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Dominion®

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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Serial No. NA3-11-024RA
Docket No. 52-017
COL/DWL

DOMINION VIRGINIA POWER
NORTH ANNA UNIT 3 COMBINED LICENSE APPLICATION
SRPs 11.02 AND 11.03: RESPONSE TO RAI LETTER 67

On May 3, 2011, the NRC requested additional information to support the review of certain portions of the North Anna Unit 3 Combined License Application (COLA). Complete responses to seven of the ten Request for Additional Information (RAI) questions were provided by Dominion letter NA3-11-024R dated June 9, 2011. The responses to the remaining three questions are provided in Enclosures 1 through 3:

- RAI 5447, Question 11.02-6 — Failed Liquid Tank Assessment
- RAI 5447, Question 11.02-7 — Cooling Tower Makeup Water Tritium
- RAI 5448, Question 11.03-4 — Annual Gaseous Effluent Releases

The enclosed response to Question 11.03-4 also supplements the Dominion response to RAI 5547, Question 11.02-4 previously submitted June 9, 2011. The supplemental information corrects an inconsistency in the "Expected" case liquid waste concentrations for Units 1 and 2 identified during the preparation of the response to Question 11.03-4.

This information will be incorporated into a future submission of the North Anna Unit 3 COLA, as described in the enclosures.

Please contact Regina Borsh at (804) 273-2247 (regina.borsh@dom.com) if you have questions.

Very truly yours,

Eugene S. Grecheck

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NRO

Enclosures:

1. Response to NRC RAI Letter No. 67, RAI 5447 Question 11.02-6
2. Response to NRC RAI Letter No. 67, RAI 5447 Question 11.02-7
3. Response to NRC RAI Letter No. 67, RAI 5448 Question 11.03-4

Commitments made by this letter:

1. Incorporate proposed changes in a future COLA submission.

COMMONWEALTH OF VIRGINIA

COUNTY OF HENRICO

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Eugene S. Grecheck, who is Vice President-Nuclear Development of Virginia Electric and Power Company (Dominion Virginia Power). He has affirmed before me that he is duly authorized to execute and file the foregoing document on behalf of the Company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 16th day of August, 2011
My registration number is 7173057 and my
Commission expires: August 31, 2012

Wanda K. Marshall
Notary Public

WANDA K. MARSHALL
Notary Public
Commonwealth of Virginia
7173057
My Commission Expires Aug 31, 2012

cc: U. S. Nuclear Regulatory Commission, Region II
C. P. Patel, NRC
T. S. Dozier, NRC
J. T. Reece, NRC

ENCLOSURE 1

Response to NRC RAI Letter 67

RAI 5447, Question 11.02-6

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5447 (RAI Letter 67)

SRP SECTION: 11.02 – LIQUID WASTE MANAGEMENT SYSTEMS

QUESTIONS for Health Physics Branch 1(CHPB)

DATE OF RAI ISSUE: 05/3/2011

QUESTION NO.: 11.02-6

NRC Staff review of FSAR (Rev. 3) found information that requires updating and/or needs to be addressed in FSAR Sections 11.2.3.2 and 2.4.13, Table 11.2-16R, and NAPS COL 11.2(3) for conformance to SRP Sections 11.2.3 and 2.4.13, and BTP 11-6. Please address the following items and provide a mark-up on the proposed FSAR changes.

1. Update FSAR Sections 11.2.3.2 and 2.4.13 with an assessment based on the methodology and information proposed in US-APWR DCD (Rev. 3) Tier 2, Section 11.2.3.2 and COL 11.2(3) which uses the RATAF code to calculate source terms for the failed liquid tank (ML1025700671) as described in MHI TR MUAP-10019[Proprietary]P (R0), MHI TR MUAP-10019[Non-Proprietary]NP (R0) (ML102850683).
2. Make reference to MHI TR MUAP-10019[Proprietary]P (R0), MHI TR MUAP-10019[Non-Proprietary]NP (R0) (ML102850683) which describes the methodology, basis, and assumptions for failed liquid tank analysis for plants referencing the US-APWR design.
3. In FSAR Sections 11.2.3.2 and 2.4.13, fully describe the approach and results to select the failed liquid tank and provide the basis and assumptions on all site-specific parameter values in the respective updated FSAR sections for assessing the radioactive effluent release to surface or groundwater from a liquid tank failure using site-specific groundwater transport and soil properties to meet compliance with 10 CFR Part 20, Appendix B, Table 2, Column 2, under the unity rule, at the nearest potable water and surface water supplies in an unrestricted area.

4. Update FSAR Section 11.2.3.2 to address the impact of the plant capacity factor of 80% applied in the calculation of doses from a liquid containing tank failure when typical operating plant capacity factors exceed 90% (see response to RAI 523-4246, Question 11.02-30, ML100770379).

Dominion Response

1. Methodology for Calculating Source Terms

The RATAF code is used to determine the radionuclide concentrations in the tanks containing radioactive liquids which are evaluated for potential to fail. The US-APWR Design Control Document (DCD) Revision 3 considers the boric acid tank (BAT), the holdup tank (HT), and the waste holdup tank (WHT) and provides a source term for each.

As described in COLA Part 7, Unit 3 has a departure from the US-APWR standard plant design in that Unit 3 replaces the boric acid evaporator (BAE) with a degasifier. The information which addresses this departure in the FSAR is identified by the left margin notation (LMN) NAPS DEP 9.2(1). The BAE departure affects the source term for the accidental liquid radioactive release for Unit 3 and the departure LMN is used in FSAR Section 11.2.3.2. Consequently, the source term for the accidental liquid radioactive release for Unit 3 is not the same as for the US-APWR standard plant design.

In the Unit 3 design, the BAT is not recycled through the BAE due to the departure. Therefore, the liquid in the BAT is non-radioactive and the BAT is eliminated from consideration for Unit 3. Also, the volume control tank, chemical drain tank, sump tanks, and refueling water storage auxiliary tank are bounded by the HT for the radionuclides of interest for the purpose of assessing compliance with 10 CFR 20. Liquid from the HT is pumped through demineralizers before combining with other waste streams in the WHT. Therefore, the WHT is also evaluated for Unit 3 but the source term could be different from the source term in the DCD depending on how the plant is operated, as described below.

The source terms for Unit 3 tanks were determined for the radionuclides identified in the ISG on Standard Review Plan Section 11.2 (DC/COL-ISG-013). A dilution factor was used to adjust the concentrations of the radionuclides in the same manner as the DCD calculation described in MHI Technical Report (TR) MUAP-10019P, Revision 1 (Proprietary) and MUAP-10019NP, Revision 1 (Non-Proprietary), provided in MHI submittal UAP-HF-11085 (ML111430877).

The methodology and input parameters for determining HT concentrations are the same as the standard plant design in the DCD, which is described in the above TRs. The difference from the standard plant design is that the BAT is eliminated from consideration due to the departure. In addition, the decay of radionuclides in the liquids

from shim bleed and coolant drains that are collected in the HT is considered in the calculation for the concentrations in the WHT. This accounts for a realistic hold-up time and the treatment effect of the demineralizer.

For the standard plant design, only contaminated waste (referred to as "dirty" waste in the DCD) provides input to the WHT. For Unit 3, shim bleed, coolant drains, and contaminated waste may provide inputs to the WHT. However, for Unit 3, the plant may be operated such that the only input to the WHT is contaminated waste. Therefore, for Unit 3, two cases are evaluated for the WHT source term. One is the contaminated waste only source term and the other is the mixture source term which includes inputs from shim bleed, coolant drains, and contaminated waste. The contaminated waste only case has the same source term as presented in DCD Table 11.2-17 for the WHT column except that for Unit 3, several additional nuclides are evaluated. The parameters used in the RATAF code for the mixture case are provided in the attached mark-ups for FSAR Table 11.2-16R. Based on the radionuclide concentrations in the WHT for these two cases, contaminated waste only case and mixture case, the source term for the WHT in the accidental release analysis in FSAR Section 2.4.13 conservatively uses the higher value for the concentration of each nuclide from these two cases. The column labeled "Waste Holdup Tank Conc" in attached new FSAR Table 2.4-206a provides the resulting composite WHT source term.

2. Add Reference for MHI TRs

TRs MUAP-10019P, Revision 1, and MUAP-10019NP, Revision 1, which evaluate the source term used in the tank failure analysis for the HT in the standard plant design, are identified as Reference 11.2-27 in DCD Subsection 11.2.6. These TRs are incorporated by reference into the Unit 3 FSAR and the reference will be cited in FSAR Section 11.2.3.2. However, due to the departure to eliminate the BAE, additional analysis for Unit 3 is required to supplement these TRs.

3. Unit 3 Accidental Releases Of Radioactive Liquid Effluents

Since the June 2010 S-COLA revision, the radionuclide source inventory has been revised. Therefore, the analysis of the Unit 3 accidental releases of radioactive liquid effluents was re-evaluated. The RATAF code was used to determine radioactive liquid tank inventories. Tanks containing radioactive liquid include the following: HT, WHT, volume control tank, chemical drain tank, sump tank, and refueling water storage auxiliary tank. Due to the elimination of the BAE, the boric acid tank and primary makeup water tank do not contain radioactive liquid. The volume control tank, chemical drain tank, sump tanks and refueling water storage auxiliary tank were eliminated from consideration as the limiting tank with respect to the accidental release analysis due to their smaller volumes and/or lower radionuclide inventories for isotopes of interest than the HT and WHT.

A screening analysis was conducted using the HT and WHT inventories to determine the limiting tank. The screening analysis considered groundwater transport from the

Auxiliary Building (release point) to the Unit 3 forebay (discharge point), accounting for advection, radioactive decay, and adsorption. The results of this analysis indicate the HT is the limiting tank, with respect to 10 CFR 20, Appendix B, Table 2 Effluent Concentration Limits (ECLs). Therefore, a single HT is selected as the limiting tank for the accidental release analysis.

The basis and assumptions for the site-specific parameter values used for assessing a postulated release of radioactive liquid effluent release to surface or groundwater are described in FSAR Subsection 2.4.13.3 and are summarized as follows:

- The hydraulic conductivity (9.9 feet/day) used in the groundwater travel time calculation is the maximum value determined from site-specific tests.
- The hydraulic gradient along the assumed accidental release flow path was determined for each of the generated potentiometric surface contour maps (see FSAR Revision 3, Figures 2.4-207 through 2.4-214b). Of the calculated hydraulic gradients, the maximum value (-0.05 feet/feet), determined from the February 2007 water level data, is used in the groundwater travel time calculation.
- Effective porosity is assumed to be 80% of the total porosity. The average total porosity of the saprolite material is 31%; the assumed effective porosity is therefore 25%. The effective porosity was established as described in FSAR Subsection 2.4.12.1.2.
- The length (1100 feet) used in the groundwater travel time calculation is the assumed flow path length for an accidental release to discharge into North Anna Unit 3 forebay (see FSAR Figure 2.4-219).
- For analyses that incorporate radionuclide adsorption, the minimum measured K_d values are used. For those parent radionuclides where no site-specific K_d values are available, 10^{th} percentile values of the element's lognormal distribution were assigned from FSAR Reference 2.4-215. For daughter products, the K_d value assumed is equal to that of the parent radionuclide. This assumption is of little consequence due to the very short half-lives of the daughter products of interest. Due to the changes in radionuclide concentrations, there are updates needed for the nuclides which are compared in FSAR Table 2.0-201. Several nuclides on Table 2.0-201 are now screened out considering only advection and radioactive decay. One nuclide and daughter (Te-127m and Te-127) need to be added to FSAR Table 2.0-201. Part 7 of the S-COLA also needs an update for the changes in nuclides in FSAR Table 2.0-201.
- The radionuclide transport analysis does not account for hydrodynamic dispersion within the groundwater system. This is a conservative assumption as hydrodynamic dispersion typically reduces radionuclide concentrations.

An accidental release of liquid effluent from a HT to groundwater would result in radionuclide concentrations in the nearest potable water supply, located in an

unrestricted area, that are below the 10 CFR 20, Appendix B, Table 2, Column 2 limits, as described in FSAR Subsections 2.4.13.3(d) and 2.4.13.4.

4. Effect of Plant Capacity Factor

Plant capacity factors greater than 80% were addressed in the response to DCD RAI 523-4246, Question 11.02-30 (ML100770379). The RATAF code, whose primary coolant activity calculation is based on the built-in primary coolant concentrations in the PWR-GALE code, is used for the accidental liquid radioactive release analysis, as described in DCD Subsection 11.2.3.2. As described in Table 11.2-9 of the DCD, the basis of the PWR-GALE source term calculation uses a built-in plant capacity factor of 80%, which is less than the expected capacity factor for the US-APWR. The RATAF code also uses the same built-in capacity factor. As described in DCD RAI 523-4246, the difference in capacity factor has no impact on the calculated tank concentrations for liquid containing tank failures.

Proposed COLA Revision

FSAR Sections 2.4.13 and 11.2.3.2 will be revised as described above and indicated on the attached markups. The markups for FSAR Section 2.4.13 include a new Table 2.4-206a. In addition, FSAR Table 2.0-201 and Part 7 will be revised as indicated on the attached markups to be consistent with the changes to FSAR Tables 2.4-206 and 2.4-206a.

Markup of North Anna COLA

The attached markup represents Dominion's good faith effort to show how the COLA will be revised in a future COLA submittal in response to the subject RAI. However, the same COLA content may be impacted by revisions to the DCD, responses to other COLA RAIs, other COLA changes, plant design changes, editorial or typographical corrections, etc. As a result, the final COLA content that appears in a future submittal may be somewhat different than as presented herein.

Table 2.0-201 Evaluation of Site/Design Parameters and Characteristics

	Parameter Description (15)	DCD Site Parameter Value (15)	Site Characteristic	Evaluation
NAPS SUP 2.0(3)	**Part 3 – Evaluation of SSAR Bounding Site Characteristics and Design Parameters For Which There is No Corresponding ESP or DCD Value**			
	Distribution Coefficients (K_d) (continued)			
	~~Zn-65~~	~~No value provided~~	~~**SSAR Table 1.9-1**~~ ~~200 cm^3/g~~	~~The SSAR Table 1.9-1 site characteristic value is the distribution coefficient used to assess subsurface hydrological radionuclide transport and is consistent with SSAR Table 2.4-20.~~
~~**NAPS ESP VAR 2.0-5**~~			~~**Unit 3**~~ ~~11.8 cm^3/g~~	~~The Unit 3 site characteristic value listed in Table 2.4-207 is the minimum measured K_d value and does not fall within (is less than) the SSAR site characteristic value. See Section 2.4.13 for the radionuclide transport analysis.~~
	Sr-90 Y-90	No value provided	**SSAR Table 1.9-1** 15 cm^3/g	The SSAR Table 1.9-1 site characteristic value is the distribution coefficient used to assess subsurface hydrological radionuclide transport and is consistent with SSAR Table 2.4-20.
NAPS ESP VAR 2.0-5			**Unit 3** 3.6 cm^3/g	The Unit 3 site characteristic value for Sr-90 listed in Table 2.4-207 is the minimum measured K_d value and does not fall within (is less than) the SSAR site characteristic value. The K_d value for Y-90 is assumed to be the same as the parent radionuclide, Sr-90. See Section 2.4.13 for the radionuclide transport analysis.

Table 2.0-201 Evaluation of Site/Design Parameters and Characteristics

NAPS SUP 2.0(3)

Parameter Description (15)	DCD Site Parameter Value (15)	Site Characteristic	Evaluation
Part 3 – Evaluation of SSAR Bounding Site Characteristics and Design Parameters For Which There is No Corresponding ESP or DCD Value			
Distribution Coefficients (K_d) (continued)			
Ru-106	No value provided	**SSAR Table 1.9-1** 55 cm^3/g	The SSAR Table 1.9-1 site characteristic value is the distribution coefficient used to assess subsurface hydrological radionuclide transport and is consistent with SSAR Table 2.4-20.
		Unit 3 272 cm^3/g	The Unit 3 site characteristic value listed in Table 2.4-207 is the minimum measured K_d value and falls within (is greater than) the SSAR site characteristic value. See Section 2.4.13 for the radionuclide transport analysis.
Te-127m Te-127	No value provided	**SSAR Table 1.9-1** No value provided **Unit 3** 0.61 cm^3/g	SSAR Table 1.9-1 does not identify distribution coefficients for these radionuclides. The Unit 3 site characteristic value listed in Tables 2.4-206 and 2.4-206a for Te-127m was conservatively assigned to the tenth percentile of its distribution based on data published in NUREG/CR-6697. The K_d values for Te-127 are assumed to be the same as the parent radionuclide, Te-127m. See Section 2.4.13 for the radionuclide transport analysis.
Cs-134	No value provided	**SSAR Table 1.9-1** 30 cm^3/g	The SSAR Table 1.9-1 site characteristic value is the distribution coefficient used to assess subsurface hydrological radionuclide transport and is consistent with SSAR Table 2.4-20.
		Unit 3 64.9 cm^3/g	The Unit 3 site characteristic value listed in Table 2.4-207 is the minimum measured K_d value and falls within (is greater than) the SSAR site characteristic value. See Section 2.4.13 for the radionuclide transport analysis.

Table 2.0-201 Evaluation of Site/Design Parameters and Characteristics

	Parameter Description (15)	DCD Site Parameter Value (15)	Site Characteristic	Evaluation
NAPS SUP 2.0(3)	**Part 3 – Evaluation of SSAR Bounding Site Characteristics and Design Parameters For Which There is No Corresponding ESP or DCD Value**			
	Distribution Coefficients (K_d) (continued)			
	Cs-137	No value provided	**SSAR Table 1.9-1** 30 cm^3/g	The SSAR Table 1.9-1 site characteristic value is the distribution coefficient used to assess subsurface hydrological radionuclide transport and is consistent with SSAR Table 2.4-20.
			Unit 3 64.9 cm^3/g	The Unit 3 site characteristic value listed in Table 2.4-207 is the minimum measured K_d value and falls within (is greater than) the SSAR site characteristic value. See Section 2.4.13 for the radionuclide transport analysis.
	~~Zr-95~~ ~~Nb-95m~~ ~~Nb-95~~	~~No value provided~~	~~**SSAR Table 1.9-1**~~ ~~No value provided~~ ~~**Unit 3**~~ ~~6.13 cm^3/g~~	~~SSAR Table 1.9-1 does not identify distribution coefficients for these radionuclides. The Unit 3 site characteristic value listed in Table 2.4-206 for Zr-95 was conservatively assigned the 10th percentile of its distribution based on data published in NUREG/CR-6697. The K_d value for Nb-95m and Nb-95 are assumed to be the same as the parent radionuclide, Zr-95. See Section 2.4.13 for the radionuclide transport analysis.~~
	~~Ag-110m~~	~~No value provided~~	~~**SSAR Table 1.9-1**~~ ~~No value provided~~ ~~**Unit 3**~~ ~~2.5 cm^3/g~~	~~SSAR Table 1.9-1 does not identify a distribution coefficient for this radionuclide. The Unit 3 site characteristic value listed in Table 2.4-207 is the minimum measured K_d value. See Section 2.4.13 for the radionuclide transport analysis.~~
	Ce-144 Pr-144m Pr-144	No value provided	**SSAR Table 1.9-1** No value provided **Unit 3** 329.1 cm^3/g	SSAR Table 1.9-1 does not identify distribution coefficients for these radionuclides. The Unit 3 site characteristic value listed in Table 2.4-207 is the minimum measured K_d value for Ce-144. The K_d value for Pr-144m and Pr-144 are assumed to be the same as the parent radionuclide, Ce-144. See Section 2.4.13 for the radionuclide transport analysis.

protected by a water barrier provided on all exterior concrete members subjected to groundwater. As described in Section 3.7.2.4.1, the groundwater design bases (assumed groundwater level elevations) for seismic category I R/B complex and PS/Bs used in the seismic and stability analyses are based on maximum groundwater levels from Figure 2.4-216. Section 3NN.6 shows that a site-specific seismic analysis for the R/B complex used 7 ft below plant grade, while the maximum groundwater level from Figure 2.4-216 for this area is 7.7 ft below plant grade. Section 2.3 of Reference 2.4-225 shows that for the site-specific analysis for the UHSRS and UHSRS pipe chase, the design margin accomodates the maximum groundwater without the need for a permanent dewatering system. Therefore, a permanent dewatering system is not required.

2.4.13 Accidental Releases of Liquid Effluents to Ground and Surface Waters

NAPS COL 2.4(1)

The information needed to address DCD COL Item 2.4(1) is included in SSAR Section 2.4.13, which is incorporated by reference with the following supplements.

The purpose of this section is to provide a conservative analysis of a postulated, accidental release of radioactive liquid effluents to the groundwater at the Unit 3 site. The accident scenario is described. The model used to evaluate radionuclide transport is presented, along with potential pathways of contamination to water users. The radionuclide transport analysis is described, and the results are summarized. The radionuclide concentrations to which a water user might be exposed are compared against the regulatory limits.

2.4.13.1 Accident Scenario

Due to the elimination of the boric acid evaporator, the boric acid tank and primary makeup water tank do not contain radioactive liquid. Tanks containing radioactive liquid include the following: holdup tank, waste holdup tank, volume control tank, chemical drain tank, sump tank, and refueling water storage auxiliary tank. The volume control tank, chemical drain tank, sump tank and refueling water storage auxiliary tank were eliminated from consideration as the limiting tank with respect to the accidental release analysis due to their smaller volumes and/or lower radionuclide inventories for isotopes of interest than the holdup tank and

waste holdup tank. A holdup tank Therefore, a holdup tank or a waste holdup tank outside containment is postulated to rupture with its contents released to the groundwater. A holdup tank was These tanks were selected to produce an accident scenario that leads to the most adverse contamination of groundwater, or surface water resources in the vicinity of the site. Derivation of the holdup tank and waste holdup tank source term is described in Section 11.2.3.2.

2.4.13.2 **Model**

Figure 2.4-217 illustrates the model used to evaluate the postulated accidental release. The key elements and assumptions embodied in the model are described and discussed below.

One A holdup tank or a waste holdup tank is postulated to rupture, and 80 percent of the liquid volume (12,800 ft^3) is assumed to be released following the guidance provided in BTP 11-6 (Reference 2.4-210). The capacity capacities of the holdup tank is and the waste holdup tank are approximately 16,000 ft3 and 4,000 ft3, respectively, as provided in DCD Table 11.2-16. Following tank rupture, it is conservatively assumed that a pathway is created that allows the entire 12,800 ft^3 release to enter the groundwater (unconfined aquifer) instantaneously.

The assumption of instantaneous release to the groundwater following tank rupture is very conservative because it requires failure of the floor drain system, plus the barriers presented by the basemat and the epoxy coated walls of the cubicles of the auxiliary building, which is seismically designed.

It should also be recognized that the lowest level of the auxiliary building is well below the water table. Post-construction groundwater model results presented in Figure 2.4-216 indicate that the expected water table in the vicinity of the auxiliary building is about 280 ft NAVD88 (280.86 ft NGVD29), or 19 ft above the floor elevation. If the basemat or exterior walls of the auxiliary building and associated epoxy coating were to fail simultaneously, groundwater would flow into the auxiliary building, precluding the release of liquid effluents out of the building. Only if the interior of the auxiliary building was flooded to a level higher than the surrounding groundwater would there be a pathway for liquid effluents to be released out of the building and to the groundwater. Hence, the assumption of an accidental release of liquid effluents from the auxiliary

building to groundwater is extremely conservative, given the hydrogeologic conditions at the site.

With the postulated instantaneous release of the contents of a holdup tank or a waste holdup tank to groundwater, radionuclides enter the unconfined aquifer and migrate with the groundwater in the direction of decreasing hydraulic head. Hydraulic head contour maps for the unconfined aquifer presented in Figure 2.4-207 through Figure 2.4-214b indicate that the groundwater pathway from the auxiliary building is true north-northeast toward Lake Anna, a groundwater discharge area. In particular, the hydrogeologic data suggest that the groundwater pathway terminates in the cove used for the Unit 3 intake from Lake Anna. The flow path is assumed to be a straight line between the auxiliary building and the true south edge of the cove, a distance of about 1100 ft based on Figure 2.1-219. As indicated in Section 2.4.12.1.2, groundwater flow occurs in both the saprolite and underlying, shallow bedrock. During saturated zone transport, radionuclide concentrations of the liquid released to the groundwater are reduced by the processes of adsorption, hydrodynamic dispersion, and radioactive decay. As described in Section 2.4.12.1.3, there is an existing water-supply well in the power block area (Well No. 2 on Figure 2.4-215). This well will be closed and grouted to accommodate the construction of Unit 3. There are no other existing water-supply or monitoring wells between the postulated release point and Lake Anna.

Lake Anna serves as a groundwater discharge area for the unconfined aquifer. The radionuclides associated with a liquid release would enter the surface water system via Lake Anna. The portion of Lake Anna closest to the release point is the cove that was created for the abandoned Units 3 and 4. As shown in Figure 2.4-204, the station water intake for Unit 3 is located at the end of the cove, which is physically separated from the rest of the lake by a cofferdam, but hydraulically connected to the lake by a set of culverts. The intake provides make-up water to the normal plant circulating water and essential service water cooling systems, and supplies water to the station water system for demineralized water and fire protection use. Because flow through the cove is induced when Unit 3 is operating, the subsequent surface water pathways for any radionuclides discharged with the groundwater to the cove depends on the operating status of the plant.

During the operational lifetime of Unit 3 (up to 60 years), any contaminated groundwater discharging to the cove would be abstracted from the lake by the station water intake for Unit 3. Any radionuclides introduced into the make-up water systems ultimately would be discharged with the cooling tower blowdown to the discharge canal. This blowdown discharge would be mixed and diluted with surface water in the discharge canal. The discharge canal is hydraulically connected to the WHTF, which in turn discharges to the North Anna Reservoir through Dike 3. Any radionuclides released from the discharge canal would undergo additional mixing and dilution in the WHTF as well as the North Anna Reservoir.

