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

Serial No. NA3-11-063R
Docket No. 52-017
COL/DWL

DOMINION VIRGINIA POWER
NORTH ANNA UNIT 3 COMBINED LICENSE APPLICATION
SRP 12.02: RESPONSE TO RAI LETTER 90

On November 10, 2011, the NRC requested additional information to support the review of certain portions of the North Anna Unit 3 Combined License Application (COLA). The responses to the following Request for Additional Information (RAI) Questions are provided in Enclosures 1 through 3:

- RAI 5784 Question 12.02-14 Degasifier Impact on Radwaste Systems
- RAI 5784 Question 12.02-15 Degasifier Liquid Source Terms
- RAI 5980 Question 12.02-16 Degasifier Gaseous Source Terms

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

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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MRO

Enclosures:

1. Response to NRC RAI Letter No. 90, RAI 5784 Question 12.02-14
2. Response to NRC RAI Letter No. 90, RAI 5784 Question 12.02-15
3. Response to NRC RAI Letter No. 90, RAI 5980 Question 12.02-16

Commitments made by this letter:

1. Incorporate proposed changes in a future COLA submission.

COMMONWEALTH OF VIRGINIA

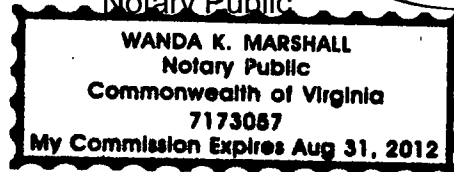
COUNTY OF HENRICO

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 14th day of December, 2011
My registration number is 7173057 and my
Commission expires: August 31, 2012

Wanda K. Marshall

Notary Public



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

ENCLOSURE 1

Response to NRC RAI Letter 90

RAI 5784, Question 12.02-14

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5784 (RAI Letter 90)

SRP SECTION: 12.02 – Radiation Sources

QUESTIONS for Health Physics Branch (CHPB)

DATE OF RAI ISSUE: 11/10/2011

QUESTION NO.: 12.02-14

The guidance contained in NUREG 0800 Standard Review Plan (SRP) Section 12.2 "Radiation Sources" and Regulatory Guide 1.206 "Combined License Applications for Nuclear Power Plants (LWR Edition)," section C.I.12.2.1 "Contained Sources," states that the applicant is to provide the models, parameters and bases for all values used to calculate source magnitudes used as the basis for designing the radiation protection program and for shield design calculations. North Anna Power Station Unit 3 (NAPS) COL FSAR Revision 3 Departure DEP 9.2(1) "Replacement of Boron Recycle System with a Degasifier Subsystem" eliminated the reuse of reactor coolant water, so this water will need to be processed as liquid waste. Based on the information contained in USAPWR DCD Tier 2 Revision 2 Table 12.2-73 "Parameters for the US-APWR Demineralizers," it is estimated that the Liquid Waste Processing System will need to process an additional 1.4 million gallons of Reactor Coolant each cycle, however, NAPS COL FSAR Table 12.2-73R, "Parameters for the US-APWR Demineralizers," does not appear to reflect the processing of this additional water by the Waste demineralizer (Anion-bed), Waste demineralizer (Cation-bed) or the Waste demineralizer (Mixed bed).

Accordingly, the NAPS COL FSAR does not appear to discuss the impact on the activity values reported in the tables depicting the accumulated activity content for the Waste Demineralizer Anion Bed, Waste Demineralizer Cation Bed and the Waste Demineralizer Mixed Bed demineralizers.

Please describe the changes to the methods, models, assumptions and the impact on radiation zones and shielding needs, including changes to ensure that FSAR Table 12.2-73R appropriately reflects the assumed flow rates and processing times for the additional waste water, and the impact of processing the additional waste water on the activity contained in the Waste Demineralizer Anion Bed, Waste Demineralizer Cation

Bed, the Waste Demineralizer Mixed Bed demineralizers and the mobile liquid waste processing systems, or describe an alternative approach that provides an acceptable method of complying with the rules or regulations of the Commission, or portions thereof, that underlie the corresponding SRP acceptance criteria.

