

## 11.0 RADIOACTIVE WASTE MANAGEMENT

The radioactive waste management systems (RWMS) 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. The systems are designed for normal operations, including anticipated operational occurrences (AOOs) (e.g., refueling outages, drywell purging, equipment downtime, maintenance).

### 11.1 Source Terms

Section 11.1, "Source Terms" of the North Anna 3 combined license (COL) application incorporates by reference, with no departures or supplements, Economic Simplified Boiling-Water Reactor (ESBWR) design control document (DCD) Revision 5, Section 11.1, "Source terms." The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the application including the corresponding sections in the referenced DCD. Specifically, the staff reviewed the sections of the DCD to ensure that the information contained therein is appropriate for incorporation by reference and that any supplemental information to be provided by the COL applicant has been addressed in the COL application. The NRC staff's review confirmed there is no outstanding information related to this subsection.

The staff is reviewing the information in DCD Section 11.1 on Docket No. 52-010. The results of the NRC staff's technical evaluation of the information related to source terms incorporated by reference in the North Anna 3 COL Final Safety Analysis Report (FSAR) will be documented in the staff's safety evaluation report (SER) on the design certification application for the ESBWR. The SER on the ESBWR 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 SER to reflect the final disposition of the design certification application.

### 11.2 Liquid Waste Management System

#### 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 a result of normal operations, including AOOs. The LWMS is designed to reduce and control radioactive releases into the environment. The LWMS is comprised of four types of major subsystems that are permanently installed equipment connected to other plant equipment, thus permitting liquid wastes from various plant systems to be segregated and processed separately. The major LWMS subsystems are:

- equipment (low conductivity) drain subsystem
- floor (high conductivity) drain subsystem
- chemical drain subsystem
- detergent drain subsystem

The LWMS processing subsystems rely on mixed bed demineralizers, charcoal filters and beds and cartridge filters, reverse osmosis, and organic and neutralization treatments. Cross-connections between subsystems provide additional flexibility in processing wastes that use alternate methods and provide redundancy if one subsystem is inoperative. The LWMS normally operates on a batch basis. The system provides for sampling at several process

points, administrative controls, and the detection and alarm of abnormal conditions against accidental discharges in the environment. The LWMS is located in the radwaste building. Airborne releases from LWMS components (e.g., tanks) and ventilation exhaust systems servicing radiologically controlled areas are conducted through the radwaste building stack.

### 11.2.2 Summary of Application

Section 11.2 of the North Anna 3 COL FSAR, Revision 1, incorporates by reference Section 11.2 of the ESBWR DCD Revision 5.

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

#### COL Items

- STD COL 11.2-1-A Implementation of Inspection and Enforcement (IE) Bulletin 80-10

The COL item addresses LWMS subsystems interfaces and connections that are considered nonradioactive, but could later become radioactive through improper interfaces with radioactive systems using the guidance and information in IE Bulletin 80-10.

- STD COL 11.2-2-A Implementation of 10 CFR 20.1406

The COL item addresses compliance with 10 CFR 20.1406 as it relates to the implementation of operational procedures for LWMS treatment subsystems.

#### Supplemental Information

- NAPS SUP 11.2-1 Implementation of Section II.D of Appendix I to 10 CFR Part 50 (Cost-Benefit Analysis)

The applicant includes a plant- and site-specific cost-benefit analysis to justify, in part, the performance of the LWMS subsystems in demonstrating compliance with the as low as reasonably achievable (ALARA) cost-benefit requirements in Section II.D of Appendix I to 10 CFR Part 50. The cost-benefit analysis is based on the guidance of Regulatory Guides (RGs) 1.109 and 1.110, with the results evaluated against the criteria of Section II.D of Appendix I to 10 CFR Part 50. The supplemental information presents a cost-benefit analysis demonstrating that any augmentation of the LWMS treatment subsystem is not cost beneficial.

North Anna 3 COL FSAR Sections 11.5 and 13.4 describes the milestones for the development and implementation of the offsite dose calculation manual (ODCM) to control and monitor all liquid effluent releases from the LWMS. FSAR Section 12.2 presents information on the estimated amounts of radioactivity in liquid effluent releases, effluent concentrations released into the environment, and associated doses to members of the public. FSAR Section 13.5 outlines the types of operational procedures used to operate the LWMS. FSAR Section 14.2 describes the initial test program, including pre-operational and startup tests for the LWMS. North Anna 3 COLA, Part 10: ITAAC presents the specific ITAAC for the LWMS.

### 11.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the Final Safety Evaluation Report (FSER) related to the DCD. The regulatory basis for acceptance of the supplementary information on LWMS is established in 10 CFR 20.1406, 10 CFR 50.34a, and Section D of Appendix I to 10 CFR Part 50, and regulatory guidance of RGs 1.109 and 1.110 and IE Bulletin 80-10. Full descriptions of the applicable regulatory and acceptance criteria, and related U.S. Nuclear Regulatory Commission (NRC) guidance, are provided in Standard Review Plan (SRP) Section 11.2 (NUREG-0800).

### 11.2.4 Technical Evaluation

The NRC staff reviewed Section 11.2 of the North Anna 3 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.<sup>1</sup> The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information related to the LWMS. The staff is reviewing Section 11.2 of the ESBWR DCD on Docket No. 52-010. The staff's technical evaluation of the information incorporated by reference relating to LWMS will be documented in the staff SER on the design certification application for the ESBWR design.

The staff reviewed the following information contained in the FSAR:

#### COL Items

- STD COL 11.2-1-A Implementation of IE Bulletin 80-10

The guidance from Bulletin 80-10 includes information on the identification and restriction of non-contaminated systems that have the potential of becoming contaminated. The applicant has addressed this COL information item in the COL application with STD COL 11.2-1-A. In FSAR Section 11.2.2.3, "Detailed System Component Description," the applicant proposes to use specific equipment connection configurations and plant sampling. Specifically, the use of double-check valves in each line where a non-radioactive system is connected to a radioactive or potentially radioactive system. A tell-tale connection is proposed for installation in each line to confirm the integrity of the line and check valves. FSAR, Revision 0, stated that to ensure that contamination has not occurred in permanently installed clean systems, sampling of these systems further upstream has been included in the plant sampling program.

FSAR Section 11.2.2.3 presents an updated description of some portions of the LWMS that sample the permanently installed non-radioactive plant system in upstream locations of radioactive systems, to avoid uncontrolled and unmonitored releases into the environment. A review of that information indicates that there is no specific information describing those sampling provisions or where samples would be collected to confirm that clean plant systems have not been cross-contaminated by radioactive process streams. This information would ensure that appropriate provisions are identified in the FSAR and are not likely to be omitted during the development of the sampling and analysis program for the North Anna 3 ODCM,

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<sup>1</sup> See Section 1.2.2, "Finality of Referenced NRC Approvals," 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.



person-rem (total body or thyroid) ALARA criterion in Section II.D of Appendix I to 10 CFR Part 50. The proposed augment would not further reduce collective doses below the FSAR estimates of 1.0 person-rem to the total body and 0.69 person-rem to the thyroid. Thus, the applicant concludes that the LWMS meets the ALARA requirement and no further system augments are necessary. The staff conducted an independent assessment of the applicant's cost-benefit analysis using the information presented in the response to this RAI, FSAR Section 12.2.2.4.2 about collective population doses, and guidance in RGs 1.110 and 1.109. The analysis confirmed the applicant's conclusions with cost-benefit ratios of \$11,385 per person-rem for the total body and \$16,264 per person rem for the thyroid. The analysis also confirmed that the cost-benefit ratios are above the \$1,000 per person-rem (total body or thyroid) ALARA criterion in Section II.D of Appendix I to 10 CFR Part 50 and that the LWMS augment would not further reduce collective doses below the FSAR estimates of 1.0 person-rem to the total body and 0.69 person-rem to the thyroid. The staff finds the response acceptable and this RAI is closed.

