11 RADIOACTIVE WASTE MANAGEMENT

Chapter 11, "Radioactive Waste Management," of this safety evaluation (SE) describes the results of the review by the staff of the U.S. Nuclear Regulatory Commission (NRC or Commission), hereinafter referred to as the staff, of Chapter 11 of the Korea Electric Power Corporation (KEPCO) and Korea Hydro & Nuclear Power Co., Ltd (KHNP), hereinafter referred to as the applicant, Design Control Document (DCD) for the design certification (DC) of the Advanced Power Reactor 1400 (APR1400).

This chapter describes the results of the staff's review of the APR1400 design-basis and realistic radioactive source terms, and radioactive waste management systems (RWMSs).

The RWMSs 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 system (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.

11.1 Source Terms

11.1.1 Introduction

The operation of the APR1400 will result in the generation of radioactive materials during normal operations, including AOOs. These materials include fission, activation, and corrosion products, present both in primary and, to lesser extents, in secondary coolant. The radioactivity generated is modeled by two types of radioactive source terms—design basis and realistic. The design-basis source term is used to determine and define the capability of the liquid, gaseous, and solid RWMS to process associated types and amounts of radioactivity and to describe how the process and effluent radiation monitoring system (RMS) controls and monitors effluent releases. This source term serves as the basis for shielding analyses and the evaluation of occupational radiation exposures to plant workers. The realistic source term is used to represent conditions characterizing radionuclide concentrations in primary and secondary coolants under normal operating conditions. The realistic source term is used in evaluating the impacts of liquid and gaseous effluent releases to the environment and assessing doses to members of the public from associated effluent releases.

Design-basis source terms are analyzed from conservative assumptions on fuel defects and form the basis for radwaste and effluent monitoring system designs and shielding requirements. The design-basis source term also provides the radionuclide inventory and coolant concentrations for the initial conditions for design-basis accident consequence calculations. Maximum core inventories in the reactor coolant are based on time-dependent fission product core inventories calculated using the ORIGEN code. Source terms for realistic conditions represent average radionuclide concentrations based on industry data from operating nuclear power plants and form the basis for calculating annual releases of radioactivity through liquid and gaseous effluent pathways. Additional sources of radioactivity such as tritium (H-3), carbon (C)-14, argon (Ar)-41, and nitrogen (N)-16 are produced by activation of constituents

within the reactor coolant. Radioactive material present in the secondary coolant occurs by leakage from the reactor coolant system (RCS) through steam generator (SG) tube defects governed by the primary-to-secondary leak rate.

11.1.2 Summary of Application

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

DCD Tier 2: The applicant has described the APR1400 radioactive source terms in DCD Tier 2, Section 11.1, "Source Terms." DCD Tier 2, Section 11.1, provides information on the sources of radioactive material generated within the reactor core and coolant systems and transferred to the LWMS and GWMS for treatment of liquid and gaseous wastes. The applicant provided design-basis and realistic radionuclide activity concentration source terms for the reactor coolant, the SG secondary side liquid, and the SG secondary side steam.

DCD Tier 2, Section 11.1, explains that the design-basis coolant source terms are conservatively based on bounding design-basis assumptions. The bounding design-basis source term is based on a combination of technical specifications (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 percent failed fuel fraction (i.e., it is assumed that 1 percent of the core thermal power is produced by fuel rods containing small cladding defects). Design-basis secondary coolant concentrations are based on the TS limit primary-to-secondary leak rate.

The APR1400 design-basis coolant source terms appear in DCD Tier 2, Table 11.1-2, "Maximum Reactor Coolant Fission Product Source Term," Table 11.1-4, "Maximum and Expected Specific Activities in the Spent Fuel Pool and Refueling Pool," Table 11.1-6, "Design-Basis Radionuclide Concentrations in the Secondary System," and Table 11.1-8, "Design-Basis Radionuclide Concentrations of Sources to gaseous radwaste system (GRS)."

The realistic coolant source terms represent the average radionuclide activity concentrations based on industry data from operating pressurized-water reactor (PWR) plants. The applicant calculated realistic reactor coolant and secondary coolant source terms based on ANSI/ANS-18.1-1999 and NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors: PWR-GALE Code," Revision 1, issued April 1985. The realistic coolant source terms provide the basis for calculating the annual release of radioactive material through liquid and gaseous effluents. DCD Tier 2, Table 11.1-9, "Expected Specific Activities of Reactor Coolant During Normal Operation," lists the APR1400 realistic coolant source terms.

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 APR1400 design parameters.

Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC): The ITAAC associated with DCD Tier 2, Chapter 11, appear in DCD Tier 1, Section 2.7, "Plant Systems." There are no ITAAC items for the source term area of review.

TS: There are no TS for the source term area of review.

Combined License (COL) Information or Action Items: See Section 11.1.5 below.

Technical Report(s): There are no technical reports associated with this area of review.

Topical Report(s): There are no topical reports associated with this area of review.

APR1400 Interface Issues Identified in the DCD: There are no APR1400 interface issues associated with this area of review.

Site Interface Requirements Identified in the DCD: There are no site interface requirements associated with this area of review.

Cross-Cutting Requirements (Three Mile Island (TMI), Unresolved Safety Issue (USI)/Generic Safety Issue (GSI), Operating Experience (Op Ex)): There are no cross-cutting issues for this area of review.

Regulatory Treatment of Nonsafety Systems (RTNSS): There are no RTNSS issues for this area of review.

Title 10 of the *Code of Federal Regulations* (10 CFR) 20.1406, "Minimization of Contamination": There are no issues related to 10 CFR 20.1406 for this area of review.

Conceptual Design Information (CDI): This DCD section does not contain CDI that is outside the scope of the APR1400 certification.

11.1.3 Regulatory Basis

The relevant requirements of the Commission's regulations for the source term area of review, associated acceptance criteria, and review interfaces with other SRP sections appear in Section 11.1 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: Light Water Reactor (LWR) Edition," issued March 2007 (hereafter referred to as the SRP). The following summarizes the regulatory requirements:

- 10 CFR Part 20, "Standards for Protection Against Radiation," as it relates to determining the realistic source term that is used in calculations associated with potential radioactivity in effluents released to unrestricted areas

- Appendix I, "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," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," as it relates to determining the realistic 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 (ALARA), for radioactive material in LWR effluents

- 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 60, "Control of Releases of Radioactive Materials to the Environment," as it relates to determining the realistic 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 AOOs

Acceptance criteria adequate to meet the above requirements include the following:

- Regulatory Guide (RG) 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors," issued March 1976, as it relates to the cost-benefit analysis (CBA) for RWMSs and equipment

- RG 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," Revision 1, issued March 2007, as it relates to the method of calculating the release of radioactive materials in effluents from nuclear power plants

- RG 1.140, "Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants," Revision 2, issued June 2001, as it relates to the design, inspection, and testing of normal ventilation exhaust system air filtration and adsorption units at nuclear power plants

- ANSI/ANS-18.1-1999, as it relates to the methodology for determining the source term for normal reactor operations, including AOOs

- NUREG-0017, Revision 1, as it relates to PWRs: (1) the volumes and concentrations of radioactive material given for normal operation and AOOs for each source of liquid and gaseous waste, (2) decontamination factors for in-plant control measures used to reduce liquid effluent releases to the environment, such as filters, demineralizers and evaporators, and (3) building mixing efficiency for containment internal cleanup

11.1.4 Technical Evaluation

Information needed to review the RWMSs includes the types and quantities of radioactivity that are put into these systems for treating 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 and guidance.

The staff evaluated the information in DCD Tier 2, Section 11.1, against the guidance of SRP Section 11.1. Compliance with the following nine criteria, as taken from SRP Section 11.1, is sufficient to meet the relevant requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I, for a PWR:

(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 AOOs should be consistent with those given in NUREG-0017, 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 be consistent with 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 be consistent with those given in NUREG-0017

(5) Radwaste augments used in the calculation of effluent releases to the environment are consistent with the findings of a CBA, which may be performed using the guidance of RG 1.110. The provisions that require a CBA 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 Table 2 of Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage," to 10 CFR Part 20

(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 as required by 10 CFR 50.34, "Contents of Applications; Technical Information," 10 CFR 50.34a, "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents—Nuclear Power Reactors," and 10 CFR 52.47, "Contents of Applications; Technical Information." This technical information should include all the basic data given in RG 1.112, Appendix B (PWRs), to calculate the releases of radioactive material in liquid and gaseous effluents (the realistic 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, which contains a complete listing of the GALE computer code for PWRs

(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 or parameters used should be provided

In reviewing the APR1400 design against the above specific SRP acceptance criteria, the staff determined that some of the 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 safety evaluation (SE). The following is the staff's evaluation of DCD Tier 2, Section 11.1, information against the above criteria.

The staff's review attempted to verify the radionuclide source term provided by the applicant in DCD Table 11.1-9, which the applicant utilizes for the calculations in the NRC GALE code. DCD Table 11.1-9 references ANSI/ANS 18.1-1999 as the basis for the table within the footnotes. Staff's review also determined that the source term values were different than the values in ANSI/ANS 18.1-1999. For this reason, the staff issued Request for Additional Information (RAI) 10-7850, Question 11.01-01 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15134A507), requesting the applicant to provide clarification on this discrepancy. In addition, the staff requested the applicant to provide conversion to microcuries per gram (μCi/g) required when submitting information to the NRC per 10 CFR 20.2101, "General Provisions."

In its response to RAI 10-7850, Question 11.01-01 (ML15166A300), the applicant stated that it will revise DCD Table 11.1-9 to use both Becquerel per gram (Bq/g) and μCi/g. Also, the applicant explained that according to Section 3.2 of ANSI/ANS-18.1-1999, if any parameter, such as power level, flow rate, or fluid quantity, differs from the values of the reference reactor, adjustment factors are needed to modify the radionuclide concentrations in Table 6 of ANSI/ANS-18.1-1999. The expected specific activities of the reactor coolant for the APR1400 design, provided in Table 11.1-9, are calculated by multiplying the adjustment factors for the APR1400 design and the reference activities of ANSI/ANS-18.1-1999. The staff determined that it is reasonable that the values submitted in DCD Table 11.1-9 did not agree with ANSI/ANS-18.1-1999 because the values of DCD Table 11.1-9 are calculated by multiplying the adjustment factors and the reference activities of ANSI/ANS-18.1-1999.

The staff confirmed the response from the applicant through confirmatory calculations and found the response acceptable as the applicant has demonstrated the correct use of ANSI/ANS-18.1-1999. Therefore, the staff considers RAI 10-7850, Question 11.01-01, resolved and closed.

After reviewing the response to RAI 10-7850, Question 11.01-01 the staff determined that the applicant used a modified version of the GALE86 computer code. The staff uses GALE86 to produce a liquid and gaseous effluent source term to determine the effluent doses in Sections 11.2 and 11.3 of this SE. The staff review of the applicant data was unable to verify the results of their GALE86 analysis. In RAI 110-7919, Question 11.01-02 (ML15206A007), the staff asked the applicant to provide information that would support the expected GALE86 source term for normal operations. Although the staff currently uses GALE86, which does not use the ANSI/ANS-18.1-1999 source term standard, RG 1.112 permits the use of ANSI/ANS-18.1-1999. The applicant's response indicated that it had modified the GALE86 code twice. In its response (ML15246A362), the applicant provided details concerning its GALE86 code revisions.

In RAI 110-7919, Question 11.01-02 (ML15206A007), the staff requested additional information concerning the basis for the realistic source term used in DCD Section 11.1, Table 11.1-9. The applicant stated that the modified GALE86 code used in the APR1400 DCD is an updated version that incorporates ANSI/ANS-18.1-1999, consistent with RG 1.112, Revision 1 (2007). This modification was made by substituting the default initial primary coolant specific activity data based on ANSI/ANS-18.1-1984 with those based on ANSI/ANS-18.1-1999. However, the code had been slightly modified before the change of the primary coolant specific activities. This change was made to print out additional gaseous radio-iodines I-132, I-134, and I-135. The original version of the GALE86 code prints out only I-131 and I-133 for the gaseous radioiodine effluents. The modified version with additional radioiodine (without incorporating ANSI/ANS-18.1-1999) produces the same results as the original version, except that it prints out three more radionuclides.

The applicant provided the verification and validation of the modified version of the GALE86 code with ANSI/ANS-18.1-1999 (used in the APR1400 DC application) by comparing the results with the original version with ANSI/ANS-18.1-1984 data. The comparison aimed at confirming if the changes in the RCS specific activity are proportionally reflected in the resulting environmental releases. The comparison showed that the annual effluent releases for each nuclide are exactly proportional to the differences of the RCS initial concentrations from ANSI/ANS-18.1-1984 to ANSI/ANS-18.1-1999.

In an audit plan sent to the applicant, the staff asked the applicant to provide all files as requested in RAI 110-7919, Question 11.01-02, (e.g., *.for, *.exe, *.bat) necessary to run the modified GALE86 codes (both first and second modified versions) and also include instructions on how to execute these codes. In addition, the staff requested that the applicant revise the DCD to identify, describe, and reference use of the modified GALE86 code as appropriate, as requested in RAI 110-7919, Question 11.01-02. The staff also requested this information be submitted before the audit. The applicant submitted the information to the staff in its response (ML15320A270). The staff subsequently verified the GALE86 code by reviewing the source code files and through confirmatory runs of the computer code executable files provided. The staff reproduced the results detailed in the response to RAI 110-7919, Question 11.01-02, and by reviewing the information located in the source code and library files, it confirmed the results of the applicant's modified GALE86 code. The staff confirmed that the only information changed was to the ANSI/ANS-18.1-1984 source term and verified the results presented by the applicant in DCD Tables 11.2-1, 11.2-10, 11.3-6, and 11.3-1 for use in determining compliance with 10 CFR Part 20 and 10 CFR Part 50, Appendix I. Therefore, the staff considers RAI 110-7919, Question 11.01-02, resolved and closed.

In its review of the information provided in DCD Section 11.1, the staff determined that table titles, footnotes, and references were not included in DCD tables and that table explanatory information was not included in the text of DCD Section 11.1. In RAI 238-8145, Question 11.01-04 (ML15296A008), the staff asked the applicant to address the information contained in tables that is not discussed in DCD Section 11.1, so that there are appropriate pointers to DCD sections where the data will be used for separate analyses. In its response to RAI 238-8145, Question 11.01-04 (ML15328A316), the applicant included proposed markups for Section 11.1 text to include clarifying words to accurately describe the use of specific tables. The applicant also provided footnote inserts to DCD Tables 11.1-2, 11.1-6, 11.1-8, 11.1-9, 11.1-10, and 11.1-18, to describe where the tabled information will be used in the DCD. In its revised response (ML16089A517), the applicant provided footnotes to describe the use of the remaining tables in DCD Section 11.1. The staff confirmed that the proposed changes have been incorporated; therefore, the staff finds this response acceptable, and considers RAI 238-8145, Question 11.01-04, resolved and closed.

11.1.5 Combined License Information Items

The staff did not identify any COL information items specifically related to radioactive source terms to be included in DCD Tier 2, Table 1.8-2, "Compilation of All Combined License Applicant Items for Chapters 1–19."

11.1.6 Conclusions

The staff determined the source terms described in DCD Tier 2, Section 11.1, are acceptable, based upon resolution of the staff's concerns in the technical evaluation above. The staff determined the acceptability of the proposed source terms based on the applicant's conformance with the guidance given in SRP Section 11.1 and ANSI/ANS-18.1-1999. The staff

determined that use of these source terms in calculating liquid and gaseous effluents, and as design parameters for the LWMS and GWMS discussed in SE Sections 11.2 and 11.3, respectively, 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 (ECLs).

The staff concludes that the applicant's proposed source terms, based on the guidance given in SRP Section 11.1 and ANSI/ANS-18.1-1999, will be acceptable in calculating liquid and gaseous effluents and as design parameters for the LWMS and GWMS discussed in SE Sections 11.2 and 11.3, respectively, and will meet the regulatory requirements of 10 CFR Part 20 and 10 CFR Part 50, with respect to offsite radiation dose limits and ECLs.

11.2 Liquid Waste Management System

11.2.1 Introduction

The LWMS is designed to ensure that process fluid streams and liquid wastes produced during normal operation, including AOOs, 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 PWRs 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, SG 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 SWMS evaluated in SE Section 11.4.

11.2.2 Summary of Application

DCD Tier 1: The applicant provided a system description in DCD Tier 1, Section 2.7.6.1, "Liquid Waste Management System," summarized here, in part, as follows.

The LWMS is located in the compound building and is a nonsafety-related system with nonseismic components. The LWMS is designed to handle, process, store, and release the liquid radioactive waste generated during normal operation, including AOOs. The LWMS treats liquid radioactive waste using eight collection tanks, two reverse osmosis (R/O) package systems, and two monitoring tanks to collected treated effluent for staging confirmatory sampling and analysis. The R/O package system is designed to process liquid radioactive waste with a pretreatment module, an R/O module, and a demineralizer module. By sampling the monitoring tanks, the LWMS confirms that the radioactivity levels in the processed liquid waste are below the release limits before discharge. Each batch of collected effluent is sampled for confirmation that effluent concentrations are within discharge limits before discharge. DCD Tier 2, Section 11.2, "Liquid Waste Management System," contains detailed descriptions of the LWMS design and operational features.

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

In DCD Tier 2, Section 11.2, the applicant described 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 compound building, is a nonsafety-related system. Failure of the LWMS does not adversely affect any safety-

related system or component and performs no function related to the safe shutdown of the plant. DCD 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 the piping and structures housing the system. The LWMS is designed in accordance with the seismic criteria of RG 1.143 (Revision 2), “Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants.” Principal LWMS equipment is housed in portions of the compound building designed to contain the liquid inventory in the event of an operating-basis earthquake. The quality assurance (QA) program ensures LWMS equipment and installation are in accordance with the codes and standards of RG 1.143 listed in DCD Tier 2, Table 11.2-7, “Codes and Standards for Equipment in the LWMS,” for structures, systems, and components (SSCs) in radioactive waste facilities. The QA program is developed in accordance with ANSI/ANS-55.6-1993 (R2007), “Liquid Radioactive Waste Processing for Light Water Reactor Plants.” The LWMS does not normally process nonradioactive secondary system effluent. The APR1400 is designed with no interconnections or sharing between systems or between units. This is to prevent contamination due to potential radioactivity or backflow, which would make water unfit for human consumption (DCD Tier 2, Section 9.2.4, “Domestic Water and Sanitary Systems”).

DCD Tier 2, Figure 11.2-1, “Liquid Radwaste System Flow Diagram,” depicts the process flow from the LWMS to the point of release. DCD Tier 2, Figures 1.2-23 to 1.2-30 present the general arrangement of the compound building in which the LWMS is located. DCD Tier 2, Sections 9.2, “Water Systems,” 9.3, “Process Auxiliaries,” and 10.4, “Other Features of Steam and Power Conversion System,” describe the equipment and floor drain drainage systems, as well as the origins and discharges of nonradioactive effluents. The boundary of the liquid waste processing system starts at the interface valves for each of the input waste streams that contain potential radioactive material from other plant systems and ends at the isolation valve of the discharge lines to a liquid-containing tank or the discharge header. For many of the waste streams, the boundary of the LWMS starts at the sump pump discharge isolation valves from the respective building sump. The boundary of the liquid waste processing system ends at the isolation valve of the discharge lines to a liquid-containing tank or the discharge header.

The LWMS comprises four subsystems to treat the major and minor liquid waste streams:

(1) Equipment drainage

(2) Floor drain processing

(3) Detergent drain

(4) Chemical drain

The liquid waste processing system, equipment drainage, floor drainage processing, detergent drain, and chemical drain systems consist of eight waste collection tanks (WCT), where each system contains two WCTs that can then be processed by a common R/O module. The LWMS is designed to operate with a tank-to-tank manual batch operation according to the plant condition. Each R/O module has four modules: pre-treatment, R/O, demineralizer, and concentrate feed. Once the effluent is processed by the R/O module, it is transferred to a monitoring tank where the effluent is sampled, analyzed, and released, once found to be within NRC regulatory limits.

The LWMS design provided in DCD Tier 2, Table 11.2-6, “Equipment List in the LWMS (Sheets 1 through 3),” includes the following nominal tanks:

- Two 68,137 liter (L) (18,000 gallon (gal)) floor drain tanks
- Two 68,137 L (18,000 gal) equipment waste tanks
- Two 34,069 L (9,000 gal) chemical waste tanks
- Two 102,206 L (27,000 gal) monitoring tanks
- One 1,703 L (450 gal) acid storage tank
- One 189 L (50 gal) acid batch tank
- One 1,703 L (450 gal) caustic storage tank
- One 1,741 L (460 gal) seal water storage tank
- One 189 L (50 gal) caustic batch tank
- One 416 L (110 gal) chemical additive tank
- Two 22,712 L (6,000 gal) detergent waste tanks

DCD Tier 2, Table 11.2-6, contains information for pump capacities in the LWMS and also includes “miscellaneous” information that provides some design information on the detergent waste filter, the seal water heat exchanger, and the R/O package.

Operation and monitoring of the LWMS is performed from the radwaste control room with provisions for local monitors. The LWMS operates on a batch basis with manual start and automatic stops. Parameters such as tank levels, processing flow rates, differential pressures across filters, and ion exchange columns, are indicated, alarmed, or both, to provide information on operational and equipment performance. High-level alarms associated with the liquid tanks are activated in the main control room (MCR). DCD Tier 2, Table 11.2-8, “Radioactive Atmospheric Tank Overflow Protection,” contains a summary of indications, level annunciations, and overflows for the LWMS. Two liquid radwaste discharge radiation detector and dual isolation valves are installed on the sole discharge line from the LWMS to monitor and control liquid effluent discharges to the environment.

The SG blowdown radiation monitor measures the radiation level in the SG blowdown water after it is treated and before it is returned to the condensate storage tank. A sample from the SG blowdown mixed-bed demineralizers is monitored for radiation. In the event of primary-to-secondary system leakage due to an SG tube leak with radiation monitored above a predetermined setpoint, an alarm is automatically initiated for operator actions in the MCR, and the valve through which treated liquid is sent to the discharge header is automatically turned off. A detailed description of the SG blowdown system can be found in Section 10.4.8 of this SE.

Design features are also provided in the LWMS to control and maintain personnel doses ALARA. Filters such as the activated carbon filter and ion exchange columns are remotely handled to eliminate direct contact and reduce potential exposures. Components that require inspections, such as tanks, are located in cubicles with access doors to allow quick ingress and

egress. Components that require maintenance, such as pumps, are located in low-radiation corridors outside the equipment cubicles. Tanks, equipment, and pumps used for storing and processing radwaste are located in controlled areas and are shielded, based on design-basis source term inventories.

The COL licensee will conduct LWMS preoperational inspections and testing to ensure that all subsystems are operationally ready and meet their design bases and performance specifications 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 licensee will develop administrative procedures governing the operation of all subsystems, control the treatment of various process and waste streams, and prevent accidental discharges into the environment.

In assessing the radiological impacts from radioactive liquid effluent releases, the DCD provides the text and tables in DCD Section 11.2 to present information supporting the development of the liquid source term, as well as compliance with the ECLs of 10 CFR Part 20, Appendix B, Table 2, Column 2, and 10 CFR 20.1301(e), insofar as it requires meeting the U.S. Environmental Protection Agency (EPA) environmental radiation protection standards of 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," and the numerical design objectives of 10 CFR Part 50, Appendix I. The results show that expected annual liquid effluents released during normal operation, including AOOs, in unrestricted areas and doses to members of the public comply with the NRC regulations and conform to NRC guidance. As discussed in SE Section 11.2, the results also demonstrate compliance with the ALARA requirements of 10 CFR Part 50, Appendix I, and SRP acceptance criteria for the postulated failure of a liquid tank containing radioactivity.

ITAAC: The ITAAC associated with DCD Tier 2, Section 11.2, appear in DCD Tier 1, Section 2.7.6.1, "Liquid Waste Management System," and Table 2.7.6.1-2, "Liquid Waste Management System ITAAC." Table 2.11.3-2, "Containment Isolation System ITAAC," describes the ITAAC associated with the LWMS equipment, components, and piping and that comprise a portion of the containment isolation system. DCD Tier 2, Section 14.3.2.7, "ITAAC for Plant Systems," summarizes how the applicant developed ITAAC for DCD Tier 1, Section 2.7.6.1.

