

11.0 RADIOACTIVE WASTE MANAGEMENT

The radioactive waste management systems are designed to control, collect, handle, process, store, and dispose of liquid, gaseous, and solid wastes that may contain radioactive materials. The systems include the instrumentation used to monitor and control the release of radioactive effluents and wastes and are designed for normal operation, including anticipated operational occurrences (e.g., refueling, purging, equipment downtime, maintenance).

11.1 Source Terms

The radioactive source terms are used to identify the potential dose to members of the public and plant employees as a result of plant operation. This includes consideration of parameters used to determine the concentration of each isotope in the reactor coolant, fraction of fission product activity released to the reactor coolant, and concentrations of all nonfission product radioactive isotopes in the reactor coolant. Gaseous and liquid waste sources are considered in the evaluation of effluent releases.

Section 11.1 of the V.C. Summer Nuclear Station (VCSNS) combined license (COL) Final Safety Analysis Report (FSAR), Revision 5, incorporates by reference, with no departures or supplements, Section 11.1, "Source Terms," of Revision 19 of the AP1000 Design Control Document (DCD). The Nuclear Regulatory Commission (NRC) staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.¹ The NRC staff's review confirmed that there is no outstanding issue related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VCSNS COL application are documented in NUREG-1793, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design," and its supplements.

11.2 Liquid Waste Management Systems

11.2.1 Introduction

The liquid waste management system (LWMS) is designed to control, collect, process, handle, store, and dispose of liquid radioactive waste generated as the result of normal operation, including anticipated operational occurrences.

11.2.2 Summary of Application

Section 11.2 of the VCSNS COL FSAR, Revision 5, incorporates by reference Section 11.2 of the AP1000 DCD, Revision 19.

¹ See Section 1.2.2 for a discussion of the staff's review related to verification of the scope of information to be included in a COL application that references a design certification (DC).

In addition, in VCSNS COL FSAR Section 11.2, the applicant provided the following:

AP1000 COL Information Items

- STD COL 11.2-1

The applicant provided additional information in Standard (STD) COL 11.2-1 to resolve COL Information Item 11.2-1 (COL Action Item 11.2-1). The additional information addresses the use of mobile or temporary equipment to process liquid effluents in VCSNS COL FSAR Section 11.2.1.2.5.2.

- STD COL 11.2-2

The applicant provided additional information in STD COL 11.2-2 regarding liquid radwaste cost-benefit analysis methodology.

- VCS COL 11.2-2

The applicant provided additional information in VCS COL 11.2-2 to resolve COL Information Item 11.2-2 (COL Action Item 11.2-2). The additional information addresses the dilution factors used for dose calculations and the cost-benefit analysis of population doses in VCSNS COL FSAR Sections 11.2.3.3 and 11.2.3.5.

- VCS COL 2.4-5 and VCS COL 15.7-1

VCSNS COL FSAR Section 11.2 does not identify VCS COL 2.4-5 and VCS COL 15.7-1 as COL information items applicable to Section 11.2. However, VCS COL 2.4-5 and VCS COL 15.7-1 provide information regarding a postulated liquid waste tank failure, which is evaluated by the NRC staff as part of liquid waste management. Therefore, VCS COL 2.4-5 and VCS COL 15.7-1 are evaluated in Section 11.2.4 of this safety evaluation report (SER). In VCSNS COL FSAR Section 2.4, the applicant performed the consequence analysis of a postulated liquid waste tank failure in FSAR Section 2.4.13 to address COL Information Items 2.4-5 and 15.7-1.

- VCS COL 11.5-3

The applicant provided additional information in VCS COL 11.5-3 to resolve COL Information Item 11.5-3 (COL Action Item 11.5-3). The additional information addresses compliance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic licensing of production and utilization facilities," 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," Section II.A in VCSNS COL FSAR Section 11.2.3.5.

Supplemental Information

- STD SUP 11.2-1

The applicant added in VCSNS COL FSAR Section 11.2.3.6 supplemental (SUP) information to address the quality assurance (QA) program to be applied to the LWMS.

- VCS SUP 11.2-1

The applicant added supplemental information in VCSNS COL FSAR Section 11.2.1.2.4 regarding the exterior radwaste discharge piping. In a letter dated July 8, 2010, the applicant committed to add to a future version of the FSAR supplemental information in VCS SUP 11.2-1 that describes site-specific design features of the discharge piping.

11.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements.

In addition, the regulatory basis for acceptance of the supplementary information on the LWMS is established in:

- 10 CFR 20.1301(e)
- 10 CFR 20.1302, "Compliance with dose limits for individual members of the public"
- 10 CFR 20.1406, "Minimization of contamination"
- 10 CFR 50.34a, "Design objectives for equipment to control release of radioactive material in effluents – nuclear power reactors"
- 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criteria (GDC) 60, "Control of Releases of Radioactive Materials to the Environment"
- 10 CFR Part 50, Appendix A, GDC 61, "Fuel Storage and Handling and Radioactivity Control"
- 10 CFR Part 50, Appendix I, Sections II.A and II.D
- 10 CFR 52.80(a)
- Title 40 of the *Code of Federal Regulations* (40 CFR) Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations"

Guidance for accepting the supplementary information on the LWMS is in:

- The codes and standards listed in Table 1 of Regulatory Guide (RG) 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants," Revision 2
- Regulatory Position C.1.1 of RG 1.143, Revision 2
- 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," Revision 1

- RG 1.110, “Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors”
- RG 1.113, “Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I,” Revision 1
- RG 4.21, “Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning”

The acceptance criteria associated with the LWMS are given in Section 11.2 of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition),” and NUREG-0800, Section 2.4.13, Acceptance Criterion No. 5, including Branch Technical Position (BTP) 11-6.

11.2.4 Technical Evaluation

The NRC staff reviewed Section 11.2 of the VCSNS COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.¹ The NRC staff’s review confirmed that the information in the application and incorporated by reference addresses the required information relating to the LWMS. The results of the NRC staff’s evaluation of the information incorporated by reference in the VCSNS COL application are documented in NUREG-1793 and its supplements.

The staff’s review of this application included the following COL information and supplementary items:

- STD COL 11.2-1, Processing of Liquid Waste by Mobile Equipment
- STD COL 11.2-2, Liquid Radwaste Cost-benefit Analysis Methodology
- VCS COL 11.2-2, Cost-benefit Analysis of Population Doses
- VCS COL 2.4-5, Accidental Release of Liquid Effluents into Groundwater and Surface Water
- VCS COL 15.7-1, Consequences of Tank Failure
- VCS COL 11.5-3, Individual Dose Limits in 10 CFR Part 50, Appendix I
- STD SUP 11.2-1, Quality Assurance
- VCS SUP 11.2-1, Exterior Radwaste Discharge Piping

In addition to the above items, the staff reviewed the entire section against Section 11.2 of NUREG-0800 to determine if the information in VCSNS COL FSAR Section 11.2 met the regulatory requirements in the regulations stated above (SER Section 11.2.3) and the NUREG-0800 acceptance criteria. The relevant NUREG-0800 acceptance criteria are as follows:

- The LWMS should have the capability to meet the dose design objectives and include provisions to treat liquid radioactive wastes such that the following is true:
 - A. The calculated annual total quantity of all radioactive materials released from each reactor at the site to unrestricted areas will not result in an estimated annual dose or dose commitment from liquid effluents for any individual in an unrestricted area from all pathways of exposure in excess of 0.03 millisievert (mSv) (3 millirem [mrem]) to the total body or 0.1 mSv (10 mrem) to any organ. RGs 1.109, 1.112, and 1.113 provide acceptable methods for performing this analysis.
 - B. In addition to A, the LWMS should include all items of reasonably demonstrated technology that, when added to the system sequentially and in order of diminishing cost-benefit return for a favorable cost-benefit ratio, can effect reductions in doses to the population reasonably expected to be within 80 kilometers (km) (50 miles [mi]) of the reactor. RG 1.110 provides an acceptable method for performing this analysis.
 - C. The concentrations of radioactive materials in liquid effluents released to unrestricted areas should not exceed the concentration limits in Table 2, Column 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, "Standards for protection against radiation."
- The LWMS should be designed to meet the anticipated processing requirements of the plant. Adequate capacity should be provided to process liquid wastes during periods when major processing equipment may be down for maintenance (single failures) and during periods of excessive waste generation. Systems that have adequate capacity to process the anticipated wastes and that are capable of operating within the design objectives during normal operation, including anticipated operational occurrences, are acceptable. To meet these processing demands, interconnections between subsystems, redundant equipment, mobile equipment, and reserve storage capacity will be considered.
- System designs should describe features that will minimize, to the extent practicable, contamination of the facility and environment; facilitate eventual decommissioning; and minimize, to the extent practicable, the generation of radioactive waste, in accordance with the guidelines of RG 1.143, for liquids and liquid wastes produced during normal operation and anticipated operational occurrences, and the requirements of 10 CFR 20.1406. These system design features should be provided in the FSAR or the COL application to the extent that they are not addressed in a referenced certified design or DC application.

- BTP 11-6, as it relates to the assessment of a potential release of radioactive liquids following the postulated failure of a tank and its components, located outside of containment, and impacts of the release of radioactive materials at the nearest potable water supply, located in an unrestricted area, for direct human consumption or indirectly through animals, crops, and food processing.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (Vogtle Electric Generating Plant [VEGP] Units 3 and 4) were equally applicable to the VCSNS Units 2 and 3 COL application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 2, to the VCSNS COL FSAR. In performing this comparison, the staff considered changes made to the VCSNS COL FSAR (and other parts of the COL application, as applicable) resulting from requests for additional information (RAIs).
- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed.
- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VCSNS COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. Section 1.2.3 of this SER provides an explanation of why the standard content material from the SER for the reference COL application (VEGP) contains evaluation material from the SER for the Bellefonte Nuclear Plant (BLN), Units 3 and 4 COL application.

The following portion of this technical evaluation section is reproduced from Section 11.2.4 of the VEGP SER:

AP1000 COL Information Items

The following portion of this technical evaluation section is reproduced from Section 11.2.4 of the BLN SER:

- *STD COL 11.2-1*

The applicant provided additional information in STD COL 11.2-1 to resolve COL Information Item 11.2-1. COL Information Item 11.2-1 states:

The Combined License applicant will discuss how any mobile or temporary equipment used for storing or processing liquid radwaste conforms to Regulatory Guide 1.143. For example, this includes discussion of equipment containing radioactive liquid radwaste in the non-seismic Radwaste Building.

The commitment was also captured in COL Action Item 11.2-1 in Appendix F of the NRC staff's FSER for the AP1000 DCD (NUREG-1793), which states:

The COL applicant will provide information on how any mobile or temporary equipment used for storing or processing liquid radwaste conforms to RG 1.143.

