12.0 RADIATION PROTECTION

This chapter provides information on radiation protection methods and estimated occupational radiation exposures to operating and construction personnel during normal operations and anticipated operational occurrences (AOOs). (In particular, AOOs may include refueling; purging; fuel handling and storage; radioactive material handling, processing, use, storage, and disposal; maintenance; routine operational surveillance; in-service inspection; and calibration.) 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 in 10 CFR Part 20 and to be consistent with the practices in the appropriate regulatory guides (RGs) that are used to implement NRC regulations. Finally, this chapter provides updated information that supplements the Economic Simplified Boiling-Water Reactor (ESBWR) design control document (DCD) with a site-specific assessment of doses to members of the public from 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 occupational radiation exposure (ORE) to personnel will be kept as low as is reasonably achievable (ALARA). The ALARA program is addressed in Appendices 12AA and 12BB in the North Anna 3 Combined Operating License (COL) Final Safety Analysis Report (FSAR), by adopting the Nuclear Energy Institute (NEI) 07-03 “Generic FSAR Template Guidance for Radiation Protection Program Description,” and the NEI 07-08 “Generic FSAR Template Guidance for Ensuring that Occupational Radiation Exposures Are As Low As Is Reasonably Achievable (ALARA),” documents.

12.1.2 Summary of Application

Section 12.1 of the North Anna 3 COL FSAR incorporates by reference Section 12.1 of the ESBWR DCD, Revision 5.

In addition, in FSAR Section 12.1, the applicant provided the following:

COL Items

- STD COL 12.1-1-A Regulatory Guide 8.10

The applicant references draft NEI 07-03 for addressing compliance with RG 8.10 in COL FSAR subsection 12.1.4 to resolve DCD COL Item 12.1-1-A.

- STD COL12.1-2-A Regulatory Guide 1.8

The applicant references draft NEI 07-03 for addressing compliance with RG 1.8 in COL FSAR subsection 12.1.4 to resolve DCD COL Item 12.1-2-A.

- STD COL12.1-3-A Operational Considerations

The applicant references draft NEI 07-03 to resolve DCD COL Item 12.1-3-A addressing criteria and conditions by which various operating procedures and techniques will be implemented to ensure that occupational exposures are ALARA using the guidance of NUREG 1736.

- STD COL12.1-4-A Regulatory Guide 8.8

The applicant references draft NEI 07-03 for addressing compliance with RG 8.8 in COL FSAR subsection 12.1.4 to resolve DCD COL Item 12.1-4-A.

Supplemental Information

- STD SUP12.1-1 ALARA Program

The applicant references drafts NEI 07-03 and NEI 07-08 for addressing the ALARA program at the site.

12.1.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the final safety evaluation report (FSER) related to the DCD.

In addition, the regulatory basis for acceptance of the resolution to the COL items is established in 10 CFR Part 20, "Standards for Protection Against Radiation;" RG 8.10 (Revision 1), "Operating Philosophy for Maintaining Occupational Radiation Exposures ALARA;" RG 1.8 (Revision 2), "Qualification and Training of Personnel for Nuclear Power Plants;" RG 8.8 (Revision 3), "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be ALARA;" and the guidance included in RGs 1.8, 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.

12.1.4 Technical Evaluation

The NRC staff reviewed Section 12.1 of the North Anna 3 COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the information in the COL represent the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information related to assuring that occupational radiation exposures are ALARA. The NRC staff is reviewing Section 12.1 of the ESBWR DCD on Docket No. 52-010. The NRC staff's technical evaluation of the information incorporated by reference related to section will be documented in the staff SER on the design certification application for the ESBWR design.

In addition, the staff reviewed the applicant's proposed resolution to the following COL information items and the supplementary item included under Section 12.1 of the North Anna

[1] See Section 1.2.2, "Finality of Referenced NRC Approvals," for a discussion on the staff's review related to verification of the scope of information to be included within a COL application that references a design certification.

COL. In this review, the staff used the applicable sections of the SRP (NUREG-0800) and RG 1.206 as guidance.

The staff reviewed the following information contained in the COL FSAR:

COL Items

- STD COL12.1-1-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 07-03, "Generic FSAR Template Guidance for Radiation Protection Program Description," which is referenced in Appendix 12BB of the FSAR. This template is currently under review by NRC staff.

The staff reviewed the current version of NEI Template 07-03 with respect to compliance with RG 8.10. RG 8.10 describes the operating philosophy for maintaining occupational radiation exposures 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 template 07-03 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 Radiation Protection Program. 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.

As stated above, NEI Template 07-03 is still under staff review and, therefore, the staff cannot find the applicant's reference to this template to be acceptable until the staff completes the review of and approves this template, and the FSAR is updated by the applicant to reference the final version of this template. Since the template addresses the applicant's commitment to RG 8.10, the staff cannot consider DCD COL Item 12.1-1-A to be resolved until the staff approves this template. The applicant has committed to update the FSAR to reference the final version of this template when this template is approved by the staff. **This is Confirmatory Item 12.01-1**

- STD COL12.1-2-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 07-03, "Generic FSAR Template Guidance for Radiation Protection Program Description," which is referenced in Appendix 12BB of the FSAR.

NRC staff has reviewed the current version of NEI Template 07-03 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 Template 07-03 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. As stated above, NEI Template 07-03 is still under staff review. Therefore, the staff cannot find the applicant's reference to this template to be acceptable until the staff completes the review and approves this template and the FSAR is updated by the applicant to reference the final version of the template. Since the template addresses the applicant's commitment to RG 1.8, the staff cannot consider DCD COL Item 12.1-2-A to be resolved until the staff approves this template. The applicant has committed to update the FSAR and reference the final version of this template when the template is approved by the staff. **See Confirmatory Item 12.01-1.**

- 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."

NRC 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 occupational radiation exposures 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 07-03, "Generic FSAR Template Guidance for Radiation Protection Program Description," which is referenced in Appendix 12 BB of the FSAR. The template is currently under review by NRC staff.

NEI 07-03 addresses various operating procedures and techniques used in dose-related activities found in typical nuclear plants. These activities include refueling, inservice inspections, radwaste handling, spent fuel handling, normal operations, routine maintenance, sampling, and calibration. The template allows for COL applicants to modify procedures based on design- 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 07-03, 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 occupational radiation exposures are ALARA. Since NEI 07-03 is still under staff review, the staff cannot find the applicant's reference to this NEI template to be acceptable until the staff completes the review and approves this template, and the FSAR is updated by the applicant to reference the final version of the template. Since the template addresses the applicant's resolution of DCD COL Item 12.1-3-A, the staff cannot consider DCD COL Item 12.1-3-A to be resolved until the staff approves the template. The applicant has committed to update the FSAR to reference the final version of the template when it is approved by the staff. **See Confirmatory Item 12.01-1.**

- STD COL12.1-4-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 07-03, "Generic FSAR Template Guidance for Radiation Protection Program Description," which is referenced in Appendix 12BB of the FSAR. NRC staff has reviewed the current version of NEI template 07-03 with respect to compliance with RG 8.8. This template, which is currently under review by the staff, 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. The template 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, and 71. The procedures described in this template include procedures for radiation protection training, access control of radiation areas, methods to maintain exposures ALARA, personnel monitoring, respiratory protection, and contamination control. Since NEI 07-03 is still under staff review, the staff cannot find the applicant's reference to this template to be acceptable until the staff completes the review and approves the template, and the FSAR is updated by the applicant to reference the final version of the template. Since the template addresses the applicant's commitment to RG 8.8, the staff cannot consider DCD COL Item 12.1-4-A to be resolved until the staff approves the template. The applicant has committed to update the FSAR to reference the final version of the template. **See Confirmatory Item 12.01-1**.

Supplemental Information

- STD SUP12.1-1 ALARA Program

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 07-08, "Generic FSAR Template Guidance for Ensuring that Occupational Radiation Exposures Are As Low As Is Reasonably Achievable (ALARA)." Appendix 12 BB refers to NEI 07-03, "Generic FSAR Template Guidance for Radiation Protection Program Description. Both templates are currently under review by NRC staff.

The staff reviewed current versions of NEI Templates 07-08 and 07-03 with respect to a description of the ALARA program. NEI template 07-08 states that company and station policies are to keep all radiation exposures of personnel within the limits defined by 10 CFR 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 template 07-03, 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 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 Radiation Protection Program, 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 template 07-08, 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.

As stated above, NEI templates 07-03 and 07-08 are still under staff review. Therefore, the staff cannot find the applicant's reference to these templates to be acceptable until the staff completes the review and approves the templates, and the FSAR is updated by the applicant to reference the final version of these templates. Since these templates provide a description of the applicant's ALARA program, the staff cannot consider the applicant's ALARA program to be acceptable until the staff approves this template. The applicant has committed to update the FSAR to reference the final version of these templates..

These are **Confirmatory Items 12.01-1** (updating the FSAR to reference the final version of NEI template 07-03) **and 12.01-3** (updating the FSAR to reference the final version of NEI template 07-08).

12.1.5 Post Combined License Activities

There are no post COL activities related to this section.

12.1.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. Pending the satisfactory resolution of the above listed confirmatory items, the review confirmed that the applicant addressed the required information relating to the introduction, and no outstanding information is expected to be addressed in the FSAR related to this section.

