

## 12.0 RADIATION PROTECTION

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## 12.0 RADIATION PROTECTION

This chapter of the U.S. Nuclear Regulatory Commission's (NRC's) safety evaluation report (SER) provides the NRC staff evaluation of the North Anna 3 radiation protection methods and estimated occupational radiation exposures (ORE) of operating and construction personnel during normal operations (including refueling; purging; fuel handling and storage; radioactive material handling, processing, use, storage, and disposal; maintenance; routine operational surveillance; in-service inspection (ISI); and calibration), and anticipated operational occurrences (AOO). Specifically, this chapter provides information on facility and equipment design, planning and procedures programs, and techniques and practices employed by the applicant to meet the radiation protection standards set forth in Title 10 of the *Code of Federal Regulations* (CFR) Part 20, "Standards for Protection Against Radiation," and to be consistent with the guidance given in the appropriate regulatory guides (RG), where the practices set forth in such guides are used to implement the NRC regulations. Finally, this chapter provides updated information that supplements the certified Economic Simplified Boiling-Water Reactor (ESBWR) Design Control Document (DCD) with a site-specific assessment of doses to members of the public from anticipated routine liquid and airborne effluent releases.

### 12.1 Ensuring that Occupational Radiation Exposures are As Low as Is Reasonably Achievable

#### 12.1.1 Introduction

Section 12.1 addresses policy and design considerations to ensure that the ORE to personnel will be kept as low as is reasonably achievable (ALARA). The ALARA program and Radiation Protection Program (RPP) are addressed in Appendices 12AA and 12BB, respectively, in the North Anna 3 Combined License (COL) Final Safety Analysis Report (FSAR). The North Anna 3 COL FSAR adopts the following final versions of the Nuclear Energy Institute (NEI) generic templates accepted by the NRC: NEI 07-03A, "Generic FSAR Template Guidance for Radiation Protection Program Description" (Agencywide Documents Access and Management System (ADAMS) Accession Number No. ML091490684) and NEI 07-08A, "Generic FSAR Template Guidance for Ensuring that Occupational Radiation Exposures are as Low as is Reasonably Achievable (ALARA)" (ADAMS Accession No. ML093220178).

#### 12.1.2 Summary of Application

Section 12.1 of the North Anna 3 COL FSAR, Revision 8, incorporates by reference Section 12.1 of the ESBWR DCD, Revision 10, referenced in Appendix E, "Design Certification Rule for the ESBWR Design," to 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." In addition, in FSAR Section 12.1, the applicant provides the following:

#### COL Items

- STD COL 12.1-1-A Regulatory Guide 8.10

The applicant is responsible for demonstrating compliance with the guidance of RG 8.10 Revision 1-R, "Operating Philosophy for Maintaining Occupational Radiation Exposures ALARA." The applicant references FSAR Appendices 12AA and 12BB, which in turn adopt NEI 07-08A and NEI 07-03A to meet the needs of this COL item.

- STD COL 12.1-2-A Regulatory Guide 1.8

The applicant is responsible for demonstrating compliance with the guidance of RG 1.8, Revision 3, “Qualification and Training of Personnel for Nuclear Power Plants.” The applicant references FSAR Appendices 12AA and 12BB, which in turn adopt NEI 07-08A and NEI 07-03A to meet the needs of this COL item.

- STD COL 12.1-3-A Operational Considerations

The applicant is responsible for providing criteria and conditions for implementing various operating procedures and techniques ensuring that occupational exposures are ALARA according to the guidance of NUREG–1736, “Consolidated Guidance: 10 CFR Part 20 — Standards for Protection Against Radiation.” The applicant references FSAR Appendices 12AA and 12BB, which in turn adopt NEI 07–08A and NEI 07–03A to meet the needs of this COL item.

- STD COL 12.1-4-A Regulatory Guide 8.8

The applicant is responsible for demonstrating compliance with the guidance of RG 8.8, Revision 3, “Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be ALARA.” The applicant references FSAR Appendices 12AA and 12BB, which in turn adopt NEI 07–08A and NEI 07–03A to meet the needs of this COL item.

#### Supplemental Information

- STD SUP 12.1-1 ALARA Program

The applicant provides supplemental information in FSAR Appendices 12AA and 12BB to address the ALARA Program and the RPP at the site. These appendices reference NEI 07–08A and NEI 07–03A, which in turn provide additional operating policy guidance for developing and implementing an ALARA program.

### **12.1.3 Regulatory Basis**

The regulatory basis of the information incorporated by reference is in NUREG–1966, “Final Safety Evaluation Report Related to the Certification of the Economic Simplified Boiling Water Reactor Standard Design.”

The staff followed the guidance in RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition),” to evaluate North Anna 3 FSAR Section 12.1 for compliance with NRC regulations.

The relevant requirements of the Commission regulations for ensuring that occupational radiation exposures are ALARA, and the associated acceptance criteria, are in Section 12.1 of NUREG–0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, (LWR Edition),” the Standard Review Plan (SRP).

In particular, the regulatory basis for the acceptance of the COL items and the supplemental information is established in 10 CFR 19.12, “Instructions to workers”; 10 CFR Part 20; and the guidance of RG 1.206; RG 8.10, Revision 1-R; RG 1.8, Revision 3; and RG 8.8, Revision 3.

Moreover, the acceptance of the COL items and the supplemental information in this section are based on guidance in the following RGs and NEI templates:

- RG 8.2, “Guide for Administrative Practices in Radiation Monitoring”
- RG 8.7, Revision 2, “Instructions for Record Keeping and Recording Occupational Radiation Exposure Data”
- RG 8.9, Revision 1, “Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program”
- RG 8.13, Revision 3, “Instruction Concerning Prenatal Radiation Exposure”
- RG 8.15, Revision 1, “Acceptable Programs for Respiratory Protection”
- RG 8.27, “Radiation Protection Training for Personnel at Light-Water-Cooled Nuclear Power Plants”
- RG 8.28, “Audible-Alarm Dosimeters”
- RG 8.29, Revision 1, “Instructions Concerning Risks from Occupational Radiation Exposure”
- RG 8.34, “Monitoring Criteria and Methods to Calculate Occupational Radiation Doses.”
- RG 8.35, “Planned Special Exposures”
- RG 8.36, “Radiation Dose to the Embryo/Fetus”
- RG 8.38, Revision 1, “Control of Access to High and Very High Radiation Areas in Nuclear Power Plants”
- RG 1.206, NEI 07–03A, and NEI 07–08A

#### **12.1.4 Technical Evaluation**

As documented in NUREG–1966, the staff reviewed and approved Section 12.1 of the certified ESBWR DCD, Revision 10. The staff reviewed Section 12.1 of the North Anna 3 COL FSAR, Revision 8 and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.<sup>1</sup> The staff’s review confirmed that the information in the application and the information incorporated by reference address the required information related to “Ensuring that Occupational Radiation Exposures are ALARA.”

In addition, the staff reviewed the applicant’s proposed resolution to the COL items and the supplemental information included under Section 12.1 of the North Anna 3 COL FSAR. In this review, the staff used the applicable sections of the SRP and RG 1.206 as guidance.

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<sup>1</sup> See “*Finality of Referenced NRC Approvals*” in SER Section 1.2.2 for a discussion on the staff’s review related to verification of the scope of information to be included in a COL application that references a design certification.

Section 1.2.3 of this safety evaluation report (SER) discusses the NRC's strategy for performing one technical review for each standard issue outside the scope of the DC and to use this review to evaluate the subsequent COL applications. To ensure that the staff's findings on the standard content that were documented in the SER for the Fermi 3 application are equally applicable to the North Anna 3 COL application (COLA), the staff undertook the following reviews:

- The staff compared the Fermi 3 COL FSAR, Revision 8, to the North Anna 3 COL FSAR, Revision 8. In this comparison, the staff considered changes to the North Anna 3 COL FSAR (and other parts of the COLA, as applicable) resulting from requests for additional information (RAI) identified in the Fermi SER.
- The staff confirmed that the applicant has endorsed all responses to the RAIs in the corresponding standard content (the Fermi SER) evaluation.
- The staff verified that the site-specific differences are not relevant to this section.

The staff completed the review and finds the evaluation of the Fermi standard content to be directly applicable to the North Anna 3 COLA.

The staff reviewed the information in the North Anna 3 COL FSAR as follows:

COL Items

- STD COL 12.1-1-A Regulatory Guide 8.10

The applicant provided additional information in STD COL 12.1-1-A to address the resolution of DCD COL Item 12.1-1-A, which states:

The COL applicant will demonstrate compliance with Regulatory Guide 8.10

The FSAR states that this COL information item is addressed in NEI Template 07-03A, which is referenced in Appendix 12BB of the FSAR.

The staff reviewed NEI 07-03A with respect to compliance with RG 8.10. RG 8.10 describes the operating philosophy for maintaining OREs ALARA and states that the management of the licensed facility should be committed to maintaining exposures ALARA, and the personnel responsible for radiation protection should be continually vigilant for means to reduce exposures. NEI 07-03A states that the plant management will establish a written policy on radiation protection that is consistent with the guidance in RG 8.10. The radiation protection responsibilities of the Radiation Protection Manager will be consistent with the guidance in RG 8.10 and will include establishing, implementing, and enforcing the RPP. In addition, management is committed to assuring that each individual working at the facility understands and accepts the responsibility to follow radiation protection procedures and instructions provided by radiation protection staff and to maintain his or her dose ALARA.

In North Anna 3 COL FSAR Revision 8, the applicant states that compliance with RG 8.10 is addressed in Appendices 12AA and 12BB, which in turn adopt NEI 07-08A and NEI 07-03A for meeting the needs of this COL item. The staff has reviewed and approved these NEI templates for addressing this COL item (ADAMS Accession Nos. ML090510379 and ML091130034).

Therefore, the applicant has adequately addressed COL Item STD COL 12.1-1-A (compliance with the guidance of RG 8.10).

- STD COL 12.1-2-A Regulatory Guide 1.8

The applicant provided additional information in STD COL 12.1-2-A to address the resolution of DCD COL Item 12.1-2-A, which states:

The COL applicant will demonstrate compliance with Regulatory Guide 1.8.

The FSAR states that this COL information item is addressed in NEI Template 07-03A, which is referenced in Appendix 12BB of the FSAR.

The staff has reviewed NEI 07-03A with respect to compliance with RG 1.8. RG 1.8 states that the American National Standards Institute (ANSI)/American Nuclear Society (ANS)-3.1-1993, with certain additions, exceptions, and clarifications delineated in the RG, provides acceptable criteria for the selection, qualification, and training of personnel for nuclear power plants. NEI 07-03A states that the Radiation Protection Manager, Radiation Protection Technicians, and Radiation Protection Supervisory and Technical Staff will be trained and qualified in accordance with the guidance in RG 1.8.

In North Anna 3 COL FSAR, Revision 8, the applicant states that compliance with this RG is addressed in Appendices 12AA and 12BB, which in turn adopt NEI 07-08A and NEI 07-03A to meet the needs of this COL item. The staff has reviewed and approved these NEI templates for addressing this COL item; therefore, the applicant has adequately addressed COL Item STD COL 12.1-2-A (compliance with the guidance of RG 1.8).

- STD COL 12.1-3-A Operational Considerations

The applicant provided additional information in STD COL 12.1-3-A to address the resolution of DCD COL Item 12.1-3-A, which states:

The COL applicant will provide the criteria and/or conditions under which various operating procedures and techniques will be implemented to ensure that occupational radiation exposures are ALARA using the guidance of NUREG-1736, to the level of detail provided in RG 1.206.

The staff reviewed the applicant's response to STD COL 12.1-3-A related to criteria and conditions under which various operating procedures and techniques will be implemented to ensure that OREs are ALARA, using the guidance in NUREG-1736 to the level of detail provided in RG 1.206. The staff also reviewed the applicant's response to ensure that the applicant has committed to follow the guidance in the following RGs: 8.2, 8.7, 8.9, 8.13, 8.15, 8.27, 8.28, 8.29, 8.34, 8.35, 8.36, and 8.38. The criteria and conditions in STD COL 12.1-3-A are addressed in NEI 07-03A, which is referenced in Appendix 12 BB of the FSAR. NEI 07-03A addresses various operating procedures and techniques used in dose-related activities found in typical nuclear plants. These activities include refueling, in-service inspections, radwaste handling, spent fuel handling, normal operations, routine maintenance, sampling, and calibration. The template allows for COL applicant's to modify procedures based on design-specific and site-specific information. The staff reviewed the categories listed in the template for coverage of the ESBWR activities. On the basis of this review, the staff determined that NEI 07-03A, as supplemented by material presented in the DCD, provides the criteria and/or conditions

under which various operating procedures and techniques will be implemented to ensure that OREs are ALARA.

In North Anna 3 COL FSAR Revision 8, the applicant states that the operational considerations for the ALARA Program are addressed in Appendices 12AA and 12BB, which in turn adopt NEI 07-08A and NEI 07-03A to meet the needs of this COL item. The staff has reviewed and approved these NEI templates for addressing this COL item; therefore, the applicant has adequately addressed COL Item STD COL 12.1-3-A (providing criteria and conditions for implementing various operating procedures and techniques to ensure that occupational exposures are ALARA, according to the guidance of NUREG-1736 to the level of detail in RG 1.206).

- STD COL 12.1-4-A Regulatory Guide 8.8

The applicant provided additional information in STD COL 12.1-4-A to address the resolution of DCD COL Item 12.1-4-A, which states:

The COL applicant will demonstrate compliance with Regulatory Guide 8.8.

The FSAR states that this COL information item is addressed in NEI Template 07-03A, which is referenced in Appendix 12BB of the FSAR. The staff has reviewed NEI 07-03A with respect to compliance with RG 8.8. NEI 07-03A addresses the operational portions of RG 8.8 that were not addressed in the ESBWR DCD, including a description of the plant organization, personnel, and personnel responsibilities; facilities (to the extent that they were not described in the DCD), instrumentation, and equipment. NEI 07-03A also includes a description of radiation protection procedures sufficient to provide adequate control over the receipt, possession, use, transfer, and disposal of byproduct, source, and special nuclear material and assure compliance with the applicable requirements in 10 CFR Parts 19, 20, 50, 70, "Domestic Licensing of Special Nuclear Material," and 71, "Packaging and Transportation of Radioactive Material." The procedures described in NEI 07-03A include procedures for radiation protection training, access control of radiation areas, methods to maintain exposures ALARA, personnel monitoring, respiratory protection, and contamination control.

In North Anna 3 COL FSAR Revision 8, the applicant states that compliance with this RG is addressed in Appendices 12AA and 12BB, which in turn adopt NEI 07-08A and NEI 07-03A to meet the needs of this COL item. The staff has reviewed and approved these NEI templates for addressing this COL item; therefore, the applicant has adequately addressed COL Item STD COL Item 12.1-4-A (compliance with the guidance of RG 8.8).

#### Supplemental Information

- STD SUP 12.1-1 ALARA Program

The STD SUP 12.1-1 of the North Anna COL FSAR references Appendices 12 AA and 12 BB for a description of the ALARA program. Appendix 12 AA refers to NEI 07-08A and Appendix 12 BB refers to NEI 07-03A. The staff reviewed NEI Templates 07-08A and 07-03A with respect to a description of the ALARA program. NEI 07-08A states that company and station policies are to keep all radiation exposures of personnel within the limits defined by 10 CFR Part 20. The ALARA policy is consistent with and will be implemented in accordance with the ALARA provisions of RGs 8.8 and 8.10. As stated in FSAR Section 13.1, "Organizational Structure of Applicant," and in NEI 07-03A, specific individuals will be assigned

the responsibility and authority for implementing the ALARA policy at North Anna 3. All station personnel are responsible for the ALARA program. Individual workers are responsible for complying with ALARA requirements, which are presented in worker training in accordance with the training requirements contained in 10 CFR 19.12. The extent of the training is commensurate with the worker's job responsibilities.

North Anna's ALARA policies and practices are consistent with the applicable regulations in 10 CFR Part 20 and the guidance in RGs 1.8, 1.206, 8.2, 8.7, 8.8, 8.9, 8.10, 8.13, 8.15, 8.27, 8.28, 8.29, 8.34, 8.35, 8.36, and 8.38 and the applicable portions of NUREG-1736.

The ALARA program is based on mature programs in use at other operating commercial nuclear facilities and incorporates lessons-learned from plant operating experience. Industry operating experience is regularly reviewed and applicable exposure control technique lessons-learned are incorporated into plans, procedures, and policies developed in accordance with RGs 1.8, 8.8, and 8.10.

Overall facility operations, as well as the RPP, integrate the procedures necessary to ensure that radiation doses are ALARA. Radiation protection procedures, which are described in FSAR Section 12.5, are developed in FSAR Sections 13.5 and 17.5 and meet the applicable requirements in 10 CFR Parts 19, 20, 50, 70, and 71. Examples of some ALARA work practices incorporated in these procedures, and described in NEI 07-08A, to help ensure that exposures to personnel will be ALARA include use of:

- Appropriate dosimetry to record personnel doses
- Pre-job briefings and post-job debriefings to ascertain lessons-learned
- Dry-run training and mockups to improve worker efficiency for complex jobs in high-radiation areas
- Protective clothing, respiratory equipment, and special ventilation systems for working in contaminated environments
- Remote monitoring of personnel to reduce worker exposures, and the establishment of low dose "waiting areas," and
- Permanent or temporary shielding to reduce worker exposure at the work site

In North Anna 3 COL FSAR, Revision 8, the applicant provides supplemental information in Appendices 12AA and 12BB to address the ALARA Program and the RPP at the site. These appendices reference NEI 07-08A and NEI 07-03A, which provide additional operating policy guidance for developing and implementing an ALARA Program. The applicant also provides site-specific information regarding access control in these appendices. The staff's evaluation of the site-specific information on access control is in Section 12.5 of this SER.

