff determined that the design of the SWMS conforms to the relevant guidance of RG 1.143 and BTP 11-3, as they relate to the seismic design, quality group classification of components used in the SWMS and RWB housing the system, and design features of the SWMS.

The operation of the SWMS itself results in the generation of both liquid and gaseous radioactive wastes, besides the initial waste streams, and includes the potential for leaks and spills. If not properly contained or collected, such byproduct wastes, leaks, and spills could potentially cross-contaminate nonradioactive systems and result in unmonitored and uncontrolled radioactive releases. In FSAR Tier 2, Sections 11.4.1 and 11.4.2, "System Description," the applicant states that the design of the SWMS follows the requirements of 10 CFR 20.1406. The design includes drains, sumps, and vents to contain and route radioactive process streams, and avoids interconnections between plant systems that could become radioactive through improper interfaces with nonradioactive systems. The liquid phases from the condensate collection tank and condenser drying units are routed to the LWMS, resin traps and the concentrate buffer tank are used to prevent contamination of downstream process systems, and the scrubber tank removes impurities. The gaseous phases released from tanks, vessels, and waste shredder and compactor are captured by the ventilation systems. FSAR Tier 2, Section 12.3.6 discusses spill prevention and control measures. The staff determined that such design features are in compliance with the requirements of 10 CFR 20.1406 and the guidelines of NRC Bulletin 80-10 and RG 4.21, and are therefore acceptable. FSAR Tier 2, Section 12.3.6 outlines design concepts and features to address such concerns using the guidance of RG 4.21. Section 12.3 of this report presents an evaluation of system design features and operating procedures used in complying with the requirements of 10 CFR 20.1406 and guidelines of NRC Bulletin 80-10 and RG 4.21.

Once all waste processing systems are installed, the COL holder will subject each to preoperational tests described in FSAR Tier 2, Section 14.2 and associated QA tests using the guidance in RG 1.143 and QA program described in FSAR Tier 2, Chapter 17. A COL applicant referencing the U.S. EPR certified design should describe those aspects of the QA Program associated with the design, procurement, construction, and operational phases of the SWMS. This requirement is noted in COL Information Item 17.2-1, as identified in FSAR Tier 2, Table 1.8-2.

The provisions of the QA plan address the design, fabrication, procurement, and installation and testing of permanently installed SWMS processing systems and integration of the operation of optional skid-mounted processing equipment interconnected with permanently installed subsystems, as selected by a COL holder. The COL holder is expected to conduct periodic inspections of system components to confirm the performance and integrity of all operational functions. The COL holder will be responsible for ensuring that the initial installation and future modifications of processing systems comply with the requirements of 10 CFR 20.1406 and conform to the guidance of NRC Bulletin 80-10 and RG 4.21 for the purpose of avoiding the cross contamination of nonradioactive systems and unmonitored and uncontrolled radioactive releases into the environment, and for minimizing the contamination of the facility and environment.

Process radiation monitors (PRM) installed at the drum drying stations detect in-process radiation exposure rates in keeping system operators informed of radiation levels. As part of the process, each drum is scanned with radiation detectors, with the results used to determine radionuclides and total radioactivity levels in packaged wastes. In addition, area radiation

monitors throughout the RWB are set up to monitor ambient radiation levels and alert operators of changing conditions and when to take corrective steps. FSAR Tier 2, Section 11.4.2.6, "Operation and Personnel Exposure," describes some of the operational controls that would be applied in reducing radiation exposures to workers, including the use of remote handling procedures and radiation shielding. FSAR Tier 2, Section 12.3, Table 12.3-4 lists the airborne radioactivity detectors and FSAR Tier 2, Table 12.3-3 lists area radiation monitors used in monitoring ambient radiation levels. The staff determined that these provisions collectively are acceptable for monitoring ambient radiation exposure rates, for complying with the requirements of 10 CFR Part 20 for maintaining doses to worker within limits, and for keeping doses ALARA using the guidance of RGs 8.8 and 8.10. The staff evaluations of the occupational radiation protection program and methods used to monitor and control radiation exposures and doses to workers are presented in Section 12.3 of this report.

The approach to LLRW management and storage described above presumes that low-level radioactive wastes will be disposed of by shipment to an authorized recipient under 10 CFR 20.2001(a)(1). Under that approach, the applicant should demonstrate the capability of the means included in the design to process dry solid and wet wastes so that these wastes meet the classification and characterization definitions in 10 CFR 61.55 and 10 CFR 61.56, respectively.

GDC 60 requires that a plant design include provisions to handle radioactive wastes produced during normal reactor operation including AOOs, and to control releases of radioactive materials to the environment. GDC 60 requires that adequate capacity to hold and store gaseous and liquid radioactive wastes, particularly where unfavorable site environmental conditions may impose unusual operational limitations in releasing effluents. In addition to the provisions described for the SWMS, the holdup capacity for liquid and gaseous effluents is addressed in FSAR Tier 2, Sections 11.2 (LWMS) and 11.3 (GWMS). The following presents the staff's evaluation of provisions provided for the storage of radioactive wastes:

- Waste volumes and activity estimates - In FSAR Tier 2, Table 11.4-1, the applicant expects that about 225 m^3 (7,900 ft^3) of low-level radioactive waste (LLRW) will be generated yearly, distributed as 192 m^3 (6,785 ft^3) for dry wastes and 33 m^3 (1,146 ft^3) for wet wastes. Expected annualized waste volumes and radioactivity levels are presented in FSAR Tier 2, Tables 11.4-1 through 11.4-13. The capacities and processing rates of SWMS subsystems are described in FSAR Tier 2, Section 11.4.2 and FSAR Tier 2, Table 11.4-14. Total activity levels are expected to be about 74 and 2,490 Terabecquerel (TBq) (1,990 – 67,300 curies, Ci) as expected and maximum levels, respectively, with about 97 percent of the activity being contained in wet wastes. For mixed wastes, the expected yearly volume is nearly 0.06 m^3 (2 ft^3) containing about 1.5 GigaBq (0.04 Ci) of radioactivity. Large components are expected to be stored in various areas or shielded rooms of the RWB and their handling, decontamination, and use of commercial processors will be addressed by the COL holder as the need arises. No specific waste volumes or activity levels are provided for this type of waste stream.

- Based on the experience at currently operating nuclear power plants, and in view of current industry operational practices, the staff expects that such wastes are typically generated during specific events, such as plant outages, refueling, etc., and that COL holders will develop specific procedures for their handling and processing. Cranes, drum transport carts, and drum transfer and handling devices provide the means to move waste containers within the facility and for loading on and off shipping trucks.

The staff determined that the design features and methods described to process and handle radioactive wastes are acceptable with respect to meeting the criteria of GDC 60, the design guidelines of SRP Section 11.4 and RG 1.143. The staff also determined that the estimated waste volumes and radioactivity levels are generally consistent to industry experience and practices, while recognizing that actual waste volumes and activity levels will be dependent upon the COL holder's operating practices and implementation of operating procedures that will minimize the generation of radioactive wastes.

- Provisions for waste storage - The RWB includes provisions to store LLRW for up to several years of generation associated with normal operation including AOOs. In FSAR Tier 2, Table 11.4-1, the applicant expects that about 225 m^3 (7,900 ft^3) of LLRW will be generated yearly. FSAR Tier 2, Section 11.4.1.2, "Design Criteria," states that the facility provides sufficient space to store higher activity wastes for several years, assuming that waste concentrates, spent filters and resins, and sludge are held for about 6 months allowing the decay of shorter-lived radionuclides. The expected storage capacity is premised on the assumptions that all lower activity wastes, classified as Class A wastes under 10 CFR Part 61, can be shipped for disposal at currently operating disposal sites licensed under Federal and State regulations. The approach assumes that only Class B and C wastes will need storage until a facility becomes commercially operational for such wastes. Typically, Class A wastes make up about 98 percent of the volume of LLRW and are characterized by the lowest levels of radioactivity under the classification criteria of 10 CFR Part 61. Class B and C wastes make up the balance of the volume, but contain higher amounts of radioactivity, about 70 to 97 percent of the total activity disposed of. These Class B and C wastes consist mainly of spent filtration media, spent resins, and irradiated hardware. The RWB includes two waste storage areas, the tubular storage area with a capacity to hold about 200 drums, and the drum store, with a capacity of about 350 drums (stacked up to five drums high). The tubular storage area is used for storing drums containing higher levels of radioactivity, such as spent filter cartridges and resins. The staff determined that the approach and means to store LLRW are adequate as interim measures for managing the generation of LLRW, except for the design storage capacity, based on the applicant's projected LLRW generation rates and an evaluation of physical space for the facility. As discussed below, the staff issued RAI 273, Question 11.04-8 with respect to the storage capacity. The need to establish a storage space capacity beyond that provided in the design is left to the determination of the COL applicant or COL holder under the implementation of a plant-specific LLRW management plan and PCP, part of which is to address storage capacity. The design of a new building or modifications to existing storage spaces should conform to the guidelines of BTP 11-3 and SRP Section 11.4, Appendix 11.4-A, and must meet the 10 CFR Part 20 requirements for protecting members of the public and plant workers. Besides the option of building a new storage facility or modifying an existing one, a COL applicant or COL holder may elect to store LLRW at an existing operating reactor site, or commercially procure the necessary storage space, such as through a waste processor.

GDC 61 and GDC 63 require that radioactive waste systems include features that ensure adequate safety under normal operation and postulated accident conditions, including the means to enable inspection and testing of components important to safety, suitable shielding and ventilation for radiation protection, and means to detect conditions that may result in excessive radiation levels in waste storage locations and initiate appropriate actions. GDC 61

and GDC 63 requires that the SWMS include shielding and ventilation design features to protect workers and control releases of gaseous radioactivity in the environment. A review of FSAR Tier 2, Sections 11.4.2 and 12.3, "Radiation Protection Design Features," indicates that the SWMS and features of the RWB include measures to shield components expected to contain higher levels of radioactivity and display higher radiation exposure rates. Similarly, gaseous phases released from tanks, vessels, and waste shredder and compactor are captured by the ventilation system of the RWB and monitored before being released to the environment through the GWMS via the plant vent stack. Finally, the design includes radiation monitors installed on system components and in the RWB to monitor ambient radiation exposure rates and airborne radioactivity levels and alert operators of changing conditions and when to take corrective steps. FSAR Tier 2, Section 11.4.5, "Failure Tolerance," presents an evaluation of potential occurrences that might affect operational activities in the RWB. The occurrences include the drop of a drum filled with radioactive wastes and the splitting and spilling of the drum's content on impact, and a fire in the drum storage area.

For the drum drop, the recovery is described as relying on the use of operating procedures and protective equipment to decontaminate affected areas, and use of the RWB ventilation system to control potential airborne radioactivity levels and minimize releases to the environment. For the fire, the scenario assumes that capped and sealed drums can withstand the effects of a fire long enough for personnel to respond to and extinguish the fire. The RWB includes provisions to detect fire and smoke in waste storage areas and alert control room operators. As before, the RWB ventilation system is relied upon to control potential airborne radioactivity levels and minimizing releases to the environment. The staff determined that these design features of the SWMS are acceptable with respect to meeting the design guidelines of SRP Section 11.4 and RGs 1.143, 8.8, and 8.10, as described in FSAR Tier 2, Section 11.4.2; in FSAR Tier 2, Section 9.4.8 for the ventilation system of the RWB; and in FSAR Tier 2, Section 12.3 on radiation shielding and ventilation to control exposures to workers. Accordingly, GDC 61 and GDC 63 are met in this regard. The staff's evaluation of the RWB ventilation system is presented in Section 9.4.8 of this report, and the evaluations of the occupational radiation protection program and associated plant design features are presented in Section 12.3 of this report. The staff's evaluation of the fire protection system is presented in Section 9.5 of this report, and the evaluation of the conduct of operation and response to plant emergencies is presented in Chapter 13 of this report.

Design Considerations

In reviewing FSAR Tier 2, the staff could not confirm that some aspects of the SWMS design comply with NRC regulatory requirements and conform to NRC guidance. These aspects include inconsistencies in system interfaces shown in drawings, differences between system descriptions and drawings to which the system descriptions referred to as information, and lack of details describing system capacities. Therefore, the staff requested that the applicant provide clarifications for technical completeness, provide details supporting design bases and design descriptions in demonstrating compliance with regulatory requirements, revise and update system drawings for consistency with system descriptions, and revise technical and regulatory references. Depending on the response from the applicant, the RAIs are either listed as satisfactory responses and resolved by the staff, or left open pending the receipt of responses or issuance of follow-up RAIs. The following discussions present the results of the staff evaluation and, when necessary, list follow-up RAIs to the applicant.

Although general descriptions of components were provided in the FSAR, the adequacy of design details could not be fully evaluated, because no system P&ID was provided in FSAR Tier 2, Section 11.4.2. In RAI 105, Question 11.04-1, the staff requested that the applicant provide a system P&ID for the SWMS in FSAR Tier 2, Section 11.4.2. In a December 5, 2008, response to RAI 105, Question 11.04-1, the applicant provided a proposed update of FSAR Tier 2, Figure 11.4-1 depicting only the process flow for wet wastes and spent filtration media from five plant subsystems to the SWMS. The staff determined that this update of FSAR Tier 2, Figure 11.4-1 is not a P&ID of the SWMS. The staff determined that the response was inadequate and submitted follow-up RAI 225, Question 11.04-5. RAI 225, Question 11.04-5, is addressed in more detail later in this section.

There is a need to address conformance with the guidance of RG 1.143, given its specific design standards and recommendations for materials. In RAI 105, Question 11.04-2, the staff requested that the applicant provide in the FSAR Tier 2, details on equipment design parameters, such as pump capacity, crane capacity, and tank volume, as well as design and material standards for SWMS components. In a December 5, 2008, response to RAI 105, Question 11.04-2, the applicant proposed the addition of FSAR Tier 2, Table 11.4-14 listing the major components of the SWMS and their associated design parameters. The staff's review indicates that the inclusion of FSAR Tier 2, Table 11.4-14 is not acceptable, as it does not include sufficient details in describing the number, capacity, grade of materials used for their manufacturing, and operating characteristics. The staff requested that the applicant provide this more detailed information in follow-up RAI 225, Question 11.04-6. RAI 225, Question 11.04-6, is addressed in more detail later in this section.

Under 10 CFR 52.47(b)(1), an applicant for design certification needs to include in FSAR Tier 1 sufficient information to confirm that a plant is built and operated in accordance with the certification and, therefore, will meet NRC regulations. However, a review of FSAR Tier 2, Chapter 14, Table 14.3-8 (Sheet 5 of 7), indicates that the SWMS is within the scope of FSAR Tier 1, but FSAR Tier 1, Section 2.9.2 states that there are no FSAR Tier 1 entries for this system. Since the SWMS, in part, is relied upon to generate waste products that meet the classifications in10 CFR 61.55, have the characteristics defined in 10 CFR 61.56, and satisfy the requirements of 10 CFR Part 20, there is a need to demonstrate that the SWMS includes the necessary equipment to treat radioactive concentrates and spent resins, among other waste streams. In RAI 105, Question 11.04-3, the staff requested that the applicant propose appropriate FSAR Tier 1 entries for the SWMS. The FSAR Tier 1 items should include appropriate ITAAC entries for the SWMS, such as ITAAC to confirm functional arrangements of the system, identify quality group and seismic classifications, and provisions to control releases of radioactive materials. In a December 5, 2008, response to RAI 105, Question 11.04-3, the applicant stated that no ITAAC are necessary, since the SWMS is not a safety-related system and does not include any ASME Section III equipment, seismic Class I equipment, and category 1E equipment. The staff determined that the response is inadequate as it does not consider the regulatory requirements of 10 CFR Part 61 and 10 CFR Part 20. While this issue has not yet been resolved to the staff's satisfaction, the staff believes that RAI 105, Question 11.04-3 need not be resolved in the context of FSAR Tier 2, Section 11.4, because it is subsumed in the context of the staff review of the ITAAC in Chapter 14 of this report. Accordingly, the staff considers RAI 105, Question 11.04-3 closed. **An RAI associated with FSAR Tier 2, Section 14.3.2, which is directly related to this issue, is being tracked as an open item.** The staff's evaluation of the applicant's responses and closure of RAIs on ITAAC are addressed in Section 14.3 of this report.

FSAR Tier 2, Revision 0, Section 11.4.1.2.4, "Controlled Releases," stated that area radiation monitors in the RWB would detect excessive radiation levels and alert operators to this condition. FSAR Tier 2, Revision 0, Table 12.3-4 lists the airborne radiation detectors; however, FSAR Tier 2, Table 12.3-3 did not list area radiation monitors in the RWB where SWMS components are located. In RAI 105, Question 11.04-4, the staff requested that the applicant include in FSAR Tier 2, Table 12.3-3 the placement of ambient area radiation monitors in rooms or cubicles of the RWB. In a December 5, 2008, response to RAI 105, Question 11.04-4, the applicant proposed to revise FSAR Tier 2, Table 12.3-3 by including the installation of two radiation monitors, one in the drumming room and one in the decontamination room. The stated operational ranges of these two radiation monitors vary from 10^{-3} to 10^{+5} mSv/hr (10^{-4} to 10^{+4} rem/hr). The staff confirmed that Revision 1 of the U.S. EPR FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff determines that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 105, Question 11.04-4 resolved.

SRP Section 11.4 states, "The scope of the review of the solid waste management system includes line or flow diagrams of the system, P&IDs, process and effluent radiation monitoring and control instrumentation, and descriptive information for the SWMS and for those auxiliary supporting systems that are essential to the operation of the SWMS." Similarly, RG 1.206 provides further guidance in Section C.I.11.4.2.4 by stating, "The applicant should provide system P&IDs and process flow diagrams showing methods of operation and factors that influence waste treatment (e.g., system interfaces and potential bypass routes) … The applicant should provide P&IDs that indicate system interconnections and seismic and quality group interfaces." In RAI 105, Question 11.04-1, the staff requested that the applicant provide additional details in FSAR Tier 2, Figure 11.4-1 or that a system P&ID be included. This information was requested to evaluate the adequacy of the design as required by 10 CFR 50.34a. In a November 5, 2008, response to RAI 105, Question 11.04-1, the applicant provided additional detail in FSAR Tier 2, Figure 11.4-1. Specifically, clarifications were added to the processing path of the wet waste stream and a concentrate recirculation pump was added. Although general descriptions of components have been included and FSAR Tier 2, Figure 11.4-1 has been revised, the applicant still needs to include a COL information item for the SWMS P&IDs. The applicant should provide additional information in FSAR Tier 2, Figure 11.4-1 on major system interfaces, potential bypass routes, and other connections within the radioactive concentrates processing system. In a follow-up request, RAI 225, Question 11.04-5, the staff requested that the applicant provide additional details by including a process flow diagram that identifies flush water connections to the resin proportioning tank, disposition of water from the vacuum unit, connections between the condensate drying units, condensate counters, and the condensate buffer sluice, and scrubber tank connections to the radioactive waste building ventilation system. In a June 9, 2009, response to RAI 225, Question 11.04-5, the applicant proposed the addition of FSAR Tier 2, Figure 11.4-2 "Radioactive Concentrates Processing System," describing process flow through this subsystem, which is the appropriate P&ID. This figures shows the connections identified above. The new figure will also be referenced in FSAR Tier 2, Sections 11.4.2.2 and 11.4.2.3.2. The staff determined that the applicant's response is acceptable. **RAI 225, Question 11.04-5, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC. Therefore, the staff considers RAI 105, Question 11.04-1 resolved.