The applicant provided information in BLN COL FSAR Section 11.2.1.2.5.2 that addresses how any mobile or temporary equipment that will be used for storing or processing liquid radwaste conforms to RG 1.143. For example, this includes discussion of equipment containing radioactive liquid radwaste in the non-seismic Radwaste Building. The staff issued Request for Additional Information (RAI) 11.2-5 to clarify some of the language used in the COL concerning the extent of compliance with RG 1.143 for the temporary and mobile equipment. The applicant responded to this RAI by proposing a revision to the BLN COL FSAR text to clearly state that the applicable requirements in RG 1.143 pertain to mobile and temporary equipment.

The NRC staff reviewed the resolution of COL Information Item 11.2-1 related to the use of mobile or temporary equipment included under Section 11.2 of the BLN COL FSAR and found that the applicant's commitments for installing and operating mobile systems meets the acceptance criteria in Section 11.2 of NUREG-0800 and RG 1.143. The NRC staff verified that Revision 1 of the BLN COL FSAR (STD COL 11.2-1) adequately incorporates the above. As a result, RAI 11.2-5 is closed.

- STD COL 11.2-2

The discussion of VEGP COL 11.2-2 addresses the site-specific cost-benefit analysis performed to address the requirements of 10 CFR Part 50, Appendix I, regarding population doses due to liquid effluents. The applicant provided additional information in STD COL 11.2-2 to resolve COL Information Item 11.2-2 with regard to the cost-benefit analysis methodology.

The NRC staff reviewed the resolution of COL Information Item 11.2-2 related to the cost-benefit analysis methodology described in VEGP FSAR Section 11.2.3.5.1 and concluded that the methodology used for the analysis was consistent with the guidance of RG 1.110 and was, therefore, acceptable.

- VCS COL 11.2-2

The applicant provided additional information in VCS COL 11.2-2 to resolve COL Information Item 11.2-2, which states:

The analysis performed to determine offsite dose due to liquid effluents is based upon the AP1000 generic site parameters included in Chapter 1 and Tables 11.2-5 and 11.2-6. The Combined License [COL] applicant will provide a site specific cost-benefit analysis to address the requirements of 10 CFR 50, Appendix I, regarding population doses due to liquid effluents.

The commitment was also captured as COL Action Item 11.2-2 in Appendix F of NUREG-1793, which states:

The applicant will provide a site-specific cost-benefit analysis to demonstrate compliance with 10 CFR Part 50, Appendix I, regarding population doses due to liquid effluents.

The NRC staff reviewed the resolution of COL Information Item 11.2-2 related to the cost benefit analysis included under Section 11.2.3.5.2 of the VCSNS COL FSAR and issued RAI 11.2-1. This RAI stated that the applicant needed to provide a detailed and plant-specific cost-benefit analysis. The applicant provided this analysis in a response to the RAI.

The results of the applicant's analysis showed that the lowest-cost option for liquid radwaste treatment system augments is a 20 gallons per minute (gpm) cartridge filter at \$11,140 per year. Assuming that this filter will eliminate all radioactivity from the liquid effluent, the resulting cost per dose reduction was \$763 per total body person-rem and \$1,714 per thyroid person-rem. The cost per person-rem total body does not exceed the \$1,000 per person-rem criteria provided in RG 1.110, and, therefore, required additional evaluation. Of the 14.6 person-rem total body dose, 4.6 person-rem is due to tritium, which will not be mitigated by the 20 gpm cartridge filter. Assuming that the augment completely eliminates the dose of 10 person-rem total body due to isotopes other than tritium, the cost of the total body dose reduction is \$11,140/10 person-rem total body or \$1,114 per person-rem total body. This is above the cost criterion of \$1,000 per person-rem for an augment in 10 CFR Part 50, Appendix I, Section II.D. Thus, the applicant concluded that the LWMS meets the as low as reasonably achievable (ALARA) requirements and requires no augments.

The NRC staff performed an independent assessment using the population doses calculated by the staff (see following section) and the guidance in RG 1.110 and came to the same conclusion. As a result, RAI 11.2-1 is closed.

- VCS COL 2.4-5 and VCS COL 15.7-1

The applicant provided additional information in VCS COL 2.4-5 and VCS COL 15.7-1 to resolve COL Information Items 2.4-5 and 15.7-1.

COL Information Item 2.4-5 states:

Combined License applicants referencing the AP1000 certified design will address site-specific information on the ability of the ground and surface water to disperse, dilute, or concentrate accidental releases of liquid effluents. Effects of these releases on existing and known future use of surface water resources will also be addressed.

The commitment was also captured as COL Action Item 2.4.1-1 in Appendix F of NUREG-1793, which states:

The COL applicant will provide site specific information on the ability of the ground and surface water to disperse, dilute, or concentrate accidental releases of liquid effluents. The COL applicant will also address the effects of such releases on existing and known future use of surface water resources.

COL Information Item 15.7-1 states:

Combined License applicant referencing the AP1000 certified design will perform an analysis of the consequences of potential release of radioactivity to the environment due to a liquid tank failure as outlined in subsection 15.7.3.

The commitment was also captured as COL Action Item 15.3.8-1 in Appendix F of NUREG-1793, which states:

The COL applicant will perform a site-specific analysis of the consequences of a potential release of radioactivity to the environment as a result of a liquid tank failure.

Section 2.4.13 of the applicant's FSAR addresses accidental release of liquid effluents into ground and surface water. The applicant postulated a release of the contents of the waste liquid system effluent hold-up tank. BTP 11-6 provides guidance in assessing potential release of radioactive liquids at the nearest potable water supply located in an unrestricted area. BTP 11-6 states the evaluation of the release should consider the use of water for direct human consumption or indirectly through animals (livestock watering), crops (agricultural irrigation), and food processing (water as an ingredient).

Evaluations performed by Westinghouse determined that the waste effluent hold-up tanks have the greatest potential radionuclide inventory of all waste effluent system tanks. The failed tank is assumed to have nuclide maximum concentrations corresponding to 101 percent of the reactor coolant source term. The entire contents of the tank are assumed to be released to the groundwater (unconfined aquifer) instantaneously. This assumption is very conservative because it requires failure of the floor drain system and it ignores the barriers presented in the basemat and exterior walls of the auxiliary building. The release migrates in the direction of decreasing hydraulic head either toward an unnamed creek north-northwest of Unit 2 or toward an unnamed creek south-southwest of Unit 3.

Flow from the release point to the creeks would be primarily through the saprolite material. Radionuclide concentrations of the liquid released would be reduced by the process of adsorption, hydrodynamic dispersion and radioactive decay. Upon reaching the two unnamed creeks, radionuclides would mix with the uncontaminated surface water in the creeks and eventually discharge into the Broad River, leading to further reduction of concentrations. In Section 2.4.13.1.2.4 of the VCSNS COL FSAR, the applicant calculated the concentrations of radionuclides taking into consideration radioactive decay, adsorption and dilution at Parr Shoals Dam, which is the nearest potable water supply. The results of the calculations are listed in FSAR Table 2.4-234. The concentrations in the table are those that represent more than 1 percent of their respective maximum permissible concentrations.

In RAI 2.4.13-1, the staff requested that the applicant address other pathways such as fish and crop irrigation. In a letter dated February 18, 2009, the applicant stated that of the three isotopes that are present following transport through groundwater and decay, tritium is the most significant, with a concentration of $5.1 \text{ E-}7$ microCi/ml for Unit 2. The applicant estimated the dose for tritium by comparing the tritium concentration to the concentrations in routine liquid effluent discharges for which doses have been calculated.

The results of the calculation of liquid effluent doses from normal releases are described in VCSNS COL FSAR Section 11.2. In response to RAI 11.2-3, the applicant provided the

breakdown of dose by pathway from normal liquid effluent releases. Table 11.2-1 of this SER provides these dose estimates.

These doses are based on the normal isotopic release shown in AP1000 DCD Table 11.2-7, including 1,010 Ci/yr for tritium. The tritium concentration in the Broad River due to routine effluents is $2.4\text{E-}7$ microCi/ml.

Whether the activity released is due to routine effluents or due to a tank failure, the assumptions at the receptor would be the same in both scenarios. If it is assumed that the doses in Table 11.2-1 of this SER are entirely due to tritium, the dose from the liquid radwaste tank failure may be estimated by multiplying the doses in Table 11.2-1 by the ratio of $5.2\text{E-}7$ microCi/ml to $2.4\text{E-}7$ microCi/ml, essentially doubling the dose in the table, or about $1.1\text{E-}1$ mrem/event. This is a conservative assumption because some of the dose from normal effluents is from radionuclides other than tritium.

The effluent concentration limits in 10 CFR Part 20, Appendix B, Table 12, Column 2 correspond to an annual dose of 50 mrem. Compared to this limit, the above dose is negligible. Based on the above evaluation and the applicant's analysis in its response to RAI 2.4.13-1, the staff finds potential doses to members of the public resulting from an accidental release of liquid effluents meet Acceptance Criterion 5 in NUREG-0800 and the referenced BTP 11-6.

- VCS COL 11.5-3

The applicant provided additional information in VCS COL 11.5-3 to resolve the COL applicant's responsibilities as set forth in Section 11.5.7 of the AP1000 DCD, which states:

The COL applicant is responsible for addressing the 10 CFR Part 50, Appendix I, Sections II.A and II.D guidelines for maximally exposed offsite individual doses and population doses via liquid and gaseous effluents.

The commitment was also captured as COL Action Item 11.5-3 in Appendix F of NUREG-1793, which states:

The COL applicant is responsible for addressing the guidelines of Appendix I to 10 CFR Part 50, as they relate to maximally exposed offsite individual doses and population doses attributable to liquid and gaseous effluents.

In VCSNS COL FSAR Section 11.2.3.5, the applicant discussed the methods used to assure that individual and estimated population doses are maintained ALARA in accordance with 10 CFR Part 50, Appendix I (this information is also applicable to FSAR Sections 11.3.3.4 and 11.4).

The NRC staff reviewed the applicant's response to VCS COL 11.5-3 related to compliance with 10 CFR Part 50, Appendix I, Sections II.A and II.D and issued RAI 11.2-3. RAI 11.2-3 requested the applicant to provide the details of the individual and population dose analysis.

In response to RAI 11.2-3, the applicant provided a description of the required model assumptions and input parameters needed to run LADTAP II computer codes to calculate radionuclide concentrations in the Broad River. The applicant also revised its LADTAP analysis to include commercial fishing.

Using radiological exposure models based on RG 1.109 and the LADTAP II computer program (NUREG/CR-4013, "LADTAP II - Technical Reference and User Guide," April 1986), the applicant calculated the estimated doses to a hypothetical maximally exposed individual (MEI) of the public and to the population within 80 km (50 mi) from the postulated liquid effluents discharged.

VCSNS COL FSAR Tables 11.2-201 and 11.2-202 include liquid pathway parameters used as input to the dose calculation, including discharge flow rate, site-specific dilution factors, transit-times to receptors, consumption factors for fish and water, and recreational usage data for the Broad River. Because discharge is directly to the Broad River, including Parr Reservoir, the applicant's analysis did not consider any impoundment reconcentration model to calculate dilution of the radioactive effluent by the Broad River. As a result, no dilution was credited beyond that provided by the Broad River. FSAR Tables 11.2-203 and 11.2-204 list the liquid pathway doses to the MEI and surrounding population, respectively.

