

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 non-fission 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 Bellefonte (BLN) Combined Operating License (COL) Final Safety Analysis Report (FSAR) incorporates by reference, with no departures or supplements, Section 11.1, "Source Terms," of Revision 17 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 Westinghouse application to amend Appendix D to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52 includes changes to Section 11.1 of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information related to source terms incorporated by reference in the BLN COL FSAR will be documented in a supplement to the NRC staff's Final Safety Evaluation Report (FSER) related to the AP1000 DCD (NUREG-1793). The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 11.1 of this Safety Evaluation Report (SER) to reflect the final disposition of the design certification (DC) application.

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.

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

11.2.2 Summary of Application

Section 11.2 of the BLN COL FSAR incorporates by reference Section 11.2 of the AP1000 DCD, Revision 17.

In addition, in BLN 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 BLN COL FSAR Section 11.2.1.2.5.2.

- BLN COL 11.2-2

The applicant provided additional information in BLN 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 BLN COL FSAR Sections 11.2.3.3 and 11.2.3.5.

- BLN COL 11.5-3

The applicant provided additional information in BLN 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, Section II.A in BLN COL FSAR Section 11.2.3.5.

Supplemental information

- STD SUP 11.2-1

The applicant added in BLN COL FSAR Section 11.2.3.6 supplemental information to address the quality assurance program to be applied to the LWMS.

11.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the DCD.

In addition, the regulatory basis for acceptance of the supplementary information on LWMS is established in 10 CFR 20.1301(e); 10 CFR 20.1302; 10 CFR 20.1406; 10 CFR 50.34a; Appendix A to 10 CFR Part 50, General Design Criteria (GDC) 60 and 61, Appendix I to 10 CFR Part 50, Sections II.A and II.D; 10 CFR 52.80(a); 40 CFR Part 190; the codes and standards listed in Table 1 of Regulatory Guide (RG) 1.143; Regulatory Position C.1.1 of RG 1.143; RG 1.109; RG 1.110; RG 1.113; and RG 4.21. The applicable acceptance criteria are identified in Section 11.2 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," (SRP), and SRP 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 BLN COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the information in the COL represent the complete scope of information relating to this review topic.¹ The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to the LWMS. Section 11.2 of the AP1000 DCD is being reviewed by the staff under Docket Number 52-006. The NRC staff's technical evaluation of the information incorporated by reference related to the LWMS will be documented in the staff SER on the DC application for the AP1000 design.

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
- BLN COL 11.2-2 Cost-benefit Analysis of Population Doses
- BLN COL 11.5-3 Individual Dose Limits in 10 CFR Part 50 Appendix I
- STD SUP 11.2-1, Quality Assurance

In addition to the above four items, the staff reviewed the entire section against Section 11.2 of NUREG-0800 to determine if the information in BLN 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, to 10 CFR Part 20.
- 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.
- 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.

AP1000 COL Information Items

- 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.

- BLN COL 11.2-2

The applicant provided additional information in BLN COL 11.2-2 to resolve COL Information Item 11.2-2. COL Information Item 11.2-2 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 in COL Action Item 11.2-2 in Appendix F of the NRC staff's FSER for the AP1000 DCD (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 Sections 11.2.3.3 and 11.2.3.5 of the BLN COL FSAR and issued RAI 11.2-1 because the cited Nuclear Energy Institute (NEI) Template 07-11 was withdrawn by NEI from further consideration. This RAI stated that the applicant needed to provide a detailed and plant-specific cost-benefit analysis. The applicant provided this analysis in 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 \$6,962 per total body person-rem and \$7,901 per thyroid person-rem. This is above the cost criterion of \$1,000 per person-rem for an augment in 10 CFR 50, Appendix I, Section II.D. Thus, the applicant concluded that the LWMS meets 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. Because the staff's population doses were lower than the applicant's doses, as shown in SER Table 11.2-5, the staff obtained higher cost-benefit ratios for the 20 gpm filter cartridge. SER Table 11.2-1 lists the cost-benefit ratios calculated by the applicant and staff and compares them to the Appendix I criterion. The NRC staff verified that Revision 1 of the BLN COL FSAR adequately incorporates the plant-specific cost-benefit analysis and has concluded that the LWMS meets ALARA requirements and requires no augments. As a result RAI 11.2-1 is closed.

- BLN COL 11.5-3

The applicant provided additional information in BLN COL 11.5-3 to resolve the COL responsibilities stated in Section 11.5.7 of the AP1000 DCD, Revision 17 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 in COL Action Item 11.5-3 in Appendix F of the NRC staff's FSER for the AP1000 DCD (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, in BLN COL FSAR Section 11.2.3.5, discussed the methods used to assure that individual and estimated population doses are maintained "as low as reasonably achievable" in accordance with 10 CFR Part 50, Appendix I (this information is also applicable to BLN COL FSAR Sections 11.3, 11.4, and 11.5).