TS: Information pertinent to TS is associated with the LWMS in DCD Tier 2, Section 11.2.3.2, "Radioactive Effluent Releases due to Liquid Containing Tank Failures," Section 11.2.3.3, "Offsite Dose Calculation Manual," and Chapter 16, "Technical Specifications," TS 5.5.1, "Offsite Dose Calculation Manual (ODCM)," TS 5.5.4 "Radioactive Effluents Controls Program," TS 3.4.15, "RCS Specific Activity," and TS 5.5.12, "Explosive Gas and Storage Tank Radioactivity Monitoring Program."

10 CFR 20.1406: There is information pertinent to 10 CFR 20.1406 in DCD Tier 2, Sections 11.2.1.2, "Design Criteria," 11.2.1.6, "Mobile or Temporary Equipment," and 11.2.2.4, "Design Features for Minimization of Contamination."

COL Information or Action Items: See Section 11.2.5 below.

Technical Report(s): There are no technical reports associated with this area of review.

Topical Report(s): There are no topical reports associated with this area of review.

APR1400 Interface Issues Identified in the DCD: There are no APR1400 interface issues associated with this area of review.

Site Interface Requirements Identified in the DCD: There are no site interface requirements associated with this area of review.

Cross-Cutting Requirements (TMI, USI/GSI, Op Ex): There are no cross-cutting issues for this area of review.

RTNSS: There are no RTNSS issues for this area of review.

CDI: This DCD section does not contain CDI that is outside the scope of the APR1400 certification.

11.2.3 Regulatory Basis

SRP Section 11.2, "Liquid Waste Management System," provides the relevant requirements of the NRC regulations for the LWMS and the associated acceptance criteria, as well as review interfaces with other SRP sections. The following acceptance criteria are applicable:

- 10 CFR 20.1301, "Dose Limits for Individual Members of the Public," as it relates to dose limits for individual members of the public
- 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 and doses in unrestricted areas
- 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
- 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
- 10 CFR 50.36a, "Technical Specifications on Effluents from Nuclear Power Reactors," as it relates to TS requiring that operating procedures be developed for radiological monitoring and sampling equipment as part of the administrative controls and surveillance on effluent controls in meeting the ALARA criterion and 10 CFR 20.1301
- 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 ALARA criterion of Appendix I
- 10 CFR Part 50, Appendix A, GDC 60, as it relates to the design of LWMS to control releases of liquid radioactive effluents
- GDC 64, "Monitoring Radioactivity Releases," as it relates to the design of LWMS to monitor for radioactivity that may be released from normal operations, including AOOs, and from postulated accidents

- 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

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

- 10 CFR 52.47(b)(1), “Contents of Applications; Technical Information,” which requires that applications for DCs 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 DC is built and will operate in accordance with the DC and provisions of the Atomic Energy Act of 1954, as amended, and NRC regulations

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

- 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

- RG 1.110, as it relates to performing a CBA for reducing cumulative doses to populations by using available technology

- RG 1.112, as it relates to the acceptable methods for calculating annual average releases of radioactivity in effluents

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

- RG 1.143, 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

- RG 1.206, “Combined License Applications for Nuclear Power Plants,” as it relates to the minimum information requirements specified in 10 CFR 52.79, “Contents of Applications; Technical Information in Final Safety Analysis Report,” to be submitted in a COL application

- RG 1.33, “Quality Assurance Program Requirements (Operation),” Revision 2, issued February 1978, as it relates to QA for operating the LWMS provisions for sampling and monitoring radioactive materials in process and effluent streams and controlling radioactive effluent releases to the environment

- RG 4.21, “Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning,” issued June 2008, as it relates to minimizing both the contamination of

equipment, plant facilities, and the environment and the generation of radioactive waste during plant operation

- 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

- NUREG-0017 (Revision 1), as it relates to the methodology for calculating gaseous and liquid effluent releases

- NUREG-1301, “Offsite Dose Calculation Manual [ODCM] Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors,” issued April 1991, as it relates to ODCM guidance for PWR plants

- NUREG-0133, “Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants,” issued October 1978, as it relates to the methodology for assessing liquid tank failures using the RATAF code

- NUREG/CR-4013, “LADTAP II—Technical Reference and User Guide,” as it relates to the methodology for calculating liquid effluent doses

- Generic Letter (GL) 89-01, “Implementation of Programmatic and Procedural Controls for Radiological Effluent Technical Specifications,” Supplement No. 1, dated November 14, 1990, as it relates to an operational program that addresses the development of a site-specific radiological environmental monitoring program

- Inspection and Enforcement (IE) Bulletin 80-10, “Contamination of Nonradioactive System and Resulting Potential for Unmonitored, Uncontrolled Release of Radioactivity to Environment,” dated 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

- ANSI/ANS-18.1-1999, as it relates to the methodology for determining the source term for normal reactor operations, including AOOs

11.2.4 Technical Evaluation

The staff reviewed the LWMS using the guidance and acceptance criteria of SRP Section 11.2.

11.2.4.1 Design Considerations

11.2.4.1.1 Waste Collection and Storage

The LWMS ensures that liquids and liquid wastes processed during normal operation, including AOOs, are handled, processed, stored, and released or routed to their final destination in accordance with the relevant NRC regulations. The LWMS is designed to monitor, control, collect, process, handle, store, and dispose of liquid radioactive waste generated during normal plant conditions, including AOOs. The LWMS comprises the floor drain, equipment waste, chemical waste, and detergent waste subsystems.

The floor drain, including the reactor containment and Auxiliary Building (AB) floor drains and compound building drains, are routed to the floor drain subsystem and processed by the R/O

package. Two floor drain tanks are provided and cross-connected to two equipment drain tanks by the common header and overflow piping on each tank. During normal operation, the waste from the floor drain subsystem is collected and stored in the floor drain tanks. Each floor drain tank is housed in a separate cubicle with individual leak detection available and sloped epoxy-coated floors to facilitate drainage and cleaning.

The equipment wastes, including the AB equipment drains, are routed to the equipment waste subsystem, where wastes are processed by the R/O package. Two equipment waste drain tanks are provided and cross-connected to two floor drain tanks by the common header and overflow piping on each tank. During normal operation, the waste from the equipment waste drain subsystem is collected and stored in the equipment waste drain tanks. Each equipment waste drain tank is housed in a separate cubicle with individual leak detection available and sloped epoxy-coated floors to facilitate drainage and cleaning.

Chemical wastes, including from the high-level laboratory, low-level laboratory, fuel handling area, and equipment decontamination drains, are directed to the chemical waste subsystem where wastes are normally processed by the R/O package. The chemical drain sump in the AB collects chemical waste from the power block and transfers it to the chemical waste tanks. Two chemical waste tanks receive the influent from a common inlet header. Under normal conditions, one tank is filled while another is on standby. The chemical waste tanks are equipped with cross-connected and overflow piping. The chemical waste tank also collects borated waste from the boric acid concentrator in the chemical volume and control system. Each chemical waste drain tank is housed in a separate cubicle with individual leak detection available and sloped epoxy-coated floors to facilitate drainage and cleaning.

Two detergent waste tanks receive detergent wastes from personal decontamination stations and detergent-type decontamination solutions. These wastes are normally filtered and discharged directly through the LWMS discharge line and are radiologically monitored. In the event that a monitor detects radiation above a certain setpoint, the detergent wastes are routed to the chemical waste tanks where the detergent waste is then processed by the R/O package.

11.2.4.1.2 Waste Processing

In DCD Tier 2, Section 11.2.2.1.3, the applicant described the waste processing system for the LWMS. The LWMS has two R/O packages for processing. Each R/O package has four modules: pretreatment, R/O, demineralizer, and concentrate feed. The pretreatment module is the first stage in which liquid wastes are passed through a pretreatment module that removes oily and suspended solids to maintain performance of the subsequent modules. The water that passed through the pretreatment module then proceeds to the R/O module for the removal of ionic activation products, which are in either particulate or ionic form. The module that follows the R/O module is the demineralizer module. After the demineralizer further treats the waste that flowed from the previous modules, the water is transferred to the respective monitoring tanks for the floor, equipment waste, and chemical waste drains. Once in the monitoring tanks, the water is sampled and analyzed before discharge.

11.2.4.1.3 Waste Monitoring and Discharge

DCD Tier 2, Section 11.2.2.2, contains the information on the LWMS monitoring and discharge. The LWMS monitoring tanks collect the liquid processes through the R/O package. A waste sampling analysis is first performed to determine the chemical composition, gross gamma activity, and pH. The sample is obtained while the tank contents are being recirculated, in compliance with American Society for Testing and Materials (ASTM) D-3370-07, “Standard

Practices for Sampling Water from Closed Circuits," to ensure a sample is taken that is representative of the tank's current concentration. The monitoring tank is then treated by a chemical addition process to adjust the pH of the effluent before monitoring and discharge.

As described in the DCD, if the water quality and radionuclide concentrations of the contents in the monitoring tank meet the specifications, the effluent is either sent to CVCS holdup tanks for plant reuse, or if the water is determined acceptable for offsite release, the contents will be discharged for release. The LWMS is designed to control the release of effluent to the limits of 10 CFR Part 20, Appendix B, Table 2, before release. The LWMS has the ability to recycle effluent for further treatment when the effluent is not below the regulatory limits. The release of effluent is also continuously monitored by dual inline radiation monitors that will alarm in the MCR and radwaste control room and simultaneously turn off the monitor tank pump and close the effluent discharge lines to prevent the release of radioactive effluents above regulatory limits. The controls described in the DCD to monitor effluent releases satisfy GDC 64.

The staff determined that the design considerations described by the applicant adequately describe methods to limit doses to members of the public by having alarms to the MCR and radwaste control room to inform operators of a release that exceeds 10 CFR Part 20, Appendix B, Table 2, requirements. In addition, to satisfy 10 CFR 50.34a, the applicant's design for treating effluents below regulatory dose limits explains how the LWMS processes effluent, including a description of the tanks, overflow measures that minimize contamination, and cross-connections established between common tanks. The applicant also satisfies 10 CFR 50.34a with a description of the R/O package and the modules within, included in the waste processing section.

In review of the information provided in DCD Section 11.2.1.3, the staff issued RAI 230-8201, Question 11.02-06 (ML15271A133), to request clarification for the following staff concerns. Initially, the applicant stated there are options for operators to initiate and terminate the operations process and select components to achieve treatment objectives. The staff asked the applicant to clarify the actions to be taken to limit doses to workers and members of the public from effluent releases. Second, the applicant also stated that a COL applicant would provide a piping and instrumentation diagram (P&ID) for review; this did not allow the staff to determine the process flows to ensure control of radioactive releases. Third, in the description of waste input streams in DCD Section 11.2.2.1.1, the DCD text suggests there potentially may be additional liquid effluent pathways other than those described. The staff requested clarification on liquid release pathways. Lastly, the staff requested a comprehensive list of waste pathways to verify an adequate control of contamination and radioactive releases.

In its response to RAI 230-8201, Question 11.02-06, dated February 3, 2016 (ML16034A291), the applicant answered the staff's four questions:

(1) In response to the staff's initial question requesting the actions an operator would take to maintain dose limits, the applicant revised DCD Section 11.2.1.3 to explain that an operator can initiate treatment using one of two trains of available equipment.

(2) In the second response, for P&IDs for the effluent release pathway, the applicant provided the P&IDs concerning the release of processed effluent, which is found in DCD Figures 11.2-1, Liquid Radwaste System Flow Diagram (1 through 7). The staff reviewed these diagrams and reference to the DCD Section 11 figure and confirmed its acceptability.

(3) In response to the third question regarding the terminology "including but not limited to," the applicant provided DCD markups in DCD Section 11.2.2.1.1 to indicate there are no additional pathways in the design, apart from those discussed in Section 11.2. The staff verified the changes and finds this response acceptable.

(4) In the final response, concerning the actions taken once a small amount of fluid is accumulated in the drain pipe and the operators receive an alarm for action, the applicant discussed the operator actions included in DCD Section 11.2.2.1.2.

The applicant also stated that a COL licensee will develop programs and procedures per COL 11.2(2), COL 11.2(7), and COL 11.2(8) to demonstrate a comprehensive listing of waste pathways to satisfy the controls for minimizing contamination.

The staff finds the proposed changes described above to be acceptable additions to the DCD. Based on its review of the DCD, the staff confirmed that the proposed changes have been incorporated. Therefore, the staff considers RAI 230-8201, Question 11.02-06, to be resolved and closed.

11.2.4.1.4 General Design Criteria 60, 61, and 64

GDC 60 requires that the nuclear power unit design include provisions to handle radioactive wastes produced during normal reactor operations, including AOOs. GDC 61 requires that the fuel storage and handling, radioactive waste, and other systems that may contain radioactivity be designed to ensure adequate safety under normal and postulated accident conditions. GDC 64 requires that the LWMS be designed to monitor radiation levels and radioactivity in effluents, as well as radioactive leakages and spills, during routine operations, including AOOs.

The applicant meets the requirements of GDC 60 and 61 by using the regulatory positions in RG 1.143, as they relate to the seismic design; quality group classification of components used in the LWMS 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.

The staff reviewed the QA and RG 1.143 provisions specified by the applicant in the DCD. The applicant states that the LWMS will conform to the QA regulatory position stated in section C.7 of RG 1.143 and RG 1.33 which indicates the QA guidance to follow. This guidance is used to determine the radwaste system classifications based on specified system source term values. DCD Tier 2, Table 3.2-1 also identifies the seismic category, quality group, and safety class for LWMS components. The QA program is stated to be designed in accordance with ANSI/ANS-55.6, which is in agreement with RG 1.143, position C.7. In determining the design guidance for radwaste systems, the applicant provided tables in the DCD, DCD Tier 2, Tables 11.2-13 and 11.2-14, to reflect the guidance contained in RG 1.143 to meet the A_1 and A_2 values in 10 CFR Part 71, "Packaging and Transportation of Radioactive Material," Appendix A, "Determinations of A_1 and A_2." The staff was unable to verify the results calculated by the applicant in accordance with RG 1.143 and provided in DCD Tables 11.2-13 and 11.2-14. The staff determined that the applicant's analysis was using a value of 0 in place of values that were not listed in 10 CFR Part 71, Appendix A, Table 1. This approach did not appear to conform to the text preceding Table 1, which states: "For individual radionuclides whose identities are known, but which are not listed in Table A-1, the A_1 and A_2 values contained in Table A-3 may be used. Otherwise, the licensee shall obtain prior Commission approval of the A_1 and A_2 values for radionuclides not listed in Table A-1, before shipping the material." The staff's confirmatory calculations used the values specified by Table 3 in Appendix A when

determining the A_1 and A_2 values. The staff determined that by using 0 in place of what Appendix A describes could change the radwaste system classifications for each system.

The staff issued RAI 156-8146, Question 11.02-02, dated August 18, 2015 (ML15230A276), requesting the applicant to evaluate the use of the values specified in determining the A_1 and A_2 values to determine radwaste system classifications. In its response to RAI 156-8146, Question 11.02-2, dated September 17, 2015 (ML15260B438), the applicant provided information indicating compliance with RG 1.143 by using the A_1 and A_2 values in 10 CFR Part 71, Appendix A. The applicant's response stated that there is no contribution from niobium-95, praseodymium-144, yttrium (Y)-89m, Y-90m, rhodium-106m, xenon (Xe)-133m, and Xe-135m, since the LWMS does not contain these nuclides in the source term. The applicant also stated that, since the nuclides barium (Ba)-137m, bromine (Br)-84, rubidium (Ru)-88, and tellurium (Te)-131 have short half-lives, their contribution to the overall total is insignificant. The applicant demonstrated this in Table 2 of its response. The table contains the nuclide contributions from Ba-137m, Br-84, Rb-88, and Te-131, where the table shows that their contribution to the overall total is so small that the result is not seen in the totals for determining RG 1.143 compliance. As a result, the staff determined that the response to this RAI is acceptable based on the staff's confirmatory calculations, and considers RAI 156-8146, Question 11.02-02, to be resolved and closed.

The staff's review of Section 11.2.2 of the DCD, describing systems intended to meet the guidance of RG 1.143, also states: "The safety classification for the LWMS components applies to components up to and including the nearest valves, fittings, and/or welded/flanged nozzle connections." The staff determined that this description does not satisfy requirements for defining systems up to their nearest isolation component and that DCD Tier 2, Section 11.3.1.3 includes an example of the necessary description for defining systems up to their nearest isolation component as they relate to the GWMS. In RAI 228-8193, Question 11.02-5, dated September 28, 2015 (ML15296A002), the staff requested the applicant to provide a description that, similar to the Section 11.3.1.3 description, contains all components, including the nearest isolation component. In its response to RAI 228-8193, Question 11.02-05, dated December 2, 2015 (ML15336B002), the applicant proposed DCD changes to reflect the RAI request. The applicant made changes to DCD Tier 2, Section 11.2.2.3 and Section 11.3.2.1, to consistently describe the component boundaries for each radwaste safety classification. The staff finds this response acceptable, since it is consistent with the guidance contained in RG 1.143. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 228-8193, Question 11.02-05, to be resolved and closed.

11.2.4.1.5 Steam Generator Blowdown and Blowdown Treatment Systems

While Chapter 11 does not describe the steam generator blowdown system (SGBS), the SGBS is an SSC that falls under the guidance of RG 1.143, Revision 2, with its resulting radwaste processed by the LWMS and SWMS. DCD Tier 2, Table 10.4.8-1, "Steam Generator Blowdown System Major Component Design Parameters," provides the radwaste safety classifications for the components in the SGBS. The flash tank, regenerative heat exchangers, post filter, and demineralizers are all components classified as RW-IIc. This part of the SGBS is located in the AB, which is classified as seismic Category I. This seismic classification is more robust than the RW-IIc system classification and is therefore acceptable for housing these radwaste system components. The safety classification for the SGBS components applies to the components, up to and including the nearest valves, fittings, and welded or flanged fittings. The staff issued RAI 254-8270, Question 11.2-07, dated October 19, 2015 (ML15293A568), to clarify the point at which the SGBS begins and ends for the radwaste system classification because the current

wording does not include the nearest isolation component as part of its description. In its response to RAI 254-8270, Question 11.2-07, dated January 20, 2016 (ML16020A523), the applicant proposed changes to DCD Tier 2, Section 10.4.8 to explain that the system classification starts and ends at the nearest isolation valve. The applicant revised the DCD to include the nearest isolation valve in its definition. The staff finds this response acceptable and consistent with the guidance in RG 1.143. However, the staff noted that, for similar RAIs, the applicant has provided slightly different responses. As a result, the staff requested that the applicant make consistent updates to DCD Tier 2, Sections 10.4.8, 11.2, 11.3, and 11.4, when discussing the start and end points for the RG 1.143 radwaste system classifications.

In addition to the revisions being made as a result of RAI 254-8270, Question 11.02-07, the staff requested that the applicant provide the SGBS component source terms used for determining the radwaste system classifications in DCD Tier 2, Section 10.4.8. The source term for these components is based on 1-percent failed fuel and an SG leak rate of 34.02 kg (75 pounds) per day. In its revised response to RAI 254-8270, Question 11.02-07, dated July 6, 2016 (ML16188A395), the applicant provided the design basis radioactive source terms for the SGBS components within DCD Tier 2, Section 10.4.8. From the source terms provided in the new table, DCD Tier 2, Table 10.4.8-4, "Design Basis Radioactive Source Terms for SGBD Components (1% Fuel Defect)," the staff performed confirmatory calculations to confirm the radwaste system classification for these components. The staff confirmed the classifications and found them to be acceptable. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 254-8270, Question 11.02-07, to be resolved and closed.

The staff issued RAI 254-8270, Question 11.02-08, on October 19, 2015 (ML15293A568), to request that the applicant revise the statement in DCD Tier 2, Section 10.4.8.1.2 to indicate that the building meets or exceeds the design requirements of RW-IIa. In its response to RAI 254-8270, Question 11.02-08, dated January 20, 2016 (ML16020A523), the applicant proposed changes to DCD Tier 2, Section 10.4.8 to state that the AB has an RW-IIa classification. The staff finds this response acceptable, since the RW-IIa classification is consistent with the components contained in the SGBS, using the guidance in RG 1.143. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 254-8270, Question 11.02-08, to be resolved and closed.

11.2.4.2 10 CFR Part 50, Appendix I, Liquid Effluent Doses

The staff reviewed Section 11.2 of the DCD to verify compliance with 10 CFR Part 50, Appendix I, Sections II.A and II.D. The applicant calculates the liquid effluent release doses using the NRC approved LADTAP II computer code. Using the data provided by the applicant's tables and LADTAP II input and output files, the staff performed a confirmatory calculation of the liquid effluent release doses stated in DCD Table 11.2-5.

In performing confirmatory dose calculations, the staff observed the use of consumption factors 100 times less than originally reported by the applicant in its input files and DCD tables. These values did not agree with RG 1.109, Table E-5. The staff issued RAI 123-7920, Question 11.01-03, on August 4, 2015 (ML15227A003), to request liquid effluent dose calculation packages so that the staff could review the justifications for the site-specific consumption factors being used and determine if an error had occurred with the applicant's calculation. In its response to RAI 123-7920, Question 11.01-03, dated September 14, 2015 (ML15278A149), the applicant provided information to support the identified error in its input and output files and also provided updated input and output files for the LADTAP II code. The staff

confirmed an error within the applicant's input file that caused its values to output results 100 times less than intended. However, in the supporting output files and DCD changes, the applicant appeared to reference different consumption factors, specifying values that were not referenced in the text of the response. In this response, the applicant provided conflicting information on the irrigation rate used in the LADTAP II input file. As a result, the staff issued follow up RAI 377-8487, Question 11.02-10, on January 28, 2016 (ML16028A039), to request that the applicant provide DCD updates to specify the consumption factors and the irrigation rate being used. In its response to RAI 377-8487, Question 11.02-10, dated April 16, 2016 (ML16107A013), the applicant included a direct reference to the consumption rates from RG 1.109 being used and also confirmed the correct irrigation rate, 41.68 L/square meter (m^2) -month, to be used in the analysis. The staff performed a confirmatory calculation based on the additional information provided and agreed with the applicants calculation and considers RAI 123-7920, Question 11.01-3; and RAI 377-8487, Question 11.02-10**,** to be resolved and closed.

In reviewing the tables in DCD Tier 2, Section 11.3, the staff found an inconsistency with the data presented in DCD Tier 2, Section 11.2.3.1. There was no corresponding table to reflect compliance doses in Section 11.2. The staff issued RAI 361-8431, Question 11.02-9, on January 11, 2016 (ML16011A251), to ask that the DCD discuss the liquid effluent doses in Section 11.2.3.1 and provide a summary of the liquid effluent dose analysis in the liquid effluent dose tables in Section 11.2. In its response to RAI 361-8431, Question 11.02-9, dated February 16, 2016 (ML16047A031), the applicant provided updates to DCD Table 11.2-5 to summarize the data output from the LADTAP II code. The staff finds this response acceptable and confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 361-8431, Question 11.02-09, to be resolved and closed.

In DCD Tier 2, Table 11.2-4, the applicant provided a summary of the liquid inputs used for the LADTAP II code. This table includes a pointer to describe the use of Table 11.2-1 for the liquid effluent curies per year (Ci/yr) source term for the analysis. This source term was confirmed by the staff in its review of the GALE code in SER Section 11.1. The staff also confirmed the use of the RG 1.109 default values, since this design does not have site-specific values to reference for the calculation.

To confirm the results provided by the applicant in DCD Tier 2, Table 11.2-5, the staff used the LADTAP II inputs reported in DCD Tier 2, Table 11.2-4. The results of the staff's confirmatory calculation indicated that the estimated total body dose is 2.82E-2 millisieverts (mSv)/yr (2.82E0 millirem (mrem)/yr), and that the maximum organ, the gastrointestinal-lower large intestine (GI-LLI), is estimated to receive 4.76E-2 mSv/yr (4.76E0 mrem/yr). In DCD Tier 2, Section 11.2.3.1, and DCD Tier 2, Table 11.2-5, the applicant reports a total body dose of 2.76E-2 mSv/yr (2.76E0 mrem/yr), and a maximum organ dose to the liver of 4.05E-2 mSv/yr (4.05E0 mrem/yr). SE Table 11.2-1 compares the applicant's and staff's results against the effluent dose design objectives in 10 CFR Part 50, Appendix I.

Table 11.2-1 Comparison of the Applicant's and NRC's Estimated Annual Individual Doses from Liquid Effluent Releases in mSv/yr (mrem/yr)

PATHWAY	APPLICANT RESULTS	NRC RESULTS	DESIGN OBJECTIVE
Total Body	2.76E-2 (2.76E0)	2.82E-2 (2.82E0)	3.0E-2 (3.0E0)
Max Organ Annual Individual Doses	4.05E-2 (4.05E0) Child Liver	4.76E-2 (4.76E0) Adult GI-LLI	0.1E-1 (1.0E1)

The staff's review determined that the applicant accurately calculated the liquid effluent release doses and the results are below the design objective values for 10 CFR Part 50, Appendix I. The staff's confirmatory calculations find the applicant results acceptable.