The applicant calculated a maximum individual annual dose to the adult total body of 0.0014 mSv (0.14 mrem) and a maximum annual individual organ dose to the adult GI-LLI of 0.005 mSv (0.5 mrem), both from all pathways. The applicant compared the MEI doses with the 10 CFR Part 50, Appendix I, Section II.A criteria and showed the doses to be well below the limits of 3 mrem to the total body and 10 mrem to any organ.

The calculated annual population doses listed in VCSNS COL FSAR Table 11.2-204 are 0.146 person-Sv (14.6 person-rem) to the total body and 0.0653 person-Sv (6.53 person-rem) to the thyroid. The applicant used the population doses in the cost-benefit analysis previously described in this SER.

In response to RAI 11.2-3, the applicant explained the derivation of values used for population water use, sport fish harvest, commercial fish harvest, and recreational time spent on the river. The staff reviewed the derivation of these values and found them to be reasonable upper bound estimates. Consequently, the staff used the applicant's values in its independent dose estimation.

The NRC staff performed an independent assessment using the LADTAP II computer code and compared results to the applicant's and the Appendix I criteria. The modeling assumptions used by the staff for the MEI and population dose calculations, as shown in Table 11.2-2 of this SER, were consistent with the applicant's. Modeling parameter values, as shown in Table 11.2-3 of this SER, were also consistent with the applicant's. The results of the staff's calculations were consistent with those of the applicant.

SER Table 11.2-4 compares the resulting dose estimates between the applicant's analysis and the 10 CFR Part 50, Appendix I criteria. This table shows that all doses are below the Appendix I criteria. The staff concludes that the applicant has provided a bounding assessment demonstrating its capability to comply with the regulatory requirements in 10 CFR Part 20 and 10 CFR Part 50, Appendix I.

The following portion of this technical evaluation section is reproduced from Section 11.2.4 of the VEGP SER:

Supplemental Information

The following portion of this technical evaluation section is reproduced from Section 11.2.4 of the BLN SER:

- STD SUP 11.2-1

The applicant provided supplemental information in BLN COL FSAR Section 11.2.3.6, "Quality Assurance," addressing the quality assurance program to be applied to the liquid waste system and stated that the program complies with the guidance presented in RG 1.143.

The NRC staff reviewed this supplemental quality assurance information included in BLN COL FSAR Section 11.2.3.6 and finds that this supplemental statement commits the applicant to the regulatory positions in RG 1.143 related to quality assurance and is acceptable.

- VCS SUP 11.2-1

The applicant provided supplemental information in VCS SUP 11.2-1 related to the exterior radwaste discharge piping. The information was provided in a July 8, 2010, letter that committed to include the supplemental information in Section 11.2.1.2.4 of a future version of the VCSNS COL FSAR. The information stated that the section of piping between the liquid radwaste system and the junction of the pipe with the wastewater system blowdown line would be stainless steel, enclosed within a guard pipe, and monitored for leakage. Between the piping junction and the plant outfall at Parr Reservoir, the discharge would be diluted to meet the release limits of 10 CFR Part 20, Appendix B, Table II, Column 2, primarily with flow from circulating water blowdown. This section of piping would be buried, high density polyethylene single-walled pipe, would have no valves, vacuum breakers, or pumps, and would be gravity drained. The applicant stated that leakage monitoring would be determined as part of the groundwater monitoring program established in accordance with Nuclear Energy Institute (NEI) 08-08A, "Generic FSAR Template Guidance for Life Cycle Minimization of Contamination."

This item is related to 10 CFR 20.1406 and is addressed in FSER Section 12.3.

Demonstrating Compliance with 10 CFR 20.1301(e)

10 CFR 20.1301(e) requires that NRC-licensed facilities comply with the Environmental Protection Agency (EPA) generally applicable environmental radiation standards of 40 CFR Part 190 for facilities that are part of the fuel cycle. The EPA annual dose limits are 0.25 mSv (25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid, and 0.25 mSv (25 mrem) to any other organ. Meeting the requirements of 10 CFR 20.1301(e) requires the consideration of all potential sources of external radiation and radioactivity, including liquid and gaseous effluents and external radiation exposures from buildings, storage tanks, radioactive waste storage areas, and N-16 skyshine from boiling-water reactor (BWR) turbine buildings. The EPA standards apply to the entire site or facility, whether it has a single unit or multiple units.

The staff's review of the VCSNS COL FSAR revealed that the applicant did not provide any information demonstrating compliance with 10 CFR 20.1301(e). Because of this, the staff issued RAI 11.2-2 requesting that the applicant demonstrate compliance with the EPA standard.

The applicant provided the demonstration by summing the annual individual liquid and gaseous effluent doses for the new Units 2 and 3 with those for the existing Unit 1. In response to RAI 11.3-3, the applicant listed the results in the draft revised FSAR Table 11.3-206. Table 11.2-5 in this SER lists these dose summations and compares them to the dose requirements in 40 CFR Part 190. The expected doses are below the EPA limits, and VCSNS COL FSAR Table 11.3-206 has been revised to include the results given in the RAI response.

Demonstrating Compliance with 10 CFR 20.1302

The annual average concentration of radioactive material released in liquid effluents at the boundary of the unrestricted area must not exceed the values specified in Table 2 of Appendix B to 10 CFR Part 20. The applicant demonstrated compliance with this requirement by referencing the AP1000 DCD. Section 11.2.3.4 of the DCD shows that even at the Technical Specification limit for percent failed fuel defects, the nominal blowdown flow provides sufficient dilution to ensure that the expected effluent release concentrations would be less than those specified in Table 2 of Appendix B to 10 CFR Part 20.

In NUREG-1793, the staff evaluated and accepted the conclusions of Section 11.2.3.4 of the AP1000 DCD. Based on this acceptance, the staff concludes that the applicant complies with 10 CFR 20.1302.

Demonstrating Compliance with 10 CFR 20.1406

10 CFR 20.1406 requires the applicant to provide a description of how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment; facilitate eventual decommissioning; and minimize, to the extent practicable, the generation of radioactive waste. The applicant demonstrated compliance with this requirement by incorporating by reference the design descriptions provided in the AP1000 DCD and providing the description of operating programs in VCSNS COL FSAR Sections 12.3 and 12.5. The staff's evaluation and conclusion pertaining to compliance with 10 CFR 20.1406 are included in SER Section 12.3.

11.2.5 Post Combined License Activities

There are no post-COL activities related to this section.

11.2.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the LWMS, and there is no outstanding information expected to be addressed in the VCSNS COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VCSNS COL application are documented in NUREG-1793 and its supplements.

In addition, the staff evaluated the additional COL information (STD COL 11.2-1, STD COL 11.2-2, VCS COL 2.4-5, VCS COL 15.7-1, VCS COL 11.2-2, VCS COL 11.5-3, STD SUP 11.2-1, and VCS SUP 11.2-1) in the application against the relevant NRC regulations, acceptance criteria defined in NUREG-0800, Section 11.2, and other NRC regulatory guides. The applicant has satisfactorily addressed all RAIs related to Section 11.2.

The staff verified that the applicant had provided sufficient information and that the review and calculations support the conclusions that follow. The staff concludes that the LWMS (as a permanently installed system or in combination with mobile systems) includes the equipment necessary to control releases of radioactive materials in liquid effluents in accordance with GDC 60 and 61 of Appendix A to 10 CFR Part 50 and the requirements of 10 CFR 50.34a. The staff concludes that the design of the LWMS is acceptable and meets the requirements of 10 CFR 20.1301(e), 10 CFR 20.1302, 10 CFR 20.1406, 10 CFR 50.34a, GDC 60 and 61, and Appendix I to 10 CFR Part 50.

11.3 Gaseous Waste Management System

11.3.1 Introduction

The gaseous waste management system (GWMS) is designed to control, collect, process, handle, store, and dispose of gaseous radioactive waste generated as the result of normal operation, including anticipated operational occurrences.

11.3.2 Summary of Application

Section 11.3 of the VCSNS COL FSAR, Revision 5, incorporates by reference Section 11.3 of the AP1000 DCD, Revision 19.

In addition, in VCSNS COL FSAR Section 11.3, the applicant provided the following:

AP1000 COL Information Items

- STD COL 11.3-1

The applicant provided additional information in STD COL 11.3-1 to resolve COL Information Item 11.3-1 (COL Action Item 11.3-1) regarding gaseous radwaste cost-benefit analysis methodology.

- VCS COL 11.3-1

The applicant provided additional information in VCS COL 11.3-1 to resolve COL Information Item 11.3-1 (COL Action Item 11.3-1). The additional information addresses the estimated doses to the public from the gaseous waste system and the associated cost-benefit analysis in VCSNS COL FSAR Section 11.3.3.4.

- VCS COL 11.5-3

The applicant provided additional information in VCS COL 11.5-3 to resolve COL Information Item 11.5-3 (COL Action Item 11.5-3). The additional information addresses compliance with 10 CFR Part 50, Appendix I, Sections II.B and II.C related to operation of the gaseous waste system in VCSNS COL FSAR Section 11.3.3.4.

Supplemental Information

- STD SUP 11.3-1

The applicant added supplemental information in VCSNS COL FSAR Section 11.3.3.6 to address the QA program to be applied to the GWMS.

- STD SUP 11.3-2

The applicant added supplemental information in VCSNS COL FSAR Section 11.3.3 to address the gaseous effluent site interface parameter.

11.3.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements.

In addition, the regulatory basis for acceptance of the supplementary information on the GWMS is established in:

- 10 CFR 20.1301(e)
- 10 CFR 20.1302
- 10 CFR 20.1406
- 10 CFR 50.34a
- 10 CFR Part 50, Appendix A, GDC 3, "Fire Protection"
- 10 CFR Part 50, Appendix A, GDC 60
- 10 CFR Part 50, Appendix A, GDC 61
- 10 CFR Part 50, Appendix I, Sections II.B, II.C, and II.D
- 10 CFR 52.80(a)

Guidance for meeting these requirements is in:

- Regulatory Position C.2 of RG 1.143, Revision 2
- RG 1.109, Revision 1

- RG 1.110
- RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Nuclear Power Reactors," Revision 1
- RG 4.21

The acceptance criteria associated with the GWMS are given in Section 11.3 of NUREG-0800, including BTP 11-5.

11.3.4 Technical Evaluation

The NRC staff reviewed Section 11.3 of the VCSNS COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.¹ The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the GWMS. The results of the NRC staff's evaluation of the information incorporated by reference in the VCSNS COL application are documented in NUREG-1793 and its supplements.