If Unit 3 were not operating, any contaminated groundwater would simply be mixed and diluted with surface water in the cove. Because the cove is isolated from the rest of the lake by the cofferdam and connected by culverts, hydraulic interaction between the two surface water bodies would occur only when there are changes in lake level or during runoff events.

As described in SSAR Section 2.1.1.3, the liquid effluent release limits for Unit 3 apply at the end of the discharge canal, which is designated as the release point to unrestricted areas in the context of 10 CFR 20. As noted in ESP-ER Table 2.3-4, the Doswell Water Treatment Plant is the nearest and only municipal water system currently supplied from the North Anna River. The treatment plant is about 20 miles downstream of the Lake Anna Dam and near the confluence with the Little River.

2.4.13.3 Radionuclide Transport Analysis

A radionuclide transport analysis has been conducted to estimate the radionuclide concentrations that might expose existing and future water users based on an instantaneous release of the radioactive liquid from a holdup tank or a waste holdup tank. Analysis of liquid effluent release commences with a screening model to determine the limiting tank, using demonstratively conservative assumptions and coefficients. Radionuclide concentrations resulting from the screening analysis are then compared against the effluent concentration limits (ECLs) identified in 10 CFR 20, Appendix B, Table 2, Column 2, to determine acceptability. Further analysis, using more realistic modeling techniques, is conducted for the radionuclides of interest as identified in the screening analysis.

a. **Methodology**

This analysis accounts for the parent radionuclides assumed present in a holdup tank or a waste holdup tank plus progeny radionuclides that are generated subsequently during transport. The analysis considered all progeny in the decay chain sequences that are important for dosimetric purposes. International Commission on Radiation Protection (ICRP) Publication 38 (Reference 2.4-211) was used to identify the member for which the decay chain sequence can be truncated. For some of the radionuclides ~~assumed present in a holdup tank~~, consideration of up to three members of the decay chain sequence was required. The derivation of the equations governing the transport of the parent and progeny radionuclides follows.

Transport of the parent radionuclide along a groundwater pathline is governed by the advection-dispersion-reaction equation (Reference 2.4-212), which is given as [equations and associated citations renumbered to 2.4.13-1 through 2.4.13-19]:

$$R\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial x^2} - v\frac{\partial C}{\partial x} - \lambda RC \qquad (2.4.13\text{-}1)$$

where: C = radionuclide concentration in terms of atom density; R = retardation factor; D = coefficient of longitudinal hydrodynamic dispersion; v = average linear velocity; and λ = radioactive decay constant. The retardation factor is defined from the relationship:

$$R = 1 + \frac{\rho_b K_d}{n_e} \qquad (2.4.13\text{-}2)$$

where: ρ_b = bulk density; K_d = distribution coefficient; and n_e = effective porosity. The average linear velocity is determined using Darcy's law, which is:

$$v = -\frac{K}{n_e}\frac{dh}{dx} \qquad (2.4.13\text{-}3)$$

where: K = hydraulic conductivity; and dh/dx = hydraulic gradient. The radioactive decay constant can be written as:

$$\lambda = \frac{\ln 2}{t_{1/2}} \qquad (2.4.13\text{-}4)$$

where: $t_{1/2}$ = radionuclide half-life.

for which:

$$K_1 = \frac{d_{13}\lambda_3 C_{10}}{\lambda_3 - \lambda_1} + \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_1)(\lambda_2 - \lambda_1)}$$

$$K_2 = \frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2} + \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_1)(\lambda_2 - \lambda_1)}$$

$$K_3 = C_{30} - \frac{d_{13}\lambda_3 C_{10}}{\lambda_3 - \lambda_1} - \frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2} + \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_1)(\lambda_3 - \lambda_2)}$$

b. **Screening Analysis**

Using the methodology developed above, a screening analysis was performed considering advection and radioactive decay only to eliminate from consideration those radionuclides in the source term that would be well below the 10 CFR 20, Appendix B, Table 2 ECLs under very conservative modeling assumptions (i.e., no adsorption and no dispersion). For this limiting case, activity concentrations for parent and relevant progeny radionuclides were calculated at the point where liquid effluent from a postulated accidental release ~~from a holdup tank~~ would discharge from the groundwater. This point has been identified to be the cove that will serve as the forebay for the Unit 3 makeup water intake, as discussed previously. This portion of the lake is within the restricted area as defined in SSAR Section 2.1.1.3 and illustrated on SSAR Figure 2.1-1. Activity concentrations for the parent and first two progeny radionuclides at the point of groundwater discharge can be calculated from Equations 2.4.13-8, 2.4.13-13, and 2.4.13-18 with time, *t*, being equal to the groundwater travel time.

The groundwater travel time between the point of the postulated release and the point of discharge to the cove is calculated based on the following data:

Hydraulic conductivity, K = 9.9 ft/d

Hydraulic gradient, dh/dx = –0.05

Effective porosity, n_e = 0.25

Transport distance, L = 1100 ft

The hydraulic conductivity value represents the maximum observed value for the site, based on test data summarized in Table 2.4-16R. The hydraulic gradient was determined from Figure 2.4-219. The February 2007 potentiometric surface contour map shows the maximum gradient

The travel time used in this analysis (1.52 years) is therefore considered very conservative compared to post-construction groundwater conditions predicted by the groundwater flow model. Radioactive decay data and decay chain specifications were taken from ICRP Publication 38 (Reference 2.4-211). Results of the screening analysis for the holdup tank and the waste holdup tank are provided in ~~Table 2.4-206~~ Tables 2.4-206 and 2.4-206a, respectively, under the column heading "Advection and Radioactive Decay" and include the groundwater concentration, *C*, at the point of discharge to the cove and the ratio of groundwater concentration to the associated effluent concentration limit, *C*/ECL. Ratios of less than 1×10^{-6} were taken to be zero. Radionuclides for which the *C*/ECL value is greater than or equal to 0.01 include H-3, Mn-54, Fe-55, Co-58, Co-60, ~~Zn-65,~~ Sr-90, Y-90, ~~Zr-95, Nb-95,~~ Ru-106, ~~Ag-110m,~~ Te-127m, Cs-134, Cs-137, and Ce-144, ~~and Pr-144,~~ and are considered to be the radionuclides of interest for the purpose of assessing compliance with 10 CFR 20. The *C*/ECL values for the remaining radionuclides are so small that they do not play a role in assessing regulatory compliance, even when summed; these radionuclides were eliminated from further consideration.

c. **Groundwater Pathway**

The radionuclides of interest identified above were further evaluated considering adsorption in addition to advection and radioactive decay. Distribution coefficient, K_d, values were determined by laboratory analysis of site soil samples (Reference 2.4-219). For the purpose of assessing 10 CFR 20 compliance, each radionuclide was assigned its minimum site-specific K_d value as obtained by laboratory testing. Site-specified K_d values were determined for Mn, Fe, Co, Zn, Sr, Ru, Ag, Cs, and Ce for 20 saprolite and weathered rock samples. These samples were obtained from borings B-901, B-904, B-913, B-917, B-919, B-920, B-928, B-929, B-931, B-932, B-949, and B-951, the locations of which are shown on Figures 2.5-221 and 2.5-222. K_d values for these samples were determined using the batch method in accordance with ASTM D 4646-03 at Savannah River National Laboratory using site water obtained from the unconfined aquifer. The results are summarized in Table 2.4-207. Site-specific K_d values are not available for some radionuclides, including isotopes of yttrium (Y), ~~zirconium (Zr), niobium (Nb),~~ tellurium (Te), and praseodymium (Pr). In the case of Y-90, the K_d value was assumed to be the same as Sr-90 serving as the parent

radionuclide. The K_d values for ~~Zr-95, Nb-95m, and Nb-95~~ Te-127 and Te-127m were conservatively assigned the 10th percentile of the ~~Zr-95~~ Te distribution based on data published in NUREG/CR-6697 (Reference 2.4-215). For Pr-144 and Pr-144m, daughter products of Ce-144, their K_d values were assumed to be the same as cerium. For H-3, a component of water, the K_d value is zero by definition. The K_d values used in the transport analysis are provided in ~~Table 2.4-206~~ Tables 2.4-206 and 2.4-206a.

Retardation factors for the radionuclides of interest were calculated using Equation 2.4.13-2 with the K_d values as described above, an effective porosity of 0.25, and a bulk density of 1.83 g/cm^3. The bulk density was estimated using a soil grain specific gravity of 2.65 and total porosity of 0.31, which were determined on a site-specific basis (Section 2.4.12.1.2). The concentration of each radionuclide was then determined at the point of groundwater discharge to the cove using Equations 2.4.13-8, 2.4.13-13, and 2.4.13-18, as necessary, and the appropriate initial concentration, decay rate, and retardation factor. ~~Table 2.4-206 provides~~ Tables 2.4-206 and 2.4-206a provide the results under the column heading "Advection, Decay, and Adsorption." As before for the groundwater concentration (*C*) to ECL ratios, *C*/ECL values less than 1×10^{-6} were taken to be zero. Radionuclides for which the *C*/ECL value is greater than or equal to 0.01 include H-3, Sr-90, and Y-90. Under the unity rule in 10 CFR 20, accounting for advection, radioactive decay, and adsorption, the sum of fractions for a holdup tank and a waste holdup tank are 717 and 552, respectively. These results, coupled with the fact that the holdup tank volume is four times larger than that of the waste holdup tank, indicate the holdup tank is the limiting tank. Therefore, a holdup tank is selected as the limiting tank for the accidental release analysis.

d. **Surface Water Pathways**

The results presented in Table 2.4-206 indicate that H-3, Sr-90, and Y-90 need to be further evaluated to determine compliance with 10 CFR 20, Appendix B, Table 2 limits, which apply to the nearest source of potable water located in an unrestricted area. This evaluation requires consideration of surface water pathways, which in turn are determined by the status of plant operation. Because of its mobility, a release of H-3 would likely enter the surface water within the operational lifetime of Unit 3 (up to 60 years), whereas the less mobile Sr-90 and Y-90 could

enter the surface water either during Unit 3 operation or after the plant has been shutdown, depending on when an accidental release might occur. As described previously, any constituent in the groundwater discharging to the cove during plant operation is expected to be: 1) entrained, mixed, and diluted with surface water in the cove that comprises the Unit 3 intake forebay; 2) subsequently withdrawn from the cove by the makeup water intake for Unit 3, introduced into the closed-cycle circulating water system, and circulated through wet cooling towers; and 3) discharged with the cooling tower blowdown to the discharge canal. If Unit 3 were not operating, constituents in groundwater discharging to the cove would simply be mixed and diluted with surface water in the cove. Note that this cove is isolated from the rest of Lake Anna by a cofferdam and is connected hydraulically with the lake by a set of culverts as shown in Figure 2.4-204.

For the scenario in which the plant is operating (where H-3, Sr-90, and Y-90 are of interest), radionuclide concentrations in the discharge canal can be estimated by diluting the volume of liquid effluent released into the volume of the discharge canal and accounting for the radioactive decay that would occur during groundwater transport. This approach assumes that Units 1 and 2 are not operating, which is conservative because it ignores the large volume of circulating water discharged from Units 1 and 2 that would otherwise be available for dilution. Assuming fully mixed conditions and no hydraulic interaction with the WHTF, the sum of fractions can be calculated as:

$$\sum\frac{C_{\text{discharge}}}{\text{ECL}} = \frac{V_{\text{release}}}{V_{\text{discharge}}}\sum\frac{C}{\text{ECL}} \qquad (2.4.13\text{-}22)$$

where: $C_{discharge}$ = radionuclide concentration in the discharge canal (restricted area); $V_{release}$ = 80 percent of the capacity of a holdup tank (13,800 ft^3); $V_{discharge}$ = volume of water in the discharge canal; and C = radionuclide concentration of the groundwater discharging to surface water (Table 2.4-206). The discharge canal is 3850 ft long and has a trapezoidal cross-section with a bottom width of 100 ft, side slopes of 2.5:1, and an invert elevation of 266.14 ft NAVD88 (227 ft msl, which corresponds to NGVD29) (ESP ER Section 3.4.2.2). Given these characteristics, the discharge canal volume can be calculated as:

$$V_{discharge} = AL = (b + zy)yL \qquad (2.4.13\text{-}23)$$

where: A = cross sectional area; b = bottom width; z = side slope; y = depth; and L = channel length. For a lake elevation of 249.39 ft NAVD88 (250.25 ft NGVD29), the volume of the discharge canal is calculated using Equation 2.4.13-23 as follows:

$$V_{discharge} = [100 + 2.5(23.25)](23.25)(3850) = 14,154,000\ ft^3$$

Applying Equation 2.4.13-22 to H-3 and Sr-90 and Y-90 then yields the following for a lake elevation of 249.39 ft NAVD88 (250.25 ft NGVD29):

H-3, Sr-90 and Y-90:

$$\sum \frac{C_{discharge}}{ECL} = \frac{12800}{14154000} \times (725 + 3.8 + 0.27) = 0.66 < 1$$

$$\sum \frac{C_{discharge}}{ECL} = \frac{12800}{14154000} \times (716 + 0.4 + 0.03) = 0.65 < 1$$

For the scenario in which the plant is not operating (where Sr-90 and Y-90 are of interest), a bounding estimate of the sum of fractions in the unrestricted area of Lake Anna can be determined by calculating the radionuclide concentration in the isolated cove of Lake Anna that receives the effluent release via groundwater discharge. Assuming fully mixed conditions and no hydraulic interaction with the main lake, this concentration can be calculated as:

$$\sum \frac{C_{cove}}{ECL} = \frac{V_{release}}{V_{cove}} \sum \frac{C}{ECL} \qquad (2.4.13\text{-}24)$$

where: C_{cove} = radionuclide concentration in the Lake Anna cove (restricted area); V_{cove} = volume of water in cove (3,984,000 ft^3 assuming a 249.39 ft NAVD88 (250.25 ft NGVD29) water surface elevation); and C = radionuclide concentration of the groundwater discharging to surface water (Table 2.4-206). This value is considered bounding because any water leaving the cove would have to mix with additional surface water prior to entering the unrestricted area. Applying Equation 2.4.13-24 to Sr-90 and Y-90 gives:

Sr-90 and Y-90:

$$\sum \frac{C_{cove}}{ECL} = \frac{12800}{3984000} \times (3.8 + 0.27) = 0.01 < 1$$

$$\sum \frac{C_{cove}}{ECL} = \frac{12800}{3984000} \times (0.4 + 0.03) = 0.001 < 1$$

The results presented above demonstrate that use of the maximum observed hydraulic conductivity and minimum site-specific K_d values result in sum of fraction values less than one (unity) within the restricted area, both during plant operation and after the plant has been shut down. Because 10 CFR 20 limits are met within the restricted area, the same limits will be achieved with even greater margin in unrestricted areas as a consequence of additional mixing and dilution. Therefore, it is concluded that the requirements of 10 CFR 20 are met under these limiting conditions that combine maximum hydraulic conductivity and minimum distribution coefficients.

2.4.13.4 Compliance with 10 CFR 20

A conservative analysis of a postulated, accidental release of liquid effluents in groundwater has been conducted. The analysis was performed using demonstratively conservative coefficients and assumptions, and physical conditions likely to give the most adverse dispersion of liquid effluent. It is concluded that an accidental release of liquid from a holdup tank (the limiting tank) to groundwater would result in radionuclide concentrations in the nearest potable water supply, located in an unrestricted area, that are below the 10 CFR 20 limits.

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2.4.14 Technical Specifications and Emergency Operation Requirements

The design plant grade elevation for safety-related SSCs is located above the design basis flood level, as stated in **Section 2.4.2**, and above the maximum groundwater elevation, as stated in **Section 2.4.12**. Safety-related SSCs for the plant are protected from external floods as discussed in **Section 3.4**. The elevation of exterior access openings, which are above the PMF and local PMP flood levels, and the design of exterior penetrations below design flood and groundwater levels, which are appropriately sealed, result in a design and site combination that do not necessitate emergency procedures or meet the criteria for Technical Specification LCOs to ensure safety-related functions at the plant.

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Unit 3 will shutdown when the water level in Lake Anna drops below Elevation 241.14 ft NAVD88 (242.0 ft NGVD29). Because this operational restriction is not related to protection of safety-related SSCs or degradation of the UHS, low lake level is not a Technical Specification LCO.

NAPS COL 2.4(1) **Table 2.4-206 Groundwater Concentrations at Point of Groundwater Discharge to The Cove**

Source Term Characteristics									Advection and Radioactive Decay					Advection, Decay and Adsorption			
			Branching Fraction[a]														
Parent Radio-nuclide	Progeny in Chain	Half-life[a] (days)	d_{12}	d_{13}	d_{23}	Decay Rate[b] (days^{-1})	ECL[c] (µCi/cm^3)	Holdup Tank Conc[d] (µCi/cm^3)	K1	K2	K3	Ground Water Conc[e] (µCi/cm^3)	Ground Water Conc/ ECL	Distribution Coefficient (cm^3/g)	Retardation Factor[f]	Ground Water Conc[g] (µCi/cm^3)	Ground Water Conc/ ECL
H-3		4.51E+03				1.54E-04	1.00E-03	~~7.00E-01~~ 7.80E-01				~~7.25E-01~~ 7.16E-01	~~7.25E+02~~ 7.16E+02	0.00	1.0	~~7.25E-01~~ 7.16E-01	~~7.25E+02~~ 7.16E+02
~~Na-24~~		~~6.25E-01~~				~~1.11E+00~~	~~5.00E-05~~	~~1.40E-03~~				~~3.66E-271~~	~~0.00E+00~~				
Cr-51		2.77E+01				2.50E-02	5.00E-04	~~1.10E-03~~ 7.70E-05				~~1.01E-09~~ 7.06E-11	2.02E-06 0.00E+00				
Mn-54		3.13E+02				2.21E-03	3.00E-05	~~6.70E-04~~ 1.60E-05				~~1.96E-04~~ 4.68E-06	~~6.53E+00~~ 1.56E-01	4.50	33.9	~~4.92E-22~~ 1.17E-23	0.00E+00
Fe-55		9.86E+02				7.03E-04	1.00E-04	~~5.10E-04~~ 8.60E-05				~~3.45E-04~~ 5.82E-05	~~3.45E+00~~ 5.82E-01	4504.00	32970.3	0.00E+00	0.00E+00
Fe-59		4.45E+01				1.56E-02	1.00E-05	~~1.10E-04~~ 4.50E-05				~~1.92E-08~~ 7.85E-09	~~1.92E-03~~ 7.85E-04				
Co-58		7.08E+01				9.79E-03	2.00E-05	~~1.80E-03~~ 7.70E-04				~~7.82E-06~~ 3.34E-06	~~3.91E-01~~ 1.67E-01	6.50	48.6	~~3.18E-118~~ 1.36E-118	0.00E+00
Co-60		1.93E+03				3.59E-04	3.00E-06	~~2.20E-04~~ 1.10E-04				~~1.80E-04~~ 9.01E-05	~~6.01E+01~~ 3.00E+01	6.50	48.6	~~1.36E-08~~ 6.79E-09	~~4.53E-03~~ 2.26E-03
Br-83		9.96E-02				6.96E+00	9.00E-04	2.52E-06				0.00E+00	0.00E+00				
	Kr-83m	7.63E-02	0.9998			9.09E+00	NA	0.00E+00	1.08E-05	-1.08E-05		0.00E+00					
Br-84		2.21E-02				3.14E+01	4.00E-04	3.48E-07				0.00E+00	0.00E+00				
~~Zn-65~~		~~2.44E+02~~				~~2.84E-03~~	~~5.00E-06~~	~~2.10E-04~~				~~4.33E-05~~	~~8.67E+00~~	~~11.80~~	~~87.4~~	~~2.72E-64~~	~~0.00E+00~~
Rb-86		1.87E+01				3.71E-02	7.00E-06	1.32E-05				1.44E-14	0.00E+00				
Rb-88		1.24E-02				5.61E+01	4.00E-04	~~1.90E-04~~ 6.24E-05				0.00E+00	0.00E+00				
Sr-89		5.05E+01				1.37E-02	8.00E-06	~~5.30E-05~~ 1.56E-05				~~2.58E-08~~ 7.61E-09	~~3.23E-03~~ 9.51E-04				
Sr-90		1.06E+04				6.54E-05	5.00E-07	~~5.10E-06~~ 5.40E-07				~~4.92E-06~~ 5.21E-07	~~9.84E+00~~ 1.04E+00	3.60	27.4	~~1.89E-06~~ 2.00E-07	~~3.78E+00~~ 4.00E-01
	Y-90	2.67E+00	1.0000			2.60E-01	7.00E-06	~~0.00E+00~~ 4.68E-07	~~5.10E-06~~ 5.40E-07	~~-5.10E-06~~ -7.21E-08		~~4.92E-06~~ 5.21E-07	~~7.03E-01~~ 7.44E-02	3.60	27.4	~~1.89E-06~~ 2.00E-07	~~2.70E-01~~ 2.86E-02
Sr-91		3.96E-01				1.75E+00	2.00E-05	~~2.00E-06~~ 1.12E-06				0.00E+00	0.00E+00				
	Y-91m	3.45E-02	0.5780			2.01E+01	2.00E-03	~~1.30E-06~~ 7.32E-07	~~1.27E-06~~ 7.09E-07	~~3.37E-07~~ 2.29E-08		0.00E+00	0.00E+00				

NAPS COL 2.4(1) **Table 2.4-206 Groundwater Concentrations at Point of Groundwater Discharge to The Cove**

Source Term Characteristics									Advection and Radioactive Decay					Advection, Decay and Adsorption			
			Branching Fraction[a]														
Parent Radio-nuclide	Progeny in Chain	Half-life[a] (days)	d_{12}	d_{13}	d_{23}	Decay Rate[b] (days^{-1})	ECL[c] (µCi/cm^3)	Holdup Tank Conc[d] (µCi/cm^3)	K1	K2	K3	Ground Water Conc[e] (µCi/cm^3)	Ground Water Conc/ ECL	Distribution Coefficient (cm^3/g)	Retardation Factor[f]	Ground Water Conc[g] (µCi/cm^3)	Ground Water Conc/ ECL
	Y-91	5.85E+01		0.4220	1.0000	1.18E-02	8.00E-06	~~6.50E-06~~ 3.36E-06	~~-1.44E-07~~ -8.05E-09	~~-1.90E-10~~ -1.35E-11	~~5.64E-06~~ 3.37E-06	~~7.81E-09~~ 4.66E-09	~~9.77E-04~~ 5.83E-04				
Y-93		4.21E-01				1.65E+00	2.00E-05	~~9.20E-05~~ 6.12E-08				0.00E+00	0.00E+00				
Zr-95		6.40E+01				1.08E-02	2.00E-05	~~1.50E-04~~ 2.88E-06				~~3.66E-07~~ 7.02E-09	~~1.83E-02~~ 3.51E-04	~~6.13~~	~~45.9~~	~~2.04E-124~~	~~0.00E+00~~
	Nb-95m	3.61E+00	0.0070			1.92E-01	3.00E-05	0.00E+00	~~1.11E-06~~ 2.14E-08	~~-1.11E-06~~ -2.14E-08		~~2.71E-09~~ 5.21E-11	~~9.04E-05~~ 1.74E-06	~~6.13~~	~~45.9~~	~~1.51E-126~~	~~0.00E+00~~
	Nb-95	3.52E+01		0.9930	1.0000	1.97E-02	3.00E-05	~~1.30E-04~~ 2.76E-06	~~3.33E-04~~ 6.40E-06	~~1.27E-07~~ 2.44E-09	~~-2.04E-04~~ -3.65E-06	~~8.09E-07~~ 1.55E-08	~~2.70E-02~~ 5.18E-04	~~6.13~~	~~45.9~~	~~4.53E-124~~	~~0.00E+00~~
Mo-99		2.75E+00				2.52E-01	2.00E-05	~~6.40E-04~~ 7.80E-04				~~9.82E-65~~ 1.20E-64	0.00E+00				
	Tc-99m	2.51E-01	0.8760			2.76E+00	1.00E-03	~~6.20E-04~~ 7.32E-04	~~6.17E-04~~ 7.52E-04	~~3.05E-06~~ -1.99E-05		~~9.46E-65~~ 1.15E-64	0.00E+00				
	Tc-99	7.78E+07		0.1240	1.0000	8.91E-09	6.00E-05	~~8.80E-11~~ 1.56E-10	~~-2.46E-11~~ -3.00E-11	~~-9.84E-15~~ 6.42E-14	~~1.13E-10~~ 1.86E-10	~~1.13E-10~~ 1.86E-10	~~1.88E-06~~ 3.10E-06				
Ru-103		3.93E+01				1.76E-02	3.00E-05	~~2.70E-03~~ 1.92E-06				~~1.50E-07~~ 1.07E-10	~~5.00E-03~~ 3.55E-06				
	Rh-103m	3.90E-02	0.9970			1.78E+01	6.00E-03	~~2.40E-03~~ 2.04E-06	~~2.69E-03~~ 1.92E-06	~~-2.95E-04~~ 1.24E-07		~~1.50E-07~~ 1.06E-10	~~2.40E-05~~ 0.00E+00				
Ru-106		3.68E+02				1.88E-03	3.00E-06	~~3.80E-02~~ 5.28E-07				~~1.34E-02~~ 1.86E-07	~~4.45E+03~~ 6.18E-02	272.00	1992.0	0.00E+00	0.00E+00
	Rh-106	3.46E-04	1.0000			2.00E+03	NA	~~3.80E-02~~ 0.00+00	~~3.80E-02~~ 5.28E-07	~~-3.57E-08~~ -5.28E-07		~~1.34E-02~~ 1.86E-07					
~~Ag-110m~~		~~2.50E+02~~				~~2.77E-03~~	~~6.00E-06~~	~~6.40E-04~~				~~1.16E-04~~	~~1.93E+01~~	~~2.50~~	~~19.3~~	~~6.63E-17~~	~~0.00E+00~~
	~~Ag-110~~	~~2.85E-04~~	~~0.0133~~			~~2.43E+03~~	~~NA~~	~~7.20E-06~~	~~7.18E-06~~	~~1.80E-08~~		~~1.54E-06~~					
Te-125m		5.80E+01				1.20E-02	2.00E-05	1.32E-06				1.73E-09	8.63E-05				
Te-127m		1.09E+02				6.36E-03	9.00E-06	1.44E-05				4.21E-07	4.68E-02	0.61	5.5	5.93E-14	0.00E+00
	Te-127	3.90E-01	0.9760			1.78E+00	1.00E-04	1.56E-05	1.41E-05	1.50E-06		4.12E-07	4.12E-03	0.61	5.5	5.81E-14	0.00E+00
Te-129m		3.36E+01				2.06E-02	7.00E-06	~~6.70E-05~~ 6.00E-05				~~7.06E-10~~ 6.32E-10	~~1.01E-04~~ 9.03E-05				
	Te-129	4.83E-02	0.6500			1.44E+01	4.00E-04	~~1.30E-04~~ 3.84E-05	~~4.36E-05~~ 3.91E-05	~~8.64E-05~~ -6.56E-07		~~4.59E-10~~ 4.11E-10	~~1.15E-06~~ 1.03E-06				