The staff is reviewing the information in DCD Section 12.1 on Docket No. 52-010. The results of the staff's technical evaluation of information related to the introduction to assuring that occupational radiation exposures are ALARA incorporated by reference in the North Anna 3 COL FSAR will be documented in the SER on the DC application for the ESBWR. The SER on the ESBWR is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 12.1 of this SER to reflect the final disposition of the DC application.

The staff used the acceptance criteria defined in Section 12.1 of NUREG-0800 to evaluate the applicant's responses to how they plan to resolve the DCD COL information items involving operational considerations and conformance with RGs 1.8, 8.8, and 8.10. In providing their proposed resolution to these DCD COL information items, the applicant referenced the information contained in NEI Template 07-03, which incorporates the guidance in RGs 1.8, 8.8, and 8.10. On this basis, the staff finds the information in this template to be acceptable to resolve these DCD COL information items. However, since this template has not yet been approved by the staff, the staff considers the resolution of these four DCD COL information items to be confirmatory subject to the staff's approval of the template.

The staff evaluated the supplemental information the applicant provided in this section to address the ALARA program at the site. The applicant stated that this supplemental information is provided in NEI Templates 07-03 and 07-08, which 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 Section 12.1 of NUREG-0800. Therefore, the staff finds that the information contained in these templates adequately addresses an acceptable ALARA program. Since NEI Templates 07-03 and 07-08 have not yet been approved by the staff, the staff cannot find the applicant's description of its ALARA program to be acceptable.

Pending a satisfactory resolution of the confirmatory items, the NRC staff will conclude that the information pertaining to North Anna COL FSAR Section 12.1 is within the scope of the design certification and adequately incorporates by reference Section 12.1 of the ESBWR DCD. The information is thus acceptable. **Confirmatory Items 12.01-1 and 12.01-3, respectively.**

12.2 Plant Sources (Related To RG 1.206, Section 12.2, "Radiation Sources")

12.2.1 Introduction

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

This section of the SER 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 stack.

12.2.2 Summary of Application

Section 12.2 of the North Anna 3 COL FSAR incorporates by reference Section 12.2 of the ESBWR DCD, Revision 5.

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

COL Items

- STD COL 12.2-4-A 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. Other contained sources are addressed in FSAR Section 12.2.1.5.

- 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 Parts 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 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 Power Station (NAPS) 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 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.

- 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 Site Safety Analysis Report (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 Unit 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, STD 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 ML083530745 and NEI ODCM Template 07-09A in 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 addressed within the FSER related to the DCD.

In addition, the regulatory basis for acceptance of the resolution to the COL information item is satisfied based on meeting the applicable requirements of 10 CFR Part 20 as they relate to limiting occupational radiation doses.

The regulatory basis for acceptance of the supplementary information in assessing doses to members of the public associated with 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 to 10 CFR Part 50 General Design Criteria (GDC) 60 and 64, and Appendix I to 10 CFR Part 50 Sections II.A, II.B, II.C, and II.D, 10 CFR 52.80(a) for the performance of the LWMS, GWMS and SWMS, and Generic Letter 89-01. The criteria for a variance from an ESP is found in 10 CFR 52.39(d). SRP acceptance criteria include RGs 1.109, 1.110, 1.111, 1.112, 1.113, and 1.206. Full descriptions of the applicable regulatory and acceptance criteria are identified in SRP Sections 11.2 to 11.5 (NUREG-0800).

12.2.4 Technical Evaluation

The NRC staff reviewed Section 12.2 of the North Anna 3 COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the information in the COL represent the complete scope of information relating to this review topic. The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information related to plant radiation sources. The staff is reviewing Section 12.2 of the ESBWR DCD on Docket No. 52-010. The staff's technical evaluation of the information incorporated by reference relating to plant radiation sources will be documented in the staff SER on the design certification application for the ESBWR design.

In addition, the staff reviewed the applicant's proposed resolution to the DCD COL items included under Section 12.2 of the North Anna COL FSAR. In the review, the staff used the applicable sections of the SRP (NUREG-0800) and RG 1.206 as guidance.

In addition, the staff reviewed the applicant's proposed resolutions to the DCD COL items, variances from the North Anna 3 ESP, and the supplemental information included under Section

12.2.2 of the North Anna 3 COL. In the review, the staff used Sections 11.2 and 11.3 of the SRP (NUREG-0800) and RG 1.206 as guidance. The staff performed an independent evaluation of doses due to liquid and gaseous effluents using the LADTAP II and GASPAR II codes, the basis for the liquid and gaseous effluent source terms, and the applicant's assumptions and data in modeling exposure pathways and estimating doses to offsite receptors.

The staff reviewed the following information contained in the FSAR:

COL Items

- 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 response to staff RAI 12.02-6, the applicant stated that, in addition to use as calibration and radiography sources, the contained sources described in Subsection 12.2.1.5 will also be used as check sources. The staff finds this response acceptable and RAI 12.02-6 is closed.

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. 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. In response to staff RAI 12.02-8, 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. Since these check sources consist of small quantities of by-product material and since access to these sources would require procedures and tools to disassemble components of the monitors, the staff finds this response acceptable and RAI 12.02-8 is closed. 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 Radiation Protection Program 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 template 07-03, referenced in the North Anna 3 COL FSAR Section 12.5, describes Radiation Protection Program 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. In response to staff RAI 12.02-5, 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 finds this response acceptable and RAI 12.02-5 is closed.

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 E+9 Bq (100 millicuries). The staff issued RAI 12.02-7 and asked the applicant to ascertain whether any of the contained sources described in Subsection 12.2.1.5 met these criteria. In response to this RAI, the applicant stated that FSAR Appendix 12BB (which incorporates by reference NEI template 07-03) addresses shielding requirements for all byproduct, source, and special nuclear material, including the portable sources described in Subsection 12.2.1.5. The applicant stated that two standard calibration sources that exceed 3.7 E+9 Bq (100 millicuries) will be purchased. Details of isotope type, quantity, form, shielding requirements, and use of future contained sources will be available when these required sources are purchased. Because these sources will be controlled by the applicant's Radiation Protection Program, the staff finds this response acceptable and RAI 12.02-7 is closed.

On the basis of the information provided in Subsection 12.2.1.5 of the 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 ESBWR DCD. Therefore, the staff finds DCD COL Item 12.2-4-A to be resolved.

- NAPS COL 12.2-2-A Airborne Effluents and Doses and Associated NAPS COL, NAPS ESP COL, and NAPS ESP Variances

This COL information item provides an update of estimated airborne releases and associated doses to members of the public. The revised information and analyses address compliance with Sections II.B and II.C of Appendix I to Part 50; gaseous effluent concentration limits in Table 2 (Column 1) of Appendix B to Part 20; and requirements in 10 CFR Part 20.1301 and 20.1302. The information also presents a comparison with the information presented in the ESP Application and Environmental Report for North Anna Unit 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). Several tables in FSAR Section 12.2.2 present updated information as compared to the ESBWR DCD Tier 2, Revision 5. The revised tables in the North Anna 3 FSAR are Tables 12.2-15R, 12.2-17R, 12.2-18aR, and 12.2-18bR. FSAR Table 12.2-17R presents an estimate of the annual gaseous effluent source term by radionuclides and results demonstrating compliance with gaseous effluent concentration limits in Appendix B to Part 20. Tables 12.2-18aR and 12.2-18bR present results demonstrating compliance with Sections II.B and II.C of Appendix I to Part 50. Compliance with the U.S. Environmental Protection Agency (EPA) standard in 40 CFR Part 190, as implemented under Part 20.1301(e), is demonstrated in FSAR Tables 12.2-201 and 12.2-203. Compliance with Section II.D of Appendix I to Part 50 on ALARA is addressed in FSAR Section 11.3 for gaseous effluents, as evaluated here in SER Section 11.3.

In a change from Section 12.2.2 of the ESBWR DCD, Tier 2, Revision 5, the applicant applied site-specific information and assumptions in assessing the radiological impacts on members of

the public. The revisions are associated with information item NAPS COL 12.2-2-A. The staff reviewed the proposed updates and has identified specific RAIs on the information and commitments identified in FSAR, Revision 0, Sections 12.2.2.1 and 12.2.2.2. The staff performed independent evaluations of offsite doses due to gaseous effluents using the GASPAR II codes and the applicant's basis for the gaseous effluent source term, and assumptions and data in modeling exposure pathways and estimating doses to offsite receptors. The gaseous effluent source terms are based on ESBWR DCD Section 12.2.2. For gaseous effluents, the exposure pathways include external exposure to the airborne plume, external exposure to ground-deposited radioactivity, inhalation of airborne radioactivity, and food products containing radioactivity. The applicant identified locations of expected maximum exposures, including the nearest site boundary, garden, residence, and meat consumption from beef cattle. Doses from the milk pathway were not estimated because there are no milk cows or goats located within 8-km (5 miles) of the unit according to local land-use census data. Although the ESBWR design has three plant stacks (the reactor/fuel building stack, the turbine building stack, and the radwaste building stack), the applicant assumed that all releases will occur from a single stack with each receptor assumed to be located at the nearest location from the proposed plant (see SER Section 2.3.5 for details). The atmospheric dispersion and deposition parameters were conservatively assigned to a distance of 1191 m (0.74 mile) in the east-southeast (ESE) sector, and 1416 m (0.88 mile) in the ESE sector of the Exclusion Area Boundary (EAB). The staff found these assumptions to be bounding in demonstrating compliance with the requirements of Table 2 (Column 1) of Appendix B to Part 20 and design objectives of Appendix I to Part 50. All other parameters were found to be consistent with the information presented in the North Anna 3 ESP.