The staff's review of this application included the following COL information and supplementary items:

- STD COL 11.3-1, Gaseous Radwaste Cost-Benefit Analysis Methodology
- VCS COL 11.3-1, Cost-Benefit Analysis of Population Doses
- VCS COL 11.5-3, 10 CFR Part 50, Appendix I, Sections II.B and II.C
- STD SUP 11.3-1, Supplemental Information on Quality Assurance
- STD SUP 11.3-2, Supplemental Information on Gaseous Effluent Site Interface Parameters

In addition to the above items, the staff reviewed the entire section against Section 11.3 of NUREG-0800 to determine if the information in VCSNS COL FSAR Section 11.3 met the regulatory requirements in the regulations stated above (SER Section 11.3.3) and NUREG-0800 acceptance criteria. The relevant NUREG-0800 acceptance criteria are as follows:

- The GWMS should have the capability to meet the dose design objectives and should include provisions to treat gaseous radioactive wastes, such that the following is true:
 - A. The calculated annual total quantity of all radioactive materials released from each reactor to the atmosphere will not result in an estimated annual external dose from gaseous effluents to any individual in unrestricted areas in excess of 0.05 mSv (5 mrem) to the total body or 0.15 mSv (15 mrem) to the skin. RGs 1.109 and 1.111 provide acceptable methods for performing this analysis.

- B. The calculated annual total quantity of radioactive materials released from each reactor to the atmosphere will not result in an estimated annual air dose from gaseous effluents at any location near ground level, which could be occupied by individuals in unrestricted areas in excess of 0.01 centigray (cGy) (10 millirads) for gamma radiation or 0.02 cGy (20 millirads) for beta radiation. RGs 1.109 and 1.111 provide acceptable methods for performing this analysis.
 - C. The calculated annual total quantity of radioiodines, carbon-14, tritium, and all radioactive materials in particulate form released from each reactor at the site in effluents to the atmosphere will not result in an estimated annual dose or dose commitment from such releases for any individual in an unrestricted area from all pathways of exposure in excess of 0.15 mSv (15 mrem) to any organ. RGs 1.109 and 1.111 provide acceptable methods for performing this analysis.
 - D. In addition to 1.A, 1.B, and 1.C, above, the GWMS should include all items of reasonably demonstrated technology that, when added to the system sequentially and in order of diminishing cost-benefit return, for a favorable cost-benefit ratio, can effect reductions in dose to the population reasonably expected to be within 80 km (50 mi) of the reactor. RG 1.110 provides an acceptable method for performing this analysis.
 - E. The concentrations of radioactive materials in gaseous effluents released to an unrestricted area should not exceed the limits specified in Table 2, Column 1, of Appendix B to 10 CFR Part 20.
 - F. The regulatory position in RG 1.143 is met, as it relates to the definition of the boundary of the GWMS, beginning at the interface from plant systems to the point of controlled discharges to the environment as defined in the Offsite Dose Calculation Manual (ODCM), or at the point of storage in holdup tanks or decay beds for gaseous wastes produced during normal operation and anticipated operational occurrences.
- System designs should describe features that will minimize, to the extent practicable, contamination of the facility and environment; facilitate eventual decommissioning; and minimize, to the extent practicable, the generation of radioactive waste in accordance with RG 1.143, for gaseous wastes produced during normal operation and anticipated operational occurrences, and the requirements of 10 CFR 20.1406 or the DC application, update in the SAR, or the COL application to the extent not addressed in a referenced certified design.
 - BTP 11-5, as it relates to potential releases of radioactive materials (noble gases) as a result of postulated leakage or failure of a waste gas storage tank or offgas charcoal delay bed.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP Units 3 and 4) were equally applicable to the VCSNS Units 2 and 3 COL application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 2, to the VCSNS COL FSAR. In performing this comparison, the staff considered changes made to the VCSNS COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs.
- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed.
- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VCSNS COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. Section 1.2.3 of this SER provides an explanation of why the standard content material from the SER for the reference COL application (VEGP) contains evaluation material from the SER for the BLN Units 3 and 4 COL application. Any confirmatory items in the standard content material retain the numbers assigned in the VEGP SER. Confirmatory items that are first identified in this SER section have a VCSNS designation (e.g., **VCSNS Confirmatory Item 11.3-1**).

AP1000 COL Information Items

The following portion of this technical evaluation section is reproduced from Section 11.3.4 of the VEGP SER:

- *STD COL 11.3-1*

The discussion of VEGP COL 11.3-1 addresses the site-specific cost-benefit analysis performed to address the requirements of 10 CFR Part 50, Appendix I, regarding population doses due to gaseous effluents. The applicant provided additional information in STD COL 11.3-1 to resolve COL Information Item 11.3-1 with regard to the cost-benefit analysis methodology.

The NRC staff reviewed the resolution of COL Information Item 11.3-1 related to the cost-benefit analysis methodology described in VEGP COL FSAR Section 11.3.3.4 and concluded that the methodology used for the analysis was consistent with the guidance of RG 1.110 and was, therefore, acceptable.

- *VCS COL 11.3-1*

The applicant provided additional information in VCS COL 11.3-1 to resolve COL Information Item 11.3-1, which states:

The analysis performed to determine offsite dose due to gaseous effluents is based upon the AP1000 generic site parameters included in Chapter 1 and

Tables 11.3-1, 11.3-2 and 11.3-4. The Combined License applicant will provide a site specific cost-benefit analysis to demonstrate compliance with 10 CFR 50, Appendix I, regarding population doses due to gaseous effluents.

The commitment was also captured as COL Action Item 11.5-3 in Appendix F of NUREG-1793, which states:

The COL applicant will provide a site-specific cost-benefit analysis to demonstrate compliance with 10 CFR 50, Appendix I, regarding population doses due to gaseous effluents.

The NRC staff reviewed the resolution of COL Information Item 11.3-1 related to the cost-benefit analysis included under Sections 11.3.3.4.2 and 11.3.5.1 of the VCSNS COL FSAR and issued RAI 11.3-1 because the NEI Template 07-11, "Generic FSAR Template Guidance for Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors," cited by South Carolina Electric and Gas (SCE&G) had been withdrawn by NEI from further consideration. This RAI asked the applicant to provide a detailed and plant-specific cost-benefit analysis.

In response to RAI 11.3-1, the applicant performed a site-specific analysis to determine whether the offsite dose due to gaseous effluents is bounded by the AP1000 site parameters included in Chapter 1 and Tables 11.3-1, 11.3-2 and 11.3-4 of the DCD. The applicant discussed the site-specific cost-benefit analysis in VCSNS COL FSAR Section 11.3.3.4 to address the requirements of 10 CFR Part 50, Appendix I, Section II.D, regarding population doses due to gaseous effluents. The dose and dose rate to man was calculated using the GASPAR II computer code, which is based on the methodology presented in RG 1.109.

The applicant's analysis showed that the lowest-cost option for gaseous radwaste treatment system augments is the steam generator flash tank vent to main condenser at \$6,320 per year. The population doses, 2.7 person-rem total body per reactor and 6.4 person-rem thyroid per reactor, are given in the VCSNS COL FSAR Table 11.3-205. Assuming that this augment will eliminate all radioactivity from the gaseous effluent, the resulting cost per dose reduction was \$2,340 per total body person-rem ($\$6,320/2.7$) and \$988 per thyroid person-rem ($\$6,320/6.4$). While the costs per person-rem reduction exceed the \$1,000 per person-rem criterion considering the total body dose, the costs considering the thyroid dose are below the \$1,000 per person-rem and, therefore, warranted further evaluation.

Since the estimated thyroid dose of 6.4 person-rem exceeds the 6.32 person-rem threshold value (\$6,320 augment at \$1,000 per person-rem), those system augments listed in RG 1.110 with a total annual cost of less than \$6,700 were evaluated to determine if they would be cost beneficial. The only such augment is the one already mentioned above. Addition of this augment presumes that the design already includes a steam generator flash tank. The AP1000 design does not include a steam generator flash tank, but instead uses steam generator piping blowdown heat exchangers that provide cooling of the blowdown fluid and prevent flashing prior to blowdown entering the main condenser. Adding the installation of a flash tank to this augment is estimated to cause the estimated total annual cost to increase significantly and would result in the conclusion that this augment is not cost beneficial.

The applicant went on to state that even if a vent line similar to the one described as the above system augment is considered, it would not mitigate the thyroid dose contribution from noble gases. Of the 6.4 person-rem thyroid dose stated above, 1.2 person-rem is due to noble gases.

Even assuming that this system augment completely eliminates the dose of 5.2 person-rem thyroid due to isotopes other than noble gases, the cost of the thyroid dose reduction would be \$6,320/5.2 person-rem thyroid, or \$1,215 per person-rem thyroid. This cost exceeds the \$1,000 per person-rem criterion described in Appendix I to 10 CFR Part 50; therefore, the system augment is not cost beneficial.

The staff reviewed this evaluation and concurred with its results. The augment considered is already the lowest cost augment available. This is above the cost criterion of \$1,000 per person-rem for an augment in 10 CFR Part 50, Appendix I, Section II.D. Thus, the staff concluded that the GWMS meets ALARA requirements and requires no augments.

- VCS COL 11.5-3

The applicant provided additional information in VCS COL 11.5-3 to resolve COL Information Item 11.5-3, which states:

The Combined License applicant is responsible for addressing the 10 CFR 50, Appendix I guidelines for maximally exposed offsite individual doses and population doses via liquid and gaseous effluents.

The commitment was also captured as COL Action Item 11.5-3 in Appendix F of NUREG-1793, which states:

The COL applicant is responsible for addressing the guidelines of Appendix I to 10 CFR Part 50, as they relate to maximally exposed offsite individual doses and population doses attributable to liquid and gaseous effluents.

The NRC staff reviewed the resolution of COL Information Item 11.5-3 related to the compliance with Appendix I to 10 CFR Part 50 as presented in Section 11.3.3.4 of the VCSNS COL and issued RAI 11.3-2 requesting the applicant provide the details of the individual and population dose analysis.

The response to RAI 11.3-2 showed that the applicant evaluated the impacts from gaseous effluent releases by considering the probable pathways to individuals and populations near the proposed new units. The applicant estimated the total-body and organ dose to the MEI from the gaseous effluent release pathways, and also calculated a collective total body and organ dose for the population within 80 km (50 mi) of the VCSNS site. The estimates of the maximum doses to the public are based on the AP1000 reactor's normal operational effluent releases as discussed in the AP1000 DCD. The applicant evaluated the impact of these doses by comparing them to applicable regulatory limits.

If built, the postulated two new units at the VCSNS site would release gaseous effluents into the atmosphere. The applicant calculated doses for several airborne pathways, including direct exposure to a radioactive plume, direct exposure to radioactivity deposited on the ground, inhalation of airborne radioactivity, and ingestion of contaminated agricultural products including vegetables, milk, and meat. The applicant assumed that the MEI consumes both cow and goat's milk, while the population consumes only cow's milk.

In response to RAI 11.3-2, the applicant provided a description of all required model assumptions and input parameters needed to run the GASPAR II computer code. Using radiological exposure models based on RG 1.109, Revision 1, and the GASPAR II computer

program (NUREG/CR-4653, "GASPAR II - Technical Reference and User Guide," March 1987), the applicant calculated the estimated doses to a hypothetical MEI of the public and to the population within 80 km (50 mi) from the postulated gaseous effluents discharged.

