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

Serial No. NA3-08-043
Docket No. 52-017
COL/JPH

DOMINION VIRGINIA POWER
NORTH ANNA UNIT 3 COMBINED LICENSE APPLICATION
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 001

On March 20, 2008, the NRC requested additional information to support the review of certain portions of the North Anna Unit 3 Combined License Application (COLA). The response to the following RAI is provided in Enclosure 1:

- RAI Question 12.02-1, Child Thyroid Doses from Gaseous Effluents

This information will be incorporated into a future submission of the North Anna Unit 3 COLA.

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

Very truly yours,

Eugene S. Grecheck

J079
NRC

Enclosure:

1. Response to RAI Letter Number 001 (RAI Question 12.02-1)

Commitments made by this letter:

1. Incorporate proposed changes in a future COLA submission.

COMMONWEALTH OF VIRGINIA

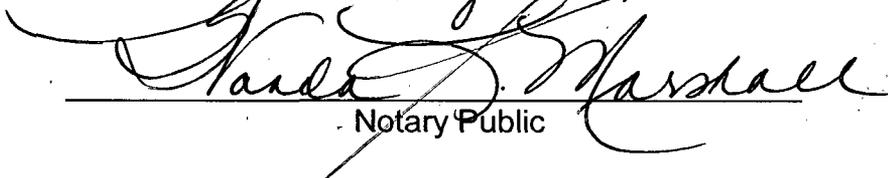
COUNTY OF HENRICO

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.

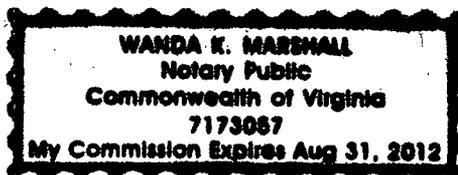
Acknowledged before me this 28th day of April, 2008

My registration number is 7173057 and my

Commission expires: August 31, 2012



Notary Public



cc: U. S. Nuclear Regulatory Commission, Region II
T. A. Kevern, NRC
J. T. Reece, NRC
J. J. Debiec, ODEC
G. A. Zinke, NuStart/Entergy
T. L. Williamson, Entergy
J. C. Kinsey, GEH
K. Ainger, Exelon

ENCLOSURE 1

Response to NRC RAI Letter No. 001

RAI Question Number 12.02-1

NRC RAI 12.02-1

RAI Summary: A review of FSAR Section 12.2.2.2 indicates two different offsite doses from gaseous effluents for the child thyroid. Please review the dose results presented in the FSAR and address this inconsistency. In addition, discuss how the correct dose complies with the requirements of Appendix I to Part 50 for the child thyroid.

Full RAI: Revised DCD Table 12.2-18bR (FSAR, p.12-16) indicates the gaseous effluent (radioiodines) dose to the child-thyroid when summed up over all exposure pathways for the ESE Sector at 1191 m. The total dose from radioiodines in this sector is 16.95 mrem/yr. The total projected dose for Unit 3 is due to the dose from the nearest garden (15 mrem/yr), inhalation at the nearest residence (1.6 mrem/yr), and nearest meat cattle (0.35 mrem/yr). These results are inconsistent with FSAR Table 12.2-201 (p.12-21) which lists a dose of 14 mrem/yr for iodines and particulates for Unit 3, and FSAR Table 12.2-203 (p.12-23) which lists a gaseous dose of 15 mrem/yr for Unit 3. In light of the above, please explain the inconsistency between DCD Table 12.2-18bR and Tables 12.2-201 and 12.2-203. Please provide corrections, if necessary, to resolve the inconsistency. Please explain how the child-thyroid dose, whether or not corrected, complies with the criteria of Section II. C of Appendix I to Part 50. Also note that as described in RAI 12.2-9S02, GEH is about to revise the gaseous effluent source terms in DCD Tier 2, Section 12.2.2.1.

Dominion Response

The RAI requests the following four items:

1. An explanation of the apparent inconsistency between the gaseous effluent (radioiodines) dose to the child-thyroid when summed up over all exposure pathways for the ESE Sector at 1191 m in FSAR Table 12.2-18bR, and the dose of 14 mrem/yr for iodines and particulates for Unit 3 in FSAR Table 12.2-201 and the gaseous dose of 15 mrem/yr for Unit 3 in FSAR 12.2-203.
2. Corrections, if necessary, to resolve the apparent inconsistency.
3. An explanation of how the child-thyroid dose complies with 10 CFR 50, Appendix I, Section II.C.
4. A description of the impact of the revised gaseous effluent source terms in DCD Tier 2, Section 12.2.2.1 in the COLA.

The response is provided in two parts:

- Explanation of COLA Revision 0 Content – This part addresses RAI Item 1 by explaining the apparent inconsistency in the presentation of information in COLA Revision 0. It provides the basis for not summing the gaseous effluent doses at the garden, residence, and meat cow locations in the FSAR, and demonstrates that, given the basis for the FSAR presentation, the information presented in the three FSAR tables is not inconsistent. This part also addresses RAI Item 2 by explaining the basis for the FSAR presentation and concluding that a correction is not needed.
- Proposed COLA Revision: Revised Source Terms and Revised Format – This part addresses RAI Item 3 by describing the proposed changes to the COLA in

response to this RAI. There are two primary changes. First, the gaseous effluent source terms are revised to reflect the anticipated changes in DCD Revision 5, which addresses RAI Item 4. Second, the doses at the garden, residence, and meat cow locations are summed in FSAR Table 12.2-18bR in arriving at the maximally exposed individual (MEI) dose due to gaseous effluent (all isotopes); similarly, the doses at the three receptors due to iodines and particulates are summed in FSAR Table 12.2-201 in arriving at the child-thyroid dose over all exposure pathways in accordance with 10 CFR 50, Appendix I, Section II.C. The analysis still keeps the conservative assumption of all three receptors in the ESE Sector at 1191 m.

Explanation of COLA Revision 0 Content

FSAR Table 12.2-18bR shows the following doses to the thyroid of the child at 1191 m:

<u>Pathway</u>	<u>Dose (mrem/yr)</u>
Vegetable Ingestion	15
Residence Inhalation	1.6
Meat Ingestion	0.35

To facilitate the comparison of the doses in this table to those in Early Site Permit-Environmental Report (ESP-ER) Table 5.4-9, the format of this table is consistent with ESP-ER Table 5.4-9. The doses from all pathways are not added because they were not added in the ESP-ER and because the three receptors (garden, residence, meat cow) are at different physical locations. If the doses had been summed, the child thyroid dose from the three pathways would have been 16.95 mrem/yr, as the RAI indicates. Please note, however, that these child thyroid doses are not due to iodines only. While iodine is the most significant contributor to the dose, C-14 also contributes to the thyroid dose.

Although the nearest residence, the nearest garden, and the nearest meat cow are at different locations, the doses in Table 12.2-18bR are calculated assuming all three receptors have the same atmospheric dispersion factors, those for a point 1191 m ESE of the plant. The distance of 1191 m is the distance to the actual nearest residence and is the shortest distance from the plant to any of the three receptors. The actual distances to the nearest garden and meat cow are 1470 m and 1758 m, respectively.

Because the three receptors are at different locations, the doses at the three receptors are not added, with the primary pathway at each location assumed to be controlling. The garden receptor considers only the vegetable pathway, the residence includes the plume and inhalation pathways, and the meat cow location considers only the meat ingestion pathway. The receptor receiving the maximum dose for a given organ is considered the MEI for that organ. The differences are as follows:

- Table 12.2-18bR presents a thyroid dose of 15 mrem/yr to the MEI (child in the garden) from the vegetable pathway due to all isotopes in gaseous effluent.
- Table 12.2-201 presents a thyroid dose of 14 mrem/yr to the MEI (child in the garden) from the vegetable pathway due to iodines and particulates in gaseous effluent. The difference between this dose and the MEI dose of 15 mrem/yr in Table 12.2-18bR is the contribution of C-14. The contribution of C-14 is

excluded when comparing to the 10 CFR 50, Appendix I, Section II.C dose limit of 15 mrem/yr due to iodines and particulates because C-14 is neither an isotope of iodine nor a particulate.

- Table 12.2-203 is consistent with Table 12.2-18bR in presenting a thyroid dose of 15 mrem/yr to the MEI (child in the garden) from the vegetable pathway due to all isotopes in gaseous effluent.

In light of this approach, the gaseous effluent MEI thyroid doses presented in Tables 12.2-18bR, 12.2-201, and 12.2-203 are not inconsistent and an FSAR correction is not needed to address this part of the RAI.

Proposed COLA Revision: Revised Source Terms and Revised Format

As stated previously, Dominion will revise the COLA to incorporate two changes. One change will revise the gaseous source terms to incorporate the anticipated changes in DCD Revision 5. The other change will sum the contributions from all pathways assuming that all three receptors are at the same nearest location (1191 m ESE of the plant), which will more clearly demonstrate compliance with 10 CFR 50, Appendix I, Section II.C..