The staff's review and evaluation of compliance with liquid effluent concentration limits and dose limits for maximally exposed individuals are addressed in Section 12.2 of the North Anna 3 FSAR and Section 12.2 of this SER.

#### **11.2.5 Post Combined License Activities**

There are no post COL activities for 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 has addressed the required information relating to LWMS, and no outstanding information is expected to be addressed in the COL FSAR related to this subsection.

The staff is reviewing the information in DCD Section 11.2 on Docket No. 52-010. The results of the NRC staff's technical evaluation of the information related to LWMS incorporated by reference in the North Anna 3 COL FSAR will be documented in the staff SER on the DC application for the ESBWR. The SER on the ESBWR 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.

The staff also compared the additional COL information in the application to the relevant NRC regulations, acceptance criteria defined in NUREG-0800, Section 11.2, and NRC RGs.

The staff concluded that the LWMS (as a permanently installed system and in combination with other plant systems) includes the equipment necessary to control releases of radioactive materials in liquid effluents in accordance with the requirements in 10 CFR 50.34a. The staff thus concluded that the LWMS is acceptable and meets the requirements in 10 CFR 50.34a, Section II.D of Appendix I to 10 CFR Part 50, and regulatory guidance of RG 1.109 and 1.110 and IE Bulletin 80-10. This conclusion is based on the following:

1. Using site-specific conditions, the applicant has met the ALARA criterion required in Section II.D of Appendix I to 10 CFR Part 50. The staff considered the potential effectiveness of augmenting the LWMS using items of reasonably demonstrated technology. The staff determined that further effluent treatment is not expected to produce further reductions in collective population doses reasonably expected within an

80-kilometer (50-mile) radius of the reactor at a cost of less than \$1,000 per person-rem or person-thyroid-rem.

2. The staff's evaluation of the applicant's compliance with the requirements in 10 CFR 20.1406 and IE Bulletin 80-10, described in North Anna 3 FSAR Sections 11.2 and 12.6, are discussed in the corresponding sections of the SER.

### **11.3 Gaseous Waste Management System**

#### **11.3.1 Introduction**

The gaseous waste management system (GWMS) is designed to receive and process radioactive gases and hydrogen-bearing gases generated during process operation. There are two main sources of plant gaseous radioactive effluents. One source is from building ventilation systems servicing radiologically controlled areas, and the other source is from the power cycle off-gas system (OGS). The GWMS and its OGS are used to control, collect, process, hold for decay, and discharge gaseous radioactive wastes generated during normal operations, including AOOs. The OGS is located in the turbine building and the major components include preheaters; recombiners; cooler/condensers; dryers; activated charcoal beds (guard and delay); and associated valves, pumps, and instrumentation. The gases removed from the condenser are radioactive and must be treated before being released into the environment to ensure that radioactivity levels are reduced to acceptable levels and ALARA. The GWMS is designed to reduce and control radioactivity released into the environment. Releases from the OGS are conducted via the turbine building stack. Releases from building ventilation exhaust systems servicing radiologically controlled areas are conducted through their respective buildings, the reactor/fuel building stack, the turbine building stack, and the radwaste building stack.

#### **11.3.2 Summary of Application**

Section 11.3 of the North Anna 3 COL FSAR, Revision 1, incorporates by reference Section 11.3 of the ESBWR DCD Revision 5.

North Anna 3 COL FSAR Sections 11.5 and 13.4 describes the milestones for the development and implementation of the ODCM to control and monitor all gaseous effluent releases from the GWMS. FSAR Section 12.2 presents information on the estimated amounts of radioactivity in gaseous effluent releases, effluent concentrations released into the environment, and associated doses to maximally exposed individuals. FSAR Section 13.5 outlines the types of operational procedures used to operate the GWMS. FSAR Section 14.2 describes the initial test program, including pre-operational and startup tests for the GWMS. North Anna 3 COLA, Part 10: ITAAC presents the specific ITAAC for the GWMS. In addition, in FSAR Section 11.2, the applicant provided supplemental as follows:

- NAPS ESP COL 11.1-1                      NAPS-ESP Action Item No. 11.1-1, SER Section 11.1.4 - Implementation of Section II.D of Appendix I to 10 CFR Part 50 (Cost-Benefit Analysis)

A COL or CP applicant should verify that the calculated gaseous and liquid effluent concentrations and radiological doses to members of the public from radioactive gaseous and liquid effluents for any facility to be built on the North Anna site are bounded by the radiological doses and gaseous and liquid effluent concentrations included in the ESP application and

reviewed by the NRC. The COL applicant should also include in the radwaste (gaseous and liquid effluents) system all items of reasonably demonstrated technology that effect reductions in population dose to maintain doses as low as reasonably achievable (ALARA) in accordance with Appendix I, Section II.D, to 10 CFR Part 50.

### 11.3.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the Final Safety Evaluation Report (FSER) related to the DCD. The regulatory basis for acceptance of the supplementary information on GWMS is established in 10 CFR 50.34a and Section II.D of Appendix I to 10 CFR Part 50, and regulatory guidance of RGs 1.109 and 1.110. Full descriptions of the applicable regulatory and acceptance criteria, and related NRC guidance, are provided in SRP Section 11.3 (NUREG-0800).

### 11.3.4 Technical Evaluation

The NRC staff reviewed Section 11.3 of the North Anna 3 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. The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information related to the GWMS. The staff is reviewing Section 11.3 of the ESBWR DCD on Docket No. 52-010. The staff's technical evaluation of the information incorporated by reference relating to GWMS will be documented in the staff SER on the design certification application for the ESBWR design.

The staff reviewed the following information contained in the FSAR:

#### Supplemental Information

- NAPS ESP COL 11.1-1                      NAPS-ESP Action Item No. 11.1-1, SER Section 11.1.4 - Implementation of Section II.D of Appendix I to 10 CFR Part 50 (Cost-Benefit Analysis)

The applicant includes a plant- and site-specific cost-benefit analysis to justify, in part, the GWMS design. The cost-benefit analysis is based on the guidance in RG 1.110 and 1.109, with the results demonstrating compliance with ALARA cost-benefit requirements in Section II.D of Appendix I to 10 CFR Part 50. The completed analyses assessed the merits of installing (a) enhanced charcoal/high-efficiency particulate air (HEPA) combined filtration units and stand alone HEPA filtration systems for the turbine building and the reactor and fuel building; (b) a 3-ton charcoal adsorber unit for the OGS, (c) a main condenser vacuum pump charcoal/HEPA filtration system, (d) a 17 m<sup>3</sup> (600 ft<sup>3</sup>) gas decay tank for the OGS, and (e) a 1,000 cubic-feet per minute (CFM) (28.3 m<sup>3</sup> per minute) charcoal/HEPA filtration system. The applicant concludes that not one of these system improvements is cost beneficial in reducing annual doses to the thyroid. Also, some of the system upgrades are not compatible with the OGS designs and building radioactive ventilation exhaust systems. As a result, these initially considered system augmentations are not being proposed for implementation.

In its analysis, the applicant referenced draft NEI Template 07-11 as the basis of the cost-benefit analysis in Revision 0 of the FSAR. However, NEI has since withdrawn the template from further consideration and, as a result, the applicant needs to develop a plant- and site-specific cost-benefit analysis that demonstrates compliance with Section II.D of Appendix I to 10 CFR Part 50. Accordingly, RAI 11.03-0 requested the applicant to provide an updated plant-

and site-specific cost-benefit analysis in FSAR Section 11.3.1 for the GWMS. This RAI also requested the applicant to provide sufficient information for the staff to evaluate the bases and assumptions used in the analysis and to conduct an independent confirmation of compliance with NRC regulations and guidance. The applicant initially responded with additional information and a proposed revision to FSAR Section 11.3.1.