The staff confirmatory determination is based on the use of nonsite-specific data for the analyses. Presently, the applicant uses conservative estimates in their LADTAP II analysis to show the bounding results for liquid releases at any chosen site. The staff finds these results acceptable, since the applicant also includes a COL item for a COL applicant referencing this design. Following COL 11.2(13), the COL applicant is to calculate doses to members of the public following the guidance of RG 1.109 and RG 1.113, using site-specific parameters, and to compare the doses due to the liquid effluents with the numerical design objectives of Appendix I to 10 CFR Part 50, 10 CFR 20.1302, and 40 CFR Part 190.

11.2.4.3 Site-Specific Cost-Benefit Analysis

DCD Tier 2, Section 11.2.1.5, "Site-Specific Cost-Benefit Analysis," describes the LWMS design for use at any site with flexibility to incorporate site-specific requirements with minor modifications, such as technology preference, degree of automated operation, and radioactive waste storage. RG 1.110 describes an acceptable method of performing a CBA to demonstrate that the LWMS design includes all items of reasonably demonstrated technology for reducing to ALARA levels cumulative population doses from releases of radioactive materials from each reactor. The applicant stated that, for the APR1400 designs, the CBA demonstrates that the addition of items of reasonably demonstrated technology will not provide a more favorable cost benefit but does not include the CBA in DCD Tier 2, Section 11.2.1.5. The COL applicant will provide the site-specific CBA to demonstrate compliance with the requirements of 10 CFR Part 50, Appendix I, Sections II.A and II.D, under COL 11.2(5). Because the CBA requires site-specific information, which is outside the scope of the requested DCD, the staff finds the inclusion of COL 11.2(5) acceptable.

11.2.4.4 10 CFR Part 20, Appendix B, Effluent Concentration Limits

The applicant provided DCD Table 11.2-10, "Design Basis Liquid Effluent Concentrations at the Site Boundary," to demonstrate compliance with the annual average liquid release concentrations to meet the 10 CFR Part 20, Appendix B, Table 2, Column 2, "unity rule," concentration limit identified in Note 4 of Appendix B. The applicant's tabulation included site concentrations that encompassed liquid effluent releases from a proposed new APR1400 unit. The staff notes that the liquid effluent site concentrations appear to be below the limits in

10 CFR Part 20, Appendix B, Table 2, Column 2, and the unity calculation described in Note 4. The staff performed an independent confirmatory assessment of the results presented in DCD Table 11.2-10 and all associated calculations. The staff finds that, based on the total liquid estimated to be discharged from the site, the concentrations of radioactive materials present in liquid effluents and discharged in unrestricted areas, listed in DCD Tier 2, Table 11.2-10, indicated compliance with the limits specified in 10 CFR Part 20, Appendix B, Table 2, Column 2, and that the sum of the ratios meets the 10 CFR Part 20, Appendix B, "unity rule."

11.2.4.5 10 CFR Part 20.1301(e), Compliance with 40 CFR Part 190

Using the applicant's LADTAP II code input/output files and response, the staff reviewed the doses from liquid effluent releases to members of the public in unrestricted areas to evaluate compliance with 10 CFR Part 50, Appendix I; 10 CFR 20.1302, and 40 CFR Part 190. Input values pertaining to environmental characteristics (i.e., the hydrologic model, water type, dilution factors, irrigation rates, usage and consumption factors, and exposure pathways) rely on site-specific information addressed by the COL applicant in COL 11.2(13).

Under COL 11.2(13) in DCD Tier 2, Section 11.2.3.1, the COL applicant is required to calculate doses to members of the public using site-specific parameters, following the guidance of RGs 1.109 and 1.113, and compare doses from liquid effluents with the dose limits in 10 CFR Part 50, Appendix I; 10 CFR 20.1302; and 40 CFR Part 190. The staff finds that, because the site-specific input parameter values used in the LADTAP II code calculation of liquid effluent doses are outside the scope of the requested DC, the inclusion of COL 11.2(13) is acceptable.

11.2.4.6 Minimization of Contamination, 10 CFR 20.1406

The staff reviewed the information presented in DCD Tier 2, Section 11.2, against the criteria in 10 CFR 20.1406 for minimizing contamination. Compliance with 10 CFR 20.1406 is achieved when the applicant identifies those design features used to minimize the release of radioactive liquid to the environment.

The applicant provided DCD Tier 2, Section 11.2.2.4, "Design Features for Minimization of Contamination," to describe how the design meets the requirements of 10 CFR 20.1406. In this section, the applicant committed to use RG 4.21 and described the use of the principles in the RG to demonstrate compliance with 10 CFR 20.1406. The design features described in DCD Tier 2, Section 11.2.2.4, include system components, such as the collection and monitoring tanks that are fabricated of stainless steel material and are welded for life-cycle planning. The tanks are designed to provide temporary storage of the liquid waste generated from normal operations, including AOOs. The tanks are also equipped with cross-connected inlet headers to control overflow and to allow for timely processing. Mixing eductors minimize the settling of suspended solids, and the tank internals have been polished to minimize crud traps. Tanks have monitors and alarms to the MCR in the event of high liquid levels, and the cubicles where LWMS tanks are located are designed to include leak detection instrumentation to initiate alarms for operator actions. The LWMS waste streams, floor drains, equipment drains, chemical drains and detergent wastes are collected in different tanks. This design feature minimizes cross contamination and waste generation. Under COL 11.2(7), a COL applicant is required to develop the leak identification program to determine site-specific components that contain radioactive materials, buried piping, embedded piping, leak detecting methods and capabilities, and methods used to prevent unnecessary contamination. Under COL 11.2(2), a COL applicant is required to prepare the operational procedures and maintenance program

related to leak detecting and contamination control. Both COL information items are acceptable to the staff for implementing the contamination minimization programs described in RG 4.21.

SER Section 12.4 evaluates additional design and operational features of SSCs intended to minimize contamination to the facility and environment and comply with 10 CFR 20.1406, using the guidance of RG 4.21. The applicant added DCD Tier 2, Section 12.4.2, "Minimization of Contamination and Radioactive Waste Generation," to discuss design features related to radiation protection.

11.2.4.7 Mobile or Temporary Equipment

The APR1400 LWMS is designed with permanently installed equipment. The APR1400 LWMS does not include mobile or temporary equipment. Considering the future use of mobile or temporary equipment in accordance with site-specific requirements, the LWMS provides connections for such equipment.

Under COL 11.2(6), the applicant is to determine that the use of mobile or temporary equipment and interconnections to plant systems conforms to regulatory requirements and guidance, such as is found in 10 CFR 50.34a, 10 CFR 20.1406, and RG 1.143. The staff finds the inclusion of this COL information item acceptable for meeting the guidance of RG 1.143 and the requirements of 10 CFR 50.34a and 10 CFR 20.1406 by ensuring mobile or temporary equipment meets the design guidance for SSCs containing radioactive waste.

The COL applicant is responsible for identifying mobile or portable LWMS connections that are considered nonradioactive but may later become radioactive through contact with or contamination by radioactive systems and for the preparation of operating procedures for mobile or portable LWMS connections in conformance with the guidance in Inspection Enforcement (IE) Bulletin 80-10. Under COL 11.2(4), an applicant will be responsible for preparing and providing the P&IDs to show the connections between existing systems and the mobile or temporary equipment that may become contaminated.

11.2.4.8 Radioactive Effluent Releases Due to Failure of Radioactive Liquid Tank

BTP 11-6 (Revision 3) describes provisions for acceptable design features, such as steel liners to mitigate the release of radioactive materials resulting from the postulated failure of a liquid waste tank located outside the containment. The applicant introduced a design change in the DCD that replaced steel liners, with an acceptable mitigative design feature, epoxy coatings. Section B.3, "Mitigating Design Features," of BTP 11-6 states, in regards to coatings, "[c]redit is not allowed for retention by coatings or leakage barriers outside the building foundation." When the applicant proposes a mitigative design feature, such as steel, and the staff finds it acceptable, a liquid tank failure analysis is not needed. DCD Section 11.2 proposes not to line LWMS cells or cubicles with stainless steel. Because the applicant's design uses epoxy coatings, the staff required the DCD to address the radiological consequences from a postulated failure of a liquid-containing tank, using the guidance in SRP Section 11.2, RG 1.206, and BTP 11-6.

DCD Tier 2, Section 11.2.3.2, "Radioactive Effluent Releases due to Failure of Radioactive Liquid Tank," describes the consequences of a postulated failed liquid tank with the numerical design objectives of 10 CFR Part 50, Appendix I, and the ECLs of 10 CFR Part 20, Appendix B, Table 2, Column 2, using the guidance in BTP 11-6 and NUREG-0133, Appendix A. Both Section 11.2.3.2 and Table 1.8-2 contain a COL information item for the COL applicant to address the site-specific hydrogeological data (such as contaminant migration time) and

analysis to demonstrate that the potential ground water contamination resulting from a radioactive release due to a liquid-containing tank failure is bounded by the analysis in the DCD. Because the hydrogeological data require site-specific information that is outside the scope of the requested DC, the staff finds the inclusion of COL 11.2(14) acceptable. However, the applicant revised COL 11.2(14) in its new approach to addressing the liquid tank failure analysis. The staff evaluates revised COL 11.2(14) later in this section.

The staff reviewed DCD Tier 2, Section 11.2.3.2, which refers to the applicant's analysis to support BTP 11-6 calculations. In DCD Tier 2, Section 11.2.3.2, the applicant assumes that effluents from this tank failure scenario will be diluted to 10 percent of the ECL and calculates the minimum dilution factor required to meet this assumption. The staff was unable to confirm the applicant's source term and did not agree that the applicant's assumption was appropriate, since the assumption does not appropriately reflect the guidance provided in BTP 11-6. In RAI 150-8144, Question 11.02-1, dated August 10, 2015 (ML15223B371), the staff requested the details of the applicant's calculation, since it had provided no significant detail for the staff to compare to its own confirmatory calculations.

In its response to RAI 150-8144, Question 11.02-01, dated January 8, 2016 (ML16008A153), the applicant provided source term information on three different CVCS yard tanks, the holdup tank (HUT), the boric acid storage tank (BAST), and the reactor makeup water tank (RMWT). Initially, the staff asked the applicant to describe how it was possible to make an assumption that a tank failure would be diluted to 10 percent of the limits. To justify this, the applicant first described how it met the intent of BTP 11-6, specifically pointing to the requirement for a tank to be 80 percent full when the applicant had been assuming 62 percent full, based on potential inputs to the tank. In its response, the applicant described a ratio to increase the overall source term, which would then reflect an 80 percent-full tank source term. The staff agrees with this approach to ensuring compliance with BTP 11-6. The applicant then stated that the calculation for 10 percent of the ECL is only to show the minimum dilution flow needed to achieve 10 percent of the ECL. The staff also agrees with the applicant's approach, given that a COL applicant referencing this design will need to ensure whatever the stated dilution factor is at the end of this calculation, based on site-specific factors, such as the location of the nearest receptors and the ground water hydrology. The applicant went on to provide the source term information, along with the tank volumes requested in Question 11.02-01. In the response, the applicant also provided a DCD markup to reflect changes to DCD Tier 2, Table 11.2-9. This DCD revision only makes changes to reflect the HUT. In reviewing the response, the staff determined that the applicant inappropriately identified the HUT as the limiting tank. Based on the RAI response, the staff performed a confirmatory calculation using the expected inventory of the CVCS, the referenced tank volumes, and the ECLs in 10 CFR Part 20, Appendix B, Table 2, and determined that the BAST was the limiting tank of the three tanks provided. The staff also asked for the DCD to include the BAST and RWMT inventories provided in the DCD text.

The staff raised these concerns and conducted an audit with the applicant on March 15, 2016, and March 16, 2016. During this audit, the staff raised its concerns over the information provided in the response, and the applicant agreed that the BAST was the limiting tank in the analysis in an updated RAI response (ML16123A266). However, as a result, the applicant dropped the assumption that the ECLs will be diluted to 10 percent of the limits, since making the BAST the limiting tank requires a significantly higher dilution factor to meet 10 percent of the ECLs. The staff agrees with this approach, since this approach describes compliance with the ECLs described in 10 CFR Part 20 Appendix B. In the applicant's analysis, the entire 95 percent volume of the tank would be released in the BAST scenario. The staff's own analysis in

determining an 80 percent release showed that the applicant's release scenario was conservative and required a higher dilution factor.

In its revised response to RAI 150-8144, Question 11.02-01, dated May 2, 2016 (ML16123A266), the applicant included changes that were consistent with discussions held during the March audit. In its response, the applicant described the BAST as the limiting tank and determined the dilution factor needed to meet the ECLs. In its own calculation, the staff confirmed this result and also agreed that the BAST is the limiting tank. In the revised response, the applicant also made DCD changes to reflect the inventories for all three tanks used in this analysis, and described a minimum dilution factor needed to meet the ECLs as specified in BTP 11-6. The staff also notes that, following COL 11.2(14), an applicant is required to perform an analysis to demonstrate that potential ground water or surface water contamination concentrations resulting from radioactive releases from the liquid-containing tank failure are in compliance with the limits in 10 CFR Part 20, Appendix B, Table 2. In review of the COL items and the information provided in DCD Tier 2, Section 11.2 to describe outdoor tank contents and volumes, the staff finds the response acceptable since it provides the necessary information needed for a site specific analysis. The staff confirmed that the proposed changes have been incorporated in the DCD. Therefore, the staff considers RAI 150-8144, Question 11.02-01, to be resolved and closed.

On March 17, 2017, the staff issued RAI 542-8731, Question 11.02-11 (ML17076A093) to request further details on the source term used in the applicant's analysis. In its response to RAI 13-7856, Question 12.02-02, Revision 2, dated October 5, 2016 (ML16279A528), the applicant provided a 0.25 percent failed fuel source term. For the BTP 11-6 analysis a 0.12 percent failed fuel source term is used. However, the previously given source term for the BTP 11-6 analysis did not correspond to half of the value given in the Chapter 12 response. As a result, the staff updated the confirmatory calculations and determined that a greater dilution factor would be needed to meet 10 CFR Part 20, Appendix B, Table 2, limits. In its response dated, August 2, 2017, to RAI 542-8731, Question 11.02-11 (ML17214A580), the applicant described the development of the proposed source terms used in the BTP 11-6 analysis. The staff's review of the data determined that the basis for developing the 0.12 percent and the 0.25 percent failed fuel source terms were different and comparing the two failed fuel fractions would not allow for a simple comparison of the 0.12 percent failed fuel being half the 0.25 percent failed fuel source term. In addition, the applicant provided clarity in the DCD to describe how the calculation was performed, and made corrections to update the planned dilution factor based on current calculations. The staff finds the applicant's response to RAI 542-8731, Question 11.02-11, acceptable because the applicant has provided the tank inventories for the outdoor tanks containing liquid radioactivity waste water and has provided staff with enough information to verify through confirmatory calculations that the applicant has correctly determined the dilution factor needed to meet the 10 CFR 20, Appendix B concentration limits. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 542-8731, Question 11.02-11, to be resolved and closed.

Given the discussion provided above, the staff finds the applicant's discussion of the liquid tank failure analysis acceptable.

11.2.4.9 10 CFR 52.47(b)(1) for ITAAC

DCD Tier 1, Section 2.7.6.1, describes the ITAAC related to the LWMS. The ITAAC address the functional arrangement of LWMS components, instrumentation controls, and displays, confirming the initial introduction of the proper types and amounts of filtration and treatment

media in processing equipment, ensuring that discharge valves terminate liquid effluent releases upon receipt of high-radiation signals from the associated detector of the RMS and deviations in plant dilution flow rates used to establish alarm setpoints, and verification that the LWMS components are designed using the guidance in RG 1.143. The LWMS is relied upon to maintain concentrations of radioactive wastes released to the environment below the exposure limits for members of the public. The associated regulatory requirements are contained in 10 CFR 20.1301 and 10 CFR 20.1302, as well as 10 CFR Part 20, Appendix B, Table 2 ECLs. Other regulatory requirements address design features that are intended to avoid unmonitored and uncontrolled radioactive releases to the environment under 10 CFR 20.1406(b). In addition, 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," states that DCD Tier 1 entries should include significant plant systems and component parameters.

The ability to maintain concentrations below 10 CFR Part 20 limits and to limit doses to members of the public, depends upon the LWMS process. The LWMS process includes the number and sizing of components, processing equipment, effluent radiological monitoring and sampling systems, automatic control features in terminating releases that exceed alarm setpoints, and process dilution before release into the environment. In reviewing the information in DCD Tier 1, Section 2.7.6.1, the staff determined that there were some deficiencies with the information provided. Details in Tier 1 did not describe the LWMS as-built design, and the staff therefore determined that there was not enough information present to perform the ITAAC. In RAI 218-8183, Question 11.02-3, dated September 21, 2015 (ML15295A511), the staff requested more details concerning the ITAAC provided, including how to determine the appropriate types of filtration and adsorption media that will meet the decontamination factors listed in DCD Tier 2, Section 11.2-3. In its response to RAI 218-8183, Question 11.02-3, dated December 31, 2015 (ML15365A314), the applicant explained that there are ITAAC present to verify the functional arrangement of the LWMS and that the systems allow for sufficient capacity, redundancy, and flexibility to treat liquid radioactive waste so as to meet the limits. In the second part of the response, the applicant described how it will confirm the filter efficiency and decontamination factors through the verification and inspection of the specification data and design reports provided by the equipment suppliers. The staff finds the DCD changes in DCD Tier 1, Section 2.7.6.1, and this response to be acceptable, since the ITAAC should verify the ability to control liquid effluent releases and the assumed filter efficiencies and decontamination factors will be verified before being used in the LWMS. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 218-8183, Question 11.02-3, to be resolved and closed.

In RAI 218-8183, Question 11.02-4 (ML15295A511), the staff also requested information to confirm that the inspection and test analysis will use a radiation source when verifying the corresponding design commitments. The currently stated provision of a simulated radiation source suggests the use of an electronic signal in verifying system function. The staff determined that an electronic signal does not test the system as a whole, because it does not verify the operation of the radiation detector. In its response dated September 30, 2016, to RAI 219-8199, Question 11.03-7 (ML16274A408), the applicant provided a response related to the same concerns on the use of a simulated test signal. In this response the applicant described that a radiation check source will be available to verify the function of a monitor in a pass/fail criterion. An electronic test signal will still be used to produce the signal needed to test the monitors for indication and alarm functionality. The staff finds this response to be acceptable because the applicant has included text in DCD Section 11.5 to state that the RMS has a radiation check source available to verify system availability automatically and is present in the system to verify the monitor's operation. The staff confirmed that the proposed changes have

been incorporated in the DCD; therefore, the staff considers RAI 218-8183, Question 11.02-4, to be resolved and closed.

Based on the discussion above, the staff finds the information provided in DCD Tier 1, Section 2.7.6.1, are complete and consistent with the plant design basis as described in DCD Tier 2, Section 11.2. Based on the discussion above, the staff finds that the LWMS complies with the requirements of 10 CFR 52.47(b)(1).

11.2.4.10 Technical Specifications

The review of DCD Tier 2, Chapter 16, shows that there are no TS directly associated with liquid waste storage and processing. However, DCD Tier 2, Chapter 16, TS 5.5.1 and TS 5.5.4, provide directions in managing releases of radioactive effluents and the control and handling of concentrated wastes for disposal. The proposed TS requirements of DCD Tier 2, Chapter 16, TS 5.5.12, restrict the amount of radioactivity in tanks located outdoors to ensure the concentration limits do not exceed those in 10 CFR Part 20, Appendix B, Table 2, Column 2, in the event of a release to an unrestricted area.

DCD Tier 2, Chapter 16, TS 5.6.1, "Annual Radiological Environmental Operating Report," and TS 5.6.2, "Radioactive 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 to the environment. As stated in TS 5.5.1, COL licensee-initiated changes to the ODCM must be justified by calculation, and changes will 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. TS 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 staff deemed these proposed TS requirements acceptable, and the applicant will address the implementation of such programs in a plant- and site-specific ODCM under COL 11.2(1), as described in DCD Tier 2, Table 1.8-2. Section 11.5 of this report contains the staff's evaluation of the applicant's proposed ODCM.

11.2.5 Combined License Information Items

Table 11.2-2 lists COL information item numbers and descriptions related to the LWMS from DCD Tier 2, Table 1.8-2:

Table 11.2-2 Combined License Items Identified in the DCD

ITEM NO.	DESCRIPTION	SECTION
COL 11.2(1)	The COL applicant is to prepare the site-specific ODCM in accordance with Nuclear Energy Institute (NEI) 07-09A.	11.2.1.2 11.2.3.3
COL 11.2(2)	The COL applicant is to prepare operational procedures and programs related to operations, inspection, calibration, and maintenance of the contamination control program.	11.2.1.2 11.2.2.1.2 11.2.2.4

ITEM NO.	DESCRIPTION	SECTION
COL 11.2(3)	The COL applicant is to determine whether contaminated laundry is sent to an offsite facility for cleaning or for disposal.	11.2.1.3
COL 11.2(4)	The COL applicant is to prepare and provide the P&IDs.	11.2.1.4
COL 11.2(5)	The COL applicant is to perform a site-specific cost-benefit analysis following the guidance in the regulatory requirements of NRC RG 1.110.	11.2.1.5
COL 11.2(6)	The COL applicant is to provide reasonable assurance that the mobile or temporary equipment and interconnections to plant systems conform with the regulatory requirements and guidance of 10 CFR 50.34a, 10 CFR 20.1406, NRC RG 1.143, NRC RG 4.21, and ANSI/ANS 40.37. The COL applicant is to ensure that the implementation of mobile and temporary equipment meets the requirements of NUREG-0800 Sections 12.3 and 12.4 and that any impacts to the radiation zone maps are evaluated.	11.2.1.6
COL 11.2(7)	The COL applicant is to develop a plant-wide NRC RG 4.21 Program following the guidance in NEI 08-08A for contamination control.	11.2.2.4
COL 11.2(8)	The COL applicant is to maintain the complete documentation of system design, construction, design modifications, field changes, and operations and make them available for decommissioning planning and implementation.	11.2.2.4
COL 11.2(9)	The COL applicant is to develop the procedure for the collection and shipment of mixed wastes, if and when they are generated, for offsite treatment. The generation of mixed liquid wastes is minimized by process control and the controlled use of hazardous chemicals.	11.2.2.11.3
COL 11.2(10)	The COL applicant is to develop the interface design and provide the site-specific information for the LWMS effluent discharge, including radioactive release points, effluent temperature, the design (type, shape, and size) of flow orifices, and the sampling requirements following the guidance of RG 1.21 and RG 4.15 and the standards incorporated therein by reference.	11.2.2.1.4 11.2.2.3.1 11.2.3.1
COL 11.2(11)	The COL applicant is to prepare the site PCP and the site radiological environmental monitoring program.	11.2.2.4
COL 11.2(12)	The COL applicant is to confirm the assumed dilution flow rate provided by cooling tower blowdown, dilution pump, or other plant discharges at the discharge point based on site-specific parameters.	11.2.3.1
COL 11.2(13)	The COL applicant is to calculate dose to members of the public following the guidance of RG 1.109 and RG 1.113 using site-specific parameters and to compare the doses due to the liquid effluents with the numerical design objectives of Appendix I to 10 CFR 50, 10 CFR 20.1302, and 40 CFR 190.	11.2.3.1
COL 11.2(14)	The COL applicant is to perform an analysis to demonstrate that the potential groundwater or surface water contamination concentrations resulting from radioactive release from the liquid-containing tank failure, are in compliance with the limits in 10 CFR 20, Appendix B, Table 2.	11.2.3.2

The staff finds the above list to be acceptable, as it adequately describes actions necessary for the COL applicant. No additional COL information items were identified that need to be included in DCD Tier 2, Table 1.8-2, for the LWMS.

11.2.6 Conclusions

The staff concludes, using the information presented in the application, that the applicant has demonstrated compliance with NRC regulations and guidance controlling liquid radioactive releases to the environment and associated doses to members of the public. The regulations are contained in 10 CFR 20.1301; 10 CFR 20.1302; 40 CFR Part 190, as referenced in 10 CFR 20.1301(e); and 10 CFR Part 20, Appendix B, Table 2, Column 2. The guidance appears in SRP Section 11.2 and BTP 11-6.