The staff's evaluation found similar results for doses to members of the public and airborne concentrations at the EAB. The staff concludes that gaseous effluents released in unrestricted areas comply with effluent concentration limits in Table 2 (Column 1) of Appendix B to Part 20, dose limits of Part 20.1301 for offsite residents, and associated design criteria for members of the public under Sections II.B and II.C of Appendix I to Part 50. Compliance with the ALARA requirements of Section II.D of Appendix I to Part 50 for gaseous effluents is addressed in FSAR Section 11.3.1.

As part of the review, the staff identified a number of issues requiring clarification and correction of specific technical and regulatory topics. The staff asked the applicant to provide additional information for the purpose of resolving these issues. The following paragraphs discuss the staff's evaluations of the applicant's responses to the staff's major RAIs.

In RAI 12.02-1, the staff identified an inconsistent presentation of child-thyroid dose results when all exposure pathways were summed up for the ESE sector at 1191 m. These results were found to be inconsistently reported among FSAR Tables 12.2-201, 12.2-203, and 12.2-18bR. The applicant was requested to resolve these inconsistencies and to confirm compliance with the criteria of Section II.C of Appendix I to Part 50. The applicant revised the FSAR tables and presented additional information describing the assignment of exposure pathways contributing to the child-thyroid dose. The applicant also noted that Section 5.4 of the ER will be revised to ensure consistency in the presentation of dose results. This change also results in the deletion of NAPS ESP VAR 12.2-2 in FSAR Part 7, "Departures Report," Revision 0. The variance requested that updated dose information for North Anna Unit 3 be used instead of the ESP, because the estimated FSAR (Revision 0) dose is higher than the dose presented in the ESP. The thyroid dose is higher because of a change in long-term atmospheric dispersion parameters in the FSAR. In response to this RAI, the applicant updated its dose analysis to reflect the new gaseous effluent source terms of ESBWR DCD Revision 5 and provided

clarifications on the contributions of the various exposure pathways to the maximally exposed individual, located offsite. The revised thyroid dose estimate is now lower than that of the ESP and, as a result, the applicant deleted NAPS ESP VAR 12.2-2 from the Departure Report. The staff confirmed the updated dose results and deletion of the variance initially included in Revision 0 of the Departure Report. In both instances, the thyroid dose estimates were found to be in compliance with Appendix I design objectives. The staff finds the response acceptable and this aspect of RAI 12.02-1 is closed.

Based on an evaluation of Dominion's response to NRC RAI 12.02-1, the staff requested further clarification in the presentation of FSAR data and dose results supporting the demonstration of regulatory compliance. In supplemental RAI 12.02-10, the staff requested the applicant to address inconsistencies in the presentation of FSAR data and dose results supporting the demonstration of regulatory compliance with (a) the unity rule of Table 2 (Column 1) of Appendix B to Part 20 for all listed radionuclides; (b) clarifying the results presented in FSAR Table 12.2-18bR in confirming compliance with Part 50 Appendix I, Sections II.B and II.C design objectives for doses that include exposures from plume and ground shine contributions; and (c) clarify the presentation of doses due to turbine building skyshine and whether differences in dose results between the North Anna 3 FSAR and ESP-ER need to be addressed in the Departures Report (Part 7 of the North Anna 3 application). The applicant's response clarified details in and revised specific sections of the FSAR. The applicant updated Table 12.2-17R to include ratios of radionuclide concentrations to their corresponding limits in Appendix B to Part 20 and the sum of the ratios demonstrating compliance with the unity rule. The applicant noted that doses presented in Table 12.2-18bR were derived using conservative assumptions and Footnote 4 was revised to clarify that the plume dose includes radiation exposure from ground shine. Finally, the applicant provided expanded explanations for dose contributions from the ISFSI facility as a contributor to the total dose at the EAB, and included revisions to doses presented in FSAR Tables 12.2-18bR, 12.2-201, and 12.2-203, given updated atmospheric dispersion and deposition parameters. The revised thyroid dose estimate, although higher than that calculated in response to RAI 12.02-1, is still below that of the ESP and, as a result, the deletion of NAPS ESP VAR 12.2-2 from the Departure Report is still appropriate and need not be reinstated. The staff confirmed the updated dose results and justification in maintaining the deletion of the variance in Revision 1 of the Departure Report. All doses, including that of the thyroid, were found to be in compliance with Appendix I design objectives. In response to a separate staff question, the applicant provided clarifying information supporting a correction for the distance of the ISFSI to the nearest residence inserted in Revision 1 of the FSAR, but included in the response to this RAI. The staff finds the responses acceptable and RAI 12.02-1 and 12.02-10 are closed. The basis for revising atmospheric dispersion and deposition parameters is presented in response to RAIs 02.03-05-1 to -03 and is evaluated in SER Section 2.3.5.

In RAI 12.02-11, the staff requested further clarification in response to RAI 12.02-1 on the presentation of FSAR information and dose results for the child and population collective doses. The staff noted that the citation of Appendix 12B in FSAR Table 12.2-15R (second column header) should be qualified as to its origin. As presented, it implies that the appendix is located in the North Anna FSAR, but in fact Appendix 12B is located in Chapter 12 of the ESBWR DCD. The staff requested the applicant to add a new footnote stating that Appendix 12B is located in Chapter 12 of the ESBWR DCD. The staff requested that the applicant provides the technical basis and year of data in FSAR Table 12.2-17R for the incremental gaseous effluent concentrations for North Anna Units 1 and 2 in making up the total effluent concentration from all three units, listed as "Units 1, 2 & 3 Concentration" in the tabulation. The staff requested the applicant to provide a new footnote to Table 12.2-18bR that refers to Table 12.2-203 for a

complementary limiting dose result for the child (bone-dose), since this dose result is derived from the same set of assumptions and analysis. In the review of FSAR Table 12.2-204, the staff requested the applicant to provide (i) a new footnote referencing ER Tables 5.4-1, 5.4-3 and 2.5-8 of the North Anna ESP (Revision 9, Sept. 2006) as the source of data in deriving collective doses; (ii) insert a new line entry to Table 12.2-204 for the purpose of listing collective dose results for the thyroid supporting the discussion presented in the FSAR markup; and (iii) insert a new footnote to Table 12.2-204 specifying the location (FSAR or ER tables) of the atmospheric dispersion and deposition parameters used in deriving collective doses from routine stack effluent releases within 50-miles of the plant. In the response to this RAI, the applicant indicated that it would revise the citation of DCD Appendix 12B, clarify the limiting dose for the child, and update dose results presented in FSAR Tables 12.2-18bR and 12.2-204. The applicant also noted that Section 5.4 of the ER will be revised to ensure consistency in the presentation of dose results. The staff finds these responses acceptable and RAI 12.02-11 is closed.

In RAI 12.02-13, the staff requested the applicant to revise Section 12.2.2.2, "Airborne Dose Evaluation Offsite," and Section 12.2.2.4, "Liquid Doses Offsite," to include a citation for NAPS ESP VAR 12.2-4, "Existing Units' and Site Total Doses," in addressing compliance with Part 20.1301(e) and 40 CFR Part 190. The only citation for NAPS ESP VAR 12.2-4 is in Table 12.2-203, with no supporting explanation. The applicant was requested to introduce a citation for NAPS ESP VAR 12.2-4 and supporting text in Sections 12.2.2.2 and 12.2.2.4 addressing compliance with Part 20.1301(e) and 40 CFR Part 190 for radiation exposures and combined doses associated with the current operations of NAPS Units 1 and 2 and the proposed operation of North Anna 3. The applicant responded with a proposal to revise FSAR Table 1.8-202 and FSAR Sections 12.2.2.2.4 and 12.2.2.4.4 to address NAPS ESP VAR 12.2-4, as it relates to compliance with 10 CFR Part 20.1301(e) and 40 CFR Part 190 dose limits from both existing units and North Anna 3. The staff finds the proposed revisions to the FSAR acceptable in flagging these requirements. This RAI is now **Confirmatory Item 12.02-13**.

Under NAPS ESP VAR 12.2-1, "Gaseous Pathway Doses," the applicant submitted a request to use updated information for 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 ESP-ER. The doses are higher because of a change in long-term atmospheric dispersion and deposition parameters. The Staff's review indicates that the associated FSAR dose results are higher than the initial estimates presented in the North Anna SSAR and ESP-ER. Although they are higher, the dose results are found to be in compliance with the design objectives of Sections II.B and II.C of Appendix I to Part 50. The staff finds NAPS ESP VAR 12.2-1 acceptable.

Under NAPS ESP VAR 12.2-4, "Existing Units' and Site Total Doses," the applicant submitted 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 those 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 ISFSI facility. The Staff's review indicates that the associated FSAR dose results are higher than the initial estimates presented in the North Anna SSAR and ESP-ER. Although they are higher, the dose results are found to be in compliance with the requirements of Part 20.1301(e) and the design objectives of Section II.B of Appendix I to Part 50. The staff finds NAPS ESP VAR 12.2-4 acceptable.