As stated earlier, the staff reviewed and approved these NEI templates for addressing the ALARA Program. Therefore, the applicant has adequately addressed the ALARA Program and has identified the locations of very high radiation areas that require access control.

### **12.1.5 Post Combined License Activities**

There are no post COL activities related to this section.

### **12.1.6 Conclusion**

The staff's findings related to information incorporated by reference are documented in NUREG-1966. The staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to policy and design considerations to ensure that ORE to personnel will be kept ALARA, and there is no outstanding information expected to be addressed in the North Anna 3 COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to "Ensuring that Occupational Radiation Exposures Are ALARA" that were incorporated by reference are resolved.

In addition, the staff compared the information in the COLA to the relevant NRC regulations, the guidance in SRP Section 12.1, and other pertinent NRC RGs. The staff's review concludes that the applicant has adequately addressed the following:

- STD COL Items 12.1-1-A through 12.1-4-A, relating to ALARA and operational considerations and conformance with RGs 1.8, 8.8, and 8.10, are acceptable because the applicant incorporates approved references NEI 07-03A (which incorporates the guidance in RGs 1.8, 8.8, and 8.10) and NEI 07-08A into the North Anna 3 COL FSAR and meets the applicable regulatory requirements and guidance specified in Sections 12.1.3 and 12.1.4 of this SER.
- STD SUP 12.1-1 pertains to the ALARA Program at the site. NEI Templates NEI 07-03A and 07-08A, which are addressed in FSAR Appendices 12AA and 12BB, describe an ALARA program that meets the ALARA provisions in 10 CFR 20.1101(b), the training requirements in 10 CFR 19.12, and the guidance in RGs 8.8 and 8.10. These templates meet the acceptance criteria defined in SRP Section 12.1. Therefore, the staff finds STD SUP 12.1-1 acceptable because the information contained in these templates adequately addresses an acceptable ALARA program.

The staff concludes that the information pertaining to North Anna COL FSAR Section 12.1 is within the scope of the DC and adequately incorporates by reference Section 12.1 of the ESBWR DCD. The information is thus acceptable.

## **12.2 Plant Sources**

### **12.2.1 Introduction**

Section 12.2 addresses the issues related to contained radiation sources and airborne radioactive material sources during normal operations, AOOs, and accident conditions affecting in-plant radiation protection.

This section also addresses doses to members of the public from radioactive effluent releases. All liquid effluent releases are conducted and monitored through the liquid waste management system (LWMS) for process liquids generated during the operation of the LWMS, the gaseous waste management system (GWMS), and the solid waste management system (SWMS). Airborne releases from the operation of the LWMS, GWMS, and SWMS and ventilation exhaust systems servicing radiologically controlled areas, where process equipment are located, are monitored and discharged through their respective stacks, specifically, the reactor/fuel building stack, turbine building stack, and the radwaste building (RWB) stack.

## 12.2.2 Summary of Application

Section 12.2 of the North Anna 3 COL FSAR, Revision 8, incorporates by reference Section 12.2 of the certified ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E.

In addition, in FSAR Section 12.2, the applicant provides the following:

### Departures

- NAPS DEP 11.4-1 Long-Term, Temporary Storage of Class B and C Low-Level Radioactive Waste

The ESBWR DCD identifies that on-site storage space for a 6-month volume of packaged waste is provided in the RWB. In this departure, the North Anna 3 RWB is configured to accommodate a minimum of 10 years volume of packaged Class B and C waste, while maintaining space for at least 3 months of packaged Class A waste. This departure reconfigures the arrangement of systems and components within the ESBWR RWB volume. The systems, structures, and components requiring re-arrangement are associated with the LWMS and SWMS. The existing RWB Fire Protection and heating, ventilation, and air conditioning systems have sufficient capacity to accommodate the extra volume of Class B and C wastes, and require no modification.

### COL Items

- NAPS COL 12.2-2-A Airborne Effluents and Doses

The applicant provided updated information to supplement the DCD with the site-specific parameters for addressing DCD COL Item 12.2-2-A, airborne effluent releases and doses to members of public. This information addresses compliance with the regulatory dose limits in Sections II.B and II.C of Appendix I to 10 CFR Part 50; compliance Section II.D of Appendix I to Part 50; airborne effluent concentration limits in Table 2 (Column 1) of Appendix B to 10 CFR Part 20; and dose limits in 10 CFR 20.1301 and 20.1302. Compliance with the requirements in Section II.D of Appendix I to Part 50 for airborne effluents is addressed in FSAR Section 11.3.1.

- NAPS COL 12.2-3-A Liquid Effluents and Doses

The applicant provided updated information to supplement the DCD with the site-specific parameters for addressing DCD COL Item 12.2-3-A, liquid effluent releases and doses to members of public. This information addresses compliance with the regulatory dose limits in Section II.A of Appendix I to 10 CFR Part 50; compliance with Section II.D of Appendix I to Part 50; liquid effluent concentration limits in Table 2 (Column 2) of Appendix B to 10 CFR Part 20; and dose limits in 10 CFR Parts 20.1301 and 20.1302. Compliance with the requirements in Section II.D of Appendix I to Part 50 for liquid effluents is addressed in FSAR Section 11.2.1.

- NAPS COL 12.2-4-A Other Contained Sources

In Subsection 12.2.1.5, "Other Contained Sources," the applicant provided information about additional contained radioactive sources not described in the DCD that contain by-product, source, or special nuclear materials that may be maintained on site. These contained sources, which are not part of the permanent plant design, are used as calibration, check, or radiography sources.

- NAPS ESP COL 11.1-1 Compliance with 10 CFR Part 50, Appendix I, Section II.D

The applicant provided updated information to supplement the DCD with a site-specific analysis in addressing North Anna 3 Early Site Permit (ESP) COL 11.1-1. This information addresses compliance with the requirements in Section II.D of Appendix I to Part 50 for liquid and airborne effluents in confirming that liquid and gaseous radwaste systems include all items of reasonably demonstrated technology in reducing population doses to ALARA levels. FSAR Section 12.2.2 includes assessments of population doses for both liquid and gaseous effluents. The results of the 10 CFR Part 50, Appendix I, Section II.D, cost-benefit analyses are presented in FSAR Section 11.2.1 for liquid effluents and FSAR Section 11.3.1 for gaseous effluents.

### Variances

A *variance* is a plant-specific deviation from one or more of the site characteristics, design parameters, or terms and conditions of an ESP or from the site safety analysis report (SSAR). A variance to an ESP is analogous to a departure from a standard DC. The applicant provided a request for a variance from a site characteristic for the North Anna ESP and from the ESP SSAR. The requests comply with the requirements of 10 CFR 52.39(d) and 10 CFR 52.93(b). To support a decision whether to grant a variance, each variance request provides the technical justification and supporting cross-references to the North Anna 3 FSAR information that meet the technically relevant regulatory acceptance criteria.

- NAPS ESP VAR 12.2-1 Gaseous Pathway Doses

The applicant submitted, under variance NAPS ESP VAR 12.2-1, a request to use updated information on offsite doses associated with gaseous effluents. The request states that the variance is necessary because FSAR dose estimates are higher than those reported in the North Anna ESP SSAR and the ESP-Environmental Review (ER). The doses are higher because of a change in long-term atmospheric dispersion and deposition parameters.

- NAPS ESP VAR 12.2-3 Annual Liquid Effluent Releases

The applicant submitted, under variance NAPS ESP VAR 12.2-3, a request to use updated information for the estimate of liquid effluent releases. The request states that the variance is necessary because FSAR estimates are different from those reported in the North Anna ESP SSAR and ESP-ER. The differences are associated with ESP estimates that were based on a composite source term reflecting different types of reactor technologies, while the FSAR applies the ESBWR DCD, Tier 2, source term. Also, the FSAR estimates for some radionuclides are higher than the ESP because the source term is based on the ESBWR design.

- NAPS ESP VAR 12.2-4 Existing Units' and Site Total Doses

The applicant submitted, under variance NAPS ESP VAR 12.2-4, a request to use updated dose information in characterizing doses from both existing units and total offsite doses. The request states that the variance is necessary as FSAR dose estimates are higher in the FSAR than that reported in the North Anna ESP SSAR and ESP-ER. The doses are higher because of the application of conservative assumptions used in presenting doses from the existing units and the Independent Spent Fuel Storage Installation (ISFSI) facility.

North Anna 3 COL FSAR, Sections 11.2, 11.3, and 11.5 present supporting details on the operation of the LWMS, GWMS, and the Process Radiation Monitoring System (PRMS). North Anna 3 COL, FSAR Section 13.5 describes the major elements of the operational procedures that will be used to operate the LWMS, GWMS, and PRMS. North Anna 3 FSAR Section 13.4 presents the milestones for the development and implementation of the offsite dose calculation manual (ODCM), standard radiological effluent controls (SREC), and radiological environmental monitoring program (REMP) for controlling all radioactive effluent releases and limiting doses to members of the public. In FSAR Section 11.5.4.5, NAPS COL 11.5-2-A, the applicant commits to the development of these programs using NEI ODCM Template 07-09A in monitoring and controlling effluent releases and doses to members of the public. The NEI ODCM Template 07-09A (Revision 0, March 2009) has been reviewed and found acceptable by the staff (see the staff's SER (in ADAMS Accession No. ML083530745) and NEI ODCM Template 07-09A (in ADAMS Accession No. ML091460258)). The staff's evaluation of these systems and operational programs is addressed in their respective sections of this SER.

- NAPS ESP VAR 12.2-5 Annual Gaseous Effluent Releases

The applicant submitted, under variance NAPS ESP VAR 12.2-5, a request to use updated information for the estimate of gaseous effluent releases. The request states that the variance is necessary because FSAR estimates are different from those reported in the North Anna ESP SSAR and ESP-ER. The differences are associated with ESP estimates that were based on a composite source term reflecting different types of reactor technologies, while the FSAR applies the ESBWR DCD, Tier 2, source term. Also, the FSAR estimates for some radionuclides are higher than the ESP because the source term is based on the ESBWR design.

#### Supplemental Information

- STD SUP 12.2-1

The applicant provides supplemental information in FSAR Subsection 12.2.1.1.2, "Other Radioactive Sources," to provide details regarding the Californium-252 (Cf-252) reactor startup source.

North Anna 3 COL, FSAR Sections 11.2, 11.3, and 11.5 present supporting details on the operation of the LWMS, GWMS, and the PRMS. North Anna 3 COL, FSAR Section 13.5 describes the major elements of the operational procedures that will be used to operate the LWMS, GWMS, and PRMS. North Anna 3 FSAR Section 13.4 presents the milestones for the development and implementation of the ODCM, SREC, and REMP for controlling all radioactive effluent releases and limiting doses to members of the public. In FSAR Section 11.5.4.5, NAPS COL 11.5-2-A, the applicant commits to the development of these programs using NEI ODCM Template 07-09A in monitoring and controlling effluent releases and doses to members of the public. The NEI ODCM Template 07-09A (Revision 0, March 2009) has been reviewed and found acceptable by the staff (see the staff's SER in (ADAMS Accession No. ML083530745) and NEI ODCM Template 07-09A in (ADAMS Accession No. ML091460258)). The staff's evaluation of these systems and operational programs is addressed in their respective sections of this SER.

### 12.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the relevant requirements of the Commission regulations for the radiation sources, and the associated acceptance criteria, are in SRP Section 12.2.

The staff followed the guidance in RG 1.206 to evaluate North Anna 3 FSAR Section 12.2 for compliance with NRC regulations.

In accordance with Section VIII, "Processes for Changes and Departures," of Appendix E to Part 52, the applicant identifies one Tier 2 departure. Tier 2 departures not requiring prior NRC approval are subject to the requirements of 10 CFR Part 52, Appendix E, Section VIII.B.5, which are similar to the requirements of 10 CFR 50.59, "Changes, tests, and experiments."

The regulatory basis for the acceptance of the COL items in this section include the applicable requirements of 10 CFR Part 20, 10 CFR Part 50, and the guidance of RG 1.206.

In particular, the regulatory basis for the acceptance of the COL Items for assessing doses to members of the public from liquid and gaseous effluent releases in unrestricted areas is established in:

- 10 CFR 20.1301(e), 10 CFR 20.1302, 10 CFR 50.34a, and 50.36a.
- Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, General Design Criterion (GDC) 60, "Control of releases of radioactive materials to the environment," and GDC 64, "Monitoring radioactivity releases."
- Appendix I to 10 CFR Part 50, Sections II.A, II.B, II.C, and II.D.

The regulatory basis for the performance of the LWMS, GWMS, and SWMS is in 10 CFR 52.80(a) and Generic Letter (GL) 89-01, "Implementation of Programmatic and Procedural Controls for Radiological Effluent Technical Specifications." The criteria for a variance from an ESP is found in 10 CFR 52.39(d).

The SRP acceptance criteria include:

- RG 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I."
- RG 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors (for comment)."
- RG 1.111, Revision 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors."
- RG 1.112, Revision 1, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors."
- RG 1.113, Revision 1, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I."

- RG 1.206.

Full descriptions of the applicable regulatory and acceptance criteria are in SRP Section 11.1 through Section 11.5.

#### **12.2.4 Technical Evaluation**

As documented in NUREG–1966, the staff reviewed and approved Section 12.2 of the certified ESBWR DCD, Revision 10. The staff reviewed Section 12.2 of the North Anna 3 COL FSAR, Revision 8, and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.<sup>1</sup> The staff's review confirmed that the information in the application and the information incorporated by reference address the required information related to "Radiation Sources."

In addition, the staff reviewed the applicant's proposed departure, variances from the North Anna 3 ESP, and the proposed resolution to the COL items included under Section 12.2 of the North Anna 3 COL FSAR. The staff's review used the applicable sections of the SRP and RG 1.206 as guidance. The staff performed an independent evaluation of doses from liquid and gaseous effluents using the LADTAP II computer code (NUREG/CR–1276, "User's Manual for LADTAP II – A Computer Program for Calculating Radiation Exposure to Man from Routine Release of Nuclear Reactor Liquid Effluents") and the GASPAR II computer code (NUREG/CR–4653, "GASPAR II – Technical Reference and User Guide"). The staff reviewed the basis for the liquid and gaseous effluents source terms and the applicant's assumptions and data used to model exposure pathways and to estimate doses to offsite receptors.

Section 1.2.3 of this SER discusses the NRC's strategy for performing one technical review for each standard issue outside the scope of the DC and to use this review to evaluate the subsequent COL applications. To ensure that the staff's findings on the standard content that were documented in the SER for the Fermi 3 application are equally applicable to the North Anna 3 COLA, the staff undertook the following reviews:

- The staff compared the Fermi 3 COL FSAR, Revision 8, to the North Anna 3 COL FSAR, Revision 8. In this comparison, the staff considered changes to the North Anna 3 COL FSAR (and other parts of the COLA, as applicable) resulting from RAIs in the Fermi SER.
- The staff confirmed that the applicant has endorsed all responses to the RAIs in the corresponding standard content (the Fermi SER) evaluation.
- The staff verified that the site-specific differences are not relevant to this section.

The staff completed the review and finds the evaluation of the Fermi standard content to be directly applicable to the North Anna 3 COLA.

The staff reviewed the following information in the North Anna 3 COL FSAR:

Tier 2 Departure Not Requiring Prior NRC Approval

- NAPS DEP 11.4-1 Long-Term, Temporary Storage of Class B and C Low-Level Radioactive Waste

The North Anna 3 RWB was reconfigured to accommodate a minimum 10-year volume of packaged Class B and C waste, while maintaining space for at least 3 months of packaged Class A waste. This reconfiguration results in changes to equipment location and layout. The applicant provides revised radiation source parameters in FSAR Table 12.2-22R. The staff reviewed the equipment location and compared FSAR Table 12.2-22R with DCD Tier 2, Table 12.2-22. This comparison confirmed that the radiation source parameters remained unchanged, except for sources in DCD Rooms 6171 and 6172, which are now located in the reconfigured FSAR Room 6171. In the new configuration, the equipment drain sample tank and floor drain sample tank will be in one room (FSAR Room 6171). These tanks were originally in two separate rooms (DCD Rooms 6171 and 6172). A review of DCD Figure 12.3-19 and FSAR Figure 12.3-19R revealed that FSAR Room 6171 has a larger overall area than the two DCD rooms (6171 and 6172) combined. The staff therefore concluded that given the size of Room 6171, the radiation level and the required shielding will remain the same as those identified for Rooms 6171 and 6172 in the DCD, regardless of the tank locations.

The applicant's evaluation determined that this departure does not require prior NRC approval in accordance with 10 CFR Part 52, Appendix E, Section VIII.B.5. Within the review scope of this section, the staff finds it reasonable that the departure does not require prior NRC approval. The applicant's process for evaluating departures and other changes to the certified ESBWR DCD is subject to NRC inspections.

COL Items

- NAPS COL 12.2-2-A Airborne Effluents and Doses, (including NAPS ESP COL 11.1-1, Compliance with 10 CFR Part 50, Appendix I, Section II.D; NAPS ESP VAR 12.2-1, Gaseous Pathway Doses; NAPS ESP VAR 12.2-4, Existing Units' and Site Total Doses; and NAPS ESP VAR 12.2-5, Annual Gaseous Effluent Releases)

The applicant provides information for compliance with the airborne effluent requirements in FSAR Subsections 12.2.2.1, 12.2.2.2, and Table 2.0-201 which address the resolution of NAPS COL 12.2-2-A, which states:

The COL Applicant is responsible for ensuring that offsite dose (using site-specific parameters) due to radioactive airborne effluents complies with the regulatory dose limits in Sections II.B and II.C of 10 CFR Part 50, Appendix I. In addition, the COL Applicant is responsible for compliance with Section II.D of 10 CFR Part 50, Appendix I; airborne effluent concentration limits of 10 CFR Part 20, Appendix B (Table 2, Column 1); and dose limits of 10 CFR Parts 20.1301 and 20.1302 to members of the public (Subsection 12.2.2.2).