The NRC staff reviewed the resolution of BLN COL 11.5-3 related to compliance with 10 CFR 50, Appendix I, Sections II.A and II.D and issued two RAIs: RAI 11.2-3 and RAI 11.2-4. RAI 11.2-3 requested that the applicant provide the details of the individual and population dose analysis and RAI 11.2-4 questioned the applicant's assumption concerning the elimination of the irrigation exposure pathway.

In its response to the staff's RAIs, the applicant provided a description of the required model assumptions and input parameters needed to run LADTAP II computer codes, justification for excluding potential exposure pathways, and basis for calculating river dilution beyond the discharge point in the unrestricted area.

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 50 miles (80 km) from the postulated liquid effluents discharged.

Tables 11.2-201 and 11.2-202 of the BLN COL FSAR 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 Tennessee River. The analysis assumed a partially mixed impoundment model to calculate dilution of the radioactive effluent by the Tennessee River. BLN COL 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 0.00206 mSv (0.206 mrem) and a maximum annual individual dose to the teenager liver of 0.00265 mSv (0.265 mrem). 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 BLN COL FSAR Table 11.2-204 are 0.0158 person-SV (1.58 person-rem) to the total body and 0.0141 person-SV (1.41 person-rem) to the thyroid. The applicant uses the population doses in the cost-benefit analysis previously described in this SER.

The NRC staff performed an independent assessment using the LADTAP II computer code and compared the results to the applicant's and the Appendix I criteria. Compared to the applicant's evaluation, the staff made different assumptions concerning surface water dilution and relevant exposure pathways. The NRC staff used a simple river dilution model because the Tennessee River, in front of the plant and for about 30 miles downstream, physically resembles a typical river channel and not the physical conditions modeled in LADTAP II for the partially mixed impoundment option. The staff added the irrigation pathway for the MEI because BLN COL FSAR Section 2.4.1.2.4 and Environmental Report (ER) Section 2.3.2.2.3 state there may be several small-quantity irrigation users in the area including two farms. BLN COL FSAR Table 2.4.1-202 indicates irrigation use from the Tennessee River downstream of the plant where gardens are watered with drinking water withdrawn from the Tennessee River.

SER Table 11.2-2 shows the comparison of important modeling assumptions between the applicant's and the NRC staff's analyses. SER Table 11.2-3 lists the modeling parameter values used by the staff for the MEI and population dose calculations.

To estimate river dilution at the individual usage location near the discharge, the staff used an annual average river flow of 2720 cubic feet per second (cfs). This flow is seven percent of the total annual average river flow of 38,850 cfs (BLN COL FSAR Section 2.4.1.2.1). The NRC staff based the seven percent on the thermal plume modeling described in Section 5.3.2.1 of the applicant's ER. Using the Environmental Protection Agency's (EPA's) CORMIX model, the applicant showed that the width of the plume is 235 feet or 14 percent of the width of the river channel in front of the plant for the discharge from both units. Needing the flow from one unit discharge, the staff used seven percent of the total river flow to approximate effluent dilution near the plant discharge.

The staff assumed an effluent transit time of 41 hours to the location of population use. This is the time it takes for the effluent to reach the midpoint between the Guntersville Dam and the BLN site assuming an average river velocity of 0.76 ft/sec (BLN COL FSAR Table 11.2-201).

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

To estimate an irrigation rate for the MEI, the staff used information from the applicant's response to RAI 11.2-4. The applicant showed that 64 L/m²/month represents an upper bound average water requirement for a wide range of vegetables grown in Alabama. Assuming that the MEI crops and pastures only need to be irrigated one-third of the time during the growing season, the staff used 21 L/m²/month as the irrigation rate.

SER Table 11.2-4 compares the resulting dose estimates between the applicant's and the NRC staff's analyses, and the 10 CFR Part 50, Appendix I criteria. This table shows that the assumptions and parameters used by the applicant result in approximately a factor

of 2 higher doses for the total body and maximum organ when compared to the NRC staff's independent assessment. In addition, all doses are below the Appendix I criteria.

SER Table 11.2-5 lists the population doses calculated by the applicant and compares them to the staff's results. The table shows that the assumptions and parameters used by the applicant result in higher doses for the total body and thyroid when compared to the NRC staff's independent assessment. The NRC 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 Appendix I to 10 CFR Part 50. As a result, RAs 11.2-3 and 11.2-4 are closed.

Supplemental information

- 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.