NAPS COL 12.2-3-A Liquid Effluents and Doses and Associated NAPS COL, NAPS ESP COL, and NAPS ESP Variances

This COL information item provides an update of estimated liquid releases and associated doses to members of the public. The revised information and analyses address compliance with Section II.A of Appendix I to Part 50; liquid effluent concentration limits in Table 2 (Column 2) of Appendix B to Part 20; and requirements of 10 CFR Parts 20.1301 and 20.1302. The information presents a comparison with the information presented in the ESP Application and Environment Report for North Anna Unit 3. These comparisons and variations are identified as NAPS ESP COL 11.1-1, and NAPS ESP VAR 12.2-3 and 12.2-4. Several tables in FSAR present updated information as compared to the ESBWR DCD Tier 2, Revision 5. The revised tables in the North Anna 3 FSAR are Tables 12.2-19bR, 12.2-20aR, 12.2-20bR and Tables 12.2-202 and 12.2-203. FSAR Table 12.2-19bR presents an estimate of the annual liquid effluent source term by radionuclides and results demonstrating compliance with liquid effluent concentration limits of Appendix B to Part 20. Compliance with the EPA standard in 40 CFR Part 190, as implemented under Part 20.1301(e), is demonstrated in FSAR Tables 12.2-202 and 12.2-203. Tables 12.2-20aR and 12.2-20bR present results demonstrating compliance with Sections II.A of Appendix I to Part 50. Compliance with Section II.D of Appendix I to Part 50 on ALARA is addressed in FSAR Section 11.2 for liquid effluents, as evaluated in SER Section 11.2.

In a change from Section 12.2.2 of the ESBWR DCD Tier 2, Revision 5, the applicant applied site-specific information and assumptions in assessing the radiological impacts on members of the public. The revisions are associated with information item NAPS COL 12.2-3-A. The staff has reviewed the proposed updates and identified specific RAIs on the information and commitments identified in FSAR Revision 0, Section 12.2.2.4. The staff performed independent evaluations of offsite doses due to liquid effluents using the LADTAP II code and the applicant's, basis for the liquid effluent source term, and assumptions and data in modeling exposure pathways and estimating doses to offsite receptors. The liquid effluent source terms are based on ESBWR DCD, Section 12.2.2. The applied liquid effluent parameters, including the discharge rate, dilution factor, and transit time to receptors were found to be consistent with the information presented in the North Anna 3 ESP. The exposure pathways include ingestion of aquatic food, ingestion of drinking water, exposure to shoreline sediment, and exposure to water through boating and swimming.

The staff's evaluation found similar results for doses to members of the public and concludes that liquid effluents released in unrestricted areas comply with effluent concentration limits in Table 2 (Column 2) of Appendix B to Part 20, dose limits of Part 20.1301 for offsite residents, and associated design criteria for members of the public under Section II.A of Appendix I to Part 50. Compliance with the ALARA requirements of Section II.D of Appendix I to Part 50 for liquid effluents is addressed in FSAR Sections 11.2.1.

As part of the review, the staff identified a number of issues requiring clarification and correction on specific technical and regulatory topics. The staff asked the applicant to provide additional information for the purpose of resolving such issues. The following paragraphs discuss the staff's evaluations of the applicant's responses to the staff's major RAIs.

In RAI 12.02-2, the staff questioned whether FSAR Section 12.2.2.4.4 and Table 12.2-203 considered doses from direct external radiation, as it is not clear if the analysis addresses increased external radiation levels from turbine building skyshine at the nearest residence. The applicant was requested to update the North Anna 3 site-specific analysis to demonstrate that

when added to the dose contribution from all other direct sources of external radiation to the nearest residence, the sum of direct sources of radiation and exposures from effluents will not exceed the dose standards of 40 CFR Part 190, as implemented under 10 CFR Part 20.1301(e). The applicant responded with additional information acknowledging increased external radiation levels from the North Anna 3 turbine building whenever hydrogen water chemistry is used during plant operation. The staff's review concurred with the applicant's response, but noted that the discussion was still ambiguous in separating dose contributions from the existing operating units and those of North Anna 3. Supplemental RAI 12.02-12 was issued requesting that the information supporting the results presented in FSAR Table 12.2-203 be clarified as to the sources of radioactivity and respective levels of radiation contributing to offsite doses in demonstrating compliance with NRC and EPA regulations. The staff finds the balance of the response acceptable and RAI 12.02-2 is closed.

In RAI 12.02-12, the staff requested further clarifications in response to RAI 12.02-2 on the proposed update in FSAR Section 12.2.2.4.4 and Table 12.2-203. The staff noted that although the discussion on external radiation due to N-16 in the RAI response preamble is acceptable, the proposed revision of Table 12.2-203 still does not identify the turbine building skyshine as a contributing source of radiation for Unit 3 because the direct dose from NAPS 1 and 2 does not have this characteristic. As written, it might be construed that the additional 1 mrem/yr (10 µSv/yr), under revised Footnote 2, would include dose contributions from the turbine building skyshine when it does not. A suggestion was made to add a new footnote only for the annual total body dose entry of 1.9 mrem (19 µSv/yr) in Table 12.2-203 for Unit 3. The footnote would state that the total annual dose includes the contribution from the turbine building skyshine ($<2.0 \times 10^{-4}$ mrem/yr or [$<2.0 \times 10^{-3}$ µSv/yr]) at the location of the highest expected exposures at the EAB. In the proposed revision of FSAR Section 12.2.2.4.4, the text discusses the dose contribution from the ISFSI facility and states that the dose at the closest point on the EAB is expected to be about 1.7 mrem/yr (17 µSv/yr) based on 40 fully-loaded cask modules. This new information should be supported with references and should state whether it is based on data for NAPS Units 1 and 2 or on generic pressurized-water reactor and BWR fuel data and storage cask modules. The applicant responded with a revised ISFSI dose estimate for the EAB of 3.7 mrem/yr (37 µSv/yr) and noted that the stated dose is associated with 84 fully loaded spent fuel storage casks. The applicant also noted that Section 5.4 of the ER will be revised to ensure consistency in the presentation of dose results. New footnotes were added to Table 12.2-203 providing information about the expected skyshine dose contribution from Unit 3 and clarifying that the total site doses are from Unit 3 and both existing plants. The staff finds the responses acceptable and RAI 12.02-12 is closed.

In RAI 12.02-3, the staff identified inconsistencies in the presentation of information and results on source terms and doses in FSAR Section 12.2.2.4 compared with the ESBWR DCD; the Applicant's Environmental Report COL Stage; and the North Anna 3 ESP Environmental Report. Specifically, the applicant was requested to address (a) differences in ESP-ER doses and North Anna 3 doses listed in FSAR Table 12.2-20bR those in Table 5.4-2 of the Applicant's Environmental Report (Revision 0, November 2007); (b) confirm compliance with the unity rule of Table 2 (Column 2) of Appendix B to Part 20 for all radionuclides listed in FSAR Table 12.2-19bR; (c) correct the inconsistent flagging of radionuclides with higher activity levels between North Anna 3 ESP-ER Table 5.4-1 and FSAR Table 12.2.19bR; (d) provide an explanation for the development of the liquid effluent source term based on a plant capacity factor of 0.8 while the ESBWR DCD design is rated at 0.92; (e) provide an explanation for higher radionuclide concentrations assumed for nine radionuclides listed in FSAR Table 12.2-19bR; and (f) provide the year of the data in FSAR Table 12.2-19bR for the incremental liquid effluent concentrations for North Anna Units 1 and 2 in making up the total effluent concentration from all three units

listed as “Units 1, 2 & 3 Concentration” in the tabulation. The applicant responded with information correcting or clarifying the issues noted above. The information corrected the differences between ESP-ER and North Anna 3 doses listed in FSAR Table 12.2-20bR and those in Table 5.4-2 of the Applicant’s Environmental Report (Revision 0, November 2007) and provided additional information confirming compliance with the unity rule of Table 2 (Column 2) of Appendix B to Part 20 for all radionuclides listed in FSAR Table 12.2-19bR. The response corrected the inconsistent flagging of radionuclides with higher activity levels between North Anna 3 ESP-ER Table 5.4-1 and FSAR Table 12.2.19bR; provided an explanation for higher radionuclide concentrations assumed for nine radionuclides listed in FSAR Table 12.2-19bR; and provided a footnote to FSAR Table 12.2-19bR explaining the incremental liquid effluent concentrations for North Anna Units 1 and 2 in making up the total effluent concentration from all three units listed as “Units 1, 2 & 3 Concentration” in the tabulation. The application of the capacity factor (item d of this RAI) was closed with the resolution of RAI 12.2-15 S03 issued on the ESBWR DCD. The staff finds the responses acceptable and RAI 12.02-3 is closed.

Under NAPS ESP VAR 12.2-3, “Annual Liquid Effluent Releases,” the applicant submitted a request to use updated information to estimate 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 estimates because the FSAR source term reflects the chosen reactor design (i.e., ESBWR). The staff’s review indicates that FSAR liquid effluent releases are higher than the initial estimates presented in the North Anna SSAR and ESP-ER. Although they are higher, the resulting concentrations are found to be in compliance with the requirements of Part 20.1301 and effluent concentration limits in Table 2 (Column 2) of Appendix B to Part 20. The staff finds that NAPS ESP VAR 12.2-3 is acceptable.