The staff reviewed the North Anna 3 FSAR for compliance with the NAPS COL Items. The FSAR also presents comparisons with the information presented in the ESP Application and ER

for North Anna 3. These comparisons and variances from the ESP are identified as NAPS ESP COL 11.1-1, and NAPS ESP VAR 12.2-1 and 12.2-4 (North Anna 3 Part 7, Departures Report). Any ESP variance or ESP COL Item in the FSAR and the ESP and ER are reviewed to ensure all regulatory requirements have been addressed in the application.

In addition, the staff listed parts of the gaseous and liquid effluent compliance process defined in the COL items to ensure compliance with the regulations noted above. These parts are the effluent Source Term, the 10 CFR Part 20 Gaseous Compliance, and the 10 CFR Part 50, Appendix I Gaseous Dose Compliance.

### **Airborne Source Term**

In the staff review of the gaseous effluent source term, the staff used the design basis noble gas, iodine, and other fission product concentrations (uCi/g) for the reactor coolant from the tables in the ESBWR DCD Chapter 11. Airborne sources (Ci/yr) for normal operating releases are calculated using the source terms given in DCD Section 11.1 along with the site design specific parameters from FSAR Table 12.2-15R (the same parameters from DCD Table 12.2-15) for North Anna 3. The staff used the boiling water reactor (BWR) methodology of NUREG-0016, Revision 1, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors (BWR-GALE CODE)," January 1979, (GALE) in determining the annual airborne sources release values (Ci/yr) presented in DCD Table 12.2-16. The staff found that the site-specific design parameters and the approved DCD Section 11.1 source term information was appropriate for the gaseous source term released from the North Anna 3 reactor design.

### **10 CFR Part 20 Gaseous Compliance**

In addition, the COL applicant is responsible for compliance with site airborne effluent concentration limits of 10 CFR Part 20, Appendix B (Table 2, Column 1), effluent concentration limits (ECL). The annual North Anna 3 airborne sources release values presented in DCD Table 12.2-16 (Ci/yr) are utilized with the site-specific parameters listed in FSAR Table 12.2-15R including the meteorology dispersion values to determine the concentrations released to the environment to the site boundary from North Anna 3. The North Anna 3 concentrations are then combined with the North Anna Units 1 and 2 concentrations to determine a total site concentration. These total site release concentrations are compared to the 10 CFR Part 20, Appendix B, Table 2, Column 1 ECL concentration values to determine if the sum of the ratios of the calculated concentration values divided by the 10 CFR Part 20, Table 2, Column 1 ECL values are less than 1.0 (Unity). Table 12.2-17R indicates that the applicant fraction of ECLs for all site radionuclides concentrations is 0.053 and is less than 1.0 (Unity). The staff reviewed the FSAR information submitted and verified all applicant calculations presented. The staff also verified the applicant methodology and results by independently calculating the gaseous effluent concentrations and comparing with the applicant results. The staff finds that these site-specific gaseous effluent releases comply with the ECLs in Table 2, Column 1 of Appendix B to 10 CFR Part 20 using the sum-of-fractions given in FSAR Tables 12.2-17R.

As the applicant points out in its variance request (See NAPS ESP COL 11.1-1; NAPS ESP VAR 12.2-1; NAPS ESP VAR 12.2-4; NAPS ESP VAR 12.2-5; FSAR sections 12.2.2.2; 12.2.2.4; 12.2.2.5; and 12.2.2.6), there are various values of North Anna 3 doses and curies per year released that are higher than the North Anna 3 ESP calculated curies per year and regulatory compliance required.

The applicant's variance request, NAPS ESP VAR 12.2-5, "Annual Gaseous Effluent Releases," states:

This is a request to use the Unit 3 maximum annual gaseous effluent release values provided in FSAR Table 12.2-17R rather than the corresponding ESP values in EIS (Reference 6) Appendix I and ESP-ER Section 5.4, as referenced in SSAR Section 2.3.5.1. The Unit 3 values for some nuclides do not fall within (are larger than) the ESP and ER values, as shown in bold font in FSAR Table 12.2-17R. This variance results from a change in the annual release values for the ESBWR since the ESP-ER table was submitted. ESP-ER Table 5.4-7 presented the annual release values for a single unit nuclear plant, based on a composite of possible radionuclide releases from a number of reactor designs, including the ESBWR. ESP-ER Table 5.4-7 also contained more radionuclides than FSAR Table 12.2-17R, due to the use of the composite set of nuclides from multiple reactor designs.

The staff reviewed variance NAPS ESP VAR 12.2-5, and found that the applicant incorporated by reference the major parts of Section 12.2.2.2 of the ESBWR DCD concerning airborne dose evaluation offsite. The applicant also provided information in the COLA as required by the ESBWR DCD for a site-specific application. However, additional information had been supplied from the North Anna 3 ESP or ER site evaluation. When changes are made from the ESP results, it is designated as a variance. The variance applied in Section 12.2.2.2 of the FSAR, states that the Unit 3 values for some nuclides are larger than the ESP and ER values, as shown in bold font in FSAR Table 12.2-17R. This variance results from a change in the annual release values for the ESBWR since the original ESP and ER and tabulated results were submitted. ESP-ER Table 5.4-7 presented the annual release values for a single unit nuclear plant, based on a composite of possible radionuclide releases from a number of reactor designs, including the ESBWR. The staff reviewed the change and the justification of the change and found the change acceptable because the estimated North Anna 3 concentrations of normal gaseous effluent releases remain within the 10 CFR Part 20 concentration limits and the annual doses from normal gaseous effluent releases also remain within 10 CFR Part 50 limits. These calculation results are acceptable based on the use of approved industry standards and industry practices. The applicant's variance is acceptable because the estimated North Anna 3 concentrations of normal gaseous effluent releases for all nuclides meet the 10 CFR Part 20 concentration limits as shown in FSAR Table 12.2-17R. Therefore, the staff considers NAPS ESP VAR 12.2-5 to be acceptable and the issue is therefore resolved.

### **10 CFR Part 50, Appendix I Gaseous Dose Compliance**

The FSAR Tables 12.2-18aR and 12.2-18bR present information submitted to demonstrate compliance with Sections II.B and II.C of Appendix I to Part 50. The parameters used for the calculation of NA3 airborne offsite doses are provided in Table 12.2-18aR. The methodology of RG 1.109 was used in determining the annual airborne dose values. The bases include values that are default parameters in RG 1.109 and other values that are site-specific NA3 parameters. The annual gaseous pathway doses are provided in Table 12.2-18bR and FSAR Table 12.2-201, "Comparison of Annual Doses to the MEI from Gaseous Effluents per Unit." The applicant's estimated annual doses from North Anna 3 to the maximally exposed individual (MEI) from gaseous effluent releases are compared with the applicable regulatory limits in FSAR Table 12.2-201. The North Anna 3 doses are within the 10 CFR Part 50, Appendix I, gaseous effluent limits, and most of the North Anna 3 dose estimates are lower than the corresponding ESP values. (See variance NAPS ESP VAR 12.2-1 below)

The staff reviewed the parameters submitted by the applicant as well as the results and the computer input and output data files submitted for GASPAR II dose calculations. In its review, the staff found insufficient information provided in the North Anna 3 FSAR to independently confirm the calculated individual doses and annual population pathway doses for compliance to applicable regulations. Therefore, in RAI 12.02-18, dated August 01, 2014 (ADAMS Accession No. ML14283A559), the staff requested additional information to include design parameters and values used in the applicant's GASPAR II code calculation, including value derivations and references. In addition, the staff requested that the applicant provide any changes made to the GASPAR II code input/output files used in the calculation of the gaseous effluent doses in Table 12.2-18bR, of the North Anna 3 FSAR, and provide a detailed breakdown of population doses by pathway and organ. On August 26, 2014, the applicant provided the details to validate the information in North Anna 3 FSAR Table 12.2-bR (ADAMS Accession No. ML14241A467). Therefore, RAI 12.02-18 is resolved and closed.

The RG 1.111 states that for gaseous effluents released from points less than the height of adjacent solid structures, ground-level release should be assumed. Ground-level releases under these circumstances account for the initial mixing of the effluent plume within the building wake.

In considering the source configuration criteria set forth in RG 1.111 and the modeling methodology used in the ESBWR DCD, the staff determined that the FSAR should be updated to include a justification for modeling the RWB vent stack as a mixed-mode release or to implement the ground-level source configuration guidance provided in RG 1.111.

Therefore, on September 09, 2014, in RAI 02.03.05-5 (ADAMS Accession No. ML 14283A554), the staff requested information regarding long-term atmospheric dispersion estimates for routine releases, the staff noted that the North Anna 3 COL, FSAR Section 2.3.5, "Long-Term (Routine) Diffusion Estimates," which describes the input data and assumptions that are used in the XOQDOQ model for routine effluent releases from the vent stacks on the Reactor Building/Fuel Building, Turbine Building, and RWB, are all modeled as mixed-mode releases. The North Anna COL FSAR also states that the RWB stack is close enough to the Turbine Building that the stack will experience building downwash effects from the Turbine Building. According to Tier 2, Table 2B-1 of the ESBWR DCD, the RWB stack height is 18.15 m (59.5 ft) above grade whereas the Turbine Building height is 52.0 m (170.6 ft) above grade.

The applicant responded on October 17, 2014, to RAI 02.03.05-5 (ADAMS Accession No. ML14295A659). After further consideration of the source configuration criteria set forth in RG 1.111, the applicant changed the type of release assumed for modeling routine releases from the RWB ventilation stack from mixed-mode to a ground-level release. The applicant stated that estimates of long-term atmospheric dispersion from routine effluent releases will be updated, and associated dose calculations, which use the estimated X/Q and D/Q from the RWB vent stack as inputs, will be revised to implement the updated values. The COLA will be revised to reflect updated values for long-term X/Q and D/Q from the RWB vent stack releases, along with the associated doses. The resulting doses remain within the appropriate acceptance criteria. The affected sections included FSAR Sections 2.3.5.1, 11.3.1, 12.2.2.2.2, and 12.2.2.4.4 and FSAR Tables 1.8-202, 2.0-201, 2.3-16R, 2.3-208, 2.3-209, 2.3-210, 2.3-211, 2.3-212, 2.3-213, 2.3-214, 2.3-215, 12.2-17R, 12.2-18bR, 12.2-201, 12.2-203, and 12.2-204. This change also involved extensive changes in ER sections 2.7.6 and 5.4.2.2 and many ER Tables. Since the applicant revised its Radwaste Stack release point to align with the guidance of RG 1.111, the staff finds that RAI 02.03.05-5 is resolved and closed. The staff verified that the

North Anna 3 COLA Part 2 FSAR Revision 9, Part 3 Revision 8, and Part 7, Revision 7, incorporated the appropriate changes described in the applicant's response to RAI 02.03.05-5. Therefore Confirmatory Item 12.2.4-01 from the staff advanced SER for North Anna 3 is resolved and closed.

The staff found, while reviewing the new effluent information provided by the applicant in response to RAI 02.03.05-5, which the dose quantities in FSAR Table 12.2-17R required additional information in order to evaluate the source term values listed in this table. The staff requested in RAI 12.02-21, that the applicant provide the calculations for all radionuclides in uCi/cc, and Ci/yr, and provide footnote(s) at the end of the Table 12.2-17R for explanation.

The applicant's response on January 08, 2015 (ADAMS Accession No. ML15009A235), explained the assumptions and equations used to calculate the concentrations and quantities of all radionuclides in the gaseous effluents from North Anna 3. This calculational process was included in the RAI response, and the applicant provided footnotes at the end of Table 12.2-17R that also explained the Table 12.2-17R radionuclide values. The staff again reviewed and compared the applicant results by independently calculating the gaseous effluent doses based upon the new information provided by the applicant. Table 12.2.4-1 below indicates the comparison of the staff review and the applicant results. The comparison of the MEI doses from the gaseous pathway yielded mostly consistent results, for the Air-Gamma and Air-Beta Design Objective. The applicant Total Body, Organ (Thyroid) dose and Skin doses were acceptable and below the regulatory requirements. The NRC confirmatory results verified that the applicant's data provided and the applicant's results were acceptable. The NRC finds that the applicant has shown that offsite dose (using site-specific parameters) due to radioactive airborne effluents complies with the regulatory dose limits in Sections II.B and II.C of 10 CFR Part 50, Appendix I.

This additional information allowed the staff to complete their review understanding the bases for the gaseous effluent against applicable regulatory requirements. Therefore, RAI 12.02-21, is resolved and closed.

Table 12.2.4-1 Site-Specific Gaseous Effluent Doses

Description	Design Objective <sup>1</sup> Or Dose Limit	Applicant Site-Specific Calculated Dose	NRC Staff Calculated Doses
MEI doses from gaseous pathway <sup>1,2</sup>	10 mrad/yr (Air-gamma)	0.27 mrad/yr (Air-gamma)	0.28 mrad/yr (Air-gamma)
	20 mrad/yr (Air-beta)	0.25 mrad/yr (Air-beta)	0.25 mrad/yr (Air-beta)
	5 mrem/yr (Total Body)	0.32 mrem/yr (Total Body)	0.18 mrem/yr (Total Body)
	15 mrem/yr (Skin)	0.59 mrem/yr (Skin)	0.43 mrem/yr (Skin)
	15 mrem/yr (Organ)	4.4 mrem/yr (Organ)	4.56 mrem/yr (Organ)
Population doses from gaseous pathway <sup>2</sup>	-	4.5 person-rem/yr (Total Body)	4.5 person-rem/yr (Total Body)
	-	25.0 person-rem/yr (Thyroid)	25.3 person-rem/yr (Thyroid)

Table 12.2.4-1 Notes:

1. Numerical design objectives in 10 CFR Part 50, Appendix I for estimating annual doses above background from gaseous effluents for any individual in an unrestricted area, for one unit, from all exposure pathways are 5 mrem/yr (Total Body) or 15 mrem/yr (Organ).
2. FSAR Section Table 12.2-18bR, Table 12.2-201 and FSAR Table 12.2-204

The applicant's variance request, NAPS ESP VAR 12.2-1, is a request to use updated information for Unit 3 gaseous effluent doses rather than the SSAR information, which referred to ESP-ER Section 5.4. Several of the gaseous pathway doses to the MEI in FSAR Table 12.2-18bR do not fall within (are greater than) the corresponding values in ESP-ER Table 5.4-9. The North Anna 3 values which are higher are shown in bold font in FSAR Table 12.2-18bR. This variance is due in part to changes in maximum long-term dispersion estimates from those used in the ESP application as discussed above under NAPS ESP VAR 2.0-1. The variance is also due to changes in maximum annual gaseous release values from those used in the ESP Application, as discussed below in NAPS ESP VAR 12.2-5.

**Compliance with the U.S. Environmental Protection Agency Standard 40 CFR Part 190**

Compliance with the U.S. Environmental Protection Agency (EPA) standard in 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," as implemented under 10 CFR Part 20.1301(e), is demonstrated in FSAR Tables 12.2-201 and 12.2-203. The applicant estimated the site-specific dose calculations from gaseous and liquid effluent releases for all three North Anna nuclear station units to address the North Anna 3 NAPS COL 12.2-2-A item and to demonstrate compliance with the dose limits to members of the public specified in 10 CFR 20.1302 and 40 CFR Part 190 as referenced in 10 CFR 20.1301(e).

The applicant addressed this requirement in FSAR 12.2.2.4.4, stating that "This section demonstrates that offsite doses due to North Anna 3, combined with offsite doses due to Units 1 and 2 and the NAPS independent spent fuel storage installation (ISFSI), comply with the regulatory limits in 10 CFR 20.1301 for doses to members of the public." The applicant used the North Anna 3 gaseous and liquid effluent release activities in FSAR Tables 12.2-17R for gaseous effluents and Table 12.2-19bR for liquid effluents, and the total annual doses to the MEI and the population resulting from North Anna 3 liquid and gaseous effluents calculated and presented in FSAR Tables 12.2-203 and 12.2-204.

The applicant states that the direct radiation contribution due to contained sources from operation of North Anna 3 is negligible. The direct dose contribution due to Turbine Building skyshine from North Anna 3 at two distances is provided in DCD Table 12.2-21. That table shows the annual dose at 1000 m (0.62 miles) to be 1.66E-06 mSv/yr (1.66E-04 mrem/yr). Section 9.3.9 shows that North Anna 3 uses hydrogen water chemistry, and DCD Section 12.2.1.3 explains that the direct dose contribution takes into account hydrogen water chemistry. The distance from North Anna 3 to the nearest residence is assumed to be 1190 m (0.74 miles) in the NW direction, as described in Section 2.3.5.1. The distance from North Anna 3 to the location on the site boundary with the highest gaseous effluent annual dose is 1416 m (0.88 miles) in the NNE direction. This is the distance from North Anna 3 to the site boundary, that is, the exclusion area boundary or as commonly referred to as the "EAB" in the direction of maximum annual  $\chi/Q$ , as shown in Table 2.3-16R. These distances from North Anna 3 to each type of receptor location are greater than those presented in the DCD, so the North Anna 3

direct radiation dose rate at each location is even lower than the very low rate cited above for 1000 m (0.62 miles).

The total annual doses to the MEI resulting from North Anna Units 1 and 2 liquid and gaseous effluents are provided in Table 12.2-203. The values shown are representative based on review of Units 1 and 2 annual radiological environmental operating reports (e.g., Reference 12.2-203). The direct radiation contribution from operation of Units 1 and 2 is negligible. An evaluation of operating plants by the NRC states that:

...because the primary coolant of an LWR is contained in a heavily shielded area, dose rates in the vicinity of light water reactors are generally undetectable and are less than 1 mrem/year at the site boundary.