Demonstrating Compliance with 10 CFR 20.1301(e)

10 CFR 20.1301(e) requires that NRC-licensed facilities comply with the 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 single or multiple units.

The staff's review of the BLN 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 the RA 11.2-2 requesting that the BLN COL FSAR demonstrate compliance with the EPA standard.

The applicant provided the demonstration by summing the annual individual liquid and gaseous effluent doses. The applicant listed the results in a proposed BLN COL FSAR Table 11.2-206. SER Table 11.2-6 lists these dose summations and compares them to the dose requirements in 40 CFR 190. Because the applicant's doses are higher than those calculated by the staff concludes that the doses represent an upper bound and the expected doses are below the EPA limits.

The NRC staff verified that Revision 1 of BLN COL FSAR Section 11.2.3.5.1 adequately incorporates the above. As a result RA 11.2-2 is closed.

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 will be less than those specified in Table 2 of Appendix B to 10 CFR Part 20.

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 provides the design descriptions by incorporating the AP1000 DCD and provides the description of additional design features of the liquid effluent discharge pipe and operating programs in BLN COL FSAR Chapter 12.

To address the design features put into place to comply with 10 CFR 20.1406, the NRC recently issued RG 4.21. In addition, NEI is in the process of developing a template to describe the operational programs applicants can adopt to comply with 10 CFR 20.1406 (NEI 08-08, Generic FSAR Template Guidance for Life Cycle Minimization of Contamination). This is an open item addressed in SER Section 12.3.

Addressing BTP 11-6, Postulated Liquid Waste Tank Failure

The applicant addresses the consequence of a Liquid Waste Tank Failure in BLN COL FSAR Section 2.4.13. Based on the staff review of this section, the staff issued two RAIs as follows:

1. RAI 2.4.13-6 - Section 2.4.13 of NUREG-0800, under Acceptance Criteria No. 5, references BTP 11-6, which provides guidance in assessing potential release of radioactive liquids at the nearest potable water supply located in an unrestricted area for direct human consumption or indirectly through animals, crops, and food processing. BTP 11-6 further states the evaluation of the release considers the use of water for direct human consumption or indirectly through animals (livestock watering), crops (agricultural irrigation), and food processing (water as an ingredient). The analysis does not include a discussion of pathways other than drinking water. The analysis should discuss these other pathways, especially the pathways such as fish and crop irrigation that may result in concentration of the source term. Either discuss other pathways, or justify why they need not be included.

In response to RAI 2.4.13-6, the applicant performed a basic evaluation of the dose consequences for the two pathways (fish and plant ingestion) to demonstrate that in the unlikely event of a liquid tank failure, there would be no significant dose to these pathways. The result of the evaluation indicates that the total dose consequence from fish and plant ingestion pathways is 0.491 mrem/year. By comparison, 10 CFR Part 20, Appendix B, Table 2, Column 2 values are based on an annual exposure of 50 milirem per year. The applicant stated that the purpose of the evaluation was not to calculate the dose consequences, but rather the concentration in the receptor water body; therefore, the direct comparison of dose

consequences is difficult. However, comparing the total of the fish and plant irrigation dose consequences to the basis for 10 CFR Part 20, Appendix B, Table 2, Column 2, the dose consequences are approximately 0.98 percent of the 10 CFR Part 20, Appendix B, Table 2, Column 2 basis value. Therefore, these are considered insignificant pathways and this is acceptable to the NRC staff. As a result, RAI 2.4.13-6 is closed.

2. RAI 2.4.13-7 - BTP 11-6, B.4. "Specifications on Tank Waste Radioactivity Concentration Levels," specifies an evaluation of the proposed technical specification limiting the radioactivity content of the tank to ensure that the technical specification is consistent with the safety evaluation. No technical specification limits were proposed in BLN COL FSAR Section 2.4.13 on the radioactivity content of the effluent holdup tanks. The applicant should provide the technical specification limits in the BLN COL FSAR or justify why no limits are needed.

In response to RAI 2.4.13-7, the applicant provided justification for not proposing any technical specification limits on the radioactivity content of the effluent holdup tanks. The applicant stated that for the AP1000 design, the liquid storage tanks do not meet the identified criteria (in the standard Technical Specification for Westinghouse Plants (NUREG-1431) for inclusion in the technical specifications, i.e., the design does not include any outdoor liquid radwaste tanks that are not surrounded by liners, dikes, or walls, capable of holding the tank's content and that do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system. This justification is acceptable to the NRC staff. As a result, RAI 2.4.13-7 is closed.

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 BLN COL FSAR related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Section 11.2 of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information incorporated by reference in the BLN COL FSAR will be documented in a supplement to NUREG-1793. The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 11.2 of this SER to reflect the final disposition of the DC application.