In RAI 105, Question 11.04-2, the staff requested that the applicant provide the general equipment design parameters for the SWMS, such as pump capacity, crane capacity, tank volume, materials, so the staff could adequately assess the design of the SWMS. In a November 5, 2008, response to RAI 105, Question 11.04-2, the applicant stated that FSAR Tier 2, Table 11.4-14, "Solid Waste Management System Component Data," will be added to FSAR Tier 2, Section 11.4. However, FSAR Tier 2, Table 11.4-14 does not list or describe the equipment design codes and standards. The staff determined that the information is inadequate to assess the system compliance with the design standards referenced in Table 1 of RG 1.143. In a follow-up request, RAI 225, Question 11.04-6, the staff requested that the applicant revise the FSAR to specify that the codes and standards referenced in RG 1.143, Table 1, have been considered for compliance in the design of the SWMS. In a June 9, 2009, response to RAI 225, Question 11.04-6, the applicant provided a proposed markup of FSAR Tier 2, Section 11.4.2.1 stating that the given SWMS equipment conforms with the codes and standards cited in RG 1.143. The staff determined that the applicant's response is acceptable because the system is designed in accordance with the codes and standards recommended in RG 1.143. **RAI 225, Question 11.04-6, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC. The staff considers RAI 105, Question 11.04-2 resolved.

As described in FSAR, Tier 2, Section 11.4.1 and as described above, the approach to LLRW management presumes LLRW shipment to an authorized recipient and may involve additional LLRW storage capacity, both of which would be implemented under the process control program (PCP). Among other things, the PCP is subject to the requirements of 10 CFR 20.2006 (governing transfer of LLRW for disposal and requiring manifests for the shipment of LLRW), 10 CFR 20.2007 (requiring compliance with other applicable Federal, State, and local regulations), 10 CFR 20.2108 (requiring records of waste disposal), and 49 CFR Parts 171-180 (requiring, among other things, the use of approved containers and packaging methods for LLRW shipment and monitoring of external radiation levels and external contamination on shipping containers). The staff determined that the application did not fully acknowledge applicable acceptance criteria. In RAI 273, Question 11.04-7, the staff requested that the applicant review SRP Section 11.4 and RG 1.206 and confirm that the design basis conforms to SRP criteria and, if not, provide justification that the alternate approach provides an acceptable method of compliance with NRC regulations. In a November 6, 2009, response to RAI 273, Question 11.04-7, the applicant agreed to provide additional information in FSAR Tier 2, Sections 11.4.1, 11.4.3, and 11.4.2.4, Table 1.8-2, and AREVA Technical Report ANP-10292 (Revision 1) to identify additional NRC regulations and commitments with SRP acceptance criteria. The information includes references and technical aspects identified in SRP 11.4, Appendix 11.4-A and NRC Bulletin 80-10. The revision includes updating COL Information Item 11.4-1 (FSAR Tier 2, Table 1.8-2) by adding 10 CFR 20.2007 as a compliance item to the radwaste process control program. The staff determined that the applicant's response and additional information are acceptable. **RAI 273, Question 11.04-7, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Section 11.4.1 states that both storage areas (drum storage and tubular storage) have a combined storage capacity of "several years' volume of solid waste." However, the staff review of the data shown in FSAR Tier 2, Table 11.4-1 indicated that the storage capacity is less than 3 years for Class B and C wastes when the 6-month decay-in-storage option is applied and all Class A wastes are being shipped as rapidly as they are being generated in

providing storage space for Class B and C wastes. In RAI 273, Question 11.04-8, the staff requested that the applicant review its approach and assumptions and confirm that it is operationally feasible to provide storage capacity for several years. **RAI 273, Question 11.04-8, which is associated with the above request, is being tracked as an open item.**

FSAR Tier 2, Section 11.4.2 describes the various components of the SWMS subsystems. The staff review of the description indicated that the information is presented inconsistently. Several components described in the text and FSAR Tier 2, Table 11.4-14 and FSAR Tier 2, Figure 11.4-1 are discussed in the text and not shown in a corresponding figure, or are not discussed in the text but shown in a figure. In RAI 273, Question 11.04-10, the staff requested that the applicant review and correct the following examples of inconsistencies in the SWMS subsystem descriptions.

- The interface between the LWMS and SWMS for the concentrate buffer tank is not shown in a corresponding P&ID drawing, see "KPC" connections for the chemical tank and concentrate tanks from LWMS in FSAR Tier 2, Figure 11.2-1, and note the lack of a KPC - Solid Waste System (KPC) connection from the demineralizer subsystem to the SWMS.

- The shredder and compactor systems and cementation station are not given in FSAR Tier 2, Table 11.4-14.

- Provisions for connecting mobile skid-mounted radwaste processing subsystems are not shown, while the FSAR states that it is an option.

- There is no indication as to where within SWMS subsystems waste samples will be collected for radiological and chemical analyses in demonstrating compliance with 10 CFR Part 20 and 10 CFR Part 61 waste form classification and characteristics, and waste disposal acceptance criteria of disposal sites.

- The location of the Drum Storage Facility and Tubular Shaft Storage Facility are shown "On-Site" in FSAR Tier 2, Figure 11.4-1 as out of the Radwaste Processing Building, but the text in FSAR Tier 2, Section 11.4 implies that they are located within the Radwaste Processing Building.

RAI 273, Question 11.04-10, which is associated with the above request, is being tracked as an open item.

The staff determined that FSAR Tier 2, Section 11.4.2 does not list the presence nor does it list their projected amounts spent charcoal and dessicant and HEPA filters as radioactive waste streams. The discussion does not address how large plant components will be processed either for disposal as radioactive waste or prepared for shipment to waste brokers or equipment refurbishers. In RAI 273, Question 11.04-11, the staff requested that the applicant address the management of such wastes in the FSAR. **RAI 273, Question 11.04-11, which is associated with the above request, is being tracked as an open item.**

FSAR Tier 2, Section 11.4.2.2 states that moisture content of wastes solidified in drums will be less than 10 percent by weight. This FSAR criterion is not consistent with the NRC, "Revised Staff Technical Position on Waste Form "(SP-91-13, January 1991), which states in its

regulatory position on compliance with 10 CFR Part 61 that free liquids shall be less than 0.5 percent by volume for Class A, B, and C stabilized waste products. In RAI 273, Question 11.04-12, the staff requested that the applicant address this inconsistency in the FSAR. **RAI 273, Question 11.04-12, which is associated with the above request, is being tracked as an open item.**

FSAR Tier 2, Sections 11.4.2 and 11.4.5 do not seem to acknowledge NRC concerns identified in NRC Bulletin 80-10, requirements of 10 CFR 20.1406, and the guidance of RG 4.21 in preventing nonradioactive systems from becoming contaminated and avoiding unmonitored and uncontrolled releases. These design features should be evaluated for all SWMS subsystem interfaces, and the FSAR should describe system features that would prevent nonradioactive systems from becoming contaminated by the SWMS. In RAI 273, Question 11.04-13, the staff requested that the applicant address this NRC guidance and describe the associated system design features in the FSAR. **RAI 273, Question 11.04-13, which is associated with the above request, is being tracked as an open item.**

FSAR Tier 2, Section 11.4.3 does not acknowledge NEI 07-10A PCP Template as an alternate means of demonstrating compliance with GL 89-01 and SECY-05-0197, "Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria," October 28, 2005, until a plant-specific PCP, including the detailed implementing procedures, is developed under a license condition. In addition, it was noted that FSAR Tier 2, Section 13.4 did not list the PCP as an operational program to be implemented under a license condition, contrary to SRP Section 13.4 and RG 1.206. In RAI 273, Question 11.04-14, the staff requested that the applicant acknowledge in the FSAR, NEI 07-10A PCP Template as an alternate means of demonstrating compliance with GL 89-01 and include the PCP in FSAR Tier 2, Section 13.4. In a November 6, 2009, response to RAI 273, Question 11.04-14, the applicant presented additional information on the options for developing a PCP in processing radioactive wastes. The additional information acknowledges the use of the NEI 07-10A PCP Template as an option to the development of a plant-specific PCP by a COL applicant. FSAR Tier 2, Section 11.4.3, "Radioactive Effluent Releases," will be revised by referencing the NEI generic PCP template, GL 89-01, and NRC SECY-05-0197 as supporting documents. FSAR Tier 2, Table 1.8-2, will be revised to include references to NEI 07-10A PCP Template, GL 89-01, and SECY-05-0197 in COL Information Item 11.4-1. FSAR Tier 2, Section 13.4 will be revised to include the PCP in its listing of operational programs. The staff determined that the applicant's response to RAI 273, Question 11.04-14 is acceptable. **RAI 273, Question 11.04-14, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Table 11.4-1 presents estimates of yearly waste volumes and activity levels of radwaste shipped for disposal or processing by waste brokers. The staff determined that some entries show radioactivity levels shipped in packages are greater than predicted as yearly estimates. For example, the expected activity level for non-compressible dry active waste (DAW) is 0.297 Ci per year, while the average activity shipped is 2.97 Ci per package. The factor of 10 is presumed to be associated with the assumed number of containers (shown as 0.1), but as tabulated the data imply that the average activity level per package is 10 times that of the total expected annual estimate. This inconsistency should be addressed, and the header of the last column of FSAR Tier 2, Table 11.4-1 should be revised and explained with appropriate footnotes. The waste streams given in FSAR Tier 2, Table 11.4-1 should be expanded to include waste volume estimates for spent charcoal and dessicant and HEPA filters.

In RAI 273, Question 11.04-15, the staff requested that the applicant address these inconsistencies in the FSAR. **RAI 273, Question 11.04-15, which is associated with the above request, is being tracked as an open item.**

Compliance with Effluent Concentration Limits and Doses to Members of the Public

Under 10 CFR Part 20, Appendix B, and 10 CFR Part 50, Appendix I, applicants are responsible for addressing requirements in controlling radioactive effluent releases in unrestricted areas and doses to a hypothetical maximally exposed member of the public and populations living near the proposed nuclear power plant. The requirements for liquid and gaseous effluent releases are in 10 CFR Part 20 (Appendix B, Table 2, Columns 1 and 2, expressed as effluent concentration limits). 10 CFR Part 50, Appendix I, Sections II.A, II.B, and II.C contain the requirements for doses to maximally exposed individuals due to liquid and gaseous effluents. The requirements for the conduct of a cost-benefit analysis in justifying installed processing and treatment systems for liquid and gaseous radioactive wastes are located in Section II.D of Appendix I to 10 CFR Part 50. The LWMS and GWMS control liquid and gaseous effluent releases, respectively, generated by the SWMS. Accordingly, compliance with the requirements of 10 CFR Part 20, Appendix B and 10 CFR Part 50, Appendix I for the SWMS is subsumed in FSAR Tier 2, Section 11.2 for the LWMS and FSAR Tier 2, Section 11.3 for the GWMS. Sections 11.2 and 11.3 of this report present the results of the staff's evaluation confirming compliance with effluent concentration limits of 10 CFR Part 20 and doses to members of the public under 10 CFR Part 50, Appendix I.

Process Control Program

FSAR Tier 2, Section 11.4.3 commits to the use of a process control program in ensuring that waste products, once treated and packaged for shipment and disposal, meet NRC and DOT shipping regulations and acceptance criteria of the disposal site. The development of a PCP is addressed under SECY-05-0197 and RG 1.206, in addition to SRP Section 11.4. A COL applicant referencing the U.S. EPR certified design will develop a plant-specific PCP, 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 wastes and parallel sets of conditions in processing and preparing dry solid wastes. FSAR Tier 2, Section 11.4.2 states that waste shipping containers will be selected from options that meet (1) the disposal requirements of 10 CFR Part 61, (2) the specific criteria of the chosen disposal facility or waste processor, and (3) radioactive material transportation requirements of 10 CFR Part 71 and relevant DOT regulations under 49 CFR Parts 171-180. In addition to the waste classification and characterization requirements of 10 CFR Part 61, wastes shipped for disposal must conform with the requirements of 10 CFR 20.2007 in demonstrating compliance with other applicable Federal, State, and local regulations governing the presence of any other toxic or hazardous properties in radioactive wastes, such as mixed wastes. Similarly, transactions of wastes shipped for disposal or to commercial waste processors must be recorded and, under 10 CFR 20.2108, such records must be maintained until the NRC terminates the license.

The COL applicant or COL holder is responsible, via the implementation of a plant-specific PCP, for confirming that the final forms of waste products conform to, "NRC Revised Staff Technical Position on Waste Form" (SP-91-13, January 1991), for stabilized wastes and comply with the requirements of 10 CFR 61.55 and 10 CFR 61.56. In FSAR Tier 2, Table 1.8-2 and 11.4.3, the applicant identifies COL Information Item 11.4-1 for meeting the above requirements and guidance concerning the processing of wet and dry solid wastes, as under a license condition

under FSAR Tier 2, Section 13.4. The COL information item requires that a COL applicant to address a site-specific functional PCP in view of the NRC guidance. The guidance includes NUREG-1301, as it relates to the development of a plant-specific PCP; and NUREG-0133, as it relates to the format and contents of PCPs. Alternatively, a COL applicant may use NEI PCP Template 07-10A (Rev 0, March 2009) for the purpose of meeting this regulatory milestone until a plant-specific PCP is prepared, before fuel load, under the requirements of a license condition described in FSAR Tier 2, Section 13.4 of a COL application. The NEI PCP Template 07-10A has been determined to be acceptable by the staff, and the NEI PCP Template 07-10A is presented in ML091460627. The staff determined that the proposed approach and integration of the operational program for the SWMS in the PCP is acceptable. Therefore, the staff finds the applicant's approach to this COL information item acceptable.

Task Action Plan

NUREG-0933, Section 2, "Resolution of Generic Safety Issues," includes a task action plan which identifies items covering a wide variety of subjects, and includes Task Action Plan Item C-17, "Interim Acceptance Criteria for Solidification Agents for Radioactive Solid Waste." In addressing Task Action Plan, Item C-17, FSAR Tier 2, Section 11.4 describes design features of the SWMS to collect, process, and package wet and dry solid wastes before shipment to disposal sites or offsite waste processors. As a result, the COL applicant is responsible for the implementation of a plant-specific PCP presenting operating procedures and technical specifications for the classification, treatment, and disposal of radioactive wastes in accordance with regulatory requirements of the NRC, DOT and State and local agencies. The parameters and criteria, used to process, treat, store, and ship wastes are to be included in a plant-specific PCP and implementing procedures. Guidance on the development of a plant-specific PCP is contained in GL 89-01 and NUREG-1301. The commitment to develop a PCP is identified under COL Information Item 11.4-1, as described in FSAR Tier 2, Table 1.8-2. In fulfilling this commitment, the COL applicant has two options: (1) Prepare a plant-specific PCP using NRC criteria and guidance; or (2) adopt by reference NEI PCP Template 07-10A (Revision 0, March 2009) in meeting this regulatory milestone. Either option is acceptable in complying with Task Action Plan Item C-17.

Long-Term Low-Level Radioactive Waste Storage

According to the applicant, the design of the U.S. EPR Radioactive Waste Processing Building includes provisions for several years' worth of onsite storage of processed solid and wet low-level radioactive wastes, exclusive of DAW. The types of wastes that are considered for storage include Class B and C wastes, as defined under 10 CFR 61.55, "Waste Classification." DAW is excluded, because currently there are commercial facilities offering disposal services for Class A wastes.

Based on the applicant's projected LLRW generation rates and an evaluation of physical space of the facility, the staff determined that the U.S. EPR design has sufficient onsite storage capacity in the near term, meaning from a few to several years depending upon operating practices and implementation of operating procedures that would minimize the generation of radioactive wastes. The need for storage space capacity beyond that is left to the determination of the COL applicant or COL holder under the implementation of a plant-specific LLRW management plan and PCP, part of which is to address storage capacity. The design of a new building or modifications to existing storage provisions should conform to the guidelines of BTP 11-3 and SRP Section 11.4, Appendix 11.4-A and the requirements of 10 CFR Part 20 in

protecting members of the public and plant workers. Besides the option of building a new storage facility or modifying an existing one, a COL applicant or COL holder may elect to store LLRW at one of its existing operating reactor sites, or commercially procure the necessary storage space, such as through a waste processor.

The NRC has issued technical and regulatory guidance on the storage of LLRW. In GL 81-038, "Storage of Low Level Radioactive Wastes at Power Reactor Sites," November 10, 1981, the NRC provides guidance to licensees on the addition of onsite LLRW storage facilities. Appendix 11.4-A, "Design Guidance for Temporary Storage of Low-Level Radioactive Waste," to SRP Section 11.4 and RIS 2008-32, "Interim Low Level Radioactive Waste Storage at Reactor Sites," December 30, 2008, provide guidance on waste storage at reactor sites. Appendix 11.4-A addresses the guidance of GL 80-009, "Low Level Radioactive Waste Disposal," on low level radioactive waste disposal; GL 81-038 discusses the storage of low level radioactive waste at reactor sites; and GL 81-039, "NRC Volume Reduction Policy," presents the NRC low level radioactive waste volume reduction policy. IE Circular 80-18, "10 CFR 50.59 Safety Evaluations for Changes to Radioactive Waste Treatment Systems," presents criteria in considering changes made to radioactive waste treatment systems under the requirements of 10 CFR 50.59, "Changes, tests and experiments," for license holders. Collectively, the guidance addresses technical issues in considering the duration of the intended storage, types and forms of LLRW, selection and expected long-term integrity of storage containers, and amounts of radioactive materials contained in LLRW in ensuring public health and safety, minimizing doses to operating personnel, and protection of the environment.

In considering the design and construction of an onsite LLRW storage facility or modifications to existing storage capacity, the COL holder is expected to follow the requirements of the change process that will be outlined in the U.S. EPR design certification rule (similar to the process included in 10 CFR 50.59), as it relates to facility modifications, changes in structures, systems, and components that could affect performance, and compliance with the requirements in 10 CFR Part 20 and 10 CFR Part 50, and changes in methods described in the FSAR and operating procedures.

The staff recognizes that the need for additional onsite storage capacity for LLRW is a plant-specific consideration that depends, in part, on whether the State or a regional LLRW compact has provided a facility for long-term storage or disposal. The availability of offsite LLRW storage space is beyond the control of this applicant. Consequently, when offsite storage or disposal capacity is not available, the COL applicant or COL holder should submit to the NRC the details of arrangements about long-term onsite storage or disposal of LLRW. The COL applicant or COL holder should evaluate the need for any additional LLRW storage capability and design features of such a facility under the requirements of the change process that are outlined in the U.S. EPR design certification rule and technical guidance in SRP Section 11.4, NRC RIS 2008-32, and RGs 1.143, 4.21, 8.8, and 8.10. The staff will review and evaluate proposals for additional plant-specific LLRW storage against these guidelines.

Minimization of Contamination

FSAR Tier 2, Section 12.3.6 addresses compliance with 10 CFR 20.1406, as it relates to facility design, including the SWMS, and operational procedures for minimizing the contamination of the facility and the generation of radioactive waste. FSAR Tier 2, Section 12.3.6 discusses programmatic aspects and design features of SSCs intended to minimize contamination. This section states that the principles embodied in the applicant's philosophy include preventing

unintended releases and early detection of unintended contamination. The SWMS generates liquid, wet, and gaseous radioactive wastes from the associated operation of the SWMS collection system and SWMS processing subsystems. Such liquid, wet, and gaseous wastes could potentially cross-contaminate nonradioactive systems, result in the contamination of nearby facilities and equipment, and potentially result in unmonitored and uncontrolled radioactive releases to the environment. In FSAR Tier 2, Section 11.4.1, the applicant states that the design of SWMS subsystems include features that are in compliance with the requirements of 10 CFR 20.1406. The design includes drains and vents to route radioactive process or waste streams and avoids interconnections between plant systems that could become radioactive through improper interfaces with radioactive systems.

The staff determined that such design features and commitments are acceptable and in compliance with the requirements of 10 CFR 20.1406 and the guidelines of NRC Bulletin 80-10 and RG 4.21. However, the staff noted that the design basis and descriptions of structures, systems, and components did not always acknowledge NRC concerns identified in NRC Bulletin 80-10 and guidance of RG 4.21 in preventing nonradioactive systems from becoming contaminated and avoiding unmonitored and uncontrolled releases of liquid effluents. These design features should be evaluated, and the FSAR should describe system features that would prevent leaks and radioactive contamination of nonradioactive support systems. While specific RAIs were submitted to the applicant to address such concerns in FSAR Tier 2, Section 11.4, the staff's evaluation of the applicant's responses and closure of such RAIs are addressed in Section 12.3 of this report.