As the GEH response to ESBWR DCD RAI 12.2-9 S02 indicates, GEH is revising the ESBWR DCD gaseous effluent source terms. The revised annual gaseous effluent source terms used in this response to FSAR RAI 12.02-1 are based on GEH's responses to RAI 12.2-9 S02 and the subsequent RAI 12.2-9 S03. These were provided in GEH letter MFN 08-222 from James C. Kinsey of GE Hitachi Nuclear Energy to U.S. Nuclear Regulatory Commission, Docket No. 52-010, March 22, 2008.

The attached COLA FSAR Section 12.2 and ER Section 5.4 markups demonstrate that the revised annual gaseous effluent doses meet the regulations of 10 CFR 50, Appendix I, Section II.C while still keeping the conservative assumption of the nearest residence, garden, and meat cow being at a single bounding location.

FSAR Tables 12.2-18bR, 12.2-201, and 12.2-203 will be revised as follows:

- New rows will be added at the end of Table 12.2-18bR, showing a Unit 3 thyroid dose of 11 mrem/yr to the MEI (child at the nearest garden/residence/meat cow location) from the vegetable, residential plume and inhalation, and meat ingestion pathways due to all isotopes in gaseous effluent. Although these summary rows were not provided in the ESP application, the bounding ESP annual dose for each age group and organ is presented, consistent with the MEI approach in the ESP application.
- Table 12.2-201 will be revised to present a thyroid dose of 9.1 mrem/yr to the MEI (child at the nearest garden/residence/meat cow location) from the vegetable, residential inhalation, and meat ingestion pathways due to iodines and particulates in gaseous effluent. This is within the 10 CFR 50, Appendix I, Section II.C limit of 15 mrem/yr.

- Consistent with Table 12.2-18bR, Table 12.2-203 will be revised to present a thyroid dose of 11 mrem/yr to the MEI (child at the nearest garden/residence/meat cow location) from the vegetable, residential plume and inhalation, and meat ingestion pathways due to all isotopes in gaseous effluent.

COLA Impact

FSAR Section 12.2 will be revised as indicated in the attached markup. ER Section 5.4 presents similar information and will also be revised per the attached markup. FSAR Section 1.8 and COLA Part 7, Departures Report, will also be revised as indicated on the attached markups, to reflect the deletion of NAPS ESP Variance 12.2-2.

Additionally, although markups are not provided with this response, FSAR Section 11.3 will also be impacted by the changes in gaseous effluent source terms and estimated annual doses. This section will be updated at a future date in conjunction with other cost-benefit analysis changes in response to the deletion of NEI 07-11.

Markup of North Anna COLA

The attached markup represents Dominion's good faith effort to show how the COLA will be revised in response to the subject RAI in a future COLA revision. However, the same COLA content may be impacted by revisions to the ESBWR 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 revision may be somewhat different than as presented herein.

Table 1.8-201 Departures from the Referenced Certified Design [NAPS SUP 1.8-3]

Number	Subject	FSAR Section
None		

Table 1.8-202 Variances from the SSAR [NAPS SUP 1.8-4]

Number	Subject	FSAR Location
NAPS ESP VAR 2.0-1a-l	Long-Term Dispersion Estimates (χ/Q and D/Q)	Section 2.3.5, Table 2.0-201
NAPS ESP VAR 2.0-2	Hydraulic Conductivity	Section 2.4.12.1.2, Table 2.0-201
NAPS ESP VAR 2.0-3	Hydraulic Gradient	Section 2.4.12.1.2, Table 2.0-201
NAPS ESP VAR 2.0-4	Vibratory Ground Motion	Section 2.5.2.5, Table 2.0-201
NAPS ESP VAR 2.0-5a-h	Distribution Coefficients (K_d)	Table 2.0-201
NAPS ESP VAR 2.4-1	Void Ratio, Porosity, and Seepage Velocity	Section 2.4.12.1.2
NAPS ESP VAR 2.4-2	NAPS Water Supply Well Information	Table 2.4-17R
NAPS ESP VAR 2.5-1	Stability of Slopes	Section 2.5.5
NAPS ESP VAR 12.2-1	Gaseous Pathway Doses	Section 12.2.2.2.6, Table 12.2-18bR
NAPS ESP VAR 12.2-2	Annual Thyroid Dose <u>[Deleted]</u>	Section 12.2, Section 12.2.2.2.6, Table 12.2-201
NAPS ESP VAR 12.2-3	Annual Liquid Effluent Releases	Section 12.2.2.4.6, Table 12.2-19bR

the corresponding concentration limit for the NAPS site from 10 CFR 20, Appendix B, Table 2, Column 1.

12.2.2.2 Airborne Dose Evaluation Offsite

Replace this section with the following.

NAPS COL 12.2-2-A

The bases for the calculation of Unit 3-specific airborne offsite doses are provided in Table 12.2-18aR. The annual gaseous pathway doses are provided in Table 12.2-18bR. The methodology of RG 1.109 was used in determining the annual airborne dose values. The bases include values that are default parameters in RG 1.109 and other values that are Unit 3 site-specific inputs.

The results of the Unit 3 gaseous pathway dose analysis are given in Table 12.2-18bR.

12.2.2.2.1 Compliance with 10 CFR 50, Appendix I, Sections II.B and II.C

Table 12.2-201 demonstrates that offsite doses due to Unit 3 radioactive airborne effluents comply with the regulatory dose limits in 10 CFR 50, Appendix I, Sections II.B and II.C.

NAPS ESP COL 11.1-1

12.2.2.2.2 Compliance with 10 CFR 50, Appendix I, Section II.D

Population dose is determined for the gaseous effluent releases from Unit 3 for both total body dose and thyroid dose. The total body dose is 6 7.7 person-rem/yr as shown in Table 12.2-204. The thyroid dose is ~~39.3~~ 28 person-rem/yr. The cost-benefit analysis performed to consider gaseous radwaste augments to reduce doses due to gaseous effluents is presented in Section 11.3. Based on the results from the cost-benefit analysis, no augments are cost-beneficial. Therefore, Unit 3 complies with 10 CFR 50, Appendix I, Section II.D.

12.2.2.2.3 Compliance with 10 CFR 20 Appendix B, Table 2, Column 1

Table 12.2-17R provides the gaseous effluent concentrations in comparison to the 10 CFR 20, Appendix B, Table 2, Column 1 limits. The Unit 3 gaseous effluent concentrations comply with 10 CFR 20, Appendix B, Table 2, Column 1.

For the milk pathway, no milk animals are within 8 km (5 miles) of Unit 3.

As noted in Section 2.3.5, the distance to the site boundary has been measured using GIS and although it is known to be further than the value used in the ESP-ER, the ESP-ER value is conservatively used in calculating Unit 3 gaseous effluent doses at the site boundary.

The locations of the nearest vegetable garden, residence, and meat cow were updated since the ESP-ER and closer locations than addressed in the ESP-ER were identified. For these pathways, the closest location from all three of the pathways was used for the distance to the MEI for each pathway.

While the total activity in the gaseous radioactive effluents for Unit 3 is much less than that estimated in the ESP-ER, the calculated doses for ~~43~~ some of the pathways shown in Table 12.2-18bR are not lower due to the reductions in the distances to the MEI receptor locations as described above. Values in Table 12.2-18bR in bold print indicate pathways for which the estimated Unit 3 ESBWR dose to the MEI is larger than the corresponding ESP-ER composite release dose to the MEI.

**NAPS ESP
VAR 12.2-1**

Although some pathways in Table 12.2-18bR show slight increases in total body and thyroid doses to the MEI from the changes in MEI locations, ~~Table 12.2-204~~ Table 12.2-18bR summarizes the annual total body, thyroid, and skin doses to the MEI for the garden, residence, and meat cow pathways, and Table 12.2-201 shows that the Unit 3 doses are lower than those calculated and presented in ESP-ER Table 5.4-10.

~~Only the annual thyroid dose to the MEI from iodine and particulates in gaseous effluents calculated using Unit 3 specific release activities is slightly higher than that presented in the ESP-ER, however, it remains within the 10 CFR 50, Appendix I limit.~~

**NAPS ESP
VAR 12.2-2**

12.2.2.4 Liquid Doses Offsite

Replace this section with the following.

NAPS COL 12.2-3-A

Liquid pathway doses were calculated based on the criteria specified in DCD Section 12.2.2.3 for compliance with 10 CFR 50, Appendix I. Dose conversion factors and methodologies consistent with RGs 1.109 and 1.113 were used as described in DCD References 12.2-7 and 12.2-4, respectively.

The liquid effluent pathway offsite dose calculation bases are provided in Table 12.2-20aR. The bases include values that are default parameters in RG 1.109 and other values that are Unit 3 site-specific inputs.

Based on the annual liquid release offsite values in DCD Table 12.2-19b, which are repeated in Table 12.2-19bR, the Unit 3 annual liquid release concentrations were calculated based upon the criteria specified in DCD Section 12.2.2.3 and the Unit 3-specific input values shown in Table 12.2-20aR. Table 12.2-19bR also shows the maximum activity concentration for each nuclide at the end of the discharge canal from the combined operation of Units 1, 2, and 3, and the corresponding concentration limit for the NAPS site from 10 CFR 20, Appendix B, Table 2, Column 2.

The LADTAPII code is used to perform the liquid effluent dose analysis (DCD Reference 12.2-3). The results of the dose calculation are given in Table 12.2-20bR.