In addition, the staff evaluated the additional COL information (STD COL 11.2-1, BLN COL 11.2-2, BLN COL 11.5-3, and STD 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 RAIs related to Section 11.2. As discussed above, the open item in SER Section 12.3 pertaining to compliance with 10 CFR 20.1406 needs to be resolved.

The staff verified that the applicant has 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 BLN COL FSAR incorporates by reference Section 11.3 of the AP1000 DCD, Revision 17.

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

AP1000 COL Information Items

- BLN COL 11.3-1

The applicant provided additional information in BLN 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 BLN COL FSAR Section 11.3.3.4.

- BLN COL 11.5-3

The applicant provided additional information in BLN 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 BLN COL FSAR Section 11.3.3.4.

Supplemental information

- STD SUP 11.3-1

The applicant added supplemental information in BLN COL FSAR Section 11.3.3.6 to address the quality assurance program to be applied to the GWMS.

11.3.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the DCD.

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; Appendix A to 10 CFR Part 50, GDC 3, 60 and 61; Appendix I to 10 CFR Part 50, Sections II.B, II.C and II.D; 10 CFR 52.80(a); Regulatory Position C.2 of RG 1.143; RG 1.109; RG 1.110; RG 1.111; and RG 4.21. The applicable acceptance criteria are identified 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 BLN COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the information in the COL represent the complete scope of information relating to this review topic.¹ The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to the GWMS. Section 11.3 of the AP1000 DCD is being reviewed by the staff under Docket Number 52-006. The NRC staff's technical evaluation of the information incorporated by reference related to the GWMS will be documented in the staff SER on the DC application for the AP1000 design.

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

- BLN COL 11.3-1, Cost-benefit Analysis of Population Doses
- BLN 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

In addition to the above three items, the staff reviewed the entire section against Section 11.3 of NUREG-0800 to determine if the information in BLN 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 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 contained 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 design certification (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 off-gas charcoal delay bed.

AP1000 COL Information Items

- BLN COL 11.3-1

The applicant provided additional information in BLN COL 11.3-1 to resolve COL Information Item 11.3-1. COL Information Item 11.3-1 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 in COL Action Item 11.5-3 in Appendix F of the NRC staff's FSER for the AP1000 DCD (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 BLN COL FSAR and issued RAI 11.3-1 because the cited NEI Template 07-11 was withdrawn by NEI from further consideration. This RAI stated that the applicant needed to provide a detailed and plant-specific cost-benefit analysis.

The applicant performed a site-specific analysis to determine that 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 from the DCD. The applicant discussed the site-specific cost-benefit analysis in BLN COL FSAR Section 11.3.3.4 to address the requirements of 10 CFR 50, Appendix I, Section II.D, regarding population doses due to gaseous effluents. The dose and dose rate to man was calculated using the GASPARD II computer code, which is based on the methodology presented in RG 1.109.

In responding to the RAI, 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. Assuming that this augment will eliminate all radioactivity from the gaseous effluent, the resulting cost per dose reduction was \$2,107 per total body person-rem and \$1,003 per thyroid person-rem. This is above the costs criterion of \$1,000 per person-rem for an augment in 10 CFR 50, Appendix I, Section II.D. Thus, the applicant concluded that the GWMS met ALARA requirements and required 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. The staff evaluated a different augment, the 1000 cfm Charcoal and High Efficiency Particulate Air (HEPA) Filtration System, because this is the lowest cost augment that would effectively remove radioiodines and particulates, which are the major contributors to the population dose. SER Table 11.3-1 lists the cost-benefit ratios calculated by the applicant and staff and compares them to the Appendix I criterion. The NRC staff verified that Revision 1 of the BLN COL FSAR adequately addresses the plant-specific cost-benefit analysis. The staff confirmed that the GWMS met ALARA requirements and required no augments. As a result RAI 11.3-1 is closed.

- BLN COL 11.5-3

The applicant provided additional information in BLN COL 11.5-3 to resolve COL Information Item 11.5-3. COL Information Item 11.5-3 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 in COL Action Item 11.5-3 in Appendix F of the NRC staff's FSER for the AP1000 DCD (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 BLN COL 11.5-3 related to the compliance with Appendix I to 10 CFR Part 50 included under Section 11.3.3.4 of the BLN COL FSAR and issued RAI 11.3-2 requesting the applicant to provide the details of the individual and population dose analysis.

The response to the RAI 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 50 miles (80 km) of the BLN site. The estimates of the maximum site-specific 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.