The applicant's analysis in FSAR Sections 11.3.1 and 12.2.2.2 showed that annual collective population doses from gaseous effluent releases are an estimated 6 person-rem to the total body and 39.3 person-rem to the thyroid. These estimates are based on the GWMS described in the ESBWR DCD. Because the estimated collective thyroid dose was higher than the interim NEI guidance of 6.32 person-rem, the applicant provided additional analyses evaluating the merits of other system augmentations to reduce collective doses to the thyroid using the guidance in RG 1.109. The revised cost-benefit analysis used the guidance in RG 1.110 to consider a 1,000 CFM charcoal/HEPA filtration system, a 3-ton charcoal adsorber, and a main condenser vacuum pump charcoal/HEPA filtration system. The analysis excluded three systems from RG 1.110 because of incompatibility with the ESBWR design. These systems include a 15,000 CFM HEPA filtration system for the reactor and turbine buildings, a 3-ton charcoal adsorber, a main condenser vacuum pump and charcoal/HEPA filtration unit, a 600 ft<sup>3</sup> gas decay tank, and a 1,000 CFM charcoal/HEPA filtration system for the reactor and turbine buildings. Two other types of treatment systems that are listed in FSAR Revision 0, Section 11.3.1 were excluded because they are for pressurized-water reactors (PWRs), which are not compatible with boiling-water reactor (BWR) plant design features. The analysis updates the annual collective population doses from gaseous effluent releases to 7.7 person-rem for the total body and 28 person-rem for the thyroid. Assuming that the lowest cost-option—a 1,000 CFM charcoal/HEPA filtration system—would remove all remaining radioactivity in gaseous effluents after treatment, the resulting estimated annual cost is \$7,960, with a cost-benefit ratio of \$1,034 per person-rem and a total body and thyroid dose of 7.96 person-rem. In a comparison of collective dose results for the total body, the applicant concluded that the ALARA criterion in Section II.D of Appendix I to 10 CFR Part 50 was met because the proposed augment would not further reduce collective doses below the FSAR estimates of 7.7 person-rem to the total body. Also, the resulting cost-benefit ratio of \$1,034 is above the \$1,000 per person-rem (total body or thyroid) ALARA criterion in Section II.D of Appendix I to 10 CFR Part 50.

The staff conducted an independent assessment of the applicant's cost-benefit analysis using information the applicant presented in response to this RAI (11.03-0), to FSAR Section 12.2.2.2, and to the guidance in RG 1.109. This assessment confirmed the applicant's conclusions of a \$1,034 per person-rem cost-benefit ratio for the total body. The staff analysis confirms that the cost-benefit ratio is above the \$1,000 per person-rem (total body) ALARA criterion in Section II.D of Appendix I to 10 CFR Part 50 and that the GWMS augment would not further reduce collective doses below the FSAR's estimates of 7.7 person-rem to the total body. In light of these results, the applicant focused the balance of the cost-benefit analysis on evaluating GWMS augments to reduce exposure doses to the thyroid. Using the guidance in RG 1.110, the applicant applied a total annual threshold cost of \$28,000, given a collective dose of 28 person-rem to the thyroid and a \$1,000 per person-rem (total body or thyroid) ALARA criterion in Section II.D of Appendix I to 10 CFR Part 50.

For the 3-ton charcoal adsorber augment, the applicant estimated an annual cost of \$9,450 and a corresponding cost-benefit ratio of \$35,000 per person-rem to the thyroid, given that this augment would provide some reduction only for the OGS (4 percent of the release of radioactivity) and contributing to about 24 percent of the dose to the thyroid. The staff conducted an independent assessment of the applicant's cost-benefit analysis using the

information presented in the response to this RAI, FSAR Section 12.2.2.2, and guidance in RG 1.110. The staff's analysis confirmed the applicant's conclusions with a cost-benefit ratio of about \$33,750 per person-rem for the thyroid. The slight difference between the staff and applicant results is associated with the rounded off FSAR values that the staff used. The staff analysis confirmed that the cost-benefit ratio is above the \$1,000 per person-rem (total body or thyroid) ALARA criterion in Section II.D of Appendix I to 10 CFR Part 50. The staff also confirmed that the GWMS augment would not further reduce collective doses below the FSAR estimates of 28 person-rem to the thyroid.

For the main condenser vacuum pump and charcoal/HEPA filtration augment, the applicant estimated an annual cost of \$8,170 and a corresponding cost-benefit ratio of \$58,000 per person-rem to the thyroid, given that this augment would provide some reduction only for the main condenser system (0.7 percent of the release of radioactivity) contributing to about 73 percent of the dose to the thyroid. The staff conducted an independent assessment of the applicant's cost-benefit analysis using the information the applicant presented in the response to this RAI, in FSAR Section 12.2.2.2, and the guidance in RG 1.110. The staff confirmed the applicant's conclusions with a cost-benefit ratio of about \$58,350 per person-rem for the thyroid. This ratio is above the \$1,000 per person-rem (total body or thyroid) ALARA criterion in Section II.D of Appendix I to 10 CFR Part 50, thus confirming that the GWMS augment would not further reduce collective doses below the FSAR estimates of 28 person-rem to the thyroid.

Although the staff's evaluation generally concurred with the resulting cost-benefit ratios of the three system augments considered, the review identified four items that require further technical and regulatory clarifications. Briefly, supplemental RAI 11.3-02 requested the applicant to (a) provide the rationale for not following the format in Appendix C to RG 1.110 in presenting cost information on GWMS augments; (b) remove information on GWMS augment systems not applicable to BWR designs; (c) reconsider the basis of the cost benefit analysis that relies on noble gas activity rather than exclusion on the basis of radionuclide half-lives; and (d) expand the discussion on the rationale for excluding system augments on the basis of design capacity or flow rates. The applicant responded with additional information and proposed revisions to the corresponding subsections in the FSAR. The revision provides a clarification by noting that the analyses are based on RG 1.110 without exceptions as to the use of cost parameters and, as a result, there is no need to repeat the cost information from RG 1.110 in the FSAR. The proposed revision removes any references to plant systems not applicable to BWR design characteristics and justifies excluding short-lived noble gases from the analysis based on a cost-benefit ratio. The proposed revision also notes that system augments with greater capacities were considered and subsequently eliminated based on cost considerations. The staff finds these responses acceptable and RAI 11.03-0 and 11.03-02 are closed.

A review of FSAR Revision 0, Section 11.3.1 indicates that the operation of the GWMS does not address a provision that allows for a full bypass of the OGS charcoal adsorber beds, as described in ESBWR DCD Tier 2, Revision 5, Section 11.3.2.5.10. The ESBWR DCD OGS design is capable of bypassing all charcoal adsorber beds under two conditions: when "fuel performance allows" and when "resulting activity release is acceptable." FSAR Revision 0, Section 11.3.1 does not acknowledge this provision of the ESBWR design and does not identify methods (e.g., operating procedures or OGS permissive interlocks) to control an inadvertent bypass of all charcoal beds. This mode of operation could result in gaseous effluent releases that exceed NRC regulatory limits. The implementation of such a design feature should be evaluated against the requirements in Parts 50.34a and 50.36a in complying with offsite gaseous effluent concentration limits of Appendix B (Table 2, Column 1) to 10 CFR Part 20 and design guides in Section II of Appendix I to 10 CFR Part 50. Accordingly, RAI 11.03-1

requested the applicant to include (a) a description of operational plant conditions and criteria on allowable fuel performance and radioactivity releases (as noble gases, iodines, and particulates) that would allow a full bypass of the OGS charcoal adsorber beds, (b) operational controls that would activate this feature, and (c) a description of procedures and/or system interlocks that would prevent the inadvertent activation of the OGS charcoal adsorber bed bypass. The applicant's response, noted that OGS interlocks and operator permissive command functions are included in the design to prevent radioactive releases that would exceed offsite gaseous effluent concentration limits in Appendix B (Table 2, Column 1) to 10 CFR Part 20, and design guides in Section II of Appendix I to 10 CFR Part 50. This response does not necessitate a revision of FSAR Section 11.3, given the descriptions of the OGS operational features in ESBWR DCD Sections 11.3.2.5.10 and 11.3.7.1. The staff finds the response acceptable because measures beyond those described above are expected to be applied using the plant-specific ODCM to control and monitor gaseous effluent releases and minimize doses to members of the public. The requirements for the development and implementation of the ODCM are described in SER Section 11.5. This RAI is closed.