The applicant maximized the estimated MEI doses by choosing conservative locations and dispersion data for the calculations. Since the application was originally submitted, the dispersion factors have been revised slightly to reflect meteorological data collected at the new tower for Units 2 and 3 in 2007. Based on the new meteorological data, the atmospheric dispersion and ground deposition factors have been revised. Although the meat animal, milk animal, and vegetable garden actually have equal or lower dispersion values, the residence location values were used for all four receptors.

VCSNS COL FSAR Tables 11.3-201 and 11.3-202 include gaseous pathway parameters used as input to the dose calculation, including population data and site-specific agricultural usage information. The applicant provided detailed justifications for these parameter values in the response to RAI 11.3-2. FSAR Tables 11.3-203 and 11.2-205 list the gaseous pathway doses to the MEI and surrounding population, respectively.

The applicant calculated the gaseous pathway doses to the MEI. The results (VCSNS COL FSAR Table 11.3-204) show for conservative locations a gamma annual air dose of 0.0071 milliGray (mGy) or 0.71 millirad (mrad), a beta annual air dose of 0.030 mGy or 3.0 mrad; a total annual body dose of 0.0058 mSv or 0.58 mrem and an annual skin dose of 0.024 mSv or 2.4 mrem.

The calculated annual population doses listed in VCSNS COL FSAR Table 11.3-205 are 0.027 person-SV (2.7 person-rem) to the total body and 0.064 person-SV (6.4 person-rem) to the thyroid. The applicant used the population doses in the cost-benefit analysis described in the VCSNS COL FSAR and evaluated in this SER.

The NRC staff performed an independent assessment using the GASPAR II computer code and compared its results to the applicant's and the Appendix I criteria. The modeling assumptions used and parameter values used were consistent with the applicant's.

In response to RAI 11.3-2, the applicant explained the derivation of values used for agricultural and usage parameters including the total production of vegetables, milk, and meat in the 80 km area around the site. The staff evaluated and verified the derivation of these values and found them to be reasonable upper bound estimates. Consequently, the staff used the applicant's agricultural and usage values listed in VCSNS COL FSAR Table 11.3-201 for the dose estimation.

The staff evaluated and agreed with the approach taken by the applicant to calculate maximum annual individual doses from gaseous effluents. Using this same approach, the staff verified the individual doses in the VCSNS COL FSAR by independently running the GASPAR II computer code with the applicant's parameter values. Table 11.3-1 in this SER compares the resulting dose estimates from the applicant's analyses with the 10 CFR Part 50, Appendix I criteria. All doses are well below the Appendix I, Sections II.B and II.C criteria.

The staff evaluated and agreed with the approach taken by the applicant to calculate population doses from gaseous effluents. Using this same approach, the staff verified the population doses in the VCSNS COL FSAR by independently running the GASPAR II computer code with the applicant's parameter values. The applicant then used these doses in a cost-benefit

analysis for augments to the GWMS. Table 11.3-2 in this SER summarizes the results of the applicant's and staff's analysis of population doses.

The staff concluded that the information provided by the applicant for VCS COL 11.5-3 is acceptable. The NRC staff found that the applicant provided a bounding assessment demonstrating its capability to comply with the individual dose criteria in 10 CFR Part 20 and 10 CFR Part 50, Appendix I. In addition, the staff found the applicant's calculation of the population dose to be appropriate for use in assessing the cost-benefit requirements in Appendix I.

The following portion of this technical evaluation section is reproduced from Section 11.3.4 of the VEGP SER:

Supplemental Information

The following portion of this technical evaluation section is reproduced from Section 11.3.4 of the BLN SER:

- *STD SUP 11.3-1*

The applicant provided supplemental information in BLN COL FSAR Section 11.3.3.6, "Quality Assurance," addressing the quality assurance program to be applied to the gaseous waste system and stated that the program complies with the guidance presented in RG 1.143.

The NRC staff reviewed this supplemental quality assurance information included in BLN COL FSAR Section 11.3.3.6 and finds that this supplemental statement commits the applicant to the regulatory positions in RG 1.143 related to quality assurance and is acceptable.

The following portion of this technical evaluation section is reproduced from Section 11.3.4 of the VEGP SER:

- *STD SUP 11.3-2*

The applicant provided additional information in VEGP COL FSAR Section 11.3.3 to address gaseous effluent site interface parameters. The applicant stated that there are no gaseous effluent site interface parameters outside the Westinghouse scope. The staff finds this statement true because all gaseous effluent release points are through the main gas vent and the turbine building exhaust and are part of the certified design.

Postulated Radioactive Release Due to a Waste Gas Leak or Failure

NUREG-0800, Section 11.3, acceptance criteria and BTP 11-5 require the staff to evaluate the results of a postulated radioactive release resulting from a leakage or failure of a waste gas storage tank or offgas charcoal delay bed. The waste gas system is part of the radioactive GWMS and information on the system is considered as part of the design information required by 10 CFR 50.34a.

*The AP1000 DCD and NUREG-1793 addressed the results of this analysis. In response to RAI SRP11.3-CHPB-02 covering AP1000 DCD, Revision 17, Westinghouse detailed the results of this analysis for inclusion in the next revision of the DCD. As documented in the staff's SER for the AP1000 DCD, the staff found this analysis acceptable and that it encompassed the site-specific parameters for the VEGP site. Once the staff confirms the inclusion of the failure analysis in a future revision of the AP1000 DCD and the incorporation by reference of that DCD revision by the VEGP applicant, the staff will consider this item closed for the VEGP COL FSAR. This is considered **Confirmatory Item 11.3-1**.*

Resolution of Standard Content Confirmatory Item 11.3-1

Confirmatory Item 11.3-1 is a commitment by the applicant to incorporate changes, by reference, proposed by Westinghouse to Section 11.3.3.4 of the AP1000 DCD to include the results of the postulated radioactive release resulting from a leakage or failure of a waste gas storage tank or offgas charcoal delay bed. The staff verified that the applicant has incorporated the AP1000 DCD Revision 18 that includes the above changes. As a result, Confirmatory Item 11.3-1 is now closed.

Demonstrating Compliance with 10 CFR 20.1301(e)

The staff discusses compliance with 10 CFR 20.1301(e) in Section 11.2.4 of this SER.

Demonstrating Compliance with 10 CFR 20.1302

The annual average concentration of radioactive material released in gaseous effluents at the boundary of the unrestricted area must not exceed the values specified in Table 2 of Appendix B to 10 CFR Part 20. The applicant demonstrated compliance with this requirement by referencing the AP1000 DCD. Section 11.3.3.5 of the DCD shows that even at the Technical Specification limit for percent failed fuel defects, the site provides sufficient atmospheric dilution to ensure that the expected effluent release concentrations will be less than those specified in Table 2 of Appendix B to 10 CFR Part 20.

In NUREG-1793, the staff evaluated and accepted the conclusions of Section 11.3.3.5 of the DCD. Based on this acceptance, the staff concludes that the applicant complies with 10 CFR 20.1302.

Demonstrating Compliance with 10 CFR 20.1406

The staff discusses compliance with 10 CFR 20.1406 in Section 11.2.4 of this SER.

Confirmatory Item 11.3-1 remains unresolved for the VCSNS COL FSAR until the staff confirms the site-specific characteristics for the VCSNS site are enveloped by the DCD site parameters. This issue is being tracked as **VCSNS Confirmatory Item 11.3-1**.

Resolution of VCSNS Confirmatory Item 11.3-1

VCSNS Confirmatory Item 11.3-1 is a commitment by the staff to confirm the site-specific characteristics for the VCSNS site are enveloped by the DCD site parameters. The staff reviewed and compared the VCSNS site-specific and DCD parameters and confirmed that the site-specific parameters are enveloped by the DCD parameters. As a result, VCSNS Confirmatory Item 11.3-1 is now closed.

11.3.5 Post Combined License Activities

There are no post-COL activities related to this section.

11.3.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the GWMS, and there is no outstanding information expected to be addressed in the VCSNS COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VCSNS COL application are documented in NUREG-1793 and its supplements.

In addition, the staff evaluated the additional COL information (STD COL 11.3-1, VCS COL 11.3-1, VCS COL 11.5-3, STD SUP 11.3-1, and STD SUP 11.3-2) in the application against the relevant NRC regulations, acceptance criteria defined in NUREG-0800, Section 11.3, and other NRC regulatory guides. The applicant has satisfactorily addressed RAIs related to Section 11.3.

STD SUP 11.3-2, related to a postulated radioactive release resulting from a leakage or failure of a waste gas storage tank or offgas charcoal delay bed, is acceptable because it demonstrates compliance with 10 CFR 50.34a.

In other areas of the evaluation of the GWMS, the staff verified that the applicant had provided sufficient information and that the review and calculations support the conclusion that the GWMS includes the equipment necessary to control releases of radioactive materials in gaseous effluents in accordance with GDC 3, 60, and 61 of Appendix A to 10 CFR Part 50 and the requirements of 10 CFR 50.34a. The staff finds that the applicant meets the requirements in GDC 3 by conforming to the guidance in BTP 11-5. The staff finds that the applicant meets the requirements in GDC 60 and 61 by demonstrating conformance to 10 CFR Part 50, Appendix I. The staff also concludes that the design of the GWMS meets the requirements of 10 CFR 20.1301(e), 10 CFR 20.1302, 10 CFR 20.1406, 10 CFR 50.34a, GDC 3, 60, and 61, and Appendix I to 10 CFR Part 50.

11.4 Solid Waste Management (Related to RG 1.206, Section C.III.1, Chapter 11, C.I.11.4, "Solid Waste Management System")

11.4.1 Introduction

The solid waste management system (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 from normal plant operation, including anticipated operational occurrences. Processing and packaging of wastes are by mobile systems and the packaged

waste is stored in the auxiliary and radwaste buildings until it is shipped offsite to a licensed disposal facility.

11.4.2 Summary of Application

Section 11.4 of the VCSNS COL FSAR, Revision 5, incorporates by reference Section 11.4 of the AP1000 DCD, Revision 19.

In addition, in VCSNS COL FSAR Section 11.4, the applicant provided the following:

AP1000 COL Information Items

- STD COL 11.4-1

The applicant provided additional information in STD COL 11.4-1 to address COL Information Item 11.4-1 (COL Action Item 11.4-1). The additional information provides a process control program (PCP) for both wet and dry solid wastes.

Supplemental Information

- STD SUP 11.4-1

The applicant added supplemental information in VCSNS COL FSAR Section 11.4.5 to address how the solid radwaste system complies with the guidance in RG 1.143. STD SUP 11.4-1 also addresses the processes to be followed to ship waste that complies with 10 CFR 61.55, "Waste classification," and 10 CFR 61.56, "Waste characteristics" in VCSNS COL FSAR Section 11.4.6.1.

License Condition

- Part 10, License Condition 3, Operational Program Implementation

VCSNS COL FSAR Section 13.4, Table 13.4-201, "Operational Programs Required by NRC Regulations," identifies Item 9, the PCP, as a program required by regulations that must be implemented by a milestone (prior to initial fuel load) to be identified as a license condition.

- Part 10, License Condition 6, Operational Program Readiness

The applicant proposed a license condition to provide a schedule to support NRC inspection of operational programs including the PCP.

11.4.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements.