Please revise and update the NAPS COL FSAR to reflect actual waste processing radiological impacts or the alternative approach taken.

Dominion Response

The North Anna Unit 3 design replaces the boron recycle system used in the US-APWR standard design with a degasifier subsystem. In addition to the renaming of the Boric Acid Evaporator (BAE) feed demineralizer and BAE feed filter to the degasifier feed demineralizer and degasifier feed filter, respectively, the key process change was in the effluent flow path from these subsystems.

In the US-APWR standard plant design, the normal output for the BAE distillate is the Primary Makeup Water Tank, with an option of being sent to the Liquid Waste Management System (LWMS). With the Unit 3 degasifier subsystem, the liquid output is sent to the LWMS Waste Holdup Tanks (WHTs) for processing through the LWMS. Therefore, the use of the Unit 3 degasifier subsystem results in additional liquid waste being processed through the LWMS.

From DCD Table 11.2-2, the BAE waste liquid inflow is 3,775 gpd which is the combined waste volume from the CVCS letdown and RCP seal leakage. This inflow is the same for the degasifier subsystem which will discharge to the WHTs. This flow is in addition to the normal LWMS input to the WHTs of 1,780 gpd. Therefore, the total normal expected waste liquid inflow to the WHTs for the Unit 3 design is 5,555 gpd. Given that the LWMS processing rate is 90 gpm, this increased total waste liquid volume results in a processing time of 380 hours per year (rounded up) or an average usage of slightly more than 1 hour per day.

Prior to entering the LWMS, the degasifier liquid discharge stream passes through the Chemical and Volume Control System (CVCS) treatment system (filter(s) and demineralizer(s)), as well as the degasifier feed filter and demineralizer. This ensures that the radionuclide concentrations in the degasifier liquid discharge stream, will be significantly lower than the other waste stream inputs into the WHTs, e.g. from various sumps and sample discharges. Therefore, the addition of the degasifier input to the LWMS effectively dilutes the radionuclide concentration in the WHTs (although they will be filled and processed more frequently) due to the increased volume of waste liquid input.

Based on the increased LWMS processing time for the additional waste liquid volume, North Anna Unit 3 FSAR Table 12.2-73R is updated to reflect the increased annual term

of service for the "Waste demineralizer (Anion-bed)," "Waste demineralizer (Cation-bed)," and "Waste demineralizer (Mixed bed)" of 380 hours. FSAR Table 11.2-2R is added to show the additional input to the LWMS WHTs from the CVCS letdown and RCP seal leakage being processed through the LWMS.

For conservatism in the shielding design the source terms for the WHTs (DCD Tables 12.2-37 and 12.2-38) are not modified to reflect the dilution afforded by the inclusion of the degasifier outflow. This is appropriate given that there are instances in which the WHT contents are not diluted by degasifier outflow. The same rationale is applied to downstream liquid source terms, including the inlet to the waste demineralizer (anion-bed), waste demineralizer (cation-bed), and waste demineralizer (mixed bed). A note is added to FSAR Table 12.2-73R to explain that the inlet flow stream activity concentrations for the waste demineralizers do not account for the dilution provided by the additional waste liquid input from the degasifier to the WHTs.

The source terms for the LWMS components that remove radioactivity from the waste stream (i.e. the waste effluent inlet filter and the waste demineralizers A, B, C and D) may increase marginally due to the additional waste liquid from the WHTs. However this increase will be very small given that the waste liquid passing through the degasifier subsystem has already been processed through multiple demineralizers and filters before reaching the WHTs. The activity of the CVCS letdown input to the WHTs is conservatively stated as 1% of the reactor coolant as explained in the note added to the revised FSAR Table 11.2-2R. As such the source terms need not be updated. The operational radiological control program will ensure that the dose rates emitted from the LWMS demineralizers and filters remain acceptably low. If necessary the media (resin or filter) will be replaced more frequently to ensure the dose rates in adjacent areas are consistent with the Radiological Zone Maps and ALARA principles. However, the change-out frequency of the waste demineralizer resins will not exceed the basis specified in the DCD.