### **11.3.5 Post Combined License Activities**

There are no post COL activities for 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 has addressed the required information relating to GWMS, and no outstanding information is expected to be addressed in the COL FSAR related to this subsection.

The staff is reviewing the information in DCD Section 11.3 on Docket No. 52-010. The results of the NRC staff's technical evaluation of the information related to GWMS incorporated by reference in the North Anna 3 COL FSAR will be documented in the staff SER on the DC application for the ESBWR. The SER on the ESBWR 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.

The staff also compared the additional COL information in the application to the relevant NRC regulations, acceptance criteria defined in NUREG-0800, Section 11.3, and NRC RGs

The staff concluded that the GWMS (as a permanently installed system and in combination with other plant systems) includes the equipment necessary to control releases of radioactive materials in gaseous effluents in accordance with the requirements in 10 CFR 50.34a. The staff thus concluded that the GWMS is acceptable and meets the requirements in 10 CFR 50.34a and Section II.D of Appendix I to 10 CFR Part 50, and regulatory guidance of RGs 1.109 and 1.110. This conclusion is based on the following:

1. The applicant has met the requirements of Section II.D of Appendix I to 10 CFR Part 50 with respect to meeting the ALARA criterion using site-specific conditions. The staff has considered the potential effectiveness of augmenting the GWMS using items of reasonably demonstrated technology and has determined that further effluent treatment is not expected to effect reductions in cumulative population doses that were reasonably expected within an 80-kilometer (50-mile) radius of the reactor at a cost of less than \$1,000 per person-rem or person-thyroid-rem.

## **11.4 Solid Waste Management System**

### **11.4.1 Introduction**

Radioactive wastes will be generated during normal operation and AOOs. The solid waste management system (SWMS) is located in the radwaste building and is designed to collect, process, control, package, and temporarily store wet and dry solid radioactive wastes before shipment. The SWMS processes wastes from the LWMS, reactor water cleanup/shutdown cooling system, fuel and auxiliary pools cooling system, and condensate purification system. The SWMS is comprised of the following major subsystems:

- SWMS collection subsystem
- SWMS processing subsystem
- dry solid waste accumulation and conditioning subsystem
- container storage subsystem

The SWMS collection subsystem consists of high and low activity resin holdup tanks, phase separators, condensate resin holdup tank, decant pumps, sampling points, control panels, instrumentation, vents and drains, and high and low activity transfer pumps. There are no provisions to release liquid and gaseous wastes directly from the SWMS system into the environment. All liquid effluent releases are conducted through the LWMS for process liquids generated during the operation of the SWMS. Airborne releases from SWMS components (e.g., tanks and vessels), and ventilation exhaust systems servicing radiologically controlled areas—where process equipment are located—are monitored and discharged through the radwaste building stack.

The container storage subsystem and the dry solid waste accumulation and conditioning subsystems are conceptual descriptions of methods of how solid wastes and packaged solid wastes would be handled and processed by the COL holder. Therefore, the process is described without the inclusion of detailed equipment and system flow diagrams. In ESBWR DCD Tier 2, Revision 5, Figures 11.4-1 and 11.4-4 provide overviews of the processes that would be used to handle dry solid and wet wastes. The actual processes are expected to be developed by the COL holder under operational programs and procedures. The operational program and procedures consider regulatory requirements of the NRC, Department of Transportation (DOT), and State and local agencies for the processing, storage, packaging, shipment, radiological monitoring, and disposal of radioactive wastes.

### **11.4.2 Summary of Application**

Section 11.4 of the North Anna 3 COL FSAR, Revision 1, incorporates by reference Section 11.4 of the ESBWR, DCD, Revision 5.

North Anna 3 COL FSAR Section 11.4 describes the development and implementation of a plant-specific process control program (PCP) for operating procedures and technical specifications on the classification, treatment, and disposal of radioactive wastes processed by the SWMS. The applicant endorses by reference NEI Template 07-10 for the development of the PCP in meeting the requirements of Generic Letter (GL) 89-01. The implementation milestone for the development of the PC is described in FSAR Section 13.4. FSAR Section 11.5 describes the process to control and monitor all liquid and gaseous effluent releases associated with the processing of radioactive wastes. FSAR Section 12.2 presents information on the estimated amounts of radioactivity in liquid and gaseous effluent releases, effluent

concentrations released into the environment, and associated doses to members of the public. FSAR Section 13.5 outlines the types of operational procedures that would be used to operate the SWMS. FSAR Section 14.2 describes the initial test program, including pre-operational and startup tests for the SWMS. North Anna 3 COLA, Part 10: ITAAC presents the specific ITAAC for the SWMS.

In addition, in FSAR Section 11.4, the applicant provided supplemental information as follows:

COL items

- STD COL 11.4-1-A SWMS Processing Subsystem Regulatory Guide Compliance

The COL item addresses the compliance of the SWMS subsystems with the guidance in RG 1.143, Revision 2, and RG 8.8 for testing and operating all SWMS subsystems.

- STD COL 11.4-2-A Compliance with IE Bulletin 80-10

The COL item addresses the evaluation of the SWMS subsystems against the guidance and information in IE Bulletin 80-10 in identifying and rectifying connections to systems that are considered nonradioactive but that could become radioactive through improper interfaces with radioactive systems (i.e., a non-radioactive system that could become contaminated due to leakage, valving errors, or other operating conditions in radioactive systems).

- STD COL 11.4-3-A Process Control Program

The COL item addresses the development of a PCP, with its implementation milestones described in FSAR Section 13.4.

STD COL 11.4-4-A Temporary Storage Facility

The COL item addresses the use of a temporary storage facility and an overall site management plan for radioactive wastes using the guidance in Section 11.4 of the SRP (NUREG-0800, March 2007).

- STD COL 11.4-5-A Compliance with 10 CFR 20.1406

The COL item addresses site-specific information describing the implementation of operating programs and procedures that implement the requirements in 10 CFR 20.1406 and RG 4.21 in minimizing the contamination of plant facilities and environment, facilitate decommissioning, and minimize the generation of radioactive wastes.

Supplemental Information

- STD SUP 11.4-1 Implementation of Section II.D of Appendix I to 10 CFR Part 50 (Cost-Benefit Analysis)

FSAR, Revision 1, Section 11.4.1 states that the associated cost-benefit analysis for the SWMS is included in the cost-benefit analyses presented in FSAR Sections 11.2.1 and 11.3.1 for

processing and treating liquid and gaseous effluents, as by-products of the operation of the SWMS.

### 11.4.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the Final Safety Evaluation Report (FSER) related to the DCD. The regulatory basis for acceptance of the supplementary information on SWMS is established in 10 CFR 20.1406, 10 CFR 50.34a, Appendix I to 10 CFR Part 50, Section II.D, 10 CFR Part 61; and regulatory guidance of RG 8.8, 1.109, 1.143, and IE Bulletin 80-10. Full descriptions of the applicable regulatory and acceptance criteria, and related NRC guidance, are provided in SRP Section 11.4 (NUREG-0800).

### 11.4.4 Technical Evaluation

The NRC staff reviewed Section 11.4 of the North Anna 3 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. The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information related to the SWMS. The staff is reviewing Section 11.4 of the ESBWR DCD on Docket No. 52-010. The staff's technical evaluation of the information incorporated by reference relating to SWMS will be documented in the staff SER on the design

The staff reviewed the following information contained in the FSAR:

#### COL Items

- STD COL 11.4-1-A SWMS Processing Subsystem Regulatory Guide Compliance

The COL item addresses the compliance of the SWMS subsystems with the guidance in RG 1.143, Revision 2, and RG 8.8 for the testing and operation of all SWMS subsystems. The applicant addressed this information item in STD COL 11.4-1-A. The applicant notes that SWMS subsystems used to process wet solid radioactive wastes are tested using a process that complies with RG 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants." The staff finds that the information provided by the applicant is acceptable. Therefore, COL Item 11.4.-1-A has been satisfied. The evaluation of the compliance with RG 8.8 is addressed in Section 12.1 of the SER.