NAPS COL 2.4(1) **Table 2.4-206 Groundwater Concentrations at Point of Groundwater Discharge to The Cove**

Source Term Characteristics									Advection and Radioactive Decay					Advection, Decay and Adsorption			
Parent Radio-nuclide	Progeny in Chain	Half-life[a] (days)	Branching Fraction[a] d$_{12}$	d$_{13}$	d$_{23}$	Decay Rate[b] (days^{-1})	ECL[c] (μCi/cm^3)	Holdup Tank Conc[d] (μCi/cm^3)	K1	K2	K3	Ground Water Conc[e] (μCi/cm^3)	Ground Water Conc/ ECL	Distribution Coefficient (cm^3/g)	Retardation Factor[f]	Ground Water Conc[g] (μCi/cm^3)	Ground Water Conc/ ECL
I-129		5.73E+09				1.21E-10	2.00E-07	~~2.40E-13~~ 9.24E-14				~~2.40E-13~~ 9.24E-14	~~1.20E-06~~ 0.00E+00				
I-130		5.15E-01				1.35E+00	2.00E-05	4.44E-06				0.00+00	0.00E+00				
Te-131m		1.25E+00				5.55E-01	8.00E-06	1.12E-05				1.81E-139	0.00E+00				
	Te-131	1.74E-02	0.2220			3.98E+01	8.00E-05	~~2.80E-05~~ 2.16E-06	~~1.78E-05~~ 2.52E-06	~~1.02E-05~~ -3.61E-07		~~2.88E-139~~ 4.08E-140	0.00E+00				
	I-131	8.04E+00		0.7780	1.0000	8.62E-02	1.00E-06	~~4.00E-04~~ 6.12E-03	~~-1.46E-05~~ -2.07E-06	~~-2.22E-08~~ 7.84E-10	~~5.05E-04~~ 6.12E-03	~~7.08E-25~~ 9.68E-24	0.00E+00				
Te-132		3.26E+00				2.13E-01	9.00E-06	~~1.90E-04~~ 2.88E-04				~~9.52E-56~~ 1.44E-55	0.00E+00				
	I-132	9.58E-02	1.0000			7.24E+00	1.00E-04	~~5.70E-04~~ 3.36E-04	~~1.06E-04~~ 2.97E-04	~~3.74E-04~~ 3.93E-09		~~9.80E-56~~ 1.49E-55	0.00E+00				
I-133		8.67E-01				7.99E-01	7.00E-06	~~1.00E-03~~ 1.20E-03				~~1.28E-196~~ 1.53E-196	0.00E+00				
	Xe-133m	2.19E+00	0.0290			3.17E-01	NA	0.00E+00	~~-1.90E-05~~ -2.28E-05	~~1.90E-05~~ 2.28E-05		~~7.00E-82~~ 8.40E-82					
	Xe-133	5.25E+00		0.9710	1.0000	1.32E-01	NA	0.00E+00	~~-1.89E-04~~ -2.26E-04	~~-1.36E-05~~ -1.63E-05	~~2.02E-04~~ 2.43E-04	~~2.63E-36~~ 3.16E-36					
I-134		3.65E-02				1.90E+01	4.00E-04	~~2.70E-04~~ 1.02E-05				0.00E+00	0.00E+00				
I-135		2.75E-01				2.52E+00	3.00E-05	~~8.40E-04~~ 2.40E-04				0.00E+00	0.00E+00				
	Xe-135m	1.06E-02	0.1540			6.53E+01	NA	0.00E+00	~~1.36E-04~~ 3.84E-05	~~-1.36E-04~~ -3.84E-05		0.00E+00					
	Xe-135	3.79E-01		0.8460	1.0000	1.83E+00	NA	0.00E+00	~~-2.23E-03~~ -6.39E-04	~~3.88E-06~~ 1.11E-06	~~2.23E-03~~ 6.37E-04	0.00E+00					
Cs-134		7.53E+02				9.21E-04	9.00E-07	~~1.60E-05~~ 5.64E-03				~~9.60E-06~~ 3.38E-03	~~1.07E+01~~ 3.76E+03	64.90	476.1	~~2.06E-111~~ 1.04E-108	0.00E+00
Cs-136		1.31E+01				5.29E-02	6.00E-06	~~2.50E-04~~ 1.68E-03				~~4.28E-17~~ 2.88E-16	0.00E+00				
Cs-137		1.10E+04				6.30E-05	1.00E-06	~~2.40E-05~~ 4.08E-03				~~2.32E-05~~ 3.94E-03	~~2.32E+01~~ 3.94E+03	64.90	476.1	~~1.39E-12~~ 2.36E-10	~~1.39E-06~~ 2.36E-04
	Ba-137m	1.77E-03	0.9460			3.91E+02	NA	~~2.20E-05~~ 3.84E-03	~~2.27E-05~~ 3.86E-03	~~-7.04E-07~~ -1.97E-05		~~2.10E-05~~ 3.73E-03					

NAPS COL 2.4(1) **Table 2.4-206 Groundwater Concentrations at Point of Groundwater Discharge to The Cove**

Source Term Characteristics									Advection and Radioactive Decay					Advection, Decay and Adsorption			
			Branching Fraction[a]														
Parent Radio-nuclide	Progeny in Chain	Half-life[a] (days)	d_{12}	d_{13}	d_{23}	Decay Rate[b] (days^{-1})	ECL[c] (µCi/cm³)	Holdup Tank Conc[d] (µCi/cm³)	K1	K2	K3	Ground Water Conc[e] (µCi/cm³)	Ground Water Conc/ ECL	Distribution Coefficient (cm³/g)	Retardation Factor[f]	Ground Water Conc[g] (µCi/cm³)	Ground Water Conc/ ECL
Ba-140		1.27E+01				5.46E-02	8.00E-06	~~3.50E-03~~ 6.60E-06				~~2.37E-16~~ 4,48E-19	0.00E+00				
	La-140	1.68E+00	1.0000			4.13E-01	9.00E-06	~~4.80E-03~~ 7.44E-06	~~4.03E-03~~ 7.61E-06	~~7.66E-04~~ -1.66E-07		~~2.74E-16~~ 5.16E-19	0.00E+00				
Ce-141		3.25E+01				2.13E-02	3.00E-05	~~5.30E-05~~ 3.00E-06				~~3.79E-10~~ 2.14E-11	~~1.26E-05~~ 0.00E+00				
Ce-143		1.38E+00				5.04E-01	2.00E-05	~~1.60E-04~~ 1.92E-07				~~3.77E-126~~ 4.52E-129	0.00E+00				
	Pr-143	1.36E+01	1.0000			5.11E-02	2.00E-05	~~8.00E-05~~ 1.68E-06	~~-1.81E-05~~ -2.17E-08	~~9.81E-05~~ 1.70E-06		~~4.55E-17~~ 7.90E-19	0.00E+00				
Ce-144		2.84E+02				2.44E-03	3.00E-06	~~1.70E-03~~ 1.68E-06				~~4.38E-04~~ 4.33E-07	~~1.46E+02~~ 1.44E-01	329.10	2410.0	0.00E+00	0.00E+00
	Pr-144m	5.00E-03	0.0178			1.39E+02	NA	0.00E+00	~~3.03E-05~~ 2.99E-08	~~-3.03E-05~~ -2.99E-08		~~7.80E-06~~ 7.71E-09		329.10	2410.0	0.00E+00	
	Pr-144	1.20E-02		0.9822	0.9990	5.78E+01	6.00E-04	~~1.70E-03~~ 1.68E-06	~~1.70E-03~~ 1.68E-06	~~2.16E-05~~ 2.13E-08	~~-2.16E-05~~ -2.14E-08	~~4.38E-04~~ 4.33E-07	~~7.30E-01~~ 7.22E-04	329.10	2410.0	0.00E+00	0.00E+00
[redacted]																	
Np-239		2.36E+00				2.94E-01	2.00E-05	~~1.90E-04~~ 7.90E-05				~~2.60E-75~~ 1.08E-75	0.00E+00				
	Pu-239	8.79E+06	1.0000			7.89E-08	2.00E-08	0.00E+00	~~-5.10E-11~~ -2.12E-11	~~5.10E-11~~ -2.12E-11		~~5.10E-11~~ -2.12E-11	~~2.55E-03~~ 1.06E-03				

a. Obtained from ICRP Publication 38 (Reference 2.4-211).
b. Calculated using Equation 2.4.13-4.
c. Obtained from 10 CFR 20, Appendix B, Table 2, Column 2.
d. Source term developed as described in Section 11.2.3.2.
e. Calculated using Equations 2.4.13-8, 2.4.13-13, or 2.4.13-18 depending on position in decay chain and assuming no retardation.
f. Calculated using Equation 2.4.13-2.
g. Calculated using Equations 2.4.13-8, 2.4.13-13, or 2.4.13-18 depending on position in decay chain.
NA - ECL is not available

Table 2.4-206a Groundwater Concentrations From a Waste Holdup Tank at Point of Groundwater Discharge to The Cove

Source Term Characteristics									Advection and Radioactive Decay					Advection, Decay and Adsorption			
			Branching Fraction[a]														
Parent Radio-nuclide	Progeny in Chain	Half-life[a] (days)	d_{12}	d_{13}	d_{23}	Decay Rate[b] (days^{-1})	ECL[c] (μCi/cm^3)	Waste Holdup Tank Conc[d] (μCi/cm^3)	K1	K2	K3	Ground Water Conc[e] (μCi/cm^3)	Ground Water Conc/ ECL	Distribution Coefficient (cm^3/g)	Retardation Factor[f]	Ground Water Conc[g] (μCi/cm^3)	Ground Water Conc/ ECL
H-3		4.51E+03				1.54E-04	1.00E-03	6.00E-01				5.51E-01	5.51E+02	0.00	1.0	5.51E-01	5.51E+02
Cr-51		2.77E+01				2.50E-02	5.00E-04	1.60E-04				1.47E-10	0.00E+00				
Mn-54		3.13E+02				2.21E-03	3.00E-05	3.00E-05				8.77E-06	2.92E-01	4.50	33.9	2.20E-23	0.00E+00
Fe-55		9.86E+02				7.03E-04	1.00E-04	1.60E-04				1.08E-04	1.08E+00	4504.00	32970.3	0.00E+00	0.00E+00
Fe-59		4.45E+01				1.56E-02	1.00E-05	8.90E-05				1.55E-08	1.55E-03				
Co-58		7.08E+01				9.79E-03	2.00E-05	1.50E-03				6.52E-06	3.26E-01	6.50	48.6	2.65E-118	0.00E+00
Co-60		1.93E+03				3.59E-04	3.00E-06	1.90E-04				1.56E-04	5.19E+01	6.50	48.6	1.17E-08	3.91E-03
Br-83		9.96E-02				6.96E+00	9.00E-04	1.02E-05				0.00E+00	0.00E+00				
	Kr-83m	7.63E-02	0.9998			9.09E+00	NA	0.00E+00	4.35E-05	-4.35E-05		0.00E+00					
Br-84		2.21E-02				3.14E+01	4.00E-04	1.36E-06				0.00E+00	0.00E+00				
Rb-86		1.87E+01				3.71E-02	7.00E-06	7.20E-06				7.85E-15	0.00E+00				
Rb-88		1.24E-02				5.61E+01	4.00E-04	7.89E-05				0.00E+00	0.00E+00				
Sr-89		5.05E+01				1.37E-02	8.00E-06	3.12E-05				1.52E-08	1.90E-03				
Sr-90		1.06E+04				6.54E-05	5.00E-07	9.72E-07				9.37E-07	1.87E+00	3.60	27.4	3.60E-07	7.20E-01
	Y-90	2.67E+00	1.0000			2.60E-01	7.00E-06	7.08E-07	9.72E-07	-2.64E-07		9.38E-07	1.34E-01	3.60	27.4	3.60E-07	5.14E-02
Sr-91		3.96E-01				1.75E+00	2.00E-05	4.32E-06				0.00E+00	0.00E+00				
	Y-91m	3.45E-02	0.5780			2.01E+01	2.00E-03	2.85E-06	2.74E-06	1.15E-07		0.00E+00	0.00E+00				
	Y-91	5.85E+01		0.4220	1.0000	1.18E-02	8.00E-06	6.36E-06	-3.11E-08	-6.77E-11	6.39E-06	8.85E-09	1.11E-03				
Y-93		4.21E-01				1.65E+00	2.00E-05	2.40E-07				0.00E+00	0.00E+00				
Zr-95		6.40E+01				1.08E-02	2.00E-05	5.52E-06				1.35E-08	6.73E-04				
	Nb-95m	3.61E+00	0.0070			1.92E-01	3.00E-05	0.00E+00	4.09E-08	-4.09E-08		9.98E-11	3.33E-06				
	Nb-95	3.52E+01		0.9930	1.0000	1.97E-02	3.00E-05	4.92E-06	1.23E-05	4.68E-09	-7.36E-06	2.98E-08	9.93E-04				
Mo-99		2.75E+00				2.52E-01	2.00E-05	2.88E-03				4.42E-64	0.00E+00				
	Tc-99m	2.51E-01	0.8760			2.76E+00	1.00E-03	2.64E-03	2.78E-03	-1.36E-04		4.26E-64	0.00E+00				
	Tc-99	7.78E+07		0.1240	1.0000	8.91E-09	6.00E-05	2.40E-10	-1.11E-10	4.40E-13	3.50E-10	3.50E-10	5.84E-06				
Ru-103		3.93E+01				1.76E-02	3.00E-05	3.96E-06				2.20E-10	7.33E-06				
	Rh-103m	3.90E-02	0.9970			1.78E+01	6.00E-03	3.96E-06	3.95E-06	7.96E-09		2.19E-10	0.00E+00				

Table 2.4-206a Groundwater Concentrations From a Waste Holdup Tank at Point of Groundwater Discharge to The Cove

Source Term Characteristics									Advection and Radioactive Decay					Advection, Decay and Adsorption			
			Branching Fraction[a]														
Parent Radio-nuclide	Progeny in Chain	Half-life[a] (days)	d_{12}	d_{13}	d_{23}	Decay Rate[b] (days^{-1})	ECL[c] (µCi/cm^3)	Waste Holdup Tank Conc[d] (µCi/cm^3)	K1	K2	K3	Ground Water Conc[e] (µCi/cm^3)	Ground Water Conc/ ECL	Distribution Coefficient (cm^3/g)	Retardation Factor[f]	Ground Water Conc[g] (µCi/cm^3)	Ground Water Conc/ ECL
Ru-106		3.68E+02				1.88E-03	3.00E-06	9.60E-07				3.37E-07	1.12E-01	272.00	1992.0	0.00E+00	0.00E+00
	Rh-106	3.46E-04	1.0000			2.00E+03	NA	0.00E+00	9.60E-07	-9.60E-07		3.37E-07					
Te-125m		5.80E+01				1.20E-02	2.00E-05	2.64E-06				3.45E-09	1.73E-04				
Te-127m		1.09E+02				6.36E-03	9.00E-06	2.64E-05				7.71E-07	8.57E-02	0.61	5.5	1.09E-13	0.00E+00
	Te-127	3.90E-01	0.9760			1.78E+00	1.00E-04	3.12E-05	2.59E-05	5.34E-06		7.56E-07	7.56E-03	0.61	5.5	1.06E-13	0.00E+00
Te-129m		3.36E+01				2.06E-02	7.00E-06	2.20E-04				1.26E-09	1.81E-04				
	Te-129	4.83E-02	0.6500			1.44E+01	4.00E-04	7.92E-05	7.81E-05	1.09E-06		8.23E-10	2.06E-06				
I-129		5.73E+09				1.21E-10	2.00E-07	8.64E-14				8.64E-14	0.00E+00				
I-130		5.15E-01				1.35E+00	2.00E-05	1.70E-05				0.00E+00	0.00E+00				
Te-131m		1.25E+00				5.55E-01	8.00E-06	4.32E-05				6.99E-139	0.00E+00				
	Te-131	1.74E-02	0.2220			3.98E+01	8.00E-05	8.16E-06	9.73E-06	-1.57E-06		1.57E-139	0.00E+00				
	I-131	8.04E+00		0.7780	1.0000	8.62E-02	1.00E-06	1.68E-02	-7.98E-06	3.40E-09	1.68E-02	2.66E-23	0.00E+00				
Te-132		3.26E+00				2.13E-01	9.00E-06	1.02E-03				5.11E-55	0.00E+00				
	I-132	9.58E-02	1.0000			7.24E+00	1.00E-04	1.20E-03	1.50E-03	1.49E-04		5.26E-55	0.00E+00				
I-133		8.67E-01				7.99E-01	7.00E-06	4.80E-03				6.13E-196	0.00E+00				
	Xe-133m	2.19E+00	0.0290			3.17E-01	NA	0.00E+00	-9.14E-05	9.14E-05		3.36E-81					
	Xe-133	5.25E+00		0.9710	1.0000	1.32E-01	NA	0.00E+00	-9.05E-04	-6.54E-05	9.70E-04	1.26E-35					
I-134		3.65E-02				1.90E+01	4.00E-04	3.97E-05				0.00E+00	0.00E+00				
I-135		2.75E-01				2.52E+00	3.00E-05	9.37E-04				0.00E+00	0.00E+00				
	Xe-135m	1.06E-02	0.1540			6.53E+01	NA	0.00E+00	1.50E-04	-1.50E-04		0.00E+00					
	Xe-135	3.79E-01		0.8460	1.0000	1.83E+00	NA	0.00E+00	-2.49E-03	4.33E-06	2.49E-03	0.00E+00					
Cs-134		7.53E+02				9.21E-04	9.00E-07	2.75E-03				1.65E-03	1.83E+03	64.90	476.1	5.08E-109	0.00E+00
Cs-136		1.31E+01				5.29E-02	6.00E-06	1.01E-03				1.73E-16	0.00E+00				
Cs-137		1.10E+04				6.30E-05	1.00E-06	1.96E-03				1.89E-03	1.89E+03	64.90	476.1	1.13E-10	1.13E-04
	Ba-137m	1.77E-03	0.9460			3.91E+02	NA	1.68E-03	1.85E-03	-1.74E-04		1.79E-03					
Ba-140		1.27E+01				5.46E-02	8.00E-06	1.56E-05				1.06E-18	0.00E+00				
	La-140	1.68E+00	1.0000			4.13E-01	9.00E-06	1.68E-05	1.80E-05	-1.18E-06		1.22E-18	0.00E+00				

Table 2.4-206a Groundwater Concentrations From a Waste Holdup Tank at Point of Groundwater Discharge to The Cove

Source Term Characteristics									Advection and Radioactive Decay					Advection, Decay and Adsorption			
			Branching Fraction[a]														
Parent Radio-nuclide	Progeny in Chain	Half-life[a] (days)	d_{12}	d_{13}	d_{23}	Decay Rate[b] (days^{-1})	ECL[c] (µCi/cm^3)	Waste Holdup Tank Conc[d] (µCi/cm^3)	K1	K2	K3	Ground Water Conc[e] (µCi/cm^3)	Ground Water Conc/ ECL	Distribution Coefficient (cm^3/g)	Retardation Factor[f]	Ground Water Conc[g] (µCi/cm^3)	Ground Water Conc/ ECL
Ce-141		3.25E+01				2.13E-02	3.00E-05	6.12E-06				4.37E-11	1.46E-06				
Ce-143		1.38E+00				5.04E-01	2.00E-05	7.44E-07				1.75E-128	0.00E+00				
	Pr-143	1.36E+01	1.0000			5.11E-02	2.00E-05	3.96E-06	-8.40E-08	4.04E-06		1.88E-18	0.00E+00				
Ce-144		2.84E+02				2.44E-03	3.00E-06	3.12E-06				8.04E-07	2.68E-01	329.10	2410.0	0.00E+00	0.00E+00
	Pr-144m	5.00E-03	0.0178			1.39E+02	NA	0.00E+00	5.55E-08	-5.55E-08		1.43E-08		329.10	2410.0	0.00E+00	
	Pr-144	1.20E-02		0.9822	0.9990	5.78E+01	6.00E-04	3.12E-06	3.12E-06	3.96E-08	-3.97E-08	8.04E-07	1.34E-03	329.10	2410.0	0.00E+00	0.00E+00
Np-239		2.36E+00				2.94E-01	2.00E-05	3.00E-04				4.10E-75	0.00E+00				
	Pu-239	8.79E+06	1.0000			7.89E-08	2.00E-08	0.00E+00	-8.05E-11	8.05E-11		8.05E-11	4.03E-03				

Sum = 552

a. Obtained from ICRP Publication 38 (Reference 2.4-211).
b. Calculated using Equation 2.4.13-4.
c. Obtained from 10 CFR 20, Appendix B, Table 2, Column 2.
d. Source term developed as described in Section 11.2.3.2.
e. Calculated using Equations 2.4.13-8, 2.4.13-13, or 2.4.13-18 depending on position in decay chain and assuming no retardation.
f. Calculated using Equation 2.4.13-2.
g. Calculated using Equations 2.4.13-8, 2.4.13-13, or 2.4.13-18 depending on position in decay chain.
NA - ECL is not available

the former also demonstrates compliance with the latter. The population doses are summarized in Table 11.3-203.

11.2.3.2 Radioactive Effluent Releases Due to Liquid Containing Tank Failures

NAPS COL 11.2(3)
NAPS DEP 9.2(1)

Replace the second and third paragraphs in DCD Subsection 11.2.3.2 with the following.

A tank failure analysis is performed in accordance with the guidance of BTP 11-6 (Ref. 11.2-17). ~~The source term from liquid radioactive tanks is calculated based on the PWR GALE code (Ref. 11.2-13) for the evaluation of releases to groundwater from the holdup tank, which is selected because it is below grade and contains the limiting amount of radioactivity for a groundwater release based upon volume and concentration.~~ For the analysis, the holdup tank and the waste holdup tank were selected because they contain the largest amount of radioactivity. A screening analysis was conducted using the holdup tank and waste holdup tank inventories to determine the limiting tank. The results of this analysis indicate the holdup tank is the limiting tank. The tank failure is modeled based on the entire contents of the holdup tank directly released unmitigated to the groundwater.

~~Table 11.2-16R shows the inputs to the evaluation for determining the source terms for the holdup tank. Table 2.4-206 provides the resulting nuclide concentrations in the holdup tank.~~

Replace the first two sentences in the fourth paragraph in DCD Subsection 11.2.3.2 with the following.

Table 11.2-16R shows input parameters for the RATAF code (Ref. 11.2-27) used to determine the source terms for the holdup tank and the waste holdup tank. Tables 2.4-206 and 2.4-206a provide the resulting nuclide concentrations in each tank.

Replace the first two sentences in the last paragraph in DCD Subsection 11.2.3.2 with the following.

The evaluation of potential radioactive effluent releases to groundwater due to failure of the holdup tank is provided in Section 2.4.13. Releases from this tank result in concentrations at the nearest unrestricted potable

NAPS COL 11.2(3)
NAPS DEP 9.2(1)

Table 11.2-16R Parameters for Calculation of Liquid Containing Tank Failures

Tank	Volume of Tank (gal)(1)	Flow Rate (gpd)	Fraction of Reactor Primary Coolant Activity (PCA)	Fraction of PCA in Tank(3)	Hydrological Travel Time (day)	Tank Factor(2)(3)	Decay Time (days)
Holdup Tank	1.2E+5	Shim Bleed: 2875 Coolant Drain: 900	Shim Bleed: 1.0 Coolant Drain: 0.1 Table 11.1-9 (Realistic)	0.79	365	1.0 (All Nuclides)	20
Waste Holdup Tank	3.0E+04	2023 (Note 7)	0.18 (Note 7)		365	1.0 (All nuclides)	
Boric Acid Tank	6.6E+04	Shim Bleed: 2875 Coolant Drain: 900	Shim Bleed: 1.0 Coolant Drain: 0.1		365	1.0(Tritium) 0.2(Anion) 0.04(Cs,Rb) 0.2(Others)	

NAPS COL 11.2(3)
NAPS DEP 9.2(1)

Table 11.2-16R Parameters for Calculation of Liquid Containing Tank Failures *(continued)*

Tank	Volume of Tank (gal)(1)	Flow Rate (gpd)	Fraction of Reactor Primary Coolant Activity (PCA)	Fraction of PCA in Tank(3)	Hydrological Travel Time (day)	Tank Factor(2)(3)	Decay Time (days)

Notes:

1. It is assumed that water equivalent to 80% of the tank volume is discharged and the volume of water contributing to dilution is 4.4E + 10 gl for defining the hydrological dilution factor of each tank.
   Hydrological Dilution Factor = 4.4E+10 / (Tank Volume x 0.8)
2. Tank factor is the ratio considering the removal effect by demineralizers or other treatment prior to the tank.
3. The TFs of evaporators express the increase in concentration or radionuclides in the evaporator bottoms resulting from evaporator operation. The value of TF for evaporator is 0.02. Holdup tank fraction is based on 2875 gpd of shim bleed with 100% PCA concentrations and 900 gpd of coolant drain with 10% of PCA concentrations, same as Table 11.2-9R.
4. The basis of the RATAF source term calculation uses a built-in plant capacity factor of 80%, which is less than the expected capacity factor for the US-APWR. This difference in capacity factor has no impact on liquid effluent release concentrations due to liquid containing tank failures.
5. Dilution factor (1.00E-20) and travel time (0 days) input parameters do not directly affect the concentrations of the tanks. Because RATAF code only display results for significant concentrations at the critical receptor, these parameters were set in order to display all the nuclides described in Tables 2.4-206 and 2.4-206a.
6. Other RATAF input parameters not described in this table are the same as PWR-GALE input parameters described in Table 11.2-9R.
7. Mixture Case for WHT: Shim bleed flow rate (for HT and BAT), 2875 gpd; Shim bleed PCA (for HT and BAT), 1; Drains flow rate (for HT and BAT), 900 gpd; Drains PCA (for HT and BAT), 0.1; WHT volume, 119688.3 gal; Bottom tank, no; Tank factors DFI=10, DFCS=2, DFO=10. Dirty waste only WHT: the source terms in DCD Table 11.2-17 are applicable. The WHT source term for each nuclide shown in Table 2.4-206a is the higher value from the mixture, or dirty waste only case for each nuclide.