FSAR Tier 1 Information

In FSAR Tier 2, Section 14.3.2; FSAR Tier 2, Section 11.4; and FSAR Tier 1, Section 2.0, the applicant indicates that the treatment of ITAAC has been divided in two groups: Certified design material and ITAAC. The applicant states further: CDM binds the design commitment of structures, systems, and components for the lifetime of the facility, and ITAAC are used to verify the as-built features of the plant. FSAR Tier 2, Section 14.3.2 assigns ITAAC based on (1) the classification of systems and equipments, and (2) systems identified during key safety and integrated plant safety analyses for the purpose of preserving specific design features in the as-built facility. Systems described in FSAR Tier 2 sections that have no safety significant features or that were not identified as part of the "key safety and integrated plant safety analyses" process are given in FSAR Tier 1 as, "No entry for this system."

Although the selection process identifies pertinent NRC regulations for safety-related design features, FSAR Tier 1, Section 2.9 with the exception of Section 2.9.4, does not identify ITAAC associated with plant systems and components used to monitor and/or control radioactivity releases in the environment in demonstrating compliance with 10 CFR Part 20 (Appendix B, Table 2) liquid and gaseous effluent concentration limits; and doses to members of the public under 10 CFR 20.1301 and 10 CFR 20.1302, as well as avoiding unmonitored and uncontrolled radioactive releases to the environment in response to 10 CFR 20.1406(b). FSAR Tier 1, Section 2.9.4 includes ITAAC in confirming that instrumentation will indicate the presence of elevated levels of radioactivity in the plant vent stack and main control room air intake, and the isolation of the intake air supply system. Specific RAIs were submitted to the applicant to address such concerns for the SWMS as part of the review of FSAR Tier 2, Section 14.3. The staff's evaluation of the applicant's responses and closure of such RAIs are addressed in Section 14.3 of this report.

ITAAC Information

FSAR Tier 2, Chapter 14, Table 14.3-8, (Sheet 6 of 8), states that the SWMS is within the scope of FSAR Tier 1; however, FSAR Tier 1, Section 2.9.2 states that there are no FSAR Tier 1 entries for the SWMS. The SWMS is relied upon to collect, treat, store, and manage low-level radioactive wastes in compliance with 10 CFR 61.55 for waste classification and 10 CFR 61.56 for waste characteristics for disposal or shipments to offsite waste processors. Other associated regulatory requirements address administrative and operational programs whose objectives are to comply with associated regulatory requirements, such as 10 CFR 20.2006 and 10 CFR 20.2007, 10 CFR Part 71, and 49 CFR Parts 71-180 on the shipment of radioactive materials under DOT regulations. ITAAC should address the descriptions and functional arrangements, operational integrity, waste storage space and associated shielding provisions for the tubular shaft storage area, and interface of SWMS subsystems with the LWMS and GWMS under expected operating conditions in ensuring that effluent concentration limits of 10 CFR Part 20 (Appendix B, Table 2, Columns 1 and 2) will not be exceeded and that waste products conform to the requirements of 10 CFR 61.55 and 10 CFR 61.56 for disposal and storage at licensed facilities. It was determined that ITAAC should be included to confirm, with respect to FSAR Tier 2 design features, the proper operation of the radioactive concentrates processing system, drum drying stations, and drum radioactivity measuring device. Specific RAIs were submitted to the applicant to address such concerns for the SWMS as part of the review of FSAR Tier 2, Section 14.3. The staff's evaluation of the applicant's responses and closure of such RAIs are addressed in Section 14.3 of this report.

Technical Specifications

The staff reviewed FSAR Tier 2, Chapter 16 and determined that TS 5.6.2 would require that the annual report include a summary of the amounts of radioactive wastes shipped offsite for disposal. The TS requires that the information included in the yearly summary be consistent with the objectives outlined in the process control program and in conformance with 10 CFR 50.36a and 10 CFR Part 50, Appendix I. The use of a PCP is under the operational programs described in SRP Section 13.4. The staff determined these requirements acceptable and agrees that the implementation of such programs will be addressed in a plant and site-specific PCP under COL Information Item 11.4-1, as described in FSAR Tier 2, Table 1.8-2.

Preoperational Testing

FSAR Tier 2, Section 14.2.12 presents descriptions of individual tests and test abstracts to be conducted on identified plant systems and components. For the SWMS, the tests include Test No. 93, "Solid Waste Storage System," and Test No. 094, "Radioactive Concentrates Processing System," in confirming the performance of its subsystems. The tests will verify flow paths, instrumentation, alarms, interlocks and proper equipment operation. Similarly, Test No. 090 is for laboratory radio-analytical equipment used to assess radionuclide concentrations in samples collected from SWMS subsystems and determine if waste products meet NRC waste classification and characterization criteria of 10 CFR 61.55 and 10 CFR 61.56 and DOT shipping regulations.

The acceptance criteria for these tests include performance in accordance with FSAR Tier 2, Sections 11.2 and 11.4. The staff reviewed these tests and generated specific RAIs on the information presented in FSAR Tier 2, Section 14.2.12. The evaluation of the applicant responses to and closure of these RAIs are addressed Section 14.2 of this report.

11.4.5 Combined License Information Items

Table 11.4-1 provides a list of SWMS related COL item numbers and descriptions from FSAR Tier 2, Table 1.8-2:

Table 11.4-1 U.S. EPR Combined License Information Items

Item No.	Description	FSAR Tier 2 Section
11.4-1	A COL applicant that references the U.S. EPR design certification will fully describe, at the functional level, elements of the Process Control Program. This program description will identify the administrative and operational controls for waste processing parameters and surveillance requirements which demonstrate that the final waste products meet the requirements of applicable Federal, State, and disposal site waste form requirements for burial at a 10 CFR Part 61 licensed low level disposal site and will be in accordance with the guidance provided in RG 1.21, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste," Revision 2, June 2009, NUREG-0800 Branch Technical Position 11-3, ANSI/ANS-55.1-1992, and Generic Letters 80-09, 81-38, and 81-39.	11.4.3

The staff determined the above list of COL information items to be complete, and concludes that they adequately describe the actions necessary for the COL applicant or holder.

11.4.6 Conclusions

Except for the open items identified below, the staff concludes that the SWMS, as a permanently installed system, includes the equipment necessary to collect, hold, process, package, and store wet and dry solid wastes and control releases of radioactive materials associated with the operation of the SWMS. The applicant provided sufficient design information to demonstrate that it has met the requirements of 10 CFR 50.34a; GDC 60, GDC 61, and GDC 63 of 10 CFR Part 50, Appendix A; and NRC guidance and acceptance criteria. This conclusion is based on the following:

- The U.S. EPR design demonstrates compliance with 10 CFR 50.34a, as it relates to the inclusion of sufficient design information and system design features that are necessary for collecting, holding, processing, handling, packaging, and safe storage of wet and dry solid radioactive wastes. The design conforms to the guidelines of BTP 11-3 and SRP Section 11.4, Appendix 11.4-A. The U.S. EPR demonstrates compliance with the requirements of GDC 61 by meeting the guidelines of RG 1.143 in providing sufficient wet and solid waste processing capacities and storage space to ensure adequate safety under normal operation, AOOs, and postulated accident conditions.

- The design of the U.S. EPR implements a plant-specific Process Control Program (PCP), as an operational program, described in FSAR Tier 2, Sections 11.4.3 and 13.4,

for the processing of low-level radioactive waste (LLRW). The PCP addresses plant-specific operating procedures and acceptance criteria as they relate to the treatment and processing of radioactive wastes such that waste products generated by the SWMS will meet the classification and characterization definitions in 10 CFR 61.55 and 61.56, respectively. The implementation of a PCP is specified under COL Information Item 11.4-1, as described in FSAR Tier 2, Table 1.8-2.

- The design of the U.S. EPR Radioactive Waste Processing Building includes provisions for several years of onsite storage of processed solid and wet wastes, exclusive of dry wastes classified as Class A wastes under 10 CFR 61.55. The approach to low-level radioactive waste (LLRW) management presumes that LLRW will be disposed of by shipment to an authorized recipient under 10 CFR 20.2001(a)(1). Under that approach, the applicant should demonstrate the capability of the means included in the design to process dry solid and wet wastes so that these wastes meet the classification and characterization definitions in 10 CFR 61.55 and 10 CFR 61.56, respectively. The need for LLRW storage space beyond that of the design capacity of the Radioactive Waste Processing Building is the responsibility of the COL applicant or COL holder under the implementation of a plant-specific waste management plan and updated PCP.

- The U.S. EPR design meets the requirements of GDC 60 with respect to controlling releases of radioactive liquid and gaseous effluents generated during the operation of the SWMS as part of the operation of the LWMS, GWMS, and PERMSS, as described in FSAR, Tier 2, Sections 11.2, 11.3, and 11.5. All LWMS and GWMS releases are monitored by radiation monitors, which will generate signals to terminate releases or alert plant operators before discharges exceed a predetermined instrumentation set point. The COL applicant is responsible for determining the operational set-point for its LWMS and GWMS radiation monitors in a plant and site-specific offsite dose calculation manual (ODCM) under COL Information Item 11.5-1, as described in FSAR Tier 2, Table 1.8-2.

- The U.S. EPR design meets the requirements of 10 CFR 20.1302 by ensuring that annual average concentrations of radioactive materials contained in liquid and gaseous wastes generated during the operation of the SWMS will be controlled and released as part of the operations of the LWMS and GWMS. The operations of the LWMS and GWMS are controlled such that releases of liquid and gaseous effluents in unrestricted areas will not exceed the limits specified in 10 CFR Part 20 (Appendix B, Table 2, Columns 1 and 2) and dose limits for members in 10 CFR 20.1301, as described in FSAR Tier 2, Sections 11.2 and 11.3. As part of this commitment, the COL applicant will be responsible for demonstrating, through the ODCM, compliance with 10 CFR 20.1301(e), which incorporates by reference 40 CFR Part 190 for facilities within the nuclear fuel cycle, including nuclear power plants.

- The U.S. EPR design complies with the design objectives of 10 CFR Part 50, Appendix I, Sections II.A, II.B, II.C, and II.D in ensuring that releases of liquid and gaseous effluents generated during the operation of the SWMS will not exceed the numerical criteria and design objectives of 10 CFR Part 50, Appendix I and are ALARA. The COL applicant is responsible for determining the operational set-point for its LWMS and GWMS radiation monitors in a plant-specific offsite dose calculation manual under COL Information Item 11.5-1, as described in FSAR Tier 2, Table 1.8-2.

- A COL applicant referencing the U.S. EPR certified design will demonstrate compliance with 10 CFR 50, Appendix I, Section II.D design objectives for offsite individual doses and population doses resulting from liquid and gaseous effluents generated during the operation of the SWMS as part of a site-specific cost-benefit analysis conducted for the LWMS and GWMS under COL Information Items 11.2-1 and 11.3-1, as described in FSAR Tier 2, Table 1.8-2.

- The U.S. EPR design provides sufficient information and design features satisfying the guidance of RG 1.143 for SWMS processing systems in establishing the seismic and quality group classifications for system components and structures housing components.

For the following open items, tracked under **RAI 273, Question 11.04-8, RAI 273 Question 11.04-10, RAI 273, Question 11.04-11, RAI 273, Question 11.04-12, RAI 273, Question 11.04-13, and RAI 273, Question 11.04-15**, the staff concludes, using the information presented in the application, that the applicant has not provided sufficient information in confirming the storage capacity for low-level radioactive wastes; and fully demonstrated compliance with NRC regulations and guidance in describing design features that would minimize the contamination of the facility and environment, prevent the cross-contamination of nonradioactive systems, and avoid unmonitored and uncontrolled radioactive releases to the environment. The regulations are contained in 10 CFR 20.1406 and the guidance is contained in RGs 4.21 and 1.143, SRP Section 11.4, and NRC Bulletin 80-10.

11.5 Process and Effluent Radiological Monitoring and Sampling Systems

11.5.1 Introduction

Process and effluent radiological monitoring and sampling systems are used to monitor liquid and gaseous process streams and effluent releases from waste management systems during normal operation, anticipated operational occurrences, and post-accident conditions. The systems include radiation monitors to detect and measure radioactivity and radiation levels and to provide indication of radioactive release rates or concentration levels in process and effluent streams. The PERMSS include sampling systems to extract samples from process or effluent streams and to provide the means to collect samples on filtration and in adsorbent media. The PERMSS provide the means to establish alarm set points for the purpose of indicating when excessive radioactivity levels are present, track and record rates of radioactivity releases, and initiate protective isolation actions, such as terminating or diverting process or effluent flows. Typically, the system consists of skid-mounted radiation monitoring equipment and permanently installed sampling lines, with the equipment being located at points to measure radioactivity or collect samples that are representative of process flows and effluent releases. Samples collected on filtration and in adsorbent media are evaluated by laboratory analyses in confirming measurement results recorded by radiation monitors and determining radioactivity levels associated with radionuclides that are not readily detected by radiation monitoring devices. The system includes local instrumentation readout panels and alarm functions in addition to those located in control rooms. The PERMSS does not generate additional sources of radioactive materials associated with its operation, given that it is used only to control and monitor liquid and gaseous process streams and effluents discharged into the environment. Fluid samples

collected from process and effluent streams are returned to their origins and are not discharged locally.

The staff review of the PERMSS included evaluation of the design basis, design objectives, and design criteria; types of radiation detection methods and instrumentation used; related sampling equipment and collection media; redundancy and independence of subsystems; instrumentation measurement ranges, calibration and sensitivity; programs and methods used in establishing alarm set-points for activating alarms or terminating process flows and effluent releases; and diversity of equipment used for normal operation, AOOs, and postulated accidents. The staff evaluated the information against the guidance of Chapter 11.5, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants – LWR Edition," March 2007. The SRP acceptance criteria provide the guidance for assuring that liquid and gaseous effluent releases and associated radiation exposures are controlled, monitored, and maintained within the limits of 10 CFR Part 20 and meet ALARA and numerical guides and design objectives of 10 CFR Part 50, Appendix I.

11.5.2 Summary of Application

FSAR Tier 1: As stated in FSAR Tier 1, Sections 2.4, "Instrumentation and Control System," and 2.9, there are no FSAR Tier 1 entries for the process and effluent radiological monitoring and sampling systems. An ITAAC supporting the sampling system described in FSAR Tier 2, Section 11.5 is given in FSAR Tier 1, Section 2.9.4. The purpose of the ITAAC is to confirm that instrumentation will indicate the presence of elevated levels of radioactivity in the plant vent stack and main control room air intake and isolate the intake air supply system in protecting plant operators.

FSAR Tier 2: The applicant has provided a description in FSAR Tier 2, Section 11.5, summarized here in part, as follows:

FSAR Tier 2, Section 11.5 describes the process and effluent radiological monitoring sampling systems and their functions in monitoring, recording and tracking, and controlling radioactivity levels, release rates, and concentrations in effluents during operations, AOOs, and accident conditions. The system provides the means to terminate and isolate process flows and effluent releases upon detecting elevated levels of radioactivity. The PERMSS is used to extract and collect liquid and gaseous samples from various process and effluent streams for analyses conducted in laboratory settings. The system consists of skid-mounted radiation monitoring equipment and permanently installed sampling lines, with the equipment being located at points to measure radioactivity or collect samples that are representative of process flows and effluent releases. Samples collected on filtration and in adsorbent media are evaluated by laboratory analyses in confirming measurement results recorded by radiation monitors and determining radioactivity levels associated with radionuclides that are not readily detected by radiation monitoring devices. The system includes local instrumentation readout panels and alarm functions in addition to those located in the main control room. PERMSS subsystems and components are located at various locations throughout the plant, as by design requirements of plant systems.

FSAR Tier 2, Section 11.5.1, "Design Basis," presents the design basis and criteria of the system; FSAR Tier 2, Section 11.5.2 presents a description of the system; FSAR Tier 2, Section 11.5.3 describes the effluent monitoring and sampling system; and FSAR Tier 2, Section 11.5.4, "Process Monitoring and Sampling," presents details on process monitoring and

sampling. FSAR Tier 2, Table 11.5-1 describes system features used for sampling and monitoring, describes operational characteristics of radiation monitors, and identifies subsystems that include automatic control functions in terminating or diverting process flows and effluent releases. FSAR Tier 2, Figures 11.5-1, 12.3-72, and 12.3-73 depict process flows from the LWMS, GWMS, and SWMS to their respective release points.

Except for specific subsystems, failure of the PERMSS does not compromise safety-related systems or components and does not prevent the safe-shutdown of the plant. FSAR Tier 2, Section 3.2 describes the seismic and quality group classification and corresponding codes and standards that apply to structures housing the system. In addition, FSAR Tier 2, Section 3.10, "Seismic and Dynamic Qualification of Mechanical and Electrical Equipment," addresses the seismic qualification of mechanical and electrical equipment, and FSAR Tier 2, Section 3.11, "Environmental Qualification of Mechanical and Electrical Equipment," covers environmental qualification of mechanical and electrical equipment. These topics are addressed in Chapter 3, "Design of Structures, Components, Equipment, and Systems," of this report.

For PERMSS subsystems that perform safety-related functions or are used for safe shut down, the system:

- Monitors the air intake of the main control room for radioactivity and isolates the air intake upon the detection elevated levels of airborne radioactivity
- Isolates the Containment Building upon the detection of elevated radiation levels
- Isolates steam generators upon the detection of elevated levels of radioactivity in steam
- Monitors building ventilation exhausts for radioactivity and directs exhaust flows to filter trains upon detecting elevated levels of radioactivity in exhausts
- Monitors radiation and radioactivity levels in plant areas and systems during operation and accidents, and provides information on radioactivity levels and radioactive releases

The associated Three Mile Island (TMI)-related items in monitoring radioactive effluents under accident conditions are covered in FSAR Tier 2, Sections 6.2.3; 7.1.1, "U.S. EPR I&C Architecture"; 7.1.2, "Identification of Safety Criteria"; 7.3.1, "Description"; 7.4.1, "Description"; 7.5.1, "Description"; 7.5.2, "Analysis"; and 9.3.2, "Process Sampling Systems." FSAR Tier 2, Sections 11.5.3 and 11.5.4 identify the means to collect process and effluent samples for radiological analyses. The sampling system includes the sampling activity system, secondary sampling system, and severe accident sampling system. The instrumentation and controls of the LWMS, GWMS, and SWMS, as they relate to the interface and operation of the PERMSS, are not required for safety as indicated in FSAR Tier 2, Section 7.7, "Control Systems Not Required for Safety."

For non-safety-related systems, the PERMSS monitor and control process streams and effluent releases for the:

- Building ventilation system exhausts and radioactivity through the plant vent stack
- Gaseous waste management system

- Main condenser evacuation system and turbine gland sealing system
- Liquid waste management system
- Component cooling water system
- Steam generator blowdown system

FSAR Tier 2, Sections 9.4.2, “Fuel Building Ventilation System”; 9.4.3, “Nuclear Auxiliary Building Ventilation System”; 9.4.4, “Turbine Building Ventilation System”; 9.4.5, “Safeguard Building Controlled-Area Ventilation System”; 9.4.7, “Containment Building Ventilation System”; 9.4.8; and 9.4.14, “Access Building Ventilation System,” describe the design bases, operation, and monitoring of such building ventilation systems. FSAR Tier 2, Figures 11.5-1, 12.3-72, and 12.3-73 describe process flows and flow paths of liquid and gaseous effluent releases from the LWMS, GWMS, and building ventilation systems. FSAR Tier 2, Sections 11.5.3 and 11.5.4 identify the means to collect process and effluent samples for radiological analyses. The preoperational testing is conducted by a COL applicant, and development of operational programs and procedures is left to COL applicants under COL Information Item 11.5-1, as described in FSAR Tier 2, Table 1.8-2.

The applicant states that PERMSS design features provide the means to detect, measure, and control liquid and gaseous effluent releases in accordance with the concentration limits of 10 CFR Part 20 (Appendix B, Table 2, Column 1 and 2), 10 CFR 20.1301(e), insofar as it requires meeting EPA environmental radiation protection standards of 40 CFR Part 190, and design objectives of 10 CFR Part 50, Appendix I. The applicant states that the design is in compliance with the requirements of 10 CFR 50.34a and GDC 60, GDC 63, and GDC 64, using the acceptance criteria of SRP 11.5 and associated regulatory guidance. For TMI-related requirements, the applicant states that the design conforms to 10 CFR 50.34(f)(2)(xvii) and 10 CFR 50.34(f)(2)(xxvii) in monitoring gaseous effluents from potential accident release points using regulatory guidance.