- STD COL 11.4-2-A Compliance with IE Bulletin 80-10

The COL item addresses the evaluation of the SWMS subsystems against the guidance and information in IE Bulletin 80-10. The purpose is to identify and rectify connections to systems that are considered nonradioactive but that could become radioactive through improper interfaces with radioactive systems (i.e., a non-radioactive system that could become contaminated due to leakage, valving errors, or other operating conditions in radioactive systems). Bulletin 80-10 includes information on identifying and restricting non-contaminated systems that could become contaminated.

The applicant has addressed this COL information item in the COL application with STD COL 11.4-2-A. FSAR Section 11.4.2.3, "Detailed System Component Description," presents an

updated description of some portions of the SWMS on sampling permanently installed non-radioactive plant system in upstream locations of radioactive systems. These provisions are intended to avoid uncontrolled and unmonitored releases into the environment. Specifically, the applicant proposes using double-check valves in each line where a non-radioactive system is connected to a radioactive or potentially radioactive system. These valves are expected to service subsystems connected to non-radioactive portable systems. The installation of tell-tale connection in each line is expected to confirm the integrity of the line and check valves. FSAR, Revision 0, stated that to ensure that contamination has not occurred in permanently installed clean systems, sampling these systems further upstream is included in the plant sampling program.

A review of the above information indicates that there is no FSAR specific description of those sampling provisions, or where samples would be collected, to confirm that clean plant systems have not been cross-contaminated by radioactive process streams. Accordingly, the applicant was requested under RAI 11.04-2 to update FSAR Section 11.4.2.3 with specific references to ESBWR DCD and/or other FSAR sections where this information is provided, or to supplement the appropriate FSAR sections with additional details. The purpose of this RAI is to ensure that these provisions are identified in the FSAR and are not likely to be omitted during the development of the sampling and analysis program for the North Anna 3 ODCM, and for confirming compliance with liquid effluent concentration limits in Table 2 (Column 2) in Appendix B to 10 CFR Part 20 and design objectives of Appendix I to 10 CFR Part 50. The applicant responded with a proposed revision to FSAR Section 11.4.2.3.5. The revised section identifies plant-specific procedures and notes that the ODCM would address potential conditions where normally non-radioactive systems might become contaminated. The staff finds that these design features and operational program demonstrating compliance with IE Bulletin 80-10. The staff therefore finds the response acceptable, and this RAI is closed.

- STD COL 11.4-3-A Process Control Program

The COL item addresses the implementation of a plant-specific PCP using operating procedures and technical specifications, as they relate to the classification, treatment, and disposal of radioactive wastes processed by the SWMS in accordance with NRC, DOT and State and local agency regulatory requirements. The applicant includes, by reference, NEI Template 07-10 as the basis for the PCP. The NEI template presents the functional elements of a PCP, which, if met, would demonstrate compliance with Part 50.34a and 50.36a. The template describes technical and regulatory considerations used to process solid, wet, and liquid wastes with selected waste processing technologies and methods. The PCP identifies surveillance requirements that are consistent with the plant's technical specifications, administrative procedures, operational procedures, quality assurance and quality control program, radiological controls and monitoring program, information to be contained in annual radiological effluent release reports, reporting requirements to the NRC, instructions on using the NRC uniform radioactive shipping waste manifest, and the process for initiating and documenting changes to the North Anna 3 PCP and its supporting procedures. The basis for acceptance in the staff's review is conformance of the applicant's endorsement of the DCD SWMS design and proposed North Anna 3 PCP. The milestones for the development and implementation of the PCP are addressed in FSAR, Revision 1, Section 13.4 of the North Anna 3 COL. NRC staff finds that this item is satisfactorily addressed in FSAR Section 13.4, Table 13.4-201 (item 9), which lists the milestones for the development and implementation of the PCP before fuel load, with the requirement identified as a license condition. The applicant was requested, under RAI 11.04-1B, to update this milestone in FSAR Section 11.4.2.3, STD COL 11.4-3-A by referencing NEI PCP Template 07-10 in applicable FSAR subsections and

references. The applicant responded with a proposed revision to STD COL 11.4-3-A once NEI PCP Template 07-10 has been issued. NEI PCP Template 07-10A (Revision 0, March 2009) has been reviewed and found acceptable by the staff. The results of the staff's evaluation are presented in ML082910077 and the NEI PCP Template 07-10A is presented in ML091460236. The staff finds the response acceptable, and this **RAI is Confirmatory Item 11.04-1B** until the applicant updates the reference to the final PCP.

- STD COL 11.4-4-A Temporary Storage Facility

The COL item addresses temporary low-level waste storage facilities used to support plant operations. The corresponding ESBWR DCD Tier 2, Revision 5 COL item states that it is the responsibility of the COL applicant to consider the development of an overall site management plan for the storage of radioactive waste using the guidance in Section 11.4 of the SRP (NUREG-0800, March 2007). Accordingly, the applicant was requested, under RAI 11.04-3, to describe the facilities and operational program addressing the long-term management and storage of radioactive wastes generated during the operation of North Anna 3, given that the ESBWR DCD design provides a storage capacity for six months. **This is being tracked as Open Item 11.04-3**, pending a response from the applicant.

- STD COL 11.4-5-A Compliance with 10 CFR 20.1406

The COL applicant has addressed compliance with the requirements of 10 CFR 20.1406 in STD COL 11.4-5A, which discusses how ESBWR design features and procedures for operation are expected to minimize the contamination of the facility and the environment, facilitate decommissioning, and minimize the generation of radioactive wastes in compliance with 10 CFR 20.1406. In FSAR Section 12.6, "Minimization of Contamination and Radwaste Generation," the applicant provides information on design features as well as information on measures used in operating procedures to minimize contamination and ensure compliance with 10 CFR 20.1406. The staff's evaluation of this information is provided in Section 12.3.4 of this SER.

#### Supplemental Information

- STD SUP 11.4-1 Implementation of Section II.D of Appendix I to 10 CFR Part 50 (cost-benefit analysis)

A review of FSAR, Revision 0, Section 11.4.1 indicates that it does not present a cost-benefit analysis for the SWMS, nor references the cost-benefit analyses presented in FSAR Sections 11.2.1 and 11.3.1, on the processing and treating liquid and gaseous effluents as by-products of the management of solid and wet wastes. This section of the FSAR should provide a justification for not including the cost-benefit analysis or should describe how the related analyses presented for the LWMS and GWMS encompass the incremental amounts of liquid and gaseous effluents generated as by-products of solid waste processing. Accordingly, the applicant was requested, under RAI 11.04-1A, to revise FSAR Section 11.4.1 to include a cost-benefit analysis for the SWMS or provide the technical justification as to why the results presented in FSAR, Revision 0, Sections 11.2 and 11.3 are adequately encompassing and in compliance with Section II.D of Appendix I to 10 CFR Part 50 and NRC guidance. The applicant responded with a proposed revision to the FSAR by adding a new supplement (STD SUP 11.4-1) stating that the cost-benefit analyses presented in FSAR Revision 1, Sections 11.2.1 and 11.3.1 include the incremental amounts of liquid and gaseous wastes that would be produced during the operation of the SWMS. As result, no other SWMS design augmentations

are necessary to handle the incremental amounts of liquid and gaseous wastes. The staff finds the response acceptable since the cost-benefit analyses presented in FSAR Sections 11.2 and 11.3 consider routinely expected sources of radioactivity discharged via the three plant stacks. For example, releases from the radwaste building ventilation exhaust systems servicing radiologically controlled areas, where SWMS components are located and venting of SWMS tanks and vessels, are conducted through the radwaste building stack. As a result, all releases from the SWMS are monitored and controlled at the release point, with all releases controlled through the implementation of the ODCM. This RAI is closed.