DFI: Decontamination Factor for Iodine
DFCS: Decontamination Factor for Cesium
DFO: Decontamination Factor for other nuclides
HT: Holdup Tank
BAT: Boric Acid Tank

ground motions for development of the FIRS in FSAR Section 3.7, but is also consistent with the SRP 2.5.2 that specifies that the GMRS be defined on an outcrop or a hypothetical outcrop that will exist after excavation.

The variance in GMRS control point location is acceptable because the US-APWR certified seismic design response spectra (CSDRS) cannot be used for analysis of the seismic design of Unit 3 Seismic Category I structures at higher frequencies. The seismic response at the Unit 3 site has high frequency exceedances of the CSDRS. Due to the spatial variation of the input ground motion, FSAR Section 3.7 provides the results of site-specific soil-structure interaction (SSI) analyses which consider the incoherence of the input control motion. The site-specific SSI analyses use the site-specific FIRS which are based on site-specific soil properties as input. The suitability of the US-APWR standard plant Seismic Category I structures for use at the Unit 3 site is confirmed by the validation analyses which compare the standard plant designs to the site-specific seismic loadings. The SSI analyses also demonstrate the seismic design adequacy of the site-specific Seismic Category I structures. See FSAR Section 3.7.2 for the results of the site-specific SSI analyses.

The variance in the Unit 3 horizontal and vertical spectral acceleration (g) values for the ground motion response spectra (GMRS) is justified given the GMRS control point location is changed from the top of competent rock for the SSAR to a hypothetical outcrop under the R/B Complex and PS/Bs for Unit 3. This location is representative of the Unit 3 site for the Seismic Category I structures in the power block area.

The number of frequencies was increased to 38 frequencies based on the minimum number of points specified in the DCD, Regulatory Guide 1.206, and Regulatory Guide 1.208. The SSAR which, presents 21 points, was written before these documents were issued or referenced. Therefore, the COLA FSAR was updated to conform to the DCD and existing guidance.

The specification of OBE in SSAR Section 2.5.2.7 is moved to FSAR Section 3.7 because neither the SRP 2.5.2 nor the DCD requests the OBE information to be described in FSAR Section 2.5.2. Further, given that OBE instrumentation is likely to be at a surface location, the definition of the OBE ground motions should consider the site response of possible surface or *at grade* locations, which is not assessed in FSAR Section 2.5.2, but is in FSAR Section 3.7. Therefore, the OBE is defined in FSAR Section 3.7.

Variance: NAPS ESP VAR 2.0-5 – Distribution Coefficients (K_d)

RAI 11.02-6

Request

This is a request to use the Unit 3 distribution coefficient (K_d) values provided in FSAR Table 2.4-206 FSAR Tables 2.4-206 and 2.4-206a rather than the corresponding values in SSAR Table 1.9-1 and SSAR Table 2.4-20. Some of the values provided in FSAR Table 2.4-206 do

not fall within (are smaller than) the SSAR values and therefore would predict higher doses than the K_d values in the SSAR.

A variance for several K_d values results from using the minimum site-specific K_d values from FSAR Table 2.4-207 for estimating the radionuclide migration to surface waters via subsurface pathways. The SSAR K_d values were assigned using literature values. Most of the Unit 3 K_d values were obtained by laboratory testing as provided in FSAR Table 2.4-207. The K_d values for ~~Zr-95 and it progeny (Nb-95m and Nb-95)~~ Te-127 and Te-127m were conservatively assigned the tenth percentile of the ~~Zr-95~~ Te distribution based on data published in NUREG/CR-6697 (FSAR Reference 2.4-215).

Justification

The variance in K_d values is acceptable because compliance with 10 CFR 20 is demonstrated in FSAR Section 2.4.13 with the use of the minimum site-specific K_d values and conservative literature K_d values, where site-specific data is not available, to evaluate radionuclide concentrations as a result of a postulated accidental release of liquid effluents in the groundwater pathways.

Variance: NAPS ESP VAR 2.0-6 – DBA Source Term Parameters and Doses

Request

This is a request to use the Unit 3 source terms and resulting doses from DCD Chapter 15 analyses of design basis accidents (DBAs). DCD Chapter 15 provides the required analyses of design basis accidents for the US-APWR. The DCD Chapter 15 source terms replace the DBA source terms in ESP-003, Appendix B, and in SSAR Chapter 15. The DCD Chapter 15 doses replace the DBA doses in SSAR Chapter 15.

10 CFR 52.17(a)(1) required that the SSAR demonstrate the acceptability of the ESP site under the radiological consequences evaluation factors identified in 10 CFR 50.34(a)(1) and that site characteristics comply with 10 CFR 100. Specifically, 10 CFR 100.21(c)(2) requires that radiological dose consequences of postulated accidents meet the criteria set forth in 10 CFR 50.34(a)(1). Therefore, SSAR Chapter 15 analyzed a set of postulated accidents to demonstrate that a reactor or reactors bounded by parameters defined therein could be operated on the ESP site without undue risk to the health and safety of the public. Accident analyses evaluated in SSAR Chapter 15 were based on accidents and associated source terms for a range of possible reactor designs, including the AP1000, ABWR, and the ESBWR plant designs. Based on these analyses, the DBA source term parameters were established for the site in ESP-003, Appendix B. However, because the US-APWR was not addressed in the SSAR, the accident analyses evaluated in SSAR Chapter 15 did not include source terms for potential accidents for this type of pressurized water reactor (PWR).

ENCLOSURE 2

Response to NRC RAI Letter 67

RAI 5447, Question 11.02-7

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5447 (RAI Letter 67)

SRP SECTION: 11.02 – LIQUID WASTE MANAGEMENT SYSTEMS

QUESTIONS for Health Physics Branch 1(CHPB)

DATE OF RAI ISSUE: 05/3/2011

QUESTION NO.: 11.02-7

Staff review of the FSAR (Rev. 3) and ER (Rev. 3) found that an evaluation on doses from an exposure pathway involving the release of radioactivity into the environment from loss of cooling tower makeup water was not addressed for compliance with NRC regulations and 40 CFR Part 190. Tables 2.3-1 and 10.4-2 to the ER show that Lake Anna contains tritium (7,460 mg/l) and has small concentrations of radioactive elements. Section 3.3.2.2 of the ER states this makeup water is not treated. FSAR Section 11.2.3.1 describes liquid effluents from existing Units 1 and 2 and proposed Unit 3 are eventually discharged into Lake Anna. FSAR Section 9.2.5.2.1 describes that the normal makeup water to the ultimate heat sink (UHS) is from Lake Anna via the cooling tower makeup water and blowdown system. FSAR Section 10.4.5 also describes makeup water to the cooling towers is provided from Lake Anna. RIS 2008-03 states licensees are responsible for evaluating any new exposure pathways and the resultant radiological hazards associated with the return of radioactive material to the operating facility and its subsequent discharge to the environment. RIS 2008-03 also states licensees must evaluate any new exposure pathways to members of the public that contribute 10 percent or more of the total effluent dose and include these dose assessments in their demonstration of compliance with 10 CFR Part 50, Appendix I. Further, RIS 2008-03 states radioactive material, previously not accounted for as an effluent, that is entrained with returned/re-used water must be considered a new effluent disposal per 10 CFR 20.2001. Please address the following items and provide a mark-up on the proposed FSAR changes.

1. Provide the offsite and onsite doses in FSAR Sections 11.2 and 12.4, respectively, from the release of radioactivity into the environment from loss of makeup water due to evaporation, blowdown, and drift during cooling tower

operation. Include the methodology, basis, and assumptions used to develop the source term and calculated doses.

2. Demonstrate that this radioactivity is previously disposed of in accordance with 10 CFR 20.2001(a)(3), that this radioactivity is naturally occurring background radiation, or justify that this radioactivity is previously accounted for as an effluent in accordance with RIS 2008-03.

Dominion Response

The Final Environmental Impact Statement for the Early Site Permit (NUREG-1811) concludes that the dose from the cooling tower evaporation pathway is less than 10% of the total effluent dose, rendering the pathway insignificant as a dose contributor. With the change in technology to the US-APWR, the cooling tower evaporation pathway dose increases to be more than 10% of the total effluent dose from Unit 3. Therefore, per RIS 2008-03, this pathway is addressed in this response.

1. Since cooling tower evaporation is a gaseous effluent pathway, it does not affect the liquid effluent evaluation in FSAR Section 11.2. The impact of this new pathway on FSAR Sections 11.3 and 12.4 is discussed below.

   A paragraph will be added to Section 11.3.3.1 to address the cooling tower evaporation pathway. Based on the maximum calculated tritium concentration in Lake Anna and the maximum evaporation rate of 16,695 gpm for the hybrid cooling tower, a release rate of 630 Ci/yr is estimated for this pathway. When added to the normal US-APWR gaseous effluent tritium release rate of 180 Ci/yr, a total of 810 Ci/yr is obtained. The maximum evaporation rate from the ultimate heat sink (UHS) cooling tower is 745 gpm. Given the conservatism of assuming the hybrid cooling tower is operating at the maximum evaporation rate for the whole year rather than the expected average annual evaporation rate of less than 10,000 gpm, the small contribution from the UHS cooling tower is neglected. The concentrations in Tables 11.3-6R and 11.3-7R, the GASPAR II code input parameters in Table 11.3-8R, the doses in Tables 11.3-9R, 11.3-201, 11.3-202, and 11.3-203, and the cost-benefit analysis in Section 11.3.1.5 will be revised to reflect the additional tritium release. Only tritium is considered for the evaporation pathway because the concentrations in the lake of isotopes other than tritium are orders of magnitude lower than tritium and because these other isotopes are much less likely than tritium to evolve from liquid phase.

   FSAR Section 12.4 incorporates DCD Section 12.4 by reference, with content specific to North Anna provided in Subsection 12.4.1.9 only. Subsection 12.4.1.9 pertains to Unit 3 construction worker doses. As the cooling tower exposure pathway will not be present while Unit 3 is under construction, there is no impact on construction worker doses from this new pathway. During Unit 3 operation, gaseous effluents are expected to be a small contributor to occupational doses.

Based on Regulatory Guide 8.19, DCD Subsection 12.4.1 evaluates worker doses from various activities, but states that "experience demonstrates that dose from airborne activity is not a significant contributor to the total doses." This observation is consistent with the evaluation of Unit 3 construction worker doses from the operation of Units 1 and 2, as presented in the Early Site Permit Environmental Report (ESP-ER). ESP-ER Table 4.5-2 shows that gaseous effluents contribute less than 1% of the total dose to the construction worker. The changes to FSAR Table 11.3-9R to incorporate the cooling tower pathway show increases in gaseous effluent doses to the maximally exposed individual of less than 50%. Onsite doses would be expected to increase by a similar magnitude, meaning that the gaseous effluent pathway would remain an insignificant contributor to worker doses. Hence, any increase in the gaseous effluent dose due to the cooling tower evaporation pathway is expected to have a negligible impact on onsite doses.

2. While the radioactivity in Lake Anna was previously disposed of as liquid effluent, the cooling tower evaporation pathway does not represent radioactivity previously disposed of as gaseous effluent, nor is it naturally occurring background radiation. Since this radioactivity has not been previously accounted for as a gaseous effluent, in accordance with RIS 2008-03, the FSAR will be revised to include this pathway as described in Item 1.

Proposed COLA Revision

FSAR Section 11.3 will be revised as indicated on the attached markup and reflect changes made in response to RAI 11.03-4. Also, for ER Section 5.4, Tables 5.4-3, 5.4-4, 5.4-6, 5.4-7, and 5.4-8 will be revised as indicated on the attached markup, to reflect the impact of adding the cooling tower pathway.

Markup of North Anna COLA

The attached markup represents Dominion's good faith effort to show how the COLA will be revised in a future COLA submittal in response to the subject RAI. However, the same COLA content may be impacted by revisions to the DCD, responses to other COLA RAIs, other COLA changes, plant design changes, editorial or typographical corrections, etc. As a result, the final COLA content that appears in a future submittal may be somewhat different than as presented herein.

11.3 Gaseous Waste Management System

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

11.3.1.5 Site-Specific Cost Analysis

NAPS COL 11.3(8)
NAPS ESP COL 11.1-1

Replace the third paragraph in DCD Subsection 11.3.1.5 with the following.

~~A site specific cost benefit analysis using the guidance of RG 1.110 was performed based on the site specific calculated radiation doses as a result of radioactive gaseous effluents during normal operations, including AOOs. Based on population dose results of 3.8 person-rem per year (Total Body), 4.1 person-rem per year (Thyroid) and the equipment and operating costs as presented in RG 1.110, the cost benefit analysis demonstrates that addition of processing equipment of reasonable treatment technology is not favorable or cost beneficial, and that the design provided herein complies with 10 CFR 50, Appendix I.~~

RAI 11.03-3

The methodology for performing cost-benefit analysis for the radwaste system is presented in Section 11.2.1.5.

The value of $1,000 per person-rem is prescribed in 10 CFR 50, Appendix I.

If it is conservatively assumed that each radwaste treatment system augment is a "perfect" technology that reduces the effluent dose by 100 percent, the annual cost of the augment can be determined and the lowest annual cost can be considered a threshold value. The lowest-cost option for augments is a steam generator flash tank vent to main condenser at $6,650 per year, which yields a threshold value of 6.65 person-rem whole body or thyroid dose from gaseous effluents.

The total body and thyroid doses to the population for the gaseous effluents from Unit 3 are given in Table 11.3-203. None of the augments provided in RG 1.110 is found to be cost beneficial in reducing the annual population doses of 5.4 person-rem total body and 5.8 person-rem thyroid.

RAI 11.02-7

The lowest cost augment for the gaseous radwaste system is the steam generator flash tank vent to main condenser, with a minimum annual cost of $6650. The total body and thyroid gaseous population doses for Unit 3 are ~~3.8~~ 5.4 and ~~4.1~~ 5.8 person-rem, respectively. These correspond to

RAI 11.02-7

equivalent annual benefits of ~~$3800 and $4100~~ $5400 and $5800 for reducing total body and thyroid doses, respectively. Because the cost of the least costly gaseous augment exceeds the benefit, no gaseous augments are justified.

11.3.2 System Description

STD COL 11.3(9)

Add the following text at the end of the second paragraph in DCD Subsection 11.3.2.

The piping and instrumentation diagrams (P&IDs) for the gaseous waste management system (GWMS) are provided in Figure 11.3-201 (Sheets 1 through 3).

NAPS COL 11.3(3)

Replace the last sentence in the last paragraph in DCD Subsection 11.3.2 with the following.

The release point of the vent stack is at an elevation of 519' 5" NAVD88 (520'3" NGVD29), which is the same height as the top of the containment. See Subsection 2.3.5 for a description of the release point assumptions for determining atmospheric dispersion factors.

11.3.3.1 Radioactive Effluent Releases and Dose Calculation in Normal Operation

NAPS DEP 9.2(1)

Replace the second sentence of the second paragraph in DCD Subsection 11.3.3.1 with the following.

The main sources of plant radioactive gaseous inputs to the GWMS are the waste gases from the VCT, CVDT, degasifier, and HTs.

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Replace the last three paragraphs in DCD Subsection 11.3.3.1 with the following.

RAI 11.02-7

The release rates and isotopic compositions are calculated using the PWR-GALE Code, NUREG-0017 (Ref. 11.3-1). The version of the code is a proprietary, modified version of the NRC PWR-GALE code that reflects the design specifics of US-APWR design (Ref. 11.3-28). Other parameters for the PWR-GALE Code calculation are listed in Section 11.1 and Subsection 11.2.3. The results of the PWR-GALE calculation are tabulated in DCD Table 11.3-5. In Tables 11.3-6R and 11.3-7R, the effluent concentrations at the exclusion area boundary (EAB) from Units 1, 2, and 3 are compared to the concentration limits of

10 CFR 20. The comparison indicates that the overall expected release is a small fraction (~~4.0%~~ 0.38%) of the concentration limit and the maximum release is 18% of the concentration limit.

RAI 11.02-7

Tables 11.3-6R and 11.3-7R include tritium contribution from an additional pathway. Since Lake Anna serves as the source of makeup water for the Unit 3 cooling tower, it is assumed that the tritium in Lake Anna is released to the environment as gaseous effluent via cooling tower evaporation. Tables 11.2-12R and 11.2-13R show that the maximum tritium concentration in Lake Anna from the operation of Units 1, 2, and 3 is 1.9E-5 μCi/ml. Multiplying this concentration by the maximum cooling tower evaporation rate of 16,695 gpm or 3.32E+13 ml/yr yields a release of 630 Ci/yr. Adding this value to the normal US-APWR release of 180 Ci/yr (DCD Table 11.3-5) results in a total tritium release of 810 Ci/yr, as shown in Tables 11.3-6R and 11.3-7R.

The maximum individual doses at the nearest EAB, residence, garden, and meat animal are calculated using the GASPAR II Code (Ref. 11.3-17). The parameters for the GASPAR II Code calculation are tabulated in Table 11.3-8R. The receptor yielding the maximum doses is the nearest residence. Calculated doses are tabulated in Table 11.3-9R. The gamma dose in air is 5.1E-02 mrad/yr and the beta dose in air is 4.0E-01 mrad/yr, which are less than the criteria of 10 mrad/yr and 20 mrad/yr, respectively, in 10 CFR 50, Appendix I. The doses to the total body and skin are 1.3E-01 and 4.2E-01 mrem/yr, less than the 10 CFR 50, Appendix I criteria of 5 and 15 mrem/yr, respectively. The dose due to iodines and particulates is 1.1E+00 mrem/yr to the child's bone, meeting the 10 CFR 50, Appendix I criterion of 15 mrem/yr.

Table 11.3-201 compares the gaseous effluent doses to those calculated in the ESPA. The total Unit 3 doses from all gaseous effluent pathways remain within the ESP values. Table 11.3-202 compares the total site doses from all sources to the limits in 40 CFR 190. Since 40 CFR 190 is more restrictive than 10 CFR 20.1302, compliance with the former also demonstrates compliance with the latter. The population doses are summarized in Table 11.3-203.

RAI 11.02-7
RAI 11.03-4

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-6R Comparison of Calculated Offsite Airborne Concentrations with 10 CFR 20 (Expected Releases)

Isotope	EAB Concentration (µCi/ml) (1)(3)			Effluent Concentration Limit (µCi/ml) (2)(4)	Fraction of Concentration Limit (5)
	Unit 3	Units 1 & 2	Total		
I-131	4.00E-16	2.1E-13 9.0E-15	2.1E-13 9.4E-15	2.0E-10	1.0E-03 4.7E-05
I-132	—	4.2E-14 1.3E-15	4.2E-14 1.3E-15	2.0E-08	2.1E-06 6.3E-08
I-133	6.09E-15	2.6E-13 8.6E-15	2.6E-13 1.5E-14	1.0E-09	2.6E-04 1.5E-05
1-134	—	1.5E-14 2.0E-16	1.5E-14 2.0E-16	6.0E-08	2.5E-07 3.3E-09
I-135	—	1.0E-13 2.5E-15	1.0E-13 2.5E-15	6.0E-09	1.7E-05 4.2E-07
Kr-85m	—	6.4E-11 2.5E-12	6.4E-11 2.5E-12	1.0E-07	6.4E-04 2.5E-05
Kr-85	1.33E-10	1.1E-09 2.0E-10	1.3E-09 3.3E-10	7.0E-07	1.8E-03 4.7E-04
Kr-87	—	3.6E-11 1.4E-12	3.6E-11 1.4E-12	2.0E-08	1.8E-03 6.8E-05
Kr-88	—	1.1E-10 4.4E-12	1.1E-10 4.4E-12	9.0E-09	1.3E-02 4.9E-04
Xe-131m	2.47E-11	1.6E-12 2.0E-13	2.6E-11 2.5E-11	2.0E-06	1.3E-05 1.2E-05
Xe-133m	1.90E-13	9.2E-11 3.7E-12	9.2E-11 3.9E-12	6.0E-07	1.5E-04 6.4E-06
Xe-133	—	8.4E-09 3.6E-10	8.4E-09 3.6E-10	5.0E-07	1.7E-02 7.1E-04

NAPS COL 11.3(6) **Table 11.3-6R Comparison of Calculated Offsite Airborne Concentrations with 10 CFR 20 (Expected Releases)**
NAPS ESP COL 11.1-1

Isotope	EAB Concentration (μCi/ml)[(1)(3)] Unit 3	EAB Concentration (μCi/ml)[(1)(3)] Units 1 & 2	EAB Concentration (μCi/ml)[(1)(3)] Total	Effluent Concentration Limit (μCi/ml)[(2)(4)]	Fraction of Concentration Limit[(5)]
Xe-135m	3.81E-13	~~6.3E-12~~ 2.9E-13	~~6.7E-12~~ 6.7E-13	4.0E-08	~~1.7E-04~~ 1.7E-05
Xe-135	1.90E-13	~~1.9E-10~~ 7.3E-12	~~1.9E-10~~ 7.5E-12	7.0E-08	~~2.7E-03~~ 1.1E-04
Xe-137	3.81E-13	—	3.8E-13	1.0E-09	3.8E-04
Xe-138	9.51E-14	~~2.0E-11~~ 7.8E-13	~~2.0E-11~~ 8.8E-13	2.0E-08	~~1.0E-03~~ 4.4E-05
H-3[(6)(7)]	~~1.71E-11~~ 7.71E-11	—	~~1.71E-11~~ 7.71E-11	1.0E-07	~~1.71E-11~~ 7.71E-04
C-14[(6)]	6.94E-13	—	6.9E-13	3.0E-09	2.3E-04
Ar-41[(6)]	3.23E-12	—	3.2E-12	1.0E-08	3.2E-04
Cr-51	5.80E-17	—	5.8E-17	3.0E-08	1.9E-09
Mn-54	4.09E-17	—	4.1E-17	1.0E-09	4.1E-08
Co-57	7.80E-19	—	7.8E-19	9.0E-10	8.7E-10
Co-58	2.19E-15	—	2.2E-15	1.0E-09	2.2E-06
Co-60	8.37E-16	—	8.4E-16	5.0E-11	1.7E-05
Fe-59	7.52E-18	—	7.5E-18	5.0E-10	1.5E-08
Sr-89	2.85E-16	—	2.9E-16	2.0E-10	1.4E-06
Sr-90	1.14E-16	—	1.1E-16	6.0E-12	1.9E-05
Zr-95	9.51E-17	—	9.5E-17	4.0E-10	2.4E-07
Nb-95	2.38E-16	—	2.4E-16	2.0E-09	1.2E-07

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-6R Comparison of Calculated Offsite Airborne Concentrations with 10 CFR 20 (Expected Releases)

Isotope	EAB Concentration (μCi/ml) (1)(3)			Effluent Concentration Limit (μCi/ml) (2)(4)	Fraction of Concentration Limit(5)
	Unit 3	Units 1 & 2	Total		
Ru-103	7.61E-18	—	7.6E-18	9.0E-10	8.5E-09
Ru-106	7.42E-18	—	7.4E-18	2.0E-11	3.7E-07
Sb-125	5.80E-18	—	5.8E-18	7.0E-10	8.3E-09
Cs-134	2.19E-16	—	2.2E-16	2.0E-10	1.1E-06
Cs-136	8.09E-18	—	8.1E-18	9.0E-10	9.0E-09
Cs-137	3.42E-16	—	3.4E-16	2.0E-10	1.7E-06
Ba-137m	3.42E-16	—	3.4E-16	1.0E-09	3.4E-07
Ba-140	4.00E-17	—	4.0E-17	2.0E-09	2.0E-08
Ce-141	4.00E-18	—	4.0E-18	8.0E-10	5.0E-09
Total	~~1.80E-10~~ 2.4E-10	~~1.0E-08~~ 5.8E-10	~~1.0E-08~~ 8.2E-10		~~4.0E-02~~ 3.8E-03

Notes:

1. ~~X/Q=1.6E-05 s/m^3 (See Section 2.3.5) is used in this calculation.~~ Based on undecayed and undepleted EAB χ/Q of 3.0E-06 sec/m^3 (Table 2.3-16R) for Unit 3. For Units 1 and 2, the releases are from NAPS UFSAR (Reference 11.2-201), Table 11.3-3, and the χ/Q is 3.3E-06 sec/m^3 (Reference 11.2-201, Section 2.3.5.1).
2. 10 CFR 20 Appendix B, Table 2.
3. DCD Discharge Concentration column has been replaced with 3 columns for EAB Concentration (Unit 3, Units 1 & 2, and Total).
4. DCD values for Effluent Concentration Limit column have been replaced with values showing only one decimal place.
5. DCD values for Fraction of Concentration Limit column have been revised to one decimal place.
6. Entries have been revised to appear in a different position in the Isotope column than the DCD entries and associated values have been replaced.
7. Unit 3 concentration for H-3 includes the contribution from the Unit 3 cooling tower evaporation pathway.