11.3 Gaseous Waste Management System

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 PWRs, gaseous wastes and process vents are characterized by the presence of noble gases, radioiodines, particulates, C-14, and H-3, among others. Process gases originate from primary coolant degasification systems, venting of tanks and vessels, the SG 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 GWMS 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 charcoal, 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 their radioactive decay before being discharged to the environment through a 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 by 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.

11.3.2 Summary of Application

DCD Tier 1: The applicant provided a system description in DCD Tier 1, Section 2.7.6.2, "Gaseous Waste Management System," summarized here, in part, as follows.

The GWMS covers the GRS and the building ventilation system. The processing system for treating offgas from CVCS is GRS. The GRS is located in the compound building and is a nonsafety-related system with nonseismic components. The compound building that houses the GRS equipment is designed to radwaste safety class RW-IIa in accordance with RG 1.143.

The GRS is designed to monitor, control, collect, process, handle, store, and dispose of gaseous radioactive waste generated as the result of normal operation, including AOOs. Charcoal beds provide for the delay and decay of radioactive gases before release into the environment. Gaseous waste streams are monitored for both hydrogen and oxygen content to prevent a flammable mixture. The nitrogen gas to purge or dilute hydrogen and oxygen content

in gaseous waste streams is operated at a higher pressure. Treated waste gas is verified with radiation monitors before release to the environment. Upon detection of radiation levels above a setpoint, the radiation monitors alarm and send a signal to close the GRS discharge valve.

The gaseous effluent waste is processed through the dryer and the charcoal bed absorbers and is sent to the plant stack for release to the environment.

DCD Tier 2, Section 11.3, "Gaseous Waste Management System," contains detailed descriptions of the design and operating features of the GRS.

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

In DCD Tier 2, Section 11.3, the applicant described the design of the GRS and its functions in monitoring, controlling, collecting, processing, handling, storing, and disposing of gaseous radioactive waste generated as the result of normal operation and AOOs. The GRS collects gas mixtures containing hydrogen and oxygen, noble gas fission products, and radioiodines and radioactive particulates, among others. The GRS is a nonsafety-related system and serves no safety functions with the exception of containment penetration isolation valves and piping. The discharge isolation valve closes on a low ventilation system exhaust flow rate and when the radiation monitor setpoint is exceeded. A failure of the GRS does not compromise safety-related systems or components and does not prevent the safe shutdown of the plant. The compound building that houses the GRS equipment is designed to radwaste safety class RW-IIa in accordance with RG 1.143 and is evaluated in SE Section 3.2. DCD Table 11.3-9, "Gaseous Radwaste System Failure Activity release and Doses," describes the failure scenarios considered for the GRS.

In DCD Tier 2, Section 3.2, the applicant described the seismic and quality group classification and corresponding codes and standards that apply to the design of the GRS components and piping and structures housing the system. The GRS is housed in a reinforced concrete structure to provide adequate shielding and minimize radiation exposures to personnel during operation and maintenance. SE Section 12.4 provides the staff's evaluation of these personnel radiation exposures.

DCD Tier 2, Figure 11.3-1, "Gaseous Radwaste System Flow Diagram," presents the process design of the GRS, and Figure 11.3-2, "Gaseous Effluent Release Points and Exhaust," presents the design operating parameters, such as flow rates, temperatures, and pressures, for the major gaseous waste streams. DCD Tier 2, Table 11.3-4, "GRS Major Equipment Design Information," lists system components and information characterizing volumetric capacities and processing flow rates for major components. DCD Tier 2, Figure 12.3-13, "Radiation Zones (Normal) Compound Building El. 100'-0," present the general arrangement of the compound building where the major components of the GRS is located.

In DCD Tier 2, Section 9.4, "Heating, Ventilation and Air Conditioning Systems," the applicant 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. SER Section 9.4 contains the staff's evaluation of these ventilation systems. DCD Tier 2, Section 11.3.3, describes design information on the vent stack and release points. DCD Tier 2, Figure 9.4.7-1, "Compound Building HVAC System Flow Diagram," shows the detailed flow diagram of the HVAC system depicting the installed airborne radioactivity monitors and release to the environment through the plant vent stack.

The GRS consists of processing equipment, associated monitoring instrumentation, and control components. The GRS treats waste gas in two ways. The first method reduces the volume of potentially explosive mixtures of hydrogen and oxygen by means of dilution with nitrogen. Moisture in the waste gas is removed in the waste gas dryer skid, which protects the charcoal adsorbed beds, and is returned to the LWMS for processing. Because a buildup of explosive mixtures of hydrogen and oxygen is possible, the GRS 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 the guidance in SRP Section 11.3. The APR1400 is designed to preclude the generation and accumulation of explosive gas mixtures.

The major components of the GWMS include the following:

- One header drain tank
- Two waste gas dryers
- One standby chiller
- Two charcoal guard beds
- Four charcoal delay beds
- One HEPA filter
- Associated piping, valves, and instrumentation
- Four hydrogen/oxygen analyzer units
- Nitrogen purge line

The waste gas dryer skid removes moisture from the waste gas and protects the charcoal bed adsorbers. Condensed moisture in the waste gas is collected in the header drain tank of the GRS and routed to the LWMS for processing.

The four charcoal bed adsorbers are arranged in series. The leading delay beds can be isolated and bypassed if they become saturated with moisture. Gaseous effluent is monitored by a radiation monitor at the discharge side of the charcoal bed adsorbers. The radioactivity of the processed gaseous waste is monitored before discharge to the environment in the compound building ventilation exhaust, where the discharge flow is automatically isolated if the preset limit is exceeded. The limit is triggered by a radiation monitor that closes the effluent discharge valve. The GRS is also designed to alarm operators when there is insufficient flow to discharge the gaseous waste effluent.

One hydrogen and one oxygen gas analyzer continuously monitor hydrogen and oxygen concentrations in the gas surge header. The other hydrogen and oxygen analyzer is located in the radwaste sample panel and is used to analyze samples from process points within the GRS. Alarms are provided in the radwaste control room of the compound building and MCR on high and high-high levels of oxygen.

In assessing the radiological impacts associated with radioactive gaseous effluent discharges, DCD Tier 2, Table 11.2-2, “PWR-GALE Code Input Parameters Used to Calculate Annual Gaseous and Liquid Effluent Releases,” and Table 11.3-5, “Input Parameters for the GASPAR II

Code," present information supporting the development of the gaseous effluent source term, as well as compliance with (1) the ECLs of 10 CFR Part 20, Appendix B, Table 2, Column 1, (2) 10 CFR 20.1301(e) in meeting the EPA environmental radiation protection standards of 40 CFR Part 190, and (3) the numerical guides and design objectives of 10 CFR Part 50, Appendix I. The applicant's results show the expected annual releases of airborne radioactivity and gaseous effluent concentrations in unrestricted areas and that gaseous effluent doses to members of the public comply with the NRC regulations. The applicant's results also demonstrate compliance with the ALARA requirements of 10 CFR Part 50, Appendix I, and the acceptance criteria in SRP Section 11.3 for evaluating a postulated leak of radioactivity from a GWMS component.

ITAAC: The ITAAC associated with DCD Tier 2, Section 11.3, "Gaseous Waste Management System," appear in DCD Tier 1, Section 2.7.6.2, "Gaseous Radwaste System," and Table 2.7.6.2-4, "Gaseous Raswaste System ITAAC." DCD Tier 2, Section 14.3.2.7, "ITAAC for Plant Systems," summarizes how ITAAC were developed for DCD Tier 1, Section 2.7.6.2.

TS: There is information pertinent to TS associated with the GWMS in DCD Tier 2, Section 11.3.3.2, "Radioactive Effluent Releases and Dose Calculation due to GWMS Leak or Failure," Section 11.3.3.3, "Offsite Dose Calculation Manual," and Chapter 16, TS 5.5.1; TS 3.4.16, "RCS Specific Activity," TS 5.5.12; TS 3.3.3, "Post Accident Monitoring (PAM) Instrumentation," TS 5.5.3, "Post-Accident Sampling," and TS 5.5.4, "Radioactive Effluents Controls Program."

10 CFR 20.1406: There is information pertinent to 10 CFR 20.1406 in DCD Tier 2, Section 11.3.1.4, "Method of Treatment," and Section 11.3.2.2.2.2, "Design Features for Minimization of Contamination."

COL Information or Action Items: See Section 11.3.5 below.

Technical Report(s): There are no technical reports associated with this area of review.

Topical Report(s): There are no topical reports associated with this area of review.

APR1400 Interface Issues Identified in the DCD: There are no APR1400 interface issues associated with this area of review.

Site Interface Requirements Identified in the DCD: There are no site interface requirements associated with this area of review.

Cross-Cutting Requirements (TMI, USI/GSI, Op Ex): There are no cross-cutting issues for this area of review.

RTNSS: There are no RTNSS issues for this area of review.

CDI: This DCD section does not contain CDI that is outside the scope of the APR1400 certification.

11.3.3 Regulatory Basis

SRP Section 11.3 provides the relevant requirements of NRC regulations for the GWMS, the associated acceptance criteria, and review interfaces with other SRP sections. The relevant regulatory requirements are as follows:

- 10 CFR 20.1301, as it relates to dose limits for individual members of the public
- 10 CFR 20.1302, as it relates to limits on doses to members of the public and gaseous effluent concentrations and doses in unrestricted areas
- 10 CFR 20.1406, as it relates to facility design and operational procedures for minimizing facility contamination and the generation of radioactive waste
- 10 CFR Part 20, Appendix B, Table 2, Column 1, as it relates to the airborne (gaseous) ECLs for release to the environment
- 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
- 10 CFR 50.36a, as it relates to TS requiring that operating procedures be developed for radiological monitoring and sampling equipment as part of the administrative controls and surveillance on effluent controls in meeting the ALARA criterion and 10 CFR 20.1301 dose limits
- 10 CFR Part 50, Appendix I, Sections II.B, II.C, and II.D, as they relate to numerical guidelines and design objectives and limiting conditions for operation in meeting dose criteria and the ALARA criterion in Appendix I.
- GDC 3, as it relates to the design of gaseous waste treatment systems and operational safeguards to minimize the generation of explosive gas mixtures and effects of explosive mixtures of hydrogen and oxygen on systems and components
- GDC 60, as it relates to the design of the GWMS to control releases of gaseous radioactive effluents
- GDC 64, as it relates to the design of the GWMS to monitor for radioactivity that may be released from normal operations, including AOOs and postulated accidents
- GDC 61, as it relates to the design of the GWMS to ensure adequate safety under normal operations and postulated accident conditions
- 40 CFR Part 190 (EPA's generally applicable environmental radiation standards), as implemented under 10 CFR 20.1301(e), as it relates to controlling doses within EPA's generally applicable environmental radiation standards
- 10 CFR 52.47(b)(1), which requires that applications for DCs 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 DC is built and will operate in accordance with the DC and provisions of the Atomic Energy Act of 1954, as amended, and NRC regulations

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

- 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

- RG 1.110, as it relates to performing a CBA for reducing cumulative doses to populations by using available technology

- RG 1.111, “Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors,” issued July 1977, as 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

- RG 1.112, as it relates to the acceptable methods for calculating annual average releases of radioactivity in effluents

- RG 1.206, as it relates to the minimum information requirements specified in 10 CFR 52.79 to be submitted in a COL application

- RG 1.140, “Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants,” as it relates to the design, testing, and maintenance of normal ventilation exhaust systems at nuclear power plants

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

- RG 1.33, as it relates to QA 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

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

- 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

- NUREG-0017 (Revision 1), as it relates to the methodology to calculate gaseous and liquid effluent releases

- NUREG-1301, as it relates to ODCM guidance for PWR plants

- NUREG/CR-4653, “GASPAR II—Technical Reference and User Guide,” as it relates to the methodology to calculate gaseous effluent doses

- IE Bulletin 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

- ANSI/ANS-18.1-1999, as it relates to the methodology for determining the source term for normal reactor operations, including AOOs

11.3.4 Technical Evaluation

The staff reviewed the GWMS using the guidance and acceptance criteria of SRP Section 11.3.

11.3.4.1 Design Considerations

11.3.4.1.1 GWMS System Description Source Term

The GWMS is designed to monitor, control, collect, process, handle, store, release to ventilation exhaust, and dispose of gaseous radioactive waste generated as a result of normal operations and AOOs. The GWMS is made up of the GRS and the building ventilation. The GRS handles and processes the radioactive effluent off-gases from the CVCS tank vents, the gas stripper off-gases containing radioactive noble gases, halogens, hydrogen, and oxygen from reactor operation, and nitrogen, which is used as a cover gas for the tanks in the CVCS.

Noble gases and halogens are removed from the gaseous radwaste by absorption from the gaseous stream for decay in the charcoal delay beds before release to the environment. The treated gases are passed through the compound building HVAC ventilation exhaust for release to the environment. When operating under normal conditions, the charcoal delay beds will provide a 45-day delay for xenon and 3.5-day delay for krypton. The waste gas dryer is used to control the inlet gas moisture and temperature to maintain normal conditions for the charcoal delay beds.

The primary sources to the gas surge header are the gas stripper, equipment drain tank (EDT), volume control tank (VCT), and reactor drain tank (RDT) in the CVCS. The gases consist primarily of hydrogen, with small amounts of nitrogen, oxygen, and trace amounts of other fission gases. The removal of gases is performed in the VCT, from depressurization, and in the gas stripper.

The GRS consists of one header drain tank, two waste gas dryers, one standby chiller, two charcoal guard beds, four charcoal delay beds, one HEPA filter, and the associated piping, valves, and instrumentation for the system.

The header drain tank collects condensed liquid from the gas surge header in the Auxiliary Building (AB) and in the GRS inlet piping in the compound building. The header drain tank is also used to collect condensate from waste gas dryer operations.

Downstream of the gas surge header, two 100-percent capacity trains comprising one waste gas dryer and one charcoal guard bed are used to reduce the gas moisture and protect the main charcoal delay beds. The waste gas dryer cools the waste gas before entering the guard beds. The GRS chiller provides the cooling water when the plant chilled water is unavailable. Humidity sensors are placed downstream of the waste gas dryer and charcoal guard beds to monitor for moisture and to provide alarms for operator actions if above a preset moisture content. With two trains of guard beds, only one is in operation at a time. While one is operating, the other is in standby or regeneration mode. Humidity sensors are installed upstream and downstream of the guard beds to further protect the integrity of the charcoal delay bed.

The four charcoal delay beds are normally operating in series. The leading delay beds can be isolated for regeneration or replacement. Nitrogen is available to dry the charcoal delay bed in the event of excess moisture contamination. Each charcoal delay bed can have nitrogen introduced to flush or dry it. The charcoal delay beds contain a total of 9,525 kilograms (kg)

(21,000 pounds) of charcoal. The charcoal delay beds also contain provisions for replacement in scenarios where there is a wetting of the delay bed. During replacement, the delay bed will be isolated and bypassed to allow for continued operation while the charcoal is replaced.

During the staff's review of the charcoal delay beds, the staff noted the lack of information pertaining to maintaining the integrity of the charcoal delay beds. The staff issued RAI 205-8230, Question 11.03-5, on September 8, 2015, (ML15295A504) requesting information pertaining to (1) monitoring potential fire conditions in the charcoal delay beds, (2) addressing potential leaks of the chilled water system, (3) detecting potential blockages within the charcoal beds, and (4) describing the flow paths that interact with the charcoal delay beds. This information was requested so that the staff could evaluate the ability of the charcoal delay beds to treat the waste gas effluent.

In its response to RAI 205-8230, Question 11.03-5, dated December 3, 2015 (ML15337A512), the applicant described how fires in the charcoal delay beds are prevented by maintaining temperatures below those needed for the self-ignition of charcoal. The applicant also described the use of inlet temperature sensors that can monitor temperature conditions and stated that the beds can be isolated in the event of a fire. To maintain charcoal beds, the applicant described the use of guard beds to protect charcoal delay beds from moisture, and the use of moisture instruments upstream and downstream of the guard beds to ensure that the gas flowing through the charcoal delay beds is dry. In the event of chilled water leakage, the applicant stated that the moisture instrumentation at the guard beds inlet will automatically isolate the entire train. In its revised response to RAI 205-8230, Question 11.03-5, dated April 25, 2016 (ML16116A388), the applicant updated the response to include DCD Section 11.3 text revisions and revised DCD Figure 11.3-1 to incorporate the discussions of the original RAI response. The staff finds this response acceptable with the applicant explaining their evaluation of the ability of the charcoal delay beds to treat the waste gas effluent and confirmed that the proposed changes have been incorporated in the DCD. Therefore, the staff considers RAI 205-8230, Question 11.03-5, to be resolved and closed.

All components of the GRS are located in shielded cubicles. After passing through the charcoal delay bed, the waste gas then flows through a HEPA filter where the particulates, including charcoal bed fines, are removed and then vented to the compound building HVAC system.

Before discharge to the environment, the radioactivity of the processed gaseous waste is monitored by a radiation monitor in the compound building ventilation exhaust, where the discharge flow is automatically isolated by alarm interlock, if the preset limit is exceeded. The limit is triggered by a radiation monitor that closes the effluent discharge valve. The GRS is also designed to alarm operators when there is insufficient flow to discharge the gaseous waste effluent. The staff reviewed the GWMS to determine whether it complies with the requirements of GDC 60, GDC 61, and 10 CFR 50.34a. GDC 60 requires that the GWMS be 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. 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. The applicant adequately describes the system's components needed to control gaseous effluent releases through the use of charcoal delay beds to delay the release of noble gases, the HEPA filter to capture the effluent particulates in the gaseous waste stream, and gas dryers and guard beds to maintain the integrity of the waste treatment systems. The applicant also describes the use of radiation monitors to isolate gaseous effluent releases above a predetermined setpoint to maintain them

below the release limits in 10 CFR Part 20, Appendix B, Table 2, Column 1; 10 CFR Part 50, Appendix I; and 40 CFR Part 190. Therefore, the applicant has designed the GWMS to control releases of gaseous radioactive effluents, to ensure adequate safety under normal operations and AOOs, and provided 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.

11.3.4.1.2 Waste Monitoring and Discharge

The staff reviewed the GWMS to determine whether it complies with GDC 3, "Fire Protection," which requires that the design of SSCs important to safety, including the gaseous waste handling and treatment systems, be adequately designed to prevent the occurrence of a fire or explosion or to withstand the effects of an explosion. The applicant has stated that the gaseous streams in the GRS are monitored for both hydrogen and oxygen content, so that a flammable mixture does not occur. The explosive mixtures of hydrogen and oxygen concentrations are monitored by two gas analyzers. The results of the gas analyzers are confirmed by periodic sampling and analysis. An explosive mixture in the GRS is prevented by maintaining an oxygen or hydrogen concentration of less than 4 percent by volume by dilution with nitrogen. The applicant references and follows the criteria established in ANSI/ANS 55.4.

In review of the charcoal guard and delay beds, the staff issued a question about compliance with National Fire Protection Act (NFPA) 804. Within NFPA 804, Section 8.4.9.4, it states that fixed water spray systems shall be provided for charcoal adsorber beds containing more than 45.5kg (100 lbs) of charcoal. DCD Section 11.3.2 describes the charcoal delay beds as having 9525 kg (21000 lb) of charcoal. In review of DCD Section 11.3.2, the staff could not find reference to the description of a spray system for the charcoal delay beds. Since the applicant has specified compliance with NFPA 804 in DCD Table 9.5.1-2 (37 of 70), item 4, the staff issued RAI 538-8720, Question 11.03-12, on February 06, 2017 (ML17037D278), to request information about how the applicant plans to remain compliant with NFPA 804 given the lack of a spray system for these charcoal delay beds. In its response to RAI 538-8720, Question 11.03-12 dated March 17, 2017 (ML17076A138), the applicant stated that the applicant plans on using nitrogen injection to control the amounts of hydrogen and oxygen concentrations below flammability limits. As is described in Section 9.5 of this SER, nitrogen has been approved as a means to limit and extinguish fire events for charcoal beds. The staff has found the response acceptable since the ability to prevent and extinguish a fire has been described by the applicant for the charcoal adsorber beds in the GRS. The staff confirmed that the proposed changes have been incorporated in the DCD. Therefore, the staff considers RAI 538-8720, Question 11.03-12, to be resolved and closed. The staff also concludes that the measures proposed by the applicant are adequate to prevent the occurrence of an explosion in accordance with GDC 3.

11.3.4.1.3 General Design Criteria 60 and 61 and 10 CFR 50.34a

In assessing compliance with GDC 60 and 61, the staff reviewed the QA provisions and RG 1.143 guidance specified by the applicant in the DCD. The applicant stated that the GRS will conform to regulatory position C.7 of RG 1.143 and RG 1.33, which specify the QA guidance to follow. DCD Table 3.2-1 also identifies the seismic category, quality group, and safety class for components of the GRS. The QA program is stated to be designed in accordance with ANSI/ANS-55.6, which is in agreement with RG 1.143, position C.7. In determining the design for radwaste systems, the applicant provided DCD Table 11.3-11 to reflect the guidance specified in RG 1.143 to meet the values for A_1 and A_2 in 10 CFR Part 71, Appendix A. The

staff's confirmatory calculations of the data provided by the applicant were initially unable to confirm the results provided. The calculations involved using the source terms in DCD Table 11.3-11 and the table of fractions in 10 CFR Part 71, Appendix A, to determine the radwaste classifications for each SSC. The staff's calculations determined that the applicant's analysis was using a value of 0 in place of values that were not listed in 10 CFR Part 71, Appendix A, Table 1. In the text preceding Table 1 in 10 CFR Part 71, Appendix A, states that "For individual radionuclides whose identities are known, but which are not listed in Table A-1, the A_1 and A_2 values contained in Table A-3 may be used. Otherwise, the licensee shall obtain prior Commission approval of the A_1 and A_2 values for radionuclides not listed in Table A-1, before shipping the material." The staff's confirmatory calculations used the values specified by 10 CFR Part 71, Appendix A, Table 3, when determining the A_1 and A_2 values. The staff issued RAI 171-8143, Question 11.03-4, on August 25, 2015 (ML15237A478), to request that the applicant evaluate the use of the values specified in its analysis in determining the A_1 and A_2 values used to determine radwaste system classifications.

In its response to RAI 171-8143, Question 11.03-4, dated December 14, 2015 (ML15348A337), the applicant described the method used to determine the RG 1.143 system classifications, and in its revised response to RAI 171-8143, Question 11.03-4, dated May 2, 2016 (ML16123A521), the applicant further updated the values in the analysis, since there was an error noted for Xe-135m, and also updated the result specified in DCD Table 11.3-11. In their response, the applicant determined that the radwaste system classification for the charcoal delay was RW-IIa, which is now consistent with the staff's results. The staff determined that all of the components described in DCD Table 11.3-11 should be classified as RW-IIa, using the guidance in RG 1.143. Since the staff can confirm the results presented by the applicant, it finds the applicant's response acceptable. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 171-8143, Question 11.03-04, to be resolved and closed.

In its review of the tanks that contain liquid, gaseous, or solid wastes that are vented to the rooms in which they are located, the staff determined that more information was required to describe the methods used to direct tank gases to the ventilation system. The staff issued RAI 538-8720, Question 11.03-11, on February 06, 2017 (ML17037D278), requesting additional details in the DCD to clarify the methods implemented to direct tank gases to the ventilation system and additional details on ensuring liquids are prevent from entering the ventilation system. In its response to RAI 538-8720, Question 11.03-11, dated March 23, 2017 (ML17082A422), the applicant described that the vent for each tank is located near each cubical vent to minimize the transport of gases. In addition, the applicant provided details on which tank vents were directed to floor drains so that water overflow would be directed to the appropriate drains before venting. The applicant also described that the low activity spent resin tank is used only during resin transfer, and is not normally open during normal operations. The staff determined that the response provided by the applicant is acceptable because the applicant provided the details about how tank gases were directed to the ventilation system. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 538-8720, Question 11.03-11, to be resolved and closed.

In its review of the GRS P&IDs, the staff had questions on the valve used to terminate discharge to the environment. The staff's review of DCD Figure 11.3-1, "Gaseous Radwaste System Flow Diagram," identified a single isolation valve, valve 008, to limit gaseous releases to the environment on a high radiation signal or low ventilation flow. The staff issued RAI 538-8720, Question 11.03-13, dated February 6, 2017 (ML17037D278), requesting information on how the system would limit releases in excess of requirements found in 10 CFR 20 Appendix B, and 10

CFR 50 Appendix I. In its response to RAI 538-8720, Question 11.03-13, dated March 17, 2017 (ML17076A138), the applicant responded and specified that there is another isolation valve that can be closed remotely at the radwaste control room in the event valve 008 does not close on receipt of a close signal. The applicant also specified that valves 1013 and 1014, which are located before and after valve 008, can be manually closed. The staff has reviewed the response and determined that the response is acceptable since the applicant has specified other valves that operations can use to control releases to the environment. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 538-8720, Question 11.03-13, to be resolved and closed.