Proposed COLA Revision

FSAR Table 12.2-73R is revised and FSAR Table 11.2-2R is added as indicated on the attached markup.

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.

NAPS DEP 9.2(1)

Table 11.2-2R Waste Liquid Inflow into the LWMS

Collection Tank and Sources	Expected Input Rate (gpd)	Activity
<u>Waste</u> Holdup tanks	---	---
CVCS letdown ⁽¹⁾	2,875	100% of reactor coolant ⁽³⁾
RCP Seal Leakage ⁽²⁾	900	10% of reactor coolant
WHTs	—	—
Reactor containment cooling	500	0.1% of reactor coolant
Leakage inside containment (to containment sump)	10	167% of reactor coolant
Leakage outside containment	80	100% of reactor coolant
Equipment drainage	250	100% of reactor coolant
Spent fuel pool liner leakage	25	0.1% of reactor coolant
Miscellaneous drainage	675	0.1% of reactor coolant
Equipment and area decontamination	40 (normal) 3,000 (shutdown)	1% of reactor coolant
Sampling drainage	200	5% of reactor coolant
Detergent Drain Tank	---	---
Hot shower	0 (normal) 400 (shutdown)	10 ⁻⁷ µCi/gal
Hand wash	200 (normal) 1,500 (shutdown)	10 ⁻⁷ µCi/gal

Note:

1. Based on average letdown for normal fuel cycle operations.
2. Based on RCP Number 2 and Number 3 seal leakage flow rate.
3. Activity input to WHTs is expected to be 1% of reactor coolant. The activity of 100% of reactor coolant is used as a conservative value as input into the PWR-GALE code.

Table 12.2-73R Parameters for the US-APWR demineralizers

Component	Parameters				Inlet flow stream activity concentration	Note
	DF	Flow rate	Term of Service			
Mixed bed demineralizer	Kr, Xe=1, Br, I=100, Cs, Rb=2, Others=50	180 gpm	731 days		Table 12.2-13	These values in the left columns are listed in Table 11.1-1
Cation-bed demineralizer	Kr, Xe=1, Br, I=1, Cs, Rb=10, Others=10	18 gpm	731 days		Table 12.2-74	
Deborating demineralizer	Anion=100, Cs, Rb=1, Others=1	180 gpm	22 hours		Table 12.2-74	
NAPS DEP 9.2(1) B.A. evaporator feed <u>Degasifier feed demineralizer</u>	Anion=10, Cs, Rb=2, Others=10	30 gpm	780 hours		Table 12.2-75 <u>Table 12.2-75R</u>	
<u>NAPS DEP 9.2(1)</u>	Waste demineralizer (Anion-bed)	I=100, Cs, Rb=1, Others=1	90 gpm	280 hours <u>380 hours</u>	Table 12.2-37 ⁽¹⁾	
<u>NAPS DEP 9.2(1)</u>	Waste demineralizer (Cation-bed)	I=1, Cs, Rb=10, Others=10	90 gpm	280 hours <u>380 hours</u>	Table 12.2-76 ⁽¹⁾	
NAPS DEP 9.2(1)	Waste demineralizer (Mixed bed) in case of treating HT system	Kr, Xe=1, I=5, Cs, Rb=1, Others=10	30 gpm	780 hours	Table 12.2-77	Parameters used when treating distilled water in the boron recycle system
NAPS DEP 9.2(1)	Waste demineralizer (Mixed bed) in case of treating WHT system	Kr, Xe=1, I=100, Cs, Rb=2, Others=100	90 gpm	280 hours <u>380 hours</u>	Table 12.2-78R ⁽¹⁾	Parameters used when treating waste liquid in the waste liquid storage tank
	Spent fuel pit demineralizer	Kr, Xe=1, Br, I=100, Cs, Rb=2, Others=100	265 gpm	731 days	Table 12.2-34	
	SG Blowdown demineralizer	Br, I=100, Cs, Rb=100, Others=1000	1.554E+05 lb/hr	731 days	Table 11.1-5	

Note:

1. The inlet flow stream activity concentrations do not account for the dilution provided by the additional input from the degasifier.