RAI 11.02-7
RAI 11.03-4

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-7R Comparison of Calculated Offsite Airborne Concentrations with 10 CFR 20 (Maximum Releases)

Isotope	EAB Concentration (µCi/ml) (1)(3) Unit 3	Units 1 & 2	Total	Effluent Concentration Limit (µCi/ml) (2)(4)	Fraction of Concentration Limit (5)
I-131	5.80E-13	~~2.1E-13~~ 2.3E-13	~~7.9E-13~~ 8.1E-13	2.0E-10	~~3.9E-03~~ 4.1E-03
I-132	—	~~4.2E-14~~ 4.6E-14	~~4.2E-14~~ 4.6E-14	2.0E-08	~~2.1E-06~~ 2.3E-06
I-133	9.89E-13	~~2.6E-13~~ 2.8E-13	~~1.2E-12~~ 1.3E-12	1.0E-09	~~1.2E-03~~ 1.3E-03
I-134	—	~~1.5E-14~~ 1.7E-14	~~1.5E-14~~ 1.7E-14	6.0E-08	~~2.5E-07~~ 2.8E-07
I-135	—	~~1.0E-13~~ 1.2E-13	~~1.0E-13~~ 1.2E-13	6.0E-09	~~1.7E-05~~ 1.9E-05
Kr-85m	—	~~6.4E-11~~ 7.0E-11	~~6.4E-11~~ 7.0E-11	1.0E-07	~~6.4E-04~~ 7.0E-04
Kr-85	4.36E-08	~~1.1E-09~~ 1.3E-09	4.5E-08	7.0E-07	6.4E-02
Kr-87	—	~~3.6E-11~~ 4.0E-11	~~3.6E-11~~ 4.0E-11	2.0E-08	~~1.8E-03~~ 2.0E-03
Kr-88	—	~~1.1E-10~~ 1.3E-10	~~1.1E-10~~ 1.3E-10	9.0E-09	~~1.3E-02~~ 1.4E-02
Xe-131m	1.51E-10	~~1.6E-12~~ 1.8E-12	1.5E-10	2.0E-06	~~7.6E-05~~ 7.7E-05
Xe-133m	1.08E-11	~~9.2E-11~~ 1.0E-10	~~1.0E-10~~ 1.1E-10	6.0E-07	~~1.7E-04~~ 1.9E-04
Xe-133	—	~~8.4E-09~~ 9.2E-09	~~8.4E-09~~ 9.2E-09	5.0E-07	~~1.7E-02~~ 1.8E-02

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-7R Comparison of Calculated Offsite Airborne Concentrations with 10 CFR 20 (Maximum Releases)

Isotope	EAB Concentration (μCi/ml) (1)(3)			Effluent Concentration Limit (μCi/ml) (2)(4)	Fraction of Concentration Limit(5)
	Unit 3	Units 1 & 2	Total		
Xe-135m	2.04E-12	~~6.3E-12~~ 6.9E-12	~~8.3E-12~~ 8.9E-12	4.0E-08	~~2.1E-04~~ 2.2E-04
Xe-135	2.66E-11	~~1.9E-10~~ 2.1E-10	~~2.2E-10~~ 2.4E-10	7.0E-08	~~3.1E-03~~ 3.4E-03
Xe-137	1.92E-12	—	1.9E-12	1.0E-09	1.9E-03
Xe-138	9.45E-13	~~2.0E-11~~ 2.2E-11	~~2.1E-11~~ 2.3E-11	2.0E-08	~~1.0E-03~~ 1.1E-03
H-3(6)(7)	~~1.71E-11~~ 7.71E-11	—	~~1.71E-11~~ 7.71E-11	1.0E-07	~~1.7E-04~~ 7.7E-04
C-14(6)	6.94E-13	—	6.9E-13	3.0E-09	2.3E-04
Ar-41(6)	3.23E-12	—	3.2E-12	1.0E-08	3.2E-04
Cr-51	5.80E-17	—	5.8E-17	3.0E-08	1.9E-09
Mn-54	4.09E-17	—	4.1E-17	1.0E-09	4.1E-08
Co-57	7.80E-19	—	7.8E-19	9.0E-10	8.7E-10
Co-58	2.19E-15	—	2.2E-15	1.0E-09	2.2E-06
Co-60	8.37E-16	—	8.4E-16	5.0E-11	1.7E-05
Fe-59	7.52E-18	—	7.5E-18	5.0E-10	1.5E-08
Sr-89	7.23E-15	—	7.2E-15	2.0E-10	3.6E-05
Sr-90	2.11E-15	—	2.1E-15	6.0E-12	3.5E-04
Zr-95	1.68E-16	—	1.7E-16	4.0E-10	4.2E-07
Nb-95	5.69E-16	—	5.7E-16	2.0E-09	2.8E-07

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-7R Comparison of Calculated Offsite Airborne Concentrations with 10 CFR 20 (Maximum Releases)

Isotope	EAB Concentration (μCi/ml)[(1)(3)] Unit 3	Units 1 & 2	Total	Effluent Concentration Limit (μCi/ml)[(2)(4)]	Fraction of Concentration Limit[(5)]
Ru-103	5.74E-19	—	5.7E-19	9.0E-10	6.4E-10
Ru-106	1.64E-20	—	1.6E-20	2.0E-11	8.2E-10
Sb-125	5.80E-18	—	5.8E-18	7.0E-10	8.3E-09
Cs-134	8.03E-12	—	8.0E-12	2.0E-10	4.0E-02
Cs-136	3.25E-15	—	3.3E-15	9.0E-10	3.6E-06
Cs-137	4.92E-12	—	4.9E-12	2.0E-10	2.5E-02
Ba-137m	2.36E-12	—	2.4E-12	1.0E-09	2.4E-03
Ba-140	1.32E-17	—	1.3E-17	2.0E-09	6.6E-09
Ce-141	1.74E-17	—	1.7E-17	8.0E-10	2.2E-08
Total	~~4.38E-08~~ 4.39E-08	~~1.0E-08~~ 1.1E-08	~~5.4E-08~~ 5.5E-08		1.8E-01

Notes:

1. ~~X/Q=1.6E-05 s/m³ (See Section 2.3.5) is used in this calculation.~~Based on undecayed and undepleted EAB χ/Q of 3.0E-06 sec/m^3 (Table 2.3-16R) for Unit 3. For Units 1 and 2, the releases are from NAPS UFSAR (Reference 11.2-201), Table 11.3-2, and the χ/Q is 3.3E-06 sec/m^3 (Reference 11.2-201, Section 2.3.5.1).
2. 10 CFR 20 Appendix B, Table 2.
3. DCD Discharge Concentration column has been replaced with 3 columns for EAB Concentration (Unit 3, Units 1 & 2, and Total).
4. DCD values for Effluent Concentration Limit column have been replaced with values showing only one decimal place.
5. DCD values for Fraction of Concentration Limit column have been revised to one decimal place.
6. Entries have been revised to appear in a different position in the Isotope column than the DCD entries and associated values have been replaced.
7. Unit 3 concentration for H-3 includes the contribution from the Unit 3 cooling tower evaporation pathway.

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-8R Input Parameters for the GASPAR II Code

Parameter	Value
~~X/Q (s/m³) at EAB~~	~~1.6E-05[(1)]~~
~~X/Q (s/m³) at offsite food production area~~	~~5.0E-06[(2)]~~
~~D/Q (at site boundary) (1/m²)~~	~~4.0E-08~~
~~Distance to site boundary (m)~~	~~800~~
Atmospheric dispersion and ground deposition factors for individual receptors	Table 2.3-16R
Atmospheric dispersion and ground deposition factors for 50-mile region	Tables 2.3-209, -211, -213, and -215
Distances to receptors	Table 2.3-16R
Midpoint of plant life ~~(s)~~(yr)	~~9.46E+08(30yr)~~ 20
Fraction of the year that leafy vegetables are grown.	~~1.0~~ 0.5
Fraction of the year that milk cows are on pasture.	~~1.0~~ 0.67
Fraction of the maximum individual's vegetable intake that is from his own garden.	0.76
Fraction of milk-cow feed intake that is from pasture while on pasture.	1.0
Average absolute humidity over the growing season (g/m³).	8.0
Fraction of the year that beef cattle are on pasture.	~~1.0~~ 0.67
Fraction of beef-cattle feed intake that is from pasture while the cattle are on pasture	1.0
Animal considered for milk pathway	~~Cow~~ None for individual Cow for population
Milk production within 50 miles in 2040 (L/yr)	7.2E+08
Meat production within 50 miles in 2040 (kg/yr)	1.7E+09
Vegetable production within 50 miles in 2040 (kg/yr)	5.4E+08
Source term	DCD Table 11.3-5 (Sheet 1 to 3) Plus H-3 at 630 Ci/yr from cooling tower evaporation.

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-9R Calculated Doses from Gaseous Effluents (Sheets 2 of 2)

	Unit 3 Dose to each organ[1] (mrem/yr)							
Pathway	**Total Body**	**GI-Tract**	**Bone**	**Liver**	**Kidney**	**Thyroid**	**Lung**	**Skin[2]**
Plume	3.3E-02	3.3E-02	3.3E-02	3.3E-02	3.3E-02	3.3E-02	3.6E-02	3.1E-01
Ground	9.7E-02	9.7E-02	9.7E-02	9.7E-02	9.7E-02	9.7E-02	9.7E-02	1.1E-01
Vegetable								
Adult	~~2.0E-01~~ 3.0E-01	~~2.1E-01~~ 3.0E-01	1.1E+00	~~2.0E-01~~ 2.9E-01	~~1.9E-01~~ 2.8E-01	~~2.5E-01~~ 3.4E-01	~~1.8E-01~~ 2.8E-01	NA
Teen	~~3.1E-01~~ 4.2E-01	~~3.2E-01~~ 4.3E-01	1.7E+00	~~3.2E-01~~ 4.3E-01	~~3.0E-01~~ 4.1E-01	~~3.8E-01~~ 4.9E-01	~~2.9E-01~~ 4.0E-01	NA
Child	~~7.0E-01~~ 8.8E-01	~~6.9E-01~~ 8.7E-01	4.1E+00	~~7.2E-01~~ 9.0E-01	~~6.9E-01~~ 8.6E-01	~~8.5E-01~~ 1.0E+00	~~6.7E-01~~ 8.5E-01	NA
Meat								
Adult	~~6.7E-02~~ 8.1E-02	~~7.8E-02~~ 9.2E-02	3.1E-01	~~6.7E-02~~ 8.1E-02	~~6.6E-02~~ 8.0E-02	~~6.7E-02~~ 8.2E-02	~~6.5E-02~~ 8.0E-02	NA
Teen	~~5.5E-02~~ 6.3E-02	~~6.1E-02~~ 7.0E-02	2.6E-01	~~5.5E-02~~ 6.4E-02	~~5.4E-02~~ 6.3E-02	~~5.5E-02~~ 6.4E-02	~~5.4E-02~~ 6.3E-02	NA
Child	~~1.0E-01~~ 1.1E-01	~~1.0E-01~~ 1.1E-01	4.9E-01	~~1.0E-01~~ 1.1E-01	~~1.0E-01~~ 1.1E-01	~~1.0E-01~~ 1.1E-01	~~1.0E-01~~ 1.1E-01	NA
~~Cow Milk~~								
~~Adult~~		~~1.17E-01~~	~~5.33E-01~~	~~1.78E-01~~	~~1.32E-01~~	~~5.10E-01~~	~~1.14E-01~~	
~~Teen~~		~~1.98E-01~~	~~9.54E-01~~	~~3.09E-01~~	~~2.29E-01~~	~~8.28E-01~~	~~2.00E-01~~	
~~Child~~		~~4.39E-01~~	~~2.27E+00~~	~~6.38E-01~~	~~5.02E-01~~	~~1.72E+00~~	~~4.53E-01~~	
~~Infant~~		~~8.82E-01~~	~~4.26E+00~~	~~1.27E+00~~	~~9.87E-01~~	~~4.02E+00~~	~~9.14E-01~~	
Inhalation								
Adult	~~1.7E-02~~ 7.2E-02	~~1.7E-02~~ 7.3E-02	4.3E-03	~~1.7E-02~~ 7.3E-02	~~1.6E-02~~ 7.2E-02	~~3.8E-02~~ 9.4E-02	~~2.7E-02~~ 8.3E-02	NA
Teen	~~1.7E-02~~ 7.3E-02	~~1.7E-02~~ 7.3E-02	5.1E-03	~~1.7E-02~~ 7.3E-02	~~1.7E-02~~ 7.3E-02	~~4.5E-02~~ 1.0E-01	~~3.2E-02~~ 8.9E-02	NA
Child	~~1.5E-02~~ 6.4E-02	~~1.5E-02~~ 6.4E-02	6.0E-03	~~1.5E-02~~ 6.5E-02	~~1.5E-02~~ 6.5E-02	~~5.1E-02~~ 1.0E-01	~~2.7E-02~~ 7.7E-02	NA

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-9R Calculated Doses from Gaseous Effluents (Sheets 2 of 2)

	Unit 3 Dose to each organ[1] (mrem/yr)							
Pathway	**Total Body**	**GI-Tract**	**Bone**	**Liver**	**Kidney**	**Thyroid**	**Lung**	**Skin[2]**
Infant	~~8.3E-03~~ 3.7E-02	~~8.3E-03~~ 3.7E-02	2.7E-03	~~8.8E-03~~ 3.8E-02	~~8.5E-03~~ 3.7E-02	~~4.2E-02~~ 7.1E-02	~~1.7E-02~~ 4.6E-02	NA
Total								
Adult	~~4.1E-01~~ 5.8E-01	~~4.3E-01~~ 6.0E-01	1.5E+00	~~4.1E-01~~ 5.8E-01	~~4.0E-01~~ 5.6E-01	~~4.8E-01~~ 6.5E-01	~~4.1E-01~~ 5.7E-01	4.2E-01
Teen	~~5.1E-01~~ 6.9E-01	~~5.2E-01~~ 7.0E-01	2.1E+00	~~5.2E-01~~ 7.0E-01	~~5.0E-01~~ 6.7E-01	~~6.1E-01~~ 7.9E-01	~~5.1E-01~~ 6.8E-01	4.2E-01
Child	~~9.5E-01~~ 1.2E+00	~~9.4E-01~~ 1.2E+00	4.7E+00	~~9.7E-01~~ 1.2E+00	~~9.3E-01~~ 1.2E+00	~~1.1E+00~~ 1.4E+00	~~9.3E-01~~ 1.2E+00	4.2E-01
Infant	~~1.4E-01~~ 1.7E-01	~~1.4E-01~~ 1.7E-01	1.3E-01	~~1.4E-01~~ 1.7E-01	~~1.4E-01~~ 1.7E-01	~~1.7E-01~~ 2.0E-01	~~1.5E-01~~ 1.8E-01	4.2E-01
Maximum[3]								
Dose	~~9.5E-01~~ 1.2E+00	~~9.4E-01~~ 1.2E+00	4.7E+00	~~9.7E-01~~ 1.2E+00	~~9.3E-01~~ 1.2E+00	~~1.1E+00~~ 1.4E+00	~~9.3E-01~~ 1.2E+00	4.2E-01
Group	Child	Child	Child	Child	Child	Child	Child	All

Notes:

1. ~~Doses due to iodine, particulate, H-3 and C-14.~~ Doses are at the nearest residence, the receptor receiving the maximum offsite dose. All DCD values have been replaced with Unit 3 values.
2. Skin dose is not applicable (NA) for internal pathways (vegetable, meat, inhalation).
3. The last two rows identify the maximum dose for each organ and the age group receiving the dose.
4. There are no milk animals within 5 miles of the plant.

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1
NAPS ESP VAR 11.3-1

Table 11.3-201 Comparison of Individual Doses from Gaseous Effluents to ESP

		ESP Dose (1) (mrem/yr)			Unit 3 Dose (2) (mrem/yr)		
Location (3)	**Pathway**	**Total Body**	**Thyroid**	**Skin**	**Total Body**	**Thyroid**	**Skin**
EAB	Plume/Ground	2.1E+00	NA	6.2E+00	1.2E-01	**1.2E-01**	3.5E-01
	Inhalation						
	Adult	3.0E-01	1.6E+00	NA	~~1.3E-02~~ 5.6E-02	~~2.9E-02~~ 7.2E-02	NA
	Teen	3.1E-01	2.0E+00	NA	~~1.3E-02~~ 5.6E-02	~~3.4E-02~~ 7.8E-02	NA
	Child	2.7E-01	2.3E+00	NA	~~1.1E-02~~ 5.0E-02	~~3.9E-02~~ 7.7E-02	NA
	Infant	1.6E-01	2.0E+00	NA	~~6.4E-03~~ 2.9E-02	~~3.2E-02~~ 5.4E-02	NA
Nearest Garden	Vegetable						
	Adult	4.4E-01	4.9E+00	NA	~~2.0E-01~~ 3.0E-01	~~2.5E-01~~ 3.4E-01	NA
	Teen	5.7E-01	6.6E+00	NA	~~3.1E-01~~ 4.2E-01	~~3.8E-01~~ 4.9E-01	NA
	Child	1.1E+00	1.3E+01	NA	~~7.0E-01~~ 8.8E-01	~~8.5E-01~~ 1.0E+00	NA
Nearest Meat Animal	Meat						
	Adult	6.7E-02	1.5E-01	NA	~~6.7E-02~~ **8.1E-02**	~~6.7E-02~~ 8.2E-02	NA
	Teen	4.9E-02	1.1E-01	NA	~~**5.5E-02**~~ **6.3E-02**	~~5.5E-02~~ 6.4E-02	NA
	Child	7.9E-02	1.7E-01	NA	~~**1.0E-01**~~ **1.1E-01**	~~1.0E-01~~ 1.1E-01	NA

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1
NAPS ESP VAR 11.3-1

Table 11.3-201 Comparison of Individual Doses from Gaseous Effluents to ESP

		ESP Dose (1) (mrem/yr)			**Unit 3 Dose (2) (mrem/yr)**		
Location (3)	**Pathway**	**Total Body**	**Thyroid**	**Skin**	**Total Body**	**Thyroid**	**Skin**
Nearest Residence	Plume/Ground	1.4E+00	NA	4.0E+00	1.3E-01	**1.3E-01**	4.2E-01
	Inhalation						
	Adult	2.0E-01	1.0E+00	NA	~~1.7E-02~~ 7.2E-02	~~3.8E-02~~ 9.4E-02	NA
	Teen	2.0E-01	1.3E+00	NA	~~1.7E-02~~ 7.3E-02	~~4.5E-02~~ 1.0E-01	NA
	Child	1.8E-01	1.5E+00	NA	~~1.5E-02~~ 6.4E-02	~~5.1E-02~~ 1.0E-01	NA
	Infant	1.0E-01	1.3E+00	NA	~~8.3E-03~~ 3.7E-02	~~4.2E-02~~ 7.1E-02	NA
Nearest Garden/ Meat Animal/ Residence	All						
	Adult	1.6E+00	4.9E+00	4.0E+00	~~4.1E-01~~ 5.8E-01	~~4.8E-01~~ 6.5E-01	4.2E-01
	Teen	1.6E+00	6.6E+00	4.0E+00	~~5.1E-01~~ 6.9E-01	~~6.1E-01~~ 7.9E-01	4.2E-01
	Child	1.6E+00	1.3E+01	4.0E+00	~~9.5E-01~~ 1.2E+00	~~1.1E+00~~ 1.4E+00	4.2E-01
	Infant	1.5E+00	1.3E+00	4.0E+00	~~1.4E-01~~ 1.7E-01	~~1.7E-01~~ 2.0E-01	4.2E-01

RAI 11-02-7

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1
NAPS ESP VAR 11.3-2

Table 11.3-202 Comparison of Site Doses with 40 CFR 190 Limits

	Dose (mrem/yr)							
	ESP Site Total (1)	**Unit 3 (2)**						
Type of Dose		**Liquid**	**Gas**	**Total**	**Units 1 and 2 (3)**	**ISFSI (4)**	**Site Total (5)**	**40 CFR 190 Limit**
Total Body	6.8E+00	5.9E-01	~~9.5E-01~~ 1.2E+00	~~1.5E+00~~ 1.8E+00	**1.4E+00**	**3.6E+00**	~~6.5E+00~~ 6.7E+00	25
Thyroid	2.7E+01	4.9E-01	~~1.1E+00~~ 1.4E+00	~~1.6E+00~~ 1.9E+00	**1.5E+00**	**3.6E+00**	~~6.7E+00~~ 7.0E+00	75
Bone	1.2E+01	1.5E-01	4.7E+00	4.8E+00	**1.5E+00**	**3.6E+00**	~~9.9E+01~~ 9.9E+00	25

Note:

1. ESP doses are from ESP-ER Table 5.4-11.
2. Unit 3 liquid and gaseous effluent doses are from Tables 11.2-15R and 11.3-9R, respectively.
3. Doses from Units 1 and 2 are based on liquid and gaseous effluents and an assumed direct radiation total dose from both units of 1 mrem/yr.
4. The ISFSI dose is based on the ISFSI fully loaded with 84 casks.
5. Doses that exceed the corresponding ESP values are shown in bold.

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-203 Population Doses within 50 Miles

Pathway	Dose (person-rem/yr)		
	ESP (1)	Unit 3	
	Total Body	Total Body	Thyroid
Liquid	8.6E+00	6.2E+00	4.2E+00
Gaseous			
Noble Gases	3.5E+00	1.0E-01	1.0E-01
Iodines and Particulates	1.4E+00	6.3E-01	9.9E-01
H-3 and C-14	1.4E+01	~~3.1E+00~~ 4.7E+00	~~3.1E+00~~ 4.7E+00
Total	1.9E+01	~~3.8E+00~~ 5.4E+00	~~4.1E+00~~ 5.8E+00
Total	2.8E+01	~~1.0E+01~~ 1.2E+01	~~8.4E+00~~ 1.0E+01
Natural Background (2)	9.2E+05	9.2E+05	—

Notes:

1. ESP doses are from ESP-ER Table 5.4-12.
2. Natural background dose is based on a dose rate of 325 mrem and 2040 population of 2.83E6.

Table 5.4-3 Release Activities (Ci/yr) in Gaseous Effluent

Isotope	ESP-ER Composite Release Activity (Ci/yr)	Unit 3 Release Activity
H-3	3.5E+03	~~1.80E+02~~ 8.10E+02
C-14	1.2E+01	7.30E+00
Na-24	4.4E-03	NP
P-32	1.0E-03	NP
Ar-41	3.0E+02	3.40E+01
Cr-51	3.8E-02	6.10E-04
Mn-54	5.9E-03	4.30E-04
Mn-56	3.8E-03	NP
Fe-55	7.1E-03	NP
Fe-59	8.9E-04	7.90E-05
Co-57	8.2E-06	8.20E-06
Co-58	2.3E-02	2.30E-02
Co-60	1.4E-02	8.80E-03
Ni-63	7.1E-06	NP
Cu-64	1.1E-02	NP
Zn-65	1.2E-02	NP
Kr-83m	1.3E-03	NP
Kr-85m	3.6E+01	0.00E+00
Kr-85	4.1E+03	1.40E+03
Kr-87	4.9E+01	0.00E+00
Kr-88	7.4E+01	0.00E+00
Kr-89	4.7E+02	NP
Kr-90	4.2E-04	NP
Rb-89	4.7E-05	NP
Sr-89	6.2E-03	3.00E-03
Sr-90	1.2E-03	1.20E-03
Sr-91	1.1E-03	NP
Sr-92	8.6E-04	NP

Table 5.4-3 Release Activities (Ci/yr) in Gaseous Effluent

Isotope	ESP-ER Composite Release Activity (Ci/yr)	Unit 3 Release Activity
Xe-137	9.8E+02	4.00E+00
Xe-138	7.8E+02	1.00E+00
Xe-139	5.3E-04	NP
Cs-134	6.8E-03	2.30E-03
Cs-136	6.5E-04	8.50E-05
Cs-137	1.0E-02	3.60E-03
Cs-138	1.9E-04	NP
Ba-137m	NP	**3.60E-03**
Ba-140	3.0E-02	4.20E-04
La-140	2.0E-03	NP
Ce-141	1.0E-02	4.20E-05
Ce-144	2.1E-05	NP
Pr-144	2.1E-05	NP
W-187	2.1E-04	NP
Np-239	1.3E-02	NP
Total w/o H-3	1.5E+04	1.71E+03
Total w/ H-3	1.8E+04	~~1.89E+03~~ 2.52E+03

Note: "NP" denotes isotopes which are "not present." For Unit 3, noble gases with values of 0.00E+00 indicates release activity is less than 1 Ci/yr. Unit 3 H-3 activity includes the contribution from cooling tower evaporation. Since Lake Anna serves as the source of makeup water for the Unit 3 cooling tower, it is assumed that the tritium in Lake Anna is released to the environment as gaseous effluent via cooling tower evaporation. The maximum tritium concentration in Lake Anna from the operation of Units 1, 2, and 3 is 1.9E-5 μCi/ml. Multiplying this concentration by the maximum cooling tower evaporation rate of 16,695 gpm (Table 3.0-2) or 3.32E+13 ml/yr yields a release of 630 Ci/yr. Adding this value to the normal US-APWR release of 180 Ci/yr (DCD Table 11.3-5) results in a total tritium release of 810 Ci/yr.