The staff concludes that the direct radiation from normal operation results in “small contributions at site boundaries” (Reference 12.2-204, Section 4.6.1.2). For the North Anna Power Station site, the nearest residence is at a distance typical of a site boundary evaluated by NRC. An assumed value of  $1\text{E-}2$  mSv/yr (1 mrem/yr) is included in Table 12.2-203 to account for the dose to the MEI at the nearest residence from operation of Units 1 and 2.

Discharged fuel assemblies from North Anna Units 1 and 2 are stored in the North Anna ISFSI (Reference 12.2-205). The direct radiation contribution from operation of the North Anna ISFSI is small, both at the residence nearest to the ISFSI, which is south and slightly east of the ISFSI at about 870 m (0.54 miles), and at the closest point to the site boundary, which is south and slightly west of the ISFSI at approximately 760 m (0.47 miles). The annual contribution at the site boundary from the ISFSI is no more than  $3.6\text{E-}02$  mSv/yr (3.6 mrem/yr). This value is based on a conservatively estimated peak dose rate from a fully-filled ISFSI with 84 casks/modules, which bounds the planned 68 casks, containing NAPS Units 1 and 2 fuel assemblies and the distance from the ISFSI to the site boundary, which is shorter than that to the residence nearest the ISFSI. This ISFSI dose contribution is then conservatively applied to the MEI for the nearest residence from North Anna 3, which is assumed to be 760 m (0.47 miles) in the northwest direction and even further from the ISFSI.

Table 12.2-203 shows that the total North Anna site doses resulting from the normal operation of Units 1, 2, and 3 and applied at the nearest residence meet 10 CFR 20.1301(e) and are well within the regulatory limits of 40 CFR Part 190. These doses are applied at the distance to the nearest residence from North Anna 3, which is assumed to be 760 m (0.47 miles). These doses bound those at the site boundary.

The staff has reviewed the information provided by the applicant and has displayed the data in SER Table 12.2.4-2, “Estimated Site Gaseous and Liquid Effluent Doses,” shown below. The staff has used the Total Body, Thyroid, and Bone (or Organ) doses for 1) liquid effluents; 2) gaseous effluents; 3) Direct dose maximum from the ISFSI (provided by the applicant); and 4) the total dose from the existing two units on site to calculate the maximum hypothetical maximum dose from all sources at this site to compare to the EPA standard doses in 40 CFR Part 190. As shown in the SER Table 12.2.4-2, using the four inputs stated above for the maximum site dose, the staff calculates a maximum  $9.02\text{E-}2$  mSv/yr (9.02 mrem/yr) Total Body dose,  $13.56\text{E-}2$  mSv/yr (13.56 mrem/yr) Thyroid dose, and  $10.22\text{E-}2$  mSv/yr (10.22 mrem/yr) Bone (Organ) dose, compared to the EPA 40 CFR 190 Limits of  $25\text{E-}2$ ,  $75\text{E-}2$ , and  $25\text{E-}2$  mSv/yr (25, 75, and 25 mrem/yr) for Total Body, Thyroid and Bone (Organ) doses, respectively. These maximum doses are within the guidelines of 40 CFR Part 190.

Investigating the applicant's total site doses listed in FSAR Table 12.2-203, their similar totals are 6.8E-2 mSv/yr (6.8 mrem/yr) total body, 27E-2 mSv/yr (27 mrem/yr) thyroid, and 12E-2 mSv/yr (12 mrem/yr), within the EPA 40 CFR Part 190 limits and lower than the staff calculations. Further review shows that by excluding the maximum ISFSI direct dose provided by the applicant, 3.6E-2 mSv/yr (3.6 mrem/yr), in FSAR section 12.2.2.4.4, in the staff maximum dose calculations in SER Table 12.2.4-2, and replacing the maximum dose from the ISFSI with the FSAR Table 12.2-203, footnote 2, combined ISFSI and the two existing units dose of 1.0E-2 mSv/yr (1.0 mrem/yr) due to direct radiation used by the applicant, the staff total doses compare very favorably with the applicant's total doses. Again, well below the EPA 40 CFR 190 dose limits.

Therefore, the staff has reviewed the information presented in the FSAR including the variance 12.2-1 to the ESP by the applicant and found it acceptable for compliance with 20.1301(e), which references EPA 40 CFR Part 190, as demonstrated in FSAR Tables 12.2-202 and 12.2-203. The compliance with this regulatory requirement has been independently reviewed and is considered acceptable to the staff.

Table 12.2.4-2 Estimated Site Gaseous and Liquid Effluent Doses.

	NRC calculated individual doses			Existing unit doses	NRC calculated total dose	NRC calculated total dose without direct <sup>2</sup>	40 CFR 190 dose limit	Applicant Totals <sup>3</sup>
	Liquid mrem/yr	Gas mrem/yr	Direct (mrem/yr) <sup>1</sup>					
Total Body	0.08	0.34	3.6	5	9.02	5.42	25	5.5
Thyroid	0.26	4.6	3.6	5.1	13.56	9.96	75	10
Bone	1.1	0.42	3.6	5.1	10.22	6.62	25	6.8

Notes:

1. Maximum direct dose assumed from fully loaded ISFSI pad from applicant
2. NRC totals without the maximum direct dose contribution
3. The applicant states that the existing units consider 1 mrem/yr direct dose radiation, which includes the ISFSI doses

The applicant's variance request, NAPS ESP VAR 12.2-4, "Existing Units' and Site Total Doses," states:

This is a request to use updated information for doses for the existing units and the site total doses in FSAR Table 12.2-203 rather than the information in SSAR Section 2.3.5.1 that refers to ESP ER Section 5.4, which contains ESP ER Table 5.4-11. The doses for total body, thyroid, and bone due to the existing units, as shown in FSAR Table 12.2-203, do not fall within (are greater than) the corresponding values in ESP ER Table 5.4-11. Because these values are higher, they are shown in bold font in FSAR Table 12.2-203. This variance is due to the conservative dose estimates for direct radiation from Units 1 and 2 and the Independent Spent Fuel Storage Installation

(ISFSI), which were added to the doses for liquid and gaseous effluents from Units 1 and 2. The direct radiation dose contributions were included in the FSAR dose estimates, but not in the ESP Application dose estimates. The addition of these direct radiation doses to the existing units' doses (annual total body, thyroid, and bone) caused the FSAR values to exceed the SSAR values.”

The applicant justification states:

This variance is acceptable because the dose estimates are more conservative and complete with the addition of the dose contributions from direct radiation from the existing units and the ISFSI. As shown in FSAR Table 12.2-203, the annual total body, thyroid, and bone doses for the site, including the doses from the existing units and the ISFSI, meet the applicable 40 CFR 190 limits.”

The staff review of variance NAPS ESP VAR 12.2-4, found that the applicant incorporated by reference the major parts of Section 12.2.2.2 of the ESBWR DCD concerning airborne dose evaluation offsite. The applicant also provided information in the COLA as required by the ESBWR DCD for a site-specific application. However, additional information has been supplied concerning the possible design and the site by the ESP or ER. This particular variance, as stated above, applied in section 12.2.2.2 of the FSAR, is a request stating this variance is due to the conservative dose estimates for direct radiation from Units 1 and 2 and the ISFSI, which were added to the doses for liquid and gaseous effluents from Units 1 and 2. The staff reviewed the change and the justification of the change and found that, as shown in FSAR Table 12.2-203, the doses are acceptable because the dose estimates are more conservative and complete with the addition of the dose contributions from direct radiation from the existing units and the ISFSI. The doses from the existing units and the ISFSI meet the applicable 40 CFR Part 190 limits, as referenced in 10 CFR 20.1301(e). The calculations and results requirements are acceptable based on the use of the applicable industry standards and industry practices. Therefore, the staff considers NAPS ESP VAR 12.2-4 to be acceptable and that the issue is resolved.

### **10 CFR Part 50 Compliance with Section II.D of Appendix I**

The 10 CFR Part 50, as it relates to ALARA, is addressed in FSAR Section 11.3 for gaseous effluents. Evaluation of 10 CFR Part 50, Appendix I, Section II.D is performed in the North Anna 3 Chapter 11 SER, Section 11.3, using data from FSAR Table 12.2-204, Collective Total Body (Population) Doses Within 50 Miles. The compliance with this regulatory requirement has been reviewed and is considered acceptable to the staff.

- NAPS COL 12.2-3-A Liquid Effluents and Doses, (NAPS ESP COL 11.1-1, Compliance with 10 CFR Part 50, Appendix I, Section II.D; NAPS ESP VAR 12.2-3, Annual Liquid Effluent Releases; and NAPS ESP VAR 12.2-4, Existing Units' and Site Total Doses)

The applicant provides information for compliance with the liquid effluent requirements in FSAR Subsections 11.2.1, 11.2.2.3, 11.2.3.2, 12.2.2.4.1-6, Tables 12.2-19bR, 12.2-20aR, 12.2-20bR, and Table 2.0-202 which address the resolution of NAPS COL 12.2-3-A, which states:

As stated in DCD section 12.2.4, the COL Applicant is responsible for ensuring that offsite dose (using site-specific parameters) due to radioactive liquid effluents complies

with the regulatory dose limits in Section II.A of 10 CFR 50, Appendix I. In addition, the COL Applicant is responsible for compliance with Section II.D of 10 CFR Part 50, Appendix I; liquid effluent concentration limits of 10 CFR Part 20, Appendix B (Table 2, Column 2); and dose limits of 10 CFR Parts 20.1301 and 20.1302 to members of the public (Subsection 12.2.2.4).

The staff reviewed the various aspects of the FSAR for compliance with the NAPS COLs, “Departures, Variances, and Exemptions.” The FSAR also presents comparisons with the information presented in the ESP application and ER for North Anna 3. These comparisons and variations are identified as NAPS ESP COL 11.1-1, and NAPS ESP VAR 12.2-1 and 12.2-4 (Part 7, Departures Report). Any ESP variances or ESP COLs noted in the FSAR and the ESP and ER are presented to ensure all commitments have been made in the application.

In addition, the staff listed parts of the gaseous and liquid effluent compliance process defined in the COLs to ensure compliance with the regulations noted above. These parts are the effluent Source Term, the 10 CFR Part 20 Liquid Compliance, and the 10 CFR Part 50, Appendix I Liquid Dose Compliance.

### **Liquid Source Term**

Liquid sources (Ci/yr) for normal operating releases are calculated using the reactor coolant system source terms given in ESBWR DCD Section 11.1 along with the site-specific design parameters from ESBWR DCD Table 12.2-19a for North Anna 3. The staff used the BWR methodology of NUREG-0016 (GALE) in determining the annual airborne sources release values (Ci/year) presented in DCD Table 12.2-19b and FSAR Table 12.2-19bR. The staff found that the site-specific design parameters and the approved DCD Section 11.1 source term information was determined to be appropriate for the liquid source term released from the North Anna 3 reactor design.

### **10 CFR Part 20 Liquid Compliance**

In addition, the COL applicant is responsible for compliance with site liquid effluent concentration limits of 10 CFR Part 20, Appendix B (Table 2, Column 1), ECLs. The annual North Anna 3 liquid sources release values presented in DCD Table 12.2-19b (and FSAR Table 12.2-19bR) (Ci/yr) are utilized with the site-specific parameters to determine the concentrations released to the environment to the site boundary from North Anna 3 in FSAR Table 12.2-19bR. The North Anna 3 concentrations are combined with the North Anna Units 1 and 2 concentrations in FSAR Table 12.2-19bR to determine a total site concentration. These total site release concentrations are compared to the 10 CFR Part 20, Appendix B, Table 2, Column 1 ECL concentration values to determine if the sum of the ratios of the calculated concentration values divided by the 10 CFR Part 20 Table 2, Column 1 ECL values is less than 1.0 (Unity). Table 12.2-19bR indicates that the applicant’s fraction of ECLs for all site radionuclides concentrations is 0.22.

The staff issued RAI12.02-22 dated November 14, 2014 (ADAMS Accession No. ML14318A652), after the review of the independent source term and dose calculations for the purpose of assessing the performance of the LWMS against the NRC requirements of 10 CFR 20.1302; Table 2, of Appendix B to 10 CFR Part 20; and the dose objectives of Appendix I to 10 CFR Part 50. The calculations in Table 12.2-19bR concerning the concentrations of radioactive materials in liquid effluents released to unrestricted areas should not exceed the concentration limits in Table 2, of Appendix B, to 10 CFR Part 20. The staff requested that the

applicant explain the source term calculations related to assessing the 10 CFR Part 20 requirement calculation(s) involved for all radionuclide values in the Annual Release column, Ci/yr and the Concentration, uCi/ml column in a footnote or note at the end of the table. The current calculations for FSAR Table 12.2-19bR require additional information to evaluate the source term quantities.

The applicant responded on January 8, 2015 (ADAMS Accession No. ML15009A235), and provided the explanations required to calculate the source term and concentrations in FSAR Table 12.02-19bR. The revised response provides further clarification of the information presented in FSAR Table 12.2-19bR, as requested by the NRC during an audit of the underlying calculations on July 1, 2015. FSAR Table 12.2-19bR was revised to include footnotes that explain the source term calculations related to 10 CFR Part 20 requirements for all radionuclide values in columns 2-5 of the table. Examples were also provided explaining the calculations of the values for particular radionuclides. The applicant also provided models showing the discharge canal and the dilution and evaporation terms for the North Anna Reservoir and the Waste Heat Treatment Facility (WHTF). The applicant also provided the equations used to calculate the values seen in the FSAR table.

The staff reviewed the FSAR information submitted and compared all of the applicant's calculation results by independently calculating the liquid effluent concentrations. The staff concludes that liquid effluents released in unrestricted areas comply with effluent concentration requirement in Table 2 (Column 1) of Appendix B to Part 20.

As the applicant points out (See NAPS ESP COL 11.1-1, NAPS ESP VAR 12.2-3, NAPS ESP VAR 12.2-4, sections 12.2.2.4.2, 12.2.2.4.4 and 12.2.2.4.6) there are various values of North Anna 3 curies per year released that are higher than the NA3 ESP calculated curies per year.

The applicant's variance request, ESP VAR 12.2-3, states:

This is a request to use the North Anna 3 maximum annual liquid release values provided in FSAR Table 12.2-19bR rather than the corresponding ESP values in EIS Appendix I (Reference 6) and ESP-ER Section 5.4 as referenced in SSAR Section 2.3.5.1. The North Anna 3 values for some nuclides do not fall within (are larger than) the ESP and ER values, as shown in bold font in FSAR Table 12.2-19bR.

This variance results from a change in the annual release values for the ESBWR since the ESP-ER table was submitted. ESP-ER Table 5.4-6 presented the annual release values for a single unit nuclear plant, based on a composite of possible radionuclide releases from a number of reactor designs including the ESBWR. ESP-ER Table 5.4-6 also contained more radionuclides than FSAR Table 12.2-19bR, due to the use of the composite set of nuclides from multiple reactor designs.

The applicant's justification states:

This variance is acceptable because the estimated North Anna 3 concentrations of normal liquid effluent releases remain within the applicable concentration limits and the annual doses from normal liquid effluent releases remain within applicable limits. The estimated Unit 3 concentrations of normal liquid effluent releases for all nuclides meet the 10 CFR Part 20 concentration limits as shown in FSAR Table 12.2-19bR. The estimated annual doses from Unit 3 to the MEI from liquid effluents are compared with the applicable limit in FSAR Table 12.2-202. The Unit 3 dose meets the 10 CFR Part 50,

Appendix I, limit, and the Unit 3 dose estimates are lower than the corresponding ESP values.

The staff's review of variance NAPS ESP VAR 12.2-3 found that the applicant incorporated by reference the major parts of Section 12.2.2.2 of the ESBWR DCD concerning airborne dose evaluation offsite. The applicant also provided information to the COL as required by the ESBWR DCD for a site-specific application. However, additional information has been supplied concerning the possible design and the site by the ESP or ER. This variance as stated above, applied in Section 12.2.2.2 of the FSAR, is a request stating that the North Anna 3 values for some nuclides are larger than the ESP and ER values, as shown in bold font in FSAR Table 12.2-19bR. This variance results from a change in the annual release values for the ESBWR since the ESP-ER table was submitted. ESP-ER Table 5.4-6 presented the annual release values for a single unit nuclear plant, based on a composite of possible radionuclide releases from a number of reactor designs including the ESBWR. The staff reviewed the change and the justification of the change and found that acceptable because the estimated North Anna 3 concentrations of normal liquid effluent releases remain within the applicable concentration limits and the annual doses from normal liquid effluent releases remain within applicable limits. The estimated North Anna 3 concentrations of normal liquid effluent releases for all nuclides meet the 10 CFR Part 20 concentration limits as shown in FSAR Table 12.2-19bR. The calculations and results requirements are acceptable based on the use of the applicable industry standards and industry practices. The applicant provided an acceptable reason that this variance is acceptable because the North Anna 3 dose meets the 10 CFR Part 50, Appendix I, limit, and the North Anna 3 dose estimates are lower than the corresponding ESP values. Therefore, the staff considers NAPS ESP VAR 12.2-3 to be acceptable and therefore the issue is resolved.