12.2.2.4.1 Compliance with 10 CFR 50, Appendix I, Section II.A

Table 12.2-202 demonstrates that offsite doses due to Unit 3 radioactive liquid effluents comply with the regulatory dose limits in 10 CFR 50, Appendix I, Section II.A.

**NAPS ESP
COL 11.1-1**

12.2.2.4.2 Compliance with 10 CFR 50, Appendix I, Section II.D

Population dose is determined for the liquid effluent releases from Unit 3 for both total body dose and thyroid dose. The total body dose is 1.0 person-rem/yr as shown in Table 12.2-204. The thyroid dose is ~~0.685~~ 0.69 person-rem/yr. The cost-benefit analysis performed to consider liquid radwaste augments to reduce doses due to liquid effluents is presented in the reference described in Section 11.2. Based on the above liquid effluent dose estimate values and the threshold value from the cost-benefit analysis, no augments are cost-beneficial. Therefore, Unit 3 complies with 10 CFR 50, Appendix I, Section II.D.

12.2.2.4.3 Compliance with 10 CFR 20 Appendix B, Table 2, Column 2

Compliance with 10 CFR 20, Appendix B, Table 2, Column 2 is demonstrated in Table 12.2-19bR.

12.2.2.4.4 Compliance with 10 CFR 20.1301 and 10.1302

This section demonstrates that offsite doses due to Unit 3, combined with offsite doses due to Units 1 and 2 and the NAPS independent spent fuel

storage installation (ISFSI), comply with the regulatory limits in 10 CFR 20.1301 for doses to members of the public.

Using the Unit 3-specific gaseous effluent release activities identified in Table 12.2-17R, and the Unit 3-specific liquid effluent release activities identified in Table 12.2-19bR, the total annual doses to the MEI and the population resulting from Unit 3 liquid and gaseous effluents are calculated and presented in Tables 12.2-203 and 12.2-204, respectively.

The direct radiation contribution from operation of Unit 3 is negligible. The direct dose contribution from Unit 3 at two distances is provided in DCD Table 12.2-21. The annual dose of $1.66\text{E-}06$ mSv/yr ($1.66\text{E-}04$ mrem/yr) at 1000 m (0.62 mi) is negligible. The distance to the site boundary from Unit 3 is at least 1416 m (0.88 mile) and the increase in distance further reduces the low dose rate.

The total annual doses to the MEI and the population resulting from North Anna Units 1 and 2 liquid and gaseous effluents are provided in Table 12.2-203 and ~~Table 12.2-204~~, respectively. The values shown are representative based on review of Units 1 and 2 annual radiological environmental operating reports (e.g., Reference 12.2-203).

The direct radiation contribution from operation of Units 1 and 2 is negligible. An evaluation of operating plants by the NRC states that:

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

The NRC concludes that the direct radiation from normal operation results in “small contributions at site boundaries” (Reference 12.2-204, Section 4.6.1.2).

The direct radiation contribution at the site boundary from operation of the NAPS ISFSI is small. The annual contribution at the site boundary from the ISFSI is no more than $1.7\text{E-}02$ mSv/yr (1.7 mrem/yr).

Table 12.2-203 shows that the total NAPS site doses resulting from the normal operation of Units 1, 2, and 3 are well within the regulatory limits of 40 CFR 190.

Table 12.2-204 shows the total body doses from liquid and gaseous effluents doses attributable to Unit 3 for the population within 50 miles of the NAPS site.

**Table 12.2-15R Airborne Sources Calculation [NAPS COL 12.2.2-A]
 [NAPS ESP COL 11.1-1]**

Calculation Bases	
<u>Methodology</u>	<u>Appendix 12B</u>
Noble Gas Source at t=30 min	740 MBq/sec (20,000 µCi/sec)
I ¹³¹ Release Rate	3.7 MBq/sec (100 µCi/sec)
NAPS COL 12.2-2-A Meteorology χ/Q	See Table 2.3-16R
NAPS COL 12.2-2-A Meteorology D/Q	See Table 2.3-16R
NAPS COL 12.2-2-A Meteorology Boundary	See Table 2.3-16R
Plant Availability Factor	0.92
Offgas System	
Offgas stream temperature	100°F
Flow rate	54 m ³ /hr
K _d (Kr)	49 <u>18.5</u> cm ³ /g
K _d (Xe)	330 cm ³ /g
K _d (Ar)	6.4 cm ³ /g
Guard tank charcoal mass	7,500 kg (single tank)
Adsorber tank charcoal mass	27,750 kg (each)
Adsorber tank arrangement	2 parallel trains of 4 tanks each
Turbine Gland Sealing System Exhaust	
I-131 release	0.81 Ci/yr per µCi/g of I-131 in coolant
I-134 I-133 release	0.22 Ci/yr per µCi/g of I-134 I-133 in coolant

Table 12.2-17R Comparison of Airborne Release Concentrations with 10 CFR 20 Limit [NAPS COL 12.2.2-A] [NAPS ESP COL 11.1-1]

Nuclide	Unit 3 Annual Release		Unit 3 Concentration		Units 1, 2 & 3 Concentration	10 CFR 20 Concentration Limit
	MBq/yr	Ci/yr	Bq/m ³	μCi/ml	μCi/ml	μCi/ml
Kr-83m	<u>8.5E+01</u>	<u>2.3E-03</u>	<u>1.0E-05</u>	<u>2.7E-16</u>	<u>2.7E-16</u>	5.0E-05
Kr-85m	<u>6.6E+05</u>	<u>1.8E+01</u>	<u>7.7E-02</u>	<u>2.1E-12</u>	<u>7.2E-11</u>	1.0E-07
Kr-85	<u>5.2E+06</u>	<u>1.4E+02</u>	<u>6.1E-01</u>	<u>1.6E-11</u>	<u>1.3E-09</u>	7.0E-07
Kr-87	<u>1.4E+06</u>	<u>3.8E+01</u>	<u>1.6E-01</u>	<u>4.4E-12</u>	<u>4.4E-11</u>	2.0E-08
Kr-88	<u>2.1E+06</u>	<u>5.7E+01</u>	<u>2.5E-01</u>	<u>6.7E-12</u>	<u>1.3E-10</u>	9.0E-09
Kr-89	<u>1.4E+07</u>	<u>3.8E+02</u>	<u>1.6E+00</u>	<u>4.4E-11</u>	<u>4.4E-11</u>	1.0E-09
Kr-90	<u>1.25E+01</u>	<u>3.4E-04</u>	<u>1.5E-06</u>	<u>4.0E-17</u>	<u>4.0E-17</u>	1.0E-09
Xe-131m	<u>1.5E+05</u>	<u>4.1E+00</u>	<u>1.8E-02</u>	<u>4.8E-13</u>	<u>2.3E-12</u>	2.0E-06
Xe-133m	<u>1.9E+02</u>	<u>5.1E-03</u>	<u>2.2E-05</u>	<u>6.0E-16</u>	<u>1.0E-10</u>	6.0E-07
Xe-133	<u>4.1E+07</u>	<u>1.1E+03</u>	<u>4.8E+00</u>	<u>1.3E-10</u>	<u>9.3E-09</u>	5.0E-07
Xe-135m	<u>2.2E+07</u>	<u>5.9E+02</u>	<u>2.6E+00</u>	<u>7.0E-11</u>	<u>7.7E-11</u>	4.0E-08
Xe-135	<u>2.8E+07</u>	<u>7.6E+02</u>	<u>3.3E+00</u>	<u>8.9E-11</u>	<u>3.0E-10</u>	7.0E-08
Xe-137	<u>2.8E+07</u>	<u>7.6E+02</u>	<u>3.3E+00</u>	<u>8.9E-11</u>	<u>8.9E-11</u>	1.0E-09
Xe-138	<u>2.3E+07</u>	<u>6.2E+02</u>	<u>2.7E+00</u>	<u>7.3E-11</u>	<u>9.5E-11</u>	2.0E-08
Xe-139	<u>1.57E+01</u>	<u>4.2E-04</u>	<u>1.8E-06</u>	<u>5.0E-17</u>	<u>5.0E-17</u>	1.0E-09
I-131	<u>8.4E+03</u>	<u>2.3E-01</u>	<u>9.9E-04</u>	<u>2.7E-14</u>	<u>2.6E-13</u>	2.0E-10
I-132	<u>5.8E+04</u>	<u>1.6E+00</u>	<u>6.8E-03</u>	<u>1.8E-13</u>	<u>2.3E-13</u>	2.0E-08
I-133	<u>4.2E+04</u>	<u>1.1E+00</u>	<u>4.9E-03</u>	<u>1.3E-13</u>	<u>4.2E-13</u>	1.0E-09
I-134	<u>1.1E+05</u>	<u>3.0E+00</u>	<u>1.3E-02</u>	<u>3.5E-13</u>	<u>3.7E-13</u>	6.0E-08
I-135	<u>5.9E+04</u>	<u>1.6E+00</u>	<u>6.9E-03</u>	<u>1.9E-13</u>	<u>3.0E-13</u>	6.0E-09
H-3	<u>2.8E+06</u>	<u>7.6E+01</u>	<u>3.3E-01</u>	<u>8.9E-12</u>	<u>8.9E-12</u>	1.0E-07
C-14	<u>5.3E+05</u>	<u>1.4E+01</u>	<u>6.2E-02</u>	<u>1.7E-12</u>	<u>1.7E-12</u>	3.0E-09
Na-24	<u>5.4E+00</u>	<u>1.5E-04</u>	<u>6.3E-07</u>	<u>1.7E-17</u>	<u>1.7E-17</u>	7.0E-09