In addition, the regulatory basis for acceptance of the supplemental information on the SWMS is established in several codes and standards. These include:

- 10 CFR Part 20
- 10 CFR Part 50
- 10 CFR 52.79, "Contents of applications; technical information in final safety analysis report"
- 10 CFR Part 71, "Packaging and transportation of radioactive material"
- 49 CFR Part 173, "Shippers—General requirements for shipments and packagings"
- State regulations and disposal site waste form requirements for burial at a low-level waste disposal site that is licensed in accordance with 10 CFR Part 61, "Licensing requirements for land disposal of radioactive waste," or equivalent State regulations
- Table 1 and Regulatory Positions C.3.2 and C.3.3 of RG 1.143, Revision 2

The acceptance criteria associated with the SWMS are given in NUREG-0800, Section 11.4, including BTP 11-3.

11.4.4 Technical Evaluation

The NRC staff reviewed Section 11.4 of the VCSNS COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.¹ The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the SWMS. The results of the NRC staff's evaluation of the information incorporated by reference in the VCSNS COL application are documented in NUREG-1793 and its supplements.

The staff's review of this application included the following COL information item and supplemental information:

- STD COL 11.4-1, Solid Waste Management System PCP
- STD SUP 11.4-1, Quality Assurance

In addition to the above items, the staff reviewed the entire section against NUREG-0800, Section 11.4, to determine if the information in VCSNS COL FSAR Section 11.4 met the regulatory requirements in the regulations stated above (SER Section 11.4.3) and NUREG-0800 acceptance criteria. The relevant NUREG-0800 acceptance criteria are as follows:

- All effluent releases (gaseous and liquid) associated with the operation (normal and anticipated operational occurrences) of the SWMS will comply with 10 CFR Part 20 and RG 1.143, as they relate to the definition of the boundary of the SWMS beginning at the interface from plant systems, including multiunit stations, to the points of controlled liquid

and gaseous effluent discharges to the environment or designated onsite storage locations, as defined in the PCP and ODCM.

- Operational Programs. For COL reviews, the description of the operational program and proposed implementation milestone for the PCP aspect of the Process and Effluent Monitoring and Sampling Program are reviewed in accordance with 10 CFR 20.1301; 10 CFR 20.1302; 10 CFR 50.34a; 10 CFR 50.36a, "Technical specifications on effluents from nuclear power reactors"; and 10 CFR Part 50, Appendix I, Sections II and IV. Its implementation is required by a license condition.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP, Units 3 and 4) were equally applicable to the VCSNS Units 2 and 3 COL application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 2, to the VCSNS COL FSAR. In performing this comparison, the staff considered changes made to the VCSNS COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs.
- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed.
- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VCSNS COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. Section 1.2.3 of this SER provides an explanation of why the standard content material from the SER for the reference COL application (VEGP) contains evaluation material from the SER for the BLN Units 3 and 4 COL application.

Although the staff concluded that the evaluation performed for the standard content is directly applicable to the VCSNS COL application, there is a difference in how the VCSNS applicant addressed STD COL 11.4-1 and how the VEGP applicant addressed this review item. This difference is evaluated by the staff below, following the standard content material for STD COL 11.4-1.

The following portion of this technical evaluation section is reproduced from Section 11.4.4 of the VEGP SER:

AP1000 COL Information Items

The following portion of this technical evaluation section is reproduced from Section 11.4.4 of the BLN SER:

- STD COL 11.4-1

The applicant provided additional information in STD COL 11.4-1 to resolve COL Information Item 11.4-1. COL Information Item 11.4-1 states:

The Combined License applicant will develop a process control program in compliance with 10 CFR Sections 61.55 and 61.56 for wet solid wastes and 10 CFR Part 71 and DOT regulations for both wet and dry solid wastes. Process control programs will also be provided by vendors providing mobile or portable processing or storage systems. It will be the plant operator's responsibility to assure that the vendors have appropriate process control programs for the scope of work being contracted at any particular time. The process control program will identify the operating procedures for storing or processing wet solid wastes. The mobile systems process control program will include a discussion of conformance to Regulatory Guide 1.143, Generic Letter GL-80-009, and Generic Letter GL-81-039 and, information of equipment containing wet solid wastes in the non-seismic Radwaste Building. In the event additional onsite storage facilities are a part of Combined License plans, this program will include a discussion of conformance to Generic Letter GL-81-038.

The commitment was also captured as COL Action Item 11.4-1 in Appendix F of the NRC staff's FSER for the AP1000 DCD (NUREG-1793), which states:

The COL applicant will develop a process control program for both wet and dry solid wastes.

In BLN COL FSAR Section 11.4.6, the applicant addressed this COL information item. The applicant adopted NEI 07-10, "FSAR Template Guidance for Process Control Program (PCP) Description." The PCP describes the administrative and operational controls used for the solidification of liquid or wet solid waste and the dewatering of wet solid waste. It provides the necessary controls such that the final disposal waste product meets applicable federal regulations (10 CFR Parts 20, 50, 61, 71 and 49 CFR Part 173), state regulations, and disposal site waste form requirements for burial at a low level waste disposal site licensed in accordance with 10 CFR Part 61. Waste processing equipment and services may be provided by the plant or by third-party vendors. In a letter dated January 8, 2009, (ML082910077), the NRC accepted NEI 07-10, Revision 3. Specifically, the NRC staff indicated that for COL applications NEI 07-10, Revision 3, provides an acceptable template for assuring that the administrative and operational controls for waste processing, processing parameters, and

surveillance requirements within the scope of the PCP will meet the requirements of 10 CFR 52.79. In a letter dated April 23, 2009 (ML091170073), the applicant proposed to revise BLN FSAR Section 11.4 to incorporate the approved NEI 07-10 Revision 3. Since the BLN COL FSAR Section 11.4 has not adopted the approved version of the NEI Template, this is **Confirmatory Item 11.4-1**. Each process used meets the applicable requirements of the PCP. BLN COL FSAR Table 13.4-201 provides milestones for PCP implementation and is acceptable.

In STD COL 11.4-1, the applicant states that “no additional onsite radwaste storage is required beyond that described in the DCD.” The applicant should explain why this statement is included or should remove it. In section 11.4 of NUREG-1793, the staff stated that if a need for onsite storage of low-level waste has been identified beyond that provided in AP1000 Standard Design because of unavailability of offsite storage, the applicant should submit the details of any proposed onsite storage facility to the NRC. The applicant needs to provide any arrangements for offsite storage for low-level waste or to submit plans for onsite storage. This is identified as **Open Item 11.4-1**.

The following portion of this technical evaluation section is reproduced from Section 11.4.4 of the VEGP SER:

Resolution of Standard Content Confirmatory Item 11.4-1

To address Confirmatory Item 11.4-1 in the BLN SER with open items, the applicant updated VEGP COL FSAR Section 11.4.6 to indicate adoption of the NRC-approved version of NEI 07-10A. VEGP adoption of this template effectively resolves Confirmatory Item 11.4-1.

Resolution of Standard Content Open Item 11.4-1

To address Open Item 11.4-1 in the BLN SER with open items, the applicant updated VEGP COL FSAR Section 11.4 with information supporting the statement that no additional onsite radwaste storage was required beyond that described in the DCD. This additional information is in VEGP COL 11.4-1 and VEGP SUP 11.4-1 and is evaluated below.

Evaluation of Site-specific Information for STD COL 11.4-1

Regarding the Resolution of Standard Content Open Item 11.4-1, the staff does not consider the open item relevant to the VCSNS COL application because the applicant has available offsite disposal of all types of low-level radioactive waste through its membership in the Atlantic Compact. Therefore, an update of the VCSNS COL FSAR is not necessary to resolve this item.

The following portion of this technical evaluation section is reproduced from Section 11.4.4 of the VEGP SER:

Supplemental Information

The following portion of this technical evaluation section is reproduced from Section 11.4.4 of the BLN SER:

- *STD SUP 11.4-1*

The applicant provided supplemental information in Section 11.4.5 of the BLN COL FSAR to describe the QA program applicable to design, construction, installation and testing provisions of the solid radwaste system. This QA program is established by procedures and complies with the guidance presented in RG 1.143.

In BLN FSAR Section 11.4.6, the applicant also added a description of procedures relating to waste shipments, waste stream processing, verifying waste as non-radioactive, periodic system maintenance, personnel training, and document revision, clearing with third party vendors. The staff reviewed the descriptions and found them to be comprehensive and acceptable.

The NRC staff reviewed the supplemental information provided in STD SUP 11.4-1 related to the QA program for the solid radwaste system included under Section 11.4.4 of the BLN COL FSAR and finds that this supplemental statement commits the applicant to the regulatory positions in RG 1.143 related to quality assurance.

License Conditions

- *Part 10, License Condition 3, Operational Program Implementation*

VEGP COL FSAR Section 11.4.6 describes the process control program. VEGP COL FSAR Table 13.4-201 provides the milestone (prior to initial fuel load) for implementation of the process control program and is acceptable as described in the staff's SER related to NEI 07-10.

- *Part 10, License Condition 6, Operational Program Readiness*

The applicant proposed a license condition to provide a schedule to support NRC inspection of operational programs including the process control program. The proposed license condition is consistent with the policy established in SECY-05-0197, "Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria [ITAAC]," and is acceptable.

Compliance with 10 CFR Part 50 Appendix I Design Criteria

The design of the SWMS described in the AP1000 DCD has no release points directly to the environment. Compliance with Appendix I ALARA criteria is strictly based on the releases from the LWMS and GWMS and not the SWMS.

11.4.5 Post Combined License Activities

For the reasons discussed in the technical evaluation section above, the staff finds the following two license conditions proposed by the applicant acceptable:

- License Condition (11-1) - Prior to initial fuel load, the licensee shall implement an operational program for process and effluent monitoring and sampling. The program shall include the subprogram and documents for a Process Control Program.
- License Condition (11-2) - No later than 12 months after issuance of the COL, the licensee shall submit to the Director of the Office of New Reactors (NRO) a schedule that supports planning for and conduct of NRC inspections of the operational program for process and effluent monitoring and sampling (including process control program). The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month thereafter until the operational program for process and effluent monitoring and sampling (including process control program) has been fully implemented.

11.4.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the SWMS, and there is no outstanding information expected to be addressed in the VCSNS COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VCSNS COL application are documented in NUREG-1793 and its supplements.

In addition, the staff evaluated the additional COL information (STD COL 11.4-1 and STD SUP 11.4-1) in the application against the relevant NRC regulations, acceptance criteria in NUREG-0800, Section 11.4, and other NRC regulatory guides. The applicant has satisfactorily addressed the RAIs related to VCSNS COL FSAR Section 11.4.

The staff verified that the applicant had provided sufficient information and that the review supports the conclusion that the design and operation of the SWMS, which discharges radioactive releases through the LWMS and GWMS, is acceptable and meets the requirements of GDC 3, 60, and 61 of Appendix A of 10 CFR Part 50, 10 CFR 50.34a, 10 CFR 20.1301(e), 10 CFR 20.1406, and Appendix I to 10 CFR Part 50, and 10 CFR Parts 61 and 71.