ITAAC: There are no ITAAC identified for the process and effluent radiological monitoring and sampling systems. An ITAAC supporting the sampling system described in FSAR Tier 2, Section 11.5 is given in FSAR Tier 1, Section 2.9.4.

Technical Specifications: There are no technical specifications for the process and effluent radiological monitoring and sampling systems. Technical specifications for the post-accident monitoring instrumentation (PAMI) are defined in FSAR Tier 2, Chapter 16, Section 3.3.2, “Post Accident Monitoring Instrumentation.”

11.5.3 Regulatory Basis

The relevant requirements of NRC regulations for the process and effluent radiological monitoring and sampling systems, and the associated acceptance criteria, are given in NUREG-0800, Section 11.5 and are summarized below. Review interfaces with other SRP sections can be found in NUREG-0800, Section 11.5.

1. 10 CFR 20.1302 and 10 CFR 20.1301(e), as they relate to monitoring radioactivity in plant radiological effluents to unrestricted areas. These criteria apply to all effluent

releases resulting from operation during normal plant operations and anticipated operational occurrences.

2. 10 CFR 50.34a, as it relates to equipment design and procedures used to control releases of radioactive material to the environment within the numerical guides provided in 10 CFR Part 50, Appendix I.

3. 10 CFR 50.36a, as it relates to operating procedures and equipment installed in radioactive waste management systems pursuant to 10 CFR 50.34a to ensure that releases of radioactive materials to unrestricted areas are kept ALARA.

4. 10 CFR Part 50, Appendix I, as it relates to numerical guides and design objectives to meet the requirements of 10 CFR 50.34a and 10 CFR 50.36a, which specify that radioactive effluents released to unrestricted areas and doses to members of the public be kept ALARA.

5. 10 CFR 20.1406, as it relates to the design and operational procedures in minimizing contamination of the facility, facilitating eventual decommissioning, and minimizing the generation of radioactive waste.

6. GDC 60 and 10 CFR Part 50, Appendix A, as it relates to controlling effluent releases from the LWMS, GWMS, and SWMS and designing these systems to handle radioactive materials produced during normal plant operation, including AOOs.

7. GDC 63 and GDC 64, "Monitoring Radioactivity Releases," as they relate to the designs of the LWMS, GWMS, and SWMS, and capabilities to monitor and control radiation levels and radioactivity in effluents, as well as radioactive leakages and spills, during routine operation, AOOs, postulated accidents, and initiate appropriate safety actions.

8. Requirements specified in 10 CFR 50.34(f)(2)(xvii) and 10 CFR 50.34(f)(2)(xxvii) for monitoring gaseous effluents from all potential accident release points, consistent with the requirements of GDC 63 and GDC 64. These requirements correspond to the NRC TMI Action Plan Items II.F.1 and III.D.3.3, respectively.

Regulatory guidance adequate to meet the above requirements includes:

1. RG 1.21, as it relates to guidance for the design, implementation, and quality assurance of effluent monitoring and sampling systems.

2. RG 1.33, as it relates to quality assurance for the operation of safety-related equipment that is part of the PERMSS.

3. RG 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants," Revision 4, June 2006, as it relates to accident monitoring instrumentation and performance of radiation monitoring systems. Additional guidance on the application of RG 1.97 is provided in SRP Section 7, BTP 7-10, "Guidance on Application of Regulatory Guide 1.97," Revision 5, March 2007, on post-accident monitoring variables.

4. RG 4.15, Revision 2, July 2007, as it relates to the design, implementation, and quality assurance of effluent monitoring and sampling systems.

5. RG 4.21, as it relates to minimizing the contamination of equipment, plant facilities, and environment, and minimizing the generation of radioactive waste during plant operation.

6. Radiological Assessment Branch Technical Position, Revision 1, November 1979, as it relates to the conduct of environmental monitoring, included as NUREG-1301, Appendix A.

7. NUREG-0133, as it relates to the format and contents of ODCMs.

8. SECY-05-0197, as it relates to descriptions of operational programs.

9. ANSI/HPS N13.1-1999, as it relates to sampling and monitoring of airborne releases from stacks.

10. ANSI N42.18-2004, as it relates to the performance of radiation monitoring equipment.

11. NUREG-0800, SRP Section 11.5, Appendix 11.5-A, "Design Guidance for Radiological Effluent Monitors Providing Signals for Initiating Termination of Flow or Other Modification of Effluent Stream Properties," as it relates to the design of automatic control functions.

12. NRC IE Bulletin No. 80-10, as it relates to methods and procedures used in avoiding the cross-contamination of nonradioactive systems and unmonitored and uncontrolled releases of radioactivity.

13. GL 89-01, as it relates to the restructuring of the ODCM and RETS. (Included in NUREG-1301)

14. NUREG-1301, as it relates to the development of a plant-specific offsite dose calculation manual. Alternatively, a COL applicant may use NEI ODCM Template 07-09A, Revision 0, January 27, 2009. The staff concluded that NEI ODCM Template 07-09A is acceptable.

11.5.4 Technical Evaluation

The staff reviewed the LWMS using the guidance and acceptance criteria of NUREG-0800, SRP Section 11.5. The staff reviewed the PERMSS to determine whether it complies with the requirements of 10 CFR 50.34a, GDC 60, GDC 63, and GDC 64. Under 10 CFR 50.34a and 10 CFR 50.36a, the applicant is required to demonstrate that sufficient design information is provided to comply with the ALARA design objectives of 10 CFR Part 50, Appendix I for equipment necessary to control releases of radioactive effluents into the environment. Staff acceptance of the PERMSS is based on the design meeting the requirements of 10 CFR 20.1301, 10 CFR 20.1302, and 10 CFR 20.1406; 10 CFR 50.34a and 10 CFR 50.36a; 10 CFR Part 50, Appendix I; GDC 60, GDC 63, and GDC 64; and 10 CFR 50.34(f)(2)(xvii) and 10 CFR 50.34(f)(2)(xxvii).

The relevant requirements of GDC 60, GDC 63, and GDC 64 are met by using the regulatory positions in RG 1.143, as they relate to the seismic design and quality group classification of structures housing the PERMSS. Other applicable NRC guidance includes RGs 1.21, 1.33, 4.15, 1.97, and 1.143 (interfaces with the LWMS and GWMS), and NUREG-0133 and

NUREG-1301 on the development of an ODCM. Relevant industry guidance includes ANSI/HPS 13.1-1999 and ANSI N42.18-2004. With respect to compliance with TMI-related items, NUREG-0718, "Proposed Licensing Requirements for Pending Applications for Construction Permits and Manufacturing License," and NUREG-0737, "Clarification of TMI Action Plan Requirements: Requirements for Emergency Response Capability," Supplement 1, RG 1.97, and SRP Section 7, BTP 7-10 provide supplemental information and guidance in meeting the requirements identified under 10 CFR 50.34(f)(2)(xvii) and 50.34(f)(2)(xxvii). Compliance with the requirements of 10 CFR 20.1406 is met by using the guidance of RGs 1.143, 4.21, and NRC Bulletin 80-10.

The primary purpose of the PERMSS is to provide information characterizing the types and amounts of radioactivity contained in process streams and liquid and gaseous effluents. Other objectives are to alert control room operators of abnormal levels of radioactivity in process streams and in liquid and gaseous effluents, and provide signals that initiate automatic safety functions, isolate process streams, and terminate effluent discharges if predetermined radioactivity levels or release rates exceed alarm set points. Another function of the PERMSS is to provide the means to collect samples from process and effluent streams for radiological analysis. The design objectives and criteria of the PERMSS are intended to address the following:

- Radiation monitoring instrumentation required for plant safety and protection
- Radiation instrumentation required for monitoring plant operation and safe shut down
- Radiation monitoring of liquid and gaseous effluent releases

FSAR Tier 2, Section 11.5 describes the design basis of the process and effluent radiological monitoring system and its functions in monitoring, recording and tracking, and controlling radioactivity levels, release rates, and concentration levels in effluents during plant operation, AOOs, and accident conditions. The PERMSS 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 improper operation. The PERMSS includes beta and gamma radiation sensitive detectors working in redundant channels, as provided by the design of 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. Local readout and alarm panel indicators are located at specific areas in providing information on the radiological status of plant systems and function to alert personnel of abnormal conditions. The PERMSS generates signals to initiate the operation of certain safety-related equipment to control radioactive releases under AOOs and accident conditions. The COL applicant will subject the PERMSS to preoperational tests and is responsible for calibrating all skid-mounted PERMSS subsystems installed in the plant. The PERMSS includes provisions for periodic inspection of components in ensuring the operational readiness and integrity of all PERMSS subsystems.

FSAR Tier 2, Section 11.5.2 presents a description of the system; FSAR Tier 2, Section 11.5.3 describes the effluent monitoring and sampling system; and FSAR Tier 2, Section 11.5.4 presents details on process monitoring and sampling. FSAR Tier 2, Table 11.5-1 describes the provisions for sampling and monitoring, describes operational characteristics of radiation monitors, and identifies subsystems that include automatic controls features in terminating or diverting process flows and effluent releases. FSAR Tier 2, Figures 11.5-1, 12.3-72,

and 12.3-73 present process flows from the LWMS, GWMS, and SWMS to their respective release points.

FSAR Tier 2, Figure 11.2-1 describes process flows and the flow path of liquid effluent releases from the LWMS. FSAR Tier 2, Sections 6.2.3, 9.4.2, 9.4.3, 9.4.4, 9.4.5, 9.4.7, 9.4.8, and 9.4.14 describe the operation and radioactivity monitoring of ventilation systems from buildings housing radioactive systems or where radiologically controlled work zones will be established (e.g., as repair shops in maintaining contaminated equipment). FSAR Tier 2, Sections 11.5.3 and 11.5.4 identify the means to collect process and effluent samples for radiological analyses.

Building ventilation systems and gaseous waste processing systems monitored by the PERMSS, as described in FSAR Tier 2, Section 11.5.3, include:

- Reactor Containment Building
- Containment annulus ventilation system
- Fuel Building
- Nuclear Auxiliary Building
- Safeguard Building(s) – controlled areas
- Radioactive Waste Processing Building
- Access building - radiologically controlled areas
- Annulus Building
- Gaseous waste process systems
- Main condenser evacuation system

The turbine building ventilation system does not include provisions for controlling and monitoring radioactive releases. Process flows from the main condenser evacuation system and the turbine gland sealing system, which are the only sources of radioactive gases in the Turbine Building are routed and released through the plant vent stack via the nuclear auxiliary building ventilation system.

Other plant systems, not subject to ambient airborne radioactivity, are monitored for radioactivity. These systems include:

- Main steam lines
- Main condenser air removal system
- Steam generator blowdown system
- Component cooling water system
- Clean drains system

- Chemical and volume control system
- Liquid waste process system
- Fuel purification system

PERMSS subsystems perform automatic control functions, as diversion and termination of process or release flows, for the following plant systems:

- Gaseous waste processing system
- Liquid radwaste monitoring tank discharge line
- Steam generator blowdown
- Component cooling water system

The sampling activity monitoring system provides the means to collect samples and conduct specific types of analyses. The sampling system includes the sampling activity system, secondary sampling system, and the severe accident sampling system.

Provisions for sample collection and radiological analyses are given for the following systems and release points:

- Plant vent stack − noble gases, particulates, radioiodines, C-14, and tritium
- Containment building ventilation system − particulates
- Nuclear Auxiliary Building − noble gases, particulates, radioiodines
- Fuel building ventilation system − particulates, radioiodines
- Radioactive Waste Processing Building − particulates, radioiodines
- Safeguard Building − particulates, radioiodines
- Annulus ventilation system − particulates, radioiodines
- Access building ventilation system − particulates, radioiodines
- Liquid radwaste monitoring tanks − radiological analyses, including tritium
- Circulating service water system − radiological analyses, including tritium
- Fuel pool purification system − radiological analyses, including tritium
- Steam generator blowdown system − radiological analyses, including tritium
- Chilled water supply to the GWMS − radiological analyses, including tritium
- Nuclear island drains and vents system − radiological analyses, including tritium

- Nuclear sampling and severe accident systems − radiological analyses, including tritium
- Turbine drains and vents system − radiological analyses, including tritium
- Laundry room − radiological analyses, including tritium
- Solid radwaste system − radiological analyses, including tritium

In addition to the above, the LWMS, GWMS, and SWMS are equipped with the means to collect samples at specific points within each subsystem in assessing the effectiveness of treatment methods (e.g., as decontamination factors) and radiological characterizations of process streams.

FSAR Tier 2, Sections 3.2, 3.10, and 3.11 describe the seismic and quality group classification and corresponding codes and standards that apply to structures housing parts of PERMSS subsystems and environmental qualification of mechanical equipment and instrumentation.

For PERMSS subsystems that perform safety-related functions and are used to achieve safe-shutdown, FSAR Tier 2, Sections 6.2.3, 7.1.1, 7.1.2, 7.3.1, 7.4.1, 7.5.1, and 7.5.2, and 9.3.2 address the associated TMI-related items in monitoring radioactive effluents under accident conditions. Except for the specific subsystems listed below, failure of the PERMSS does not compromise safety-related systems or components and does not prevent the safe-shutdown of the plant. In addition, FSAR Tier 2, Sections 11.5.3 and 11.5.4 identify the means to collect process and effluent samples for radiological analyses as a mean of complementing instrumentation readings generated by related PERMSS subsystems. The portion of radiation monitoring subsystems that perform safety-related functions is classified as safety-related and designated a Seismic Category I, with the balance of subsystems being classified as non-seismic. PERMSS subsystems perform safety-related functions or are used for safe-shutdown, as follows:

- Initiation of the main control room isolation and supplemental filtration system upon the detection of elevated levels of airborne radioactivity in the air intake
- Steam generator isolation upon the detection of high activity levels in steam
- Containment isolation on the detection of specified radiation exposure rates in the containment
- Diversion of exhaust flows and initiation of ventilation system filtration trains upon the detection of high levels of radioactivity in exhaust ventilation systems of the:
    - Reactor Containment Building
    - Containment annulus ventilation system
    - Fuel Building
    - Nuclear Auxiliary Building

- Safeguard Buildings
- Access Building

For the Radioactive Waste Processing Building, the exhaust system is shut down manually upon detecting high levels of radioactivity in its exhaust flow.

The staff's review indicates that the applicant identified in FSAR Tier 2, Section 11.5.1 the design basis, design objectives, and design criteria for the PERMSS in compliance with NRC regulations and in conformance with NRC guidance. FSAR Tier 2, Sections 11.5.2 to 11.5.4 describe the design of the process and effluent radiological monitoring and its functions in monitoring, recording and tracking, and controlling radioactivity levels, release rates, and concentration levels in effluents during operations, AOOs, and accident conditions. The system provides the means to terminate and isolate process flows and effluent releases upon detecting elevated levels of radioactivity and includes local instrumentation readout panels and alarm functions in addition to those located in the main control room. PERMSS radiation detectors are located at various locations throughout the plant and the system provides the means to extract liquid and gaseous samples from various process and effluent streams. Sample results are evaluated and compared with NRC limits in confirming that measurement results recorded by radiation monitors are consistent, and for the purpose of assessing and quantifying radioactivity levels associated with radionuclides that are not readily detected by direct means. The staff determined that these design features are acceptable, given the requirements of 10 CFR 50.34a and 10 CFR 50.36a; 10 CFR Part 50, Appendix I; GDC 60, GDC 63, and GDC 64; and NRC guidance of RGs 1.21, 1.33, 4.15, and 1.97. Compliance with these provisions provides reasonable assurance that the design is equipped with systems and provisions to monitor radioactivity levels in plant process streams and to control and monitor liquid and effluent releases to the environment.

In FSAR Tier 2, Sections 11.5.1 and 11.5.3, the applicant states that NRC guidelines and industry guidance are endorsed by reference and are part of the design basis of PERMSS subsystems. FSAR Tier 2, Table 11.5-1 presents the expected operational range of PERMSS instrumentation and identifies provisions for radiological sampling and analyses of liquid and gaseous process and effluent streams. FSAR Tier 2, Section 9.3.2 presents a process flow drawing of the nuclear sampling system and lists process equipment serviced by the system, number of sampling points, and types of samples and process measurements. The nuclear sampling system includes the secondary sampling system and the severe accident sampling system.

The staff determined that the applicant proposed endorsed and application of the industry guidance of ANSI/HPS N13.1-1999 and ANSI N42.18-2004 and is acceptable in providing the means to sample and monitor airborne releases from building ventilation ductworks and stacks, and ensure the performance of instrumentation used for the continuous monitoring of radioactivity in effluent and process streams. In addressing the sampling and analysis of process and effluent streams, the applicant proposed measures conforming to the guidance of RGs 1.21, 1.33, and 4.15. RG 1.21 addresses the ability to perform specific types of radiological analyses, and RG 4.15 covers measures to calibrate, maintain, and inspect instrumentation used to monitor the presence of radioactivity in process and effluent streams, as well as methods to measure effluent discharge flow and radioactivity release rates. RG 1.33 identifies quality assurance provisions for PERMSS subsystems. The staff determined that the application of RGs 1.21, 4.15, and 1.33 is acceptable.

FSAR Tier 2, Section 3.2 categorizes buildings where PERMSS equipment are located. In addition, FSAR Tier 2, Section 3.10 addresses the seismic qualification of mechanical and electrical equipment, and FSAR Tier 2, Section 3.11 covers environmental qualification of mechanical and electrical equipment. The staff's evaluation of the qualifications of PERMSS mechanical and electrical equipment is presented in Section 3.11 of this report.

Once all PERMSS subsystems are installed, the COL holder will subject each to preoperational tests described in FSAR Tier 2, Section 14.2 and associated QA tests using the guidance in RG 1.143 and QA program described in FSAR Tier 2, Chapter 17. The QA provisions address the design, fabrication, procurement, installation, testing of equipment and operational integration with skid-mounted monitoring instrumentation and sampling equipment and proper interface with plant systems. A COL applicant referencing the U.S. EPR certified design should describe those aspects of the QA Program associated with the design, procurement, construction, and operational phases of the PERMSS. This requirement is noted in COL Information Item 17.2-1, as identified in FSAR Tier 2, Table 1.8-2. The COL holder will be responsible for ensuring that the initial installation of monitoring and sampling systems complies with the requirements of 10 CFR 20.1406 and conforms to guidance of NRC Bulletin 80-10 and RG 4.21 in avoiding the cross contamination of nonradioactive systems and unmonitored and uncontrolled radioactive releases into the environment. Skid-mounted equipment and its connections to permanently installed systems would be subjected to pressure and leak testing using guidelines described in SRP Sections 11.2 and 11.3 and technical guidance of RG 1.143.

Under the requirements of 10 CFR 50.34(f)(2)(xvii) (TMI-related item II.F.1) and 10 CFR 50.34(f)(2)(xxvii) (TMI-related item III.D.3.3), the applicant must provide the means to monitor radiation and radioactivity levels for routine operating and accident conditions, in compliance with the requirements of GDC 63 and GDC 64 using the guidance of NUREG-0718 and NUREG-0737, RG 1.97, and SRP Section 7, BTP 7-10. FSAR Tier 2, Sections 12.3.4, "Area Radiation and Airborne Radioactivity Monitoring Instrumentation," and 12.3.5, "Dose Assessment," describe provisions for the conduct of radiological monitoring following an accident. FSAR Tier 2, Section 13.5, "Plant Procedures," calls for a COL applicant to prepare emergency procedures under COL Information Item 13.5-1, as described in FSAR Tier 2, Table 1.8-2. Section 12.3 of this report presents an evaluation of the high-range containment radiation monitors in the context of TMI-related Item II.F.1 under 10 CFR 50.34(f)(2)(xvii). FSAR Tier 2, Sections 1.9, "Conformance with Regulatory Criteria"; 7.1.1; 7.1.2; 7.5.1; 7.5.2; 9.3.2; and 13.5 provide more specific information on the applicant's approach in complying with TMI-related requirements using the provisions of RG 1.97 and SRP Section 7, BTP 7-10. FSAR Tier 2, Section 9.3.2 addresses Type E variables in defining operational ranges of gaseous effluent radiation monitors used to assess releases during accidents. The applicant has adopted the provisions of BTP 7-10 in defining instrumentation response ranges, given Revision 4 of RG 1.97 (FSAR Tier 2, Tables 7.1-2, "I&C System Requirements Matrix"; 1.9-2, "U.S. EPR Conformance with Regulatory Guides"; and 1.9-3, "U.S. EPR Conformance with TMI Requirements (10 CFR 50.34(f)) and Generic Issues (NUREG-0933)"). Under COL Information Item 7.1-1, the COL holder will be responsible for updating the initial inventory of accident monitoring variables given in FSAR Tier 2, Table 7.5-1, "Initial Inventory of Post-Accident Monitoring Variables," with a final list prepared upon completion of emergency procedures prior to fuel load.