A review of North Anna Unit 3 FSAR, Revision 1, Section 11.4.1, indicates that the development of operating procedures refers to the "mobile/portable SWMS." ESBWR DCD Revision 5, Sections 11.4.1 and 11.4.2 no longer refer to the use of portable and mobile SWMS. Accordingly, the applicant was requested, under RAI 11.04-4, to revise the description of the type of SWMS in FSAR Section 11.4.1 and to make the description consistent with FSAR Revision 1, Section 11.4, and ESBWR DCD, Revision 5, Sections 11.4.1 and 11.4.2. The applicant proposes to revise FSAR Revision 1, Section 11.4.1 by deleting the reference to the mobile/portable SWMS and apply instead the nomenclature of Chapter 11.4.1 of the ESBWR DCD. The staff finds the response acceptable. **This RAI is now Confirmatory Item 11.04-4.**

#### **11.4.5 Post Combined License Activities**

There are no post COL activities for this section.

#### **11.4.6 Conclusion**

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant has addressed the required information relating to SWMS, and no outstanding information is expected to be addressed in the COL FSAR related to this subsection.

The staff is reviewing the information in DCD Section 11.4 on Docket No. 52-010. The results of the NRC staff's technical evaluation of the information related to SWMS incorporated by reference in the North Anna 3 COL FSAR will be documented in the staff SER on the DC application for the ESBWR. The SER on the ESBWR 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.

In addition, the staff compared the additional COL information in the application to the relevant NRC regulations, acceptance criteria defined in NUREG-0800 Section 11.4, NRC and RGs.

Upon the satisfactory closure of all open and confirmatory items, the staff concludes that the SWMS (either as a permanently installed system and in combination with other plant systems) includes the equipment necessary to process liquid, wet, and dry solid wastes, describes an operational program to manage radioactive wastes, and includes provisions to control releases of radioactive materials associated with the operation of the SWMS. The SWMS and PCP are found to be acceptable and meet the requirements of 10 CFR 50.34a; Appendix I, Section II.D; to 10 CFR Part 61; and regulatory guidance of RGs 8.8, 1.109, 1.143, and IE Bulletin 80-10. This conclusion is based on the following:

1. The applicant has fulfilled the requirements of Section II.D of Appendix I to 10 CFR Part 50 with respect to meeting the ALARA criterion for the SWMS, given that all associated effluent releases are expected to be managed through the operation of the

LWMS and GWMS. The staff has considered the potential effectiveness of augmenting the LWMS and GWMS using items of reasonably demonstrated technology and has determined that further waste treatment is not expected to effect reductions in cumulative population doses reasonably expected within an 80-kilometer (50-mile) radius of the reactor at a cost of less than \$1,000 per person-rem or person-thyroid-rem.

2. The staff's evaluation of the applicant's compliance with the requirements in 10 CFR 20.1406 and IE Bulletin 80-10 is discussed in Section 12.6 of the SER.
3. The applicant's proposed PCP for North Anna 3, as it relates to classifying, processing, and disposal of radioactive wastes, meets the requirements of 10 CFR Part 61. The staff concludes that the endorsement of NEI PCP Template 07-10A (Revision 0) and SWMS supplemental information contained in FSAR Section 11.4 are consistent with the requirements of GL 89-01.

## **11.5 Process Radiation Monitoring System**

### **11.5.1 Introduction**

The process radiation monitoring system (PRMS) is used to monitor liquid and gaseous process streams and effluents from the LWMS, GWMS, and SWMS during normal operation and anticipated operational occurrences and under post-accident conditions. Another objective is to alert control room operators of abnormal levels of radioactivity in process streams and liquid and gaseous effluents, and to provide signals that initiate automatic safety functions, isolate process streams, and terminate effluent discharges if predetermined radioactivity levels or release rates exceed established alarm set-points. The PRMS generates signals to initiate the operation of certain safety-related equipment to control radioactive releases under normal operation, AOOs, and accident conditions. Another function of the PRMS is to provide the means to collect samples from process and effluent streams for radiological analyses that assess compliance with NRC regulations.

The PRMS consists of skid-mounted and permanently installed sampling and monitoring equipment designed to indicate operational radiation levels and releases of radioactive materials, equipment or component failures, and system malfunctions or improper operation. The PRMS system includes beta and gamma radiation-sensitive detectors working in redundant channels. The radiation detectors are capable of detecting the types and energies of radiation emitted from the fuel, radioactive activation and corrosion products, radioactive wastes, and radioactive materials present in process and effluent streams. Local readout and alarm modules are located at specific areas to provide information on the radiological status of plant systems and to alert personnel of plant conditions beyond established parameters, AOOs, or accident conditions.

### **11.5.2 Summary of Application**

Section 11.5 of the North Anna 3 COL FSAR, Revision 1, incorporates by reference Section 11.5 of the ESBWR DCD, Revision 5.

In addition, in FSAR Section 11.5, the applicant provided supplemental information as follows:

The applicant endorses by reference NEI Template 07-09 for the development of a plant-specific ODCM in meeting the requirements of GL 89-01. The ODCM is used to control and

monitor all liquid and gaseous effluent releases, and implement an environmental sampling and monitoring program. North Anna 3 COL FSAR Section 13.4 describes the milestones for the development and implementation of the ODCM. FSAR Section 12.2 presents information on the estimated amounts of radioactivity in liquid and gaseous effluent releases, effluent concentrations released into the environment, and associated doses to members of the public. FSAR Section 13.5 outlines the types of operational procedures used to operate the PRMS. FSAR Section 14.2 describes the initial test program, including pre-operational and startup tests for the PRMS. North Anna 3 COLA, Part 10: ITAAC presents the specific ITAAC for the PRMS.

### COL Items

- STD COL 11.5-1-A                      Sensitivity or Subsystem Lower Limit of Detection

The COL item addresses the derivation of lower limits of detection or detection sensitivity levels for each effluent PRMS subsystem, following the requirements of the ODCM for North Anna 3.

- STD COL 11.5-2-A                      Offsite Dose Calculation Manual (ODCM)

The COL item addresses the development of a plant- and site-specific ODCM for calculating offsite doses resulting from liquid and gaseous effluents. The milestones for the development and implementation of the ODCM are addressed under a license condition in FSAR, Section 13.4 of the North Anna 3 COL.

- STD COL 11.5-3-A                      Process and Effluent Monitoring and Sampling Program

The COL item addresses the implementation of a site-specific monitoring and sampling program as described in the ODCM for North Anna 3.

- STD COL 11.5-4-A                      Site-Specific Offsite Dose Calculation

The COL item addresses compliance with the design objectives of Appendix I to 10 CFR Part 50 in controlling doses to a hypothetical maximally exposed member of the public and populations living near North Anna 3.

- STD COL 11.5-5-A                      Instrumentation Sensitivities

The COL item addresses the derivation of instrumentation detection sensitivity levels and bases for sampling all expected liquid and gaseous effluent release points described in the ODCM for North Anna 3.

### **11.5.3 Regulatory Basis**

The regulatory basis of the information incorporated by reference is addressed in the FSER related to the DCD. The regulatory basis for acceptance of the supplementary information for the PRMS is established in 10 CFR 20.1301 and 20.1302; 10 CFR 50.34a and 50.36a; Appendix I to 10 CFR Part 50; and GL 89-01. Full descriptions of the applicable regulatory and acceptance criteria, and related NRC guidance, are provided in SRP Section 11.5 (NUREG-0800).

#### 11.5.4 Technical Evaluation

The NRC staff reviewed Section 11.5 of the North Anna 3 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. The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information related to the PRMS. The staff is reviewing Section 11.5 of the ESBWR DCD on Docket No. 52-010. The staff's technical evaluation of the information incorporated by reference relating to PRMS will be documented in the staff SER on the design certification application for the ESBWR design.