### **10 CFR Part 50, Appendix I Liquid Dose Compliance**

The FSAR Tables 12.2-20aR and 12.2-20bR present information submitted to demonstrate compliance with Sections II.B and II.C of Appendix I to 10 CFR Part 50. The parameters used for the calculation of North Anna 3 liquid offsite doses are provided in Table 12.2-20aR. The methodology of RG 1.109 was used in determining the annual liquid dose values. The basis include values that are default parameters in RG 1.109 and other values that are North Anna 3 parameters. The annual liquid pathway doses are provided in Table 12.2-20bR and FSAR Table 12.2-202, "Comparison of Annual Doses to the MEI from Liquid Effluents per Unit." The applicant's estimated annual doses from North Anna 3 to the MEI from liquid effluent releases are compared with the applicable regulatory limit in FSAR Table 12.2-202. The North Anna 3 doses are within the 10 CFR Part 50, Appendix I, liquid effluent limits, and the North Anna 3 dose estimates are lower than the corresponding ESP values.

The staff reviewed the parameters submitted by the applicant as well as the results and the computer input and output data files submitted for LADTAPII dose calculations. The staff also compared the applicant's results by independently calculating the liquid effluent doses to the MEI. The table below indicates the comparison of the staff review and the applicant results. The staff used the input provided by the applicant and duplicated the applicant's results. Therefore the staff accepts the liquid dose calculations provided.

Table 12.2.4-3 Site-Specific Liquid Effluent Doses

Description	Design Objective <sup>1</sup> Or Dose Limit	Applicant Site-Specific Calculated Dose	NRC Staff Calculated Doses
MEI doses from liquid pathway <sup>1,2</sup>	3.0 mrem/yr (Total Body)	0.079 mrem/yr (Total Body)	0.08 mrem/yr (Total Body)
	10.0 mrem/yr (Bone)	1.1 mrem/yr (Bone)	1.1 mrem/yr (Bone)
Population doses from liquid pathway <sup>2</sup>	-	0.84 person-rem/yr (Total Body)	0.84 person-rem/yr (Total Body)
	-	0.99 person-rem/yr (Thyroid)	0.99 person-rem/yr (Thyroid)

Notes:

1. Numerical design objectives in 10 CFR Part 50, Appendix I for estimating annual doses above background from liquid effluents for any individual in an unrestricted area, for one unit, from all exposure pathways are 3 mrem/yr (Total Body) or 10 mrem/yr (Organ).
2. FSAR Section Table 12.2-20aR, Table 12.2-20bR, Table 12.2-202, Table 12.2-203 and Table 12.2-204.

**Compliance with the U.S. Environmental Protection Agency Standard 40 CFR Part 190**

Compliance with the EPA standard in 40 CFR Part 190, as implemented under 10 CFR 20.1301(e), is demonstrated in FSAR Table 12.2-204. (Liquid and Gaseous). Compliance with the EPA standard in 40 CFR Part 190, as implemented under Part 20.1301(e), is demonstrated in FSAR Table 12.2-203. The compliance with this regulatory requirement has been reviewed in Table 12.2.4-2 and is considered acceptable to the staff.

**10 CFR Part 50 Compliance with Section II.D of Appendix I**

The 10 CFR Part 50 on ALARA is addressed in FSAR Section 11.2 for liquid effluents. Evaluation of 10 CFR Part 50 Appendix I Section II.D is performed in the North Anna 3, Chapter 11 SER, Section 11.2, using data from FSAR Table 12.2-204, "Collective Total Body (Population) Doses Within 50 Miles." The compliance with this regulatory requirement has been reviewed and is considered acceptable to the staff.

- STD COL 12.2-4-A Other Contained Sources

The applicant provided additional information under STD COL 12.2-4-A that addresses the resolution of DCD COL Item 12.2-4-A, which states:

The COL applicant will address any additional contained radiation sources (including sources for instrumentation and radiography) not identified in Subsection 12.2.1.5.

The COL applicant stated that additional contained sources which contain by-product, source, or special nuclear materials may be used and maintained on site. These sources are typically used as calibration or radiography sources. In addition, the contained sources described in Subsection 12.2.1.5 will also be used as check sources.

Calibration sources will be used to calibrate the process and effluent radiation monitors, the area radiation monitors, and portable and laboratory radiation detectors and radiation measurement instruments. In addition to gamma calibration sources, beta and alpha calibration radiation sources are also available. All calibration sources will be traceable to the National Institute of Standards and Technology, or equivalent. Radiography sources will be surveyed upon entry to the site and radiation protection personnel will maintain copies of the most recent leak test records for owner-controlled sources. Radiography will be conducted in accordance with approved procedures. Check sources, which are not necessarily calibrated, are used to confirm the continuing satisfactory operation of an instrument. The applicant stated that check sources which are an integral part of (i.e., physically located in) area, process, and effluent monitors and are not easily removed do not require special handling, storage, or use procedures for radiation protection purposes. The staff finds this acceptable, since these check sources consist of small quantities of by-product material and access to these sources would require procedures and tools to disassemble components of the monitors. Except for check sources physically located in monitors, as described above, and exempt quantities or concentrations of solid and liquid sources used for instrument calibration, the applicant stated that RPP procedures will be used to govern the use and control of these additional contained radiation sources. The applicant stated that these procedures will consider guidance provided in RG 8.8 to ensure that occupational doses from the control and use of these sources are ALARA.

In addition, Section 12.5.4.10 of NEI 07-03A, referenced in the North Anna 3 COL FSAR Appendix 12BB, describes RPP radioactive material control procedures. This section states that procedures will be established, implemented, and maintained to ensure compliance with the relevant requirements in 10 CFR Part 20 to ensure positive control over licensed radioactive material to avoid unnecessary or inadvertent exposures and releases of such material into uncontrolled areas in a manner that is not authorized by regulation or the license. The applicant verified that these procedures will apply to byproduct, source, and special nuclear material, including the contained sources described in Subsection 12.2.1.5. The staff has reviewed and approved NEI 07-03A and the staff, therefore, finds this acceptable.

The RG 1.206 states that the applicant should describe any required radiation sources containing byproduct, source, and special nuclear material that may warrant shielding considerations, and, for any such sources, should provide a listing by isotope, quantity, form, and use for all of these sources that exceed  $3.7 \text{ E}+9 \text{ Bq}$  (100 millicuries). FSAR Appendix 12BB (which incorporates by reference NEI 07-03A) addresses shielding requirements for all byproduct, source, and special nuclear material, including the portable sources described in NA3 FSAR Subsection 12.2.1.5. The applicant stated that they will utilize two standard calibration sources, a neutron (Am-Be) source and a Cs-137 source, that exceed  $3.7 \text{ E}+9 \text{ Bq}$  (100 millicuries). Details of isotope type, quantity, form, shielding requirements, and use of future contained sources will be available when these required sources are purchased. As discussed above, these sources will be controlled by the applicant's RPP.

On the basis of the information provided in Subsection 12.2.1.5 of the North Anna 3 FSAR, the staff finds that the applicant has adequately addressed DCD COL Item 12.2-4-A regarding the description of any other contained radiation sources not described in Subsection 12.2.1.5 of the ESWR DCD. Therefore, the staff finds DCD COL Item 12.2-4-A to be resolved.

As stated above, the applicant's radioactive material control procedures (which are part of the RPP) will apply to byproduct, source, and special nuclear materials. FSAR Subsection 12.2.1.5 provides a description of the specific types of byproduct, source, and special nuclear materials

(including their chemical or physical forms and maximum quantities held at any one time) for the requested material licenses under 10 CFR Part 30, “Rules of General Applicability to Domestic Licensing of Byproduct Material”; 10 CFR Part 40, “Domestic Licensing of Source Material”; and 10 CFR Part 70) that will be received; possessed; or used during the period between the issuance of the COL and the 10 CFR 52.103(g) finding.

In FSAR Subsection 12.2.1.5, the applicant states that no 10 CFR Part 40 (“Domestic Licensing of Source Material”) specifically licensed material—including natural uranium, depleted uranium, or uranium hexafluoride—will be received; possessed; or used during the period between the issuance of the COL and the 10 CFR 52.103(g) finding. Pursuant to 10 CFR Part 30, the FSAR provides a description of the nominal values of projected radioactive byproduct materials (in the form of sealed sources) that will be used for radiation monitoring and laboratory and portable monitoring instrumentation. This information is in FSAR Table 12.2-206. The applicant stated that no byproduct material will be received, possessed, or used in a physical form that is “in unsealed form, on foils or plated sources, or sealed in glass,” and that exceeds the quantities in Schedule C in 10 CFR 30.72, “Schedule C—Quantities of radioactive materials requiring consideration of the need for an emergency plan for responding to a release.” The applicant stated that special nuclear material shall be in the form of reactor fuel and spent fuel, in accordance with limitations for storage and amounts required for reactor operation as described in COLA Part 2. Pursuant to 10 CFR Part 70, the FSAR provides a description of the non-fuel special nuclear material specifically required for use at North Anna 3. This non-fuel special nuclear material consists of local power range monitor assemblies and startup range nuclear monitor assemblies. This information is listed in FSAR Table 12.2-207. The applicant stated that the special nuclear material to be received, possessed, or used does not involve enriched uranium for which a criticality accident alarm system is required; uranium hexafluoride in excess of 50 kilograms (110 pounds) in a single container or 1,000 kilograms (2,200 pounds) total; or plutonium in excess of  $7.4E+10$  Becquerels (Bq) (2 curies (Ci)) in an unsealed form or on foils or plated sources. The staff finds that the specific material information described above satisfies the requirements of 10 CFR 30.32, “Application for specific licenses”; 10 CFR 40.31, “General domestic licenses for byproduct material”; 10 CFR 70.21, “filing”; and 10 CFR 70.22, “Contents of applications,” to receive, possess, and use byproduct, source, and special nuclear material. Therefore, this information is acceptable.

In addition, as part of the North Anna 3 review of plant-specific information on other contained sources under COL Item STD COL 12.2-4-A, the staff issued RAI 02.04.13-6 to determine the applicant’s basis and assumptions used to develop the condensate storage tank (CST) radionuclide inventories listed in North Anna 3 FSAR Table 12.2-205. The staff also issued RAI 12.02-20 requesting that the applicant describe the dimensions, wall composition, and wall thickness of the CST and provide the applicant’s basis for stating in the FSAR that the maximum expected exposure rate at 30 centimeters (cm) (1 ft) from the outside surface of the CST would not exceed  $5E-2$  mSv/hr (5 mrem/hr). The staff requested this information to evaluate the dose rates in the vicinity of the CST and ascertain whether the applicant will need to implement any physical or administrative features to limit the access to the CST to ensure that radiation exposures to personnel in the vicinity of the tank are maintained ALARA. In the applicant’s response to RAI 02.04.13-16 dated January 27, 2015 (ADAMS Accession No. ML15028A392), the applicant stated that the CST is fed by the following four fluid streams; makeup water transfer pumps, control rod drive pump recirculation, LWMS, and condensate reject. Of these four CST input streams, only the streams from the LWMS and condensate reject contribute to the CST radionuclide inventory. The applicant first determined the activity concentrations of the radionuclides in the CST input streams from both the LWMS and condensate reject. Then, in order to ensure the highest potential radionuclide material inventory

is represented in the CST, the applicant selected the bounding concentration for each radionuclide from these two CST input streams to be the maximum concentration from all contaminated CST input streams.

In the applicant's responses to RAI 12.02-20 dated December 3, 2014 and August 31, 2015 (ADAMS Accession No. ML14338A782 and ADAMS Accession No. ML15245A229, respectively), the applicant provided the requested information including the projected CST design dimensions and material of construction and the estimated radionuclide inventory of the CST based on the various potentially contaminated liquid inputs into the tank. The applicant amended the FSAR to include a new table (Table 12.2-205), which lists the estimated radionuclide source term concentrations and source term inventories in the CST. The ESBWR DCD states that the capacity of the CST is 4,885 cubic meters (1.29 million gallons). The ESBWR DCD does not provide any further design parameters for the CST, so the applicant considered two different CST design configurations based on tank aspect ratios (ratio of the tank height to tank diameter) of 0.5 and 2 that limit the tank diameter and height. Based on these tank configurations, the applicant calculated the potential dose rate at 30 cm (1 ft) from the surface of the tank to be  $1.84\text{E-}2$  mSv/hr (1.84 mrem/hr) for the shorter tank (aspect ratio of 0.5) and  $1.78\text{E-}2$  mSv/hr (1.78 mrem/hr) for the taller tank (aspect ratio of 2). Because these estimated dose rates are below the threshold considered to be a radiation area per 10 CFR 20.1003, the applicant concluded that no special physical or administrative features are needed to maintain the exposures ALARA in the vicinity of the CST.

The staff reviewed the applicant's information, assumptions, and the method of analysis and found them acceptable. The staff performed confirmatory analyses to determine the expected dose rates in the vicinity of the CST. The staff's analyses confirmed the applicant's cited results. Therefore, the staff considers RAI 12.02-20, resolved and closed. Overall, the staff finds that the applicant's resolution of COL Item STD COL 12.2-4-A meets the requirements of 10 CFR Part 20 and is therefore acceptable. The staff verified that the North Anna 3 FSAR Revision 9 incorporated the appropriate changes described in the applicant's responses to RAI 12.02-20 and RAI 02.04.13-16. Therefore Confirmatory Item 12.2.4-02 from the staff advanced SER for North Anna 3 is resolved and closed.

### Supplemental Information

- STD SUP 12.2-1

The STD SUP 12.2-1 specifies that each of the required six Cf-252 sealed sources required for reactor startup contains 0.5 to 0.822 mg ( $1.76\text{E-}5$  to  $2.9\text{E-}5$  ounces (oz)) of Cf-252, for a total of 3 to 5 mg ( $1.06\text{E-}4$  to  $1.74\text{E-}4$  oz) of Cf-252. This supplemental information relating to the material description of the Cf-252 reactor startup source satisfies the requirements of 10 CFR 30.32 and, therefore, the staff finds STD SUP 12.2-1 to be acceptable.

### **12.2.5 Post Combined License Activities**

There are no post COL activities related to this section.

### **12.2.6 Conclusion**

The staff's finding related to information incorporated by reference is in NUREG-1966. The staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the relevant information relating to plant radiation sources, and

no outstanding information is expected to be addressed in the North Anna 3 COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the radiation sources that were incorporated by reference are resolved.

In addition, the staff compared the information in the COLA to the relevant NRC regulations, the guidance in SRP Section 12.2, and other NRC RGs.

- STD COL 12.2.4-A states that the applicant should provide information about additional contained radioactive sources not described in the DCD that contain by-product, source, or special nuclear materials that may be maintained on site. In response to this COL information item, the applicant specified that the additional sources not described in the DCD would be used as calibration, radiography, or check sources. The staff concluded that the applicant had adequately responded to this DCD COL information item by providing a description of the contained sources that were not described in the ESBWR DCD. In the response to this DCD COL information item, the applicant also stated that the procedures used to govern the control and use of these contained sources considers the guidance in RG 8.8.
- STD SUP 12.2-1-As discussed in the staff's evaluation above, the staff finds the information in STD SUP 12.2-1 acceptable.

### **12.3 Radiation Protection Design Features**

#### **12.3.1 Introduction**

The FSAR Section 12.3 addresses the issues related to radiation protection equipment and design features used to ensure that occupational radiation exposures are ALARA. The discussion takes into account design dose rates, AOOs, and accident conditions. These issues include the facility design features, shielding, ventilation, area radiation and airborne radioactivity monitoring instrumentation, and dose assessment.

#### **12.3.2 Summary of Application**

Section 12.3 of the North Anna 3 COL FSAR, Revision 8 incorporates by reference Section 12.3 of the certified ESBWR DCD, Revision 10, referenced in 10 CFR Part 52, Appendix E. In addition, in FSAR Section 12.3, the applicant provided the following:

##### **Tier 2 Departure Not Requiring Prior NRC Approval**

- NAPS DEP 11.4-1 Long-Term, Temporary Storage of Class B and C Low-Level Radioactive Waste

The North Anna 3 RWB was reconfigured to accommodate a minimum 10 years of volume from packaged Class B and C waste, while maintaining space for at least 3 months of packaged Class A waste. This reconfiguration results in changes in equipment location and layout affecting various DCD figures and tables. The replacement table and figures are in: FSAR Sections 1.2.2.10.2, 1.2.2.16.9, 11.4, 11.4.1, 11.4.2.2.1, 11.4.2.2.2, 11.4.2.2.4, 11.4.2.3.1, 12.2 and 12.3; FSAR Tables 1.9-11R, 9A.5-5R, 11.4-1R, 11.4-2R, 12.2-22R, and 12.3-8R; and FSAR Figures 1.2-21R, 1.2-22R, 1.2-23R, 1.2-24R, 1.2-25R, 9A.2-20R, 9A.2-21R, 9A.2-22R, 9A.2-23R, 9A.2-24R, 11.4-1R, 11.4-2R, 12.3-19R, 12.3-20R, 12.3-21R, 12.3-22R, 12.3-39R,



In FSAR Subsection 12.3.1.5, “Minimization of Contamination and Radioactive Waste Generation,” the applicant adds a description of the North Anna 3 groundwater monitoring program which meets the guidelines established in NEI 08-08A.

### **12.3.3 Regulatory Basis**

The regulatory basis of the information incorporated by reference is in NUREG–1966. In addition, the relevant requirements of the Commission regulations for the radiation protection design features, and the associated acceptance criteria, are in SRP Section 12.3-12.4.

The staff followed the guidance in RG 1.206 to evaluate North Anna 3 FSAR Section 12.3 for compliance with NRC regulations.

In accordance with Section VIII, “Processes for Changes and Departures,” of “Appendix E to Part 52, the applicant identifies two Tier 2 departures. Tier 2 departures not requiring prior NRC approval are subject to the requirements of 10 CFR Part 52, Appendix E, Section VIII.B.5, which are similar to the requirements of 10 CFR 50.59.