Table 12.2-17R Comparison of Airborne Release Concentrations with 10 CFR 20 Limit [NAPS COL 12.2.2-A] [NAPS ESP COL 11.1-1]

Nuclide	Unit 3 Annual Release		Unit 3 Concentration		Units 1, 2 & 3 Concentration	10 CFR 20 Concentration Limit
	MBq/yr	Ci/yr	Bq/m ³	μCi/ml	μCi/ml	μCi/ml
P-32	<u>1.3E+00</u>	<u>3.5E-05</u>	<u>1.5E-07</u>	<u>4.1E-18</u>	<u>4.1E-18</u>	5.0E-10
Ar-41	<u>1.4E+03</u>	<u>3.8E-02</u>	<u>1.6E-04</u>	<u>4.4E-15</u>	<u>4.4E-15</u>	1.0E-08
Cr-51	<u>1.8E+02</u>	<u>4.9E-03</u>	<u>2.1E-05</u>	<u>5.7E-16</u>	<u>5.7E-16</u>	3.0E-08
Mn-54	<u>1.5E+02</u>	<u>4.1E-03</u>	<u>1.8E-05</u>	<u>4.8E-16</u>	<u>4.8E-16</u>	1.0E-09
Mn-56	<u>1.1E+01</u>	<u>3.0E-04</u>	<u>1.3E-06</u>	<u>3.5E-17</u>	<u>3.5E-17</u>	2.0E-08
Fe-55	<u>4.7E+01</u>	<u>1.3E-03</u>	<u>5.5E-06</u>	<u>1.5E-16</u>	<u>1.5E-16</u>	3.0E-09
Fe-59	<u>2.0E+01</u>	<u>5.4E-04</u>	<u>2.3E-06</u>	<u>6.3E-17</u>	<u>6.3E-17</u>	5.0E-10
Co-58	<u>4.0E+01</u>	<u>1.1E-03</u>	<u>4.7E-06</u>	<u>1.3E-16</u>	<u>1.3E-16</u>	1.0E-09
Co-60	<u>3.2E+02</u>	<u>8.6E-03</u>	<u>3.8E-05</u>	<u>1.0E-15</u>	<u>1.0E-15</u>	5.0E-11
Ni-63	<u>4.7E-02</u>	<u>1.3E-06</u>	<u>5.5E-09</u>	<u>1.5E-19</u>	<u>1.5E-19</u>	1.0E-09
Cu-64	<u>6.9E+00</u>	<u>1.9E-04</u>	<u>8.1E-07</u>	<u>2.2E-17</u>	<u>2.2E-17</u>	3.0E-08
Zn-65	<u>3.2E+02</u>	<u>8.6E-03</u>	<u>3.8E-05</u>	<u>1.0E-15</u>	<u>1.0E-15</u>	4.0E-10
Rb-89	<u>2.0E-01</u>	<u>5.4E-06</u>	<u>2.3E-08</u>	<u>6.3E-19</u>	<u>6.3E-19</u>	2.0E-07
Sr-89	<u>1.5E+02</u>	<u>4.1E-03</u>	<u>1.8E-05</u>	<u>4.8E-16</u>	<u>4.8E-16</u>	2.0E-10
Sr-90	<u>1.0E+00</u>	<u>2.7E-05</u>	<u>1.2E-07</u>	<u>3.2E-18</u>	<u>3.2E-18</u>	6.0E-12
Y-90	<u>8.1E-02</u>	<u>2.2E-06</u>	<u>9.5E-09</u>	<u>2.6E-19</u>	<u>2.6E-19</u>	9.0E-10
Sr-91	<u>6.7E+00</u>	<u>1.8E-04</u>	<u>7.9E-07</u>	<u>2.1E-17</u>	<u>2.1E-17</u>	5.0E-09
Sr-92	<u>4.6E+00</u>	<u>1.2E-04</u>	<u>5.4E-07</u>	<u>1.5E-17</u>	<u>1.5E-17</u>	9.0E-09
Y-91	<u>1.7E+00</u>	<u>4.6E-05</u>	<u>2.0E-07</u>	<u>5.4E-18</u>	<u>5.4E-18</u>	2.0E-10
Y-92	<u>3.7E+00</u>	<u>1.0E-04</u>	<u>4.3E-07</u>	<u>1.2E-17</u>	<u>1.2E-17</u>	1.0E-08
Y-93	<u>7.2E+00</u>	<u>1.9E-04</u>	<u>8.4E-07</u>	<u>2.3E-17</u>	<u>2.3E-17</u>	3.0E-09
Zr-95	<u>4.4E+01</u>	<u>1.2E-03</u>	<u>5.2E-06</u>	<u>1.4E-16</u>	<u>1.4E-16</u>	4.0E-10
Nb-95	<u>2.4E+02</u>	<u>6.5E-03</u>	<u>2.8E-05</u>	<u>7.6E-16</u>	<u>7.6E-16</u>	2.0E-09
Mo-99	<u>1.7E+03</u>	<u>4.6E-02</u>	<u>2.0E-04</u>	<u>5.4E-15</u>	<u>5.4E-15</u>	2.0E-09
Tc-99m	<u>2.2E+00</u>	<u>5.9E-05</u>	<u>2.6E-07</u>	<u>7.0E-18</u>	<u>7.0E-18</u>	2.0E-07
Ru-103	<u>1.0E+02</u>	<u>2.7E-03</u>	<u>1.2E-05</u>	<u>3.2E-16</u>	<u>3.2E-16</u>	9.0E-10
Rh-103m	<u>3.5E-03</u>	<u>9.5E-08</u>	<u>4.1E-10</u>	<u>1.1E-20</u>	<u>1.1E-20</u>	2.0E-06

Table 12.2-17R Comparison of Airborne Release Concentrations with 10 CFR 20 Limit [NAPS COL 12.2.2-A] [NAPS ESP COL 11.1-1]

Nuclide	Unit 3 Annual Release		Unit 3 Concentration		Units 1, 2 & 3 Concentration	10 CFR 20 Concentration Limit
	MBq/yr	Ci/yr	Bq/m ³	μCi/ml	μCi/ml	μCi/ml
Ru-106	<u>1.4E-01</u>	<u>3.8E-06</u>	<u>1.6E-08</u>	<u>4.4E-19</u>	<u>4.4E-19</u>	2.0E-11
Rh-106	<u>4.5E-06</u>	<u>1.2E-10</u>	<u>5.3E-13</u>	<u>1.4E-23</u>	<u>1.4E-23</u>	1.0E-09
Ag-110m	<u>1.0E-01</u>	<u>2.7E-06</u>	<u>1.2E-08</u>	<u>3.2E-19</u>	<u>3.2E-19</u>	1.0E-10
Sb-124	<u>5.3E+00</u>	<u>1.4E-04</u>	<u>6.2E-07</u>	<u>1.7E-17</u>	<u>1.7E-17</u>	3.0E-10
Te-129m	<u>1.6E+00</u>	<u>4.3E-05</u>	<u>1.9E-07</u>	<u>5.1E-18</u>	<u>5.1E-18</u>	3.0E-10
Te-131m	<u>5.5E-01</u>	<u>1.5E-05</u>	<u>6.5E-08</u>	<u>1.7E-18</u>	<u>1.7E-18</u>	1.0E-09
Te-132	<u>1.4E-01</u>	<u>3.8E-06</u>	<u>1.6E-08</u>	<u>4.4E-19</u>	<u>4.4E-19</u>	9.0E-10
Cs-134	<u>1.8E+02</u>	<u>4.9E-03</u>	<u>2.1E-05</u>	<u>5.7E-16</u>	<u>5.7E-16</u>	2.0E-10
Cs-136	<u>1.5E+01</u>	<u>4.1E-04</u>	<u>1.8E-06</u>	<u>4.8E-17</u>	<u>4.8E-17</u>	9.0E-10
Cs-137	<u>2.7E+02</u>	<u>7.3E-03</u>	<u>3.2E-05</u>	<u>8.6E-16</u>	<u>8.6E-16</u>	2.0E-10
Cs-138	<u>8.5E-01</u>	<u>2.3E-05</u>	<u>1.0E-07</u>	<u>2.7E-18</u>	<u>2.7E-18</u>	8.0E-08
Ba-140	<u>7.8E+02</u>	<u>2.1E-02</u>	<u>9.2E-05</u>	<u>2.5E-15</u>	<u>2.5E-15</u>	2.0E-09
La-140	<u>1.3E+01</u>	<u>3.5E-04</u>	<u>1.5E-06</u>	<u>4.1E-17</u>	<u>4.1E-17</u>	2.0E-09
Ce-141	<u>2.6E+02</u>	<u>7.0E-03</u>	<u>3.1E-05</u>	<u>8.2E-16</u>	<u>8.2E-16</u>	8.0E-10
Ce-144	<u>1.3E-01</u>	<u>3.5E-06</u>	<u>1.5E-08</u>	<u>4.1E-19</u>	<u>4.1E-19</u>	2.0E-11
Pr-144	<u>1.6E-04</u>	<u>4.3E-09</u>	<u>1.9E-11</u>	<u>5.1E-22</u>	<u>5.1E-22</u>	2.0E-07
W-187	<u>1.3E+00</u>	<u>3.5E-05</u>	<u>1.5E-07</u>	<u>4.1E-18</u>	<u>4.1E-18</u>	1.0E-08
Np-239	<u>8.3E+01</u>	<u>2.2E-03</u>	<u>9.7E-06</u>	<u>2.6E-16</u>	<u>2.6E-16</u>	3.0E-09
Total w/o H-3	<u>1.7E+08</u>	<u>4.5E+03</u>	<u>2.0E+01</u>	<u>5.3E-10</u>	1.2E-08	NA
Total w/ H-3	<u>1.7E+08</u>	<u>4.6E+03</u>	<u>2.0E+01</u>	<u>5.4E-10</u>	1.2E-08	NA

Note: For clarity, replaced values are not shown in this table.