In Section 11.5 of the ESBWR DCD Tier 2, Revision 4, the applicant replaced DCD Tier 2, Table 11.5-5, which described the provisions in sampling process and effluent streams, with North Anna 3 COL FSAR, Revision 0, Table 11.5-201. The revision is associated with information item STD COL 11.5-3-A. The staff's review of FSAR Table 11.5-201 has identified specific RAIs on the information and sampling provisions identified in the FSAR.

The staff reviewed the following information contained in the FSAR:

##### COL Items

- STD COL 11.5-1-A                      Sensitivity or Subsystem Lower Limit of Detection

The COL item addresses the derivation of lower limits of detection for each effluent PRMS subsystem, following the requirements of the ODCM for North Anna 3. The applicant outlines, given the endorsement of NEI ODCM Template 07-09, methods used to derive the lower limits of detection for PRMS subsystems in monitoring and controlling liquid and gaseous effluent releases. The milestones for the development and implementation of the ODCM are addressed in FSAR Revision 1, Section 13.4 of the North Anna 3 COL. NRC staff finds this item satisfactorily addressed in FSAR Section 13.4, Table 13.4-201 (item 9), which lists the milestones for the development and implementation of the ODCM before fuel load, with the requirement identified as a license condition.

- STD COL 11.5-2-A                      Offsite Dose Calculation Manual

The COL item addresses the development of a plant- and site-specific ODCM for calculating offsite doses resulting from liquid and gaseous effluents. FSAR, Section 11.5.4.5. The applicant endorses by reference NEI ODCM Template 07-09 as the basis of its ODCM as an operational program document. The NEI template presents the functional elements of an ODCM that, if met, would demonstrate compliance with Part 50.34a and 50.36a and Appendix I to 10 CFR Part 50. The NEI ODCM Template identifies monitoring criteria, liquid and gaseous radiological effluent controls, monitoring instrumentation, methods for deriving lower limits of detection and detection sensitivities, methods for establishing instrumentation alarm set-points, dose limits for members of the public, requirements for process and effluent sampling in various plant systems, requirements limiting effluent releases, surveillance requirements, methods for calculating effluent release rates and doses, elements of a radiological environmental monitoring program, elements of a quality assurance and quality control program, information to be contained in annual radiological effluent release reports, reporting requirements to the NRC, process for initiating and documenting changes to the North Anna 3 ODCM and supporting procedures, and record keeping. The NRC staff finds this item satisfactorily addressed in FSAR Section 13.4, Table 13.4-201 (item 9), which lists the milestones for the development and implementation of

the ODCM before fuel load as a license condition. Accordingly, the applicant was requested, under RAI 11.05-1, to update the provisions of FSAR, Revision 0, Section 11.5.4.5, (STD COL 11.5-2-A), by referencing NEI ODCM Template 07-09 in applicable FSAR subsections and references. In its response, the applicant proposed a revision to STD COL 11.5-2-A once the final NEI ODCM Template 07-09 is issued. The NEI ODCM Template 07-09A (Revision 0, March 2009) has been reviewed and found acceptable by the staff. The results of the staff's evaluation are presented in ML083530745 and the NEI ODCM Template 07-09A is presented in ML091460258. The staff finds the response acceptable, and **this RAI is Confirmatory Item 11.05-1**, until the applicant updates the reference to the final ODCM.

- STD COL 11.5-3-A Process and Effluent Monitoring Program

The COL item addresses the development and implementation of a site-specific monitoring and sampling program as described in the ODCM for North Anna 3. The milestones for the development and implementation of the radiological environmental monitoring program (REMP) are addressed in Section 13.4 of the North Anna 3 COL FSAR, Revision 1. The NRC staff finds this item satisfactorily addressed in FSAR Section 13.4, Table 13.4-201 (item 9), which lists the milestone for development and implementation of the REMF before fuel load, with the requirement being a license condition.

FSAR Revision 0, Section 11.5.4.6, on process and effluent monitoring and sampling, presents information in Table 11.5-201 on sampling for several North Anna 3 plant systems, including the plant service water system (item 2), storm drains and cooling tower blowdown (item 11), and sanitary waste water (item 14). A review of the information revealed internal inconsistencies in describing sampling provisions and where the supporting information may be found in the DCD and/or FSAR. The applicant was requested, under RAI 11.05-2, to address the following observations:

- a. Plant Service Water System (PSWS) (line item 2) - For this system, footnotes number 6 and 8 of FSAR Table 11.5-201 are provided in clarifying sampling provisions and each sampling stream that would be treated through the LWMS. However, a review of a response to ESBWR DCD RAI 9.2-8 S02 on a related DCD section indicates that footnote number 8 is being replaced with footnote number 4, but FSAR Table 11.5-201 does not reflect that change. Accordingly, the applicant was requested to update FSAR Table 11.5-201, line item 2 for the PSWS, to include the proper footnote citations. This information would ensure that such provisions are identified in the FSAR and not likely to be omitted during the development of the sampling and analysis program for the North Anna 3 ODCM in confirming compliance with liquid effluent concentration limits in Table 2 (Column 2) in Appendix B to 10 CFR Part 20 and design objectives of Appendix I to 10 CFR Part 50. The applicant responded with more information about system interfaces and proposed revisions to relevant sections and included proposed marked up sections. The response points out that no radioactive plant systems are directly connected to the PSWS. The reactor component cooling water systems (RCCWS) serves as a buffer between contaminated plant systems and the PSWS. The RCCWS system is monitored by its own radiation monitor and leakage between the two systems would be detected by increases in water volume inventories in the RCCWS. The staff finds the response acceptable as the revision of line 2 in Table 11.5-201 includes the plant PSWS and circulating water system (CWS), with both being qualified by a new footnote. Footnote number 9 indicates that grab water samples can be obtained from a cooling tower basin and refers to FSAR Sections 9.2.1.2 and 10.4.5.2.3 for more details on the PSWS and CWS, respectively. This RAI is closed.

- b. Storm Drains and Cooling Tower Blowdown (line item 11) – For these systems, footnote number 4 in FSAR Table 11.5-201 does not refer to specific sampling provisions, such as sampling points or installation of automatic composite samplers. A review of FSAR, Revision 0, Sections 11.5, 9.2, and 10.4 indicates that no such provisions are provided for either system. The applicant was requested to confirm whether these observations are correct and update FSAR Sections 11.5, 9.2 and 10.4 by providing specific references to DCD and/or FSAR sections where this information is presented and, if not, supplement the appropriate FSAR sections with additional details. This information would ensure that such provisions are identified in the FSAR and not likely to be omitted during the development of the sampling and analysis program for the North Anna 3 ODCM in confirming compliance with liquid effluent concentration limits in Table 2 (Column 2) in Appendix B to 10 CFR Part 20 and design objectives of Appendix I to 10 CFR Part 50. The applicant responded with more information about system interfaces and proposed revisions to relevant sections and included proposed marked up sections. The staff finds the response acceptable as the revision of line 11 to Table 11.5-201 applies to all storm drains and qualifies it with a new footnote, number 10, which indicates that grab water samples can be obtained from the condensate storage tank (CST) basin sump and refers to FSAR Section 9.2.6.2 for more details on the CST basin. This RAI is closed.
- c. Sanitary Waste Water System (line item 14) – For this system, the applicant was requested to add a new footnote to the system’s line item 14 (Column 3 in Table 11.5-201) indicating that composite samplers are installed in the sanitary waste discharge lines to the sewage treatment plant for the purpose of detecting the presence of radioactivity, based on FSAR, Revision 0, Section 9.2.4.2. This information would ensure that those provisions are identified in the FSAR and are not likely to be omitted during the development of the sampling and analysis program for the North Anna 3 ODCM in confirming compliance with liquid effluent concentration limits of Table 2 (Column 2) in Appendix B to 10 CFR Part 20 and design objectives of Appendix I to 10 CFR Part 50. In its response, the applicant provided more information on system interfaces and proposed revisions to relevant sections and included proposed marked up sections. The staff finds the response acceptable as the revision of line 14 to Table 11.5-201 identifies instead grab sampling of sewage treatment plant (STP) discharges and qualifies it by a new footnote, number 11, which indicates that grab samples can be obtained from the STP and refers to FSAR Sections 9.2.4.2 and 9.2.4.3 for more details on the STP. This RAI is closed.