In particular, the regulatory basis for the acceptance of the COL items and the supplemental information is in the applicable requirements of 10 CFR Part 20; Part 50; and Part 70; and in the following guidelines:

- Item III.D.3.3 of NUREG–0737, “Clarification of TMI Action Plan Requirements”
- RG 1.97, Revision 4, “Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants”
- RG 4.21, RG 8.2, and RG 8.8

### **12.3.4 Technical Evaluation**

As documented in NUREG–1966, the staff reviewed and approved Section 12.3 of the certified ESBWR DCD, Revision 10. The staff reviewed Section 12.3 of the North Anna 3 COL FSAR, Revision 8 and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of information relating to this review topic.<sup>1</sup> The staff’s review confirmed that the information in the application and the information incorporated by reference address the required information related to the “Radiation Protection Design Features.”

The staff also reviewed the applicant’s proposed departure, the proposed resolution to the COL items, and the supplemental information included under Section 12.3 of the North Anna 3 COL FSAR. In the review, the staff used the applicable sections of the SRP and RG 1.206 as guidance.

Section 1.2.3 of this SER discusses the NRC’s strategy for performing one technical review for each standard issue outside the scope of the DC and to use this review to evaluate the subsequent COL applications. To ensure that the staff’s findings on the standard content that

were documented in the SER issued for the Fermi 3 application are equally applicable to the North Anna 3 COLA, the staff undertook the following reviews:

- The staff compared the Fermi 3 COL FSAR Revision 8, to the North Anna 3 COL FSAR, Revision 8. In this comparison, the staff considered changes to the North Anna 3 COL FSAR (and other parts of the COLA, as applicable) resulting from RAIs identified in the Fermi SER.
- The staff confirmed that the applicant has endorsed all responses to the RAIs in the corresponding standard content (the Fermi SER) evaluation.
- The staff verified that the site-specific differences are not relevant to this section.

The staff completed the review and finds the evaluation of the Fermi standard content to be directly applicable to the North Anna 3 COLA.

The staff reviewed the information in the North Anna 3 COL FSAR as follows:

*Tier 2 Departure Not Requiring Prior NRC Approval*

- NAPS DEP 11.4-1 Long-Term, Temporary Storage of Class B and C Low-Level Radioactive Waste

The FSAR Section 12.3, Revision 2, provides revised DCD tables and figures as a result of Departure NAPS DEP 11.4-1. In Part 7 of the North Anna 3 COLA, the applicant states that, consistent with the guidance of SRP, Section 11.4, the North Anna 3 RWB waste storage space is configured to accommodate approximately 10 years of Class B and C waste generated during plant operation. In addition, a shielding analysis was performed for this design change showing that the resultant dose rates in surrounding areas—within the building and externally—are maintained below the allowable limits in accordance with the radiological area classification in DCD Tier 2, Subsection 12.3.1.3. Long-term temporary storage of Class B and C waste in high integrity containers, with design lifetimes of 300 years, will not adversely affect the integrity of the waste containers. Furthermore, periodic inspections will be performed to confirm container integrity during storage.

The staff reviewed the information in Part 7 of the COLA. A comparison of the revised FSAR tables and figures with those in Section 12.3 of the DCD Tier 2, Revision 7 revealed numerous changes in room layout and dimensions, with some FSAR rooms/walls showing elevations above the grade level, where, as in Section 12.3 of the DCD, they are below grade. Although this departure reconfigured the RWB to accommodate increased storage space capacity for Class B and C solid waste, the applicant stated that the equipment size, content, and source terms remained unchanged. The applicant revised the thickness of various RWB shield walls to maintain the same radiation zones in accessible areas as those identified in the DCD. The staff finds that the revised configuration enhances the arrangement of equipment locations. In this arrangement, the rooms with lower radiation zones are usually located between the corridor and the rooms with equipment containing higher radiation sources. Equipment cubicles with high radiation sources that are adjacent to a corridor have thicker concrete walls than the comparable cubicle walls in the DCD, in order to reduce the doses in the adjacent corridors. North Anna 3 FSAR Table 12.3-8R and Figures 12.3-19R through 12.3-22R show the revised wall thicknesses and the reconfigured equipment locations in the RWB. The staff reviewed the applicant's information, compared the revised figures and tables against those in the DCD, and

found the changes in accordance with this departure to increase storage space beyond the requirements of the DCD is acceptable.

COL Items

- STD COL 12.3-2-A Operational Considerations

The applicant provided additional information in STD COL 12.3-2-A to address the resolution of DCD COL Item 12.3-2-A, which states:

Airborne radiation monitoring operational considerations, such as the procedures for operations and calibration of the monitors, as well as the placement of the portable monitors, are the COL applicant's responsibility.

The staff reviewed STD COL 12.3-2-A in regards to airborne radiation monitoring operational considerations included in Section 12.3.4 of the North Anna COL FSAR. The COL applicant stated that the airborne radioactivity monitors are classified as non-safety related. Although airborne radioactivity monitors are classified as non-safety related, they are necessary to show compliance with 10 CFR 20.1501.

The COL applicant stated that operation considerations and portable monitor placement are discussed in COL Section 12.5. COL Section 12.5 references NEI 07-03A. NEI 07-03A describes several monitoring instruments that will be maintained and used at the facility, including:

- High and low volume air samplers used to take grab samples to assess airborne radioactivity concentrations to determine respiratory protection measures;
- Continuous air monitors (CAM) to observe trends in airborne radioactivity concentrations and to alert personnel of sudden changes in airborne radioactivity concentrations;
- Portable air sampling and analysis system to determine airborne radioiodine concentrations during and following an accident; and
- Portable sampling and on-site analysis capability to assess airborne radio-halogens and particulates released during and following an accident.

Section 12.5.4.1 of NEI 07-03A describes the operational considerations of these monitors. The template states that airborne radioactivity levels are surveyed by using CAMs and by taking grab samples using portable high and low volume air samplers. The CAM alarm set points are set at a fraction of the concentration values in 10 CFR Part 20, Appendix B, Table 1 (Column 3) for radionuclides expected to be encountered.

Section 12.5.4.1 of NEI 07-03A also describes calibration frequency and procedures for airborne monitors. The template states that CAMs have daily operational checks to test function or response. All monitors used to perform surveys are calibrated before initial use, after maintenance or repairs that might affect the calibration, and at least annually. In addition, emergency and special-use monitors will have operational checks on a regular schedule as specified in written procedures.

Section 12.5.3.2 of NEI 07-03A states that CAMs equipped with local alarm capability are used in occupied areas where needed to alert personnel to sudden changes in airborne radioactivity concentrations. This section also states that radiation monitoring instrumentation and equipment will provide the appropriate detection capabilities, ranges, sensitivities, and accuracies required for the types and levels of radiation anticipated in the plant and in the environs during routine operations, major outages, abnormal occurrences, and postulated accident conditions. Milestone 1.c. of NEI 07-03A ensures that an adequate number of instruments is available to provide for appropriate detection capabilities to conduct radiation surveys in accordance with 10 CFR 20.1501 and 20.1502, including the capability to sample air at all normally occupied locations where airborne radioactivity may exist. The staff finds that the applicant has adequately described the airborne radiation monitoring operational considerations to resolve DCD COL Item 12.3-2-A.

The 10 CFR 20.1101, "Radiation Protection Programs," states that the licensee shall use, to the extent practical, procedures and engineering controls based on sound radiation protection principles to achieve occupational doses that are ALARA. Cobalt-60 is one of the primary long-term source of radiation fields in BWRs. Minimizing the plateout of radioactive cobalt on reactor coolant piping can lead to potentially lower dose rates in the vicinity of this piping and result in correspondingly lower doses to personnel in the portions of the plant containing this piping. In order to minimize the plateout of radioactive cobalt on reactor coolant piping and other components, the North Anna 3 design will incorporate a Zinc Injection System (ZNIS). This system, which is described in North Anna 3 FSAR Section 9.3.11, "Zinc Injection System," is available at startup, along with the Hydrogen Water Chemistry System and On-Line Noble Chem, to provide defense-in-depth against the plateout of radioactive cobalt. The presence of trace quantities of zinc injected into the reactor feedwater reduces occupational exposure to plant personnel by forming a thin oxide layer on stainless steel piping and components. This protective oxide layer inhibits corrosion by reducing soluble Co-60 buildup and is a primary factor in reducing shutdown dose rates on piping and components in low flow rate areas, like the vessel lower plenum, and in primary piping like the Reactor Water Cleanup/Shutdown Cooling System. The use of the ZNIS complies with the requirements of 10 CFR 20.1101 since its use contributes to a reduction in occupational exposure and the decontamination burden.

- CWR COL 12.3-4-A Compliance with 10 CFR 20.1406

The applicant provided information in CWR COL 12.3-4-A related to compliance with 10 CFR 20.1406 in regards to operating procedures that the applicant will implement to prevent the spread of contamination and thereby facilitate decommissioning. This information is described in the COL FSAR Section 12.3.1.5.2. The COL applicant lists several measures used to prevent the spread of contamination, including the use of engineering controls to reduce concentrations of radioactivity in air or fluids; criteria for selecting tools, materials, and equipment used in contaminated areas; the segregation of contaminated tools and equipment from clean tools and equipment; the use of containments, caches, and enclosures to promptly contain spills and releases; conducting surveys of potentially contaminated systems, equipment, and components; and the use of procedures that ensure that equipment performs and is operated in accordance with the design requirements. Most of the items listed in CWR COL 12.3-4-A were taken from the list of practical measures to prevent the spread of contamination in Section 12.5.4.8 of NEI 07-03A. The applicant references this NEI template in Appendix 12BB of the North Anna 3 COL FSAR.

The applicant implements programs and procedures that are consistent with NEI 08-08A, to meet the operational and post-construction objectives of RG 4.21 and the requirements of 10 CFR 20.1406. These objectives include:

- Periodic review of operational practices to ensure that operating procedures reflect the installation of new or modified equipment, personnel qualification and training are kept current, and personnel are following the operating procedures.
- Maintenance of records relating to facility design and construction, facility design changes, site conditions before and after construction, onsite waste disposal and contamination, and results of radiological surveys. Maintenance of such records will be beneficial during decommissioning.
- Maintenance of a conceptual site model based on site characterization and facility design and construction.
- Evaluation of the final site configuration after construction to assist in preventing the migration of radionuclides offsite via unmonitored pathways.
- Implementation of an onsite contamination monitoring program along the potential pathways from the release sources to the receptor points.

The staff finds that these objectives agree with the objectives listed in RG 4.21 and are therefore acceptable and meet the requirements of 10 CFR 20.1406.

Section 12.3.1.5.1 of the COL FSAR lists the radwaste effluent discharge pipeline as one of the three piping systems contain segments that will have to be run underground at North Anna 3. All three of these piping systems are required to have features to minimize contamination or to have monitoring to ensure that the potential for unmonitored, uncontrolled releases of radioactivity to the environment is minimized. Subsection 12.3.1.5.1 of the ESBWR DCD, Tier 2, Revision 10, states that these lines will be kept as short and direct as possible, and they will be designed to preclude inadvertent or unidentified leakage into the environment.

The NAPS SUP 11.2-2, in COL FSAR Section 11.2.3.2, provides a description of the features associated with the radwaste effluent discharge pipeline that will ensure that the potential for unmonitored, uncontrolled releases of radioactivity to the environment from this pipeline will be minimized, in accordance with the guidance in RG 4.21 and the requirements of 10 CFR 20.1406. The radwaste effluent discharge pipeline is used to route liquid radioactive waste generated as a result of plant operations from the RWB to the North Anna 3 discharge structure, where it then flows into the discharge canal. Dilution flow is provided by the North Anna Units 1 and 2 circulating water system which also discharges into the discharge canal. The mixed stream flows through the discharge canal into the WHTF and then out into the Lake Anna Reservoir. At the point where the mixed stream enters the WHTF, the mixture meets the release limits of 10 CFR Part 20, Appendix B Table II, Column 2.

The applicant states that the piping associated with the radwaste effluent discharge pipeline is designed to preclude inadvertent or unidentified leakage to the environment. The buried portion of the piping is enclosed within a guard pipe and monitored for leakage and the other portion of the piping is accessible for visual inspection via a tunnel. This piping incorporates several features to reduce the potential for unmonitored and uncontrolled releases to the environment, in accordance with the guidance provided in RG 4.21. Threaded and flanged pipe connections are kept to a minimum. Other joints, depending on piping material, are welded or otherwise

permanently bonded. Fittings are kept to a minimum and no in-line components, such as valves, are incorporated into this line outside of the power block.

In order to obtain additional information regarding the routing of the radwaste effluent discharge pipeline and design features incorporated to preclude inadvertent or unidentified leakage from this pipe into the environment, the staff issued RAI 12.03-55. The applicant provided an initial response to this RAI on January 8, 2015 (ADAMS Accession No. ML15009A235), and a supplemental response on June 30, 2015 (ADAMS Accession No. ML15187A050). In response to this RAI, the applicant provided a drawing and description of the radwaste effluent discharge pipeline. This pipeline will run from the RWB to the North Anna 3 discharge structure, where it then flows into the discharge canal. The portion of the pipeline that is located in the RWB and the Turbine Building (approximately 76.2 meters (m) (250 feet (ft))) is a single walled pipe which is accessible for inspection. The remainder of the pipeline (approximately 649.2 m (2130 ft)), which runs from the Turbine Building to the discharge structure, is a double walled pipe which has leak detection of the inner pipe. The portion of this pipeline between the Turbine Building and an existing tunnel is buried. The remainder of the pipeline is routed through a buried tunnel that provides access to the inner pipe leak detection as well as visual inspection of the outer guard pipe. The above ground portions of the pipeline are stainless steel while HDPE (high density polyethylene) is used (for both the inner pipe and guard pipe) for the underground portions. NAPS SUP 11.2-2 states that no in-line components (e.g., valves) are incorporated into the radwaste effluent discharge pipeline outside of the power block. In the applicant's response to RAI 12.03-55, the applicant clarified NAPS SUP 11.2-2 by stating that the portion of the radwaste effluent discharge pipeline outside of the power block will not include in-line components such as vacuum breakers or vent valves. The use of these in-line components on the radwaste effluent discharge pipeline could increase the probability of inadvertent or unidentified leakage to the environment. On the basis of the additional information that the applicant provided in response to RAI 12.03-55, on the design of the radwaste effluent discharge pipeline, the staff finds the applicant's response to this RAI acceptable. Therefore, the staff considers RAI 12.03-55, resolved and closed. The staff verified that the North Anna 3 FSAR Revision 9 incorporated the appropriate changes described in the applicant's response to RAI 12.03-55. Therefore Confirmatory Item 12.3.4-01 from the staff advanced SER for North Anna 3 is resolved and closed.

The NEI 08-08A, referenced above, provides a description of the operational and programmatic elements and controls that minimize contamination of the facility, site, and the environment in order to meet the requirements of 10 CFR 20.1406. NEI 08-08A also states that the COL applicant should establish an on-site groundwater monitoring program to ensure timely detection of inadvertent radiological releases to the groundwater.

#### Supplemental Information

- NAPS SUP 12.3-2 North Anna 3 Groundwater Monitoring

In response to discussions held with the staff, the applicant supplemented the North Anna 3 FSAR to add a more detailed description of the North Anna 3 groundwater monitoring program. The North Anna 3 groundwater monitoring program, which is included in the North Anna site Groundwater Protection Program, is implemented to meet the guidelines established in NEI 08-08A. The Groundwater Monitoring Program is part of the applicant's Radiological Environmental Monitoring Program. The North Anna 3 Groundwater Monitoring Program will include a network of wells to ensure timely detection of inadvertent radiological releases to the ground water, in accordance with the guidance of RG 4.21. Some of these wells are placed

downgradient from North Anna 3, based on hydrogeological studies. Other wells are placed close to structures, systems, and components (SSCs) judged to have greater potential for inadvertent radiological releases. In addition, the applicant utilizes groundwater monitoring wells for Units 1 and 2, where feasible, for North Anna 3 groundwater monitoring. NAPS SUP 12.3-2 includes a listing of areas of the North Anna 3 site considered for groundwater monitoring. The applicant monitors potential radiation exposure pathways for groundwater contamination as part of the site REMP. Units 1 and 2 station procedures for the ODCM establish the requirements for the REMP, per the guidance in NEI 07-09A, Attachment 9, "Radiological Environmental Monitoring Program."

As discussed above, the applicant will implement the groundwater monitoring program consistent with the guidelines established in NEI 08-08A to meet the objectives of RG 4.21. Therefore, the staff finds the information contained in NAPS SUP 12.3-1 to be acceptable.

- NAPS SUP 12.3-1 Radwaste Building

In FSAR Subsection 12.3.1.4.5, "Radwaste Building," the applicant adds the following design features to minimize occupational exposures in the RWB:

- Provision for control of fluids exiting high activity rooms, including provision to isolate floor drains, and remote operation of control valves from the radwaste control room.
- Piping from high activity rooms (process and drain piping) are arranged to minimize exposure to normally occupied areas, and are designed to maintain radiation levels in the RWB process system area, as shown in Figure 12.3-19R through Figure 12.3-22R.

The first supplemental provision provides an isolation capability (both local and remote) to prevent the spread of contamination to undesired areas. Remote isolation capability minimizes occupational exposure in the event that such isolation is necessary. The second supplemental provision minimizes occupational exposures from radioactive fluids in the piping in the RWB. RG 8.8 contains guidelines related to facility and equipment design, including pipe routing and shielding, to minimize occupational exposures. The staff finds that these two supplemental provisions to FSAR Subsection 12.3.1.4.5 incorporate the guidance of RG 8.8 for preventing the spread of contamination and minimizing OREs. Therefore the staff finds the information contained in NAPS SUP 12.3-1 to be acceptable.