Table 12.2-18bR Gaseous Pathway Doses to the MEI (mrem/yr)
 [NAPS COL 12.2.2-A] [NAPS ESP COL 11.1-1]
 [NAPS ESP VAR 12.2-1]

Location	Pathway	ESP			Unit 3		
		Total Body	Thyroid	Skin	Total Body	Thyroid	Skin
Nearest Site Boundary (1416 m (0.88 mi) ESE for ESP-ER and FSAR)	Plume	2.1E+00	NA	6.2E+00	1.6E+00	1.6E+00	4.0E+00
	Inhalation						
	Adult	3.0E-01	1.6E+00	NA	9.6E-03 <u>9.1E-03</u>	9.7E-04 <u>6.8E-01</u>	NA
	Teen	3.1E-01	2.0E+00	NA	4.0E-02 <u>9.7E-03</u>	4.2E+00 <u>8.9E-01</u>	NA
	Child	2.7E-01	2.3E+00	NA	9.8E-03 <u>9.1E-03</u>	4.5E+00 <u>1.1E+00</u>	NA
Infant	1.6E-01	2.0E+00	NA	6.0E-03 <u>5.5E-03</u>	4.4E+00 <u>9.8E-01</u>	NA	
Nearest Garden (1513 m (0.94 mi) ESE <u>NE</u> for ESP-ER; 1191 m (0.74 mi) ESE for FSAR)	Vegetable						
	Adult	4.4E-01	4.9E+00	NA	2.6E-04 <u>3.6E-01</u>	5.6E+00 <u>3.3E+00</u>	NA
	Teen	5.7E-01	6.6E+00	NA	4.4E-04 <u>5.7E-01</u>	7.6E+00 <u>4.6E+00</u>	NA
Child	1.1E+00	1.3E+01	NA	9.4E-04 <u>1.3E+00</u>	4.5E+04 <u>9.1E+00</u>	NA	
Nearest Residence (1545 m (0.96 mi) ESE <u>NNE</u> for ESP-ER; 1191 m (0.74 mi) ESE for FSAR)	Plume	1.4E+00	NA	NA <u>4.0E+00</u>	2.8E-04 <u>3.0E-01</u>	2.8E-04 <u>3.0E-01</u>	5.6E-04 <u>6.2E-01</u>
	Inhalation						
	Adult	2.0E-01	1.0E+00	NA	4.0E-02 <u>9.9E-03</u>	4.0E+00 <u>7.2E-01</u>	NA
	Teen	2.0E-01	1.3E+00	NA	4.1E-02 <u>1.0E-02</u>	4.3E+00 <u>9.3E-01</u>	NA
	Child	1.8E-01	1.5E+00	NA	4.0E-02 <u>9.6E-03</u>	4.6E+00 <u>1.1E+00</u>	NA
Infant	1.0E-01	1.3E+00	NA	6.4E-03 <u>5.8E-03</u>	4.5E+00 <u>1.0E+00</u>	NA	
Nearest Meat Cow (2205 m (1.37 mi) ESE <u>SE</u> for ESP-ER; 1191 m (0.74 mi) ESE for FSAR)	Meat						
	Adult	6.7E-02	1.5E-01	NA	9.1E-02 <u>1.3E-01</u>	2.8E-04 <u>2.4E-01</u>	NA
	Teen	4.9E-02	1.1E-01	NA	7.6E-02 <u>1.1E-01</u>	2.1E-04 <u>1.9E-01</u>	NA
Child	7.9E-02	1.7E-01	NA	4.4E-04 <u>2.0E-01</u>	3.5E-04 <u>3.2E-01</u>	NA	

Table 12.2-18bR Gaseous Pathway Doses to the MEI (mrem/yr)
 [NAPS COL 12.2.2-A] [NAPS ESP COL 11.1-1]
 [NAPS ESP VAR 12.2-1]

Location	Pathway	ESP			Unit 3		
		Total Body	Thyroid	Skin	Total Body	Thyroid	Skin
<u>Nearest Garden/ Residence/Meat Cow (Varies for ESP-ER; 1191 m (0.74 mi) ESE for FSAR)</u>	<u>All</u>						
	<u>Adult</u>	<u>1.6E+00</u>	<u>4.9E+00</u>	<u>4.0E+00</u>	<u>8.0E-01</u>	<u>4.6E+00</u>	<u>6.2E-01</u>
	<u>Teen</u>	<u>1.6E+00</u>	<u>6.6E+00</u>	<u>4.0E+00</u>	<u>9.9E-01</u>	<u>6.0E+00</u>	<u>6.2E-01</u>
	<u>Child</u>	<u>1.6E+00</u>	<u>1.3E+01</u>	<u>4.0E+00</u>	<u>1.9E+00</u>	<u>1.1E+01</u>	<u>6.2E-01</u>
	<u>Infant</u>	<u>1.5E+00</u>	<u>1.3E+00</u>	<u>4.0E+00</u>	<u>3.1E-01</u>	<u>1.3E+00</u>	<u>6.2E-01</u>

- Notes:
1. There are no infant doses for the vegetable and meat pathways because infants do not consume these foods.
 2. "NA" denotes "not applicable."
 3. 1 mrem = 0.01 msv
 4. For Unit 3, the doses shown for "nearest garden/residence/meat cow" location are the sum of garden, residence, and meat cow doses at 1191 m. For ESP, these doses are the maximum of garden, residence, and meat cow doses at 1513 m NE, 1545 m NNE, and 2205 m SE, respectively.

Table 12.2-201 Comparison of Annual Doses to the MEI from Gaseous Effluents Per Unit [NAPS COL 12.2.2-A] [NAPS ESP COL 11.1-1]

Type of Dose	Location	ESP (Single Unit)	Unit 3	10 CFR 50 Limit
Gamma Air (mrad/yr)	Site Boundary	3.2	2.4 <u>2.2</u>	10
Beta Air (mrad/yr)	Site Boundary	4.8	2.4 <u>2.5</u>	20
Total Body (mrem/yr)	Site Boundary	2.4	1.6	5
Skin (mrem/yr)	Site Boundary	6.2	4.0	15
NAPS-ESP VAR 12.2-2 Iodines and Particulates – Thyroid (mSv/yr <u>mrem/yr</u>)	Garden/ <u>Residence/</u> <u>Meat Cow</u>	12	14 <u>9.1</u>	15

1 mrad = 1E-05 Gy

1 mrem = 0.01 mSv

**Table 12.2-203 Comparison of Site Doses to the MEI [NAPS COL 12.2.2-A]
 [NAPS COL 12.2-3-A] [NAPS ESP COL 11.1-1]**

Type of Dose	ESP Site Total ⁽¹⁾	Unit 3 (ESBWR)			Existing Units ⁽²⁾	Site Total ⁽³⁾	40 CFR 190 Limit
		Liquid	Gaseous	Total			
Total Body (mrem/yr)	6.8	0.094	4.6 <u>1.9</u>	4.7 <u>1.9</u>	2.1	3.7 <u>4.0</u>	25
Thyroid (mrem/yr)	27	0.18	45 <u>11</u>	45 <u>11</u>	2.2	47 <u>13</u>	75
Bone (mrem/yr)	12	1.3	4.6 <u>7.9</u>	5.8 <u>9.2</u>	2.2	8.4 <u>11</u>	25

Notes:

- (1) The ESP site total doses are for two new units and two existing units, and do not include a dose contribution from the ISFSI.
- (2) The doses from existing units include ISFSI contribution.
- (3) This site total dose includes the Unit 3 total dose and the dose from the existing units.
- (4) 1 mrem = 0.01 msv

Table 12.2-204 Collective Total Body (Population) Doses Within 50 Miles
 [NAPS COL 12.2.2-A] [NAPS COL 12.2-3-A] [NAPS ESP COL 11.1-1]

Units in person-rem/yr

	ESP (Single Unit)	Unit 3
Liquid	8.6	1.0
Noble Gases (Gaseous)	3.5	4.4 <u>1.5</u>
Iodines and Particulates (Gaseous)	1.4	0.90 <u>0.88</u>
H-3 and C-14 (Gaseous)	14	3.7 <u>5.3</u>
<u>Gaseous Total</u>	<u>19</u>	<u>7.7</u>
Total	28	7.0 <u>8.7</u>

1 rem = 0.01 sv

indicate isotopes for which the estimated ESBWR release activity is greater than the corresponding ESP-ER composite release activity. "NP" denotes isotopes which are not present in ESBWR liquid effluents.