A review of North Anna 3 FSAR, Revision 0, Section 11.5.4.6 and ESBWR DCD Tier 2, Revision 5, Section 9.2.6.2 indicates that the supplemental information presented in FSAR Revision 0, Table 11.5-201 does not include a system line item identifying sampling provisions for condensate water that might be present in the condensate storage tank basin in the event of a tank rupture or spill. The basin’s design includes a sump with provisions to pump water out of the basin to the LWMS or to release it to the storm drain, depending on radionuclide concentrations and requirements in Table 2, Column 2 of Appendix B to 10 CFR Part 20 and design objectives of Appendix I to 10 CFR Part 50. FSAR Revision 0, Table 11.5-201 does not identify any sampling provisions and criteria for the case where water contained in the condensate tank retention basin would be discharged to the storm drain. Accordingly, the applicant was requested, under RAI 11.05-4, to add a new system line item to FSAR Table 11.5-201 in describing sampling provisions and criteria given the possibility of discharging such water to the storm drain. This information would ensure that such provisions are identified in the FSAR and are not likely to be omitted during the development of the sampling and analysis program for the North Anna 3 ODCM in confirming compliance with liquid effluent concentration limits in Table 2 (Column 2) in Appendix B to 10 CFR Part 20 and design objectives of

Appendix I to 10 CFR Part 50. The applicant responded by noting that Table 11.5-201 has a provision for sampling all “storm drains,” including those that would receive water from the condensate storage tank basin should it be discharged to the site storm drain system. The staff finds the response acceptable as the revision of line 11 to Table 11.5-201 applies to all storm drains and qualifies it with a new footnote, number 10, which indicates that grab water samples can be obtained from the CST basin sump and refers to FSAR Section 9.2.6.2 for more details on the CST basin. This RAI is closed.

- STD COL 11.5-4-A                      Site-Specific Offsite Dose Calculation

The COL item addresses the requirements of the design objectives in Appendix I to 10 CFR Part 50 in controlling doses to a hypothetical, maximally exposed member of the public and populations living near North Anna 3. The staff’s review and evaluation of compliance with liquid and gaseous effluent concentration limits and dose limits for members of the public are addressed in Section 12.2 of the North Anna 3 FSAR and Section 12.2 of the SER. The applicant outlines, given the endorsement of NEI ODCM 07-09, methods used to derive doses for members of the public and demonstrate compliance with the design objectives of Appendix I to 10 CFR Part 50, as they relate to liquid and gaseous effluent releases. The milestones for the development and implementation of the ODCM are addressed in FSAR, Revision 1, Section 13.4 of the North Anna 3 COL. The NRC staff finds this item satisfactorily addressed in FSAR Section 13.4, Table 13.4-201 (item 9), which lists the milestones for the development and implementation of the ODCM before fuel load, with the requirement being a license condition.

- STD COL 11.5-5-A                      Instrumentation Sensitivities

The COL item addresses the derivation of instrumentation detection sensitivity levels and bases for sampling all listed liquid and gaseous effluent release points described in the ODCM for North Anna 3. The applicant outlines, given the endorsement of NEI ODCM Template 07-09, methods used to derive instrumentation sensitivities and bases for sampling all listed liquid and gaseous effluent release points. The milestones for the development and implementation of the ODCM are addressed in FSAR Revision 1, Section 13.4 of the North Anna 3 COL. NRC staff finds this item satisfactorily addressed in FSAR Section 13.4, Table 13.4-201 (item 9), which lists the milestone for development and implementation of the ODCM before fuel load, with the requirement being a license condition.

FSAR Revision 1, Section 11.5.4.5, STD COL 11.5-2-A addresses the development of an ODCM using NEI ODCM Template 07-09. However, this provision is inconsistent with the technical basis and approach presented in the Applicant’s Environmental Report - Combined License Stage (Part 3, Revision 0, November 2007) and Early Site Permit Application (Part 3, Revision 9, September 2006). The approach described in the North Anna ESP (Section 6.2.1) cites NUREG-0472 as the basis, but this document is for PWR plant designs, and that the REMP would be implemented through the existing ODCM for NAPS Unit 1 and 2. The applicant was requested, under RAI 11.05-03, to revise FSAR Section 11.5.4.5 and identify appropriate changes to the basis of the ODCM and approach used in implementing the North Anna 3 ODCM. In its response, the applicant noted that the changes in guidance documents and provisions to use instead NEI ODCM Template 07-09 are not new or significant information and such changes do not have the potential of affecting the findings of the staff’s evaluation of the North Anna ESP. The staff finds the response acceptable as the use of NEI ODCM Template 07-09 in the North Anna 3 FSAR would ensure compliance with NRC regulations and guidance. This RAI is closed.

A review of North Anna Unit 3 FSAR Revision 1, Section 11.5.4.5 indicates that the provisions for sampling liquid and gaseous waste streams are missing an ESBWR DCD table citation. The citation of ESBWR DCD Table 11.5-6 is appropriate for gaseous streams, but a corresponding ESBWR DCD table citation is missing for liquid streams in the FSAR. Accordingly, the applicant, under RAI 11.05-5, was requested to introduce the applicable reference in FSAR, Revision 1, Section 11.5.4.5 in describing liquid and gaseous sampling provisions and make it consistent with ESBWR DCD, Revision 5. The applicant responded with a proposed revision of FSAR Revision 1, Section 11.5.4.5 by adding a reference to ESBWR DCD Table 11.5-7 in noting the corresponding provisions for sampling liquid streams. The staff finds the response acceptable. **This RAI is now Confirmatory Item 11.05-5.**

### **11.5.5 Post Combined License Activities**

There are no post COL activities for this section.

### **11.5.6 Conclusion**

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant has addressed the required information relating to PRMS, and no outstanding information is expected to be addressed in the COL FSAR related to this subsection.

The staff is reviewing the information in DCD Section 11.5 on Docket No. 52-010. The results of the NRC staff's technical evaluation of the information related to PRMS incorporated by reference in the North Anna 3 COL FSAR will be documented in the staff SER on the DC application for the ESBWR. The SER on the ESBWR 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 has compared the additional COL information in the application to the relevant NRC regulations, acceptance criteria defined in NUREG-0800, Section 11.5, GL 89-01, and NRC RGs.

Upon the satisfactory closure of all confirmatory items, the staff concludes that the process and effluent radiological monitoring system includes the equipment necessary to monitor process and effluent streams, describes an operational program to control releases of radioactive materials associated with the operation of the LWMS, GWMS, and SWMS, and incorporates provisions to implement a sampling and monitoring program. The PRMS and ODCM are found acceptable and meet the applicable requirements 10 CFR 20.1301 and 20.1302; 10 CFR 50.34a and 50.36a; Appendix I to 10 CFR Part 50; and GL 89-01. This conclusion is based on the following:

1. The PRMS includes the instrumentation for monitoring and sampling radioactivity in contaminated liquid and gaseous process and effluent streams, and in solid wastes under during routine operations, AOOs, and accident conditions. The staff evaluated the provisions proposed to sample and monitor appropriate process streams and effluent release points, including non-radioactive systems that could become contaminated through interfaces with radioactive systems.
2. The applicant has described processes through which instrumentation sensitivity and detection levels, and PRMS instrumentation alarm set-points are going to be established

3. The applicant's proposed ODCM for North Anna 3, as it relates to controlling and monitoring effluent releases and doses to members of the public, meets the requirements of Appendix I to 10 CFR Part 50 and requirements of 10 CFR 20.1301 and 20.1302. The staff concludes that the endorsement of the NEI ODCM Template 07-09A (Revision 0) and PRMS supplemental information contained in FSAR Section 11.5 are consistent with the requirements of GL 89-01.