12.2.5 Post Combined License Activities

There are no post COL activities related to this section.

12.2.6 Conclusion

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

The staff is reviewing the information in DCD Section 12.2 on Docket No. 52-010. The results of the NRC staff’s technical evaluation of the information related to plant radiation sources incorporated by reference in the North Anna 3 COL FSAR will be documented in the staff SER on the DC application for the ESBWR. The SER on the ESBWR is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 12.2 of this SER to reflect the final disposition of the DC application.

In this section, the staff used the acceptance criteria defined in Section 12.02 of NUREG-0800 to evaluate the applicant’s response to how they plan to resolve the DCD COL information item

describing other contained sources. RG 1.206 states that the COL applicant should specify any contained radioactive sources to be used that are not described in the DCD. 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. The staff concludes that the information pertaining to North Anna COL FSAR Section 12.2, including COL FSAR Section 12.2.2, is within the scope of the design certification and adequately incorporates by reference Section 12.2 of the ESBWR DCD. The staff finds the applicant's response to this COL information item acceptable; and it meets the applicable requirements of 10 CFR Part 20 as they relate to limiting occupational radiation doses.

Regarding liquid and gaseous effluent releases and doses to members of the public, the staff concludes that the results of the dose assessment analyses and estimates of offsite liquid and gaseous effluent concentrations are acceptable and meet the applicable requirements of 10 CFR 20.1301, 20.1302, and 20.1301(e); 10 CFR Part 50, Appendix I design and ALARA objectives; and effluent concentration limits of Appendix B (Table 2) to 10 CFR Part 20.

12.3 Radiation Protection (Related to RG 1.206, Section 12.3, "Radiation Protection Design Features")

12.3.1 Introduction

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, anticipated operational occurrences, 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 incorporates by reference Section 12.3 of the ESBWR DCD, Revision 5. In addition, in FSAR Section 12.3, the applicant provided the following:

COL Items

- STD COL 12.3-2-A Operational Considerations

STD COL 12.3-2-A 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. The applicant references draft NEI 07-03 for addressing the resolution of DCD COL Item 12.3-2-A.

- STD COL12.3-3-H Controlled Access

STD COL 12.3-3-H addresses controlled access to "Very High Radiation Areas" (VHRAs). The applicant references draft NEI 07-03 for addressing the resolution of DCD COL Item 12.3-3-H.

Supplemental Information

- STD SUP 12.6-1 Minimization of Contamination and Radwaste Generation

STD SUP 12.6-1 contains supplemental information describing operating procedures that the applicant will implement to ensure compliance with 10 CFR 20.1406 and prevent the spread of contamination. (Note-Since FSAR Section 12.6, Minimization of Contamination and Radwaste Generation (including STD SUP 12.6-1), will be relocated to FSAR Section 12.3 in a future revision to the North Anna COL FSAR), STD SUP 12.6-1 is addressed in FSAR Section 12.3).

12.3.3 Regulatory Basis

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

In addition, the regulatory basis for acceptance of the resolution to the COL information items is satisfied based on meeting the requirements of 10 CFR Parts 20, 50, and 70 and on following the guidelines of item III.D.3.3 of NUREG-0737 and RGs 1.97, 8.2, and 8.8.

SRP Section 12.3-12.4, "Radiation Protection Design Features" is used to evaluate both Section 12.3 and 12.4 of the North Anna COL FSAR.

12.3.4 Technical Evaluation

The NRC staff reviewed Section 12.3 of the North Anna 3 COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the information in the COL represent the complete scope of information relating to this review topic. The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information related to radiation protection. The staff is reviewing Section 12.3 of the ESBWR DCD on Docket No. 52-010. The staff's technical evaluation of the information incorporated by reference relating to radiation protection will be documented in the staff SER on the design certification application for the ESBWR design.

In addition, the staff reviewed the applicant's proposed resolution to the following DCD COL items and the supplementary item included under Section 12.6 of the North Anna 3 COL FSAR. The staff's review used the applicable sections of the SRP (NUREG-0800) and RG 1.206 as guidance.

The staff reviewed the following information contained in the FSAR:

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 07-03, "Generic FSAR Template Guidance for Radiation Protection Program Description," which the staff is currently reviewing. NEI 07-03 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 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 07-03 describes the operational considerations of these monitors. The template states that airborne radioactivity levels are surveyed by using continuous air monitors (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 07-03 also describes calibration frequency and procedures for airborne monitors. The template states that continuous air monitors 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.

In response to the staff's RAI 12.03/04-1 requesting the applicant to describe the criteria for the placement and sensitivities of portable airborne monitors, the applicant stated that the requested information is contained in NEI template 07-03. Section 12.5.3.2 of this template 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. Staff RAI 12.03/04-1 also requested the applicant to verify that North Anna 3 has a sufficient number of portable airborne radiation monitors to sample air at all normally occupied locations where airborne radioactivity may exist. The applicant stated that Milestone 1.c. of NEI template 07-03 ensures that an adequate number of instruments is available to provide for appropriate detection capabilities to conduct radiation surveys in accordance with 10 CRF 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 both RAI 12.03/04-1 and DCD COL Item 12.3-2-A. However, as stated previously, NEI template 07-03 is still under staff review and, therefore, the staff cannot find the applicant's reference to this NEI template to be acceptable until the staff completes the review and approves this template and the FSAR is updated by the applicant to reference the final version of this template. Since the applicant references this template in responses to both RAI 12.03/04-1 and DCD COL Item 12.3-2-A, the staff cannot consider either RAI 12.03/04-1 or DCD COL Item 12.3-2-A resolved until the staff approves this template. The applicant has committed to update the FSAR to reference the final version of this template.

See Confirmatory Item 12.01-1.

- STD COL 12.3-3-H Controlled Access

The applicant provided additional information in STD COL 12.3-3-H to address the resolution of DCD COL Item 12.3-3-H, which states:

> "Controlled access to "Very High Radiation Areas" is provided by the COL applicant."

The COL applicant stated that access to very high radiation areas is discussed in COL Section 12.5. COL Section 12.5 references NEI 07-03, "Generic FSAR Template Guidance for Radiation Protection Program Description," which is currently under staff review. Section 12.5.4.4 of NEI 07-03 describes access control to ensure compliance with 10 CFR 20.1902, 20.1903, 20.1601, and 20.1602. Since NEI template 07-03 is still under staff review, the staff cannot find the applicant's reference to this NEI template to be acceptable until the staff completes the review and approves this template and the FSAR is updated to reference the final version of this template. Since the template addresses the applicant's access controls to very high radiation areas, the staff cannot consider DCD COL Item 12.3-3-H to be resolved until the staff approves this template. The applicant has committed to update the FSAR to reference the final version of this template. **See Confirmatory Item 12.01-1.**

STD CDI for North Anna 3 FSAR Section 1.2.2.12.15, "Zinc Injection System," states that a Zinc Injection System will not be utilized at North Anna, Unit 3. One of the benefits of utilizing a Zinc Injection System to inject zinc into the feedwater is to suppress cobalt plateout on reactor coolant piping. Since cobalt-60 is the primary long-term source of radiation fields in most 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 ascertain why the applicant elected not to utilize the Zinc Injection System at North Anna 3, NRC staff issued RAI 12.03/04-3. In response to this RAI, the applicant stated that in order to minimize the potential for cobalt plateout on the reactor coolant piping, General Electric-Hitachi (GEH) had reduced the amount of cobalt in contaminated applications throughout the plant and reduced the use of stainless steel in the coolant system. The applicant stated that the benefits realized from using a Zinc Injection System to minimize cobalt plateout on the reactor coolant piping are more prominent for plants where cobalt-containing alloys are relatively abundant in high-fluence areas of the plant. The applicant stated that the expected lower levels of cobalt plateout on the reactor coolant piping at North Anna 3 (due to the ESBWR's reduced use of cobalt containing alloys in high fluence areas) would minimize the benefits gained from the use of a Zinc Injection System at startup at North Anna 3.

The staff issued supplemental RAI 12.03/04-10 to determine if the cobalt reduction measures described in Section 12.3.1 of the ESBWR DCD are adequate to justify the applicant's decision to not utilize the Zinc Injection System at North Anna 3. In their response to RAI 12.03/04-10, the applicant referenced sections of the ESBWR DCD which described several measures incorporated in the ESBWR design to reduce cobalt levels in the reactor coolant by minimizing the use of cobalt-containing alloys. In addition, the applicant stated that the ESBWR design reduces or eliminates the sources of radiation from certain components that have been significant sources of radiation in the drywells of typical BWRs. The ESBWR does not have recirculation lines, which typically are the most significant shutdown source of radiation in the drywell. The applicant stated that the purpose of utilizing a Zinc Injection System in existing BWR plants is to reduce the radiation levels in the primary containment due to cobalt deposition, primarily on the recirculation system piping. Since the ESBWR does not have recirculation piping and the ESBWR design has reduced the levels of cobalt in materials in contact with the reactor coolant, the applicant states that the beneficial effects from implementing zinc injection at startup are limited. RAI 12.03/04-10 also requested the applicant to state whether the design will retain the option of utilizing a Zinc Injection System at North Anna 3 in the event that the cobalt levels in the contaminated applications throughout the plant reach t levels that the use of a Zinc Injection System would prove to be beneficial in reducing these cobalt levels. In response to this portion of RAI 12.03/04-10, the applicant stated that the ESBWR standard plant design includes the capability to connect a Zinc Injection System, but the system itself is not part of the ESBWR standard plant design. Therefore, North Anna 3 retains the option of utilizing a Zinc Injection System. The staff finds the applicant's response acceptable and considers RAI 12.03/04-10 closed.