There are small increases in liquid effluent release activities for twelve radioisotopes associated with normal operation of Unit 3 as compared to the composite release activities presented in the ESP-ER. However, the total liquid effluent release activity of Unit 3 is at least an order of magnitude lower than the total ESP-ER composite release activity.

ESP-ER Table 5.4-10 provided the total body and organ doses to the maximally exposed individual (MEI) resulting from liquid and gaseous effluent releases of a single new unit. These calculated doses were determined to be within the design objectives of 10 CFR 50, Appendix I. Using design-specific release activities of liquid effluents from Unit 3, the total annual doses to the MEI from liquid effluents are calculated and presented in Table 5.4-2. The total annual doses from liquid effluents were calculated using the same methodologies and parameters (with the exception of release activity) as those used in ESP-ER annual MEI dose calculations.

As shown in Table 5.4-2, the annual doses to the MEI from different liquid effluent pathways are consistently lower than those calculated and presented in the ESP-ER. Therefore, the dose impacts to the MEI remain SMALL, and no new mitigation measures or controls are warranted.

5.4.2.2 Gaseous Pathway Doses

ESP-ER Table 5.4-7 presented the composite release activities of gaseous effluents for a single new unit. These composite activities were obtained by taking the maximum activity for each isotope from multiple reactor designs. ESBWR-specific gaseous effluent release activities are presented in Table 5.4-3 and are compared to ESP-ER composite release activities. All Unit 3 ESBWR-specific release activities are lower than the corresponding ESP-ER composite release activities. "NP" denotes isotopes which are not present in ESBWR liquid gaseous effluents.

The total annual doses to the MEI from gaseous effluents have been re-calculated using the ESBWR-specific gaseous release activities and the same methodologies and parameters as those used in ESP-ER calculations, with the exception of MEI locations. As discussed in Section 2.7, the MEI locations for the vegetable garden, residential, and meat cow receptors have changed. A single, bounding location (0.74 mile ESE from the facility boundary) has been selected for these receptors and the doses from the garden, residential, and meat cow pathways are summed to arrive at the total dose at this location. ~~However, since the three receptors are not physically at the same location, the doses for the three receptors are not summed.~~ The nearest site boundary MEI location (0.88 mile ESE of the site) is the same as was used in the ESP-ER. The results of the total annual dose calculations are provided in Table 5.4-4. The values in bold print indicate the Unit 3 gaseous pathway doses to the MEI that are larger than the corresponding ESP-ER doses.

As shown in Table 5.4-4, several pathways show slight increases in total body and thyroid doses to the MEI, resulting from the change in MEI locations. Table 5.4-5 shows that the annual total body,

~~thyroid~~, and skin doses to the MEI are lower than those calculated and presented in the ESP-ER. Although the annual thyroid dose to the MEI from iodine and particulates in gaseous effluents calculated using Unit 3 specific release activities is slightly higher than that presented in the ESP-ER, it remains within the 10 CFR 50, Appendix I limit. Therefore, the impact of gaseous pathway doses remains SMALL, and no mitigation measures or controls are warranted.

5.4.2.3 Direct Radiation from Station Operation

As indicated in ESP-ER Section 5.4.1.3, the offsite dose due to direct radiation from the new and existing units will be negligible. However, another source of direct radiation is the NAPS ISFSI, which is located south of the proposed Unit 3 site. The distance from the ISFSI to the site boundary is 2500 ft. The annual direct radiation contribution at the site boundary from the ISFSI is about 1.7 mrem/yr. The distance from the ISFSI to the nearest residence is 2860 ft. Since this is farther away than the site boundary, the direct radiation dose to the MEI at the nearest residence would be less than 1.7 mrem/yr.

5.4.3 Impacts to Members of the Public

ESP-ER Table 5.4-11 demonstrated that the total site liquid and gaseous effluent doses resulting from the normal operation of the two existing North Anna units and two proposed new units would be well within the regulatory limits of 40 CFR 190. ESP-ER Table 5.4-12 presented the collective doses attributable to two new units for the population within 50 miles of the proposed ESP site. Accounting for changes in the liquid and gaseous effluent release activities, identified in Table 5.4-1 and Table 5.4-3, the total annual doses to the MEI and the total population doses resulting from the proposed Unit 3 liquid and gaseous effluents are calculated and presented in Table 5.4-6 and Table 5.4-7, respectively. These total annual doses to the MEI and to the population were calculated using the same methodologies and parameters (with the exception of the release activities) as those used in ESP-ER.

As shown in Table 5.4-6 and Table 5.4-7, the annual total site dose to the MEI and the population within 50 miles resulting from Unit 3 liquid and gaseous effluents are lower than those calculated and presented in ESP-ER. Therefore, the liquid and gaseous effluent doses to the MEI and the population provided in the ESP-ER are bounding, the impact to members of the public remains SMALL, and no mitigation measures or controls are warranted.

5.4.4 Impacts to Biota Other Than Members of the Public

ESP-ER Table 5.4-16 presented the maximum calculated doses to biota from liquid and gaseous effluents. In FEIS Section 5.9.5.3, the NRC staff concluded that, based on Dominion calculations, the impacts to the biota would be small, and mitigation is not warranted. The maximum doses to biota resulting from proposed Unit 3 liquid and gaseous effluents have been calculated using the same methodologies in the ESP-ER, accounting for the changes in liquid and gaseous effluent release activities. These doses are provided in Table 5.4-8.

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	7.6E+01
C-14	1.2E+01	9.6E+00 <u>1.4E+01</u>
Na-24	4.4E-03	4.5E-05 <u>1.5E-04</u>
P-32	1.0E-03	3.6E-06 <u>3.5E-05</u>
Ar-41	3.0E+02	7.7E-03 <u>3.8E-02</u>
Cr-51	3.8E-02	2.1E-03 <u>4.9E-03</u>
Mn-54	5.9E-03	4.0E-03 <u>4.1E-03</u>
Mn-56	3.8E-03	2.9E-05 <u>3.0E-04</u>
Fe-55	7.1E-03	4.3E-04 <u>1.3E-03</u>
Fe-59	8.9E-04	5.2E-04 <u>5.4E-04</u>
Co-57	8.2E-06	NP
Co-58	2.3E-02	4.0E-03 <u>1.1E-03</u>
Co-60	1.4E-02	8.6E-03
Ni-63	7.1E-06	4.3E-07 <u>1.3E-06</u>
Cu-64	1.1E-02	4.9E-05 <u>1.9E-04</u>
Zn-65	1.2E-02	7.6E-03 <u>8.6E-03</u>
Kr-83m	1.3E-03	4.0E-03 <u>2.3E-03</u>
Kr-85m	3.6E+01	1.8E+01
Kr-85	4.1E+03	4.2E+02 <u>1.4E+02</u>
Kr-87	4.9E+01	3.9E+01 <u>3.8E+01</u>
Kr-88	7.4E+01	5.9E+01 <u>5.7E+01</u>
Kr-89	4.7E+02	3.8E+02
Kr-90	4.2E-04	3.4E-04 <u>NP</u>
Rb-89	4.7E-05	5.4E-07 <u>5.4E-06</u>
Sr-89	6.2E-03	4.0E-03 <u>4.1E-03</u>
Sr-90	1.2E-03	2.4E-05 <u>2.7E-05</u>
Sr-91	1.1E-03	4.8E-05 <u>1.8E-04</u>
Sr-92	8.6E-04	4.3E-05 <u>1.2E-04</u>

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

Isotope	ESP-ER Composite Release Activity (Ci/yr)	Unit 3 Release Activity
Y-90	5.0E-05	8.8E-07 <u>2.2E-06</u>
Y-91	2.6E-04	4.7E-06 <u>4.6E-05</u>
Y-92	6.8E-04	9.9E-06 <u>1.0E-04</u>
Y-93	1.2E-03	2.0E-05 <u>1.9E-04</u>
Zr-95	1.7E-03	1.2E-03
Nb-95	9.2E-03	6.6E-03 <u>6.5E-03</u>
Mo-99	6.5E-02	4.5E-02 <u>4.6E-02</u>
Tc-99m	3.3E-04	6.0E-06 <u>5.9E-05</u>
Ru-103	3.8E-03	2.8E-03 <u>2.7E-03</u>
Ru-106	7.8E-05	3.6E-07 <u>3.8E-06</u>
Rh-103m	1.2E-04	2.2E-06 <u>9.5E-08</u>
Rh-106	2.1E-05	3.6E-07 <u>1.2E-10</u>
Ag-110m	2.2E-06	1.6E-06 <u>2.7E-06</u>
Sb-124	2.0E-04	1.5E-04 <u>1.4E-04</u>
Sb-125	6.1E-05	NP
Te-129m	2.4E-04	4.4E-06 <u>4.3E-05</u>
Te-131m	8.3E-05	1.5E-06 <u>1.5E-05</u>
Te-132	2.1E-05	3.8E-07 <u>3.8E-06</u>
I-131	5.1E-01	4.1E-01 <u>2.3E-01</u>
I-132	2.4E+00	1.6E+00
I-133	1.9E+00	1.3E+00 <u>1.1E+00</u>
I-134	4.1E+00	2.9E+00 <u>3.0E+00</u>
I-135	2.6E+00	1.7E+00 <u>1.6E+00</u>
Xe-131m	1.8E+03	3.0E+00 <u>4.1E+00</u>
Xe-133m	8.7E+01	2.3E-03 <u>5.1E-03</u>
Xe-133	4.6E+03	8.4E+02 <u>1.1E+03</u>
Xe-135m	7.7E+02	6.1E+02 <u>5.9E+02</u>
Xe-135	8.2E+02	6.6E+02 <u>7.6E+02</u>