Table 5.4-4 Gaseous Pathway Doses (mrem/yr) to the MEI

		ESP-ER			Unit 3		
Location	**Pathway**	**Total Body**	**Thyroid**	**Skin**	**Total Body**	**Thyroid**	**Skin**
Site Boundary (0.88 mi ESE for ESP-ER; same location for this ER)	Plume	2.1E+00	N/A	6.2E+00	1.2E-01	**1.2E-01**	3.5E-01
	Inhalation						
	Adult	3.0E-01	1.6E+00	N/A	~~1.3E-02~~ 5.6E-02	~~2.9E-02~~ 7.2E-02	N/A
	Teen	3.1E-01	2.0E+00	N/A	~~1.3E-02~~ 5.6E-02	~~3.4E-02~~ 7.8E-02	N/A
	Child	2.7E-01	2.3E+00	N/A	~~1.1E-02~~ 5.0E-02	3.9E-02 7.7E-02	N/A
	Infant	1.6E-01	2.0E+00	N/A	~~6.4E-03~~ 2.9E-02	~~3.2E-02~~ 5.4E-02	N/A
Nearest Garden (0.94 mi NE for ESP-ER; 0.74 mi ESE for this ER)	Vegetable						
	Adult	4.4E-01	4.9E+00	N/A	~~2.0E-01~~ 3.0E-01	~~2.5E-01~~ 3.4E-01	N/A
	Teen	5.7E-01	6.6E+00	N/A	~~3.1E-01~~ 4.2E-01	~~3.8E-01~~ 4.9E-01	N/A
	Child	1.1E-00	1.3E+01	N/A	~~7.0E-01~~ 8.8E-01	8.5E-01 1.0E+00	N/A
Nearest Residence (0.96 mi NNE for ESP-ER; 0.74 mi ESE for this ER)	Plume	1.4E+00	N/A	4.0E+00	1.3E-01	**1.3E-01**	4.2E-01
	Inhalation						
	Adult	2.0E-01	1.0E+00	N/A	~~1.7E-02~~ 7.2E-02	~~3.8E-02~~ 9.4E-02	N/A
	Teen	2.0E-01	1.3E+00	N/A	~~1.7E-02~~ 7.3E-02	~~4.5E-02~~ 1.0E-01	N/A
	Child	1.8E-01	1.5E+00	N/A	~~1.5E-02~~ 6.4E-02	~~5.1E-02~~ 1.0E-01	N/A
	Infant	1.0E-01	1.3E+00	N/A	~~8.3E-03~~ 3.7E-02	~~4.2E-02~~ 7.1E-02	N/A

Table 5.4-4 Gaseous Pathway Doses (mrem/yr) to the MEI

		ESP-ER			Unit 3		
Location	**Pathway**	**Total Body**	**Thyroid**	**Skin**	**Total Body**	**Thyroid**	**Skin**
Nearest Meat Cow (1.37 mi SE for ESP-ER; 0.74 mi ESE for this ER)	Meat						
	Adult	6.7E-02	1.5E-01	N/A	~~6.7E-02~~ **8.1E-02**	~~6.7E-02~~ 8.2E-02	N/A
	Teen	4.9E-02	1.1E-01	N/A	~~5.5E-02~~ **6.3E-02**	~~5.5E-02~~ 6.4E-02	N/A
	Child	7.9E-02	1.7E-01	N/A	~~1.0E-01~~ **1.1E-01**	~~1.0E-01~~ 1.1E-01	N/A
Nearest Garden/ Residence/ Meat Cow (Varies for ESP-ER; 0.74 mi ESE for this ER)	All						
	Adult	1.6E+00	4.9E+00	4.0E+00	~~4.1E-01~~ 5.8E-01	~~4.8E-01~~ 6.5E-01	4.2E-01
	Teen	1.6E+00	6.6E+00	4.0E+00	~~5.1E-01~~ 6.9E-01	~~6.1E-01~~ 7.9E-01	4.2E-01
	Child	1.6E+00	1.3E+01	4.0E+00	~~9.5E-01~~ 1.2E+00	~~1.1E+00~~ 1.4E+00	4.2E-01
	Infant	1.5E+00	1.3E+00	4.0E+00	~~1.4E-01~~ 1.7E-01	~~1.7E-01~~ 2.0E-01	4.2E-01

Table 5.4-6 Comparison of Site Doses (mrem/yr) to the MEI

Type of Dose	ESP Site Total (1)(4)	Unit 3 Liquid	Unit 3 Gaseous	Unit 3 Total	Existing Units (2)(4)	Site Total (3)	40 CFR 190 Limit
Total Body (mrem/yr)	6.8	5.9E-01	~~9.5E-01~~ 1.2E+00	~~1.5E+00~~ 1.8E+00	5.0E+00	~~6.5E+00~~ 6.7E+00	25
Thyroid (mrem/yr)	27	4.9E-01	~~1.1E+00~~ 1.4E+00	~~1.6E+00~~ 1.9E+00	5.1E+00	~~6.7E+00~~ 7.0E+00	75
Bone (mrem/yr)	12	1.5E-01	4.7E+00	4.8E+00	5.1E+00	9.9E+00	25

Notes:

1. The ESP site total doses are for two new units and the two existing units, and do not include a dose contribution from the ISFSI.
2. The doses from existing units include contributions from liquid and gaseous effluents, ISFSI, and an assumed dose of 1 mrem/yr due to direct radiation from the existing units.
3. This site total dose includes the Unit 3 total dose and the dose from the existing units.
4. The effluent dose from ESP-ER Section 5.4, Reference 11, is a critical organ dose that is applied as the thyroid and bone dose.

Table 5.4-7 Collective Total Body (Population) Doses (person-rem/yr) Within 50 Miles

	ESP-ER 1 New Unit	Unit 3
Liquid	8.6E+00	6.2E+00
Noble Gases (Gaseous)	3.5E+00	1.0E-01
Iodines and Particulates (Gaseous)	1.4E+00	6.3E-01
H-3 and C-14 (Gaseous)	1.4E+01	~~3.1E+00~~ 4.7E+00
Total	2.8E+01	~~1.0E+01~~ 1.2E+01
Natural Background	9.2E+05	9.2E+05

Notes:

1. ESP doses are based on data from ESP-ER Tables 2.5-8, 5.4-1, and 5.4-3.
2. The corresponding collective thyroid doses for Unit 3 are 4.2 person-rem/year from liquid effluents and ~~4.1~~ 5.8 person-rem/year from gaseous effluents.
3. The long-term χ/Q and D/Q values used in deriving Unit 3 collective doses from routine gaseous effluent releases within 50 miles of the plant are shown in Tables 2.7-5 to 2.7-12.

Table 5.4-8 Comparison of Annual Doses (mrad/yr) to Biota from Liquid and Gaseous Effluent

Biota Effluents	ESP-ER		Unit 3	
	Liquid	**Gaseous**	**Liquid**	**Gaseous**
Fish	9.7E+00	N/A	**2.3E+01**	N/A
Invertebrates	4.6E+01	N/A	1.5E+01	N/A
Algae	5.4E+01	N/A	2.3E+01	N/A
Muskrat	4.3E+01	3.4E+01	4.2E+00	~~6.0E+00~~ 7.5E+00
Raccoon	4.9E+00	3.4E+01	1.4E+00	~~6.0E+00~~ 7.5E+00
Heron	5.4E+01	3.4E+01	1.7E+01	~~6.0E+00~~ 7.5E+00
Duck	4.3E+01	3.4E+01	3.9E+00	~~6.0E+00~~ 7.5E+00

ENCLOSURE 3

Response to NRC RAI Letter 67

RAI 5448, Question 11.03-4

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5448 (RAI Letter 67)

SRP SECTION: 11.03 – GASEOUS WASTE MANAGEMENT SYSTEMS

QUESTIONS for Health Physics Branch 1(CHPB)

DATE OF RAI ISSUE: 05/3/2011

QUESTION NO.: 11.03-4

NRC Staff review of FSAR (Rev. 3) Section 11.3.3.1, Tables 11.2-9R, 11.3-6R, and 11.3-7R found information that requires updating and/or needs to be addressed on the calculation of annual gaseous effluent releases (expected and maximum) to satisfy NAPS COL 11.3(6) and for the staff to verify compliance with NRC regulations and 40 CFR Part 190. Please address the following and provide a mark-up on the proposed FSAR changes.

1. In the applicable FSAR sections, make reference to the MHI PWR-GALE code and the MHI TR MUAP-10019 [Proprietary] P(R0), MHI TR MUAP-10019 [Non-Proprietary] NP(R0) (ML102850683) which describes the methodology, basis, and assumptions for the calculation of expected and maximum annual gaseous effluent releases during normal operation including AOOs for plants referencing the US-APWR design.

2. Tables 11.3-6R and 11.3-7R present discharge concentrations, effluent concentration limits, and fractions of concentration limits for gaseous effluent releases from existing Units 1 and 2 and proposed Unit 3. Provide the reference for the staff to confirm the respective fractions of gaseous concentration limits and the sum-of-ratios for operation of three units at the site.

__Dominion Response__

1. MHI revised Technical Reports MUAP-10019P and MUAP-10019NP and provided them as part of the response to DCD RAI No. 711-5533, Question No. 11.02-34, dated March 30, 2011. These Technical Reports were added as

Reference 11.3-28 in US-APWR DCD Rev. 3, Tier 2, Section 11.3.8, *References*. The Unit 3 FSAR will include this new DCD reference in the next submittal of the COLA because the FSAR incorporates DCD Section 11.3.8 by reference.

Also, FSAR Section 11.3.3.1 will be revised to identify these Technical Reports by citing the new DCD reference number 11.3-28. These Technical Reports describe the US-APWR-specific methodology, basis, and assumptions for the calculation of expected and maximum annual gaseous effluent releases during normal operation including abnormal operational occurrences for plants referencing the US-APWR design.

As described in COLA Part 7, Unit 3 has a departure from the standard US-APWR design in that Unit 3 replaces the boric acid evaporator (BAE) with a degasifier. The information which addresses this departure in the FSAR is identified by the LMN NAPS DEP 9.2(1). The BAE departure does not affect the results for annual gaseous effluent releases for Unit 3 and the departure LMN is not used in FSAR Section 11.3.3.1 or its tables. The US-APWR-specific version of the PWR-GALE code that is used for Unit 3 annual gaseous effluent releases is the same as for the US-APWR standard plant design because there are no effects due to the Unit 3 BAE departure Therefore, the annual gaseous effluent releases from Unit 3 are the same as from the US-APWR standard plant design except that additional tritium is released through cooling tower evaporation of makeup water from Lake Anna. (Refer to RAI 5447, Question 11.02-7 in Enclosure 2 of this response.)

2. For Unit 3 FSAR Tables 11.3-6R and 11.3-7R, three updates were identified as required to more clearly and consistently address annual gaseous effluent releases (expected and maximum) to satisfy DCD COL Information Item 11.3(6) and for the NRC to verify compliance with NRC regulations and 40 CFR Part 190. The three changes are:

    - Exclusion Area Boundary (EAB) χ/Q Values for Normal Doses – The maximum χ/Q and D/Q values for the EAB provided in Table 2.3-16 of the Early Site Permit Application (ESPA) Site Safety Analysis Report (SSAR) were based on bounding reactor building dimensions for the types of reactor designs considered in the ESPA. Although these values were conservative for use in the Unit 3 FSAR in the Combined License Application (COLA), for consistency with the other receptors listed in this table, FSAR Table 2.3-16R will be revised to reflect Unit 3 EAB χ/Q values based on the dimensions of the US-APWR Reactor Building. As shown in the attached markup for this FSAR table, the maximum undecayed/undepleted χ/Q value for a US-APWR at the Unit 3 site is 3.0E-06 sec/m^3 and was 3.7E-06 sec/m^3 in the ESPA. This change will result in a corresponding update shown in the attached markup for FSAR Tables 11.3-6R and 11.3-7R. The footnotes for these tables cite FSAR Table 2.3-16R as the basis for the χ/Q value used in calculating

radionuclide concentrations at the EAB. The value of 3.0E-06 sec/m^3 used for FSAR Tables 11.3-6R and 11.3-7R will now be appropriately identified in FSAR Table 2.3-16R (which currently shows the conservative maximum χ/Q value of 3.7E-06 sec/m^3 for the EAB).

- Updated Maximum Atmospheric Dispersion Factor (χ/Q) Value for Unit 1 and Unit 2 – Had the conservative maximum χ/Q value of 3.7E-06 sec/m^3 for the EAB (from FSAR Table 2.3-16R) been used as was intended by the footnotes for FSAR Tables 11.3-6R and 11.3-7R, then the χ/Q of 3.7E-06 sec/m^3 would have exceeded the maximum EAB χ/Q for Units 1 and 2, which is 3.3E-06 sec/m^3 as shown in NAPS UFSAR Section 2.3.5.1. With the change to Unit 3 specific maximum χ/Q values for the EAB as noted above, the maximum EAB χ/Q of 3.3E-06 sec/m^3 for Units 1 and 2 will be used to determine the Units 1 and 2 EAB concentrations in Tables 11.3-6R and 11.3-7R. As shown in the attached markups, the footnotes for these tables will be updated to provide the maximum χ/Q value of 3.3E-06 sec/m^3 for Units 1 and 2 and the reference for this value.

- Updated Expected Releases Used for Unit 1 and Unit 2 – FSAR Tables 11.3-6R and 11.3-7R both utilize the maximum activity releases from the Units 1 and 2 UFSAR in calculating the effluent concentrations from Units 1 and 2. This approach is overly conservative for expected releases from all three Units and is not consistent with the US-APWR DCD or Units 1 and 2 UFSAR, both of which provide both maximum and expected annual releases. The concentrations in Table 11.3-6R will be revised to reflect expected releases, not maximum Units 1 and 2 releases. As shown in the attached markups, Table 11.3-6R will be updated to reflect expected releases for all three units.

Unit 3 FSAR Tables 11.3-6R and 11.3-7R will be revised to include the following information for each isotope:

- EAB Concentration from Unit 3 – The concentration, C, at the EAB is calculated using the following equation:

  C = (A Ci/yr)(0.0317 μCi/sec per Ci/yr)(3.0E-12 sec/ml) = (9.51E-14)A μCi/ml

  Where:

  – A is the activity from DCD Table 11.3-5 (Sheets 1 to 3 for expected releases; Sheets 4 to 6 for maximum releases) except that the tritium activity of 810 Ci/yr is the sum of 180 Ci/yr from the DCD and 630 Ci/yr from cooling tower evaporation of Lake Anna water, as described in the response to RAI #5447, Question Number 11.02-7.

- 0.0317 is a unit conversion factor
- 3.0E-12 sec/ml is the undecayed and undepleted EAB χ/Q of 3.0E-06 sec/m^3 from FSAR Table 2.3-16R.

- EAB Concentration from Units 1 and 2 – The same equation is used as for Unit 3 above except that activity A is taken from UFSAR Tables 11.3-3 (expected releases) and 11.3-2 (maximum releases) and χ/Q is 3.3E-06 sec/m^3 (UFSAR Section 2.3.5.1), yielding C = (1.05E-13)A µCi/ml.
- Total EAB Concentration – This is the sum of concentrations from Unit 3 and Units 1 and 2.
- Effluent Concentration Limit – The limit for each isotope is from 10 CFR 20, Appendix B, Table 2, Column 1.
- Fraction of Concentration Limit – The total concentration is divided by the concentration limit from 10 CFR 20.

In the "Total" row of Tables 11.3-6R and 11.3-7R, the concentrations and fractions of concentration limits are summed within the respective columns.

Section 2.3.5.1 and Tables 11.3-2 and 11.3-3 of NAPS UFSAR, Revision 45 are attached.

Supplemental Information

The response to RAI Question Number 11.02-4 submitted in letter number NA3-11-024R on June 9, 2011 addressed liquid effluent discharge concentrations from Units 1, 2 and 3. The following information supplements that response for consistency with the update of expected concentrations for gaseous effluents described above.

In Revision 3 of the Unit 3 FSAR, Tables 11.2-12R and 11.2-13R show the liquid effluent concentrations in the discharge canal based on expected and maximum releases, respectively. While the Unit 3 concentrations in Table 11.2-12R are based on expected releases, the concentrations for Units 1 and 2 are based on maximum releases. For consistency with the US-APWR DCD and Units 1 and 2 UFSAR, both of which provide expected annual releases, Table 11.2-12R will be revised to reflect expected releases for Units 1 and 2 from NAPS UFSAR Table 11.2-17.

Table 11.2-17 (expected releases) from NAPS Units 1 and 2 UFSAR, Revision 45 is attached.

Proposed COLA Revisions

For gaseous effluents, FSAR Table 2.3-16R, Section 11.3.3.1, and Tables 11.3-6R and 11.3-7R will be revised as described above and indicated on the attached markups. In

addition to the changes described above, FSAR Table 2.0-201 will be revised as indicated on the attached markups to be consistent with the above changes to FSAR Table 2.3-16R. Also, Tables 11.3-6R and 11.3-7R reflect changes made in response to RAI Question 11.02-7.

For liquid effluents, FSAR Table 11.2-12R will be revised as described above and indicated on the attached markup.

Attachment to Enclosure 3

RAI 5448, Question 11.03-4

**Excerpts from North Anna Units 1 and 2 UFSAR
(Revision 45 - 09/30/09)**

**Section 2.3.5.1
Table 11.2-17
Table 11.3-2
Table 11.3-3**

This relationship, which is usually associated with continuous-release sources, is also applicable to North Anna. These releases can be treated as continuous sources (i.e., with regard to using the same diffusion equations) when the travel time of the plume is less than 10 times the duration of release (Reference 34).

2.3.4.3 Atmospheric Transport and Diffusion Assessment Model

A near real-time, site-specific atmospheric transport and diffusion model for assessing accidental airborne radioactive releases is available for use with the installation and operation of the plant computer system (PCS) hardware and software, as required in NUREG 0696. The model uses actual 15-minute average meteorological field data obtained from the station's meteorological system. The model provides relative concentrations (X/Q) and transit times within the plume exposure EPZ. Atmospheric diffusion rates are based on atmospheric stability as a function of site-specific conditions. Source characteristics (release mode, and building complex influence) are factored into the model. The output from the model includes plume dimensions and position, and the location, magnitude, and arrival time of (1) the peak relative concentration and (2) the relative concentrations at approximate locations. The calculated output of the model will be placed in the PCS data base for display in the station's TSC and in the central office EOF.

2.3.5 Long-Term (Routine) Diffusion Estimates

2.3.5.1 Basis

Annual average atmospheric dilution factors (X/Q) were determined for the North Anna site. Again, site data were used in lieu of the longer period of record available for Richmond data because the North Anna measurements were more representative of site dilution conditions. However, the average wind speed of 7.5 mph at Richmond for the report period (September 16, 1971 to September 15, 1972) closely approximates the climatic normal of 7.6 mph. Therefore, site meteorological data for the September 16, 1971 to September 15, 1972 period are considered reasonably representative of long-term conditions. Figure 2.3-31 shows the distribution of X/Q in sec/m^3 based on North Anna 35-foot wind data. The configurations of X/Q isopleths reflect the distribution of wind direction, wind speed, and vertical (delta $T_{150\text{-}35\ ft}$) atmospheric stability for the period. The maximum X/Q at the exclusion distance radius (4430 feet (1350 m)) is 3.30×10^{-6} sec/m^3. At the low population zone radius (6 miles (9656 m)), the value is 1.7×10^{-7} sec/m^3, and at the population center radius (23.5 miles (37,821 m)), 2.8×10^{-9} sec/m^3, based on available site data. These maximum values are associated with winds from the west-northwest and were conservatively based on the analysis of all wind directions.

The average X/Q value calculated for the nearest residence (1770 m to the west-northwest of the plant) is 1.0×10^{-6} sec/m^3. These X/Q values are somewhat higher than those presented in the PSAR based on Richmond data (the maximum annual X/Q at 1350 m was 2.5×10^{-6} sec/m^3 and the annual X/Q at the nearest residence was 5.0×10^{-7} sec/m^3).

Table 11.2-17
ACTIVITY IN DISCHARGE CANAL - EXPECTED CASE

Nuclide	Activity (μC/gm)
CR51	5.9E-12
MN54	3.1E-12
FE55	1.6E-11
FE59	4.4E-12
CO58	6.8E-11
CO60	2.3E-11
SR89	1.5E-12
SR90	1.0E-13
SR91	7.7E-13
Y90	7.9E-14
Y91M	2.5E-13
Y91	2.9E-13
Y93	4.0E-14
ZR95	5.7E-13
NB95	6.8E-13
MO99	2.1E-10
TC99M	1.1E-10
RU103	1.6E-13
RU106	8.1E-13
RH103M	8.8E-14
RH106	7.9E-13
TE125M	7.9E-14
TE127M	9.7E-13
TE127	1.6E-12
TE129M	4.1E-12
TE129	1.9E-12
TE-131M	4.8E-12
TE-131	4.8E-13
TE-132	5.2E-11
BA137M	2.4E-10
BA140	6.1E-13
LA140	3.8E-13
CE141	2.9E-13

Table 11.2-17 (continued)
ACTIVITY IN DISCHARGE CANAL - EXPECTED CASE

Nuclide	Activity (μC/gm)
CE143	4.8E-14
CE144	1.7E-12
PR143	1.2E-13
PR144	1.6E-12
NP239	3.0E-12
BR83	2.7E-12
BR84	4.0E-13
BR85	4.4E-15
I130	6.6E-12
I131	1.3E-09
I132	1.6E-10
I133	1.4E-09
I134	2.9E-11
I135	4.8E-10
RB86	3.3E-13
RB88	2.3E-11
CS134	2.9E-10
CS136	4.6E-11
CS137	2.8E-10
H3	5.5E-06
Total	5.5E-06
Total (Non-Tritium)	4.8E-09

Table 11.3-2
ESTIMATED GASEOUS EFFLUENTS
CI/YR FOR TWO UNITS
DESIGN CASE

Isotope	Waste Gas Decay Tanks	Boron Recovery and High-Level Waste Tanks	Containment Purge	Auxiliary Building Vent	Steam Generator Blowdown Tank Vents	Main Condenser Air Ejector Vents	Auxiliary Steam Drain Receiver	Turbine Bldg. Ventilation Exhaust	Gland Seal Ejector Vent	Heating System Drain Receiver Vents	Chilled Water Air Ejector Vents	Total
I-131	2.0×10^{-5}	—	4.6×10^{-2}	6.0×10^{-1}	1.3×10^{-1}	1.8×10^{-2}	4.4×10^{-1}	4.4×10^{-1}	4.8×10^{-1}	1.6×10^{-2}	3.7×10^{-3}	2.2×10^{0}
I-132	—	—	8.1×10^{-3}	2.1×10^{-1}	1.9×10^{-2}	2.7×10^{-3}	6.4×10^{-2}	6.4×10^{-2}	7.0×10^{-2}	2.4×10^{-3}	5.3×10^{-4}	4.4×10^{-1}
I-133	—	—	6.0×10^{-2}	9.7×10^{-1}	1.5×10^{-1}	2.0×10^{-2}	4.9×10^{-1}	4.9×10^{-1}	5.3×10^{-1}	1.8×10^{-2}	4.0×10^{-3}	2.7×10^{0}
I-134	—	—	1.4×10^{-3}	1.3×10^{-1}	2.3×10^{-3}	3.2×10^{-4}	7.7×10^{-3}	7.7×10^{-3}	8.4×10^{-3}	2.8×10^{-4}	6.4×10^{-5}	1.6×10^{-1}
I-135	—	—	2.3×10^{-2}	5.2×10^{-1}	4.5×10^{-2}	6.2×10^{-3}	1.5×10^{-1}	1.5×10^{-1}	1.6×10^{-1}	5.5×10^{-3}	1.2×10^{-3}	1.1×10^{0}
Kr-85m	—	—	3.0×10^{-1}	5.1×10^{1}	—	6.2×10^{2}	—	—	—	—	—	6.7×10^{2}
Kr-85	1.0×10^{4}	—	4.9×10^{2}	1.3×10^{2}	—	1.5×10^{3}	—	—	—	—	—	1.2×10^{4}
Kr-87	—	—	5.2×10^{-2}	2.9×10^{1}	—	3.5×10^{2}	—	—	—	—	—	3.8×10^{2}
Kr-88	—	—	3.4×10^{-1}	9.0×10^{1}	—	1.1×10^{3}	—	—	—	—	—	1.2×10^{3}
Xe-131m	1.5×10^{0}	5.6×10^{-1}	1.5×10^{1}	2.9×10^{-3}	—	—	—	—	—	—	—	1.7×10^{1}
Xe-133m	1.3×10^{-6}	1.8×10^{-2}	5.7×10^{0}	7.7×10^{1}	—	8.9×10^{2}	—	—	—	—	—	9.7×10^{2}
Xe-133	9.0×10^{0}	3.2×10^{-1}	1.2×10^{3}	6.9×10^{3}	—	8.0×10^{4}	—	—	—	—	—	8.8×10^{4}
Xe-135m	—	7.5×10^{0}	1.4×10^{-1}	4.2×10^{0}	—	5.4×10^{1}	—	—	—	—	—	6.6×10^{1}
Xe-135	—	5.8×10^{-1}	2.3×10^{0}	1.5×10^{2}	—	1.8×10^{3}	—	—	—	—	—	2.0×10^{3}
Xe-138	—	—	6.2×10^{-3}	1.5×10^{1}	—	1.9×10^{2}	—	—	—	—	—	2.1×10^{2}

Table 11.3-3
ESTIMATED GASEOUS EFFLUENTS
CI/YR FOR TWO UNITS
EXPECTED CASE

Isotope	Waste Gas Decay Tanks	Boron Recovery and High-Level Waste Tanks	Containment Purge	Auxiliary Building Vent	Steam Generator Blowdown Tank Vents	Main Condenser Air Ejector Vents	Auxiliary Steam Drain Receiver	Turbine Bldg. Ventilation Exhaust	Gland Seal Ejector Vent	Heating System Drain Receiver Vents	Chilled Water Air Ejector Vents	Total
I-131	4.0×10^{-7}	—	4.2×10^{-4}	4.8×10^{-3}	4.2×10^{-3}	9.9×10^{-4}	2.4×10^{-2}	2.4×10^{-2}	2.6×10^{-2}	1.1×10^{-3}	2.4×10^{-4}	8.6×10^{-2}
I-132	—	—	7.7×10^{-5}	1.7×10^{-3}	5.3×10^{-4}	1.2×10^{-4}	3.0×10^{-3}	3.0×10^{-3}	3.3×10^{-3}	1.3×10^{-4}	3.0×10^{-5}	1.2×10^{-2}
I-133	—	—	5.6×10^{-4}	7.8×10^{-3}	3.8×10^{-3}	9.1×10^{-4}	2.2×10^{-2}	2.2×10^{-2}	2.4×10^{-2}	9.8×10^{-4}	2.2×10^{-4}	8.2×10^{-2}
I-134	—	—	1.4×10^{-5}	1.0×10^{-3}	4.6×10^{-5}	1.1×10^{-5}	2.6×10^{-4}	2.6×10^{-4}	2.8×10^{-4}	1.2×10^{-5}	2.6×10^{-6}	1.9×10^{-3}
I-135	—	—	2.1×10^{-4}	4.2×10^{-3}	1.0×10^{-3}	2.4×10^{-4}	5.8×10^{-3}	5.8×10^{-3}	6.3×10^{-3}	2.6×10^{-4}	5.8×10^{-5}	2.4×10^{-2}
Kr-85m	—	—	3.0×10^{-2}	4.2×10^{0}	—	2.0×10^{1}	—	—	—	—	—	2.4×10^{1}
Kr-85	1.8×10^{3}	—	4.1×10^{1}	1.0×10^{1}	—	4.8×10^{1}	—	—	—	—	—	1.9×10^{3}
Kr-87	—	—	5.2×10^{-3}	2.4×10^{0}	—	1.1×10^{1}	—	—	—	—	—	1.3×10^{1}
Kr-88	—	—	3.4×10^{-2}	7.3×10^{0}	—	3.5×10^{1}	—	—	—	—	—	4.2×10^{1}
Xe-131m	3.0×10^{-1}	9.5×10^{-2}	1.5×10^{0}	2.3×10^{-4}	—	—	—	—	—	—	—	1.9×10^{0}
Xe-133m	2.1×10^{-7}	2.5×10^{-3}	5.7×10^{-1}	6.2×10^{0}	—	2.9×10^{1}	—	—	—	—	—	3.5×10^{1}
Xe-133	1.5×10^{0}	4.4×10^{-2}	1.2×10^{2}	5.6×10^{2}	—	2.7×10^{3}	—	—	—	—	—	3.4×10^{3}
Xe-135m	—	1.0×10^{0}	1.4×10^{-2}	3.4×10^{-1}	—	1.8×10^{0}	—	—	—	—	—	2.8×10^{0}
Xe-135	—	7.9×10^{-2}	2.3×10^{-1}	1.2×10^{1}	—	5.8×10^{1}	—	—	—	—	—	7.0×10^{1}
Xe-138	—	—	6.2×10^{-4}	1.2×10^{0}	—	6.3×10^{0}	—	—	—	—	—	7.5×10^{0}

Markup of North Anna COLA

The attached markup represents Dominion's good faith effort to show how the COLA will be revised in a future COLA submittal in response to the subject RAI. However, the same COLA content may be impacted by revisions to the DCD, responses to other COLA RAIs, other COLA changes, plant design changes, editorial or typographical corrections, etc. As a result, the final COLA content that appears in a future submittal may be somewhat different than as presented herein.