Supplemental Information

- STD SUP 12.6-1 Minimization of Contamination to Facilitate Decommissioning

The applicant provided supplemental information in STD SUP 12.6-1 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. NRC staff reviewed STD SUP 12.6-1 in the COL FSAR Section 12.6.1. The COL applicant lists several measures that prevent the spread of contamination, including the use of engineering controls; criteria for selecting tools, materials, and equipment used in contaminated areas; the use of containments, caches, and enclosures to contain spills and releases; conducting surveys of potentially contaminated systems, equipment, and components; and the use of temporary and permanent design modifications to prevent and limit the spread of contamination. Most of the items listed in STD SUP 12.6-1 in COL Section 12.6.1 were taken from the list of practical measures to prevent the spread of contamination in Section 12.5.4.8 of NEI 07-03, "Generic FSAR Template Guidance for Radiation Protection Program Description." This NEI template, which is currently under review by NRC staff, is referenced in Appendix 12BB of the North Anna 3 COL FSAR. However, the COL application, DCD, and NEI 07-03 do not address operational programs to the degree of detail that is described in RG 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning." To determine compliance with the guidance in RG 4.21, the staff issued RAI 12.03/04-8. In response to this RAI, the applicant stated that the COL application will be revised to incorporate by reference NEI 08-08, "Generic FSAR Template Guidance for Life Cycle Minimization of Contamination," which is currently being developed to address the guidance in RG 4.21. The applicant also committed to revise the COL application to provide a description of the operational programs that will be in place to meet the requirements of 10 CFR 20.1406. In addition, the applicant committed to revise the COL application to include any additional COL items that may be developed by GEH for FSAR

Section 12.3 and included in a future revision to the ESBWR DCD. Since the applicant's response to this RAI references NEI Template 08-08, which the NRC staff considers to be still in the developmental stages, and since the COL application currently does not include a description of the operational programs that will be in place to meet the requirements of 10 CFR20.1406, the staff considers RAI 12.03/04-8 to **be Open Item 12.03/04-8.**

The North Anna FSAR for Chapter 12 is based on the format of the Tier 2 ESBWR DCD for Chapter 12. For this reason, the FSAR contains Section 12.6 entitled "Minimization of Contamination and Radwaste Generation." Since GEH will be modifying Chapter 12 of the ESBWR DCD to eliminate Section 12.6 and relocate the information in this section to Section 12.3 of the DCD, the staff issued RAI 12.03/04-4 to request that the applicant revise Chapter 12 of the FSAR to be consistent with the format in Chapter 12 of the DCD. In the applicant's response to this RAI, the applicant stated that FSAR Chapter 12 will be revised to be consistent with the format in Chapter 12 of the ESBWR DCD once the revised DCD incorporating the change has been issued. Since the applicant has committed to make the FSAR changes described above in a future revision to the FSAR, the staff considers this response to RAI 12.03/04-4 to be confirmatory, pending the incorporation of these changes in an upcoming revision of the FSAR. **This RAI is Confirmatory Item 12.03/04-4**.

12.3.5 Post Combined License Activities

There are no post COL activities related to this section.

12.3.6 Conclusion

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

The staff is reviewing the information in DCD Section 12.3 on Docket No. 52-010. The results of the NRC staff's technical evaluation of the information related to radiation protection incorporated by reference in the North Anna 3 COL FSAR will be documented in the staff SER on the DC application for the ESBWR. The SER on the ESBWR is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 12.3 of this SER to reflect the final disposition of the DC application.
In this section, the staff used the acceptance criteria defined in Section 12.03/04 of NUREG-0800 to evaluate the applicant's response describing how they plan to resolve the DCD COL information item involving operational considerations for airborne radiation monitoring (DCD COL 12.3-2-A). In the proposed resolution to this DCD COL information item, the applicant referenced the information in NEI Template 07-03. NEI Template 07-03 specifies that an adequate number of airborne radioactivity monitors will be available for monitoring and for performing surveys in accordance with the requirements of 10 CFR 20.1501 and 20.1502. The staff finds that the information in this template is acceptable to resolve this DCD COL information item. However, since this template has not yet been approved by the staff, the staff considers the resolution of this DCD COL information item to be confirmatory and subject to the staff's approval of NEI Template 07-03.

The staff evaluated the applicant's response for resolving the DCD COL information item involving controlled access to "Very High Radiation Areas" (DCD COL 12.3-3-H). The applicant's response to this DCD item referenced NEI Template 07-03, which describes

procedures for access control that will assure compliance with the requirements of 10 CFR 20.1601, 20.1602, 20.1902, and 20.1903 and the guidance in RG 8.38. The staff finds the information in this template meets the relevant acceptance criteria defined in Section 12.03/04 of NUREG-0800. However, since NEI template 07-03 is still under staff review, the staff cannot find the applicant's reference to this NEI template acceptable until the staff completes the review and approves this template and the FSAR is updated by the applicant to reference the final version of this template. Since the template addresses the applicant's access controls to very high radiation areas, the staff considers the resolution of DCD COL Information Item 12.3-3-H to be confirmatory and subject to the staff's approval of NEI Template 07-03.

The staff also evaluated the supplemental information (STD SUP 12.6-1) provided to address the minimization of contamination to facilitate decommissioning, in compliance with 10 CFR 20.1406. To further address compliance with 10 CFR 20.1406, the applicant also committed to incorporate by reference NEI Template 08-08, which addresses the guidance provided in RG 4.21. However, NEI 08-08 has not been approved by the staff. In addition, the FSAR does not include a description of the operational programs that will be in place to meet the requirements of 10 CFR 20.1406. Therefore, the staff cannot conclude that the applicant meets the requirements of 10 CFR 20.1406.

Since Section 12.3, "Radiation Protection", contains an open item (Open Item 12.03/04-8), the staff is unable to finalize its conclusions on this section.

12.4 Dose Assessment

12.4.1 Introduction

Section 12.4 addresses the issues related to estimating the annual personal doses associated with operation, normal maintenance, radwaste handling, refueling, in-service inspection, and special maintenance (e.g., maintenance that goes beyond routine scheduled maintenance, modification of equipment to upgrade the plant, or repairs to failed components).

12.4.2 Summary of Application

Section 12.4 of the North Anna 3 COL FSAR incorporates by reference Section 12.4 of the ESBWR DCD Revision 5. In addition in FSAR Section 12.4, the applicant provided the following:

Supplemental Information

- NAPS SUP 12.4-1 Annual Doses to Construction Workers

The applicant stated that the doses to construction workers were evaluated in the North Anna ESP Final EIS (NUREG 1811) and the associated impacts were resolved as SMALL. The applicant adds that they have evaluated the following more recent information to ascertain what effects these changes may have on the estimated annual doses to construction workers; additional readings for TLDs located closest to the Unit 3 site, more recent radioactive effluent release data, changes to the spent fuel cask types planned for the ISFSI, and changes to the peak number of construction workers. The applicant concludes, after analyzing the above listed changes, that the estimated construction worker doses in the ESP-ER would remain bounding.

12.4.3 Regulatory Basis

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

In addition, the regulatory basis for acceptance of the resolution to the COL supplemental information is satisfied based on meeting the requirements of 10 CFR Part 20 and compliance with the guidance provided in RG 1.206.

SRP Section 12.3-12.4, "Radiation Protection Design Features" is used to evaluate both Section 12.3 and 12.4 of the North Anna COL FSAR.

12.4.4 Technical Evaluation

The NRC staff reviewed Section 12.4 of the North Anna 3 COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the information in the COL represent the complete scope of information relating to this review topic. The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information related to dose assessment. The staff is reviewing Section 12.4 of the ESBWR DCD on Docket No. 52-010. The staff's technical evaluation of the information incorporated by reference relating to dose assessment will be documented in the staff SER on the design certification application for the ESBWR design.

In addition, the staff reviewed the applicant's supplemental item included under Section 12.4 of the North Anna COL. In the review, the staff used the applicable sections in the SRP (NUREG-0800) and RG 1.206 as guidance.

The staff reviewed the following information contained in the FSAR:

Supplemental Information

- NAPS SUP 12.4-1 Annual Doses to Construction Workers

The applicant provided additional text as part of the FSAR to address Supplemental Information Item NAPS SUP 12.4-1 regarding the dose to construction workers.