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	7.8E+02	<u>7.6E+02</u>
Xe-138	7.8E+02	6.3E+02	<u>6.2E+02</u>
Xe-139	5.3E-04	4.2E-04	NP
Cs-134	6.8E-03	4.8E-03	<u>4.9E-03</u>
Cs-136	6.5E-04	4.0E-04	<u>4.1E-04</u>
Cs-137	1.0E-02	7.3E-03	
Cs-138	1.9E-04	2.3E-06	<u>2.3E-05</u>
Ba-140	3.0E-02	2.1E-02	
La-140	2.0E-03	3.5E-05	<u>3.5E-04</u>
Ce-141	1.0E-02	7.2E-03	<u>7.0E-03</u>
Ce-144	2.1E-05	3.6E-07	<u>3.5E-06</u>
Pr-144	2.1E-05	3.6E-07	<u>4.3E-09</u>
W-187	2.1E-04	3.5E-06	<u>3.5E-05</u>
Np-239	1.3E-02	2.2E-04	<u>2.2E-03</u>
Total w/o H-3	1.5E+04	4.2E+03	<u>4.5E+03</u>
Total w/ H-3	1.8E+04	4.2E+03	<u>4.6E+03</u>

Note: "NP" denotes isotopes which are "not present."

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

Location	Pathway	ESP-ER			Unit 3		
		Total Body	Thyroid	Skin	Total Body	Thyroid	Skin
Nearest Site Boundary (0.88 mi ESE for ESP-ER; same location for this ER)	Plume	2.1E+00	N/A	6.2E+00	1.6E+00	1.6E+00	4.0E+00
	Inhalation						
	Adult	3.0E-01	1.6E+00	N/A	<u>9.6E-03</u> <u>9.1E-03</u>	<u>9.7E-01</u> <u>6.8E-01</u>	N/A
	Teen	3.1E-01	2.0E+00	N/A	<u>1.0E-02</u> <u>9.7E-03</u>	<u>1.2E+00</u> <u>8.9E-01</u>	N/A
	Child	2.7E-01	2.3E+00	N/A	<u>9.8E-03</u> <u>9.1E-03</u>	<u>1.5E+00</u> <u>1.1E+00</u>	N/A
	Infant	1.6E-01	2.0E+00	N/A	<u>6.0E-03</u> <u>5.5E-03</u>	<u>1.4E+00</u> <u>9.8E-01</u>	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	<u>2.6E-01</u> <u>3.6E-01</u>	5.6E+00 <u>3.3E+00</u>	N/A
	Teen	5.7E-01	6.6E+00	N/A	<u>4.1E-01</u> <u>5.7E-01</u>	7.6E+00 <u>4.6E+00</u>	N/A
	Child	1.1E-00	1.3E+01	N/A	<u>9.4E-01</u> 1.3E+00	1.5E+01 <u>9.1E+00</u>	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	<u>2.8E-01</u> <u>3.0E-01</u>	2.8E-01 3.0E-01	<u>5.6E-01</u> <u>6.2E-01</u>
	Inhalation						
	Adult	2.0E-01	1.0E+00	N/A	<u>1.0E-02</u> <u>9.9E-03</u>	<u>1.0E+00</u> <u>7.2E-01</u>	N/A
	Teen	2.0E-01	1.3E+00	N/A	<u>1.1E-02</u> <u>1.0E-02</u>	<u>1.3E+00</u> <u>9.3E-01</u>	N/A
	Child	1.8E-01	1.5E+00	N/A	<u>1.0E-02</u> <u>9.6E-03</u>	1.6E+00 <u>1.1E+00</u>	N/A
	Infant	1.0E-01	1.3E+00	N/A	<u>6.4E-03</u> <u>5.8E-03</u>	1.5E+00 <u>1.0E+00</u>	N/A
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	<u>9.1E-02</u> <u>1.3E-01</u>	2.8E-01 <u>2.4E-01</u>	N/A
	Teen	4.9E-02	1.1E-01	N/A	<u>7.6E-02</u> <u>1.1E-01</u>	2.1E-01 <u>1.9E-01</u>	N/A
	Child	7.9E-02	1.7E-01	N/A	<u>1.4E-01</u> <u>2.0E-01</u>	3.5E-01 <u>3.2E-01</u>	N/A

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

Location	Pathway	ESP-ER			Unit 3		
		Total Body	Thyroid	Skin	Total Body	Thyroid	Skin
Nearest Garden/ Residence/Meat Cow (Varies for ESP-ER; 0.74 mi ESE for this ER)	All						
	Adult	<u>1.6E+00</u>	<u>4.9E+00</u>	<u>4.0E+00</u>	<u>8.0E-01</u>	<u>4.6E+00</u>	<u>6.2E-01</u>
	Teen	<u>1.6E+00</u>	<u>6.6E+00</u>	<u>4.0E+00</u>	<u>9.9E-01</u>	<u>6.0E+00</u>	<u>6.2E-01</u>
	Child	<u>1.6E+00</u>	<u>1.3E+01</u>	<u>4.0E+00</u>	<u>1.9E+00</u>	<u>1.1E+01</u>	<u>6.2E-01</u>
	Infant	<u>1.5E+00</u>	<u>1.3E+00</u>	<u>4.0E+00</u>	<u>3.1E-01</u>	<u>1.3E+00</u>	<u>6.2E-01</u>

Notes:

1. There are no infant doses for the vegetable and meat pathways because infants do not consume those foods.
2. "N/A" denotes "not applicable."
3. For Unit 3, the doses shown for "nearest garden/residence/meat cow" location are the sum of garden, residence, and meat cow doses at 0.74 mi. For ESP-ER, these doses are the maximum of garden, residence, and meat cow doses at 0.94 mi NE, 0.96 mi NNE, and 1.37 mi SE, respectively.

Table 5.4-5 Comparison of Annual Doses to the MEI from Gaseous Effluents

Type of Dose	ESP-ER 1 New Unit (MEI Location)	Unit 3 (MEI Location)	10 CFR 50 Appendix I Limit
Gamma Air (mrad/yr)	3.2 (Site Boundary)	2.4 <u>2.2</u> (Site Boundary)	10
Beta Air (mrad/yr)	4.8 (Site Boundary)	2.4 <u>2.5</u> (Site Boundary)	20
Total Body (mrem/yr)	2.4 (Site Boundary)	1.6 (Site Boundary)	5
Skin (mrem/yr)	6.2 (Site Boundary)	4.0 (Site Boundary)	15
Iodine and Particulates – Thyroid (mrem/yr)	12 (Garden)	44 <u>9.1</u> (Garden/ <u>Residence/ Meat Cow</u>)	15

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

Type of Dose	ESP	North Anna Unit 3 (ESBWR)			Existing Units ⁽²⁾	Site Total ⁽³⁾	40 CFR 190 Limit
	Site Total ⁽¹⁾	Liquid	Gaseous	Total			
Total Body (mrem/yr)	6.8	0.094	4.6 <u>1.9</u>	4.7 <u>1.9</u>	2.1	3.7 <u>4.0</u>	25
Thyroid (mrem/yr)	27	0.18	45 <u>11</u>	45 <u>11</u>	2.2	47 <u>13</u>	75
Bone (mrem/yr)	12	1.3	4.6 <u>7.9</u>	5.8 <u>9.2</u>	2.2	8.4 <u>11</u>	25

Notes:

1. The ESP site total doses are for two new units, and do not include a dose contribution from the ISFSI.
2. The doses from existing units include ISFSI contribution.
3. This site dose includes the Unit 3 total dose and the dose from the existing units.

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	1.0E+00
Noble Gases (Gaseous)	3.5E+00	1.4E+00 1.5E+00
Iodines and Particulates (Gaseous)	1.4E+00	9.0E-04 8.8E-01
H-3 and C-14 (Gaseous)	1.4E+01	3.7E+00 5.3E+00
Total	2.8E+01	7.0E+00 8.7E+00
Natural Background	9.2E+05	9.2E+05

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	3.3E+00	N/A
Invertebrates	4.6E+01	N/A	1.2E+01	N/A
Algae	5.4E+01	N/A	1.7E+01	N/A
Muskrat	4.3E+01	3.4E+01	2.1E+01	1.7E+01 <u>2.0E+01</u>
Raccoon	4.9E+00	3.4E+01	6.2E-01	1.7E+01 <u>2.0E+01</u>
Heron	5.4E+01	3.4E+01	9.9E+00	1.7E+01 <u>2.0E+01</u>
Duck	4.3E+01	3.4E+01	2.1E+01	1.7E+01 <u>2.0E+01</u>

VARIANCES

Introduction

A *variance* is a plant-specific deviation from one or more of the site characteristics, design parameters, or terms and conditions of an ESP or from the site safety analysis report (SSAR). A variance to an ESP is analogous to a departure from a standard design certification.