In the operation phase, the proposed two new units at the BLN 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 maximum individual consumes goat's milk rather than cow's milk because goat's milk yields higher doses and individuals who live near the site raise both types of livestock. When calculating the population dose, the applicant assumed that the population consumes only cow's milk because agricultural statistics show that the surrounding population produces much more cow's milk than goat's milk.

In response to RAI 11.3-2, the applicant provided a description of required model assumptions and input parameters needed to run GASPAR II computer code. Using radiological exposure models based on RG 1.109 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 50 miles (80 km) from the postulated gaseous effluents discharged.

The applicant maximized the estimated MEI doses by choosing worst-case locations for the calculations. For plume exposure, the applicant chose the worst-case dispersion location outside the Exclusion Area Boundary even though this location is unoccupied and not an actual receptor location. For the remaining pathways, the applicant used the worst-case receptor location (a farm field) even though no one resides or raises livestock at this location.

Tables 2.3-323, 2.3-325, 2.3-326, and 2.3-328 of the BLN COL FSAR include all the atmospheric dispersion and deposition factors used by the applicant to calculate individual and population doses. BLN 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 its response to RAI 11.3-2. BLN COL FSAR Tables 11.3-203 and 11.3-205 list the gaseous pathway doses to the MEI and surrounding population, respectively.

The applicant calculated the gaseous pathway doses to the MEI. The results show for the worst-case location outside the exclusion boundary a gamma annual air dose of 0.00265 milliGray (mGy) or 0.265 millirad (mrad), a beta annual air dose of 0.0139 mGy or 1.39 mrad; a total annual body dose of 0.00158 milliSieverts (mSv) or 0.158 millirem (mrem) and an annual skin dose of 0.00957 mSv or 0.957 mrem. Table 11.3-204 of the BLN COL FSAR also lists the maximum annual organ dose (thyroid) of 0.0911 mSv or 9.11 mrem for the infant.

The calculated annual population doses listed in BLN COL FSAR Table 11.3-205 is 0.03 person-SV (3.00 person-rem) to the total body, and 0.063 person-SV (6.3 person-rem) to the thyroid. The applicant uses the population doses in the cost-benefit analysis described in this SER.

The NRC staff performed an independent assessment using the GASPARD II computer code and it's compared results to the applicant's and the Appendix I criteria. The staff used MEI locations that would produce more realistic dose estimates when compared to the applicant's locations. SER Table 11.3-2 shows the comparison of different MEI locations between the applicant's and the NRC staff's analyses. The staff chose the maximum residence location for the inhalation pathway and ground deposition pathways because people currently live at this location. The staff also chose the maximum pasture location for the milk and meat pathways because livestock currently graze at this location.

In its response to RAI 11.3-2, the applicant explains the derivation of values used for agricultural and usage parameters including the total production of vegetables, milk, and meat in the 50-mile 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 NRC staff used the applicant's agricultural and usage values listed in BLN COL FSAR Table 11.3-201 for the dose estimation.

SER Table 11.3-3 compares the resulting dose estimates between the applicant's and the NRC staff's analyses, and the 10 CFR Part 50, Appendix I criteria. SER Table 11.3.3 shows that the assumptions and parameters used by the applicant result in roughly a factor of 2 higher doses for radioiodines and particulates when compared to the NRC staff's independent assessment. In addition, all doses are well below the Appendix I, Sections II.B and II.C criteria. The NRC 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 Appendix I to 10 CFR Part 50.

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 BLN COL FSAR by independently running the GASPARD 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. SER Table 11.3-4 summarizes the results of the applicant's and staff's analysis of population doses. As a result, RAI 11.3-2 is closed.

Supplemental Information

- 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.

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 rationale for performing such analysis for NUREG-0800 Section 11.3 stems from the fact that system malfunctions or operator errors are much more likely events than explosions or earthquakes, and releases from these more likely events approximate releases from a tank rupture or pipe break. The applicant needs to incorporate the results of this analysis into the facilities' technical specifications Section 5.5, Programs and Manuals, and show the results of this analysis in BLN COL FSAR Section 11.3.

The staff's review of BLN COL FSAR Section 11.3 revealed that the applicant had not performed the analysis as required by NUREG-0800. The staff is pursuing this issue through the DC and it is being tracked as part of Open Item 1-1.

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.

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 provides the design descriptions by incorporating the AP1000 DCD and provides the description of operating programs in BLN COL FSAR Chapter 12.

To address the design features put into place to comply with 10 CFR 20.1406, the NRC recently issued RG 4.21. In addition, NEI is in the process of developing a template to describe the operational programs applicants can adopt to comply with 10 CFR 20.1406 (NEI 08-08, Generic FSAR Template Guidance for Life Cycle Minimization of Contamination). This is an open item and is addressed in SER Section 12.3.