ENCLOSURE 2

Response to NRC RAI Letter 90

RAI 5784, Question 12.02-15

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5784 (RAI Letter 90)

SRP SECTION: 12.02 – Radiation Sources

QUESTIONS for Health Physics Branch (CHPB)

DATE OF RAI ISSUE: 11/10/2011

QUESTION NO.: 12.02-15

10 CFR 20.1101(b) requires licensees to control external occupational exposure, and to ensure that engineering controls are used to keep occupational doses as low as is reasonable acceptable (ALARA). 10 CFR Part 50, General Design Criterion (GDC) 61 requires licensees to ensure that there is adequate shielding for routine activities in the area of equipment that may contain radioactivity. The guidance contained in NUREG 0800 Standard Review Plan (SRP) Section 12.2 "Radiation Sources" and Regulatory Guide 1.206 "Combined License Applications for Nuclear Power Plants (LWR Edition)" section C.I.12.2.1 "Contained Sources" states that the applicant is to provide the models, parameters and bases for all values used to calculate source magnitudes used as the basis for designing the radiation protection program and for shield design calculations. Table 12.2-73R "Parameters for the US-APWR demineralizers" states that the Decontamination Factors (DFs) for the Reactor Coolant Drain demineralizer are (Anion=10, Cs, Rb=2, Others=10). NAPS COL FSAR Table 12.2-75R "Inlet Flow Steam Activity of the Reactor Coolant Drain demineralizer" provides the radionuclide concentrations entering the Degasifier Feed/ Reactor Coolant Drain Demineralizer. However, the values presented in COL FSAR Table 12.2-201 "Chemical and Volume Control System Radiation Sources Degasifier Activity (Liquid Phase)" do not appear consistent with the inlet fluid activity stated in Table 12.2-75R and the decontamination factors stated in Table 12.2-73R.

Please describe the methods, models and assumptions that support NAPS COL FSAR Table 12.2-201, and explain how those methods, models, and assumptions are consistent with the stated assumptions used in NAPS COL FSAR Tables 12.2-73R and 12.2-75R, or describe an alternative approach that provides an acceptable method of

complying with those rules or regulations of the Commission, or portions thereof, that underlie the corresponding SRP acceptance criteria.

Dominion Response

The methods, models, and assumptions that support NAPS COL FSAR Table 12.2-201, "Chemical and Volume Control System Radiation Sources Degasifier Activity (Liquid Phase)," and Table 12.2-202, "Chemical and Volume Control System Radiation Sources Degasifier Source Strength (Liquid Phase)," are described below.

The reactor coolant in the holdup tanks is pumped to the degasifier through the degasifier feed demineralizer and degasifier feed filter. The degasifier is designed to have a processing capacity of 30 gpm, and is normally operated on an intermittent basis, but is capable of being operated continuously.

It is assumed that the holdup tank effluent continuously flows through the degasifier feed demineralizer into the degasifier and then discharges from the degasifier at 30 gpm when calculating the degasifier liquid phase radioactivity concentration. The degasifier liquid phase radioactivity concentrations for each set of parent and daughter nuclides are calculated by differential equations, which use time-dependent degasifier activities because the concentration of each nuclide may change while in the degasifier. The concentration changes result from 1) the addition of radioactivity due to inflow, 2) degasification, 3) radioactive decay, and 4) the removal of radioactivity due to outflow.

Using this calculation method, the degasifier liquid phase radioactivity concentration for each nuclide is essentially the same as the inflow and outflow radioactivity concentrations for nuclides with long half-lives since radioactive decay in the degasifier is minimal relative to the transit time through the degasifier. On the other hand, the degasifier liquid phase radioactivity concentration decreases for nuclides with short half-lives since radioactive decay can be significant while in the degasifier.

Degasifier Feed Demineralizer:

The radioactivity concentrations for each set of parent-daughter nuclides for the outflow of the degasifier feed demineralizer are calculated using the following:

1. Equations (1) & (2)
2. Calculation parameters as described in Table 1.
3. Table 12.2-75R, "Inlet Flow Stream Activity in Degasifier Feed Demineralizer," provides the radioactivity concentration of each nuclide in the flow stream to the degasifier feed demineralizer.