11.5 Radiation Monitoring (Related to RG 1.206, Section C.III.1, Chapter 11, C.I.11.5, "Process and Effluent Radiological Monitoring and Sampling Systems")

11.5.1 Introduction

The radiation monitoring systems are used to monitor liquid and gaseous process streams and effluents from the LWMS, GWMS, and SWMS. The radiation monitoring system includes

subsystems used to collect process and effluent samples during normal operation and anticipated operational occurrences and under post-accident conditions.

11.5.2 Summary of Application

Section 11.5 of the VCSNS COL FSAR, Revision 5, incorporates by reference Section 11.5 of the AP1000 DCD, Revision 19.

In addition, in VCSNS COL FSAR Section 11.5, the applicant provided the following:

AP1000 COL Information Items

- STD COL 11.5-1

The applicant provided additional information in STD COL 11.5-1 to resolve COL Information Item 11.5-1 (COL Action Item 11.5-1). The information addresses the ODCM.

- STD COL 11.5-2

The applicant provided additional information in STD COL 11.5-2 to resolve COL Information Item 11.5-2 (COL Action Item 11.5-2). The information provides programmatic aspects of the effluent monitoring and sampling program.

- VCS COL 11.5-2

The applicant provided additional information in VCS COL 11.5-2 to add language to VCSNS COL FSAR Section 11.5.3 addressing extension of the existing Unit 1 program for QA of radioactive effluent and environmental monitoring to apply to VCSNS Units 2 and 3.

- VCS COL 11.5-3

The applicant provided additional information in VCS COL 11.5-3 to resolve COL Information Item 11.5-3 (COL Action Item 11.5-3). The information relates to the 10 CFR Part 50, Appendix I guidelines.

License Conditions

- Part 10, License Condition 3, Operational Program Implementation, Item G.3

VCSNS COL FSAR Section 13.4, Table 13.4-201, "Operational Programs Required by NRC Regulations," identifies three entries under Item 9, "Process and Effluent Monitoring and Sampling Program," as follows: (1) Radiological Effluent Technical Specifications/Standard Radiological Effluent Controls; (2) Offsite Dose Calculation Manual; and (3) Radiological Environmental Monitoring program, as programs identified in FSAR Section 11.5 that are required to be implemented by a milestone. In accordance with License Condition 3, Item G.3, these programs are to be implemented prior to initial fuel load.

- Part 10, License Condition 6, Operational Program Readiness

The applicant proposed a license condition to provide a schedule to support the NRC's inspection of operational programs including the Radiological Effluent Technical Specifications/Standard Radiological Effluent Controls; the ODCM; and the Radiological Environmental Monitoring program.

11.5.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements.

In addition, the regulatory basis for acceptance of the supplementary information on radiation monitoring addressed in COL Information Items 11.5-1, 11.5-2, and 11.5-3 is established in the requirements and guidelines of:

- 10 CFR Part 50, Appendix A, GDC 64, "Monitoring Radioactivity Releases"
- 10 CFR Part 20
- 10 CFR Part 50
- 10 CFR Part 52, "Licenses, certifications, and approvals for nuclear power plants"
- 10 CFR Part 61
- 10 CFR Part 71
- American National Standards Institute/Health Physics Society (ANSI/HPS) N13.1, "Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities"
- ANSI N42.18, "Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents"
- RG 1.21, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste," Revision 2
- RG 4.15, "Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) – Effluent Streams and the Environment," Revision 2

The applicable acceptance criteria associated with the radiation monitoring system are given in NUREG-0800, Section 11.5.

11.5.4 Technical Evaluation

The NRC staff reviewed Section 11.5 of the VCSNS COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.¹ The NRC staff's review confirmed

that the information in the application and incorporated by reference addresses the required information relating to the radiation monitoring system. The results of the NRC staff's evaluation of the information incorporated by reference in the VCSNS COL application are documented in NUREG-1793 and its supplements.

The staff reviewed the information in the VCSNS COL FSAR:

AP1000 COL Information Items

- STD COL 11.5-1, ODCM
- STD COL 11.5-2, Programmatic Aspects of the Effluent Monitoring and Sampling Program
- VCS COL 11.5-2 adds language to VCSNS COL FSAR Section 11.5.3 addressing extension of the existing Unit 1 program for QA of radioactive effluent and environmental monitoring to apply to VCSNS Units 2 and 3.
- VCS COL 11.5-3, 10 CFR Part 50, Appendix I Guidelines

In addition to the above items, the staff reviewed the entire section against NUREG-0800, Section 11.5, to determine if the information in VCSNS COL FSAR Section 11.5 met the regulatory requirements in the regulations stated above (SER Section 11.5.3) and NUREG-0800 acceptance criteria. The relevant NUREG-0800 acceptance criteria are as follows:

- Provisions should be made to ensure representative sampling from radioactive process streams and tank contents. Recirculation pumps for liquid waste tanks (collection or sample test tanks) should be capable of recirculating at a rate of not less than two tank volumes in 8 hours. For gaseous and liquid process stream samples, provisions should be made for purging sampling lines and for reducing the plate-out of radioactive materials in sample lines. Provisions for gaseous sampling from ducts and stacks should be consistent with ANSI/HPS N13.1-1999.
- For COL reviews, the description of the operational program and proposed implementation milestone for the radiological effluent technical specification/standard radiological effluent control, ODCM and Radiological Environmental Monitoring Program aspects of the Process and Effluent Monitoring and Sampling Program are reviewed in accordance with 10 CFR 20.1301, 10 CFR 20.1302, 10 CFR 50.34a, 10 CFR 50.36a, and 10 CFR Part 50, Appendix I, Sections II and IV. Its implementation is required by a license condition.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP, Units 3 and 4) were equally applicable to the VCSNS Units 2 and 3 COL application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 2, to the VCSNS COL FSAR. In performing this comparison, the staff considered changes made to the VCSNS COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs.
- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed.
- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VCSNS COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. Section 1.2.3 of this SER provides an explanation of why the standard content material from the SER for the reference COL application (VEGP) contains evaluation material from the SER for the BLN Units 3 and 4 COL application.

The following portion of this technical evaluation section is reproduced from Section 11.5.4 of the VEGP SER:

AP1000 COL Information Items

The following portion of this technical evaluation section is reproduced from Section 11.5.4 of the BLN SER:

- *STD COL 11.5-1*

The applicant provided additional information in STD COL 11.5-1 to resolve COL Information Item 11.5-1. COL Information Item 11.5-1 states:

The Combined License applicant will develop an offsite dose calculation manual that contains the methodology and parameters used for calculation of offsite doses resulting from gaseous and liquid effluents. The Combined License applicant will address operational setpoints for the radiation monitors and address programs for monitoring and controlling the release of radioactive material to the environment, which eliminates the potential for unmonitored and uncontrolled release. The offsite dose calculation manual will include planned discharge flow rates.

This commitment was also captured as COL Action Item 11.5-1 in Appendix F of the NRC staff's FSER for the AP1000 DCD (NUREG-1793), which states:

The COL applicant will develop an offsite dose calculation manual that contains the methodology and parameters used to calculate offsite doses resulting from gaseous and liquid effluents.

In BLN COL FSAR Section 11.5.7, the applicant adopts NEI 07-09, "FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description." The ODCM program description contains: (1) the methodology and parameters used for calculating doses resulting from liquid and gaseous

effluents; (2) operational setpoints, including planned discharge rates, for radiation monitors and monitoring programs; and (3) the limitations on operation of the radwaste systems, including functional capability of monitoring instruments, concentrations of effluents, sampling, analysis, 10 CFR Part 50, Appendix I dose and dose commitments and reporting. In a letter dated January 27, 2009 (ML083530745), the NRC accepted NEI 07-09, Revision 4. Specifically, the NRC indicated that for COL applications, NEI 07-09, Revision 4 provides an acceptable template assuring that the ODCM program meets applicable NRC regulations and guidance. In a letter dated April 23, 2009 (ML091170073), the applicant proposed to revise BLN COL FSAR Section 11.5 to incorporate the approved NEI 07-09, Revision 4. Since the BLN COL FSAR Section 11.5 has not adopted the approved version of the NEI Template, this is **Confirmatory Item 11.5-1**. BLN COL FSAR Table 13.4-201 provides milestones for ODCM implementation. This section also addresses Plant Interface Item 11.4, "requirements for offsite sampling and monitoring of effluent concentrations." The staff finds the applicant's consideration of Plant Interface Item 11.4 to be acceptable based on a review of the ODCM program (NEI 07-09). The NRC staff reviewed the resolution of STD COL 11.5-1 related to the ODCM included under Section 11.5.7 of the BLN COL FSAR and considers it adequately addressed in NEI 07-09.

The following portion of this technical evaluation section is reproduced from Section 11.5.4 of the VEGP SER:

Resolution of Standard Content Confirmatory Item 11.5-1

To address Confirmatory Item 11.5-1, the applicant updated the VEGP FSAR Section 11.5.7 to indicate adoption of the NRC-approved version of NEI 07-09A. VEGP adoption of this template effectively resolves Confirmatory Item 11.5-1.

The following portion of this technical evaluation section is reproduced from Section 11.5.4 of the BLN SER:

- STD COL 11.5-2

The applicant provided additional information in STD COL 11.5-2 to resolve COL Information Item 11.5-2 (COL Action Item 11.5-2). COL Information Item 11.5-2 states:

The Combined License applicant is responsible for the site-specific and program aspects of the process and effluent monitoring and sampling in accordance with ANSI N13.1 and RGs 1.21 and 4.15.

The commitment was also captured as COL Action Item 11.5-2 in Appendix F of the NRC staff's FSER for the AP1000 DCD (NUREG-1793), which states:

The COL applicant is responsible for ensuring that the process and effluent monitoring and sampling program at its site conforms to the guidelines of ANSI N13.1-1969, RG 1.21, and RG 4.15.

In BLN COL FSAR Sections 11.5.1.2, 11.5.2.4, 11.5.4, 11.5.4.1, 11.5.4.2 and 11.5.6.5, the applicant described the programmatic aspects of the effluent monitoring and sampling program. In addition, the applicant provided in BLN COL 11.5-2 specific language regarding the applicant's extension of the existing TVA program for quality assurance of radiological effluent and environmental monitoring which is based on RG 4.15, Revision 1, instead of the most current Revision 2. To maintain consistency, the applicant proposes to apply the same program to BLN Units 3 and 4.

The NRC staff reviewed the resolution of BLN COL 11.5-2 related to the effluent monitoring and sampling program included under Sections 11.5.1.2, 11.5.2.4, 11.5.3, 11.5.4, 11.5.4.1, 11.5.4.2 and 11.5.6.5 of the BLN COL FSAR and considers it adequately addressed in NEI 07-09.

- VCS COL 11.5-2

In VCS COL 11.5-2, the applicant extended the existing, NRC-approved SCE&G QA program, including RG 4.15, Revision 1, for effluent and environmental monitoring, to Units 2 and 3. By using the current program, which is based on RG 4.15, Revision 1 instead of Revision 2, the applicant will avoid confusion and the potential for error because the program for the existing and planned units will share the same equipment and personnel. Therefore, the staff finds the use of RG 4.15, Revision 1, acceptable.