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 BLN COL FSAR related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Section 11.3 of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information incorporated by reference in the BLN COL FSAR will be documented in a supplement to the NRC staff's FSER (NUREG-1793). The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 11.3 of this SER to reflect the final disposition of the DC application.

In addition, the staff evaluated the additional COL information (BLN COL 11.3-1, BLN COL 11.5-3, and STD SUP 11.3-1) 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. As discussed above, the open item in SER 12.3 pertaining to compliance with 10 CFR 20.1406 needs to be resolved.

The staff verified that the applicant has provided sufficient information and that the review and calculations support the conclusions that follow. The staff concludes 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 concludes that the design of the GWMS 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 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 BLN COL FSAR incorporates by reference Section 11.4 of the AP1000 DCD, Revision 17.

In addition, in BLN 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 resolve COL Information Item 11.4-1 (COL Action Item 11.4-1). The additional information provides a process control program for both wet and dry solid wastes.

Supplemental Information

- STD SUP 11.4-1

The applicant provided supplemental information in BLN 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 and 10 CFR 61.56 in BLN COL FSAR Section 11.4.6.1.

License Condition

- Part 10, License Condition 3, Operational Program Implementation

BLN COL FSAR Section 13.4, Table 13.4-201, "Operational Programs Required by NRC Regulations," identifies Item 9, the process control program, 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.

11.4.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the DCD.

In addition, the regulatory basis for acceptance of the supplemental information on solid waste management systems is established in several codes and standards. These include Table 1 and Regulatory Positions C.3.2 and C.3.3 of RG 1.143, 10 CFR Parts 20, 50, 52.79, 71 and 49 CFR Part 173, 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 or equivalent State regulations. The applicable acceptance criteria are identified in NUREG-0800 Section 11.4, including BTP 11-3.

11.4.4 Technical Evaluation

The NRC staff reviewed Section 11.4 of the BLN COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the information in the COL represent the complete scope of information relating to this review topic.¹ The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to the SWMS. Section 11.4 of the AP1000 DCD is being reviewed

by the staff under Docket Number 52-006. The NRC staff's technical evaluation of the information incorporated by reference related to the SWMS will be documented in the staff SER on the DC application for the AP1000 design.

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 Process Control Program
- STD SUP 11.4-1, Quality Assurance

In addition to the above two items, the staff reviewed the entire section against NUREG-0800, Section 11.4 to determine if the information in BLN 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, and 10 CFR 50, Appendix I, Sections II and IV. Its implementation is required by a license condition.

AP1000 COL Information Items

- 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 nonseismic 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**.

Supplemental information

- STD SUP 11.4-1

The applicant provided supplemental information in Section 11.4.5 of the BLN COL FSAR to describe the quality assurance 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 Condition

- Part 10, License Condition 3, Operational Program Implementation

BLN COL FSAR Section 11.4.6 describes the process control program. BLN 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.

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

The following items were identified as the responsibility of the COL holder:

- License Condition 3, Item G.3 regarding the PCP prior to the initial fuel load.
- License Condition 6, "Operational Program Readiness," in Part 10 of the BLN COL application will require the licensee to develop a schedule that supports planning for and conduct of NRC inspections of the operational programs (the PCP) listed in BLN COL FSAR Table 13.4-201, "Operational Programs Required by NRC Regulations." This schedule must be available to the NRC staff no later than 12 months after issuance of the COL. The condition will also require that the schedule be updated every 6 months until 12 months before scheduled fuel load, and every month thereafter until either the operational programs listed in BLN COL FSAR Table 13.4-201 have been fully implemented or the plant has been placed in commercial service, whichever comes first.

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 BLN COL FSAR related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Section 11.4 of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information incorporated by reference in the BLN COL FSAR will be documented in a supplement to NUREG-1793. The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 11.4 of this SER to reflect the final disposition of the DC application.

However, as a result of Open Item 11.4-1 concerning the long-term storage of Class B and C low-level radioactive waste, and Confirmatory Item 11.4-1 concerning NEI 07-10, the staff is unable to finalize its conclusions on STD COL 11.4-1.

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 BLN COL FSAR incorporates by reference Section 11.5 of the AP1000 DCD, Revision 17.

In addition, in BLN 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 Offsite Dose Calculation Manual (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.

- STD COL 11.5-3

The applicant provided additional information in STD 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.

- BLN COL 11.5-2

The applicant provided additional information in BLN COL 11.5-2 to add language to BLN COL FSAR Section 11.5.3 addressing Tennessee Valley Authority's (TVA's) extension of the existing TVA program for quality assurance of radioactive effluent and environmental monitoring to apply to BLN.