The parent nuclides in the outflow from the degasifier feed demineralizer are calculated considering their removal due to decontamination by the resin. The daughter nuclides in the outflow from the degasifier feed demineralizer are calculated considering their removal due to decontamination by the resin, and their addition due to decay from the accumulated parent nuclide concentration in the resin. The outflow radioactivity concentrations from the degasifier feed demineralizer are described by the following:

$$A_{DO} = \frac{A}{DF_A} \quad \text{Eq. (1)}$$

$$B_{DO} = \frac{B}{DF_B} + \lambda_B \cdot A_{DR} \cdot Y \cdot \frac{V_R}{Q} \cdot \frac{1}{DF_B} \quad \text{Eq. (2)}$$

Where:

- A_{DR} Parent nuclide radioactivity concentration in the demineralizer resin (Ci/cm³)
- A_{DO} Parent nuclide radioactivity concentration of the flow into the degasifier, which is the same as the radioactivity concentration of parent nuclide in the demineralizer outflow for long-lived parent nuclides (Ci/cm³)
- B_{DO} Daughter nuclide radioactivity concentration of the flow into the degasifier, which is the same as the radioactivity concentration of the daughter nuclide in the demineralizer outflow for long-lived daughter nuclides (Ci/cm³)
- A Parent nuclide radioactivity concentration of the flow into the demineralizer (Ci/cm³)
- B Daughter nuclide radioactivity concentration of the flow into the demineralizer (Ci/cm³)
- Q Inflow rate to the demineralizer (m³/s)
- V_R Volume of demineralizer resin (m³)
- DF_A Decontamination factor of parent nuclide
- DF_B Decontamination factor of daughter nuclide
- λ_B Decay constant of daughter nuclide (sec⁻¹)
- Y Yield rate of daughter nuclide due to parent nuclide disintegration

Table 1: Parameters Used in Calculating the Radioactivity Concentrations in Degasifier Feed Demineralizer Outflow

Parameter	Value	Units*	FSAR Reference
Flow rate (Q)	30	gpm	Table 12.2-73R
Volume of demineralizer resin (V _R)	70	ft ³	Table 12.2-65R
Decontamination Factor (DF)	Anion=10, Cs, Rb=2, Others=10	-	Table 12.2-73R

*Units require conversion for use in stated equations.

Degasifier:

The radioactivity concentrations in the inflow to the degasifier is the same as the outflow from the degasifier feed demineralizer. The radioactivity concentration for each set of parent and daughter nuclides in the liquid phase in the degasifier are calculated using the following:

1. Equations (3) & (4)
2. Calculation parameters described in Table 2.
3. The radioactivity concentrations in the outflow of the degasifier feed demineralizer are the same as in the inflow to the degasifier.

The liquid phase radioactivity concentrations in the degasifier are calculated by assuming that the noble gases in the inlet coolant flow to the degasifier are instantly converted to the vapor phase. This assumption is conservative for calculating the source strength of the vapor in the degasifier because there is less shielding in the vapor phase than in the liquid phase. The vapor phase in the degasifier has a smaller self-shielding effect than the liquid phase. The daughter nuclide generated from a parent is assumed to remain in the liquid phase.

The liquid phase radioactivity concentrations in the degasifier are calculated by use of the following equations (denoting the balance of inflow, outflow, and the decay of radionuclides in the liquid phase in the degasifier):

$$\frac{dA_L}{dt} = -\lambda_A \cdot A_L + \frac{A_{DO} \cdot Q \cdot (1-FS_A)}{V_L} \cdot \frac{Q_L}{V_L} \cdot A_L \quad \text{Eq. (3)}$$

$$\frac{dB_L}{dt} = -\lambda_B \cdot B_L + \frac{B_{DO} \cdot Q \cdot (1-FS_B)}{V_L} \cdot \frac{Q_L}{V_L} \cdot B_L + \lambda_B \cdot A_L \cdot Y \quad \text{Eq. (4)}$$