Finally, the staff has determined that some of these aspects will be integrated as part of the engineering process described in FSAR Tier 1, Section 3.7, "Accident Monitoring

Instrumentation." Section 7.5 of this report presents the staff's evaluation of the provisions associated with compliance with TMI-related items using the guidance of RG 1.97 and BTP 7-10 given the requirements of 10 CFR 50.34(f)(2)(xvii) and 10 CFR 50.34(f)(2)(xxvii) and GDC 60 and GDC 64.

FSAR Tier 2, Section 11.5.1 describes the design objectives of PERMSS subsystems used to monitor the air intake of the main control room in complying with GDC 19, "Control Room," and 10 CFR Part 20 using the guidance of RGs 8.8 and 8.10. FSAR Tier 2, Figure 12.3-74, "Access, Nuclear Auxiliary, and Radioactive Waste Buildings Airborne Monitoring," describes the main control room ventilation system, filter trains, and locations of radiation monitors on air intakes. The description of the monitoring system and compliance with NRC regulations under 10 CFR 50.34(f)(2)(xxviii) (TMI-related item III.D.3.4) are presented in FSAR Tier 2, Sections 1.8.1, "COL Information Items"; 6.4, "Habitability Systems"; 9.4.1, "Main Control Room Air Conditioning System"; and 12.3.4. The design provides the means to initiate the isolation of the outside air intake and exhaust dampers and startup of the emergency air filtration system upon the detection of elevated levels of radioactivity in the air intake. FSAR Tier 2, Table 1.8-2 includes COL Information Item 6.4-4 to confirm that the GDC 19 dose limit of 0.05 Sv (5 rem) is met, and COL Information Item 6.4-2 to address the development of emergency radiological procedures. The staff's evaluations of these systems and habitability of the main control room are presented in Sections 6.4, 9.4, and 12.3 of this report.

As part of their operation, the PERMSS do not generate any radioactive materials associated with their functions, since they are used to control and monitor liquid and gaseous effluents discharged to the environment. Fluid samples extracted from process and effluent streams are returned to their origins and clean process fluids, such as water or air, used to purge or flush sampling lines are routed to the most appropriate systems, such as the LWMS or GWMS, and are not discharged locally. As a result, this aspect of the evaluation focuses only on whether such provisions comply with requirements of 10 CFR 20.1406 and conform to the guidance of RGs 4.21 and NRC Bulletin 80-10 and RG 1.143 as interfaces with the LWMS and GWMS. The staff determined that these features are acceptable in avoiding the contamination of nonradioactive systems during the operation of sampling systems, and avoiding unmonitored and uncontrolled releases of radioactivity in the environment.

Design Considerations

In reviewing FSAR Tier 2, Revision 1, the staff could not confirm that some aspects of the PERMSS design comply with NRC regulatory requirements and conform to NRC guidance. These aspects included inconsistencies in system interfaces shown in drawings, differences between system descriptions and drawings to which the system descriptions referred as supporting information, and lack of detail describing response characteristics, detection levels, use of radioactive check sources, types of instrument failure indications, etc. In RAIs, the staff requested that the applicant provide clarifications for technical completeness, provide details supporting design bases and design descriptions in demonstrating compliance with regulatory requirements, revise and update system drawings for consistency with system descriptions, and revise technical and regulatory references. Depending on the response from the applicant, the RAIs are either listed as satisfactory responses and resolved by the staff, or left open pending the receipt of responses or issuance of follow-up RAIs. The following subsections present the results of the staff evaluation and, when necessary, list follow-up RAIs to the applicant.

FSAR Tier 2, Section 11.5.1 describes the design basis of the PERMSS. However, the staff determined that the design basis does not acknowledge SRP acceptance criteria, such as implications of the use of Revision 3 vs. Revision 4 of RG 1.97 in defining operating ranges for Type E variables, and NRC Bulletin 80-10. In RAI 273, Question 11.05-1, the staff requested that the applicant review Sections 11.5 and BTP 7-10 of the SRP and RG 1.206 and confirm that the design basis is in conformance with applicable SRP criteria and, if not, provide the justification that the alternate approach provides acceptable methods of compliance with NRC regulations. **RAI 273, Question 11.05-1, which is associated with the above request, is being tracked as an open item.**

FSAR Tier 2, Sections 11.5.2, 11.5.3 and 11.5.4 describe the various functions and components of PERMSS subsystems. The staff determined that descriptions indicate the information is presented inconsistently. Several components described in the text and FSAR Tier 2, Table 11.5-1 are not shown in a corresponding figure, or are not discussed in the text but shown in a figure. In RAI 273, Question 11.05-2, the staff requested that the applicant review the following observations and address them throughout FSAR Tier 2, Section 11.5. The observations include:

- The descriptions do not address subsystem features to perform functional channel checks and source checks, and whether subsystems need to be brought off line to perform the surveillance and functional checks called for by standard radiological effluent controls (see GL 89-01 and NUREG-1301).

- The design features do not describe provisions and methods for offline radiation detectors to be purged or flushed with clean air or water, which portions of the LWMS and GWMS systems will contaminated purge or flush fluids be returned to, and provisions to prevent the cross-contamination of purge and flush supply systems.

- The design features do not describe the calibration of subsystems under different operational conditions (e.g., routine, AOOs, and accident) given expected differences in radionuclide distributions; and how raw instrument output data will be converted to meaningful radiological units in determining compliance with 10 CFR Part 20, Appendix B, Table 2, and 10 CFR Part 50, Appendix I. Also the description does not address how the quality assurance/quality control (QA/QC) process will be applied to verify and validate computer codes and algorithms purchased through vendors or supplied with PERMSS instrumentation.

- Subsystem figures and diagrams do not show sampling locations for liquid and gaseous process and effluent streams, and sample conditioning for specific systems to minimize sample loss and distortion of chemical and physical compositions. Also, the relationship with FSAR Tier 2, Section 9.3.2 is not well established in understanding shared use of equipment and sampling functions among LWMS and GWMS subsystems.

- The design features do not address the derivation of lower limits of detection for liquid and gaseous effluent monitors and detection sensitivities for liquid and gaseous process monitors.

- The design features do not address the placement of isolation or diversion valves and radiation detectors on process and effluent piping/ductwork in order to ensure the timely closure of such valves upon the detection of elevated radioactivity levels in liquid and

gaseous effluent streams in terminating releases and isolating process streams from further contamination.

- The design features of the liquid and gaseous monitoring systems do not reflect how the failure of a radiation detector or its corresponding channel is indicated on local and control room panels. For example, does a detector or channel failure result in a high or zero instrumentation reading? Are there specific warnings differentiating various types of equipment failures, such as loss of detector only, loss of an entire channel, or loss of sampling flow from a process or effluent stream?

RAI 273, Question 11.05-2, which is associated with the above request, is being tracked as an open item.

The staff determined that FSAR Tier 2, Sections 11.5.3.1, "Gaseous Effluents," and 11.5.3.2 did not acknowledge the NEI 07-09A ODCM Template as an alternate means of conforming to the guidance of with GL 89-01 and SECY-05-0197 until a plant and site-specific ODCM is developed under a license condition. In RAI 273, Question 11.05-3, the staff requested that the applicant address this omission in the FSAR. In a November 6, 2009, response to RAI 273, Question 11.05-3, the applicant presented additional information on the options for developing an ODCM for controlling, monitoring, and reporting liquid and gaseous effluent releases to the NRC. The additional information acknowledges the use of NEI 07-09A ODCM Template as an option to the development of a plant-specific ODCM by a COL applicant. The applicant proposed revising FSAR Tier 2, Sections 11.5.3.1 and 11.5.3.2 to reference the NEI generic ODCM template, GL 89-01, and NRC SECY-05-0197 as supporting documents. The applicant also proposed revising FSAR Tier 2, Table 1.8-2, to include references to the NEI 07-09A ODCM Template, GL 89-01, and SECY-05-0197 in COL Information Item 11.5-1. The staff finds the applicant's response and additional information acceptable. **RAI 273, Question 11.05-3, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

In FSAR Tier 2, Section 11.5.4.3, "Steam Generator Blowdown Radiation Monitoring System," the applicant describes the radiation monitoring system for the SG blowdown. The discussion refers to releases occurring via Turbine Building (TB) roof ventilators in the event of SG tube ruptures. The staff determined that FSAR Tier 2, Figure 11.5-1 did not identify this discharge path, as all gaseous effluent releases are shown to be discharged via the plant vent stack, and FSAR Tier 2, Table 11.5-1 identifies this radiation monitor as a liquid effluent monitor and not as a gaseous effluent monitor. In RAI 273, Question 11.05-4, the staff requested that the applicant provide further information on whether releases from TB roof ventilators are unmonitored and uncontrolled release points to the environment. If the system design allows the means to determine radionuclide distributions and concentrations during and after a SG tube rupture, the staff requested that the applicant describe methods and sources of radiological information with which to characterize such releases and assess offsite doses to members of the public. In a November 12, 2009, response to RAI 273, Question 11.05-4, the applicant presented information clarifying that TB roof ventilators are not gaseous effluent discharge points and that the gaseous phase of steam generator blowdowns is routed to the turbine where gases are captured by the main condenser evacuation system. FSAR Tier 2, Section 11.5.4.3 will be revised to remove TB roof ventilators as release points and state that the gaseous phase of SG blowdowns is processed by the main condenser evacuation system. The staff determined that the applicant's response and proposed revisions to the FSAR are acceptable. **RAI 273,**

Question 11.05-4, is being tracked as a confirmatory item and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Sections 11.5.2 to 11.5.4 present the descriptions of PERMSS subsystems, and Table 11.5-1 lists radiation monitoring instrumentation used to monitor process and effluent streams. However, the staff determined that the subsystems given in FSAR Tier 2, Table 11.5-1 and Figure 11.5-1 of the descriptions were inconsistent and incomplete. In RAI 273, Question 11.05-5, the staff requested that the applicant review the following observations and address them throughout FSAR 2, Section 11.5. The observations include:

- Several PERMSS subsystems given in FSAR Tier 2, Table 11.5-1 are not described in FSAR Tier 2, Sections 11.5.2 to 11.5.4. FSAR Tier 2, Section 11.5.4 provides descriptions for six subsystems with in-process radiation detectors, while FSAR Tier 2, Table 11.5-1 lists 15 subsystems. Similarly, there are differences between the text and tables in nomenclatures used to describe subsystems (e.g., condenser air removal RMS (FSAR Tier 2, Section 11.5.4.2) vs. condenser evacuation system (FSAR Tier 2, Table 11.5-1)).

- FSAR Tier 2, Table 11.5-1 does not differentiate between safety and non-safety-related PERMSS subsystems.

- FSAR Tier 2, Table 11.5-1 does not indicate which radiation detectors will be equipped with built-in radioactive check sources for the purpose of performing channel checks.

- The operational range noted for the upstream radiation monitor of the GWMS delay beds is presented in a meaningless radiological unit. The range should be expressed in µCi/cc instead of counts per second (cps).

- FSAR Tier 2, Section 10.4.3.2.2, "Component Description," states that the exhaust from the turbine gland seal exhausters is routed to the "turbine building air removal system" where they are monitored for radioactivity. FSAR Tier 2, Table 11.5-1 does not list a radiation monitor for the turbine air removal system. Accordingly, the design descriptions in FSAR Tier 2, Sections 10.4.3, "Turbine Gland Sealing System," and 9.4.4 should be reviewed and corrected to indicate that there is no turbine building air removal system and that instead the exhaust from the turbine gland seal exhausters is a system exhaust that is directed and discharged via the Nuclear Auxiliary Building exhaust.

- For the Nuclear Auxiliary Building exhaust, FSAR Tier 2, Figure 9.3.4-2, "Coolant Purification System," shows a radiation detector on the ductwork going into Cell 1 of the NABVS, but it is not clear if this radiation detector is an extra one or it is the same as that shown in FSAR Tier 2, Figure 11.3-1, given its location.

- FSAR Tier 2, Figure 9.3.4-2 shows a radiation detector in Cell 3 of the NABV, but it is not clear if this radiation detector is part of an existing PERMSS subsystem and not described in FSAR Tier 2, Sections 11.5 and 9.4.3, or is part of another system, such as used for monitoring ambient airborne radioactivity levels in radiologically controlled areas.

- FSAR Tier 2, Figure 9.4.3-3, "Nuclear Auxiliary Building Exhaust Filtration Trains Subsystem," does not include a radiation detector in the Reactor Building Exhaust (last

input on lower left side of drawing) and it appears that this input to the system should be instead identified as Containment Building Vent Exhaust System.

- FSAR Tier 2, Table 11.5-1 implies that there are two continuous noble gas monitors for the containment building ventilation purge subsystem, but FSAR Tier 2, Figure 9.4.7-2, "Containment Building Low Flow and Full Flow Purge Exhaust Subsystem," shows one monitor on the low flow purge exhaust and none for the full flow purge exhaust.

- FSAR Tier 2, Figure 11.5-1 shows a radiation monitor on the Turbine Building Plant drainage line, but this monitor is not given in FSAR Tier 2, Table 11.5-1.

- FSAR Tier 2, Table 11.5-1 does not indicate any automatic control features for GWMS, but FSAR Tier 2, Section 11.3.3.1, "Discharge Requirements," states that discharge requirements consider gaseous waste activity and "automatic isolation settings."

- FSAR Tier 2, Table 11.5-1 does not indicate any automatic control features for the NABVS, but FSAR Tier 2, Section 9.4.3.2.1, "General Description," states that the exhaust from the NABVS is diverted to an iodine filtration system upon receiving a radiation alarm.

- FSAR Tier 2, Table 11.5-1 does not indicate any automatic control features for the SBVS, but FSAR Tier 2, Section 9.4.5.1, "Design Bases," states that the exhaust from the SBVS is diverted to charcoal filtration beds upon receiving a radiation alarm.

- FSAR Tier 2, Table 11.5-1 presents operational ranges for gaseous and liquid process and effluent radiation monitors. This information appears incomplete. For gaseous process and effluent monitors, the supporting text to this table does not present the technical basis for the stated operational ranges for those monitors that are included and does not provide corresponding sets of values for the plant vent stack radiation monitor used in confirming compliance with 10 CFR Part 20, Appendix B, Table 2 effluent concentration limits. For particulates, iodines, and tritium expected in gaseous streams, FSAR Tier 2, Table 11.5-1 does not include operational ranges and surrogate radionuclides for the corresponding radiation monitoring systems. The above comments also apply to radiation monitors assigned to liquid process and effluent streams.

- FSAR Tier 2, Table 11.5-1 presents operational ranges for gaseous process and effluent radiation monitors. This information appears incomplete. The description does not indicate whether the plant vent stack radiation monitoring system will be used to monitor radioactivity levels during normal operations and accident conditions with a sufficient range to encompass the entire range of effluent concentration levels given in RG 1.97 (Revision 3) and BTP 7-10 (SRP, NUREG-0800) for Type E variables, as they relate to compliance with 10 CFR 50.34(f)(2)(xxvii) and (xxvii). If multiple radiation monitoring components are part of the design of the plant vent stack monitor to comply with the operational ranges of RG 1.97, the FSAR should describe the additional radiation monitoring components and address overall system accuracies in the overlapping ranges of components in both systems when operating in the upper end of expected radioactivity levels.

In a November 12, 2009, response to RAI 273, Question 11.05-5, the applicant presented additional information describing the operational features of the PERMSS. The applicant

proposed to expand the descriptions and listing of radiation monitoring and sampling systems to reflect all effluent and process systems. The expanded information describes the types of radiation detectors, provisions for local grab sampling, safety- and non-safety-related automatic control functions, whether detectors are equipped with radioactive check sources, operational ranges for noble gases, particulates and radioiodines, and features to perform operational functional checks. The descriptions clarify the process and exhaust flows and functions of radiation monitors in performing automatic control functions for the Safeguard Building (SB), Fuel Building (FB), and NAB ventilation systems. The information describes the approach used in demonstrating conformance with the guidance of RG 1.97 and SRP Section 7, BTP 7-10 as they related to TMI-related requirements. Revisions will be made to FSAR Tier 2, Sections 11.5.3, 11.5.4, 9.4.3.2.1, and 10.4.3.2.2, and Table 11.5-1. The staff finds the applicant's response and proposed FSAR revisions acceptable in that they reconciled the apparent inconsistencies and provide the missing information. **RAI 273, Question 11.05-5, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Sections 11.5.2 to 11.5.4 present the descriptions of PERMSS subsystems, and Table 11.5-1 lists radiation monitoring instrumentation used to monitor airborne effluent streams from the fuel building ventilation system, as described in FSAR Tier 2, Section 9.4.2. Of the subsystems given in FSAR Tier 2, Table 11.5-1 and FSAR Tier 2, Figures 11.5-1 and 9.4.2-1, "Fuel Building Ventilation System," the staff determined that the descriptions were inconsistent and incomplete. In RAI 273, Question 11.05-6, the staff requested that the applicant review the following observations and address them in FSAR Tier 2, Section 11.5. The observations include:

- FSAR Tier 2, Table 11.5-1 states that the FBVS radiation monitor isolates the ventilation system on high radioactivity levels. However, FSAR Tier 2, Section 9.4.2.1, "Design Bases," and FSAR Tier 2, Figure 9.4.2-1 show a radiation monitor only on the exhaust flow from Cell 5 and none on Cell 4 of the FBVS, but the FSAR states that iodine radioactivity is detected separately in each cell and each cell services about half of the FB's ventilation needs. Similarly, the exhaust from Cell 5 leading to the safeguard building ventilation system does not show a radiation monitor and isolation dampers on the line going to the SBVS. Accordingly, system descriptions should be reviewed and revised as it is not clear if there is a need to show other radiation monitors on the exhaust line from Cell 4 before connecting to its exhaust shaft. Moreover, there is a need to clarify the isolation of the FBVS given the connection to the SBVS, since the design basis implies a full isolation of the FBVS on detection of high radiation levels in the exhaust duct of Cells 4 and 5.

- FSAR Tier 2, Table 11.5-1 states that the FBVS radiation monitor isolates the ventilation system on high radioactivity levels, but FSAR Tier 2, Section 9.4.2.1 and FSAR Tier 2, Figure 9.4.2-1 show a radiation monitor only on the exhaust flow from Cell 5 and none on Cell 4 of the FBVS. Accordingly, the Automatic Control Features (ACF) provisions of FSAR Tier 2, Table 11.5-1 for the FBVS should be reviewed and revised to note whether the isolation of FB Cells 4 and 5 is part of the ACF design features for that radiation monitor.

- FSAR Tier 2, Section 9.4.2 does not refer to FSAR Tier 2, Section 11.5 for the associated airborne process radiation monitoring systems. FSAR Tier 2,

Section 9.4.2.5, "Instrumentation Requirements," refers to FSAR Tier 2, Table 9.4.1-1, "Minimum Instrumentation, Indication, and Alarm Features for ESF Filter Systems," for details on instrumentation, but this table addresses generic ESF features and not those of the FBVS. Accordingly, FSAR Tier 2, Sections 11.5 and 9.4.2 should be reviewed and revised to ensure a consistent use of internal references on radiation instrumentation design features in controlling airborne radioactivity releases via the plant vent stack.