License Condition

- Part 10, License Condition 3, Operational Program Implementation

BLN COL FSAR Section 13.4, Table 13.4-201, "Operational Programs Required by NRC Regulations," identifies Item 9, Offsite Dose Calculation Manual, 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.

11.5.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the DCD.

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, 11.5-3 and Plant Interface Item 11.4 is established in the requirements and guidelines of GDC 64, 10 CFR Parts 20, 50, 52, 61 and 71; American National Standards Institute/Health Physics Society (ANSI/HPS) N13.1, ANSI N42.18, RGs 1.21 and 4.15. The applicable acceptance criteria are addressed in NUREG-0800 Section 11.5.

11.5.4 Technical Evaluation

The NRC staff reviewed Section 11.5 of the BLN COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the information in the COL represent the complete scope of information relating to this review topic.¹ The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to the radiation monitoring system. Section 11.5 of the AP1000 DCD is being reviewed by the staff under Docket Number 52-006. The NRC staff's technical evaluation of the information incorporated by reference related to the radiation monitoring system will be documented in the staff SER on the DC application for the AP1000 design.

The staff reviewed the information contained in the BLN 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
- STD COL 11.5-3, 10 CFR Part 50, Appendix I Guidelines
- BLN COL 11.5-2 adds language to BLN COL FSAR Section 11.5.3 addressing TVA's extension of the existing TVA program for quality assurance of radioactive effluent and environmental monitoring to apply to BLN.

In addition to the above four items, the staff reviewed the entire section against NUREG-0800 Section 11.5 to determine if the information in BLN 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 (RETS)/SREC, ODCM and Radiological Environmental Monitoring Program (REMP) 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.

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 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.

- STD COL 11.5-2 and BLN 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.

- STD COL 11.5-3

The applicant provided additional information in STD COL 11.5-3 to resolve COL Information Item 11.5-3. COL Information Item 11.5-3 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 the NRC staff's FSER for the AP1000 DCD (NUREG-1703), 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 BLN COL FSAR Sections 11.2.3.5 and 11.3.3.4 for liquid and gaseous effluents, respectively.

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

License Condition

- Part 10, License Condition 3, Operational Program Implementation

BLN COL FSAR Section 11.5.7 describes the offsite dose calculation manual. BLN COL FSAR Table 13.4-201 provides the milestone (prior to initial fuel load) for implementation of the offsite dose calculation manual and is acceptable.

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.

11.5.5 Post-Combined License Activities

The following items were identified as the responsibility of the COL holder:

- License Condition 3, Item G.3 regarding the effluent monitoring and sampling program (the ODCM).
- License Condition 6, "Operational Program Readiness," in Part 10 of the BLN COL application will require the licensee to develop a schedule that supports planning for and conduct of NRC inspections of the operational programs (the process and effluent

monitoring and sampling program) listed in BLN COL FSAR Table 13.4-201, "Operational Programs Required by NRC Regulations." This schedule must be available to the NRC staff no later than 12 months after issuance of the COL. The condition will also require that the schedule be updated every 6 months until 12 months before scheduled fuel load, and every month thereafter until either the operational programs listed in BLN COL FSAR Table 13.4-201 have been fully implemented or the plant has been placed in commercial service, whichever comes first.

BLN COL application, Part 10, License Condition 6 - The COL holder shall submit to the NRC a schedule no later than 12 months after issuance of the COL that supports planning for and conduct of NRC inspection of the process and effluent monitoring and sampling program.

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 COL FSAR related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Section 11.5 of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information incorporated by reference in the BLN COL FSAR will be documented in a supplement to NUREG-1793. The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 11.5 of this SER to reflect the final disposition of the DC application.

In addition, the staff evaluated the additional COL information (STD COL 11.5-1, STD COL 11.5-2, STD COL 11.5-3 and BLN COL 11.5-2) in the application against the relevant NRC regulations, acceptance criteria defined in NUREG-0800, Section 11.5 and other NRC regulatory guides. Pending resolution of Confirmatory Item 11.5-1 concerning NEI 07-09, the applicant has satisfactorily addressed all RAIs related to Section 11.5.