11.3.4.2 10 CFR Part 50, Appendix I, Gaseous Effluent Doses

The staff reviewed the GWMS to determine whether it complies with the requirements of 10 CFR Part 50, Appendix I. The applicant calculates releases using the GASPAR II computer code, approved for use by the NRC. Using the data in the applicant-provided tables and GASPAR II input and output files, the staff performed confirmatory calculations of the effluent releases stated in the DCD. In performing the calculations, the staff observed the use of two separate X/Q values in the analysis. The applicant states that the X/Q value used at the food receptor location would be half of the X/Q referenced for the exclusion area boundary (EAB). The EAB X/Q has a reference to DCD Table 2.0-1. Upon inspection of DCD Section 2.3.5 and DCD Table 2.0-1, the staff found only one referenced X/Q value and determined that the assumption provided by the applicant was not acceptable. The staff issued RAI 147-7933, Question 11.03-2, on August 10, 2015 (ML15226A659), to request that the applicant further justify the use of an X/Q value not referenced in DCD Section 2.3.5, and a detailed explanation of parameters being used to support the GASPAR II calculation in the form of a calculation package for staff review. In its response to RAI 147-7933, Question 11.03-2, dated September 25, 2015 (ML15269A019), the applicant provided additional information to confirm the correct use of the X/Q value in DCD Section 11.3, the food pathways, and to resolve the inconsistency between DCD Table 11.3-7 and the provided GASPAR files. The applicant confirmed the use of the X/Q value by referencing the X/Q values used by other plants in the United States. The applicant also stated that COL 11.3(7) will address the need for the applicant to perform a site-specific dose calculation, which would require an applicant for the design to consider its own site-specific X/Q value. In the same response, the applicant corrected the inconsistency in DCD Table 11.3-7. The staff finds this response acceptable, and confirmed that the proposed changes have been incorporated in the DCD. Therefore, the staff considers RAI 147-7933, Question 11.03-2, to be resolved and closed.

In RAI 389-8430, Question 11.03-09, dated February 1, 2016 (ML16032A202), the staff asked the applicant to update DCD Table 11.3-7 to reflect an organ dose and to provide a revision to compare the calculated doses to the annual dose limits. The applicant included a description of dose in DCD Section 11.3.3.1. The staff issued this question to ensure consistency with the DCD text and tables. In its response to RAI 389-8430, Question 11.03-09, dated February 18, 2016 (ML16049A155), the applicant provided DCD changes to include the organ doses and dose compliance column in DCD Table 11.3-7. The staff finds this response acceptable, and confirmed that the proposed changes have been incorporated in the DCD. Therefore, the staff considers RAI 389-8430, Question 11.03-09, to be resolved and closed.

In DCD Table 11.3-5, the applicant summarized the inputs used for the GASPAR II code. This table includes a pointer to DCD Table 11.3-1 for the Ci/yr source term required for the analysis. The staff confirmed this source term and the results produced by the GALE86 code in SER Section 11.1. The staff confirms the use of the RG 1.109 default values without site-

specific values to reference for its calculation. In addition to the values in RG 1.109, the applicant references the X/Q values discussed above for Question 11.03-02.

To confirm the applicant's results in DCD Table 11.3-7, the staff used the GASPAR II inputs reported in DCD Table 11.3-5. The results of the staff's confirmatory calculation indicated that the estimated gamma air dose is 6E-3 milligray (mGy) (6.0E-1 mrad), beta air dose is 7.9E-2 mGy (7.9E0 mrad), total body dose is 4E-3 mSv (4.0E-1 mrem), skin dose is 5.6E-2 mSv (5.6E0 mrem), and the max organ dose is 1.48E-1 mSv (1.48E1 mrem). In DCD Table 11.3-7, the applicant provides its results, which are summarized in SE Table 11.3-1 below. SE Table 11.3-1 compares the applicant's and staff's results to the dose objectives in 10 CFR Part 50, Appendix I.

Table 11.3-1 Comparison of the Applicant's and NRC's Estimated Annual Individual Doses from Gaseous Effluent Releases

PATHWAY	APPLICANT RESULTS	NRC RESULTS	DESIGN OBJECTIVES
Gamma Air	0.006 mGy (0.6 mrad)	0.006 mGy (0.6 mrad)	0.10 mGy (10 mrad)
Beta Air	0.079 mGy (7.9 mrad)	0.079 mGy (7.9 mrad)	0.20 mGy (20 mrad)
Total Body	0.004 mSv (0.4 mrem)	0.004 mSv (0.4 mrem)	0.05 mSv (5 mrem)
Skin	0.056 mSv (5.6 mrem)	0.056 mSv (5.6 mrem)	0.15 mSv (15 mrem)
Max Organ (Child Bone)	0.145 mSv (14.5 mrem)	0.148 mSv (14.8 mrem)	0.15 mSv (15 mrem)

The staff's calculations confirmed that the applicant's effluent release doses are below the design objectives for 10 CFR Part 50, Appendix I. The staff finds its results and those of the applicant acceptable because of the conservative use of nonsite-specific data for the analysis. The results are found to be below the limits in 10 CFR Part 50, Appendix I, and are acceptable. The applicant includes COL 11.2(13), for a COL applicant to calculate these doses to a member of the public using the guidance of RG 1.109 and RG 1.113. An applicant following the COL item will use site-specific parameters to develop gaseous effluent releases based on any specific site. This COL is consistent with staff guidance in the SRP, and the staff finds this COL information item acceptable, since a COL applicant will develop a site-specific dose analysis that is in compliance with 10 CFR Part 50, Appendix I.

11.3.4.3 Site-Specific Cost-Benefit Analysis

DCD Tier 2, Section 11.3.1.6, "Site-Specific Cost-Benefit Analysis," describes the GRS design for use at any site with flexibility to incorporate site-specific requirements with minor modifications, such as technology preference, degree of automated operation, and radioactive waste storage. RG 1.110 describes an acceptable method of performing a CBA to demonstrate that the GWMS design includes all items of reasonably demonstrated technology for reducing to ALARA levels each reactor's cumulative population doses from releases of radioactive materials. The applicant states the CBA for the APR1400 design demonstrates that the addition of items of reasonably demonstrated technology will not provide a more favorable cost benefit but does not include a

CBA in DCD Tier 2, Section 11.3.1.6. The COL applicant will provide the site-specific CBA to demonstrate compliance with the requirements of 10 CFR Part 50, Appendix I, Sections II.A and II.D under COL 11.3(2). Because the CBA requires site-specific information, which is outside the scope of the requested DC, the staff finds the inclusion of COL 11.3(2) acceptable.

11.3.4.4 10 CFR Part 20, Appendix B, Gaseous Effluent Concentration Limits

The staff reviewed the information provided by the applicant to support compliance with 10 CFR 20.1302. This is a review of the Effluent Concentration Levels (ECL) calculated by the applicant in using the source term developed in Section 11.1 and the ECL values found in 10 CFR Part 20, Appendix B, where the staff finds that the applicant's determined value would be less than 1.

The applicant initially provided DCD Table 11.3-6, "Design Basis Gaseous Effluent Concentrations at the Site Boundary," to demonstrate compliance with the annual average gaseous release concentrations identified in Note 4 of 10 CFR Part 20, Appendix B, Table 2, Column 1, "unity rule" concentration limit. The applicant's tabulation included site concentrations that encompassed gaseous effluent releases from a proposed APR1400 unit. The staff notes that the gaseous effluent site concentrations are below the limits in 10 CFR Part 20, Appendix B, Table 2, Column 1, and the unity calculation described in Note 4.

The staff performed an independent confirmatory assessment of the results presented in DCD Table 11.3-6 and all associated calculations. The staff finds that, based on the total gaseous effluent estimated to be discharged from the site, the concentrations of radioactive materials present in gaseous effluents and discharged in unrestricted areas, listed in Table 11.3-6, the DCD is in compliance with the limits specified in 10 CFR Part 20, Appendix B, Table 2, Column 1, and that the sum of the ratios meets the 10 CFR Part 20, Appendix B, "unity rule."

When the staff reviewed DCD Table 11.2-10 and DCD Table 11.3-6 to verify the unity requirement in 10 CFR Part 20, Appendix B, Table 2, Note 4, the design-basis release values and the Appendix B, Column 1, values listed in these tables either did not include sufficient information to verify the values, or contained incorrect values from 10 CFR Part 20, Appendix B. The footnotes included with these two tables did not provide any significant information to be used to verify the numbers developed in DCD Table 11.2-10 and DCD Table 11.3-6. The staff's confirmatory calculations to verify the numbers in the DCD indicated discrepancies when solving for the ECL ratios from the information in Appendix B, Table 2. In RAI 145-7932, Question 11.03-1 dated August 10, 2015 (ML15222A648), the staff requested the applicant to provide detailed calculations to resolve the discrepancies between the staff's confirmatory calculations and the information in the DCD on the liquid and gaseous table values. In its response to RAI 145-7932, Question 11.03-01, dated September 25, 2015 (ML15269A016), the applicant provided additional information to clarify the methods used to calculate compliance with the ECLs. The staff verified the methods used to calculate and confirmed the correction of several ECL values identified in the original RAI. However, the staff could not verify various liquid and gaseous effluent values and issued follow-up RAI 429-8491, Question 11.03-10, dated March 4, 2016 (ML16064A432), to request the applicant to provide the calculations for all remaining unconfirmed nuclides. In its response to RAI 429-8491, Question 11.03-10, dated April 22, 2016 (ML16113A423), the applicant provided the exact method used to describe its calculations. The staff verified the methodology and results and found the applicant's approach acceptable, since it would bound the results produced by the staff, and the staff could also confirm the results developed by the applicant. Based on its confirmatory calculations, the staff

considers both RAI 145-7932, Question 11.03-01, and RAI 429-8491, Question 11.03-10, to be resolved and closed.

11.3.4.5 10 CFR 20.1301(e), Compliance with 40 CFR Part 190

The staff reviewed the applicant's GASPAR II code input/output files and response evaluating the dose from gaseous effluent releases to members of the public in unrestricted areas for compliance with 10 CFR Part 50, Appendix I, 10 CFR 20.1302, and 40 CFR Part 190. Input values pertaining to environmental characteristics, such as meteorology, release rates, and exposure pathways, rely on site-specific information addressed by the applicant in COL 11.3(7).

Under COL 11.3(7) in DCD Tier 2, Section 11.3.3.1, the COL applicant is required to calculate doses to members of the public using site-specific parameters following the guidance of RG 1.109 and RG 1.113, and to compare doses from gaseous effluents in 10 CFR Part 50, Appendix I, 10 CFR 20.1302, and 40 CFR Part 190. The staff finds that, because the site-specific input parameter values used in the GASPAR II code calculation of gaseous effluent doses are outside the scope of the requested DC, the inclusion of COL 11.3(7) is acceptable.

11.3.4.6 10 CFR 20.1406, Minimization of Contamination

The staff reviewed the information presented in DCD Tier 2, Section 11.3 against the criteria in 10 CFR 20.1406 for minimizing contamination. Compliance with 10 CFR 20.1406 is met when the applicant identifies those design features used to minimize the release of radioactive gases to the environment.

The applicant provides DCD Tier 2, Section 11.3.2.2.2, "Design Features for Minimization of Contamination," to meet the requirements of 10 CFR 20.1406. In this section, the applicant commits to the use of RG 4.21 and to the principles described in the RG to demonstrate compliance with 10 CFR 20.1406. The design features described in DCD Tier 2, Section 11.3.2.2.2 include information on the amount of charcoal used to increase the holdup time for noble gases, the use of waste gas dryers and guard beds to maintain charcoal bed integrity, the use of a HEPA filter to prevent the spread of charcoal fines and other radioactive particulates, and an explanation of how cubical walls are coated with epoxy to facilitate spill cleanup. The GRS is designed with gas analyzers and a radiation monitor to indicate potentially explosive mixtures of gas and to ensure prompt operator actions on detection above preset radiation limits, as can be seen within the ITAAC. In its review of the information provided in DCD Tier 2, Section 11.3.1.3.b.3, the staff found the following statement: "For the APR1400, pipes less than 22 mm (1 in.) are exempt from pressure testing provided the original system pressure tested." The staff issued RAI 231-8233, Question 11.03-08, dated September 28, 2015 (ML15271A337), to ask for the regulatory basis behind the statement and for the applicant to explain the basis for not pressure testing this specific piping. In its response to RAI 231-8233, Question 11.03-8, dated January 6, 2016 (ML16006A562), the applicant provided changes to DCD Section 11.3.1.3.b.3. The changes included a pointer to the equipment codes and standards table, Table 11.3-2, referring to American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, which specifies that certain components are exempt from pressure testing. The staff finds this response acceptable, since the applicant provides information to describe why the piping is exempt and also refers to ASME Section XI. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 231-8233, Question 11.03-08, to be resolved and closed.

The COL applicant is required to develop the leak identification program (COL 11.3(4)) to identify site-specific components that contain radioactive materials, buried piping, embedded piping, leak detecting methods and capabilities, and methods used to prevent unnecessary contamination. The COL applicant is also required to maintain complete documentation on system design, construction, design modifications, field changes, and operations (COL 11.3(5)).

11.3.4.7 Postulated Gaseous Effluent Radioactive Releases Due to a Waste Gas System Leak or Failure

The staff reviewed DCD Section 11.3.3.2, which refers to the analysis to support the calculations in BTP 11-5, "Postulated Radioactive Releases Due to a Waste Gas System Leak or Failure." The applicant provided a list of input parameters and equations in the DCD text that were used in the staff's confirmatory calculation. Using this information, the staff was unable to confirm the results of the applicant's BTP 11-5. As a result, the staff issued RAI 171-8143, Question 11.03-03, on August 25, 2015 (ML15237A478), requesting that the applicant provide a calculation package containing the details of its analysis. The staff found that not all of the parameters used in the applicant's stated equation are fully explained. In its response to RAI 171-8143, Question 11.03-03, dated December 12, 2015 (ML15348A337), the applicant included two source terms — a normal GWMS release rate and an accident release rate from the GWMS. In addition to these gaseous effluent source terms, the applicant briefly described the calculation used to develop the gaseous effluent dose results and provided the atmospheric dispersion data. The staff review could not determine the basis of the GALE code gaseous effluent source term.

The staff raised these concerns and conducted an audit with the applicant on March 15, 2016, and March 16, 2016 (ML16238A421).

The staff questioned the applicant's information and the use of the GALE86 code to develop the gaseous effluent source term. The applicant stated that only the results from the gas stripping operations source term would be used in the accidental effluent release calculations. The staff determined that only using the gaseous effluent source term from gas stripping operations would provide a reasonable approach to the calculations. BTP 11-5 requires an analysis of the waste gas system, not a total gaseous effluent release source term normally provided by the GALE86 code. The total gaseous effluent normal releases assume the full use of the charcoal delay beds, while the accidental release described by BTP 11-5 takes no credit for the charcoal delay beds. To generate the total source term, the applicant adds the normal release and accidental release together and ratios the maximum coolant concentration with the ANSI 18.1 source term to generate a 1-percent failed fuel source term. The staff verified these source terms with confirmatory calculations and determines that approach performed by the applicant is acceptable. In addition, the applicant references the use of dose conversion factors in Federal Guidance Report 12, "External Exposure to Radionuclides in Air, Water, and Soil," issued in September 1993, which complies with the guidance in BTP 11-5.

In its revised response to RAI 171-8143, Question 11.03-03, on May 5, 2016 (ML16123A251), the applicant provided changes to the DCD, including footnotes to DCD Table 11.3-9, reflecting changes within the table that clarified the basis of the gaseous source terms used in the BTP 11-5 analysis. The applicant's results in DCD Table 11.3-9 indicate that gaseous effluent doses are calculated to be 1.16E-2 mSv (1.16E0 mrem) at the EAB, and 2.55E-3 mSv (2.55E-1 mrem) at the low-population zone (LPZ). The staff independently calculated similar results. These results are within the 1E0-mSv (100-mrem) limit specified by BTP 11-5. The staff finds the applicant's response acceptable. The staff confirmed that the proposed changes have been

incorporated in the DCD; therefore, the staff considers RAI 171-8143, Question 11.03-03, to be resolved and closed.

11.3.4.8 10 CFR 52(b)(1) for ITAAC

DCD Tier 1, Section 2.7.6.2, contains the ITAAC related to the GWMS. The ITAAC address the functional arrangement of the GRS, verification of the mass of charcoal needed to facilitate adsorption of radionuclides, GRS discharge valve closure on high-radiation signals, verification of an alarm from the gaseous waste discharge radiation monitor in the MCR, automatic opening of a nitrogen injection valve on a high-oxygen concentration signal, and verification that GRS components are designed using the guidance in RG 1.143. The GWMS is relied upon to maintain concentrations of radioactive waste released to the environment below the exposure limits for members of the public. The associated regulatory requirements are contained in 10 CFR 20.1301 and 20.1302, and 10 CFR Part 20, Appendix B, Table 2, ECLs. Other regulatory requirements address design features that are intended to avoid unmonitored and uncontrolled radioactive releases to the environment under 10 CFR 20.1406(b). In addition, 10 CFR Part 52 states that significant plant systems and component parameters should be included in DCD Tier 1 entries.

The ability to maintain concentrations below 10 CFR Part 20 limits and exposure limits to members of the public depends upon the GWMS process, including the number and sizing of components, processing equipment, effluent radiological monitoring and sampling systems, automatic control features in terminating releases that exceed alarm setpoints, and process dilution before release into the environment. In its review of DCD Tier 1, Section 2.7.6.2, the staff determined that there were some deficiencies with the information provided. In RAI 219-8199, Question 11.03-06, dated September 21, 2015 (ML16091A003), the staff requested more details concerning the ITAAC and GWMS design information so that it could verify the ability to monitor and control radioactive releases to the environment. The staff requested the process design of the GWMS subsystems to describe how the loading of demineralizers and vessels include the proper types and amounts of charcoal media and how to verify charcoal adsorption efficiency. The staff also requested information on an ITAAC that confirms the radiation monitor at the discharge side of the charcoal adsorbers' ability to close the GWMS discharge valves on detection of high-radiation levels. In its response to RAI 219-8199, Question 11.03-06, dated January 6, 2016 (ML16006A553), the applicant updated DCD Tier 1, Section 2.7.6.2, to describe those features that are used to protect the charcoal delay beds and updated DCD Tier 1, Table 2.7.6.2 4, to indicate that the appropriate mass for the charcoal delay beds is verified in an ITAAC. The staff also determined that DCD Figure 11.3-1 was updated in the applicant's response to RAI 205-8230, Question 11.03-05, dated April 25, 2016 (ML16116A388), to provide additional design information for the charcoal delay beds. The staff finds this response acceptable because the applicant provided additional information indicating that the charcoal delay beds will have the ability to reduce gaseous effluent releases to the dose objectives in 10 CFR Part 50, Appendix I. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 219-8199, Question 11.03-06, and RAI 205-8230, Question 11.03-05, to be resolved and closed.

In RAI 219-8199, Question 11.03-07, dated September 21, 2015 (ML16091A003), the staff requested information to confirm that the inspection and test analysis will use a radiation source when verifying the corresponding design commitments. The currently stated use of a simulated radiation source suggests the use of an electronic signal in verifying system function. The staff determined that an electronic signal does not test the system as a whole by not verifying the

operation of the radiation detector. In its first response to RAI 219-8199, Question 11.03-07, dated December 3, 2015 (ML15337A120), the applicant revised the text in DCD Tier 1, Section 2.7.6.4, to state that all monitors would be tested using a radiation check source. In its second revised response to RAI 219-8199, Question 11.03-07, dated April 16, 2016 (ML16107A010), the applicant further clarified its intent to ensure that a radiation check source would be used to check the function of each monitor. In the third response to RAI 219-8199, Question 11.03-07, dated September 30, 2016 (ML16274A408), the applicant provided a response related to the same concerns on the use of a simulated test signal. In this response, the applicant described that a radiation check source will be available to verify the function of a monitor in a pass/fail criterion. An electronic test signal will still be used to produce the signal needed to test the monitors for indication and alarm functionality. The staff finds this response acceptable because the applicant has included text in DCD Section 11.5 to state that the RMS has a radiation check source available to verify system availability automatically and is present in the system to verify the monitors operation. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 219-8199, Question 11.03-6, and RAI 219-8199, Question 11.03-07, to be resolved and closed.

Based on the discussion above, the staff finds the information provided in DCD Tier 1, Section 2.7.6.2, are complete and consistent with the plant design basis as described in DCD Tier 2, Section 11.3. Based on the discussion above, the staff finds that the GWMS complies with the requirements of 10 CFR 52.47(b)(1).

11.3.4.9 Technical Specifications

A review of DCD Tier 2, Chapter 16, indicates that TS 5.5.12 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 1 mSv (100 mrem) in the event of a bed failure. In addition, TS 5.5.1 and TS 5.5.4 provide direction in managing releases of radioactive effluents and the control and handling of concentrated wastes for disposal. 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 effluent radioactivity to meet the requirements of 10 CFR 20.1302; 40 CFR Part 190; 10 CFR 50.36a; and 10 CFR Part 50, Appendix I.

The TS 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; monitor, sample, and analyze gaseous 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 gaseous effluents. The staff determines these requirements acceptable and agreed that further implementation of such programs will be addressed in a plant- and site-specific ODCM under COL 11.3(9), as described in DCD Tier 2, Table 1.8-2. SE Section 11.5 contains the staff's evaluation of the applicant's proposed ODCM.

11.3.5 Combined License Information Items

SER Table 11.3-2 lists COL information item numbers and descriptions from DCD Table 1.8-2.

Table 11.3-2 Combined License Items Identified in the DCD

ITEM NO.	DESCRIPTION	SECTION
COL 11.3(1)	The COL applicant is to prepare and implement the epoxy inspection and maintenance program in the GRS.	11.3.1.2
COL 11.3(2)	The COL applicant is to perform a site-specific cost-benefit analysis following the guidance in RG 1.110 for conformance with 10 CFR 50 Appendix I.	11.3.1.6
COL 11.3(3)	The COL applicant is to prepare and provide the piping and instrumentation diagram (P&ID) for the combined operating license application.	11.3.2
COL 11.3(4)	The COL applicant is to prepare the operational procedures and maintenance programs related to leak detection and contamination control.	11.3.2.2.2
COL 11.3(5)	The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations for decommissioning planning.	11.3.2.2.2
COL 11.3(6)	The COL applicant is to prepare the site PCP and the site radiological environmental monitoring program.	11.3.2.2.2
COL 11.3(7)	The COL applicant is also to perform the dose calculation using the total gaseous effluents from the site for comparison with the requirements of 40 CFR 190.	11.3.3.1
COL 11.3(8)	The COL applicant is to perform an analysis using site-specific meteorological data to demonstrate that the potential airborne concentration resulting from GRS failure meets the requirements of 10 CFR 20, Appendix B, Table 2.	11.3.3.2
COL 11.3(9)	The COL applicant is to prepare an ODCM following the guidance in NEI 07-09A template.	11.3.3.3

The staff finds the above list to be complete. Also, the list adequately describes actions necessary for the COL applicant. No additional COL information items were identified that need to be included in DCD Tier 2, Table 1.8-2, for the GWMS.

11.3.6 Conclusions

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, including AOOs. The applicant provided sufficient design information to demonstrate that it has met the requirements of 10 CFR 50.34a, 10 CFR 50.36a, 10 CFR Part 20, 10 CFR Part 50, GDC 3, GDC 60, GDC 61, and GDC 64, 40 CFR Part 190, and NRC guidance and SRP Section 11.3 acceptance criteria. This conclusion is based on the following:

- The APR1400 design demonstrates compliance with 10 CFR 50.34a, as it relates to the inclusion of sufficient design information and system design features 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 APR1400 design demonstrates compliance with 10 CFR Part 50, Appendix A, 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 APR1400 design meets the requirements of 10 CFR Part 50, Appendix A, 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 radiation monitor setpoint. The COL applicant is required to determine the operational setpoint for its GWMS radiation monitor in a plant- and site-specific ODCM under COL 11.5(2), as described in DCD Tier 2, Table 1.8-2. As part of this commitment, the COL applicant is required to demonstrate, 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 APR1400 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 the guidance of RG 4.21 and RG 1.143 in minimizing the contamination of the facility and generation of radioactive wastes, and the concerns of IE Bulletin 80-10 in avoiding the cross-contamination of nonradioactive systems and unmonitored and uncontrolled radioactive releases to the environment.