In a November 12, 2009, response to RAI 273, Question 11.05-6, the applicant presented additional information describing the operational features of the PERMSS. The applicant proposed to clarify the descriptions of the process and exhaust flows and functions of radiation monitors in performing automatic control functions for SB, FB, and NAB ventilation systems. Revisions will be made to FSAR Tier 2, Section 9.4.2.5 and FSAR Tier 2, Table 11.5-1. The staff finds the response and additional information acceptable. **RAI 273, Question 11.05-6, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Sections 11.5.2 to 11.5.4 present the descriptions of PERMSS subsystems, and Table 11.5-1 lists radiation monitoring instrumentation used to monitor airborne effluent streams from the nuclear auxiliary building ventilation system, as described in FSAR Tier 2, Section 9.4.3. Subsystems given in FSAR Tier 2, Table 11.5-1 and FSAR Tier 2, Figures 11.5-1 and 9.4.3-2, of the "Nuclear Auxiliary Building Air Supply and Exhaust Subsystem" to 9.4.3-4, "Nuclear Auxiliary Building Exhaust Iodine Filtration Train Subsystem," the staff determined that the descriptions were inconsistent and incomplete. In RAI 273, Question 11.05-7, the staff requested that the applicant review the following observations and address them in the FSAR. The observations include:

- FSAR Tier 2, Table 11.5-1 does not identify the ACF of the radiation monitor for the NABVS radiation monitoring system. FSAR Tier 2, Section 9.4.3, however, indicates that if elevated radiation levels are detected, the NABVS exhaust flow is diverted to the iodine filtration train prior to discharge via the plant vent stack. Accordingly, the ACF provisions of FSAR Tier 2, Table 11.5-1 for the NABVS should be reviewed and revised to note whether the isolation of NABVS Cells 1, 2 and 3 is part of the ACF design features for that radiation monitor.

- FSAR Tier 2, Section 9.4.3.5 provides information on instrumentation requirements. However, FSAR Tier 2, Section 9.4.3.5 does not refer to FSAR Tier 2, Section 11.5 and FSAR Tier 2, Table 11.5-1 for specific details on the associated radiation monitoring equipment. Accordingly, FSAR Tier 2, Sections 11.5 and 9.4.3 should be reviewed and revised to ensure a consistent use of internal references on radiation instrumentation design features in controlling airborne radioactivity releases via the plant vent stack.

- In support to FSAR Tier 2, Table 11.5-1, Section 11.5.3.1 should list all radiological exhaust ventilation systems supported by radiation monitoring instrumentation and sampling systems. Accordingly, FSAR Tier 2, Sections 9.3, 9.4, 11.2, 11.3, 11.4, and 11.5 should be reviewed and revised to ensure a complete and consistent presentation of all systems serviced by radiation instrumentation in controlling and monitoring airborne radioactivity releases via the plant vent stack.

In a November 12, 2009, response to RAI 273, Question 11.05-7, the applicant presented additional information describing these operational features of the PERMSS. The applicant proposed to clarify the descriptions of the process and exhaust flows and functions of radiation monitors in performing automatic control functions for the RB, SB, FB, and NAB ventilation systems, and confirm internal system cross-references of figures and tables in FSAR Tier 2. Revisions will be made to FSAR Tier 2, Sections 11.2, 11.3, 11.4, 11.5, and 9.4.3.5, Figure 9.4.3-3, and Table 11.5-1. The staff finds the response and additional information acceptable. **RAI 273, Question 11.05-7, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Sections 11.5.2 to 11.5.4 present the descriptions of PERMSS subsystems, and FSAR Tier 2, Table 11.5-1 lists radiation monitoring instrumentation used to monitor airborne effluent streams from the safeguard building controlled-area ventilation system, as described in FSAR Tier 2, Section 9.4.5. Of the subsystems given in FSAR Tier 2, Table 11.5-1 and FSAR Tier 2, Figures 11.5-1 and 9.4.5-2, "Safeguard Buildings Exhaust Air Subsystem," the staff determined that the descriptions were inconsistent and incomplete. In RAI 273, Question 11.05-8, the staff requested that the applicant review the following observations and address them in the FSAR. The observations include:

- FSAR Tier 2, Table 11.5-1 does not identify the ACF of the radiation monitor for the SBVS radiation monitoring system. However FSAR Tier 2, Section 9.4.5 indicates that if elevated radiation levels are detected, the SBVS exhaust flow is diverted to the iodine filtration train located in the FB prior to discharge via the plant vent stack. FSAR Tier 2, Sections 9.4.5.1 and 9.4.5.2.3, "System Operation," state that in the event of an accident in the FB or RB, the exhaust flows from these systems are diverted to the iodine train of the SBVS. However, it is not clear if all stated isolation and diversion functions of exhaust flows from these systems are automatic or whether some involve manual operation for the described abnormal operating conditions and accidents. Accordingly, the ACF provisions of FSAR Tier 2, Table 11.5-1 for the SBVS should be reviewed and revised to distinguish the automatic isolation of SBVS dampers in directing exhaust to the SBVS iodine filtration train, and isolation features (automatic or manual as the case may be) for abnormal operations and accident conditions occurring in the FB and RB but which depend on the design features of the SBVS.

- Although FSAR Tier 2, Table 11.5-1 identifies the use of a multi-function process radiation monitor, its location could not be readily determined in FSAR Tier 2, Figure 9.4.5-2. Accordingly, FSAR Tier 2, Figure 9.4.5-2 should be reviewed to confirm whether its location is indicated and, if not, it should be added to the figure to ensure a complete presentation of the system.

- FSAR Tier 2, Section 9.4.5.5, "Instrumentation Requirements," provides information on instrumentation requirements. However, FSAR Tier 2, Section 9.4.5.5 does not refer to FSAR Tier 2, Section 11.5 and FSAR Tier 2, Table 11.5-1 for specific details on the associated radiation monitoring equipment. Accordingly, FSAR Tier 2, Sections 11.5 and 9.4.5 should be reviewed and revised to ensure a consistent use of internal references on radiation instrumentation design features in controlling airborne radioactivity releases via the plant vent stack.

In a November 12, 2009, response to RAI 273, Question 11.05-8, the applicant presented additional information describing the operational features of the PERMSS. The applicant

proposed to clarify the descriptions of the process and exhaust flows and functions of radiation monitors in performing automatic control functions for the SB, FB, and NAB ventilation systems, and number and location of radiation monitors. Revisions will be made to FSAR Tier 2, Section 9.4.5.5, Figure 9.4.5-2, and Table 11.5-1. The staff finds the applicant's response and proposed FSAR revisions acceptable. **RAI 273, Question 11.05-8, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Sections 11.5.2 to 11.5.4 present descriptions of PERMSS subsystems, and FSAR Tier 2, Table 11.5-1 lists radiation monitoring instrumentation used to monitor airborne effluent streams from the radioactive waste building ventilation system, as described in FSAR Tier 2, Section 9.4.8. Of subsystems given in FSAR Tier 2, Table 11.5-1 and FSAR Tier 2, Figures 11.5-1 and 9.4.8-1, "Radioactive Waste Building Ventilation System Air Supply," and 9.4.8-2, "Radioactive Waste Building Ventilation System Exhaust Air Station," the staff determined that the descriptions were inconsistent and incomplete. In RAI 273, Question 11.05-9, the staff requested that the applicant review the following observations and address them in the FSAR. The observations include:

- In FSAR Tier 2, Table 11.5-1, the entry on Automatic Control Features for the RWBVS radiation monitoring system should state "n/a" or "none" as opposed to the ambiguous entry shown as "---". In addition, there is a need to ensure a consistent use of system nomenclature between figures and descriptions. For example, FSAR Tier 2, Sections 11.5 and 9.4.8 do not refer to RWBVS Cells 1 and 2 exhausts, while FSAR Tier 2, Figure 9.4.8-2 makes a distinction in differentiating sources with different radioactivity levels. Accordingly, FSAR Tier 2, Sections 11.5 and 9.4.8 should be reviewed and revised for a consistent presentation of design features and nomenclatures used in demonstrating compliance with effluent concentration limits of 10 CFR Part 20, Appendix B.

- FSAR Tier 2, Sections 11.5 and 9.4.8 figures and descriptions, do not clearly indicate if a radiation detector is missing or one needs to be relocated in FSAR Tier 2, Figure 9.4.8-2 on the line coming from the RWBVS Processing Rooms (Line C from Sheet 1 to Sheet 2). In contrast, the corresponding lines from RWBVS Cells 1 and 2 show a radiation detector for Lines A and B from Sheet 1 to Sheet 2 before the filter trains. Accordingly, FSAR Tier 2, Sections 11.5 and 9.4.8 should be reviewed and revised to ensure a consistent presentation of design and operational features to aid in understanding how RWBVS radiation monitors function and alert operators when effluent releases could exceed the effluent concentration limits of 10 CFR Part 20, Appendix B.

- In FSAR Tier 2, Table 11.5-1, the entry for the RWBVS radiation monitoring system indicates that there are two iodine radiation monitors and four aerosol radiation monitors. FSAR Tier 2, Figures 11.5-1 and 9.4.8-2 does not clearly indicate the placement of these monitors, given that there are three input flows to the RWBVS exhaust, one for Cell 1 and one for Cell 2 (Lines A and B from Sheet 1 to Sheet 2), and one for the RWBVS Processing Rooms (Line C from Sheet 1 to Sheet 2). There is no rationale provided for having one set of radiation monitors before each particulate/charcoal train for Cells 1 and 2 vent exhausts and none after it, and no explanation for the placement of the Processing Rooms monitor after the particulate/charcoal train with none before it.

Accordingly, FSAR Tier 2, Sections 11.5 and 9.4.8 should be reviewed and revised to provide the technical rationale for the placement of radiation monitoring instrumentation in ensuring that effluent releases do not exceed the effluent concentration limits of 10 CFR Part 20, Appendix B.

- FSAR Tier 2, Section 9.4.8.5, "Instrumentation Requirements," provides information on instrumentation requirements. However, FSAR Tier 2, Section 9.4.8.5 does not refer to FSAR Tier 2, Section 11.5 and FSAR Tier 2, Table 11.5-1 for specific details on the associated radiation monitoring equipment. Accordingly, FSAR Tier 2, Sections 11.5 and 9.4.8 should be reviewed and revised to ensure a consistent use of internal references on radiation instrumentation design features in controlling airborne radioactivity releases via the plant vent stack.

In a November 12, 2009, response to RAI 273, Question 11.05-9, the applicant presented additional information describing the operational features of the PERMSS for the RWB ventilation system. The applicant proposed to clarify the descriptions of the exhaust flows and functions and placement of radiation monitors in the exhaust system. Revisions will be made to FSAR Tier 2, Section 9.4.8.5, Figure 9.4.8-2, and FSAR Tier 2, Table 11.5-1. The staff finds the applicant's response and the proposed FSAR revisions acceptable. **RAI 273, Question 11.05-9, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Sections 11.5.2 to 11.5.4 present the descriptions of PERMSS subsystems, and FSAR Tier 2, Table 11.5-1 lists radiation monitoring instrumentation used to monitor airborne effluent streams from the access building ventilation system, as described in FSAR Tier 2, Section 9.4.14. Of subsystems given in FSAR Tier 2, Table 11.5-1 and FSAR Tier 2, Figures 11.5-1 and 9.4.14-2, "Access Building Ventilation System - Supply and Exhaust Air Subsystem," the staff determined that the descriptions were inconsistent and incomplete. In RAI 273, Question 11.05-10, the staff requested that the applicant review and address the following observations FSAR Tier 2, Section 11.5. The observations include:

- FSAR Tier 2, Table 11.5-1 identifies only a sampling system for the ABVS, while FSAR Tier 2, Figure 9.4.14-2 identifies a radiation monitor before the filtration train. Accordingly, FSAR Tier 2, Sections 11.5 and 9.4.14 should be reviewed and revised to ensure a consistent description of radiation instrumentation and design features used in controlling airborne radioactivity releases via the plant vent stack.

- FSAR Tier 2, Section 9.4.14.6, "Instrumentation Requirements," provides information on instrumentation requirements for the ABVS. However, FSAR Tier 2, Section 9.4.14.6 does not refer to FSAR Tier 2, Section 11.5 and FSAR Tier 2, Table 11.5-1 for specific details on the associated radiation monitoring equipment for the ABVS. Accordingly, FSAR Tier 2, Sections 11.5 and 9.4.14.6 should be reviewed and revised to ensure a consistent use of internal references on radiation instrumentation design features in controlling airborne radioactivity releases via the plant vent stack.

In a November 12, 2009, response to RAI 273, Question 11.05-10, the applicant presented additional information describing the operational features of the PERMSS for the AB ventilation system. The applicant proposed to clarify the descriptions of the exhaust flows and functions and placement of radiation monitors and sampling systems in the exhaust system. Revisions will be made to FSAR Tier 2, Section 9.4.14.6, Figure 9.4.14-2, and Table 11.5-1. The staff

finds the applicant's response and proposed FSAR revisions acceptable. **RAI 273, Question 11.05-10, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Sections 11.5.2 to 11.5.4 present descriptions of the PERMSS subsystems, and FSAR Tier 2, Table 11.5-1 lists radiation monitoring instrumentation used to monitor airborne effluent streams from the containment building ventilation system, as described in FSAR Tier 2, Section 9.4.7. Of subsystems given in FSAR Tier 2, Table 11.5-1 and FSAR Tier 2, Figures 11.5-1 and 9.4.7-1, "Containment Building Low Flow and Full Flow Purge Supply Subsystem," to 9.4.7-5, "Containment Building Service Compartments Cooling Subsystem," the staff determined that descriptions were inconsistent and incomplete. In RAI 273, Question 11.05-11, the staff requested that the applicant review and address the following observations in FSAR Tier 2, Section 11.5. The observations include:

- In FSAR Tier 2, Table 11.5-1, the two entries for the CBVS radiation monitoring systems indicate that there are a total of four noble gas monitors (two process and two effluents), two aerosol monitors, two iodine monitors, and one tritium monitor, all as process monitors. FSAR Tier 2, Figures 11.5-1, 9.4.7-2 and 9.4.7-3, "Containment Building Internal Filtration Subsystem," does not clearly indicates that the placement of these monitors given that there are two input flows to the CBVS exhaust, one from the low flow and one from the full flow purge exhaust. The figures show the placement of radiation monitors at three locations. The locations are: One out of the low flow purge exhaust; one after the CBVS dual particulate/charcoal filter train servicing only the low flow purge exhaust; and one before the single particulate/charcoal filter train of the CBVS internal filtration subsystem. There is no rationale provided for the placement of radiation monitors at these locations, no explanation for the lack of a radiation monitor on the full flow purge exhaust line before being routed to the nuclear auxiliary building ventilation system, and no details are provided in reconciling their locations shown in FSAR Tier 2, Figures 9.4.7-2 and 9.4.7-3. Accordingly, FSAR Tier 2, Sections 11.5 and 9.4.7 should be reviewed and revised to provide the technical rationale for the number and placement of radiation monitoring instrumentation in ensuring that effluent releases do not exceed the effluent concentration limits of 10 CFR Part 20, Appendix B.

- In FSAR Tier 2, Table 11.5-1, the entries on ACF for the CBVS radiation monitoring system are left blank with no details as to whether this system includes features that perform automatic functions upon receiving a high radiation signal. FSAR Tier 2, Sections 9.4.3, 9.4.5, and 9.4.7 indicates that if elevated radiation levels are detected, the CBVS exhaust flow can be diverted to the safeguard building controlled-area ventilation system and nuclear auxiliary building ventilation system. However, it is not clear if the isolation and diversion functions of exhaust flows from the CBVS are automatic and based only on responses of the monitors given for the CBVS, are dependent on conditions associated with the operations of the monitors assigned to the SBVS and NABVS, or involve manual operations based on the described abnormal operating conditions and accidents. Accordingly, the ACF provisions of FSAR Tier 2, Table 11.5-1 for the CBVS should be included to distinguish the automatic isolation of CBVS dampers in directing exhaust flows to the SBVS and NABVS, and isolation features (automatic or manual as the case may be) for abnormal operations and accident conditions in demonstrating compliance with effluent concentration limits of 10 CFR Part 20, Appendix B.

- FSAR Tier 2, Section 9.4.7.5, "Instrumentation Requirements," provides information on instrumentation requirements for the CBVS. However, FSAR Tier 2, Section 9.4.7.5 does not refer to FSAR Tier 2, Section 11.5 and FSAR Tier 2, Table 11.5-1 for specific details on the associated radiation monitoring equipment for the CBVS. Accordingly, FSAR Tier 2, Sections 11.5 and 9.4.7 should be reviewed and revised to ensure a consistent use of internal references on radiation instrumentation design features in controlling airborne radioactivity releases via the plant vent stack.

In a November 12, 2009, response to RAI 273, Question 11.05-11, the applicant presented additional information describing the operational features of the PERMSS for the Containment Building (CB), NAB, and SB ventilation systems. The applicant proposed to clarify the description of purge exhaust flows, placement of radiation monitors in exhaust systems, and automatic isolation functions. Revisions will be made to FSAR Tier 2, Sections 9.4.7.2.1, "General Description," and 9.4.7.5. The staff finds the applicant's response and proposed FSAR revisions acceptable. **RAI 273, Question 11.05-11, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Sections 11.5.2 to 11.5.4 present descriptions of the PERMSS subsystems, and FSAR Tier 2, Table 11.5-1 lists radiation monitoring methods used to monitor airborne effluent streams from the annulus ventilation system (AVS), as described in FSAR Tier 2, Section 6.2.3. However, the staff determined that FSAR Tier 2, Section 6.2.3.5, "Instrumentation Requirements," did not refer to FSAR Tier 2, Section 11.5 and FSAR Tier 2, Table 11.5-1 for specific details on the associated radiation monitoring equipment for the AVS. In RAI 273, Question 11.05-12, the staff requested that the applicant review and revise FSAR Tier 2, Sections 11.5 and 6.2.3 to ensure a consistent use of internal references on radiation instrumentation design features in controlling airborne radioactivity releases via the plant vent stack. In a November 12, 2009, response to RAI 273, Question 11.05-12, the applicant proposed a clarification by adding an internal reference for information on operational features of the PERMSS for the AVS. The applicant proposed to insert a reference to FSAR Tier 2, Section 11.5 in FSAR Tier 2, Section 6.2.3.5. The staff finds the applicant's response and proposed FSAR change acceptable. **RAI 273, Question 11.05-12, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Sections 11.5.1.2, "Design Criteria," and 5.2.5.1.2, "Containment Atmosphere Radiation Monitoring," address instrumentation and methods used to quantify reactor coolant system leakage and leakage rates, as required by U.S. EPR Technical Specifications 16.3.4.12, "RCS Operational LEAKAGE," and TS B16.3.4.12, "RCS Operational LEAKAGE." The technical basis for RCS leakage detection instrumentation [see TS 16.3.4.14, "RCS Leakage Detection Instrumentation," and TS B16.3.4.14, "RCS Leakage Detection Instrumentation"; RG 1.45, "Guidance on Monitoring and Responding to Reactor Coolant System Leakage," Revision 1, May 2008; and RIS 2009-02, Revision 1] establish radiation monitor sensitivity requirements for a leakage detection increase of 3.785 lpm (1 gpm) within 1 hour, using a realistic primary coolant concentration. Although FSAR Tier 2, Section 5.2.5.1.2 refers to FSAR Tier 2, Section 11.5 for information on the associated radiation monitoring instrumentation, FSAR Tier 2, Section 11.5.4 and FSAR Tier 2, Table 11.5-1 did not identify instrumentation and did not describe the methodology that would be used by COL applicants to monitor containment atmosphere for the presence of radioactive particulates in order to satisfy the requirements of U.S. EPR TS 16.3.4.12 on RCS leakage rates. In RAI 276,

Question 11.05-13, the staff requested that the applicant review and revise FSAR Tier 2, Sections 5.2.5, "RCPB Leakage Detection," and 11.5 to address the following observations:

- Revise FSAR Tier 2, Table 11.5-1 to include the appropriate numbers of particulate radiation monitors used to satisfy TS 16.3.4.14 and TS B16.3.4.14, and specify the minimum radiation monitor sensitivities for the containment particulate radiation monitors necessary to satisfy the RCS leakage rate technical basis given in the safety analysis. Indicate whether noble gas radiation monitors will be used to supplement the particulate radiation monitor, given RG 1.45 Regulatory Position C.2.3, and, if so, provide similar supporting information for that type of monitoring method.