Where:

- A_L Radioactivity concentration of parent nuclide in degasifier liquid phase (Ci/cm^3)
- B_L Radioactivity concentration of daughter nuclide in degasifier liquid phase (Ci/cm^3)
- A_{DO} Radioactivity concentration of parent nuclide in effluent flowing into degasifier, which is calculated using equation (1) (Ci/cm^3)
- B_{DO} Radioactivity concentration of daughter nuclide in effluent flowing into degasifier, which is calculated using equation (2) (Ci/cm^3)
- λ_A Decay constant of parent nuclide (sec^{-1})
- λ_B Decay constant of daughter nuclide (sec^{-1})
- FS_A Degasification coefficient of parent nuclide
- FS_B Degasification coefficient of daughter nuclide
- V_L Volume of Degasifier liquid phase (m^3)
- Q Inflow rate to Degasifier (m^3/s)
- Q_L Outflow rate from Degasifier liquid phase (m^3/s)
- Y Yield rate of daughter nuclide due to disintegration of parent nuclide
- t Term of service (sec)

Table 2: Parameters Used to Calculate Degasifier Radioactivity Concentration (Liquid Phase)

Parameter	Value	Units*	FSAR References
Inflow rate (Q)	30	gpm	Table 12.2-73R Same as outflow from the degasifier feed demineralizer.
Outflow rate (Q_L)	30	gpm	Table 12.2-73R Same as inflow rate.
Volume in liquid phase (V_L)	95.4	ft^3	Table 12.2-1R (Sheet 3 of 6) $(27 \text{ in.})^2 \times \pi \times 72 \text{ in.} = 95.4 \text{ ft}^3$
Term of Service (t)	780	hr	Table 12.2-73R Same as degasifier feed demineralizer.
Degasification coefficient (FS)	Noble gases=1 Other=0	-	Subsection 12.2.1.1.3 E

*Units require conversion for use in stated equations.

The resulting radioactive concentrations for each nuclide in the degasifier liquid phase are identified in FSAR Table 12.2-201, "Chemical and Volume Control System Radiation Sources Degasifier Activity (Liquid Phase)." The nuclide concentrations in Table 12.2-201 are converted into the source strengths described in FSAR Table 12.2-

202, "Chemical and Volume Control System Radiation Sources Degasifier Source Strength (Liquid Phase)," using the MicroShield® code as described in DCD Subsection 12.2.1.3.

Proposed COLA Revision

None.

ENCLOSURE 3

Response to NRC RAI Letter 90

RAI 5980, Question 12.02-16

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**North Anna Unit 3
Dominion
Docket No. 52-017**

RAI NO.: 5980 (RAI Letter 90)

SRP SECTION: 12.02 – Radiation Sources

QUESTIONS for Health Physics Branch (CHPB)

DATE OF RAI ISSUE: 11/10/2011

QUESTION NO.: 14.03.08-1

The guidance contained in Regulatory Guide (RG) 8.8 "Information Relevant to Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as is Reasonably Achievable" states that the applicant should estimate the quantity and isotopic composition of the radioactive material to be contained, deposited, or accumulated in station equipment. The guidance contained in Regulatory Guide (RG) 1.206 "Combined License Applications for Nuclear Power Plants" Section C.1.12.2.1 "Contained Sources," states that the applicant is to provide the models, parameters and bases used to calculate source magnitudes, including isotopic composition for all values.

North Anna Power Station Unit 3 (NAPS) Combined License (COL) "Departures Report," states that NAPS DEP 9.2(1) "Replacement of Boron Recycle System with a Degasifier Subsystem," replaces the Boron Recycle System with a degasifier subsystem. NAPS COL FSAR Table 12.2-203 "Chemical and Volume Control System Radiation Sources Degasifier Activity (Vapor Phase)" and Table 12.2-204 "Chemical and Volume Control System Radiation Sources Degasifier Source Strength (Vapor Phase)" provide source concentrations for the activity contained in the vapor space of the degasifier. NAPS COL FSAR Section 12.2 "Radiation Sources" does not contain the methods models and assumptions, including stripping factors, used to determine these source term activity values for the degasifier as described in the guidance contained in SRP Section 12.2 and RG 1.206 Section C.1.12.2.1.