### Operational Program

- Operational Program Item Number 22 Lifecycle Minimization of Contamination

In Operational Program Item Number 22 of North Anna 3 FSAR Table 13.4-201, "Operational Programs Required by NRC Regulations," the applicant committed to develop an operational program for the lifecycle minimization of contamination, before fuel loading, in compliance with 10 CFR 20.1406. This operational program will be a license condition. This license condition states:

Prior to initial fuel load, the licensee shall implement an operational program for lifecycle minimization of contamination.

Operational Program Item Number 22 in Table 13.4-201 is composed of a number of elements and considerations that are described in NEI 08–08A. Because the operational program incorporates by reference NEI 08–08A into FSAR Subsection 12.3.1.5.2, the staff finds this program milestone acceptable.

### **12.3.5 Post Combined License Activities**

For the reasons discussed in the technical evaluation section above, the staff identifies the following license condition:

- License Condition - Prior to initial fuel load, the licensee shall implement an operational program for lifecycle minimization of contamination.

### **12.3.6 Conclusion**

The staff's findings related to information incorporated by reference are documented in NUREG–1966. The staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to the radiation protection design features, and there is no outstanding information expected to be addressed in the North Anna 3 COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the radiation protection design features that were incorporated by reference are resolved. In addition, the staff compared the information in the COLA to the relevant NRC regulations, the guidance in SRP Section 12.3-12.4, and other NRC RGs. The staff's review also finds that the applicant has adequately addressed the following:

- STD COL 12.3-2-A, which addresses the operational considerations for airborne radiation monitoring, such as the procedures for operations and calibration of the monitors, as well as the placement of the portable monitors, is acceptable because the applicant has incorporated the approved reference NEI 07-03A into the NAPS COL FSAR and meets the applicable regulatory requirements and guidance specified in Sections 12.3.3 and 12.3.4 of this SER.
- CWR COL 12.3-4-A, which address the programs and procedures implemented to minimize contamination in order to facilitate decommissioning, consistent with NEI 08-08A and the requirements of 10 CFR 20.1406, is acceptable because it meets the applicable regulatory requirements and guidance specified in Sections 12.3.3 and 12.3.4 of this SER.

Section 12.3 of the North Anna 3 COL FSAR also includes a discussion of NAPS DEP 11.4-1, the applicant's proposed departure to reconfigure the North Anna RWB waste storage space to accommodate approximately 10 years of Class B and C waste generated during plant operation. On the basis of the staff's review of this departure, the staff finds the RWB reconfiguration departure to be reasonable and in accordance with 10 CFR 52.63(b)(2).

The staff concludes that the information pertaining to North Anna COL FSAR Section 12.3 is within the scope of the DC and adequately incorporates by reference Section 12.3 of the ESBWR DCD. The information is thus acceptable.



Section 1.2.3 of this SER discusses the NRC's strategy for performing one technical review for each standard issue outside the scope of the DC and to use this review to evaluate the subsequent COL applications. To ensure that the staff's findings on the standard content that were documented in the SER for the Fermi 3 application are equally applicable to the North Anna 3 COLA, the staff undertook the following reviews:

- The staff compared the Fermi 3 COL FSAR, Revision 8, to the North Anna 3 COL FSAR, Revision 8. In this comparison, the staff considered changes to the North Anna 3 COL FSAR (and other parts of the COLA, as applicable) resulting from RAIs identified in the Fermi SER.
- The staff confirmed that the applicant has endorsed all responses to the RAIs in the corresponding standard content (the Fermi SER) evaluation.
- The staff verified that the site-specific differences are not relevant to this section.

The staff completed the review and finds the evaluation of the Fermi standard content to be directly applicable to the North Anna 3 COLA.

The staff reviewed the information in the North Anna 3 COL FSAR as follows:

Supplemental Information

- NAPS SUP 12.4-1 Annual Doses to Construction Workers

This supplemental information discusses the potential sources of radiation exposure to construction workers and provides the basis for the applicant's annual and collective dose estimates to construction workers. The sources of radiation exposures to site preparation and construction workers include direct radiation and gaseous and liquid radioactive effluents from North Anna 1 and 2 operations.

**A. Direct Radiation Dose**

The applicant states that the principal radiation sources from Units 1 and 2 (which are located to the east of the North Anna 3 construction site) that contribute to direct radiation exposure at the North Anna 3 construction site are the boron recovery tanks and the low-level contaminated storage area. Another source of direct radiation is the ISFSI, which is located south of the construction area.

The applicant used Thermo-luminescent dosimeter (TLD) measurements taken at a location near operating Units 1 and 2 and at locations in the vicinity of the ISFSI to determine the direct dose contributions to the construction work force. The staff issued RAI 12.03-52 (ADAMS Accession No. ML14329B372) dated November 25, 2014, in order to determine the locations of the TLDs used and the quarterly dose measurements recorded at each of these TLD locations. In the response to RAI 12.03-52, dated January 23, 2015 (ADAMS Accession No. ML15028A184), the applicant provided a site map showing the location of the requested TLDs. For each of these TLDs, the applicant also provided tables showing the quarterly TLD readings measured at each of these locations over a several year period. On the basis of the information provided, the staff finds the applicant's response to RAI 12.03-52 acceptable. Therefore, the staff considers RAI 12.03-52 resolved and closed. The staff verified that the North Anna 3 FSAR Revision 9 incorporated the appropriate changes described in the applicant's response to

RAI 12.03-52. Therefore Confirmatory Item 12.3.4-02 from the staff advanced SER for North Anna 3 is resolved and closed.

The TLD readings at the west protected area fence of Units 1 and 2 indicate an average annual dose of  $7.2\text{E-}1$  millisievert (mSv) (72 millirem (mrem)). This equates to a continuous dose rate of  $8.22\text{E-}5$  mSv/hr ( $8.22\text{E-}3$  mrem/hr) along the eastern edge of the North Anna 3 construction area. The ISFSI is located on the southern edge of the North Anna 3 construction area and there are two TLDs located along the ISFSI perimeter fence, one on the northern perimeter fence closest to the North Anna 3 construction area and one on the southern perimeter fence further from the North Anna 3 construction area. The licensee conservatively used the higher TLD reading from the southern perimeter fence as the estimated dose from the north side of the ISFSI closest to the North Anna 3 construction area. This maximum quarterly dose reading of 1.92 mSv (192 mrem) was taken when there were a total of 40 casks on the two pads of the ISFSI. The applicant stated that the planned capacity of the two fully loaded ISFSI pads is 68 casks. Therefore, to be conservative, the applicant assumed that the quarterly dose rate at the ISFSI perimeter fence from a fully loaded ISFSI would be double the measured quarterly dose, or 3.84 mSv (384 mrem). This equates to a continuous dose rate of  $1.76\text{E-}3$  mSv/hr (0.176 mrem/hr) at the ISFSI fence.

Since the ISFSI perimeter fence is nearly 300 feet (ft) from the southern portion of the construction area boundary, the applicant calculated that the dose rate at the construction area boundary nearest a fully loaded ISFSI would be approximately  $3.04\text{E-}4$  mSv/hr ( $3.04\text{E-}2$  mrem/hr). The estimated construction worker dose at the center of the construction area (approximately 486 m (1600 ft) from the ISFSI) is  $5.98\text{E-}6$  mSv ( $5.98\text{E-}4$  mrem/hr) from a fully loaded ISFSI. The staff reviewed the applicant's method of calculating these estimated dose rates and finds this method to be acceptable.

## **B. Gaseous Effluent Sources**

The sources of gaseous effluent releases at Units 1 and 2 include the waste decay tanks, boron recovery and high-level waste tanks, containment purge system, auxiliary building vent, main condenser air ejector vents, auxiliary steam drain receiver, Turbine Building ventilation exhaust, and gland seal ejector vent. On the basis of information contained in the applicant's annual radioactive effluent release reports for the years 2001 to 2011, the average annual gaseous releases from Units 1 and 2 are  $1.776\text{E+}12$ Bq (48 curies (Ci)) of fission and activation gases and  $2.04\text{E+}12$  Bq (55 Ci) of tritium. The resulting average doses (calculated in accordance with the ODCM for Units 1 and 2) to the maximally exposed member of the public from these gaseous releases are  $1.01\text{E-}4$  mSv/yr ( $1.01\text{E-}2$  mrem/yr) for the whole body and  $1.29\text{E-}3$  mSv/yr ( $1.29\text{E-}1$  mrem/yr) for the critical organ. The maximally exposed member of the public who would receive these doses is located at or beyond the site boundary. Since the North Anna 3 construction area is closer to the effluent release point than is the site boundary, the applicant increased the estimated average dose estimates from gaseous effluents to a construction worker by a factor of ten (the ratio of the x/Q values for these two areas) to get  $1.01\text{E-}3$  mSv/yr (0.101 mrem/yr) for the whole body and  $1.29\text{E-}2$  mSv/yr (1.29 mrem/yr) for the critical organ.

## **C. Liquid Effluent Sources**

Effluents from the liquid waste disposal system of Units 1 and 2 are the source of small amounts of radioactivity in the North Anna Reservoir and the WHTF. The applicant's annual radioactive effluent release reports for the years 2001 to 2011 indicate average annual liquid releases of

7.4E+9 Bq (0.2 Ci) of fission and activation products and 3.6E+13 Bq (966 Ci) of tritium. The resulting average doses (calculated in accordance with the ODCM for Units 1 and 2) to the maximally exposed member of the public from these liquid releases are 3.57E-3 mSv/yr (0.357 mrem/yr) for the whole body and 4.35E-3 mSv/yr (0.435 mrem/yr) for the critical organ.

#### **D. Annual Construction Worker Dose**

The applicant estimated that the peak loading during the construction of North Anna 3 will be 4,088 construction workers per year and each worker will work 2,500 hours per year. The North Anna 3 construction workers may be exposed to direct radiation and gaseous and liquid radioactive effluents from North Anna 1 and 2 operations. As discussed above, the North Anna 3 construction workers will be exposed to both a direct dose rate contribution of 8.22E-5 mSv/hr (8.22E-3 mrem/hr) from Units 1 and 2 along the eastern edge of the North Anna 3 construction area and a larger direct dose rate contribution of approximately 3.04E-4 mSv/hr (3.04E-2 mrem/hr) from the ISFSI along the southern edge of the construction area. Even though these two locations are separated by more than 1,000 ft, the applicant conservatively added these two direct radiation dose rates to get a total dose rate of 3.86E-4 mSv/hr (3.86E-2 mrem/hr). Adjusting for the construction worker residence time of 2,500 hours per year, a North Anna 3 construction worker would receive a maximum annual dose of 9.64E-1 mSv (96.4 mrem) from direct radiation.

Although the southern portion of the North Anna 3 construction area near the ISFSI has the highest direct dose rate, the applicant states that the center of the construction area is representative of the location of the average member of the construction workforce over the course of a year. Adding the dose rate from Units 1 and 2 along the eastern edge of the North Anna 3 construction area to the calculated ISFSI dose rate at the center of the construction area yields a total dose rate of 8.82E-5 mSv/hr (8.82E-3 mrem/hr). Adjusting for the construction worker residence time of 2,500 hours per year, the applicant stated that a North Anna 3 construction worker would receive an annual dose of 2.2E-1 mSv (22.0 mrem) from direct radiation at this location.

As stated above, the applicant calculated that the estimated average dose rates in the construction area from gaseous effluents from Units 1 and 2 would be 1.01E-3 mSv/yr (0.101 mrem/yr) for the whole body and 1.29E-2 mSv/yr (1.29 mrem/yr) for the critical organ. For an expected occupancy time of 2,500 hours per year, a construction worker would be expected to receive an annual dose of 2.89E-4 mSv (2.89E-2 mrem) to the whole body and 3.68E-3 mSv (0.368 mrem) to the critical organ from gaseous effluents. Converting these doses into the total effective dose equivalent (TEDE) (by applying a weighting factor of 0.3 to the critical organ dose and adding the product to the whole body dose) yields an annual construction worker dose of 1.39E-3 mSv (0.139 mrem) TEDE from gaseous effluents.

The applicant calculated that the estimated average dose rates from liquid effluents from Units 1 and 2 would be 3.57E-3 mSv/yr (0.357 mrem/yr) for the whole body and 4.35E-3 mSv/yr (0.435 mrem/yr) for the critical organ. These estimated average dose rates are what the maximally exposed member of the public would receive due to the release of liquid effluents from Units 1 and 2. Although construction workers are not expected to be exposed to liquid effluents from Units 1 and 2, the applicant assumed that construction workers are exposed to the same dose rates as the maximally exposed member of the public. For an expected occupancy time of 2,500 hours per year, a construction worker would receive an annual dose of 1.02E-3 mSv (0.102 mrem) to the whole body and 1.24E-3 mSv (0.124 mrem) to the critical organ. This is equivalent to an annual dose of 1.39E-3 mSv (0.139 mrem) TEDE for liquid effluents.

The applicant considers construction workers working at the North Anna 3 construction area to be members of the general public. 10 CFR 20.1301, "Dose limits for individual members of the public," states that the total effective dose equivalent for members of the public from licensed operations not exceed 1 mSv (100 mrem) in a year and 2E-2 mSv (2 mrem in any 1 hour). The applicant states that the total annual dose to the maximally exposed construction worker will not exceed 9.7E-1 mSv (97 mrem) TEDE (sum of the construction worker dose from direct radiation (9.64E-1 mSv/yr (96.4 mrem/yr) TEDE), from gaseous effluents (1.39E-3 mSv (0.139 mrem) TEDE), and from liquid effluents (1.39E-3 mSv (0.139 mrem) TEDE)). The maximum dose rate in the construction area is less than 4E-4 mSv (4E-2 mrem) in any 1 hour. Since these calculated doses meet the public dose limits of 10 CFR 20.1301, the construction workers would not need to be classified as radiation workers, in accordance with the requirements of 10 CFR 19.12.

The total annual dose to an average member of the construction workforce is based on the dose to a worker who would spend most of the time working near the center of the construction area. The total annual dose to an average member of the construction workforce is 2.2E-1 mSv (22.0 mrem) TEDE. With a peak loading of 4,088 construction workers per year, the estimated construction worker collective dose would be 9.1E-1 person-sieverts (91 person-rem).

Since the applicant's estimate of 9.7E-1 mSv (97 mrem) TEDE to the maximally exposed construction worker is very close to the 10 CFR 20.1301 limit of 1.0 mSv (100 mrem) to a member of the public, the staff requested RAI 12.03-58) (ADAMS Accession No. ML14329B372) that the applicant provide a description of dose reduction measures identified or taken as a result of the dose assessment process to ensure that worker doses are maintained as low as is reasonably achievable and do not exceed the applicable dose limits. In the applicant's January 8, 2015 (ADAMS Accession No. ML14329B372), response to RAI 12.03-58, the applicant provided a number of conservative assumptions that they made in their construction worker dose assessment.

- In calculating the direct dose to a construction worker working in the southern part of the construction area closest to the ISFSI, the applicant added the full direct dose component of 2.05E-1 mSv (20.5 mrem) from Units 1 and 2 (measured at the eastern edge of the construction area) to the ISFSI direct dose component, without adjusting the dose from Units 1 and 2 based on the distance from the ISFSI. Since the eastern and southern edges of the construction area are separated by more than 1,000 feet, the component of the dose from Units 1 and 2 at the southern edge of the construction area would be negligible compared to the ISFSI dose of 7.59E-1 mSv (75.9 mrem). By making this distance adjustment to the direct dose contribution from Units 1 and 2 at the ISFSI, the estimated construction worker direct dose component would have been reduced by 27 percent.
- The applicant based the direct dose component to the construction workers from the ISFSI on a loading of 80 spent fuel casks, when the current plan is to load a maximum of 68 spent fuel casks into the ISFSI. If the dose assumption had been based on the lower number of casks, the estimated direct dose would have been reduced by 18 percent.
- Although the North Anna 3 construction area is on the north side of the ISFSI, the applicant conservatively used the higher dose reading from the TLD located on the south side of the ISFSI to determine the construction worker dose from the ISFSI.

- The applicant assumed that the construction worker spends the entire 2,500 hours per year working on the southern perimeter of the construction area near the ISFSI, where the dose rate is maximized. Realistically, a construction worker would work in different areas with varying dose rates throughout the construction area, resulting in an exposure to a lower average dose rate for the year.

In evaluating the applicant's calculations to determine the estimated dose to North Anna 3 construction workers from the ISFSI and from operating Units 1 and 2, the staff reviewed the dose conservatisms used by the applicant and described in the applicant's response to RAI 12.03-58. On the basis of these conservatisms, the staff agrees that the applicant's estimated maximum annual construction worker dose of  $9.64E-1$  mSv (96.4 mrem) from direct radiation is conservative and the actual measured doses to the North Anna 3 construction workers could be lower than the applicant's dose estimates. In the applicant's response to RAI 12.03-58, the applicant also stated that the construction area will be continually monitored during the construction period and that the applicant will take appropriate actions, as necessary, to ensure that doses to the construction workers will be maintained ALARA. The staff agrees that the applicant's construction worker dose estimates are conservative and that the applicant is committed to ensuring that doses to construction workers during the construction of North Anna 3 will be maintained ALARA. Therefore, the staff finds the applicant's response to RAI 12.03-58 to be acceptable and considers RAI 12.03-58 resolved and closed.

On the basis of the above evaluation, the staff finds that the applicant's estimates of doses to construction workers during the construction of North Anna 3 are within the applicable limits of 10 CFR 20.1301; and 10 CFR Part 50, Appendix I (for gaseous effluents) and are, therefore, acceptable.

#### **12.4.5 Post Combined License Activities**

There are no post COL activities related to this section.

#### **12.4.6 Conclusion**

The staff's findings related to information incorporated by reference are documented in NUREG-1966. The staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the required information relating to dose assessment, and there is no outstanding information expected to be addressed in the North Anna 3 COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to dose assessments that were incorporated by reference are resolved.