- In FSAR Tier 2, Section 11.5.2, provide the methodology to demonstrate that particulate radiation monitors will be capable of satisfying the technical basis for RCS leakage detection instrumentation using a realistic radioactive concentration in the RCS. Include descriptions of the model, methodology, assumptions, and parametric values used in the calculations and their basis, and references to enable the staff to conduct an independent evaluation.

- In FSAR Tier 2, Sections 5.2.5.1.2 and 5.2.5.5, revise the descriptions and discussions on which type of radiation monitor instrumentation will be used to comply with U.S. EPR TS 16.3.4.14, and update all internal citations in referencing FSAR Tier 2, Section 11.5 for specific details on the associated radiation instrumentation.

RAI 276, Question 11.05-13, which is associated with the above request, is being tracked as an open item.

FSAR Tier 2, Sections 11.5.2 to 11.5.4 present descriptions of the PERMSS subsystems and FSAR Tier 2, Table 11.5-1 lists radiation monitoring methods used to monitor radioactive process and effluent streams for normal operations, AOOs, and accident conditions. Subsystem descriptions presented in FSAR Tier 2, Section 11.5 are supported by information presented in FSAR Tier 2, Sections 1.9, 7.1.2, 7.5.1, and 9.3.2. The staff determined that the design bases and descriptions of these sections are not presented consistently. Accordingly, FSAR Tier 2, Sections 1.9, 7.1.2, 7.5.1, 9.3.2, and 11.5 should be revised to ensure a consistent presentation of all design bases, system descriptions, and design features of radiation instrumentation and sampling systems used in monitoring and controlling airborne radioactivity releases under normal operations, AOOs, and accident conditions in meeting the requirements of 10 CFR 50.34(f)(2). In RAI 276, Question 11.05-14, the staff requested that the applicant review and address the following observations:

- FSAR Tier 2, Section 11.5 refers to FSAR Tier 2, Section 9.3.2 for details, and itself does not state how the requirements of 10 CFR 50.34(f)(2)(viii) are met, with respect to the capability of promptly collecting samples from reactor coolant and containment.

- FSAR Tier 2, Section 11.5 refers to FSAR Tier 2, Section 9.3.2 for details; and FSAR Tier 2, Sections 11.5.3 and 11.5.4 do not state how the requirements of 10 CFR 50.34(f)(2)(xvii) are met, with respect to design provisions for continuous sampling of radioiodines and particulates from all potential accident release points.

- For 10 CFR 50.34(f)(2)(xvii), FSAR Tier 2, Section 7.5.2 refers only to the monitoring of noble gases and does not refer to FSAR Tier 2, Section 9.3.2 for supporting details on

design features. Also, FSAR Tier 2, Section 7.1.2 and Table 7.1-2 do not present specific information on how these requirements of 10 CFR 50.34(f)(2)(xvii) are being met, with respect to design provisions for continuous sampling of radioiodines and particulates from all potential accident release points.

- FSAR Tier 2, Section 9.3.2 should be added to the commitment on 10 CFR 50.34(f)(2)(xvii) and (f)(2)(xxvi) for consistency. Similarly, FSAR Tier 2, Section 11.5 should be added to the commitment on 10 CFR 50.34(f)(2)(xxvii).

- FSAR Tier 2, Section 1.9, Table 1.9-2 commits to the guidance of RG 1.21 without any exclusion. FSAR Tier 2, Section 9.3.2 refers to RG 1.21 (Regulatory Position C.2) as it relates to the placement of radiation monitoring equipment on all potential effluent release points, but it does not address other equally important considerations. Such considerations include ensuring that sample collection is representative of effluent streams being monitored (Regulatory Position C.6) along with ANSI/HPS 13.1-1999, and whether composite sampling will be used to assess releases for specific process and effluent streams (Regulatory Position C.7).

- FSAR Tier 2, Section 9.3.2, Tables 9.3.2-1, "Primary Side Sampling Points," and 9.3.2-2, "Secondary Side Sampling Points," refer to "activity" as one of several process measurements that will be evaluated from primary and secondary sampling points. In sampling for noble gases, radioiodines, and particulates, the descriptions and tables do not identify significant or surrogate radionuclides that will be monitored as indicators of plant conditions; what type of analytical methods will be used for liquid, particulate, and gaseous samples, such as gross beta and alpha counting, gamma and alpha spectroscopy, and liquid scintillation counting; and types of samples that would involve radionuclide chemical extraction before conducting radiological analyses.

RAI 276, Question 11.05-14, which is associated with the above request, is being tracked as an open item.

FSAR Tier 2, Sections 11.5.3.2, 11.2.2.1.6, 11.2.3.3, and 10.4.5, "Circulating Water System," and FSAR Tier 2, Figure 11.5-1 present information on the process and release path that will be used to discharge liquid effluents from the plant during operation. The staff determined that this information was incomplete. Specifically, the following items were noted, given the FSAR's adopts RGs 1.143 and 1.206. In RAI 290, Question 11.05-15, the staff requested that the applicant review and address the following observations:

- FSAR Tier 2, Sections 11.2.3 and 10.4.5 do not define or describe the complete process path of LWMS discharges after the isolation valves shown in FSAR Tier 2, Figure 11.2-1 to the discharge canal. The information does not describe the connection from the LWMS discharge line to the circulating water system (CWS) and discharge canal as the ultimate point of release into the environment. FSAR Tier 2, Section 10.4.5 and FSAR Tier 2, Figure 10.4.5-1, "Circulating Water System Flow Diagram," present no input stream for the LWMS into the CWS, and no information describing the type of blowdown system and blowdown rates of the process stream receiving discharges from the LWMS before going into the CWS. Accordingly, the staff requested that the applicant provide the missing information defining the boundary of the LWMS beginning at the interface with plant systems provided for the collection of radioactive liquid wastes to the point of

discharge into the environment in complying with the requirements of 10 CFR Part 20, Appendix B, and 10 CFR Part 50, Appendix I.

- The staff requested that the applicant describe or reconcile the basis of the dilution flow rate of 2.83 m^3/s (100 ft^3/s) presented in FSAR Tier 2, Section 11.2.3.3, "Release Points and Dilution Factors," against a discharge flow rate of 1.11 m^3/s (39.3 ft^3/s) given in FSAR Tier 2, Table 11.2-9, as both were used in characterizing radioactive effluent discharges into the environment.

- FSAR Tier 2, Section 11.5.3.2 did not describe equipment and types of potential releases occurring from the Turbine Building Plant Drainage (TBPD). FSAR Tier 2, Table 11.5-1 and FSAR Tier 2, Figure 11.5-1 identify a radiation monitor on the line leading to a "water source" before being released into the environment. The information does not describe the connection from the TBPD discharge line to the circulating water system and discharge canal as the ultimate point of release into the environment.

- FSAR Tier 2, Sections 9.3.3 and 10.4.5, FSAR Tier 2, Figure 10.4.5-1, and FSAR Tier 2, Table 1.1-1, did not show an input stream for the TBPD into the CWS, and included no information describing the type of blowdown system and blowdown rates of the process stream receiving discharges from the TBPD before going into the CWS. Accordingly, the staff requested that the applicant provide the missing information defining the boundary of the TBPD beginning at the interface of TB systems provided for the collection of process streams and radioactive liquid wastes to the point of discharge into the environment in complying with the requirements of 10 CFR Part 20, Appendix B, and 10 CFR Part 50, Appendix I.

RAI 290, Question 11.05-15, which is associated with the above request, is being tracked as an open item.

FSAR Tier 2, Sections 11.5.2 to 11.5.4 present descriptions of the PERMSS subsystems, and FSAR Tier 2, Table 11.5-1 lists radiation monitoring instrumentation used to monitor process and effluent streams. The staff determined that the descriptions of the subsystems given in FSAR Tier 2, Table 11.5-1 and FSAR Tier 2, Figure 11.5-1 were inconsistent and incomplete. In RAI 290, Question 11.05-16, the staff requested that the applicant review and address the following observations in the FSAR:

- FSAR Tier 2, Table 11.5-1 does not indicate any automatic control features for the component cooling water system (CCWS), but FSAR Tier 2, Sections 9.2.2.3.1, "Normal System Operation," and 11.5.4.4, "Component Cooling Water Radiation Monitoring System," state that upon detection of elevated radioactivity levels, the affected CCWS train is isolated from the associated CCWS cooler for the chemical and volume control system (CVCS). FSAR Tier 2, Section 9.2.2.6, "Instrumentation Requirements," provides information on instrumentation requirements for the CCWS. However, FSAR Tier 2, Section 9.2.2.6 does not refer to FSAR Tier 2, Section 11.5 and FSAR Tier 2, Table 11.5-1 for specific details on the associated radiation monitoring equipment for the CCWS. Accordingly, the staff requested that the applicant revise FSAR Tier 2, Table 11.5-1 to include the isolation feature for that system's description and revise FSAR Tier 2, Section 9.2.2.6 in referring to FSAR Tier 2, Section 11.5.4.4 for specific operating features of the radiation monitoring system.

- FSAR Tier 2, Section 10.4.8.3.2, "Abnormal Operating Conditions," and FSAR Tier 2, Table 11.5-1 identify an automatic control feature for the steam generator blowdown system (SGBS), but FSAR Tier 2, Section 11.5.4.3 states that "This system does not initiate automatic actions." Upon detection of elevated radioactivity levels, the affected SG is isolated and the blowdown is diverted to the LWMS. FSAR Tier 2, Section 10.4.8, "Steam Generator Blowdown System (PWR)," and FSAR Tier 2, Figures 10.4.8-1, "Steam Generator Blowdown System Discharge and Cooling," and 10.4.8-2, "Steam Generator Blowdown Demineralizing System Flow Diagram," did not show the SGBS radiation monitor on the SGBS P&ID, but it is represented schematically in FSAR Tier 2, Figure 11.5-1. Accordingly, the staff requested that the applicant revise FSAR Tier 2, Section 11.5.4.3 to provide a consistent description of the isolation feature of that system and revise FSAR Tier 2, Figures 10.4.8-1 and 10.4.8-2 to include the location of the radiation monitor in the SGBS system drawing.

In a November 12, 2009, response to RAI 290, Question 11.05-16, the applicant agreed to provide additional information in FSAR Tier 2, Sections 11.5.4.3; 10.4.8.3.2; 10.4.8.3.3, "Accident Conditions"; 10.4.8.2.1, "General Description"; and 9.2.2.6; FSAR Tier 2, Table 11.5-1; and FSAR Tier 2, Figure 10.4.8-1 describing the automatic control features of the component cooling water system and steam generator blowdown system. The information includes additional details on conditions that would result in the activation of automatic control features and placement of radiation monitors in system flow diagrams. The staff finds that the applicant's response and proposed FSAR revisions acceptable. **RAI 290, Question 11.05-16, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Section 10.4.6.3, "System Operation," describes the operation of the condensate polishing system (CPS) and states that in the event that spent resins become contaminated with radioactive materials, shielding will be provided. While correct as an interim measure in reducing radiation exposures to plant workers, the main focus of the discussion is on spent resin disposal and not about the radiation protection program described in FSAR Tier 2, Section 12.3. In RAI 290, Question 11.05-17, the staff requested that the applicant revise the discussion by pointing out that the disposal of spent resin contaminated with radioactive materials, following the rupture of SG tubes, will be managed using a plant-specific process control program as described in FSAR Tier 2, Section 11.4. In an October 22, 2009, response to RAI 290, Question 11.05-17, the applicant agreed to provide additional details in FSAR Tier 2, Section 10.4.6.3 noting that spent resins will be shipped in accordance with the PCP, as described in FSAR Tier 2, Section 11.4.3. The staff finds the applicant's response and proposed FSAR revision acceptable. **RAI 290, Question 11.05-17, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Sections 11.5.4.3 and 10.3.5, "Secondary Side Water Chemistry Program," describe operational and radiological aspects in the event of SG tube ruptures. In addressing the radiological consequences on the secondary side water chemistry, FSAR Tier 2, Section 10.3.5.5, "Primary to Secondary Leakage," focuses on the presence of radioiodines. While the presence of radioiodines would be expected, the discussion should note that in such an event, the assessment and compliance with dose limits for members of the public (10 CFR Part 20) and release criteria (10 CFR Part 50, Appendix I) would consider the presence of other equally predominant radionuclides. The sampling of the secondary side and

types of analyses, in part, will be dictated by FSAR Tier 2, Sections 9.3.2 and 11.5 and a plant-specific offsite dose calculation manual in addition to plant technical specifications. In RAI 290, Question 11.05-18, the staff requested that the applicant revise the discussion by pointing out that the radiological implications of detecting radioactivity in the secondary side will be addressed by the requirements identified in FSAR Tier 2, Section 11.5 and a site-specific ODCM developed by COL applicants. In an October 22, 2009, response to RAI 290, Question 11.05-18, the applicant agreed to provide additional details in FSAR Tier 2, Section 10.3.5.5 noting that other radionuclides, besides radioiodines, will be considered in assessing the radiological impacts of SG tube defects or ruptures. In the proposed marked-up, the revision states that other predominant radionuclides will be considered in assessing compliance with 10 CFR Part 20, and doses will be evaluated using the ODCM, as described in FSAR Tier 2, Section 11.5. The staff finds the applicant's response and proposed FSAR revisions acceptable. **RAI 290, Question 11.05-18, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Sections 11.5.3 and 11.5.4 describe effluent and process monitoring and sampling. The descriptions are supplemented with information presented in FSAR Tier 2, Table 11.5-1, which identifies process and effluent sampling provisions for the activity monitoring system and the nuclear sampling severe accident sampling system. The staff determined that the information presented in these subsections of FSAR Tier 2, Section 11.5 was incomplete, and the interface with complementary provisions of FSAR Tier 2, Section 9.3.2 (Tables 9.3.2-1 and 9.3.2-2) was not described and was not in conformance with SRP Sections 11.5 and 9.3.2 and RG 1.206. In RAI 290, Question 11.05-19, the staff requested that the applicant review and address the following observations:

- The Sampling Activity Monitoring System and the Nuclear Sampling Severe Accident Sampling System are described as "systems" in FSAR Tier 2, Section 11.5.4. However, there are no subsections in FSAR Tier 2, Section 11.5 that describe either system. It is not clear if the information presented for the various subsystems consists, in the aggregate, of the descriptions of each system. The applicant is requested to organize the information for the sampling activity monitoring system and the nuclear sampling severe accident sampling systems in their respective subsections to ensure that all relevant information and criteria are clearly identifiable for the staff to assess compliance with the requirements of 10 CFR Part 20, Appendix B; 10 CFR Part 50, Appendix I; and TMI-related requirements of 10 CFR 50.34(f)(2).

- Many of the entries in FSAR Tier 2, Table 11.5-1 for the sampling activity monitoring system and the nuclear sampling severe accident sampling systems are populated with "---" under the process and effluent table headers. As a result, it is impossible to confirm how these two systems will be used in complying with the requirements of 10 CFR Part 20, Appendix B; 10 CFR Part 50, Appendix I; and TMI-related requirements of 10 CFR 50.34(f)(2). The applicant was requested to review all associated FSAR Tier 2, Table 11.5-1 entries and populate each one with criteria demonstrating compliance with NRC regulatory requirements and conformance with NRC guidance, or insert footnotes providing supporting details or pointing out other sections of the FSAR where the requirements are addressed.

- Given that FSAR Tier 2, Table 11.5-1 lists the nuclear sampling severe accident sampling systems, it is presumed that such an entry would complement supporting

information presented in FSAR Tier 2, Section 9.3.2 (Tables 9.3.2-1 and 9.3.2-2). However, the interface between FSAR Tier 2, Sections 11.5 and 9.3.2 is not established. FSAR Tier 2, Section 11.5 references FSAR Tier 2, Section 9.3.2, but does not provide further details. Similarly, FSAR Tier 2, Section 9.3.2 does not reference FSAR Tier 2, Section 11.5 even though FSAR Tier 2, Table 11.5-1 includes an entry for the nuclear sampling severe accident sampling systems, which should be linked to FSAR Tier 2, Section 9.3.2. The staff requested that the applicant review and revise FSAR Tier 2, Sections 11.5 and 9.3.2 and integrate the information to show the complementary provisions and interfaces in demonstrating compliance with the requirements of 10 CFR Part 20, Appendix B and TMI-related requirements of 10 CFR 50.34(f)(2).

In a November 12, 2009, response to RAI 290, Question 11.05-19, the applicant agreed to provide additional information in FSAR Tier 2, Section 11.5.4.6, "Reactor Coolant Radiation Monitoring and Sampling System," and FSAR Tier 2, Tables 11.5-1 and 9.3.2-1. The applicant proposes to correct the operational descriptions of the nuclear severe accident sampling system, populate FSAR Tier 2, Table 11.5-1 with appropriate entries in indicating compliance with NRC criteria, expand the description of the nuclear severe accident sampling system, add the description of a noble gas radiation monitor, and indicate system interfaces between FSAR Tier 2, Sections 9.3.2 and 11.5. The staff finds that the applicant's response and proposed FSAR revisions acceptable. **RAI 290, Question 11.05-19, is being tracked as a confirmatory item** and will be evaluated when the next revision to the FSAR is submitted to the NRC.

FSAR Tier 2, Sections 11.5.1.2 and 5.2.5.3.2 address instrumentation and methods used to quantify reactor coolant system leakage to the secondary side and leakage rates, as would be required by TS 16.3.4.12.d and TS B16.3.4.12. The proposed TS requirement specifies a maximum leakage rate of 150 gallons per day through any SG using realistic primary coolant radionuclide concentrations. The technical basis for leakage detection and instrumentation is provided in TS B16.3.4.12, RG 1.45, Revision 1, and RIS 2009-02, Revision 1, in selecting appropriate monitoring methods and in establishing radiation monitoring sensitivity. The staff determined that FSAR Tier 2, Sections 11.5.4.3, 5.2.5.3.2, 10.4.8.6, and FSAR Tier 2, Table 11.5-1 did not indicate whether the associated radiation monitoring instrumentation can detect a primary system leakage rate to the secondary side of 150 gallons (gal) per day through any one SG and did not describe the methodology that would be used by COL applicants to comply with the requirements of TS 16.3.4.12.d on allowable SG operational leakage rates. In RAI 346 Question 11.05-20, the staff requested that the applicant review and revise FSAR Tier 2, Sections 11.5 and 5.2.5 and address the below noted items, and include in its response descriptions of the model, methodology, assumptions, parametric values used in the calculations and their basis, and references to enable the staff to conduct an independent evaluation.

- Revise FSAR Tier 2, Table 11.5-1 to identify the appropriate types and numbers of radiation monitors used to satisfy TS 16.3.4.12.d and TS B16.3.4.12, and specify the minimum radiation monitor sensitivities to satisfy the SG maximum leakage rate technical basis.

- In FSAR Tier 2, Section 11.5.2 and/or 5.2.5.3.2, describe the methodology to demonstrate that the SG blowdown radiation monitors will be capable of satisfying the technical basis of the primary to secondary leakage rate of 150 gal per day using

realistic RCS radioactive concentrations for COL applicants to comply with the requirements of TS 16.3.4.12.d.

- In FSAR Tier 2, Sections 5.2.5.3.2 and 5.2.5.5, revise the descriptions and discussions on which types of radiation monitor instrumentation will be used to comply with TS 16.3.4.12.d, and update all internal citations in referencing FSAR Tier 2, Section 11.5 for specific details on the associated radiation instrumentation.

RAI 346, Question 11.05-20, which is associated with the above request, is being tracked as an open item.