- The COL applicant referencing the APR1400 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 CBA using NRC guidance under COL 11.3(2), as described in DCD Tier 2, Table 1.8-2.

- The APR1400 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.

11.4 Solid Waste Management System (SWMS)

11.4.1 Introduction

The SWMS is designed to collect and accumulate spent ion exchange resins and deep bed filtration media, spent filter cartridges, dry active wastes, and mixed wastes generated as a

result of normal plant operation, including AOOs. Mobile systems process and package waste, which is stored in the compound building until it is shipped offsite to a licensed disposal facility.

As the SWMS does not directly discharge effluents into the environment, SER Sections 11.2 and 11.3 contain the staff's evaluation of the LWMS and GWMS, respectively, for the liquid and gaseous effluents generated during the operation of the SWMS and the associated releases of effluents into the environment and doses to members of the public.

11.4.2 Summary of Application

DCD Tier 1: The Tier 1 information associated with this section is found in DCD Tier 1, Section 2.7.6.3, "Solid Waste Management System," summarized here, in part, as follows:

The SWMS is located in the compound building. The portions of the compound building that house the principal SWMS equipment are designed to RW-IIa. The SWMS is a nonsafety-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. The SWMS consists of several subsystems designed to handle spent resin, spent filter elements, R/O concentrates, and dry active waste (DAW). DCD Tier 1, Table 2.7.6.3-2, lists the ITAAC for the SWMS.

DCD Tier 2: The applicant has provided a system description in DCD Tier 2, Section 11.4, "Solid Waste Management System," summarized here, in part, as follows:

In DCD Tier 2, Section 3.2, the applicant described 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. The components of the SWMS are designed to the seismic criteria of RG 1.143 (Revision 2) and have a safety classification of RW-IIa, based on the determination of the A_1 and A_2 quantities specified in 10 CFR Part 71, Appendix A. The SWMS is housed in a reinforced concrete structure to provide adequate shielding and minimize radiation exposures to personnel during operation and maintenance. The thickness of the shield walls of the radioactive waste areas is determined using the design-basis source term (1-percent failed fuel fraction) in DCD Tier 2, Table 11.4-2, "Expected Radioactive Source Terms for the SWMS," and Table 11.4-3, "Design Basis Radioactive Source Terms for SWMS." The SWMS design consists of two spent resin storage tanks (SRSTs), components, and subsystems used to dewater or solidify radioactive waste before storage or offsite shipment.

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 the appropriate LWMS sumps and storage tanks. Each cubicle containing an SRST is designed to contain the maximum liquid inventory in the event the SRST ruptures. The SRST cubicles are coated with an impermeable epoxy liner (coating) to facilitate decontamination of the facility in the event of a tank leakage and failure. SE Section 11.2 evaluates this nonsafety-related Service Level II epoxy coating used as a design feature, in part, for compliance with 10 CFR 20.1406. SE Section 11.4 evaluates other design features, such as early leak detection, drainage, and transfer capabilities that minimize the release of radioactive liquid to the ground water and environment.

The COL applicant will subject the SWMS to preoperational inspections and testing 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.

In DCD Tier 2, Section 11.4, the applicant described the design of the SWMS and its functions in collecting, processing, packaging, storing, and preparing wet and dry solid radwaste for shipment and disposal. The SWMS processes and packages radioactive waste from the LWMS, the CVCS, the spent fuel pit cooling and purification system, and the SGBS.

The SWMS is divided into five subsystems to handle the following waste types:

(1) Spent resin and packaging subsystem

(2) Spent filter handling subsystem

(3) Dry active waste subsystem

(4) R/O concentrate treatment subsystem

(5) Temporary waste storage subsystem

The spent resin transfer and packaging subsystem is designed to hydraulically transfer spent radioactive resins from the demineralizer vessels to the spent resin tanks where the resin is held before processing.

The spent filter handling subsystem provides the ability to replace normally radioactive filters while reducing personnel radiation exposure. The spent filters are removed from service following a drop in pressure and are removed from the filter vessels using a shield plug and shielded transfer cask. The spent filters are then transported using a filter transporter and placed and capped into a 200-Liter (55-gal) drum.

Plant personnel sort the DAW collected by the subsystem. Noncontaminated wastes are not processed by the SWMS. DAW such as contaminated rags, paper, clothing, glass, and other small items is collected at the sorting area located within the compound building.

The R/O concentrate subsystem dries the concentrate waste from the R/O membrane separation process. The dried concentrate waste is packaged in a 200-Liter (55-gal) drum or high-integrity container (HIC).

The temporary waste storage subsystem is located in the compound building and provides an area to allow the storage of higher activity packaged wastes. The temporary waste storage area is sized to accommodate the number of drums and HICs generated in a 6-month period of normal operation. The SWMS design includes a truck bay located next to the packaged waste storage area, providing an enclosed area where packaged radioactive waste can be loaded onto shipping trucks for offsite burial or processing in an offsite facility. A permanently installed overhead crane moves the packaged waste into and out of the waste storage area and loads the radioactive waste onto shipping trucks.

In DCD Tier 2, Figure 1.2-23, “General Arrangement Compound Building Sections A-A and B-B,” the applicant depicts the general arrangement of the compound building where the SWMS is located. DCD Tier 2, Section 9.4.7, “Compound Building HVAC System,” presents design information on ventilation systems servicing the compound building where SWMS subsystems are located, as well as systems used to collect gases vented from tanks and vessels. DCD Tier 2, Section 11.2, presents design information on the processing of equipment and floor drains, including the collection of liquids from the SWMS.

In DCD Tier 2, Table 11.4-1, “Estimated Annual Solid Waste Generation,” the applicant identifies the volumes and waste classification of oil and sludge wet wastes. DCD Tier 2, Table 11.4-2, “Expected Radioactive Source Terms for SWMS,” identifies the volumes and waste classification of DAW, spent resin, spent filter, spent carbon, and sludge dry wastes, based on the average PWR operating experience. The expected annual solid waste volumes and classifications to be shipped offsite are estimated in DCD Tier 2, Table 11.4-1, as well.

In DCD Tier 2, Section 11.4.8, “Instrumentation Requirements,” the applicant states the SWMS is operated and monitored from the radwaste control room in the compound. Major system parameters, such as SRST level, demineralized water flow rate, and tank pressure are provided for the low-activity spent resin tank, and tank level information is provided for the spent resin long-term storage tank. Indications and alarms are provided to operational personnel in the radwaste control room. DCD Tier 2, Table 11.4-6, “Instrument Indication and Alarm Information,” identifies alarm instruments and readout locations. Alarm instruments, including back flushing provisions, are located in low-radiation areas, when possible, for accessibility and ALARA considerations.

The SWMS process flow diagrams are presented in DCD Tier 2, Figure 11.4-1, and “Solid Radwaste System Flow Diagram.”

In DCD Tier 2, Section 11.4.3, “Radioactive Effluent Releases,” the applicant stated any liquids and gases generated from the operation of the SWMS are processed by the LWMS (described in DCD Tier 2, Section 11.2) and the plant ventilation system (described in DCD Tier 2, Section 9.4). Any liquids and gases from operating the SWMS are routed to the LWMS and GWMS for treatment. As a result, the radiological impacts associated with the expected liquid and gaseous effluents generated during the operation of the plant, including those from SWMS, are addressed in DCD Tier 2, Sections 11.2 and 11.3, for the LWMS and GWMS, respectively. SE Sections 11.2 and 11.3 present the staff’s evaluation of liquid and gaseous effluent releases and doses, respectively.

The SWMS design criteria in DCD Tier 2, Section 11.4.1.2, provide the means to package radwaste for compliance with 10 CFR Part 61, “Licensing Requirements for Land Disposal of Radioactive Waste,” and the applicable parts of 10 CFR Part 60, “Disposal of High-Level Radioactive Wastes in Geologic Repositories,” and 10 CFR Part 63, “Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada,” to collect, process, package, and store radioactive waste for compliance with 10 CFR Part 20; to contain radioactive waste for compliance with 49 CFR Part 171, “General Information, Regulations, and Definitions,” and process and package radioactive waste for transportation and disposal for compliance with 49 CFR Part 173, “Shippers—General Requirements for Shipments and Packagings,” Subpart I, “Class 7 (Radioactive) Materials,” using the acceptance criteria of SRP Section 11.4 and NRC guidance.

ITAAC: The ITAAC associated with DCD Tier 2, Section 11.4, are given in DCD Tier 1, Section 2.7.6.3, “Solid Waste Management System,” and Table 2.7.6.3-2, “Solid Waste Management System ITAAC.” DCD Tier 2, Section 14.3.2.7, “ITAAC for Plant Systems,” summarizes how ITAAC were developed for DCD Tier 1, Section 2.7.6.3.

TS: There is information pertinent to TS associated with the SWMS in DCD Tier 2, Section 11.4.4.4, “Process Control Program,” and DCD Tier 2, Chapter 16, Section 5.5.1.

10 CFR 20.1406: There is information pertinent to 10 CFR 20.1406 in DCD Tier 2, Sections 11.4.1.7, “Mobile Equipment,” 11.4.2.2.5, “Interim Radwaste Storage Facility (IRSF),” 11.4.2.4,

"Operation and Personnel Doses," and 11.4.2.5, "Design Features for Minimization of Contamination."

COL Information or Action Items: See Section 11.4.5 below.

Technical Report(s): There are no technical reports associated with this area of review.

Topical Report(s): There are no topical reports associated with this area of review.

APR1400 Interface Issues Identified in the DCD: There are no APR1400 interface issues associated with this area of review.

Site Interface Requirements Identified in the DCD: There are no site interface requirements associated with this area of review.

Cross-Cutting Requirements (TMI, USI/GSI, Op Ex): There is a cross-cutting issue for this area of review described in NUREG-0933, "Resolution of Generic Safety Issues," Section 2, "Task Action Plan Items" (NUREG-0933, Main Report Item C-17, "Interim Acceptance Criteria for Solidification Agents for Radioactive Solid Wastes").

RTNSS: There are no RTNSS issues for this area of review.

CDI: This DCD section does not contain CDI that is outside the scope of the APR1400 certification.

11.4.3 Regulatory Basis

SRP Section 11.4 provides the relevant requirements of NRC regulations for the radioactive waste system, the associated acceptance criteria, and review interfaces with other SRP sections. The following are the relevant regulatory requirements:

- 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

- 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

- 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 ALARA

- 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

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

- 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

- GDC 61, as it relates to the system design for solid radioactive waste systems and the ability of such systems containing radioactivity to ensure adequate safety under normal and AOOs and suitable shielding for radiation protection

- 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

- 10 CFR 52.47(b)(1), which requires that applications for DCs 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 DC is built and will operate in accordance with the DC and provisions of the Atomic Energy Act and NRC regulations

Regulatory guidance adequate to meet the above requirements includes the following:

- SRP Section 11.4, BTP 11-3, "Design Guidance for Solid Waste Management Systems Installed in Light-Water-Cooled Nuclear Power Reactor Plants," Revision 3, issued March 2007

- 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)

- 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 RWMSs

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

- GL 89-01, as it relates to the restructuring of the process control program (PCP) and radiological effluent technical specifications (RETS) (included in NUREG-1301)

- NUREG-1301, as it relates to the development of a plant-specific PCP or, alternatively, a COL applicant may use NEI PCP Template 07-10A (Revision 0, issued March 2009) (NRC-approved, ML091460627) 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 DCD Tier 2, Section 13.4, of a COL application

- 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

- 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, issued June 1978

- RG 8.10, “Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable,” Revision 1-R, issued May 1977

- 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

11.4.4.1 Design Considerations

11.4.4.1.1 Waste Collection and Storage

The SWMS is designed to process, package, and store the dry and wet solid wastes generated from the plant in accordance with regulatory guidelines, to handle and store dry and low-activity wastes before shipment to an offsite disposal facility, and to provide reasonable assurance that worker and public doses are ALARA. The SWMS is divided into five subsystems:

(1) Spent resin and packaging subsystem

(2) Spent filter handling subsystem

(3) Dry active waste subsystem

(4) R/O concentrate treatment subsystem

(5) Temporary waste storage subsystem

In DCD Figure 11.4-1, the applicant provides a process flow diagram for the SWMS.

The spent resin transfer and packaging subsystem is designed to transfer spent radioactive resins from the demineralizer vessels to the spent resin tanks where the resin is held up before processing. The major components within this subsystem are the low-activity spent resin tank and the spent resin long-term storage tank. The spent resin tanks provide a settling capacity for radioactive resins transferred to these storage tanks and allow the spent resins to be stored while waiting for them to decay. Spent resin (high-activity) from the CVCS is transferred to the long-term storage tank hydraulically, using demineralized water for sluicing. The sluiced water in the SRST is then removed and sent to the LWMS for processing. The low-activity resins from the LWMS, spent fuel pool cooling and cleanup system, and SGBS are transferred to the low-activity spent resin tank using the same method described for the high-activity spent resins. The applicant states that the spent resin transfer and packaging subsystem starts at the spent resin discharge isolation valves from each of the demineralizers and ends at the temporary waste storage area.

The spent filter handling subsystem provides the capability to replace normally radioactive filters while reducing personnel radiation exposure. The spent filters are removed from service following a drop in pressure and are removed from the filter vessels using a shield plug and shielded transfer cask. The spent filters are then transported using a filter transporter and

placed and capped into a 200-L (55-gal) drum. R/O membranes are dewatered and packaged in 200-L (55-gal) drums. Low-activity filters (drain filters of detergent waste and HEPA filters from GRS) are removed manually and disposed of in drums. The applicant stated that the spent filter handling subsystem starts at the point of removal of the filter media from the filter housing and ends at the temporary waste storage area.

Plant personnel sort the DAW collected by the subsystem. Noncontaminated wastes are not processed by the SWMS. DAW, such as contaminated rags, paper, clothing, glass, and other small items, is collected at the DAW sorting area located within the compound building. DAW is compacted or packaged into approved disposal containers and transferred to and stored in a temporary waste storage area in the compound building before shipment. Charcoal within the GRS is not expected to be replaced. If it is replaced, it will be processed in accordance with the PCP provided by the COL applicant in COL 11.4(5). The applicant stated that the DAW subsystem starts at the collection point of DAW and ends at the temporary waste storage area.

The R/O concentrate subsystem dries the concentrate waste from the R/O membrane separation process. The dried concentrate waste is packaged in a 200-L (55-gal) drum or HIC. The applicant stated that the R/O concentrate treatment subsystem starts at the R/O concentrate discharge isolation valve and ends at the temporary waste storage area.

The temporary waste storage subsystem is located in the compound building and provides an area to store higher activity packaged wastes. The temporary waste storage area is sized to accommodate the number of drums and HICs generated in a 6-month period of normal operation. DCD Table 11.4-1 contains information on the expected and maximum shipped volumes for offsite storage. DCD Section 11.4.2, for the temporary waste storage subsystem contains information on the compliance with the 30-day storage criteria in ANSI/ANS-55.1, "Solid Radioactive Waste Processing System for Light-Water-Cooled Reactor Plants." The temporary waste storage area has an overhead crane with direct access to an adjacent truck bay to allow for direct loading of packaged waste. In its review of the generated waste being stored in the temporary storage area, the staff questioned how the applicant determined its 6-month storage capacity using DCD Table 11.4-1. As a result, the staff issued RAI 242-8276, Question 11.04-03, on October 14, 2015 (ML15296A011), asking the applicant to provide references to plant drawings and the available surface area to store waste.

The staff also requested that the applicant provide information to supplement the expected generation and maximum generation rates for DAW to compare the expected generation rates to the available storage area. In its response to RAI 242-8276, Question 11.04-3, dated January 28, 2016 (ML16028A058), the applicant referred to a plant drawing for the temporary storage area, in DCD Figure 1.2-27, "General Arrangement Compound Building EL 100'-0," and also described the high-activity and low-activity storage areas, as well as the expected volumes to be contained in these spaces. The staff reviewed the planned storage areas and confirmed that the building can contain the volumes of waste generated during operations. The applicant also updated DCD Table 11.4-1 to include the expected generation rates for DAW and included a footnote to discuss how the volume of waste generated was being compressed and packaged with the assumed ratios and reduction factors. The staff verified this information through confirmatory calculations using the expected waste storage drum base areas, and the staff determined that the expected surface areas are contained within the temporary waste storage area.

In its revised response to RAI 242-8276, Question 11.04-03, dated April 16, 2016 (ML16107A010), the applicant proposed additional DCD changes. The applicant included the

description within the RAI text that describes the development of the waste generation rates. The staff finds this response acceptable. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 242-8276, Question 11.04-03, to be resolved and closed. The applicant also included COL 11.4(6), which requires a COL applicant to describe how it will handle waste that is generated in excess of the shipment amounts.

In DCD Tier 2, Section 11.4.2 and in the footnote to DCD Tier 2, Table 11.4-1, the applicant stated that charcoal used in the GRS is not expected to be replaced. However, in the cases where charcoal waste is generated, the COL applicant will process it in accordance with the PCP developed by the COL applicant (COL 11.4(5)).

Included as COL 11.4(8), a COL applicant is responsible for providing the information on a site wide interim radwaste storage facility (IRSF), if additional storage space is warranted by the COL applicant.

11.4.4.1.2 Mobile Equipment

The APR1400 design's spent resin dewatering system is designed as a modular and mobile system. The mobile design allows for replacement when the equipment is broken or a new technology is available. The mobile system is cited to have an exhaust fan and HEPA filter, in accordance with BTP 11-3. The exhaust air is discharged to the compound building HVAC system, which then allows it to be processed by the GRS. The applicant specified that a COL applicant is to provide reasonable assurance that provisions meet ANSI/ANS-40.37, "Mobile Low-Level Radioactive Waste Processing Systems," and also requires that a COL applicant conform to the regulatory requirements of 10 CFR 50.34a, 10 CFR 20.1406, and RG 1.143 (COL 11.4(3)).

11.4.4.1.3 General Design Criteria 60 and 61 and 10 CFR 50.34a

GDC 60 requires the nuclear power unit design to include provisions to handle radioactive wastes produced during normal reactor operations, including AOOs. GDC 61 requires that the fuel storage and handling, radioactive waste, and other systems that may contain radioactivity be designed to ensure adequate safety under normal and postulated accident conditions.

The requirements of GDC 60 and 61 are met by the use of the regulatory positions in RG 1.143 as they relate to the seismic design, quality group classification of components used in the SWMS 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.

The staff reviewed the QA provisions and RG 1.143 requirements specified by the applicant in the DCD. The applicant stated that the SWMS will conform to regulatory position C.7 of RG 1.143 and RG 1.33, which specifies the QA guidance to follow. DCD Table 3.2-1 also identifies the seismic category, quality group, and safety class for components of the SWMS. The QA program is stated to be designed in accordance with ANSI/ANS-55.6, which is in agreement with RG 1.143, position C.7. In determining the design guidance for radwaste systems, the applicant provided DCD Table 11.4-3, to reflect the guidance specified in RG 1.143 to meet the A_1 and A_2 values in 10 CFR Part 70, Appendix A. The staff's confirmatory calculations of the data provided by the applicant were unable to verify the results provided. The staff's analysis determined that the applicant's analysis was using a value of 0 in place of values that were not listed in 10 CFR Part 70, Appendix A, Table 1. In the text preceding

Table 1, it states: “For individual radionuclides whose identities are known, but which are not listed in Table A-1, the A_1 and A_2 values contained in Table A-3 may be used. Otherwise, the licensee shall obtain prior Commission approval of the A_1 and A_2 values for radionuclides not listed in Table A-1, before shipping the material.” The staff’s confirmatory calculations used the values specified by Table 3 in Appendix A when determining the A_1 and A_2 values. The staff issued RAI 157-8149, Question 11.04-01, on August 18, 2015 (ML15230A390), to request that the applicant evaluate the use of the values specified in determining the A_1 and A_2 values to determine radwaste system classifications. In its response to RAI 157-8149, Question 11.04-01, dated September 17, 2015 (ML15260B441), the applicant stated that the SWMS receives resins, filters, and concentrations from the chemical volume and control system (CVCS) and LWMS after sufficient time for the decay of shorter lived radionuclides has occurred. The applicant explained that there are short-lived nuclides that have a negligible impact on the compliance determination and therefore will not be considered. The staff agrees with the statements made by the applicant and finds this response acceptable; therefore, the staff will not consider the short-lived radionuclides. The staff confirmed the results reported by the applicant in DCD Table 11.4-3. The staff used the guidance of RG 1.143 to determine that the applicant’s radwaste system classifications are in agreement with the staff’s analysis; therefore, the staff considers RAI 157-8149, Question 11.04-01, to be resolved and closed.

In review of the description of systems to satisfy RG 1.143, the staff reviewed the text in DCD Section 11.4.5 that states: “The safety classification for the SWMS components applies to components up to and including the nearest valves, fittings, and/or welded/flanged nozzle connections.” The staff finds that this does not satisfy the necessary description for defining systems up to their nearest isolation component. In RAI 229-8194, Question 11.04-02, dated September 28, 2015 (ML15296A003), the staff asked the applicant to provide a description that contains all components, including the nearest isolation component. In its response to RAI 229-8194, Question 11.04-02, dated December 11, 2015 (ML15345A369), the applicant changed the DCD text to ensure that the nearest isolation component was contained within the components description. The applicant’s revision is in agreement with the request made by the staff. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 229-8194, Question 11.04-02, to be resolved and closed.

For compliance with 10 CFR 50.34a, the applicant must provide sufficient information to demonstrate that the design objectives of equipment necessary to treat and control releases of radioactive effluents into the environment have been met. The requirements of 10 CFR 50.34a are met by describing the process used to treat and handle solid waste and also by identifying the system boundaries. The applicant provided DCD Table 11.4-1 to identify the planned waste generation rates alongside the planned shipped waste rates. DCD Table 11.4-1 also includes the waste classifications for the waste streams generated from the SWMS.

The requirements of GDC 61 and GDC 63 specify that the SWMS include shielding and ventilation design features to protect workers and control releases of gaseous radioactivity in the environment. A review of DCD Tier 2, Sections 11.4.2 and 12.3, “Radiation Protection Design Features,” indicates that the SWMS and features of the compound building 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 the waste compactor are captured by the ventilation system of the compound building and are monitored before being released to the environment through the GWMS. Finally, the design includes radiation monitors installed on system components and in the compound building to monitor ambient radiation exposure rates and airborne radioactivity levels and alert operators of changing conditions and when to take corrective steps.

11.4.4.2 10 CFR Part 50, Appendix I

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. SE Sections 11.2 and 11.3 present the staff's evaluation. 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; the design objectives of 10 CFR Part 50, Appendix I; and the requirements of 10 CFR 20.1301(e) to control doses within EPA's generally applicable environmental radiation standards under 40 CFR Part 190. A COL applicant referencing this design is required to perform the CBA following RG 1.110 in accordance with 10 CFR Part 50, Appendix I, Section II.D (COL 11.4(2)). The staff finds this COL information item acceptable because a COL applicant referencing this design will be following NRC guidance to demonstrate compliance with 10 CFR Part 50, Appendix I.

11.4.4.3 Site-Specific Cost-Benefit Analysis

DCD Tier 2, Section 11.4.1.6, "Site-Specific Cost-Benefit Analysis," describes the SWMS design for use at any site with flexibility to incorporate site-specific requirements with minor modifications such as technology preference, degree of automated operation, and radioactive waste storage. RG 1.110 describes an acceptable method of performing a CBA to demonstrate that the SWMS design includes all items of reasonably demonstrated technology for reducing to ALARA levels cumulative population doses from releases of radioactive materials from each reactor. The applicant states the CBA for the APR1400 design demonstrates that the addition of items of reasonably demonstrated technology will not provide a more favorable cost benefit but does not include a CBA in DCD Tier 2, Section 11.4.1.6. The COL applicant will provide the site-specific CBA to demonstrate compliance with the requirements of 10 CFR Part 50, Appendix I, Sections II.A and II.D, under COL 11.4(2). Because the CBA requires site-specific information, which is outside the scope of the requested DC, the staff finds the inclusion of COL 11.4(2) acceptable.