RAI 11.02-7

Table 2.0-201 Evaluation of Site/Design Parameters and Characteristics

	Parameter Description(15)	DCD Site Parameter Value(15)	Site Characteristic	Evaluation
NAPS SUP 2.0(1)	**Part 1 – Evaluation of DCD Site Parameters**			
	Atmospheric Dispersion Factors (χ/Q Values) for Onsite Locations			
	Exclusion Area Boundary (EAB) 0–2 hr	5.0×10^{-4} s/m^3	**ESP and Unit 3** 2.26×10^{-4} s/m^3	The ESP site characteristic value for short-term (accident release) atmospheric dispersion for 0–2 hr χ/Q value at the EAB is defined as the 0–2 hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the EAB. The ESP site characteristic value falls within (is lower than) the DCD site parameter value. SSAR Table 2.3-3 and SSAR Table 1.9-1 provide the same value as the ESP. Note that although the EAB location yielding the highest atmospheric dispersion factors was determined by GIS measurement to be 0.94 mi ESE, the SSAR distance of 0.88 mi ESE is conservative and used. The Unit 3 site characteristic value falls within (is the same as) the ESP site characteristic value.
	EAB Annual Average	1.6×10^{-5} s/m^3	**ESP** ~~and Unit 3~~ 3.7×10^{-6} s/m^3, annual average, undepleted/no decay, EAB, east-southeast, 1.4 km (0.88 mi) **Unit 3** 3.0×10^{-6} s/m^3, annual average, undepleted/no decay, EAB, east-southeast, 1.4 km (0.88 mi)	The ESP site characteristic value for this long term dispersion estimate is defined as the maximum annual average EAB undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual. The ESP site characteristic value falls within (is less than) the DCD site parameter value. See Section 11.3 for the site-specific concentration and dose analysis inputs and results. The Unit 3 site characteristic value is provided inTable 2.3-16R and falls within (~~is the same as~~ is lower than) the ESP site characteristic value.

Table 2.0-201 Evaluation of Site/Design Parameters and Characteristics

	Parameter Description[15]	DCD Site Parameter Value[15]	Site Characteristic	Evaluation
NAPS SUP 2.0(1)	**Part 1 – Evaluation of DCD Site Parameters**			
	Atmospheric Dispersion Factors (χ/Q Values) for Onsite Locations (continued)			
RAI 11.02-7	EAB Annual Average	1.6 x 10^{-5} s/m^3	**ESP~~and Unit 3~~** 3.7 × 10^{-6} s/m^3, annual average, undepleted/2.26-day decay, EAB, east-southeast, 1.4 km (0.88 mi) **Unit 3** 3.0 × 10^{-6} s/m^3, annual average, undepleted/2.26-day decay, EAB, east-southeast, 1.4 km (0.88 mi)	The ESP site characteristic value for this long term dispersion estimate is defined as the maximum annual average EAB undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual. The ESP site characteristic value falls within (is less than) the DCD site parameter value. See Section 11.3 for the site-specific concentration and dose analysis inputs and results. The Unit 3 site characteristic value is provided in Table 2.3-16R and falls within (~~is the same as~~ is lower than) the ESP site characteristic value.
RAI 11.02-7	EAB Annual Average	1.6 x 10^{-5} s/m^3	**ESP~~and Unit 3~~** 3.3 × 10^{-6} s/m^3, annual average, depleted/8.00-day decay, EAB, east-southeast, 1.4 km (0.88 mi) **Unit 3** 2.6 × 10^{-6} s/m^3, annual average, depleted/8.00-day decay, EAB, east-southeast, 1.4 km (0.88 mi)	The ESP site characteristic value for this long term dispersion estimate is defined as the maximum annual average EAB depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual. The ESP site characteristic value falls within (is less than) the DCD site parameter value. See Section 11.3 for the site-specific concentration and dose analysis inputs and results. The Unit 3 site characteristic value is provided in Table 2.3-16R and falls within (~~is the same as~~ is lower than) the ESP site characteristic value.

RAI 11.02-7

Table 2.0-201 Evaluation of Site/Design Parameters and Characteristics

	Parameter Description(15)	DCD Site Parameter Value(15)	Site Characteristic	Evaluation
NAPS SUP 2.0(1)	**Part 1 – Evaluation of DCD Site Parameters**			
	Deposition Factor (D/Q Value) for Onsite and Offsite Locations			
	EAB Annual Average	4.0×10^{-8} 1/m^2	**ESP and Unit 3** 1.2×10^{-8} 1/m^2, annual average, D/Q value, EAB, east-southeast*, 1.4 km (0.88 mi) **Unit 3** 1.1×10^{-8} 1/m^2, annual average, D/Q value, EAB, south, 1.0 km (0.62 mi)	The ESP site characteristic value for this long term relative deposition estimate is defined as the maximum annual average EAB D/Q value for use in determining gaseous pathway doses to the maximally exposed individual. The ESP site characteristic value falls within (is less than) the DCD site parameter value. See Section 11.3 for the site-specific dose analysis inputs and results. The Unit 3 site characteristic value is provided in Table 2.3-16R and falls within (is the same as is lower than) the ESP site characteristic value. * The direction is south and the distance is 1 km (0.62 mi) as shown in ESP-ER Table 2.7-16 and in Table 2.3-16R.
	Nearest Resident Annual Average	4.0×10^{-8} 1/m^2 (at EAB per DCD Table 11.3-8)	**ESP** 7.2×10^{-9} 1/m^2, annual average, nearest resident, north-northeast, 1.5 km (0.96 mi)	The ESP site characteristic value for this long term relative deposition estimate is defined as the maximum annual average resident D/Q value for use in determining gaseous pathway doses to the maximally exposed individual. The ESP site characteristic value falls within (is less than) the DCD site parameter value.
NAPS ESP VAR 2.0-1d			**Unit 3** 1.1×10^{-8} 1/m^2 north-northeast, 1.2 km (0.74 mi)	The Unit 3 site characteristic value for this long term relative deposition estimate is provided in Table 2.3-16R. The Unit 3 site characteristic value falls within (is less than) the DCD site parameter value. See Section 11.3 for the site-specific dose analysis inputs and results. The Unit 3 site characteristic value does not fall within (is greater than) the ESP site characteristic value.

RAI 02.03.04-2 S1 R1

Table 2.3-218. ~~The distances presented in Table 2.3-217 represent NAPS DEP 2.3(1) from the US-APWR DCD source-receptor distances listed in DCD Tables 2.3.4-1 through 2.3.4-7.~~

2.3.5 Long-Term (Routine) Diffusion Estimates

NAPS COL 2.3(3)

Replace the content of DCD Section 2.3.5 with the following.

The information needed to address DCD COL Item 2.3(3) is included in SSAR Section 2.3.5, which is incorporated by reference with the following supplements and variances.

2.3.5.1 Basis

The third through sixth paragraphs of this SSAR section are supplemented as follows with information to address the receptors near the Unit 3 site.

NAPS ESP COL 2.3-3

The following input data and assumptions were used in the XOQDOQ modeling:

- Meteorological Data: Three-year combined (1996–1998) onsite joint frequency distribution of wind speed, wind direction, and atmospheric stability.
- Type of Release: Ground level.
- Wind Sensor Height: 10 m (33 ft).
- Vertical Temperature Difference: 10 m (33 ft) – 48.4 m (158.9 ft).
- Number of Wind Speed Categories: 7.
- Release Height: 10 m (33 ft) (default height).
- Containment portion of the Reactor Building Height: 229.4 ft.
- Minimum Reactor Building Cross-Sectional Area: 3092 m^2 (33,282 ft^2).
- Distances from the release point to the nearest residence, nearest site boundary, milk cow, vegetable garden, milk goat, meat animal: See Table 2.3-15R.

For the dispersion analysis, the Containment portion of the Reactor Building, which has a height of 229.4 ft, is used to determine the minimum building cross-sectional area for evaluating building downwash effects. Conservatively, only the Containment was considered in the calculation of the effective height and cross-sectional area inputs to the

RAI 11.02-7

(no decay, undepleted) at the EAB is ~~3.70~~ 3.0 × 10^{-6} sec/m^3; at a distance of 1.42 km (0.88 mile) to the ESE of the plant facility boundary (Figure 2.0-205).

NAPS ESP VAR 2.0-1a to 2.0-1l

The results are summarized in Table 2.3-16R and Table 2.3-17R. These tables present the maximum calculated χ/Qs and D/Qs at receptors and at various distances from the site.

Add the following at the end of this SSAR section to address annual average χ/Q and D/Q estimates.

Long-term (annual average) χ/Q and D/Q estimates generated by the XOQDOQ model are also presented for each directional sector at twenty-two specific distances, as well as for ten distance segments. Table 2.3-208 presents the no decay and undepleted χ/Q estimates at various downwind distances between 0.4 km (0.25 mi) and 80.5 km (50 mi). Table 2.3-209 presents the no decay and undepleted χ/Q estimates for various distance segments out to 80.5 km (50 mi).

Table 2.3-210 presents the 2.26 day decay (for short-lived noble gases) and undepleted χ/Q estimates at the same downwind distances. Table 2.3-211 presents the 2.26 day decay and undepleted χ/Q estimates for the same distance segments.

Table 2.3-212 presents the 8 day decay (for all iodines released to the atmosphere) and depleted χ/Q estimates at the same downwind distances. Table 2.3-213 presents the 8 day decay and depleted χ/Q estimates for the same distance segments.

Table 2.3-214 presents the D/Q estimates for the same downwind distances. Table 2.3-215 presents the D/Q estimates for the same distance segments.

2.3.6 Combined License Information

NAPS COL 2.3(1)

2.3(1) Site Meteorology

This COL item is addressed in Subsections 2.3.1, 2.3.2, and 2.3.3, and associated tables.

NAPS COL 2.3(2)

2.3(2) Short term atmospheric transport and diffusion

This COL item is addressed in Subsection 2.3.4 and associated tables.

NAPS ESP COL 2.3-3
NAPS ESP VAR 2.0-1a to 2.0-1l

Table 2.3-16R XOQDOQ Predicted Maximum χ/Q and D/Q Values at Specific Points of Interest

Type of Location	Direction from Site	Distance (miles)	χ/Q (No Decay, Undepleted)	χ/Q (2.26 Day Decay, Undepleted)	χ/Q (8 Day Decay, Depleted)	D/Q
Residence	ESE	0.74	~~4.20E-06~~ 3.9E-06	~~4.10E-06~~ 3.9E-06	~~3.70E-06~~ 3.5E-06	1.1E-08[b]
EAB~~[c]~~	ESE	0.88	~~3.7E-06~~ 3.0E-06	~~3.7E-06~~ 3.0E-06	~~3.3E-06~~ 2.6E-06	~~1.2E-08[a]~~ 1.1E-08[a]
Meat Animal	ESE	0.74	~~4.20E-06~~ 3.9E-06	~~4.10E-06~~ 3.9E-06	~~3.70E-06~~ 3.5E-06	1.1E-08[b]
Veg. Garden	ESE	0.74	~~4.20E-06~~ 3.9E-06	~~4.10E-06~~ 3.9E-06	~~3.70E-06~~ 3.5E-06	1.1E-08[b]

Notes:

χ/Q – sec/m^3

D/Q – 1/m^2

a: direction South and distance of 0.62 mi for maximum D/Q for EAB

b: direction North-Northeast for maximum D/Q for residence, meat animal, and vegetable garden

~~c: from SSAR Table 2.3-16~~

ODCM and supporting procedures ensure appropriate actions to prevent an unmonitored release.

Any leakage from the bypass valve is collected in the floor drain sump, and is forwarded to the waste holdup tank for re-processing. It should be noted that the discharge control valves are downstream of the discharge isolation valves (AOV-522A and AOV-522B). During normal operations, the discharge is anticipated to occur once a week for approximately three hours for treated effluent, and one discharge (approximately one hour at 20 gpm) of detergent waste (filtered personnel showers and hand washes) daily. After each discharge, the line is flushed with demineralized water for decontamination.

RAI 11.05-6

The bypass valve is normally locked-closed and tagged. It requires an administrative approval key to open and the valve position is verified by at least two technically qualified members of the Operations staff before discharge can start. Thus, a single operator error does not result in an unmonitored release. In the unlikely event that the valve is inadvertently left open, or partially open, the flow element detects flow and initiates an alarm for operator action. ~~Also, at least a portion of the flow goes through the radiation monitor.~~ Also, a portion of the flow continues to flow through the radiation monitor sample chamber. Because the monitor output depends on radionuclide concentration and not flow rate, there is no impact on radiation monitor sensitivity from reduced flow conditions. Prior to opening VLV-531 to establish the alternate flow path, the tanks (ATK-006A and ATK-006B) will be sampled and water volume verified by level indicator to confirm that the contents meet the discharge specifications. Therefore, there is no impact on the annual liquid release and the annual dose to the members of the public if the bypass valve is inadvertently left fully-open. If the monitor reaches the high setpoint, it sends signals to initiate pump shutdown, valve closure and operator actions.

11.2.3.1 Radioactive Effluent Releases and Dose Calculation in Normal Operation

Replace the last six paragraphs in DCD Subsection 11.2.3.1 with the following.

NAPS COL 11.2(2)
NAPS COL 11.2(4)
RAI 11.02-4 **NAPS ESP COL 11.1-1**
RAI 11.03-4 **NAPS DEP 9.2(1)**

The annual average release of radionuclides is estimated by the PWR-GALE Code (Ref. 11.2-13) with the reactor coolant activities that are described in Section 11.1. The version of the code is a proprietary

modified version of the NRC PWR-GALE code reflecting the design specifics of US-APWR design (Ref. 11.2-27). The parameters used by the PWR-GALE Code are provided in Table 11.2-9R, and the calculated effluents for expected releases are provided in Table 11.2-10R. The calculated effluents for maximum releases are provided in Table 11.2-11R. ~~In these tables,~~ The inputs and results provided in these tables reflect the boric acid evaporator departure. ~~the~~ The detergent waste effluent is not considered because handling of contaminated laundry is contracted to off-site services.

RAI 11.03-4

As with Units 1 and 2, the effluents from Unit 3 are released into the discharge canal, providing a minimum dilution factor of 1000. The discharge canal feeds into the Waste Heat Treatment Facility and the North Anna Reservoir, the two bodies of water comprising Lake Anna, providing further dilution. However, no credit is taken for dilution downstream of the discharge canal.

The calculated effluent concentrations in the discharge canal from Units 1, 2, and 3 are compared to the concentration limits of 10 CFR 20, Appendix B (Ref. 11.2-8) in Tables 11.2-12R and 11.2-13R for expected and maximum releases, respectively.

The calculation uses the discharge canal flow of 100,000 gpm as dilution water. Considering the contributions from Unit 3 as well as existing Units 1 and 2, the sum of the fractions of the ratios to the concentration limits of 10 CFR 20 Appendix B are ~~2.3E-01~~ 2.1E-02 (with expected releases) and 3.1E-01 (with maximum defined fuel defects). These values are less than the allowable value of 1.0.

RAI 11.03-4

The individual doses are evaluated with the LADTAP II Code (Ref. 11.2-14). The parameters used in the LADTAP II Code are listed in Table 11.2-14R. Based on these parameters, the maximum total body dose is 5.9E-01 mrem/yr (child) and the maximum organ dose is 7.4E-01 mrem/yr (child's liver), as shown in Table 11.2-15R. These values are less than the criteria of 3 and 10 mrem/yr, respectively, as specified in 10 CFR 50 Appendix I (Ref. 11.2-2).

Table 11.2-201 compares the liquid effluent doses to those calculated in the ESPA. The total Unit 3 doses from all liquid effluent pathways remain within the ESP values. Table 11.3-202 compares the total site doses from all sources to the limits in 40 CFR 190 (Ref. 11.2-20). Since 40 CFR 190 is more restrictive than 10 CFR 20.1302 (Ref. 11.2-19), compliance with

NAPS COL 11.2(4)
NAPS DEP 9.2(1)
NAPS ESP COL 11.1-1

RAI 11.02-5
RAI 11.03-4

Table 11.2-12R Comparison of Annual Average Liquid Release Concentrations with 10 CFR 20 (Expected Releases) (Sheet 1 of 2)

Isotope(1)	Discharge Concentration (μCi/ml)(2)(4) Unit 3(7)	Units 1 & 2	Total	Effluent Concentration Limit (μCi/ml)(3)(5)	Fraction of Concentration Limit(6)
Na-24	3.62E-11	—	3.6E-11	5.0E-05	7.2E-07
~~P-32~~			~~8.77E-12~~	~~9.00E-06~~	~~9.74E-07~~
Cr-51	4.59E-12	~~2.3E-11~~ 5.9E-12	~~2.8E-11~~ 1.0E-11	5.0E-04	~~5.5E-08~~ 2.1E-08
Mn-54	3.21E-12	~~3.9E-11~~ 3.1E-12	~~4.2E-11~~ 6.3E-12	3.0E-05	~~1.4E-06~~ 2.1E-07
Fe-55	3.02E-12	— 1.6E-11	~~3.0E-12~~ 1.9E-11	1.0E-04	~~3.0E-08~~ 1.9E-07
Fe-59	5.19E-13	~~2.6E-11~~ 4.4E-12	~~2.7E-11~~ 4.9E-12	1.0E-05	~~2.7E-06~~ 4.9E-07
Co-58	7.48E-12	~~7.4E-10~~ 6.8E-11	~~7.5E-10~~ 7.5E-11	2.0E-05	~~3.7E-05~~ 3.8E-06
Co-60	—	~~6.0E-11~~ 2.3E-11	~~6.0E-11~~ 2.3E-11	3.0E-06	~~2.0E-05~~ 7.7E-06
Zn-65	9.93E-13	—	9.9E-13	5.0E-06	2.0E-07
W-187	2.41E-12	—	2.4E-12	3.0E-05	8.0E-08
Np-239	2.71E-12	— 3.0E-12	~~2.7E-12~~ 5.7E-12	2.0E-05	~~1.4E-07~~ 2.9E-07
Br-83	—	2.7E-12	2.7E-12	9.0E-04	3.0E-09
Br-84	7.53E-14	— 4.0E-13	~~7.5E-14~~ 4.8E-13	4.0E-04	~~1.9E-10~~ 1.2E-09
Rb-86	—	3.3E-13	3.3E-13	7.0E-06	4.7E-08
Rb-88	2.51E-10	— 2.3E-11	~~2.5E-10~~ 2.7E-10	4.0E-04	~~6.3E-07~~ 6.9E-07
Sr-89	2.09E-13	~~1.1E-10~~ 1.5E-12	~~1.1E-10~~ 1.7E-12	8.0E-06	~~1.4E-05~~ 2.1E-07
Sr-90	6.02E-14	~~1.2E-11~~ 1.0E-13	~~1.2E-11~~ 1.6E-13	5.0E-07	~~2.4E-05~~ 3.2E-07
Y-90	—	~~1.3E-11~~ 7.9E-14	~~1.3E-11~~ 7.9E-14	7.0E-06	~~1.9E-06~~ 1.1E-08

NAPS COL 11.2(4)
NAPS DEP 9.2(1)
NAPS ESP COL 11.1-1

RAI 11.02-5
RAI 11.03-4

Table 11.2-12R Comparison of Annual Average Liquid Release Concentrations with 10 CFR 20 (Expected Releases) (Sheet 1 of 2) ***(continued)***

Isotope(1)	Discharge Concentration (μCi/ml)(2)(4) Unit 3(7)	Units 1 & 2	Total	Effluent Concentration Limit (μCi/ml)(3)(5)	Fraction of Concentration Limit(6)
Sr-91	5.52E-13	~~1.9E-11~~ 7.7E-13	~~2.0E-11~~ 1.3E-12	2.0E-05	~~9.8E-07~~ 6.6E-08
Y-91m	3.62E-13	— 2.5E-13	~~3.6E-13~~ 6.1E-13	2.0E-03	~~1.8E-10~~ 3.1E-10
Y-91	4.21E-14	~~1.3E-10~~ 2.9E-13	1.3E-10 3.3E-13	8.0E-06	~~1.6E-05~~ 4.2E-08
Y-93	2.51E-12	— 4.0E-14	~~2.5E-12~~ 2.6E-12	2.0E-05	1.3E-07
Zr-95	5.31E-13	~~2.1E-11~~ 5.7E-13	~~2.2E-11~~ 1.1E-12	2.0E-05	~~1.1E-06~~ 5.5E-08
Nb-95	5.14E-13	~~2.2E-11~~ 6.8E-13	~~2.3E-11~~ 1.2E-12	3.0E-05	~~7.5E-07~~ 4.0E-08
Mo-99	8.24E-12	~~9.9E-08~~ 2.1E-10	~~9.9E-08~~ 2.2E-10	2.0E-05	~~5.0E-03~~ 1.1E-05
Tc-99m	8.03E-12	~~8.5E-08~~ 1.1E-10	~~8.5E-08~~ 1.2E-10	1.0E-03	~~8.5E-05~~ 1.2E-07
Ru-103	1.14E-11	— 1.6E-13	~~1.1E-11~~ 1.2E-11	3.0E-05	~~3.8E-07~~ 3.9E-07
Rh-103m	1.15E-11	— 8.8E-14	1.2E-11	6.0E-03	1.9E-09
Ru-106	1.79E-10	— 8.1E-13	1.8E-10	3.0E-06	6.0E-05
Ag-110m	2.50E-12	—	2.5E-12	6.0E-06	4.2E-07
Te-125m	—	7.9E-14	7.9E-14	2.0E-05	4.0E-09
Te-127m	—	9.7E-13	9.7E-13	9.0E-06	1.1E-07
Te-127	—	1.6E-12	1.6E-12	1.0E-04	1.6E-08
Te-129m	2.92E-13	— 4.1E-12	~~2.9E-13~~ 4.4E-12	7.0E-06	~~4.2E-08~~ 6.3E-07
Te-129	2.46E-12	— 1.9E-12	~~2.5E-12~~ 4.4E-12	4.0E-04	~~6.2E-09~~ 1.1E-08
Te-131m	1.56E-12	— 4.8E-12	~~1.6E-12~~ 6.4E-12	8.0E-06	~~1.9E-07~~ 7.9E-07

NAPS COL 11.2(4)
NAPS DEP 9.2(1)
NAPS ESP COL 11.1-1

RAI 11.02-5
RAI 11.03-4

Table 11.2-12R Comparison of Annual Average Liquid Release Concentrations with 10 CFR 20 (Expected Releases) (Sheet 1 of 2) *(continued)*

Isotope[1]	Discharge Concentration (μCi/ml)[2][4] Unit 3[7]	Units 1 & 2	Total	Effluent Concentration Limit (μCi/ml)[3][5]	Fraction of Concentration Limit[6]
Te-131	5.52E-13	— 4.8E-13	~~5.5E-13~~ 1.0E-12	8.0E-05	~~6.9E-09~~ 1.3E-08
I-131	5.03E-13	~~5.6E-08~~ 1.3E-09	~~5.6E-08~~ 1.3E-09	1.0E-06	~~5.6E-02~~ 1.3E-03
Te-132	2.21E-12	~~4.8E-09~~ 5.2E-11	~~4.8E-09~~ 5.4E-11	9.0E-06	~~5.3E-04~~ 6.0E-06
I-132	1.81E-12	~~8.5E-09~~ 1.6E-10	~~8.5E-09~~ 1.6E-10	1.0E-04	~~8.5E-05~~ 1.6E-06
I-133	3.67E-12	~~6.2E-08~~ 1.4E-09	~~6.2E-08~~ 1.4E-09	7.0E-06	~~8.9E-03~~ 2.0E-04

Notes:

1. Br-85, Rh-106, Ag-110, Ba-137m are not included in Table 2 of 10 CFR 20 Appendix B. Therefore, these nuclides are excluded from the calculation of the discharge concentration.
2. ~~Annual average discharge concentration based on release of average daily discharge for 292 days per year with 12,9000 gpm dilution flow. (See Section 10.4.5).~~ Unit 3 annual average discharge concentration based on release of average daily discharge for 292 days per year with 100,000 gpm dilution flow. Concentrations for Units 1 & 2 are obtained from NAPS UFSAR (Reference 11.2-201), Table ~~11.2-14~~ 11.2-17.
3. 10 CFR 20 Appendix B, Table 2.
4. DCD Discharge Concentration column has been replaced with 3 site-specific columns (Unit 3, Units 1 & 2, and Total).
5. DCD values for Effluent Concentration Limit column have been replaced with values showing only one decimal place.
6. DCD values for Fraction of Concentration Limit column have been replaced with site-specific values and revised to one decimal place.
7. The basis of the PWR-GALE source term calculation uses a built-in capacity factor of 80%, which is less than the expected capacity factor for the US-APWR. This difference in capacity factor has no impact on liquid effluent release concentrations.