The following sections provide requests for variances from the proposed site characteristics for the North Anna ESP and from the ESPA SSAR. The requests comply with the requirements of 10 CFR 52.39 and 10 CFR 52.93. To support a decision whether to grant a variance, each variance request provides the technical justification and supporting cross-references to the Unit 3 FSAR information that meet the technically relevant regulatory acceptance criteria.

This COLA complies with the requirements of 10 CFR 52.79, *Contents of Applications; Technical Information in Final Safety Analysis Report*, and 10 CFR 52.39, *Finality of Early Site Permit Determinations*. In accordance with 10 CFR 52.79(b)(2) and 10 CFR 52.39(d), where the Unit 3 FSAR references the North Anna ESP and does not demonstrate that the design of Unit 3 falls within the ESP site characteristics, i.e., the proposed ESP site characteristics from FSER Supplement 1, Appendix A (Reference), this COLA includes the following requests for variances from the proposed ESP site characteristics:

- NAPS ESP VAR 2.0-1 - Long-Term Dispersion Estimates (X/Q and D/Q)
- NAPS ESP VAR 2.0-2 - Hydraulic Conductivity
- NAPS ESP VAR 2.0-3 - Hydraulic Gradient
- NAPS ESP VAR 2.0-4 - Vibratory Ground Motion

This COLA complies with the requirements of 10 CFR 52.39, *Finality of Early Site Permit Determinations*. In accordance with 10 CFR 52.39(d), where the Unit 3 FSAR references the North Anna ESP and does not incorporate the ESPA SSAR information by reference without the need for certain changes, this COLA requests the following variances from the ESPA SSAR information:

- NAPS ESP VAR 2.0-5 - Distribution Coefficients (Kd)
- NAPS ESP VAR 2.4-1 - Void Ratio, Porosity, and Seepage Velocity
- NAPS ESP VAR 2.4-2 - NAPS Water Supply Well Information
- NAPS ESP VAR 2.5-1 - Stability of Slopes
- NAPS ESP VAR 12.2-1 - Gaseous Pathway Doses
- NAPS ESP VAR 12.2-2 - Annual Thyroid Dose ~~[Deleted]~~
- NAPS ESP VAR 12.2-3 - Annual Liquid Effluent Releases

Variance: NAPS ESP VAR 2.0-1 – Long-Term Dispersion Estimates (χ/Q and D/Q)

Request

This is a request to use the Unit 3 maximum long-term dispersion estimates (χ/Q and D/Q values) provided in FSAR Table 2.3-16R for types of locations other than the EAB rather than the corresponding ESP values in FSER Supplement 1, Appendix A and in SSAR Table 2.3-16. The Unit 3 values do not fall within (are larger than) the ESP and SSAR values.

This variance results from a review of the Radiological Environmental Monitoring Program (FSAR Reference 2.3-201). The review determined that since the time of the SSAR, distances to several of the "closest receptors" had changed. FSAR Table 2.3-15R shows the closest of all receptors to be a residence in the Northwest direction. The χ/Q and D/Q evaluation, and the subsequent normal gaseous effluent dose evaluation, conservatively assumed that each receptor (meat animal, vegetable garden, residence) is at the distance of that closest receptor and in the East-Southeast direction, which is the direction with the maximum annual average χ/Q value at that distance.

Justification

This variance is acceptable because all estimated annual doses from normal gaseous effluent releases remain within applicable limits as shown in FSAR Table 12.2-201.

Because of the change in Unit 3 maximum long-term dispersion estimates, some of the gaseous effluent doses are higher than the corresponding ESP value. See the related variances NAPS ESP VAR 12.2-1 and ~~NAPS ESP VAR 12.2-2~~, which are is addressed below.

Variance: NAPS ESP VAR 2.0-2 – Hydraulic Conductivity

Request

This is a request to use the Unit 3 maximum hydraulic conductivity value provided in FSAR Section 2.4.12.1.2 rather than the corresponding ESP value in FSER Supplement 1, Appendix A and in SSAR Table 1.9-1. The Unit 3 value does not fall within (is larger than) the ESP and SSAR value.

The ESP value of 1.04 m/day (3.4 ft/day) represents the upper limit of the values obtained by in situ hydraulic conductivity testing of observation wells installed for the ESP subsurface investigation. These values varied from 0.076 to 1.04 m/day (0.25 to 3.4 ft/day) as shown in SSAR Table 2.4-16. The corresponding maximum hydraulic conductivity value reported in FSAR Section 2.4.12.1.2 is 3.0 m/day (9.9 ft/day) based on an expanded range from 0.076 to 3.0 m/day (0.25 to 9.9 ft/day). This data set includes in situ hydraulic conductivity test results for the observation wells installed for the ESP subsurface investigation plus additional observation wells installed for the Unit 3

This variance results from the need to provide Unit 3-specific information which is different from that presented in the SSAR.

Justification

This variance in Unit 3 slopes and slope analyses is acceptable because the slopes being considered in FSAR Section 2.5.5 are lower, less steep, and have a smaller applied seismic acceleration than the slopes analyzed in SSAR Section 2.5.5. As a result, the Unit 3 slopes have a higher computed factor of safety against failure, and are shown to be stable under both long-term static and short-term seismic conditions.

Variance: NAPS ESP VAR 12.2-1 – Gaseous Pathway Doses

Request

This is a request to use updated information for Unit 3 gaseous effluent doses rather than the SSAR information which referred to ESP-ER Section 5.4. Several of the gaseous pathway doses to the maximally exposed individual (MEI) in FSAR Table 12.2-18bR do not fall within (are greater than) the corresponding values in ESP-ER Table 5.4-9. The Unit 3 values which are higher are shown in bold font in FSAR Table 12.2-18bR.

This variance is due to a change in maximum long-term dispersion estimates from those used in the ESP Application as discussed above under NAPS ESP VAR 2.0-1.

Justification

This variance is acceptable because estimated annual doses from normal gaseous effluent releases remain within applicable limits. FSAR Table 12.2-18bR shows the annual gaseous pathway doses to the maximally exposed individual (MEI) for Unit 3 and compares each to the corresponding estimate from the ESP-ER Table 5.4-9. Not all doses increased for the three locations with higher long term dispersion estimates because the normal release source term is lower for Unit 3 than the composite source term used to bound the multiple reactor types considered in the ESP Application. The effect of these changes is slight increases in ~~thirteen~~ some Unit 3 total body and thyroid doses when compared to the earlier estimates for the ESP. The Unit 3 values that exceed the corresponding ESP value are shown in bold font in FSAR Table 12.2-18bR.

Although some of the individual pathway doses increased compared to the ESP Application, all gaseous effluent doses are acceptable when compared with the applicable limits in FSAR Table 12.2-201. As shown, the Unit 3 annual total body dose meets the 10 CFR 50, Appendix I, limit. This table also shows that the Unit 3 total body dose estimate is lower than the corresponding ESP value.

~~The gaseous effluent pathway thyroid dose for the MEI is also compared with the applicable limit in FSAR Table 12.2-201. While it meets the 10 CFR 50, Appendix I, limit, this table shows that the~~

~~Unit 3 thyroid dose estimate is higher than the corresponding ESP value. This variance, NAPS ESP VAR 12.2-2, is addressed below.~~

Variance: NAPS ESP VAR 12.2-2 – Annual Thyroid Dose [Deleted]

Request

~~This is a request to use updated information for the Unit 3 annual thyroid dose from gaseous effluents rather than the SSAR information which referred to ESP ER Section 5.4. The iodines and particulates gaseous pathway dose to the thyroid in FSAR Table 12.2-201 does not fall within (is greater than) the corresponding value in ESP-ER Table 5.4-10. The Unit 3 value which is higher is shown in bold font in FSAR Table 12.2-201.~~

~~This variance is due to a change in maximum long-term dispersion estimates from those used in the ESP Application as discussed above under NAPS ESP VAR 2.0-1.~~

Justification

~~This variance is acceptable because the estimated Unit 3 annual thyroid dose from iodines and particulates in the normal gaseous effluent releases remains within the applicable 10 CFR Part 50, Appendix I limit.~~

Variance: NAPS ESP VAR 12.2-3 – Annual Liquid Effluent Releases

Request

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

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

Justification

This variance is acceptable because the estimated Unit 3 concentrations of normal liquid effluent releases remain within the applicable concentration limits and the annual doses from normal liquid effluent releases remain within applicable limits.

The estimated Unit 3 concentrations of normal liquid effluent releases for all nuclides meet the 10 CFR 20 concentration limits as shown in FSAR Table 12.2-19bR.