Section 4.5 of the ESP-ER and Section 4.9 of the Final Environmental Impact Statement (FEIS) determined that the doses to construction workers for Unit 3 from radiation from the existing Units 1 and 2 were small and in compliance with the annual dose limits for individual members of the public, as stated in 10 CFR 20.1301 and 10 CFR 20.1302 during the construction of North Anna Unit 3. In the supplemental information (NAPS SUP 12.4-1) in Section 12.4.6.1 of the North Anna COL FSAR, the applicant listed several changes that have been made since the time of the ESP-ER analysis and evaluated this more recent information to determine whether the dose estimates to Unit 3 construction workers still remain conservative. These changes include the current locations and readings for thermoluminescent dosimeters (TLDs) located closest to the Unit 3 site, the most recent effluent release data from Units 1 and 2, changes to spent fuel cask types that will be stored in the on-site ISFSI, and the current estimated peak number of construction workers. The applicant states that the dose calculated in the ESP-ER of 120 person-rem remains a conservative estimate of the maximum annual collective dose to the construction force.

In reviewing the changes that have occurred since the ESP-FEIS was prepared, the staff noted that the current locations and readings for TLDs located closest to the Unit 3 site have changed. The licensee used readings from the TLDs located closest to the Unit 3 site to calculate one component (direct radiation dose) of the annual dose to construction workers. Since the licensee's estimate of the dose to the construction workers is partially based on readings from these TLDs, the staff issued RAI 12.03/04-5 to obtain more detailed information about these changes to the TLD locations and readings and to ascertain what effect, if any, these changes have on the estimated direct radiation dose component contribution to construction workers working on Unit 3. In the applicant's response to this RAI, the applicant referred to evaluations for four additional years of recent TLD data as well as readings from an additional TLD located near the northwest corner of the Unit 3 boundary. After evaluating these additional data, the applicant concluded that the estimated direct dose component to Unit 3 construction workers that was submitted in the ESP application remains bounding. The staff finds the applicant's response to RAI 12.03/04-5 acceptable and this RAI is closed.

North Anna 3 COL FSAR Section 12.4.6.1 states that the spent fuel cask types planned for the on-site ISFSI have changed. To determine whether this change in the type of cask used for the storage of spent fuel in the ISFSI will affect the expected dose to the construction workers from the ISFSI, the staff issued RAI 12.03/04-6. In the response to this RAI, the applicant stated that instead of using TN-32 casks on all three pads in the ISFSI, the plan is to now use TN-32 casks on one pad and the horizontal NUHOMS-RD modules on the other two pads. The applicant stated, however, that since the dose rate from the NUHOMS-RD modules is projected to be comparable to that from a TN-32 cask, the use of a different cask for spent fuel storage in the ISFSI will not affect the expected annual dose to the construction workers from the ISFSI. The staff finds the applicant's response to RAI 12.03/04-6 acceptable and this RAI is closed.

The estimated maximum annual dose of 120 person-rem to construction workers referenced in the North Anna ESP Final EIS (NUREG-1811) assumes that the peak number of construction workers for the construction of Units 3 and 4 would be approximately 5,000 workers. NAPS SUP 12.4-1 states that the estimated peak number of workers has been changed from 5,000 to between 2,500 and 3,500 workers. In RAI 12.03/04-7, the staff asked the applicant to ascertain what effect this reduction in the total estimated number of workers would have on the estimated maximum annual dose to the North Anna 3 construction workforce. In the response to this RAI, the applicant stated that this reduction in the estimated peak number of construction workers from 5,000 to between 2,500 and 3,500 would reduce the estimated maximum annual dose to the construction workforce from 120 person-rem to between 60 and 84 person-rem. Since this change in the total number of workers results in an estimated collective dose to the construction workforce that is more conservative than the 120 person-rem estimate listed in the North Anna ESP-EIS , the staff finds this change acceptable and RAI 12.03/04-7 is closed

10 CFR 20.1101(b) states that the licensee shall use, to the extent practical, procedures and engineering controls based on sound radiation protection principles to achieve occupational doses and doses to members of the public that are ALARA. Although the applicant references the expected maximum annual collective dose to the construction work force in Section 12.4 of the North Anna COL FSAR, the applicant does not describe the program to ensure that the construction worker site (i.e., the general area where construction workers will be located during the construction of North Anna Unit 3) will be continually monitored for radiation during the construction period to ensure that exposures to the construction workers are minimized and maintained ALARA in accordance with the requirements of 10 CFR Part 20.1101(b). In order to obtain this information, the staff issued RAI **12.03/04-12**. **This is Open Item 12.03/04-12 .**

12.4.5 Post Combined License Activities

There are no post COL activities related to this section.

12.4.6 Conclusion

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

The staff is reviewing the information in DCD Section 12.4 on Docket No. 52-010. The results of the NRC staff's technical evaluation of the information related to dose assessment incorporated by reference in the North Anna 3 COL FSAR will be documented in the staff SER on the DC application for the ESBWR. The SER on the ESBWR is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 12.4 of this SER to reflect the final disposition of the DC application.

In this section, the staff evaluated the supplemental information the applicant provided to address changes to the evaluation of doses to construction workers that was performed in the North Anna ESP-ER. The staff evaluated this supplemental information using the acceptance criteria in Section 4.5, "Radiation Exposure to Construction Workers," of NUREG-1555. NUREG-1555 addresses the relevant requirements of 10 CFR Part 20 with respect to occupational and public dose limits. The staff noted that the applicant did not describe the program to ensure that that the construction worker site will be continually monitored for radiation during the construction period to ensure that exposures to the construction workers are minimized and maintained ALARA in accordance with the requirements of 10 CFR Part 20.1101 (b). Therefore, the staff cannot conclude that the applicant meets the requirements of 10 CFR 20.1101(b). This **is Open Item 12.03/04-12**.

Since Section 12.4, "Dose Assessment", contains an open item (Open Item 12.03/04-12), the staff is unable to finalize its conclusions on this section.

12.5 Operational Radiation Protection Program

12.5.1 Introduction

Section 12.5 addresses the operational Radiation Protection Program, which is designed to maintain occupational and public doses below regulatory limits and ALARA. The operational Radiation Protection Program is designed with the following objectives:

- Providing the capability for administrative control of the activities of plant personnel to limit personnel exposures to radiation and radioactive materials ALARA and within the guidelines in 10 CFR 20.

12.5.2 Summary of Application

Section 12.5 of the North Anna 3 COL FSAR incorporates by reference Section 12.5 of ESBWR DCD Revision 5. In addition, in FSAR Section 12.5, the applicant provided the following:

COL Items

- STD COL12.5-1-A Equipment, Instrumentation, and Facilities

STD COL 12.5-1-A describes radiation protection equipment, instrumentation, and facilities. The applicant references draft NEI 07-03 as a means to address the needs of this standard COL item.

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

STD COL 12.5-2-A describes accident portable instruments to measure radio-iodine concentrations. The applicant is responsible to describe accident portable instruments to measure radio-iodine concentrations in compliance with the requirements of 10 CFR Part 50.34(f)(2)(xxvii) and the guidance in NUREG-0737 Item III.D.3.3. The applicant references draft NEI 07-03 as a means to address the needs of this standard COL item.

- STD COL12.5-3-A Radiation Protection Program

This DCD COL item requires the applicant to provide a description of the operational Radiation Protection Program. The applicant references draft NEI 07-03 as a means to address the needs of this standard COL item.

12.5.3 Regulatory Basis

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

In addition, the regulatory bases for acceptance of the resolution to the COL items are:

- Management and organization are established in RGs 1.8, 8.2, 8.8, and 8.10, as required by 10 CFR 20.1101 and 10 CFR 20.2102.

- Adequate facilities are established in RGs 1.97, 8.4, 8.8, 8.9, 8.15, 8.20, 8.26, and 8.28, as required by 10 CFR 20.1801, 10 CFR 20.1802, and 10 CFR 20.1906.

- Instrumentation and equipment are established in 10 CFR 20.1501, 10 CFR 20.1502, 10 CFR 50.34(f)(2)(xxvii), and in the criteria in Item III.D.3.3 of NUREG-0737.

- Training and procedures are established in RGs 1.8, 1.33, 8.2, 8.7, 8.8, and 8.10, as required in 10 CFR 19.11, 10 CFR 19.12, and the applicable requirements in 10 CFR Parts 20, 50, 70, and 71.

The regulatory basis for acceptance of the resolution to Operational Program #10 in Table 13.4-201, dealing with the Radiation Protection Program, is satisfied based on meeting the requirements of 10 CFR 20.1101.

12.5.4 Technical Evaluation

The NRC staff reviewed Section 12.5 of the North Anna 3 COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the information in the COL

represent the complete scope of information relating to this review topic. The NRC staff's review confirmed that the information contained in the application and incorporated by reference (with respect to equipment, instrumentation, and facilities) addresses the required information related to the operational radiation protection program. The staff is reviewing Section 12.5 of the ESBWR DCD on Docket No. 52-010. The staff's technical evaluation of the information incorporated by reference (with respect to equipment, instrumentation, and facilities) relating to operational Radiation Protection Program will be documented in the staff SER on the design certification application for the ESBWR design.

In addition, the staff reviewed the applicant's proposed resolution to the following COL information items included under Section 12.5 of the North Anna COL. In the review, the staff used the applicable sections in the SRP (NUREG-0800) and in RG 1.206 as guidance.

The staff reviewed the following information contained in the FSAR:

COL Items

- STD COL12.5-1-A Equipment, Instrumentation, and Facilities

The applicant provided additional information in STD COL 12.5-1-A to address the resolution of DCD COL Item 12.5-1-A, which states:

> "The COL applicant will provide a description of plant health physics equipment, instrumentation, and facilities."