RAI 11.02-5

NAPS COL 11.2(4)
NAPS DEP 9.2(1)
NAPS ESP COL 11.1-1

RAI 11.02-5
RAI 11.03-4

Table 11.2-12R Comparison of Annual Average Liquid Release Concentrations with 10 CFR 20 (Expected Releases) (Sheet 2 of 2)

Isotope[1]	Discharge Concentration (μCi/ml)[2][4] Unit 3[7]	Units 1 & 2	Total	Effluent Concentration Limit (μCi/ml)[3][5]	Fraction of Concentration Limit[6]
I-134	7.53E-13	~~1.2E-09~~ 2.9E-11	~~1.2E-09~~ 3.0E-11	4.0E-04	~~3.0E-06~~ 7.4E-08
Cs-134	1.46E-11	~~1.8E-02~~ 2.9E-10	~~1.8E-08~~ 3.0E-10	9.0E-07	~~2.0E-02~~ 3.4E-04
I-135	4.22E-12	~~3.6E-09~~ 4.8E-10	~~3.6E-09~~ 4.8E-10	3.0E-05	~~1.2E-04~~ 1.6E-05
Cs-136	1.34E-10	~~2.6E-09~~ 4.6E-11	~~2.7E-09~~ 1.8E-10	6.0E-06	~~4.6E-04~~ 3.0E-05
Cs-137	1.72E-11	~~1.2E-07~~ 2.8E-10	~~1.2E-07~~ 3.0E-10	1.0E-06	~~1.2E-01~~ 3.0E-04
Ba-140	1.91E-11	~~9.2E-11~~ 6.1E-13	~~1.1E-10~~ 2.0E-11	8.0E-06	~~1.4E-05~~ 2.5E-06
La-140	3.47E-11	~~4.8E-11~~ 3.8E-11	~~8.3E-11~~ 3.5E-11	9.0E-06	~~9.2E-06~~ 3.9E-06
Ce-141	2.56E-13	— 2.9E-13	~~2.6E-13~~ 5.5E-13	3.0E-05	~~8.5E-09~~ 1.8E-08

Notes:

1. Br-85, Rh-106, Ag-110, Ba-137m are not included in Table 2 of 10 CFR 20 Appendix B. Therefore, these nuclides are excluded from the calculation of the discharge concentration.
2. ~~Annual average discharge concentration based on release of average daily discharge for 292 days per year with 12,9000 gpm dilution flow. (See Section 10.4.5).~~ Unit 3 annual average discharge concentration based on release of average daily discharge for 292 days per year with 100,000 gpm dilution flow. Concentrations for Units 1 & 2 are obtained from NAPS UFSAR (Reference 11.2-201), Table ~~11.2-14~~ 11.2-17.
3. 10 CFR 20 Appendix B, Table 2.
4. DCD Discharge Concentration column has been replaced with 3 site-specific columns (Unit 3, Units 1 & 2, and Total).
5. DCD values for Effluent Concentration Limit column have been replaced with values showing only one decimal place.
6. DCD values for Fraction of Concentration Limit column have been replaced with site-specific values and revised to one decimal place.
7. The basis of the PWR-GALE source term calculation uses a built-in capacity factor of 80%, which is less than the expected capacity factor for the US-APWR. This difference in capacity factor has no impact on liquid effluent release concentrations.

RAI 11.02-5

NAPS COL 11.2(4)
NAPS DEP 9.2(1)
NAPS ESP COL 11.1-1

RAI 11.02-5
RAI 11.03-4

Table 11.2-12R Comparison of Annual Average Liquid Release Concentrations with 10 CFR 20 (Expected Releases) (Sheet 2 of 2) *(continued)*

Isotope[1]	Discharge Concentration (μCi/ml)[2][4] Unit 3[7]	Units 1 & 2	Total	Effluent Concentration Limit (μCi/ml)[3][5]	Fraction of Concentration Limit[6]
Ce-143	3.01E-12	— 4.8E-14	~~3.0E-12~~ 3.1E-12	2.0E-05	1.5E-07
Pr-143	1.82E-13	— 1.2E-13	~~1.8E-13~~ 3.0E-13	2.0E-05	~~9.1E-09~~ 1.5E-08
Ce-144	7.62E-12	~~1.8E-11~~ 1.7E-12	~~2.6E-11~~ 9.3E-12	3.0E-06	~~8.5E-06~~ 3.1E-06
Pr-144	6.03E-12	— 1.6E-12	~~6.0E-12~~ 7.6E-12	6.0E-04	~~1.0E-08~~ 1.3E-08
H-3	1.35E-05	5.5E-06	1.9E-05	1.0E-03	1.9E-02
TOTAL	1.35E-05	~~6.0E-06~~ 5.5E-06	1.9E-05		~~2.3E-01~~ 2.1E-02

Notes:

1. Br-85, Rh-106, Ag-110, Ba-137m are not included in Table 2 of 10 CFR 20 Appendix B. Therefore, these nuclides are excluded from the calculation of the discharge concentration.
2. ~~Annual average discharge concentration based on release of average daily discharge for 292 days per year with 12,9000 gpm dilution flow. (See Section 10.4.5).~~ Unit 3 annual average discharge concentration based on release of average daily discharge for 292 days per year with 100,000 gpm dilution flow. Concentrations for Units 1 & 2 are obtained from NAPS UFSAR (Reference 11.2-201), Table ~~11.2-14~~ 11.2-17.
3. 10 CFR 20 Appendix B, Table 2.
4. DCD Discharge Concentration column has been replaced with 3 site-specific columns (Unit 3, Units 1 & 2, and Total).
5. DCD values for Effluent Concentration Limit column have been replaced with values showing only one decimal place.
6. DCD values for Fraction of Concentration Limit column have been replaced with site-specific values and revised to one decimal place.
7. The basis of the PWR-GALE source term calculation uses a built-in capacity factor of 80%, which is less than the expected capacity factor for the US-APWR. This difference in capacity factor has no impact on liquid effluent release concentrations.

RAI 11.02-5

RAI 11.02-7

equivalent annual benefits of ~~$3800 and $4100~~ $5400 and $5800 for reducing total body and thyroid doses, respectively. Because the cost of the least costly gaseous augment exceeds the benefit, no gaseous augments are justified.

11.3.2 System Description

STD COL 11.3(9)

Add the following text at the end of the second paragraph in DCD Subsection 11.3.2.

The piping and instrumentation diagrams (P&IDs) for the gaseous waste management system (GWMS) are provided in Figure 11.3-201 (Sheets 1 through 3).

NAPS COL 11.3(3)

Replace the last sentence in the last paragraph in DCD Subsection 11.3.2 with the following.

The release point of the vent stack is at an elevation of 519' 5" NAVD88 (520'3" NGVD29), which is the same height as the top of the containment. See Subsection 2.3.5 for a description of the release point assumptions for determining atmospheric dispersion factors.

11.3.3.1 Radioactive Effluent Releases and Dose Calculation in Normal Operation

NAPS DEP 9.2(1)

Replace the second sentence of the second paragraph in DCD Subsection 11.3.3.1 with the following.

The main sources of plant radioactive gaseous inputs to the GWMS are the waste gases from the VCT, CVDT, degasifier, and HTs.

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Replace the last three paragraphs in DCD Subsection 11.3.3.1 with the following.

RAI 11.02-7
RAI 11.03-4

The release rates and isotopic compositions are calculated using the PWR-GALE Code, NUREG-0017 (Ref. 11.3-1). The version of the code is a proprietary, modified version of the NRC PWR-GALE code that reflects the design specifics of US-APWR design (Ref. 11.3-28). Other parameters for the PWR-GALE Code calculation are listed in Section 11.1 and Subsection 11.2.3. The results of the PWR-GALE calculation are tabulated in DCD Table 11.3-5. In Tables 11.3-6R and 11.3-7R, the effluent concentrations at the exclusion area boundary (EAB) from Units 1, 2, and 3 are compared to the concentration limits of

RAI 11.02-7
RAI 11.03-4

10 CFR 20. The comparison indicates that the overall expected release is a small fraction (~~4.0%~~ 0.38%) of the concentration limit and the maximum release is 18% of the concentration limit.

RAI 11.02-7

Tables 11.3-6R and 11.3-7R include tritium contribution from an additional pathway. Since Lake Anna serves as the source of makeup water for the Unit 3 cooling tower, it is assumed that the tritium in Lake Anna is released to the environment as gaseous effluent via cooling tower evaporation Tables 11.2-12R and 11.2-13R show that the maximum tritium concentration in Lake Anna from the operation of Units 1, 2, and 3 is 1.9E-5 µCi/ml. Multiplying this concentration by the maximum cooling tower evaporation rate of 16,695 gpm or 3.32E+13 ml/yr yields a release of 630 Ci/yr. Adding this value to the normal US-APWR release of 180 Ci/yr (DCD Table 11.3-5) results in a total tritium release of 810 Ci/yr, as shown in Tables 11.3-6R and 11.3-7R.

The maximum individual doses at the nearest EAB, residence, garden, and meat animal are calculated using the GASPAR II Code (Ref. 11.3-17). The parameters for the GASPAR II Code calculation are tabulated in Table 11.3-8R. The receptor yielding the maximum doses is the nearest residence. Calculated doses are tabulated in Table 11.3-9R. The gamma dose in air is 5.1E-02 mrad/yr and the beta dose in air is 4.0E-01 mrad/yr, which are less than the criteria of 10 mrad/yr and 20 mrad/yr, respectively, in 10 CFR 50, Appendix I. The doses to the total body and skin are 1.3E-01 and 4.2E-01 mrem/yr, less than the 10 CFR 50, Appendix I criteria of 5 and 15 mrem/yr, respectively. The dose due to iodines and particulates is 1.1E+00 mrem/yr to the child's bone, meeting the 10 CFR 50, Appendix I criterion of 15 mrem/yr.

Table 11.3-201 compares the gaseous effluent doses to those calculated in the ESPA. The total Unit 3 doses from all gaseous effluent pathways remain within the ESP values. Table 11.3-202 compares the total site doses from all sources to the limits in 40 CFR 190. Since 40 CFR 190 is more restrictive than 10 CFR 20.1302, compliance with the former also demonstrates compliance with the latter. The population doses are summarized in Table 11.3-203.

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

RAI 11.02-7
RAI 11.03-4

Table 11.3-6R Comparison of Calculated Offsite Airborne Concentrations with 10 CFR 20 (Expected Releases)

	EAB Concentration (μCi/ml)(1)(3)			Effluent Concentration Limit (μCi/ml) (2)(4)	Fraction of Concentration Limit(5)
Isotope	**Unit 3**	**Units 1 & 2**	**Total**		
I-131	4.00E-16	~~2.1E-13~~ 9.0E-15	~~2.1E-13~~ 9.4E-15	2.0E-10	~~1.0E-03~~ 4.7E-05
I-132		~~4.2E-14~~ 1.3E-15	~~4.2E-14~~ 1.3E-15	2.0E-08	~~2.1E-06~~ 6.3E-08
I-133	6.09E-15	~~2.6E-13~~ 8.6E-15	~~2.6E-13~~ 1.5E-14	1.0E-09	~~2.6E-04~~ 1.5E-05
I-134		~~1.5E-14~~ 2.0E-16	~~1.5E-14~~ 2.0E-16	6.0E-08	~~2.5E-07~~ 3.3E-09
I-135		~~1.0E-13~~ 2.5E-15	~~1.0E-13~~ 2.5E-15	6.0E-09	~~1.7E-05~~ 4.2E-07
Kr-85m		~~6.4E-11~~ 2.5E-12	~~6.4E-11~~ 2.5E-12	1.0E-07	~~6.4E-04~~ 2.5E-05
Kr-85	1.33E-10	~~1.1E-09~~ 2.0E-10	~~1.3E-09~~ 3.3E-10	7.0E-07	~~1.8E-03~~ 4.7E-04
Kr-87		~~3.6E-11~~ 1.4E-12	~~3.6E-11~~ 1.4E-12	2.0E-08	~~1.8E-03~~ 6.8E-05
Kr-88		~~1.1E-10~~ 4.4E-12	~~1.1E-10~~ 4.4E-12	9.0E-09	~~1.3E-02~~ 4.9E-04
Xe-131m	2.47E-11	~~1.6E-12~~ 2.0E-13	~~2.6E-11~~ 2.5E-11	2.0E-06	~~1.3E-05~~ 1.2E-05
Xe-133m	1.90E-13	~~9.2E-11~~ 3.7E-12	~~9.2E-11~~ 3.9E-12	6.0E-07	~~1.5E-04~~ 6.4E-06
Xe-133		~~8.4E-09~~ 3.6E-10	~~8.4E-09~~ 3.6E-10	5.0E-07	~~1.7E-02~~ 7.1E-04

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-6R Comparison of Calculated Offsite Airborne Concentrations with 10 CFR 20 (Expected Releases)

Isotope	EAB Concentration (μCi/ml) [1][3] Unit 3	Units 1 & 2	Total	Effluent Concentration Limit (μCi/ml) [2][4]	Fraction of Concentration Limit[5]
Xe-135m	3.81E-13	~~6.3E-12~~ 2.9E-13	~~6.7E-12~~ 6.7E-13	4.0E-08	~~1.7E-04~~ 1.7E-05
Xe-135	1.90E-13	~~1.9E-10~~ 7.3E-12	~~1.9E-10~~ 7.5E-12	7.0E-08	~~2.7E-03~~ 1.1E-04
Xe-137	3.81E-13	—	3.8E-13	1.0E-09	3.8E-04
Xe-138	9.51E-14	~~2.0E-11~~ 7.8E-13	~~2.0E-11~~ 8.8E-13	2.0E-08	~~1.0E-03~~ 4.4E-05
H-3[6][7]	~~1.71E-11~~ 7.71E-11	—	~~1.71E-11~~ 7.71E-11	1.0E-07	~~1.71E-11~~ 7.71E-04
C-14[6]	6.94E-13	—	6.9E-13	3.0E-09	2.3E-04
Ar-41[6]	3.23E-12	—	3.2E-12	1.0E-08	3.2E-04
Cr-51	5.80E-17	—	5.8E-17	3.0E-08	1.9E-09
Mn-54	4.09E-17	—	4.1E-17	1.0E-09	4.1E-08
Co-57	7.80E-19	—	7.8E-19	9.0E-10	8.7E-10
Co-58	2.19E-15	—	2.2E-15	1.0E-09	2.2E-06
Co-60	8.37E-16	—	8.4E-16	5.0E-11	1.7E-05
Fe-59	7.52E-18	—	7.5E-18	5.0E-10	1.5E-08
Sr-89	2.85E-16	—	2.9E-16	2.0E-10	1.4E-06
Sr-90	1.14E-16	—	1.1E-16	6.0E-12	1.9E-05
Zr-95	9.51E-17	—	9.5E-17	4.0E-10	2.4E-07
Nb-95	2.38E-16	—	2.4E-16	2.0E-09	1.2E-07

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-6R Comparison of Calculated Offsite Airborne Concentrations with 10 CFR 20 (Expected Releases)

Isotope	EAB Concentration (μCi/ml)[(1)(3)] Unit 3	Units 1 & 2	Total	Effluent Concentration Limit (μCi/ml) [(2)(4)]	Fraction of Concentration Limit[(5)]
Ru-103	7.61E-18	—	7.6E-18	9.0E-10	8.5E-09
Ru-106	7.42E-18	—	7.4E-18	2.0E-11	3.7E-07
Sb-125	5.80E-18	—	5.8E-18	7.0E-10	8.3E-09
Cs-134	2.19E-16	—	2.2E-16	2.0E-10	1.1E-06
Cs-136	8.09E-18	—	8.1E-18	9.0E-10	9.0E-09
Cs-137	3.42E-16	—	3.4E-16	2.0E-10	1.7E-06
Ba-137m	3.42E-16	—	3.4E-16	1.0E-09	3.4E-07
Ba-140	4.00E-17	—	4.0E-17	2.0E-09	2.0E-08
Ce-141	4.00E-18	—	4.0E-18	8.0E-10	5.0E-09
Total	~~1.80E-10~~ 2.4E-10	~~1.0E-08~~ 5.8E-10	~~1.0E-08~~ 8.2E-10		~~4.0E-02~~ 3.8E-03

Notes:

1. ~~X/Q=1.6E-05 s/m³ (See Section 2.3.5) is used in this calculation.~~ Based on undecayed and undepleted EAB χ/Q of 3.0E-06 sec/m³ (Table 2.3-16R) for Unit 3. For Units 1 and 2, the releases are from NAPS UFSAR (Reference 11.2-201), Table 11.3-3, and the χ/Q is 3.3E-06 sec/m³ (Reference 11.2-201, Section 2.3.5.1).
2. 10 CFR 20 Appendix B, Table 2.
3. DCD Discharge Concentration column has been replaced with 3 columns for EAB Concentration (Unit 3, Units 1 & 2, and Total).
4. DCD values for Effluent Concentration Limit column have been replaced with values showing only one decimal place.
5. DCD values for Fraction of Concentration Limit column have been revised to one decimal place.
6. Entries have been revised to appear in a different position in the Isotope column than the DCD entries and associated values have been replaced.
7. Unit 3 concentration for H-3 includes the contribution from the Unit 3 cooling tower evaporation pathway.

RAI 11.02-7
RAI 11.03-4

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-7R Comparison of Calculated Offsite Airborne Concentrations with 10 CFR 20 (Maximum Releases)

Isotope	EAB Concentration (μCi/ml)[(1)(3)] Unit 3	EAB Concentration Units 1 & 2	EAB Concentration Total	Effluent Concentration Limit (μCi/ml) [(2)(4)]	Fraction of Concentration Limit[(5)]
I-131	5.80E-13	~~2.1E-13~~ 2.3E-13	~~7.0E-13~~ 8.1E-13	2.0E-10	~~3.9E-03~~ 4.1E-03
I-132	—	~~4.2E-14~~ 4.6E-14	~~4.2E-14~~ 4.6E-14	2.0E-08	~~2.1E-06~~ 2.3E-06
I-133	9.89E-13	~~2.6E-13~~ 2.8E-13	~~1.2E-12~~ 1.3E-12	1.0E-09	~~1.2E-03~~ 1.3E-03
I-134	—	~~1.5E-14~~ 1.7E-14	~~1.5E-14~~ 1.7E-14	6.0E-08	~~2.5E-07~~ 2.8E-07
I-135	—	~~1.0E-13~~ 1.2E-13	~~1.0E-13~~ 1.2E-13	6.0E-09	~~1.7E-05~~ 1.9E-05
Kr-85m	—	~~6.4E-11~~ 7.0E-11	~~6.4E-11~~ 7.0E-11	1.0E-07	~~6.4E-04~~ 7.0E-04
Kr-85	4.36E-08	~~1.1E-09~~ 1.3E-09	4.5E-08	7.0E-07	6.4E-02
Kr-87	—	~~3.6E-11~~ 4.0E-11	~~3.6E-11~~ 4.0E-11	2.0E-08	~~1.8E-03~~ 2.0E-03
Kr-88	—	~~1.1E-10~~ 1.3E-10	~~1.1E-10~~ 1.3E-10	9.0E-09	~~1.3E-02~~ 1.4E-02
Xe-131m	1.51E-10	~~1.6E-12~~ 1.8E-12	1.5E-10	2.0E-06	~~7.6E-05~~ 7.7E-05
Xe-133m	1.08E-11	~~9.2E-11~~ 1.0E-10	~~1.0E-10~~ 1.1E-10	6.0E-07	~~1.7E-04~~ 1.9E-04
Xe-133	—	~~8.4E-09~~ 9.2E-09	~~8.4E-09~~ 9.2E-09	5.0E-07	~~1.7E-02~~ 1.8E-02

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-7R Comparison of Calculated Offsite Airborne Concentrations with 10 CFR 20 (Maximum Releases)

Isotope	EAB Concentration (μCi/ml)(1)(3) Unit 3	Units 1 & 2	Total	Effluent Concentration Limit (μCi/ml)(2)(4)	Fraction of Concentration Limit(5)
Xe-135m	2.04E-12	~~6.3E-12~~ 6.9E-12	~~8.3E-12~~ 8.9E-12	4.0E-08	~~2.1E-04~~ 2.2E-04
Xe-135	2.66E-11	~~1.9E-10~~ 2.1E-10	~~2.2E-10~~ 2.4E-10	7.0E-08	~~3.1E-03~~ 3.4E-03
Xe-137	1.92E-12	—	1.9E-12	1.0E-09	1.9E-03
Xe-138	9.45E-13	~~2.0E-11~~ 2.2E-11	~~2.1E-11~~ 2.3E-11	2.0E-08	~~1.0E-03~~ 1.1E-03
H-3(6)(7)	~~1.71E-11~~ 7.71E-11	—	~~1.71E-11~~ 7.71E-11	1.0E-07	~~1.7E-04~~ 7.7E-04
C-14(6)	6.94E-13	—	6.9E-13	3.0E-09	2.3E-04
Ar-41(6)	3.23E-12	—	3.2E-12	1.0E-08	3.2E-04
Cr-51	5.80E-17	—	5.8E-17	3.0E-08	1.9E-09
Mn-54	4.09E-17	—	4.1E-17	1.0E-09	4.1E-08
Co-57	7.80E-19	—	7.8E-19	9.0E-10	8.7E-10
Co-58	2.19E-15	—	2.2E-15	1.0E-09	2.2E-06
Co-60	8.37E-16	—	8.4E-16	5.0E-11	1.7E-05
Fe-59	7.52E-18	—	7.5E-18	5.0E-10	1.5E-08
Sr-89	7.23E-15	—	7.2E-15	2.0E-10	3.6E-05
Sr-90	2.11E-15	—	2.1E-15	6.0E-12	3.5E-04
Zr-95	1.68E-16	—	1.7E-16	4.0E-10	4.2E-07
Nb-95	5.69E-16	—	5.7E-16	2.0E-09	2.8E-07

NAPS COL 11.3(6)
NAPS ESP COL 11.1-1

Table 11.3-7R Comparison of Calculated Offsite Airborne Concentrations with 10 CFR 20 (Maximum Releases)

Isotope	EAB Concentration (μCi/ml)[(1)(3)] Unit 3	EAB Concentration (μCi/ml)[(1)(3)] Units 1 & 2	EAB Concentration (μCi/ml)[(1)(3)] Total	Effluent Concentration Limit (μCi/ml)[(2)(4)]	Fraction of Concentration Limit[(5)]
Ru-103	5.74E-19	—	5.7E-19	9.0E-10	6.4E-10
Ru-106	1.64E-20	—	1.6E-20	2.0E-11	8.2E-10
Sb-125	5.80E-18	—	5.8E-18	7.0E-10	8.3E-09
Cs-134	8.03E-12	—	8.0E-12	2.0E-10	4.0E-02
Cs-136	3.25E-15	—	3.3E-15	9.0E-10	3.6E-06
Cs-137	4.92E-12	—	4.9E-12	2.0E-10	2.5E-02
Ba-137m	2.36E-12	—	2.4E-12	1.0E-09	2.4E-03
Ba-140	1.32E-17	—	1.3E-17	2.0E-09	6.6E-09
Ce-141	1.74E-17	—	1.7E-17	8.0E-10	2.2E-08
Total	~~4.38E-08~~ 4.39E-08	~~1.0E-08~~ 1.1E-08	~~5.4E-08~~ 5.5E-08		1.8E-01

Notes:

1. ~~X/Q=1.6E-05 s/m³ (See Section 2.3.5) is used in this calculation.~~ Based on undecayed and undepleted EAB χ/Q of 3.0E-06 sec/m³ (Table 2.3-16R) for Unit 3. For Units 1 and 2, the releases are from NAPS UFSAR (Reference 11.2-201), Table 11.3-2, and the χ/Q is 3.3E-06 sec/m³ (Reference 11.2-201, Section 2.3.5.1).
2. 10 CFR 20 Appendix B, Table 2.
3. DCD Discharge Concentration column has been replaced with 3 columns for EAB Concentration (Unit 3, Units 1 & 2, and Total).
4. DCD values for Effluent Concentration Limit column have been replaced with values showing only one decimal place.
5. DCD values for Fraction of Concentration Limit column have been revised to one decimal place.
6. Entries have been revised to appear in a different position in the Isotope column than the DCD entries and associated values have been replaced.
7. Unit 3 concentration for H-3 includes the contribution from the Unit 3 cooling tower evaporation pathway.