11.4.4.4 Minimization of Contamination

The staff reviewed the information presented in DCD Section 11.4 against the criteria in 10 CFR 20.1406 for minimizing contamination. Compliance with 10 CFR 20.1406 is met when the applicant identifies those design features used to minimize the release of radioactive gases to the environment.

The applicant provides DCD Section 11.4.2.5, "Design Features for Minimization of Contamination," to meet the requirements of 10 CFR 20.1406. In this section, the applicant commits to the use of RG 4.21 and the principles described within the RG to demonstrate compliance with 10 CFR 20.1406. The design features described in Section 11.4.2.5 describe the ways in which the SWMS was designed to limit leakage and control the spread of contamination. System components, including the low-activity spent resin tank and spent resin long-term storage tank, are designed with stainless steel material and welded for construction for life-cycle planning. The tanks are designed to have sufficient capacity to contain spent resins for enough time to allow for decay. The concentrate treatment and spent resin dewatering subsystems are designed as skid-mounted packages with self-containing drip pans to contain leakage from the subsystems. Drains are connected to these subsystems to direct liquid waste to the LWMS for treatment. The temporary waste storage area is coated with an

epoxy and contains a drainage system to facilitate cleanup of any leaks or spills. The low-activity and long-term resin storage tanks are designed with level indication instrumentation to ensure tank integrity.

The COL applicant is required to develop a plant wide RG 4.21 life-cycle planning program for minimizing contamination following the guidance in NEI 08-08A, "Generic FSAR Template Guidance for Life Cycle Minimization of Contamination," in which the SWMS procedures and programs are to be integrated (COL 11.4(12)). The COL applicant is also required to maintain the complete documentation of system design, construction, design modifications, field changes, and operations (COL 11.4(13)).

Section 12.4 of this SE evaluates the additional design and operational features of SSCs intended to minimize contamination to the facility and environment and to comply with 10 CFR 20.1406, using the guidance of RG 4.21. The applicant added DCD Tier 2, Section 12.4.2, "Minimization of Contamination and Radioactive Waste Generation," to discuss design features related to radiation protection. The staff finds this COL information item acceptable because a COL applicant referencing this design will follow the guidance described in RG 4.21.

11.4.4.5 Process Control Program

The applicant stated that solid waste is processed in accordance with the PCP, which contains site-specific requirements. An applicant is to provide the PCP under COL 11.4(5). A PCP ensures that the production of solid waste is handled in accordance with 10 CFR Part 71 and the guidance of BTP 11-3. The PCP contains the planned effluent discharge flow rates and addresses the numerical guidelines provided in 10 CFR Part 50, Appendix I. The PCP will be developed to meet the requirements in 10 CFR Part 71 and will conform to the guidance in NUREG-1301, NUREG-0133, and RG 1.109, RG 1.111, or RG 1.113.

In its review of the information provided by the applicant, the staff raised a question on the use of NEI 07-10A, which is an NRC-endorsed template for the implementation of the PCP. Implementation of the PCP using the NEI PCP Template 07-10A ensures that radioactive waste, once treated and packaged for shipment and disposal, will meet the NRC and U.S. Department of Transportation (DOT) shipping regulations and the acceptance criteria of the disposal site. The staff issued RAI 242-8276, Question 11.04-4, on October 14, 2015 (ML15296A011), requesting the applicant to provide the rationale for not adopting this previously approved template. In its response to RAI 242-8276, Question 11.04-4, dated December 22, 2015 (ML15356A011), the applicant committed to updating DCD Section 11.4 to include NEI 07-10A as the guidance for developing the PCP as listed in COL 11.4(5). The staff finds this response acceptable, since the DCD was revised to include a reference to NEI 07-10A for COL 11.4(5), which states: "The COL applicant is to prepare the site PCP and the site radiological environmental monitoring program." The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 242-8276, Question 11.04-4, to be resolved and closed.

The staff finds the PCP acceptable, since a COL applicant for this design will reference NEI 07-10A.

11.4.4.6 10 CFR 52.47(b)(1) for ITAAC

DCD Tier 1, Section 2.7.6.3, contains the ITAAC related to the SWMS. The ITAAC address the functional arrangement of SWMS components, spent resin storage tank capacities, the SWMS

ability to meet transportation and waste acceptance criteria, the SWMS ability to dry R/O concentrate, and RG 1.143 design guidance. The SWMS is relied upon to collect, treat, store, and manage low level radioactive waste (LLRW) in compliance with 10 CFR 61.55, "Waste Classification," and 10 CFR 61.56, "Waste Characteristics," for disposal or shipments to offsite waste processors. Other associated regulatory requirements address administrative and operational programs with objectives that are to comply with associated regulatory requirements, such as 10 CFR 20.2006, "Reports of Individual Monitoring" and 10 CFR 20.2007, "Reports of Transactions Involving Nationally Tracked Sources," 10 CFR Part 71, and 49 CFR Parts 171–180 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 storage area, and the interface of SWMS subsystems with the LWMS and GWMS under expected operating conditions in ensuring that ECLs 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.

The staff reviewed the descriptions, arrangement, design features, environmental qualification, performance requirements, and information provided in DCD Tier 1, Section 2.7.6.3, to confirm completeness and consistency with the plant design basis as described in DCD Tier 2, Section 11.4. The staff determined that the Tier 1 information is complete, consistent, and accurate. Based on the discussion above, the staff finds that the SWMS complies with the requirements of 10 CFR 52.47(b)(1).

11.4.4.7 Technical Specifications

In DCD Tier 2, Chapter 16, the applicant described the TS associated with the RWMSs. DCD Tier 2, Chapter 16, Section 5.6.2, "Radioactive Effluent Release Report," requires that the annual report include a summary of the quantities of the radioactive liquid and gaseous effluents and solid waste released from the unit. Section 5.6.2 also requires that the information included in the annual summary be consistent with the objectives outlined in the PCP and complies with the requirements of 10 CFR 50.36a and 10 CFR Part 50, Appendix I. The staff finds the TS requirements acceptable, as the implementation of such programs will be addressed in the plant-specific PCP under COL 11.4(5) evaluated previously.

11.4.5 Combined License Information Items

SE Table 11.4-1 lists the COL information item numbers and descriptions from DCD Table 1.8-2.

Table 11.4-1 Combined License Items Identified in the DCD

ITEM NO.	DESCRIPTION	SECTION
COL 11.4(1)	The COL applicant can incorporate an onsite laundry facility for processing of contaminated clothing.	11.4.1.3
COL 11.4(2)	The COL applicant is to perform a site-specific cost-benefit analysis following the guidance in NRC RG 1.110.	11.4.1.6
COL 11.4(3)	The COL applicant is to provide reasonable assurance that the provisions and requirements of ANSI/ANS--40.37--2009 are met. The COL applicant is to provide reasonable assurance that mobile and temporary solid radwaste processing operations and its interconnection	11.4.1.7

ITEM NO.	DESCRIPTION	SECTION
	to plant systems conform with regulatory requirements and guidance such as 10 CFR 50.34a, 10 CFR 20.1406, RG 1.143, IE Bulletin 80-10, and RG 4.21. The COL applicant is to ensure that the implementation of mobile and temporary equipment meets the requirements of NUREG-0800 Sections 12.3 and 12.4 and that any impacts to the radiation zone maps are evaluated. The COL applicant is to prepare a plan to develop and use operating procedures and portable radiation monitoring instruments, so that regulatory requirements and guidance are followed.	
COL 11.4(4)	The COL applicant is to provide P&IDs.	11.4.2
COL 11.4(5)	The COL applicant is to prepare the site PCP, which is consistent with the guidance of NEI 07-10A, and the site radiological environmental monitoring program.	11.4.2 11.4.2.5 11.4.4
COL 11.4(6)	The COL applicant is to determine the number of shipment. If the generated waste exceeds the shipment amounts, the COL applicant is to provide details for how the extra generated waste that exceeds the shipment amounts will be handled.	11.4.2
COL 11.4(7)	The COL applicant is responsible for the collection, temporary storage, and shipment of mixed waste for offsite treatment and disposal.	11.4.2.2.4
COL 11.4(8)	The COL applicant is responsible for the provision of a site-wide IRSF for interim storage of radioactive wastes. The COL applicant is to provide reasonable assurance that the design and operation of such a facility meets the regulations and guidance specified in NUREG-0800, Section 12.3 and 12.4, including 10 CFR 20.1101, 10 CFR 20.1406, RG 4.21 and RG 8.8.	11.4.2.2.5
COL 11.4(9)	The COL applicant is to provide a mobile crane to retrieve a waste package that becomes stuck in the lifted condition or that is dropped.	11.4.2.3
COL 11.4(10)	The COL applicant is also to provide operational procedures to properly ship low-level wastes to external sites in accordance with the NRC and DOT regulations.	11.4.2.3
COL 11.4(11)	The COL applicant is to prepare the operational procedures and maintenance programs for the SWMS as related to leak detection and contamination control.	11.4.2.5
COL 11.4(12)	The COL applicant is to develop plant-wide RG 4.21 life-cycle planning for minimization of contamination program following the guidance in NEI 08-08A, in which the SWMS procedures and programs are to be integrated.	11.4.2.5
COL 11.4(13)	The COL applicant is to maintain the complete documentation of system design, construction, design modifications, field changes, and operations.	11.4.2.5

The staff finds the above listing to be complete. Also, the list adequately describes actions necessary for the COL applicant. No additional COL information items were identified that need to be included in DCD Tier 2, Table 1.8-2, for the SWMS.

11.4.6 Conclusions

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 APR1400 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 safely storing 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 APR1400 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 APR1400 implements a plant-specific PCP, as an operational program, described in DCD Tier 2, Sections 11.4.3 and 13.4, for processing 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 10 CFR 61.56, respectively. The implementation of a PCP is specified under COL 11.4(5), as described in DCD Tier 2, Table 1.8-2.

- The design of the APR1400 radioactive temporary waste storage area in the compound building includes provisions for 6 months regarding onsite storage. The approach to 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 COL applicant should demonstrate 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 storage areas is the responsibility of the COL applicant under the implementation of a plant-specific waste management plan and updated PCP.

- The APR1400 design meets the requirements of 10 CFR Part 50, Appendix A, 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 DCD 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 setpoint. The COL applicant is responsible for determining the operational setpoints for its LWMS and GWMS radiation monitors in a plant-specific ODCM under COL 11.5(1), as described in DCD Tier 2, Table 1.8-2.

- The APR1400 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 of the public in 10 CFR 20.1301, as described in DCD Tier 2, Sections 11.2 and 11.3. As part of this commitment, the COL applicant will be responsible for demonstrating, through the plant-specific 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 APR1400 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 setpoints for its LWMS and GWMS radiation monitors in a plant-specific ODCM under COL 11.5(44), as described in DCD Tier 2, Table 1.8-2.

- A COL applicant referencing the APR1400 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 and gaseous effluents generated during the operation of the SWMS as part of a site-specific CBA conducted for the LWMS and GWMS under COL 11.2(13) and COL 11.3(2), as described in DCD Tier 2, Table 1.8-2.

- The APR1400 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.

11.5 Process and Effluent Radiation Monitoring and Sampling System

11.5.1 Introduction

The PERMSS is used to monitor liquid and gaseous process streams and effluent releases from RWMSs during normal operation, AOOs, and post-accident conditions. The system includes radiation monitors to detect and measure radioactivity and radiation levels and to indicate radioactive release rates or concentration levels in process and effluent streams. The PERMSS includes 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 provides the means to establish alarm setpoints to indicate 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, a system consists of skid-mounted radiation monitoring equipment and permanently installed sampling lines, with the equipment located at points to measure radioactivity or collect samples representative of process flows and effluent releases. Samples collected on filtration and in adsorbent media are evaluated by laboratory analyses to confirm measurement results recorded by radiation monitors and to determine 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.

11.5.2 Summary of Application

DCD Tier 1: The applicant provided a system description in DCD Tier 1, Section 2.7.6.4, "Process and Effluent Radiation Monitoring and Sampling System," summarized here, in part, as follows:

The PERMSS provides the capability to sample, measure, control, and record the radioactivity levels of selected process streams within the plant and effluent streams released into the environment; actuate alarms and control releases of radioactivity; provide data to keep worker exposures ALARA; and provide process data to support plant operation in accordance with NRC regulations. The PERMSS monitors are located in the containment building, the AB, the compound building, and the turbine building. DCD Tier 1, Table 2.7.6.4-1, "Process Effluent Radiation Monitoring and Sampling System Components List," includes the design characteristics of PERMSS components on monitor type, seismic category, Class 1E division, and indications of the monitor. The safety-related MCR gas, iodine, and particulate effluent radiation monitors and containment air monitors are classified as Class 1E, while the remaining PERMSS monitors are nonsafety related. The safety-related function of the MCR monitors is to automatically activate signals to start the MCR isolation and an alarm in the MCR requiring operator actions when detecting radioactivity levels that exceed predetermined setpoints. PERMSS monitors are provided for the reactor containment atmosphere, spaces containing components for recirculation of loss-of coolant accident (LOCA) fluids, effluent discharge paths, the plant environs for radioactivity released during normal operation, AOOs, and post-accident conditions. DCD Tier 1, Table 2.7.6.4-3, "Process Effluent Radiation Monitoring and Sampling System ITAAC," identifies the ITAAC for the PERMSS. DCD Tier 2, Section 11.5, "Process and Effluent Radiation Monitoring and Sampling Systems," contains detailed descriptions on the PERMSS design and operational features.

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

In DCD Tier 2, Section 11.5, the applicant described the PERMSS and its 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 to confirm measurement results recorded by radiation monitors and determine 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 MCR. PERMSS subsystems and components are found at various locations throughout the plant, as design requirements of plant systems.

In DCD Tier 2, Section 11.5.1, "Design Bases," the applicant presented the design basis and criteria of the system; DCD Tier 2, Section 11.5.2 presents a description of the system; DCD Tier 2, Section 11.5.3, describes the effluent monitoring and sampling system; and DCD Tier 2, Section 11.5.4, "Process Monitoring and Sampling," includes details on process monitoring and sampling. DCD Tier 2, Tables 11.5-1 and 11.5-2, describe system features

used for sampling and monitoring, as well as operational characteristics of radiation monitors, and identify subsystems that include automatic control functions in terminating or diverting process flows and effluent releases. DCD Tier 2, Figures 11.5-1, 11.5-2A through 11.5-2Z, depict the monitor locations.

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. DCD 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, DCD Tier 2, Section 3.10, "Seismic and Dynamic Qualification of Mechanical and Electrical Equipment," addresses the seismic qualification of mechanical and electrical equipment, and DCD Tier 2, Section 3.11, "Environmental Qualification of Mechanical and Electrical Equipment," covers the environmental qualification of mechanical and electrical equipment. Chapter 3, "Design of Structures, Components, Equipment, and Systems," of this report addresses these topics.

The PERMSS includes the following subsystems that perform safety-related functions or are used for safe shutdown:

- MCR air intake radiation monitors
- Containment operating area monitors
- Spent fuel pool area monitors
- Containment air radiation monitors

The associated TMI-related items in monitoring radioactive effluents under accident conditions are covered in DCD Tier 2, Sections 7.5, "Information Systems Important to Safety," 7.1.2, "Identification of Safety Criteria," and 9.3.2, "Process and Post-Accident Sampling Systems." DCD 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 DCD Tier 2, Section 7.7 "Control Systems Not Required for Safety."

For nonsafety-related systems, the PERMSS monitors and controls process streams and effluent releases for the following:

- Building ventilation system exhausts and radioactivity through the plant vent stack
- GWMS
- Main condenser evacuation system and turbine gland sealing system
- LWMS
- Component cooling water system
- SGBS

In DCD Tier 2, Sections 9.4.2, “Fuel Handling Area HVAC System,” 9.4.3, “Auxiliary Building Clean Area HVAC System,” 9.4.4, “Turbine Generator Building HVAC System,” 9.4.5, “Engineered Safety Feature Ventilation System,” 9.4.6, “Reactor Containment Building HVAC System and Purge System,” and 9.4.7, “Compound Building HVAC System,” the applicant describes the design bases, operation, and monitoring of such building ventilation systems. In DCD Tier 2, Sections 11.5.2.2 and 11.5.2.3, the applicant identified the means to collect process and effluent samples for radiological analyses. DCD Tier 2, Section 14.2 describes the preoperational testing.

The applicant stated 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, Columns 1 and 2), 10 CFR 20.1301(e), insofar as it requires meeting the EPA environmental radiation protection standards of 40 CFR Part 190; and the design objectives of 10 CFR Part 50, Appendix I. The applicant stated 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 Section 11.5, “Process and Effluent Radiological Monitoring Instrumentation and Sampling Systems,” and associated regulatory guidance. For TMI-related requirements, the applicant stated 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: The ITAAC associated with DCD Tier 2, Section 11.5, are given in DCD Tier 1, Section 2.7.6.4, “Process Effluent Radiation Monitoring and Sampling System,” and Tables 2.7.6.4-1, “Process Effluent Radiation Monitoring and Sampling System Equipment Component List,” and 2.7.6.4-3, “Process Effluent Radiation Monitoring and Sampling System ITAAC.”

TS: There is information pertinent to TS associated with the PERMSS in DCD Tier 2, Chapter 16, TS 5.5.1, TS 5.5.12, TS 5.6.1, TS 5.6.2, TS 3.4.13, “RCS Operational Leakage,” TS 3.4.12, “RCS Leakage Detection Instrumentation,” and TS 3.4.17 “Steam Generator (SG) Tube Integrity.”

10 CFR 20.1406: There is information pertinent to 10 CFR 20.1406 in DCD Tier 2, Section 11.5.2.4.

COL Information or Action Items: See Section 11.5.5 below.

Technical Report(s): There are no technical reports associated with this area of review.

Topical Report(s): There are no topical reports associated with this area of review.

APR1400 Interface Issues Identified in the DCD: There are no APR1400 interface issues associated with this area of review.

Site Interface Requirements Identified in the DCD: There are no site interface requirements associated with this area of review.

Cross-Cutting Requirements (TMI, USI/GSI, Op Ex): The associated TMI-related items in monitoring radioactive effluents under accident conditions, as they relate to the post-accident monitoring system, are addressed in SE Sections 7.1, “Introduction,” 7.5, and 9.3.2.

RTNSS: There are no RTNSS issues for this area of review.

CDI: This DCD section does not contain CDI, since it is outside the scope of the APR1400 certification.

11.5.3 Regulatory Basis

SRP Section 11.5 provides the relevant requirements in the NRC regulations for the PERMSS, the associated acceptance criteria, and review interfaces with other SRP sections. The following regulatory requirements apply to the PERMSS:

- 10 CFR 20.1302 and 10 CFR 20.1301(e), as they relate to monitoring radioactivity in plant radiological effluents to unrestricted areas, noting that these criteria apply to all effluent releases resulting from operation during normal plant operations and AOOs

- 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

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

- 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

- 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

- GDC 60 and GDC 61, as they relate 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

- GDC 63 and GDC 64, 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, and postulated accidents, and to initiate appropriate safety actions

- 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, which are consistent with the requirements of GDC 63 and GDC 64 and which correspond to TMI Action Plan Items II.F.1 and III.D.3.3, respectively

- 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analysis are performed and the acceptance criteria met, a plant that incorporates the DC is built and will operate in accordance with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and NRC regulations

- Institute of Electrical and Electronics Engineers (IEEE) Std. 603-1991, “Standard Criteria for Safety Systems for Nuclear Power Generating Stations,” as it relates to compliance

with 10 CFR 50.55a(h)(3), which stipulates that DCs are to meet the requirements for safety systems in IEEE Std. 603-1991

- GDC 13, as it stipulates, in part, that instrumentation be provided to monitor variables and systems over their anticipated ranges for accident conditions, as appropriate, to ensure adequate safety

Regulatory guidance adequate to meet the above requirements includes the following:

- RG 1.21, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste," as it relates to guidance for the design, implementation, and QA of effluent monitoring and sampling systems

- RG 1.33, as it relates to QA for the operation of safety-related equipment that is part of the PERMSS

- 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, as well as additional guidance on the application of RG 1.97, provided in SRP Section 7, BTP 7-10, "Guidance on Application of Regulatory Guide 1.97," Revision 5, issued March 2007 on post-accident monitoring variables

- RG 4.15, "Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination)—Effluent Streams and the Environment," Revision 2, issued July 2007 as it relates to the design, implementation, and QA of effluent monitoring and sampling systems

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

- Radiological Assessment BTP, Revision 1, issued November 1979 as it relates to the conduct of environmental monitoring, included as NUREG-1301, Appendix A

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

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

- ANSI/Health Physics Society (HPS) N13.1-1999, as it relates to sampling and monitoring airborne releases from stacks

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

- 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

- 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

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

- NUREG-1301, as it relates to the development of a plant-specific ODCM, or the use of NEI ODCM Template 07-09A (Revision 0, found acceptable by the staff (ML083530745)) to meet this regulatory milestone until a site-specific ODCM is prepared, before fuel load, under the requirements of a license condition described in DCD Section 13.4 of COL applications

- Electric Power Research Institute (EPRI), "PWR Primary-to-Secondary Leak Guidelines—Revision 2," Technical Report-104788-R2 (2000), as it relates to an industry-developed approach for calculating and monitoring primary-to-secondary leak rates

- Information Notice (IN) 2005-24, "Nonconservatism in Leakage Detection Sensitivity" (issued August 3, 2005), as it relates to reactor coolant activity assumptions for containment radiation gas channel monitors

11.5.4 Technical Evaluation

11.5.4.1 Design Considerations

The staff reviewed the PERMSS, using the guidance and acceptance criteria of SRP Section 11.5, to determine whether it complies with NRC requirements, including 10 CFR 50.34a and GDC 13, 60, 63, and 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 also based on the design meeting the requirements of 10 CFR 20.1301, 10 CFR 20.1302, and 10 CFR 20.1406, 10 CFR 50.36a, 10 CFR Part 50, Appendix I, and 10 CFR 50.34(f)(2)(xvii) and 10 CFR 50.34(f)(2)(xxvii).

11.5.4.1.1 General Design Criteria 60, 61, 63, and 64

The relevant requirements of GDC 60, 61, 63, and 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 N13.1-1999 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 10 CFR 50.34(f)(2)(xxvii). Compliance with the requirements of 10 CFR 20.1406 is met by using the guidance of RG 1.143, RG 4.21, and NRC Bulletin 80-10.

11.5.4.1.2 Liquid and Gaseous PERMSS

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 setpoints. 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 operations and safe shutdown
- Radiation monitoring of liquid and gaseous effluent releases

In DCD Tier 2, Section 11.5, the applicant described 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 to provide 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 to ensure the operational readiness and integrity of all PERMSS subsystems.

The discussion of the PERMSS is divided into liquid and gaseous process effluent monitoring. The gaseous PERMSS is described in Section 11.5.2.2 and the liquid PERMSS is described in Section 11.5.2.3. The review of DCD Section 11.5.2.2, for the gaseous PERMSS, determined that it did not include enough detail, and the staff referred to SRP Section 11.5 for the necessary PERMSS information. The staff noted a lack of consistent information between Section 11.5.2.2 and Table 11.5-1, where information was being described in one place but not the other. As an example, Table 11.5-1 includes detectors with alarm (MCR) in its indications. The corresponding text in DCD Section 11.5.2.2 provided no such detail on alarms or automatic control functions that would take place. In addition, the staff review of DCD Tier 1, Section 2.7.6.4, showed more information that was again inconsistent with that in DCD Tier 2, Section 11.5. The staff conducted a similar review for the liquid PERMSS description in DCD Section 11.5.2.3, and found similar problems with the descriptions and consistency of information between DCD sections. As a result, on August 7, 2015, the staff issued RAI 131-8087, Question 11.05-1 (ML15219A713), for the gaseous PRMSS, and RAI 132-8088, Question 11.05-2 (ML15227A012), for the liquid PERMSS to request that more information be provided in the DCD so that the detectors in DCD Section 11.5 are described according to SRP Section 11.5. Specifically, the staff requested the following information:

- Each monitor should contain a description of its functions and safety-related requirements in meeting redundancy or independence (where applicable)
- Each monitor should contain a discussion on radiation detection ranges
- Each monitor should contain a discussion on the process configuration of the detector
- Each monitor should contain a discussion on its location
- Discussions of applicable RGs should be referenced
- A discussion on the alarms and interlocks established for each detector should be provided
- Each monitor should contain information on the sampling stations, if applicable, especially effluent monitors
- Provisions should be made for purging sample lines and minimizing process and effluent volumes
- Each monitor should contain a discussion of the safety classification associated with it
- There should be a discussion on the calibration and QA for each detector

In its responses to RAI 131-8087, Question 11.05-1, dated December 8, 2015 (ML15342A499) and RAI 132-8088, Question 11.05-2, dated December 8, 2015, (ML16034A350), the applicant provided some discussion but made no improvements to the text of DCD Section 11.5. The staff's original request asked for the applicant to provide a complete revision of text incorporating all points discussed in the original request. The RAI requested that the PERMSS tables be updated with the essential data concerning each radiation monitor and that the DCD text explain the details of each radiation monitor (e.g., function, placement). The applicant provided the technical data but not the added text detailing the radiation monitors. The staff raised these concerns and conducted an audit with the applicant on March 15, 2016, and March 16, 2016 (ML16238A421). During this audit, the applicant presented some revised DCD text. The staff reviewed this information and found the applicant had made changes consistent with the staff's original request. In its responses to RAI 131-8087, Question 11.05-1 dated May 11, 2016 (ML16132A380), and RAI 132-8088, Question 11.05-2, dated May 12, 2016 (ML16133A545), the applicant provided revised responses and DCD markups based on the discussions from the March audit. The updated responses are incorporated in the discussions below.