Table 11.2-1. Comparison of Cost-Benefit Ratios (\$ per Person-Rem)

Organ/Body	Application	NRC Staff's Analysis	10 CFR 50, Appendix I, Section II.D
Total Body	6,962	39,655	1,000
Thyroid	7,901	32,870	1,000

Table 11.2-2. Comparison of Important Modeling Assumptions

	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)	No	Yes
Surface Water Dilution Model	Partially mixed impoundment	Simple river dilution

Table 11.2-3. Modeling Parameter Values*

	Value	Basis
Annual radionuclide release (Ci/yr)	Multiple values	DCD Table 11.2-7
Effluent discharge rate (cfs)	13.4	Cooling tower blowdown requirement in DCD Section 11.2.3.3
Annual average river flow for the MEI doses (cfs)	2720	See text for derivation
Annual average river flow for population doses (cfs)	38,850	BLN COL FSAR Section 2.4.1.2.1
Transit time to MEI location (hr)	0.1	MEI assumed to be a short distance from the discharge
Transit time for population use (hr)	41	See text for derivation
Population drinking river water	326,308	BLN COL FSAR Table 11.2-202
Sport fishing harvest (kg/yr)	309,134	BLN COL FSAR Table 11.2-202
Commercial fishing harvest (kg/yr)	761,931	BLN COL FSAR Table 11.2-202
Swimming/Boating/Shoreline usage (person-hours per year)	22,814,630	BLN COL FSAR Table 11.2-202
Irrigation rate for the MEI garden and pastures (L/m ² /month)	21	See text for derivation
Growing season (days)	180	Assumed season duration included all of spring and summer

* 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*	NRC Staff's Analysis	10 CFR 50 Appendix I Section II.A
Liver	2.65 E-01**	1.22 E-01	10
Total Body	2.06 E-01**	8.34 E-02**	3
Thyroid	4.96 E-02	1.36 E-01**	10

* Taken from BLN COL FSAR Table 11.2-203

** Doses used for compliance to Appendix I, Section II.A

Table 11.2-5. Comparison of Population Doses (person-rem/yr)

	Application*	NRC Staff's Analysis
Total Body	1.58	0.281
Thyroid	1.41	0.339

* Taken from BLN COL FSAR Table 11.2-204

Table 11.2-6. Comparison of Maximum Individual Doses to 40 CFR 190 (mrem/yr)

	Application*	40 CFR 190
Total Body	1.25	25
Thyroid	18.6	75
Bone	4.69	25

* Taken from BLN COL FSAR Table 11.2-206

Table 11.3-1. Comparison of Cost-Benefit Ratios (\$ per Person-Rem)

Organ/Body	Application	NRC Staff's Analysis	10 CFR 50, Appendix I, Section II.D
Total Body	2,107	3,789	1,000
Thyroid	1,003	1,203	1,000

Table 11.3-2. Comparison of Receptor Locations

Receptor	Location	X/Q (sec/m³)	D/Q (m⁻²)
Plume • Application • NRC	Overall Max. Point, 1.74 miles, S Overall Max. Point, 1.74 miles, S	2.8 E-06 2.8 E-06	4.8 E-09 4.8 E-09
Deposition and Inhalation • Application • NRC	Max. Farm Field, 1.13 miles, SW Max. Residence, 1.19 miles, NNE	1.16 E-06 8.37 E-07	4.8 E-09 4.8 E-09
Vegetable Garden • Application • NRC	Max. Farm Field, 1.13 miles, SW Max. Farm Field, 1.13 miles, SW	1.16 E-06 1.16 E-06	4.8 E-09 4.8 E-09
Pasture for Livestock • Application • NRC	Max. Farm Field, 1.13 miles, SW Max. Pasture, 0.78 miles, NW	1.16 E-06 2.87 E-07	4.8 E-09 2.6 E-09

Table 11.3-3. Comparison of Maximum Annual Individual Doses

Description	Application*	NRC Staff's Analysis	10 CFR 50 Appendix I Section II.B and II.C
Noble Gases • Gamma Dose (mrad) • Beta Dose (mrad) • Total Body (mrem) • Skin (mrem)	0.265 1.39 0.158 0.957	0.263 1.39 0.157 0.0507	10 20 5 15
Radioiodines and Particulates • Maximum Organ (mrem)	9.11**	4.93**	15

* Taken from BLN COL FSAR Table 11.3-204

** Dose for the infant thyroid

Table 11.3-4. Comparison of Population Doses (person-rem/yr)

	Application*	NRC Staff's Analysis
Total Body	3.0	3.0
Thyroid	6.3	6.3

* Taken from BLN COL FSAR Table 11.3-205

Table 11.3-4. Comparison of Population Doses (person-rem/yr)

	Application*	NRC Staff's Analysis
Total Body	3.0	3.0
Thyroid	6.3	6.3

* Taken from BLN COL FSAR Table 11.3-205

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OFFICE	DNRL/NWE1/LA	DNRL/NWE1/PM	DCIP/CHPB	OGC	DNRL/NWE1/BC
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DATE	6/17/09	6/17/09	6/17/09	06/22/09	06/23/09

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