The FSAR states that this COL information item is addressed in NEI template 07-03, "Generic FSAR Template Guidance for Radiation Protection Program Description," which is referenced in Appendix 12BB of the FSAR. This template is currently under review by NRC staff. The template thoroughly describes radiation protection facilities and monitoring instrumentation and equipment.

The radiation protection facilities described in the template include a radiochemistry laboratory, personnel and equipment decontamination facilities, an access control facility, radiation protection offices, portable instrument calibration and respirator facilities, storage and issue areas for contaminated tools and equipment, a machine shop for activated/contaminated components and equipment, radioactive materials storage area, facilities for dosimetry processing and bioassay, and a laundry facility. The ESBWR DCD provides additional information for the personnel decontamination area, radiation protection offices, and a portable instrument calibration facility that is consistent with the template. 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 to resolve DCD COL Item 12.5-1-A. However, as stated previously, NEI template 07-03 is still under staff review and, therefore, the staff cannot find the applicant's reference to this NEI template acceptable until the staff completes the review and approves the template and the FSAR is updated by the applicant to reference the final version of this template. Since the applicant references this template in addressing the resolution of DCD COL Item 12.5-1-A, the staff cannot consider DCD COL Item 12.5-1-A resolved until the

staff approves this template. The applicant has committed to update the FSAR to reference the final version of this template. **See Confirmatory Item 12.01-1.**

- STD COL 12.5-2-A Compliance with Paragraph 50.34(f)(2)(xxvii) of 10 CFR 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 template 07-03, "Generic FSAR Template Guidance for Radiation Protection Program Description," which is referenced in Appendix 12BB of the FSAR. This template is currently under review by NRC staff. In order to resolve this COL action item, the licensee must show compliance with 10 CFR 50.34(f)(2)(xxvii) and Item III.D.3.3 of NUREG-0737. 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 07-03 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 07-03, 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 07-03 ensures that an adequate number of instruments are available to provide for appropriate detection capabilities to conduct radiation surveys in accordance with 10 CR 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. However, as stated above, because the NEI template 07-03 is still under staff review, the staff cannot find the applicant's reference to this NEI template acceptable until the staff completes the review and approves the template and the FSAR is updated by the applicant to reference the final version of this template. Since the applicant makes reference to this template in addressing the resolution of DCD COL Item 12.5-2-A, the staff cannot consider DCD COL Item 12.5-2-A resolved until the staff approves the template. The applicant has committed to update the FSAR to reference the final version of this template. **See Confirmatory Item 12.01-1.**

- 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 template 07-03, "Generic FSAR Template Guidance for Radiation Protection Program Description," which is referenced in Appendix 12BB of the FSAR. This template is currently under review by NRC staff. The template provides a detailed description of the Radiation Protection Program. **See Confirmatory Item 12.01-1**

NEI template 07-03 contains several bracketed sections that allow for design and site specific deviations or additions. In the review of the COL, the staff noted that the applicant did not address how they would disposition each of these bracketed sections of the template. The staff issued RAI 12.05-2 to determine whether the applicant planned to deviate from or supplement the information provided in the template for each bracketed section. In response to this RAI, the applicant supplemented Appendix 12BB of the FSAR in Revision 1 to state how they will address each bracketed section in NEI 07-03. The staff finds this response acceptable and RAI 12.05-2 is closed.

As discussed in Section 12.3.1.3 of the North Anna 3 FSAR, 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 07-03 (which is currently under review by NRC staff) as the generic FSAR template guidance for the description of North Anna's Radiation Protection Program.

Section 12.5.4.4 of NEI 07-03 (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 Very High Radiation Area is required by 10 CFR 20.1602. Section 12.5.4.4 of NEI 07-03 also states that applicants need to provide detailed drawings of each VHRA and indicate physical access controls for each of these areas. Since the applicant did not provide the plant-specific information on access controls described in Section 12.5.4.4 of NEI 07-03, the NRC staff issued RAI 12.03/04-2. In response to this RAI, the applicant revised Appendix 12BB of FSAR Revision 1, by adding a description of some physical and administrative access controls that will be used to restrict access to the very high radiation areas at North Anna 3. The applicant's response to RAI 12.03/04-2 did not address all of the plant-specific information on access controls described in Section 12.5.4.4 of NEI 07-03. Therefore, the staff issued RAI 12.03/04-11. This supplemental RAI requested that the applicant to (1) provide a listing and location of all designated VHRAs in the plant, (2) describe why each of these areas would need to be accessed, and (3) provide a description of the physical barriers (and a description of how these barriers will be verified in the final design of the facility) used to preclude inadvertent access to these areas. In the applicant's response to RAI 12.03/04-11, the applicant committed to add a table to the FSAR listing all accessible VHRAs in the plant, the conditions under which each area will be designated a VHRA, and the area's location on the DCD plant layout drawings. The applicant also committed to modify the FSAR to specify the administrative requirements for accessing each of these VHRAs. Finally, the applicant committed to modify the FSAR to describe the physical barriers in place to prevent inadvertent access to each of the identified VHRAs. The existence of these barriers will be verified via ITAAC as identified in DCD Tier 1 Table 2.5.10-1. The applicant will amend Section 12.5.4.4 of the FSAR to reference sections of the ESBWR DCD that identify the physical controls, interlocks, and annunciators used to control access to areas immediately adjacent to the Inclined Fuel Transfer System (IFTS). These areas are immediately adjacent to the IFTS, and they become VHRAs during the transfer of spent fuel in the IFTS. The staff finds that the

applicant's response to this RAI is acceptable. However, since the applicant will incorporate the response to this RAI in a future amendment to the FSAR, the staff considers the applicant's response to RAI 12.03/04-11 to be confirmatory. **This is Confirmatory Item 12.03/04-11.**

Operational Program

The applicant provided implementation schedules and milestones to address Operational Program #10, which is associated with the Radiation Protection Program 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 Radiation Protection Program implementation. The four listed milestones are: prior to initial receipt of byproduct, source, or special nuclear materials; prior to fuel receipt; prior to fuel load; and prior to the first shipment of radioactive waste. The Radiation Protection Program is composed of a number of elements that are described in NEI template 07-03. Since these elements were not specifically mentioned in FSAR Table 13.4-201, the staff issued RAI 12.05-3 to ascertain at which implementation milestone each program element would be implemented. As a result of this RAI, NEI template 07-03 was revised to describe when each of these program elements will be implemented. However, since NEI template 07-03 is still under staff review, the staff cannot find the applicant's reference to this template as a resolution to RAI 12.05-3 acceptable until the staff completes the review and approves the template and the FSAR is updated by the applicant to reference the final version of this template. Therefore the staff considers the status of RAI 12.05-3 to be **Confirmatory Item 12.01-1.** The applicant has committed to update the FSAR to reference the final version of the template.

12.5.5 Post Combined License Activities

The applicant will implement milestones of the Radiation Protection Program as specified in Table 13.4-201.

12.5.6 Conclusion

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

The staff is reviewing the information in DCD Section 12.5 on Docket No. 52-010. The results of the NRC staff's technical evaluation of the information related to operational Radiation Protection Program incorporated by reference in the North Anna 3 COL FSAR will be documented in the staff SER on the DC application for the ESBWR. The SER on the ESBWR is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 12.5 of this SER to reflect the final disposition of the DC application.

In this section, the staff evaluated the description of the applicant's operational program for radiation protection. FSAR Section 13.4 presents the milestones, as license conditions, for the implementation of the Radiation Protection Program (Operational Program #10). FSAR Section 13.5 includes a description of the plant procedures that comprise the operational Radiation Protection Program. The overall description of the applicant's operational program for radiation protection is addressed in FSAR Appendix 12BB, which references NEI Template 07-03. An acceptable Radiation Protection Program meets 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. An acceptable

Radiation Protection Program 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. NEI Template 07-03 is currently under review by the NRC staff for acceptability. Therefore, the staff cannot find the applicant's operational program for radiation protection acceptable until the staff has approved NEI Template 07-03.

The staff used the acceptance criteria defined in Section 12.5 of NUREG-0800 to evaluate the applicant's responses for resolving the DCD COL information items involving the operational Radiation Protection Program; radiation protection equipment, instrumentation, and facilities; and portable instruments to measure radio-iodine concentrations in plant areas under accident conditions. In the proposed resolutions to these DCD COL information items, the applicant referenced the information in NEI Template 07-03, which describes a Radiation Protection Program that is sufficient to ensure compliance with the applicable provisions in 10 CFR Parts 19, 20, 50, 52, and 71; with 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 with the applicable portions in NUREG-1736. The staff finds that the information in this template is acceptable to resolve these DCD COL information items. However, since this template has not yet been approved by the staff, the staff considers the resolution of these three DCD COL information items to be confirmatory and subject to the staff's approval of NEI Template 07-03. **This is Confirmatory Item 12.01-1.**

Pending resolution of the confirmatory item, NRC staff will conclude that the information pertaining to the North Anna 3 COL FSAR Section 12.5 is within the scope of the design certification and adequately incorporates by reference Section 12.5 of the ESBWR DCD. This information is thus acceptable.