Offsite Dose Calculation Manual

FSAR Tier 2, Section 11.5.2 commits to the use of an Offsite Dose Calculation Manual in controlling and monitoring all liquid and gaseous effluent releases. The development of an ODCM is addressed under SECY-05-0197 and RG 1.206 in addition to SRP Section 11.5. The description of the operational program of the ODCM should present the plant's Standard Radiological Effluent Controls (SREC) and 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 the current local land-use census. The ODCM should contain the methodology and parameters used for calculating offsite doses to members of the public from gaseous and liquid effluents in demonstrating compliance with the numerical objectives of 10 CFR Part 50, Appendix I, the dose limits of 10 CFR 20.1301 for members of the public, the effluent concentration limits of 10 CFR Part 20, Appendix B (Table 2), and compliance with the requirements of 10 CFR 20.1302. The ODCM should present methods and parameters used to determine operational set points for effluent radiation monitors in limiting releases of radioactive materials into the environment within the liquid and gaseous effluent concentration limits of 10 CFR Part 20, Appendix B, Table 2. The ODCM should provide instructions for identifying and eliminating the potential for unmonitored and uncontrolled releases given NRC concerns identified in NRC Bulletin 80-10 and RG 4.21.

In FSAR Tier 2, Table 1.8-2 and FSAR Tier 2, Section 11.5.2, the applicant states that the development of the ODCM is the responsibility of the COL applicant under COL Information Item 11.5-1. FSAR Tier 2, Section 13.4 identifies milestones as being due in accordance with the implementation of a site specific schedule. The development of the ODCM and its companion programs should meet the provisions of GL 89-01, "Radiological Assessment Branch Technical Position" (Revision 1, November 1979), included as NUREG-1301, Appendix A, as ODCM guidance for PWRs, and the guidance of NUREG-0133. Alternatively, a COL applicant may use NEI ODCM Template 07-09A (Revision 0, March 2009) to meet this regulatory milestone until preparation of a plant and site-specific ODCM, which includes implementing procedures, before fuel load, as described in FSAR Tier 2, Section 13.4 of the COL application. The staff has reviewed NEI ODCM Template 07-09A and determined it to be acceptable on January 27, 2009. The staff determined that either approach is acceptable, given the inclusion of COL Information Item 11.5-1 in FSAR Tier 2, Sections 1.8.1 and 11.5.2, and its implementation described in FSAR Tier 2, Section 13.4.

Task Action Plan

NUREG-0933, Section 2, "Resolution of Generic Safety Issues," includes a task action plan which identifies items covering a wide variety of subjects, and includes Task Action Plan Item B-67, "Effluent and Process Monitoring Instrumentation." In addressing Task Action Plan, Subtask 1 of Item B-67 for normal plant operation and AOO effluents, FSAR Tier 2, Section 11.5 conforms to the acceptance criteria and guidance of SRP Section 11.5. The associated TMI-related items in monitoring radioactive effluents under accident conditions are covered in FSAR Tier 2, Sections 7.1.1, 7.1.2, 7.5.1, 7.5.2, and 9.3.2. The staff's evaluations of these FSAR Tier 2 sections are addressed in their respective sections of this report.

In addressing Task Action Plan, Subtask 2 of Item B-67, the radiological impacts at the EAB associated with a GWMS leak or component failure are addressed in FSAR Tier 2, Section 11.3.3.6. The assumptions and dose results of the radiological analysis were determined to be in conformance to the SRP acceptance criteria and guidelines of SRP Section 11.3, BTP 11-5 for systems designed to preclude the accumulations of oxygen and hydrogen explosive gas mixtures and detonations within the GWMS. The staff determined that the results of this analysis are acceptable. Section 11.3 of this report addresses this topic and presents the results of the staff's evaluation.

In addressing Task Action Plan, Subtask 3 of Item B-67, the radiological impact associated with the failure of a LWMS radioactive waste tank is addressed in FSAR Tier 2, Section 11.2.3.7. The assessment considers the potential impacts of the release of radioactive materials on the nearest potable water supply located in an unrestricted area. The analysis assumes that the impacted area is located at about 366 m (1,200 ft) from the initial leak out of the Auxiliary Building, with the movement of radioactivity to the assumed location being mitigated by retardation in ground water. The staff determined that the assumptions and results of the analysis are acceptable. Section 11.2 of this report addresses this topic and presents the results of the staff's evaluation.

In addressing Task Action Plan, Subtask 4 of Item B-67, FSAR Tier 2, Section 11.4 describes the installation and use of permanently installed solid and wet processing subsystems. This approach conforms to the acceptance criteria and guidance of SRP Section 11.4 and is determined to be acceptable by the staff. Section 11.4 of this report addresses this topic and presents the results of the staff's evaluation.

Minimization of Contamination

FSAR Tier 2, Section 12.3.6 addresses compliance with 10 CFR 20.1406, as it relates to facility design and operational procedures for permanently installed subsystems in minimizing the contamination of the facility and generation of radioactive waste. FSAR Tier 2, Section 12.3.6, discusses programmatic aspects and design features of SSCs intended to minimize contamination. This section states that the principles embodied in the applicant's philosophy include preventing unintended releases and early detection of unintended contamination. In its review of the PERMSS, the staff noted that the design basis and descriptions of subsystems and components did not always acknowledge NRC concerns identified in NRC Bulletin 80-10 and the guidance of RG 4.21 in preventing nonradioactive systems from becoming contaminated and avoiding unmonitored and uncontrolled releases of liquid and gaseous effluents. These design features should be evaluated, and the FSAR should describe system features that would prevent spills and leaks, and avoid radioactive contamination of

nonradioactive support systems. For example, fluid samples extracted from process and effluent streams should be returned to their origins. Clean process fluids, such as water or air, used to purge or flush sampling lines should be routed to the most appropriate systems after being used, such as to the LWMS or GWMS and not discharged locally or recirculated back to their supply sources. While specific RAIs were submitted to the applicant to address such concerns in FSAR Tier 2, Section 11.5, the staff's evaluation of the applicant's responses and closure of such RAIs are addressed in Section 12.3 of this report.

FSAR Tier 1 Information

In FSAR Tier 2, Section 14.3.2; FSAR Tier 2, Section 11.5; and FSAR Tier 1, Section 2.0, the applicant indicates that the treatment of ITAAC has been divided into two groups: Certified design material and ITAAC. The applicant states further: CDM binds the design commitment of structures, systems, and components for the lifetime of the facility, and ITAAC are used to verify the as-built features of the plant. FSAR Tier 2, Section 14.3.2 assigns ITAAC based on (1) the classification of systems and equipments, and (2) systems identified during key safety and integrated plant safety analyses for the purpose of preserving specific design features in the as-built facility.

Systems described in FSAR Tier 2 sections that have no safety-significant features or that were not identified as part of the "key safety and integrated plant safety analyses" process are given in FSAR Tier 1 as "No entry for this system." Although the selection process identifies pertinent NRC regulations for safety-related design features, FSAR Tier 1, with the exception of Section 2.9.4, Section 2.9 does not identify ITAAC associated with plant systems and components used to monitor and/or control radioactivity releases in the environment in demonstrating compliance with 10 CFR Part 20, Appendix B, Table 2 liquid and gaseous effluent concentration limits; and doses to members of the public under 10 CFR 20.1301 and 10 CFR 20.1302, as well as avoiding unmonitored and uncontrolled radioactive releases to the environment in response to 10 CFR 20.1406(b). FSAR Tier 1, Section 2.9.4 includes ITAAC in confirming that instrumentation will indicate the presence of elevated levels of radioactivity in the plant vent stack and main control room air intake and the isolation of the intake air supply system. FSAR Tier 1, Section 2.4.22 includes ITAAC for the radiation monitoring system in confirming that its instrumentation will alarm on a high radiation signal from the containment high range monitor and initiate an isolation of the reactor building ventilation system. Specific RAIs were submitted to the applicant to address such concerns for the PERMSS as part of the review of FSAR Tier 2, Section 14.3. The staff's evaluation of the applicant's responses and closure of such RAIs are addressed in Section 14.3 of this report.

ITAAC Information

A review of FSAR Tier 1, Section 2.4, and FSAR Tier 2, Chapter 14, Table 14.3-8 indicates that there are no ITAAC for the PERMSS.

FSAR Tier 2, Chapter 14, Table 14.3-8, (Sheet 5 of 8), states that the nuclear sampling system (NSS) is within the scope of FSAR Tier 1; however, FSAR Tier 1, Section 2.9.6, "Nuclear Sampling System," states that there are no FSAR Tier 1 entries for the NSS. FSAR Tier 1, Section 2.4.22 includes ITAAC for the radiation monitoring system in confirming that its instrumentation will alarm on a high radiation signal from the containment high range monitor and initiate an isolation of the reactor building ventilation system. FSAR Tier 1, Section 2.9.4 includes ITAAC in confirming that instrumentation will indicate the presence of elevated levels of

radioactivity in the plant vent stack and main control room air intake and initiate the isolation of the intake air supply system.

The PERMSS is relied upon to provide indication of radioactivity levels in process and effluent streams, initiate the closure of valves and shutting off of pumps, and diversion of process and effluent streams upon the detection of high radioactivity levels, and to provide the means to extract samples for radiological analyses. Collectively, instrumentation readings and results of sample analyses are used to confirm that liquid and gaseous effluent concentration levels are in compliance with the limits of 10 CFR Part 20, Appendix B, Table 2 and that associated doses to members are within the annual dose limits of 10 CFR 20.1301 and design objectives of 10 CFR Part 50, Appendix I. The ability to maintain effluent concentrations and doses below 10 CFR Part 20 and 10 CFR Part 50 limits depends upon the PERMSS, including the proper placement, operation, and calibration of radiation monitors, sampling system, and automatic control features in diverting process flows or terminating effluent releases that exceed alarm set-points and process dilution flow before discharge into the environment. Specific RAIs were submitted to the applicant to address such concerns about the PERMSS as part of the review of FSAR Tier 2, Section 14.3. The staff's evaluation of the applicant's responses and closure of such RAIs are addressed in Section 14.3 of this report.

Technical Specifications

Review of FSAR Tier 2, Chapter 16 shows that there are no TS directly associated with the process and effluent radiological monitoring and sampling systems, other than the post-accident monitoring instrumentation under TS 16.3.3.2. However, FSAR Tier 2, Chapter 16, TS 5.5.1 and TS 5.5.3 describe requirements in managing releases of radioactive liquid and gaseous effluents. FSAR Tier 2, Chapter 16, TS 5.6.1 and TS 5.6.2 specify annual reporting requirements in describing the results of the radiological monitoring program and providing summaries describing the quantities of radioactive liquid and gaseous effluents released and solid wastes shipped out for disposal. The implementation of an ODCM is one of the operational programs described in FSAR Tier 2, Section 13.4.

Collectively, the requirements address the control and monitoring of liquid and gaseous effluents in determining compliance with effluent concentrations limits of 10 CFR Part 20, Appendix B, Table 2; monitoring, sampling, and analysis of effluents in demonstrating compliance with 10 CFR Part 20.1302; dose criteria of 10 CFR Part 20, Appendix I; and doses to any members of the public under the EPA generally applicable environmental standards of 40 CFR Part 190, as implemented under 10 CFR Part 20.1301(e). As stated in TS 5.5.1, COL-initiated changes to the ODCM must be justified by calculations and changes must maintain levels of radioactivity in effluents in compliance with the requirements of 10 CFR 20.1302, 40 CFR Part 190, 10 CFR 50.36a, and 10 CFR Part 50, Appendix I.

Technical specifications require the radioactive effluent controls program, which is contained in the ODCM, to include instrumentation in monitoring and controlling liquid and gaseous effluent discharges; to meet limits on effluent concentrations released to unrestricted areas; to monitor, sample, and analyze liquid and gaseous effluents before and during releases; to set limitations on annual and quarterly dose commitments to members of the public; and to assess cumulative doses from radioactive liquid and gaseous effluents. The staff concludes that these requirements are acceptable because they are contained in NEI ODCM Template 07-09A and that the implementation of these TS in demonstrating compliance with NRC regulations will be

addressed in a plant and site specific ODCM under COL Information Item 11.5-1, as described in FSAR Tier 2, Table 1.8-2.

Preoperational Testing

FSAR Tier 2, Section 14.2.12 presents descriptions of individual tests and test abstracts to be conducted on identified plant systems and components. For the PERMSS, the tests include Test No. 144, "Process and Effluent Radiological Monitoring," in confirming the performance of PERMSS for the instrumentation given in FSAR Tier 2, Sections 11.5.2, 11.5.3 and FSAR Tier 2, Table 11.5-1. This test will verify the installation of all instrumentation and operation of sampling subsystems; confirm the calibration of all radiation detectors; confirm the operation of all alarms, controls and indication on control panels; and confirm proper equipment operation via the use of high radiation signals in tripping alarm set-points in verifying automatic control functions, such as valve closures, stopping of pumps, and diversion of process or effluent flows. For Test No. 159, "Process Radiation Monitor," the scope and acceptance criteria are similar to those of Test No. 144 for instrumentation given in FSAR Tier 2, Section 11.5.4 and FSAR Tier 2, Table 11.5-1. Regarding the sampling of primary and secondary fluid streams, Test No. 092, "Sampling Activity Monitoring System," Test No. 071, "Secondary Sampling System," Test No. 100, "Nuclear Sampling System," and Test No. 204, "Sampling Primary and Secondary Systems," describe the scope and acceptance criteria for the collection and analysis or measurements of radiological parameters from process and effluent streams.

For the measurement of radioactivity, the acceptance criteria include the means to collect samples from systems identified in FSAR Tier 2, Section 9.3.2; confirm that measured radioactivity levels are within their respective limits; and compare the results of laboratory analyses with that of process radiation monitors in assessing consistencies within measurements, given uncertainties in instrument responses. Test No. 155, "Post-Accident Monitoring Instrumentation," is used to verify that all post-accident monitoring instrumentation operates properly and displays results for the instrumentation identified in FSAR Tier 2, Section 7.5, "Information System Important to Safety." Similarly, Test No. 090 applied to laboratory radio-analytical equipment, is used to quantify radionuclide concentrations in process and effluent samples collected from the LWMS and GWMS subsystems, and determine if radioactivity levels and radionuclide concentrations are within effluent concentrations limits of 10 CFR Part 20, Appendix B, Table 2. The staff reviewed these tests and generated specific RAIs on the information presented in FSAR Tier 2, Section 14.2.12. The evaluation of the applicant responses to and closure of these RAIs are addressed in Section 14.2 of this report.

11.5.5 Combined License Information Items

Table 11.5-1 provides a list of PERMSS related COL item numbers and descriptions from FSAR Tier 2, Table 1.8-2:

Table 11.5-1 U.S. EPR Combined License Information Items

Item No.	Description	FSAR Tier 2 Section
11.5-1	A COL applicant that references the U.S. EPR will fully describe, at the functional level, elements of the process and effluent monitoring and sampling programs required by 10 CFR Part 50, Appendix I and 10 CFR 52.79(a)(16). This program description, Offsite Dose Calculation Manual, will specify how a licensee controls, monitors, and performs radiological evaluations of releases. The program will also document and report radiological effluents discharged to the environment.	11.5.2

The staff concludes that the above list of COL information items to be complete, and adequately describes the actions necessary for the COL applicant or holder.

11.5.6 Conclusions

Except for the open items identified below, the staff concludes that the PERMSS (as permanently installed system components in combination with skid-mounted equipment) includes the necessary equipment to measure and control releases of radioactive materials in plant process streams and liquid and gaseous effluents; alert control room operators 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 predetermined radioactivity levels or release rates exceed alarm set points. Based on this evaluation, the staff determined that the PERMSS is in compliance with the requirements of GDC 60, GDC 63, and GDC 64 of Appendix A to 10 CFR Part 50; the requirements of 10 CFR 50.34a and 50.36a; design objectives of 10 CFR Part 50, Appendix I; 10 CFR 20.1301 and 20.1302; and NRC guidance and acceptance criteria. This conclusion is based on the following:

- The U.S. EPR demonstrates compliance with 10 CFR Part 50.34a and GDC 60, GDC 63, and GDC 64 by providing the means to monitor and control liquid and gaseous effluent releases. The design conforms to the guidelines of SRP Section 11.5. The instrumentation of the PERMSS monitors combined effluent releases from the plant vent stack. The PERMSS monitors exhausts and process streams from the Reactor Building, Containment Building, Reactor Annulus Building, Fuel Building, Nuclear Auxiliary Building, Safeguard Buildings, Controlled Access Building, and Radioactive Waste Building. Similarly, the PERMSS monitors releases from the LWMS through a single discharge line.

- The U.S. EPR provides the means to monitor systems required for plant safety. The PERMSS provide signals and initiate automatic safety functions for the following ventilation systems: reactor containment building, containment annulus ventilation system, fuel building, nuclear auxiliary building, safeguard buildings, and access building. The safety related portions of the PERMSS are classified as safety Class 2, Seismic Category I, based on the requirements of 10 CFR Part 50, Appendices B and S.

- The U.S. EPR provides the means, in accordance with GDC 64, to monitor systems required for normal operations and AOOs. The PERMSS provide signals and initiate automatic functions for the gaseous waste processing system, liquid radioactive waste monitoring tank discharge line, component cooling water system, and steam generator blowdown.

- The U.S. EPR identifies the implementation of a plant and site-specific ODCM, as an operational program, described in FSAR Tier 2, Sections 11.5.2 and 13.4, in controlling and monitoring radioactive liquid and gaseous effluent releases, and for implementing standard radiological effluent controls and a radiological environmental monitoring program. The ODCM addresses plant and site-specific operating procedures and acceptance criteria, as they relate to the means of controlling radioactive effluent releases and conducting radiological surveys in the environs of operating nuclear power plants. A COL applicant is responsible for the implementation of a plant and site-specific ODCM under COL Information Item 11.5 1, as described in FSAR Tier 2, Table 1.8-2. The ODCM should conform to the guidance of GL 89 01 and NUREG-1301 for PWR plants; NUREG-0133; RG 1.21, 1.33, 4.1, 4.8, and 4.15; and guidance from Radiological Assessment Branch Technical Position (Revision 1). As part of this commitment, the COL applicant is responsible for demonstrating, through the ODCM, compliance with 10 CFR 20.1301(e), which incorporates by reference 40 CFR Part 190 for facilities within the nuclear fuel cycle, including nuclear power plants.

- The design features of the U.S. EPR PERMSS, operating in conjunction with the LWMS, GWMS, and SWMS used to control and monitor radioactive effluent releases, were determined to provide the means to comply with the dose requirements of 10 CFR 20.1301 and 10 CFR 20.1302 by ensuring that annual average concentrations of radioactive materials in liquid and gaseous effluents released into unrestricted areas will not exceed the limits specified in 10 CFR Part 20 (Appendix B, Table 2, Columns 1 and 2).

- The design of the U.S. EPR PERMSS, in conjunction with the operations of the LWMS, GWMS, and SWMS, complies with the design objectives of 10 CFR Part 50, Appendix I, Sections II.A, II.B, and II.C in ensuring that offsite individual doses resulting from liquid and gaseous effluent releases are ALARA and will not exceed numerical guides and design objectives and comply with 10 CFR 50.34a and 50.36a. Compliance with the design objectives of 10 CFR Part 50, Appendix I, Section II.D, as it relates to the conduct of cost-benefit analyses in reducing population doses, is addressed in Sections 11.2, 11.3, and 11.4 of this report for the LWMS, GWMS, and SWMS.

- The U.S. EPR conforms to the quality group classifications used for system components, and the seismic design applied to structures housing PERMSS subsystems using the guidance of RG 1.143.

For the following open items, tracked under **RAI 273, Question 11.05-1; RAI 273, Question 11.05-2; RAI 276, Question 11.05-13; RAI 276, Question 11.05-14; RAI 290, Question 11.05-15; and RAI 346, Question 11.05-20**, the staff concludes, using the information presented in the application, that the applicant has not provided sufficient information in describing the performance characteristics of radiation monitoring instrumentation, means to collect samples for radiological analyses from process and effluent streams, and provisions to avoid unmonitored and uncontrolled radioactive releases to the environment. The relevant regulations are contained in 10 CFR 20.1406 and 20.1501; 10 CFR 50.34(f)(2) as specific additional TMI-related requirements; and the guidance contained in RGs 1.21, 1.45, 1.143, 1.197, 4.15, and 4.21; SRP Section 7.1 and BTP 7-10; SRP Section 11.5; and NRC Bulletin 80-10.