In addition, the staff compared the information in the COLA to the relevant NRC regulations, the guidance in SRP Section 12.3-12.4, and other NRC RGs. The staff's review also finds that the applicant has adequately addressed the following:

- NAPS SUP 12.4-1, which provides site-specific supplemental information to address dose to construction workers, is acceptable because the applicant has demonstrated compliance with the applicable requirements of 10 CFR 20.1101, 20 CFR 20.1301, and 10 CFR 20.1302. The applicant has also demonstrated compliance with the acceptance criteria in Section 4.5, "Radiation Exposure to Construction Workers," of NUREG-1555 and the applicable acceptance criteria provided SRP Section 12.3-12.4.



## Operational Program

- Operational Program Item Number 10      Radiation Protection Program

The DCD Tier 2, Section 13.4 directs the COL applicant to develop and implement the required operational programs. The applicant provides Operational Program Item Number 10, "Radiation Protection Program," in FSAR Table 13.4-201, which identifies the program milestones.

### **12.5.3      Regulatory Basis**

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the relevant requirements of the Commission regulations for the Operational RPP, and the associated acceptance criteria, are in SRP Section 12.5.

The staff followed the guidance in RG 1.206 to evaluate North Anna 3 FSAR Section 12.5 for compliance with NRC regulations.

In particular, the regulatory basis for the acceptance of the COL items is established in the following requirements and guidance documents:

- Management and organization are established in RG 1.8, Revision 3, RG 8.2, Revision 1, RG 8.8, Revision 3, and RG 8.10, Revision 1-R; as required by 10 CFR 20.1101; and 10 CFR 20.2102, "Records of radiation protection program."
- Adequate facilities are established in RG 1.97, Revision 4, RG 8.8, Revision 3, RG 8.9, Revision 1, RG 8.15, Revision 1, RG 8.20, Revision 1, "Applications of Bioassay for I-125 and I-131," and RG 8.28; as required by 10 CFR 20.1801, "Security of stored material"; 10 CFR 20.1802, "Control of material not in storage"; and 10 CFR 20.1906, "Procedures for receiving and opening packages."
- Instrumentation and equipment are established in 10 CFR 20.1501, "General"; 10 CFR 20.1502, "Conditions requiring individual monitoring of external and internal occupational dose"; 10 CFR 50.34(f)(2)(xxvii); and the criteria in Item III.D.3.3 of NUREG-0737.
- Training and procedures are established in RG 1.8, Revision 3, RG 1.33, Revision 2, "Quality Assurance Program Requirements (Operation)," RG 8.2, Revision 1, RG 8.7 Revision 2, RG 8.8, Revision 3, and RG 8.10, Revision 1-R; as required by 10 CFR 19.11, "Posting of notices to workers"; 10 CFR 19.12, "Instruction to workers"; and the applicable requirements in 10 CFR Part 20, Part 50, Part 70, and Part 71.

The regulatory basis for acceptance of the resolution to Operational Program Number 10 in Table 13.4-201, which addresses the RPP, is satisfied based on meeting the requirements of 10 CFR 20.1101.

### **12.5.4      Technical Evaluation**

As documented in NUREG-1966, the staff reviewed and approved Section 12.5 of the certified ESBWR DCD. The staff reviewed Section 12.5 of the North Anna 3 COL FSAR and checked the referenced ESBWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD appropriately represents the complete scope of



instrument calibration facility that is consistent with NEI 07-03A. Equipment to be used for radiation protection purposes includes portable radiation survey instruments, personnel monitoring equipment, fixed and portable area and airborne radioactivity monitors, laboratory equipment, air samplers, respiratory protective equipment, and protective clothing.

The staff finds that the applicant has adequately described the plant health physics equipment, instrumentation, and facilities addressed by DCD COL Item 12.5-1-A and this information is sufficient to resolve DCD COL Item 12.5-1-A.

- STD COL 12.5-2-A Compliance with Paragraph 50.34(f)(2)(xxvii) of 10 CFR Part 50 and NUREG-0737, Item III.D.3.3

The applicant provided additional information in STD COL 12.5-2-A to address the resolution of DCD COL Item 12.5-2-A, which states:

The COL applicant will provide a description of the portable instruments that accurately measure radio-iodine concentrations in plant areas under accident conditions and of the training and procedures on the use of these instruments.

The FSAR states that this COL information item is addressed in NEI 07-03A, which is referenced in Appendix 12BB of the FSAR. The licensee must show compliance with 10 CFR 50.34(f)(2)(xxvii) and Item III.D.3.3 of NUREG-0737 in order to resolve this COL action item. 10 CFR 50.34(f)(2)(xxvii) (as supplemented by the criteria in Item III.D.3.3 of NUREG-0737) requires the licensee to provide equipment and associated training and procedures for accurately determining the airborne iodine concentration in areas within the facility where plant personnel may be present during an accident. NEI 07-03A discusses procedures to be used to collect and analyze samples to detect and measure radioiodine. This template states that radiation protection technicians will be trained and qualified under a program established in accordance with 10 CFR 50.120. This training, along with the procedures on radiological surveillance described in NEI 07-03A, will ensure that the radiation protection technicians will have the capability of determining the airborne iodine concentrations in areas within the facility where personnel may be present during an accident and for a broad range of routine conditions. Milestone 1.c. of NEI 07-03A ensures that an adequate number of instruments are available to provide for appropriate detection capabilities to conduct radiation surveys in accordance with 10 CFR 20.1501 and 20.1502, including the capability to determine the airborne iodine concentration in areas within the facility where plant personnel may be present during an accident.

The staff finds that the applicant has provided an adequate description of the portable instruments that accurately measure radio-iodine concentrations in plant areas under accident conditions and of the training and procedures provided on the use of these instruments. Therefore, the staff finds that the applicant has provided sufficient information in the FSAR to resolve DCD COL Item 12.5-2-A.

- STD COL 12.5-3-A Radiation Protection Program

The applicant provided additional information in STD COL 12.5-3-A to address the resolution of DCD COL Item 12.5-3-A, which states:

The COL applicant will provide a description of the operational Radiation Protection Program.

The FSAR states that this COL information item is addressed in NEI 07-03A, which is referenced in Appendix 12BB of the FSAR. NEI 07-03A provides a detailed description of the RPP.

Access to very high radiation areas is discussed in Section 12.5 of the North Anna 3 FSAR as part of the operational program for radiation protection. In Section 12.5.3 of the North Anna 3 COL FSAR, the applicant states that the operational program for radiation protection is addressed in Appendix 12BB. Appendix 12BB references NEI 07-03A as the generic FSAR template guidance for the description of North Anna's RPP.

Section 12.5.4.4 of NEI 07-03A (specifically the bracketed "Note" portion of Section 12.5.4.4) states that each COL applicant should provide additional plant-specific information in the FSAR to describe each Very High Radiation Area (VHRA) and to refer to each location on the plant layout diagrams in FSAR Section 12.3. The description of additional administrative controls for restricted access to each VHRA is required by 10 CFR 20.1602. Section 12.5.4.4 of NEI 07-03A also states that applicant's should provide detailed drawings of each VHRA and indicate physical access controls for each of these areas. Appendix 12BB of the North Anna 3 FSAR includes a table which lists all the accessible VHRAs in the plant (those VHRAs which are normally submerged are identified in the DCD Section 12.3 layout drawings), along with their cubicle numbers and a reference to the DCD plant layout drawings which depict each of these areas. The accessible VHRAs are located in the upper and lower drywells, in the Inclined Fuel Transfer Tube Room, and in other areas adjacent to the Inclined Fuel Transfer tube. In addition, Appendix 12BB includes a description of administrative controls which the licensee will implement to control entrance into VHRAs. The applicant states that, in the unlikely event that access to a VHRA is required, entry into will be controlled in accordance with the requirements of a specific (Special) radiation work permit. The applicant also described, in Appendix 12BB, the physical barriers and controls which are in place to preclude inadvertent access to each of the identified VHRAs. These include postings, barricades, physical barriers, and the use of locks that are keyed so only keys designated as VHRA can open the locks. The existence of the barriers, interlocks, and alarms used to control access to areas immediately adjacent to the Inclined Fuel Transfer System is verified via Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) which are identified in DCD Tier 1, Table 2.5.10-1.

By incorporating the guidance of NEI 07-03A, the staff finds that the applicant has provided an adequate description of the operational RPP. Therefore, the staff finds that the applicant has provided sufficient information in the FSAR to resolve DCD COL Item 12.5-3-A.

#### Operational Program

- Operational Program Item 10                      Radiation Protection Program

The applicant provided implementation schedules and milestones to address Operational Program Number 10, which is associated with the RPP, as required by 10 CFR Part 20.1101. In Table 13.4-201 of the North Anna 3 FSAR, the applicant lists four milestones for the RPP implementation. The four listed milestones are:

1. Prior to initial receipt of byproduct, source, or special nuclear materials (excluding Exempt Quantities as described in 10 CFR 30.18) for those elements of RPP necessary to support such receipt.

2. Prior to fuel receipt for those elements of RPP necessary to support receipt and storage of fuel onsite.
3. Prior to fuel load for those elements of RPP necessary to support fuel load and plant operation.
4. Prior to the first shipment of radioactive waste for those elements of the RPP necessary to support shipment of radioactive waste.

The RPP is composed of a number of elements that are described in NEI 07-03A. Since the applicant incorporates by reference NEI 07-03A into FSAR Appendix 12BB, the staff finds these program milestones acceptable.

For operational program readiness in Section 3.6 of Part 10 of the COLA, the applicant provides a general implementation plan for operational programs that are listed in Table 13.4-201. This implementation plan states that:

The licensee shall submit to the Director of NRO, a schedule, no later than 12 months after issuance of the COL, for implementation of the operational programs listed in FSAR Table 13.4-201. The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month thereafter until the operational programs in the FSAR table have been fully implemented.

The staff finds the applicant's general implementation plan for operational programs in Table 13.4-201 to be consistent with the guidance in SECY-05-197, "Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria." In addition, in FSAR Appendix 12BB, the applicant incorporates by reference NEI 07-03A (which provides the RPP milestones). Therefore, the staff finds that the applicant adequately addresses Operational Program Item Number 10.

### **12.5.5 Post Combined License Activities**

For the reasons discussed in the technical evaluation section above, the staff identifies the following two license conditions:

- License Condition – The licensee shall implement the RPP (including the ALARA principle) or applicable portions thereof, on or before the associated milestones identified below:
  - a. Receipt of Materials – Prior to initial receipt of byproduct, source, or special nuclear materials onsite (excluding exempt quantities as described in 10 CFR 30.18, "Exempt quantities.")
  - b. Fuel Receipt – Prior to initial receipt and storage of fuel onsite
  - c. Fuel Loading – Prior to initial fuel load
  - d. Waste Shipment – Prior to first radioactive waste shipment

- License Condition – No later than 12 months after issuance of the COL, the licensee shall submit to the Director, NRO a schedule that supports planning for and conduct of NRC inspections of the operational program (Radiation Protection Program). The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month thereafter until this operational program has been fully implemented.

### 12.5.6 Conclusion

The staff's finding related to information incorporated by reference is in NUREG-1966. The staff reviewed the application and checked the referenced DCD. The staff's review confirms that the applicant has addressed the relevant information relating to the operational RPP, and no outstanding information is expected to be addressed in the North Anna 3 COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the operational RPP that were incorporated by reference are resolved.

In addition, the staff compared the additional information in the COLA to the relevant NRC regulations, the guidance in SRP Section 12.5, and other pertinent NRC RGs. The staff's review concludes that the applicant has adequately addressed the following:

- STD COL 12.5-1-A requires the applicant to describe radiation protection equipment, instrumentation, and facilities. The FSAR states that this COL information item is addressed in NEI Template 07-03A which is referenced in Appendix 12BB of the FSAR. The staff has reviewed and accepted NEI 07-03A for addressing this COL item. This template thoroughly describes radiation protection facilities and monitoring instrumentation and equipment. The staff finds that the applicant has adequately described the plant health physics equipment, instrumentation, and facilities addressed by DCD COL Item 12.5-1-A and this information is sufficient to resolve DCD COL Item 12.5-1-A.
- STD COL 12.5-2-A requires the applicant to describe portable instruments for measuring radioiodine concentrations under accident conditions and the training and procedures on the use of these instruments, in compliance with the requirements of 10 CFR 50.34(f)(2)(xxvii) and the guidance of NUREG-0737 Item III.D.3.3. The applicant references FSAR Appendix 12BB, which in turn adopts NEI 07-03A to address the needs of this standard COL item. The staff has reviewed and accepted NEI Template 07-03A for addressing this COL item. This template discusses the procedures to be used to collect and analyze samples to detect and measure radioiodine. It also states that radiation protection technicians will have sufficient training (in accordance with the requirements of 10 CFR 50.120) to ensure that they will have the capability of determining the airborne iodine concentrations in areas within the facility where personnel may be present during an accident and for a broad range of routine conditions. The staff finds that the applicant has adequately described the portable instruments for measuring radioiodine concentrations under accident conditions and the training and procedures on the use of these instruments addressed by DCD COL Item 12.5-2-A and this information is sufficient to resolve DCD COL Item 12.5-2-A.
- STD COL 12.5-3-A requires the applicant to provide a description of the operational RPP and to include the locations of the VHRA in the plant and as well as descriptions of the access controls for each of these areas. FSAR Section 13.5 includes a description of the plant procedures that comprise the operational RPP. The applicant references FSAR Appendix 12BB, which in turn adopts NEI 07-03A to address the needs of this standard

COL item. NEI 07-03A describes a RPP that is sufficient to ensure compliance with the requirements of 10 CFR 19.12, 10 CFR 19.13, 10 CFR Part 20, and the applicable parts of 10 CFR 50, 52 and 71. The RPP described in NEI 07-03A is also consistent with the guidance in RGs 1.8, 8.2, 8.4, 8.6, 8.7, 8.8, 8.9, 8.10, 8.13, 8.15, 8.27, 8.28, 8.29, 8.34, 8.35, 8.36, and 8.38 and with the applicable portions in NUREG-1736. In addition to describing each VHRA in the plant, FSAR Appendix 12BB includes a description of additional administrative controls for restricted access to each VHRA, as required by 10 CFR 20.1602. The staff finds that this information is acceptable to resolve DCD COL Item 12.5-3-A.

The applicant also lists Operational Program Item Number 10, which pertains to the RPP and its implementation milestones, in FSAR Table 13.4-201. As stated above, the overall description of the applicant's operational program for radiation protection is in FSAR Appendix 12BB, which references NEI 07-03A. On the basis of the staff's review of the applicant's operational RPP described above, the staff finds the applicant's operational RPP and the associated milestones to be acceptable.

## References

1. 10 CFR 19.12, "Instructions to workers."
2. 10 CFR 20.1101, "Radiation protection programs."
3. 10 CFR 20.1301, "Dose limits for individual members of the public."
4. 10 CFR 20.1302, "Compliance with dose limits for individual members of the public."
5. 10 CFR 20.1406, "Minimization of contamination."
6. 10 CFR 20.1501, "General."
7. 10 CFR 20.1502, "Conditions requiring individual monitoring of external and internal occupational dose."
8. 10 CFR 20.1801, "Security of stored material."
9. 10 CFR 20.1802, "Control of material not in storage."
10. 10 CFR 20.1906, "Procedures for receiving and opening packages."
11. 10 CFR 30.18, "Exempt quantities."
12. 10 CFR 30.72, "Schedule C-Quantities of radioactive materials requiring consideration of the need for an emergency plan for responding to a release."
13. 10 CFR 50.120, "Training and qualification of nuclear power plant personnel."
14. 10 CFR 50.59, "Changes, tests, and experiments."
15. 10 CFR Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations."
16. 10 CFR Part 20, "Standards for Protection against Radiation."
17. 10 CFR Part 20, Appendix B, "Radiation Protection Programs."
18. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."
19. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants."
20. 10 CFR Part 50, Appendix A, GDC 60, "Control of releases of radioactive materials to the environment."
21. 10 CFR Part 50, Appendix A, GDC 64, "Monitoring radioactivity releases."
22. 10 CFR Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents."
23. 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

24. 10 CFR Part 52, Appendix E, "Design Certification Rule for the ESBWR Design."
25. 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material."
26. 10 CFR Part 71, "Packaging and Transportation of Radioactive Material."
27. 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."
28. ANSI/ANS-3.1-1993, "Selection, Qualification, and Training of Personnel for Nuclear Power Plants."
29. GEH ESBWR Design Control Document (DCD), Revision 10, April 2014 (ADAMS Accession No. ML14104A929).
30. NEI 07-03A, Revision 0, "Generic FSAR Template Guidance for Radiation Protection Program Description," May 2009. (ADAMS Accession No. ML091490684.)
31. NEI 07-08A, "Generic FSAR Template Guidance for Ensuring that Occupational Radiation Exposures Are As Low As Is Reasonably Achievable (ALARA)," October 2009 (ADAMS Accession No. ML093220178).
32. NEI 07-09A, "Generic FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description," March 2009, (ADAMS Accession No. ML091460258) and (see also the staff's SER in ADAMS Accession No. ML083530745).
33. NEI 08-08A, "Generic FSAR Template Guidance for Life Cycle Minimization of Contamination," October 2009 (ADAMS Accession No. ML093220530).
34. NRC GL 89-01, "Implementation of Programmatic and Procedural Controls for Radiological Effluent Technical Specifications," January 31, 1989 (ADAMS Accession No. ML031140051).
35. NRC RG 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," October 1977 (ADAMS Accession No. ML003740384).
36. NRC RG 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors (for comment)," March 1976 (ADAMS Accession No. ML003740332).
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