In DCD Sections 11.5.2.2.4 and 11.5.2.3.5, the applicant discussed the function of all gaseous and liquid monitors. The monitors that were being used to describe or demonstrate compliance and their function, whether safety related or not, were clearly stated as such.

In DCD Section 11.5.2.2.3, "Effluent Monitoring," the applicant provided information relating to the installed effluent monitoring instrumentation. In the discussion, the applicant committed to the special provisions described in NUREG-0737, 10 CFR Part 50, Appendix I, and RG 1.97 for post-accident sampling and sampling locations. The DCD states that the containment atmosphere and liquid radioactive waste tanks are sampled before release to the environment

and documented in the ODCM. The relevant release criteria and setpoints are in accordance with 10 CFR Part 20 limits. Sampling equipment is designed to prevent the spread of contamination and radiation exposures while collecting samples. In DCD Sections 11.5.2.2.1 and 11.5.2.3.1, the descriptions for the process configurations of the gaseous and liquid monitors were provided, along with Figures 11.5-3A, "Typical Gaseous PIG (Particulate/Iodine/Noble Gas) Monitor," 11.5-3B, "Typical Liquid Monitor," and 11.5-3C, "Monitor Assembly for Main Steam Line Effluent +N-16 Detectors." These figures demonstrate the ability to take samples and also show the location of the detector chambers and sample pumps.

In DCD Section 11.5.1.2.g, the applicant stated that vent samplers provide continuous sampling of all potential post-accident release points. The samplers are designed to be used during normal operation and post-accident conditions to address the requirements of 10 CFR 50.34(f)(2)(xvii) and 10 CFR 50.34(f)(2)(xxvii). In its responses to RAI 131-8087, Question 11.05-1, and RAI 132-8088, Question 11.05-2 the applicant described a commitment to RG 1.97 for the equipment qualification, QA testing, and calibration. The applicant also provided a pointer to DCD Section 11.5.2.1, that highlights a commitment to RG 1.97 for post-accident monitors and refers to the discussions provided in DCD Sections 7.1.2.44 and 7.5.2.1. The staff finds the commitment to RG 1.97 for equipment qualification, QA testing, and calibration acceptable and has confirmed that the monitor measuring ranges conform to the guidance in RG 1.97, Revision 3.

In DCD Tables 11.5-1 and 11.5-2, the applicant listed the monitor measuring ranges, safety classification, seismic categories, quality classifications, electrical classification, locations, radiation functions, and radiation monitoring tag numbers. These tables provide a summary for the information discussed in the text of DCD Section 11.5.

The staff reviewed DCD Figures 11.5-1 and 11.5-2A through 11.5-2Z for sampling points, filter locations, and tank locations relative to release points. In RAI 131-8087, Question 11.05-1 (ML15219A713), and RAI 132-8088, Question 11.05-2 (ML15227A012), the staff requested the details for the locations of the radiation monitors provided in Section 11.5. In its responses to RAI 131-8087, Question 11.05-1, dated November 18, 2016 (ML16323A484), and RAI 132-8088, Question 11.05-2, dated November 18, 2016 (ML16323A480) the applicant updated the monitor discussions with the respective locations. The applicant also provided updates to include the specific figure to reference and ensure that the update reflects the location of the monitor.

The applicant's revised responses to RAI 131-8087, Question 11.05-1, dated February 7, 2017 (ML17038A574), and RAI 132-8088, Question 11.05-2, dated February 3, 2017 (ML16034A350), addressed the QA provisions for PERMSS. The current discussion in DCD Sections 11.5.2.2 and 11.5.2.3 will be updated to show compliance with the QA provisions contained within RG 1.143 and indicate that the safety classifications for each gaseous and liquid monitor are found in DCD Tables 11.5-1 and 11.5-2. Tables 11.5-1 and 11.5-2 also contain information on the safety classifications for each monitor. The staff finds the reference for QA classifications acceptable, since they are conforming to regulatory position C.7 of RG 1.143. The staff also agrees with the safety classifications for the monitors in Table 11.5-1 and 11.5-2, since all monitors, with the exception of the containment air and MCR air intake monitors, are non-safety related. The applicant indicated that the containment air monitor's sample line is isolated when a containment isolation signal is sent. This is performed to control containment leakage. The MCR air intake monitors are used to perform automatic actions to reroute outside air through an air cleanup unit on a high-radiation signal.

In additional responses to RAI 131-8087, Question 11.05-1, dated August 18, 2017 (ML17230A231), and RAI 132-8088, Question 11.05-2, dated August 11, 2017 (ML17223A081), the applicant included new information about a Condenser Pit Sump monitor and Component Cooling Water (CCW) Heat Exchanger sump monitor. This information was not originally provided in Section 11.5 and the monitor listings and have now been added into Section 11.5 for consistency. This information included the monitoring type, ranges, and a description of the locations that these monitors. The staff finds the inclusion of this information acceptable because it contains all the information specified for describing the radiation monitors as is found in NUREG-0800, section 11.5, "Process and Effluent Radiological Monitoring Instrumentation and Sampling Systems." The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 131-8087, Question 11.05-01, and RAI 132-8088, Question 11.05-2, as resolved and closed.

In RAI 222-8203, Question 11.05-03, dated September 23, 2015 (ML15295A514), the staff asked for additional information relating to the steam line effluent monitors. Information about the sensitivity, response time, and alarm limit for the primary-to-secondary leakage detection equipment was not clearly described as in an ITAAC. In its response to RAI 222-8203, Question 11.05-3, dated December 8, 2015 (ML15342A505), the applicant responded that the information relating to leakage of SG tubes was not included in the ITAAC, as they are not used for the design-basis analysis. In a follow up call with the applicant, the staff clarified the need to describe these effluent monitors in DCD Section 11.5. As a result of this call, the applicant submitted a revised response dated April 28, 2016 (ML16119A142). In the revised response, the applicant provided text inserts for DCD Section 11.5 to add significant detail on the main steam line effluent and N-16 monitors. In this response, the applicant described the monitor by discussing its function, location, and detection ranges. In addition, the applicant described how these monitors will be used to assess effluent releases in a scenario where the main steam atmospheric depressurization valves (MSADVs) and main steam safety valves (MSSVs) are opened during a primary-to-secondary leakage event. The applicant stated the use of calculation software will estimate releases based on the monitor readings, time period that the relief valves are opened, and flow capacity. The applicant stated that the calculation is started upon detection of high radiation in the steam line and where an MSADV or MSSV is being opened, or the auxiliary feedwater pump turbine is running. In addition to the DCD text changes, the applicant updated DCD figures detailing the monitor locations, included a figure detailing the configuration of the main steam line effluent monitors, and updated DCD Appendix 11B.

In DCD Appendix 11B, the applicant performs a calculation to demonstrate the ability to monitor N-16 activity in the main steam line, which can be used to determine compliance with the minimum SG leakage rate of 4.73 L/hr (30 gal/day), as well as the TS limit of 23.66 L/hr (150 gal/day). In the revised response to RAI 222-8203, Question 11.05-3, dated June 22, 2016 (ML16174A118), the applicant added details in Appendix 11B to show compliance with monitoring SG tube leakage. The staff was then able to perform confirmatory calculations to verify the result produced by the applicant. As a result, the staff agrees with the assumptions made by the applicant in using an N-16 concentration from DCD Table 12.2-7 operational data from Shin-Kori 3 & 4, and other plant component data found in DCD Appendix 11B. The staff's confirmatory calculation agrees with the results presented in DCD Tables 11B-1 and 11B-2. The staff also confirms that the calculated N-16 activities are within the ranges specified in DCD Table 11.5-1 for the main steam line monitors.

The staff finds that the applicant's response to RAI 222-8203, Question 11.05-3, is acceptable because the staff has confirmed the information provided by the applicant, performed

confirmatory calculations to verify the applicant's results, and confirmed that this response is also consistent with the changes made in response to RAI 131-8087, Question 11.05-1. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 222-8203, Question 11.05-3, to be resolved and closed.

The staff review of safety-related monitors in DCD Section 11.5.2.2.h noted the lack of references to IEEE Std. 603-1991, which is used to demonstrate compliance with 10 CFR 50.55a(h)(3). On September 23, 2015, the staff issued RAI 223-8204, Question 11.05-4 (ML15295A515), requesting that the applicant discuss whether the safety-related monitors described in DCD Section 11.5 meet the criteria of 10 CFR 50.55(h)(3). In its response to RAI 223-8204, Question 11.05-4, dated December 30, 2015 (ML15364A275), the applicant described the criteria discussed in the IEEE standard. However, the staff also requested that this information be contained within the discussions for the safety-related monitors. As a result, the applicant provided a revised response to RAI 223-8204, Question 11.05-4, dated May 19, 2016 (ML16142A024), that included a DCD markup indicating that the MCR air intake monitors conform to the IEEE standard. The safety-related radiation PERMSS monitors conform to IEEE Std. 603-1991, which comply with the requirements of 10 CFR Part 50, Appendix A, GDC 13. Incorporation of this standard satisfies the staff's request. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 223-8204, Question 11.05-4, to be resolved and closed.

In its review of the containment air monitors, the staff performed a confirmatory calculation to verify the ability of the monitor to detect RCS leakage of 0.5 gpm within one hour. The staff's review indicated that the applicant was using H-3 and N-16 as part of their total activity to verify their particulate air monitor was capable of detecting RCS leakage. These radionuclides would either be decayed by the time they reached the monitor or were hard to detect with the current monitor, and should not be relied on for the RCS leakage calculation. Without these radionuclide contributions the applicant would be unable to detect RCS coolant leakage within one hour with the 3.7E-6 Bq/cc (1.00E-9 uCi/cc) range originally specified. The applicant agreed that its calculation should not include these contributions and modified the monitor range to be 3.7E-5 Bq/cc (1E-10 uCi/cc). The staff's confirmatory calculations determined that this new range allowed the applicant to detect RCS leakage in 12.1 minutes and determined this new range was acceptable. As part of the applicant's response to RAI 131-8087, Question 11.05-1 (ML16132A380), the applicant provided updated particulate and iodine monitor ranges to conform with the requested changes to the RCS leakage detection calculation.

11.5.4.2 Minimization of Contamination

The staff reviewed the information presented in DCD Section 11.2 against the criteria for 10 CFR 20.1406 for minimizing contamination. The liquid and gaseous processes and streams that are radioactive or have the potential of becoming radioactive from cross-contamination are monitored by the PERMSS.

The applicant provides DCD Section 11.5.2.4, to meet the requirements of 10 CFR 20.1406. In this section, the applicant commits to the use of RG 4.21 and describes the use of the principles described within the RG to demonstrate compliance with 10 CFR 20.1406. The PERMSS design features that are used to comply with 10 CFR 20.1406 include offline and inline-type detectors. Process and effluent monitors come into contact with radioactive fluids and are fabricated of stainless steel to prevent contamination. The PERMSS is designed with automatic features that will provide early alarms for potential leak detection. Radiation levels and alarms

will be displayed in the MCR or the radwaste control room. The PERMSS monitors can purge or flush the detector assembly using nitrogen or demineralized water. The PERMSS is also able to return process fluids back to the system to minimize the wastes being generated.

Section 12.4 evaluates the additional design and operational features of SSCs intended to minimize contamination to the facility and environment and comply with 10 CFR 20.1406 using the guidance of RG 4.21. The applicant added DCD Tier 2, Section 12.4.2, "Minimization of Contamination and Radioactive Waste Generation," to discuss design features related to radiation protection.

11.5.4.3 10 CFR 52.47(b)(1) for ITAAC

DCD Tier 1, Section 2.7.6.4, contains the ITAAC related to the PERMSS. The ITAAC address the functional arrangement of the PERMSS, ensuring that: (1) gaseous and liquid processing systems are equipped with radiation monitoring, (2) MCR and remote shutdown room (RSR) alarms are displayed, (3) each safety-related radiation monitor channel monitors radiation levels and provides an indication to the MCR, (4) automatic engineered safety features initiation signals, (5) the seismic Category I monitors can withstand seismic design basis loads, and (6) there is physical separation and electrical isolation between Class 1E divisions, and between a Class 1E and non-Class 1E division.

The PERMSS is relied upon to indicate 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 systems, and automatic control features in diverting process flows or terminating effluent releases that exceed alarm setpoints, and process the dilution flow before discharge into the environment.

Based on the discussion above, the staff finds the information provided in DCD Tier 1, Section 2.7.6.4, is complete and consistent with the plant design basis as described in DCD Tier 2, Section 11.5. Based on the discussion above, the staff finds that the PERMSS complies with the requirements of 10 CFR 52.47(b)(1).

11.5.4.4 Technical Specifications

DCD Tier 2, Chapter 16, describes the TS associated with the RWMSs. DCD Tier 2, Chapter 16, TS 5.5.1, and TS 5.5.4 provide directions in managing releases of radioactive effluents and the control and handling of concentrated wastes for disposal. TS 5.5.12, specifies the quantity of radioactivity contained in gas storage tanks and in unprotected outdoor liquid storage tanks, in accordance with BTP 11-5 and BTP 11-6, respectively. TS 5.5.12 requires concentration limits and surveillances of hydrogen and oxygen in the GWMS, whether or not the system is designed to withstand a hydrogen explosion and ensures that the quantity of radioactivity in each gas storage tank is less than the amount that would result in a whole body exposure greater than or equal to 0.1 rem to any individual in an unrestricted area in the event of a tank failure. It also ensures that the quantity of radioactivity in all outdoor liquid tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not

have tank overflows and surrounding area drains connected to the LWMS, is less than ECLs in 10 CFR Part 20, Appendix B, Table 2, Column 2, at the nearest potable water supply and the nearest surface water supply in an unrestricted area in the event of a tank failure.

In TS 5.6.1 and TS 5.6.2, the applicant specified annual reporting requirements in describing the results of the radiological monitoring program and provides summaries of the quantities of radioactive liquid effluents released into the environment. In TS 5.5.1, COL-initiated changes to the ODCM are to be documented with sufficient information by analyses or evaluations and comply with 10 CFR 20.1302,40 CFR Part 190, 10 CFR 50.36a, and 10 CFR Part 50, Appendix I. TS 5.5.4, contained in the ODCM, includes alarm setpoints for effluent monitors; monitoring, sampling, and analysis of liquid and gaseous effluents to comply with 10 CFR 20.1302; determination of cumulative and projected public dose limits from liquid and gaseous effluents and noble gases to comply with 10 CFR Part 50, Appendix I; and annual public dose limits to comply with 40 CFR Part 190. The implementation of such programs will be addressed in a plant- and site-specific ODCM under COL 11.5(2), COL 11.5(3), and COL 11.5(4) in DCD Tier 2, Section 11.5.5, "Combined License Information," as described in DCD Tier 2, Table 1.8-2.

11.5.4.5 Offsite Dose Calculation Manual

In DCD Section 11.5.1.2.l, the staff reviewed the description of the COL information item on the ODCM. COL 11.5(4) specifies that an applicant is to prepare an ODCM that describes the methodology and parameters for calculating offsite doses for the gaseous and liquid effluents. The COL applicant is to follow NEI 07-09A as an alternative to providing an ODCM.

NEI 07-09A presents the functional elements of an ODCM that, if met, would demonstrate compliance with 10 CFR 50.34a, 10 CFR 50.36a, and 10 CFR Part 50, Appendix I. NEI 07-09A identifies monitoring criteria, liquid and gaseous radiological effluent controls, monitoring instrumentation, methods for deriving lower limits of detection and detection sensitivities, methods for establishing instrumentation alarm setpoints, dose limits for members of the public, requirements for process and effluent sampling in various plant systems, requirements limiting effluent releases, surveillance requirements, methods for calculating effluent release rates and doses, radiological environmental monitoring, QA and quality control programs, information to be contained in annual radiological effluent release reports, reporting requirements to the NRC, the process for initiating and documenting changes to the ODCM and supporting procedures, and recordkeeping. The staff has reviewed NEI 07-09A and found it to be acceptable.

NEI 07-09A also addresses the standard radiological effluent controls (SREC) and the radiological effluent monitoring program (REMP). The description to implement the administrative and operational programs for the SREC, ODCM, and REMP were found to be consistent with the requirements of GL 89-01 and the guidance of NUREG-1301, NUREG-0133, RG 1.21, RG 1.33, RG 4.1, RG 4.8, "Environmental Technical Specifications for Nuclear Power Plants," RG 4.15, and the Radiological Assessment BTP in NUREG-1301, Appendix A.

In RAI 262-8296, Question 11.05-5, dated October 22, 2015 (ML15296A019), the staff asked the applicant to discuss COL 11.5(4). In its review of DCD Section 11.5.1.2.l, the staff found the applicant's discussion on the ODCM did not include the COL information item. In its place, the applicant discussed COL 11.5(5). The staff's RAI asked the applicant to discuss the correct COL information item and to verify the inclusion of the correct COL information items in DCD Section 11.5.1.2.l. In its response to RAI 262-8296, Question 11.05-5, dated February 3, 2016 (ML16034A119), the applicant corrected the COL information item in DCD Section 11.5.1.2.l. The applicant made a DCD change to reflect COL 11.5(4) in the discussion on the ODCM. The

staff finds this response acceptable, and because the applicant made this administrative change. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 262-8296, Question 11.05-5, to be resolved and closed.

The staff reviewed the applicant's submittal against the requirements of 10 CFR Part 50, as it relates to a program that provides the means to calculate offsite doses to the public resulting from gaseous and liquid effluents, and found it acceptable. Both DCD Tier 2, Section 11.5.5, and Table 1.8-2 provide a COL information item for the COL applicant to address the ODCM. Under COL 11.5(4), the COL applicant is required to prepare the ODCM following NEI 07-09A as an alternative to providing the ODCM at the time of application, because the ODCM requires plant- and site-specific information, which is outside the scope of the requested DC. The staff therefore finds the inclusion of COL 1.5(4) acceptable.

11.5.4.6 Radiological Environmental Monitoring Program

In DCD Tier 2, Section 11.5.1.2.m, the staff reviewed the description of the COL information items on the REMP. The applicant specified that a COL applicant will develop a REMP that is in accordance with NUREG-1301 and NUREG-0133. COL 11.5(9) commits a COL applicant to following NEI 07-09A, which includes describing the necessary information for the REMP. The plant- and site-specific REMP will consider local land use and census data to identify all potential radiation exposure pathways and take into account associated radioactive materials present in liquid and gaseous effluents and direct external radiation from SSCs.

The REMP describes the process and methods for monitoring, sampling, and analyzing environmental samples representative of expected radionuclide distributions and concentrations in environmental media and associated exposure pathways. The REMP also identifies the types, numbers, and sampling locations and the sampling and analytical frequencies of environmental samples. The REMP follows the guidance in GL 89-01, NUREG-1301, NUREG-0133, and the Radiological Assessment BTP in NUREG-1301, Appendix A.

In RAI 262-8296, Question 11.05-6, dated October 22, 2015 (ML15296A019), the staff asked the applicant to discuss COL Information Item 11.5(7) as it relates to the REMP. In its review of DCD Section 11.5.1.2.m, the staff found the applicant's discussion on the REMP did not include the COL information item. In its place the applicant discussed COL 11.5(8) as it relates to the development of detailed locations, tubing installations, and the sampling method. The staff's RAI asked the applicant to discuss the correct COL information item and to verify the inclusion of the correct COL information items in DCD Section 11.5.1.2.m. In its response to RAI 262-8296, Question 11.05-6, dated February 3, 2016 (ML16034A119), the applicant corrected the DCD text concerning the REMP to include a reference to the newly reorganized COL 11.5(7). The staff finds the insertion of this COL information item into the text discussion, along with additional rearrangement of other COL information items, in DCD Section 11.5.1.2.m, to be acceptable. The staff confirmed that the proposed changes have been incorporated in the DCD; therefore, the staff considers RAI 262-8296, Question 11.05-6, to be resolved and closed, because the applicant made this administrative change.

The staff reviewed the applicant's submittal against the requirements of 10 CFR Part 50, as it relates to a program that provides the means to monitor and quantify radiation and radioactivity levels in the environs of the plant associated with gaseous and liquid effluent releases and the direct external radiation from contained sources of radioactive materials in tanks and equipment and in buildings, and found it acceptable. Both DCD Tier 2, Section 11.5.5, and Table 1.8-2 provide a COL information item for the COL applicant to develop the REMP. Under COL 11.5(7), the COL applicant is required to develop the REMP following the guidance in

NUREG-1301, NUREG-0133, and NEI 07-09A, as an alternative to providing the REMP at the time of application. Because the REMP requires plant- and site-specific information, which is outside the scope of the requested DC, the staff finds the inclusion of COL 11.5(7) acceptable.

11.5.5 Combined License Information Items

Table 11.5-1 lists COL information items and descriptions related to the PERMSS from DCD Tier 2, Table 1.8-2.

Table 11.5-1 Combined License Items Identified in the DCD

ITEM NO.	DESCRIPTION	SECTION
COL 11.5(1)	The COL applicant is to determine the WARN and ALARM setpoints of the PERMSS based on the site-specific conditions and operational requirements.	11.5.1.2
COL 11.5(2)	The COL applicant is to develop an annual report that specifies the quantity of each principal radionuclide released to unrestricted areas in liquid and gaseous effluents.	11.5.1.2
COL 11.5(3)	The COL applicant is to provide site-specific procedures that conform with the numerical guides of 10 CFR 50.34a and 10 CFR Part 50, Appendix I.	11.5
COL 11.5(4)	The COL applicant is to prepare an ODCM that contains a description of the methodology and parameters for the calculation of the offsite doses for the gaseous and liquid effluents.	11.5.1.2 Table 11.5-2
COL 11.5(5)	The COL applicant is to provide analytical procedures and sensitivity for selected radio-analytical methods and types of sampling media for site-specific applications.	11.5.1.2
COL 11.5(6)	The COL applicant is also to develop operational procedures in accordance with RG 1.33 and RG 4.15.	11.5.1.2
COL 11.5(7)	The COL applicant is to develop a REMP in accordance with NUREG-1301 and NUREG-0133, and RG 4.1, which describes the scope of the program, taking into account local and land use census data in identifying all potential radiation exposure pathways, associated radioactive materials present in liquid and gaseous effluent, and direct external radiation from SSCs.	11.5.1.2 11.5.2.4
COL 11.5(8)	The COL applicant is to develop detailed locations, tubing installations, and provide the sampling method including the sampling frequency and time to acquire representative sampling.	11.5.1.2
COL 11.5(9)	The COL applicant is to determine the monitor type, safety class, measuring range, and installed location of the RE-165, RE-166, RE-167, and RE-168.	11.5.2.3.5 Table 11.5-2

ITEM NO.	DESCRIPTION	SECTION
COL 11.5(10)	The COL applicant is to provide operational procedures and maintenance programs related to leak detection and contamination control.	11.3.3.1 11.5.2.4
COL 11.5(11)	The COL applicant is to design the sample nozzle location, sample line size, line routing/configuration/length, and monitor location to minimize the line loss in accordance with ANSI/HPS N13.1.	11.5.2.2.1

As previously evaluated, the staff concludes that the above list of COL information items is complete and adequately describes the actions necessary for the COL applicant.

11.5.6 Conclusions

The staff concludes, using the information presented in the application, that the applicant has demonstrated compliance with NRC regulations and guidance and provided sufficient information in describing the provisions to avoid unmonitored and uncontrolled radioactive releases to the environment. The relevant regulation is contained in 10 CFR 20.1406 and the NRC guidance is contained in RG 4.21, RG 1.143, SRP Section 11.5, and IE Bulletin 80-10.