- VCS COL 11.5-3

The applicant provided additional information in VCS COL 11.5-3 to resolve COL Information Item 11.5-3, which states:

The Combined License applicant is responsible for addressing the 10 CFR 50, Appendix I guidelines for maximally exposed offsite individual doses and population doses via liquid and gaseous effluents.

The commitment was also captured as COL Action Item 11.5-3 in Appendix F of NUREG-1793, which states:

The COL applicant is responsible for addressing the guidelines of Appendix I to 10 CFR Part 50, as they relate to maximally exposed offsite individual doses and population doses attributable to liquid and gaseous effluents.

The applicant addressed this COL item by adding information to VCSNS COL FSAR Sections 11.2.3 and 11.3.3.4 for liquid and gaseous effluents, respectively.

The NRC staff reviewed the resolution of VCS COL 11.5-3 related to compliance with 10 CFR Part 50, Appendix I, as discussed in SER Sections 11.2.4 and 11.3.4, and considers it adequately addressed.

The following portion of this technical evaluation section is reproduced from Section 11.5.4 of the VEGP SER:

The following portion of this technical evaluation section is reproduced from Section 11.5.4 of the BLN SER:

Section 11.5.4.2, Representative Sampling

In this section, the applicant describes how it will take representative samples for analysis. Based on the staff's review, the staff issued RAIs 11.5-1 and 11.5-2. RAI 11.5-1 requested clarification about the use of ANSI/HPS N13.1-1999. RAI 11.5-2 requested more information concerning how the applicant ensures representative liquid effluent and environmental sampling.

In response to RAI 11.5-1, the applicant revised its commitment to use the 1999 standard. Because the applicant made no changes to the certified design, it removed the commitment to use ANSI/HPS N13.1-1999, and committed to ANSI N13.1-1969 to be consistent with the AP1000 certified design. ANSI withdrew the 1969 standard and replaced it with ANSI/HPS N13.1-1999 because the approach taken in the 1969 standard did not provide assurance that the sample in the effluent vent would be representative. The 1999 standard differs significantly from the earlier version in that it is now performance based. NUREG-0800 Section 11.5 (2007) uses the 1999 standard as acceptance criteria. The staff is pursuing this issue through the DC because it deals with the design of the sampling systems for radioactive gas streams.

The applicant provided a response to RAI 11.5-2 and the staff finds the response acceptable. The response provided a more detailed description of how the applicant will assure that liquid samples will be representative. The applicant committed to follow the recommendations in ANSI N42.18 and RG 1.21. In addition, the applicant provided more operational descriptions for composite sampling. The NRC staff verified that Revision 1 of the BLN COL FSAR adequately addressed the above. As a result, RAI 11.5-2 is closed.

The following portion of this technical evaluation section is reproduced from Section 11.5.4 of the VEGP SER:

License Conditions

- *Part 10, License Condition 3, Operational Program Implementation, Item G.3*

VEGP COL FSAR Section 11.5.3 describes effluent monitoring and sampling and Section 11.5.7 describes the offsite dose calculation manual. License Condition 3, Item G.3 requires the licensee to implement the "Process and Effluent Monitoring and Sampling" program prior to initial fuel load. VEGP COL FSAR Section 13.4, Table 13.4-201, "Operational Programs Required by NRC Regulations," identifies three entries under Item 9, "Process and Effluent Monitoring and Sampling Program," as follows: (1) Radiological Effluent Technical Specifications/Standard Radiological Effluent Controls, (2) Offsite Dose Calculation Manual; and (3) Radiological Environmental Monitoring program, as programs identified in FSAR Section 11.5 required to be implemented by a milestone. The ODCM includes the Radiological Effluent Technical Specifications/Standard Radiological Effluent Controls and the Radiological Environmental Monitoring program. In accordance with License Condition 3, Item G.3, these programs are to be implemented prior to initial fuel

load. VEGP COL FSAR Table 13.4-201 provides the milestones (prior to initial fuel load) for implementation of these elements of the Process and Effluent Monitoring and Sampling Program and is acceptable as described in the staff's SER related to NEI 07-09.

- *Part 10, License Condition 6, Operational Program Readiness*

The applicant proposed a license condition to provide a schedule to support NRC inspection of operational programs, including the ODCM, effluent technical specifications, and the radiological environmental monitoring program. The proposed license condition is consistent with the policy established in SECY-05-0197 and is acceptable.

11.5.5 Post Combined License Activities

For the reasons discussed in the technical evaluation section above, the staff finds the following two license conditions proposed by the applicant acceptable:

- License Condition (11-3) - Prior to initial fuel load, the licensee shall implement an operational program for process and effluent monitoring and sampling. The program shall include the following subprograms and documents:
 - a. Radiological Effluent Technical Specifications/Standard Radiological Effluent Controls
 - b. Offsite Dose Calculation Manual
 - c. Radiological Environmental Monitoring Program
- License Condition (11-4) - No later than 12 months after issuance of the COL, the licensee shall submit to the Director of NRO a schedule that supports planning for and conduct of NRC inspections of the operational program for process and effluent monitoring and sampling (including Radiological Effluent Technical Specifications/Standard Radiological Effluent Controls, Offsite Dose Calculation Manual, and Radiological Environmental Monitoring Program). The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month thereafter until the above operational program has been fully implemented.

11.5.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the radiation monitoring system, and there is no outstanding information expected to be addressed in the VCSNS COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VCSNS COL application are documented in NUREG-1793 and its supplements.

In addition, the staff evaluated the additional COL information (STD COL 11.5-1, STD COL 11.5-2, VCS COL 11.5-2, and VCS COL 11.5-3) in the application against the relevant NRC regulations, acceptance criteria defined in NUREG-0800, Section 11.5, and other

NRC regulatory guides. The applicant has satisfactorily addressed all RAIs related to Section 11.5.

The staff verified that the applicant has provided sufficient information and that the review supports the conclusion that follows: The staff concludes that the Process and Effluent Radiological Monitoring and Sampling Systems are sufficient to comply with applicable portions of GDC 64 of Appendix A of 10 CFR Part 50; applicable requirements of 10 CFR Parts 20, 50, and 52; ANSI/HPS N13.1; ANSI N42.18; RGs 1.21 and 4.15; and applicable acceptance criteria in NUREG-0800, Section 11.5.

Table 11.2-1. Adult Total Body Dose from Normal Effluent Releases for Each Pathway

Pathway	Normal Effluent Release Adult Total Body Dose (mrem/yr)
Fish	2.1E-2
Drinking water	1.1E-2
Shoreline	2.1E-5
Irrigated Vegetables	9.5E-3
Irrigated Leafy Vegetables	1.2E-3
Irrigated Milk	6.3E-3
Irrigated Meat	2.0E-3
Total	5.1E-2

Table 11.2-2. Comparison of Important Modeling Assumptions

Pathways and Parameters	Application	NRC Staff's Analysis
Drinking water pathway for MEI and population	Yes	Yes
Fish ingestion pathway for MEI and population	Yes	Yes
Recreational use of river for MEI and population	Yes	Yes
Irrigation pathway for the MEI (including irrigated vegetable ingestion and ingestion of milk and meat from livestock grazing on irrigated land)	Yes	Yes
Surface Water Dilution Model	Mixing with Broad River	Mixing with Broad River

Table 11.2-3. Modeling Parameter Values*

Parameter	Value	Basis
Annual radionuclide release (Ci/yr)	Multiple values	DCD Table 11.2-7
Effluent discharge rate (cfs)	1782	FSAR Table 11.2-202
Annual average river flow for the MEI doses (cfs)	1782	FSAR Table 11.2-201
Dilution factors	1	FSAR Table 11.2-201
Transit time (hr)	0.1 for MEI 96 for others	FSAR Table 11.2-202
Reconcentration model	None	FSAR Table 11.2-202
Population drinking lake water	299,930	FSAR Table 11.2-202
Sport fishing harvest (kg/yr)	377,000	FSAR Table 11.2-202
Commercial fishing harvest (kg/yr)	12,100,000	FSAR Table 11.2-202
Fraction of SC crops irrigated	0.0696	FSAR Table 11.2-202
Fraction of population using contaminated water for drinking and food production	0.141	FSAR Table 11.2-202
Fraction of SC agricultural products within 50 mile radius	0.258	FSAR Table 11.2-202
Irrigation rate for food products (l/m ² /mon)	110	FSAR Table 11.2-202
Fraction of contaminated water not used for feed or drinking water	0	FSAR Table 11.2-202
Total production of vegetables within 50 mi radius (kg/yr)	6.86E+07	FSAR Table 11.2-202
Production rate for irrigated vegetables (kg/yr)	6.71E+05	FSAR Table 11.2-202
Total production of leafy vegetables within 50 mi radius (kg/yr)	1.80E+07	FSAR Table 11.2-202
Production rate for irrigated leafy vegetables (kg/yr)	1.76E+05	FSAR Table 11.2-202
Total production of milk within 50 mi radius (l/yr)	6.78E+07	FSAR Table 11.2-202
Production rate for irrigated milk (l/yr)	6.63E+05	FSAR Table 11.2-202
Total production of meat within 50 mi radius (kg/yr)	9.15E+08	FSAR Table 11.2-202
Production rate for irrigated meat (kg/yr)	8.96E+06	FSAR Table 11.2-202
Swimming/Boating/Shoreline usage (person-hours per year)	359,000 for Swimming 3,590,000 for Others	FSAR Table 11.2-202

* The staff used LADTAP II default values for parameters not listed in the table.

Table 11.2-4. Comparison of Maximum Individual Doses (mrem/yr)

Organ/Body	Application*	10 CFR Part 50 Appendix I Section II.A
GI-LLI	5.0E-01	10
Total Body	1.4E-01	3
Thyroid	1.9E-01	10

* Taken from VCSNS COL FSAR Table 11.2-203.

**Table 11.2-5. Comparison of Maximum Individual Doses to
40 CFR Part 190 (mrem/yr)**

Organ/Body	Application*	40 CFR Part 190
Total Body	2.2	25
Thyroid	14	75
Other Organ (Bone)	3.5	25

* Taken from VCSNS COL FSAR Table 11.3-206

Table 11.3-1. Comparison of Maximum Annual Individual Doses

Description	Application	10 CFR Part 50 Appendix I Section II.B and II.C
<u>Noble Gases</u>		
• Gamma Dose (mrad)	0.71*	10
• Beta Dose (mrad)	3.0*	20
• Total Body (mrem)	0.58**	5
• Skin (mrem)	2.4*	15
<u>Radioiodines and Particulates</u>		
• Maximum Organ (mrem)	7.0**	15

* Taken from VCSNS COL FSAR Table 11.3-204

** Dose for the infant thyroid

**Table 11.3-2. Comparison of Population Doses
(person-rem/yr)**

Organ/Body	Application*	NRC Staff's Analysis
Total Body	2.7	2.7
Thyroid	6.4	6.4

* Taken from VCSNS COL FSAR Table 11.3-205