Please provide above information and revise the FSAR as appropriate.

Dominion Response

The activity and source strength of the vapor phase within the degasifier were determined using the following assumptions, equations and methodology:

Assumptions:

- 1) Once the feed stream enters the degasifier column, 100% of the noble gas radionuclides are removed from the liquid phase and enter into the vapor phase. All other nuclides remain in the liquid phase. This is a conservative assumption in the calculation of vapor phase activity concentrations and source strengths.
- 2) Any noble gases formed from the decay of parent nuclides in the liquid phase, after the process fluid has entered the degasifier column, are insignificant and remain within the liquid phase. Thus, they are not accounted for in the vapor phase source terms.

Equations:

The following set of differential equations and input parameters (Table 1 below) was used to calculate the radioactivity concentrations in the degasifier vapor phase:

$$\frac{dA_G}{dt} = -\lambda_A A_G + \frac{A_O Q F S_A}{V_G} - \frac{Q_G}{V_G} A_G$$

$$\frac{dB_G}{dt} = -\lambda_B B_G + \frac{B_O Q F S_B}{V_G} - \frac{Q_G}{V_G} B_G + \lambda_B A_G Y$$

Where:

- A_G = Radioactivity concentration of parent nuclide in the degasifier vapor phase ($\mu\text{Ci}/\text{cm}^3$)
- B_G = Radioactivity concentration of daughter nuclide in the degasifier vapor phase ($\mu\text{Ci}/\text{cm}^3$)
- A_O = Radioactivity concentration of parent nuclide in the degasifier feed ($\mu\text{Ci}/\text{cm}^3$)
- B_O = Radioactivity concentration of daughter nuclide in the degasifier feed ($\mu\text{Ci}/\text{cm}^3$)
- λ_A = Decay constant of parent nuclide (sec^{-1})
- λ_B = Decay constant of daughter nuclide (sec^{-1})
- $F S_A$ = Degasification coefficient of parent nuclide
- $F S_B$ = Degasification coefficient of daughter nuclide
- V_G = Volume of degasifier column (m^3)
- Q = Feed flow rate to degasifier column (m^3/s)
- Q_G = Exit flow rate of vapor phase from degasifier column (m^3/s)
- Y = Yield rate of daughter nuclide due to decay of parent nuclide
- t = Term of service (sec)

Table 1: Input Parameters for Radioactivity Concentrations in Degasifier Vapor Phase

Parameter	Value	Unit*	References
Feed flow rate	30	gpm	Table 12.2-73R
Exit flow rate	4.1E-4	m ³ /s	Same as that of the B.A. evaporator vent condenser
Volume in vapor phase	254	ft ³	Table 12.2-1R(Sheet 3 of 6) (27 in.) ² x π x 192 in. = 254 ft ³
Operation time	780	h	Table 12.2-73R
Degasification coefficient	Noble gases=1 Other=0	-	Subsection 12.2.1.1.3E

*Some units require conversion for use in stated equations.

Methodology:

The feed radioactivity concentration of each noble gas nuclide into the degasifier column was obtained from FSAR Table 12.2-75R, "Inlet Flow Stream Activity of Degasifier Feed Demineralizer." It is conservatively assumed that all of the noble gas radioactivity concentrations are unaffected by the feed demineralizer. However, it should be noted that the majority of the liquid phase nuclides contained within this table are removed by the feed demineralizer before the feed stream enters the degasifier. This consideration provides further justification for Assumption 2 as there are very low levels of liquid phase nuclides.

The above set of differential equations was used to solve for the radioactivity concentrations of the noble gas nuclides in the vapor phase. The results from these differential equations are presented in FSAR Table 12.2-203, "Chemical and Volume Control System Radiation Sources Degasifier Activity (Vapor Phase)."

The MicroShield[®] Code (version 7.02) was used to determine the source strengths of the degasifier vapor phase based on the calculated nuclide concentration activities. These results are presented in FSAR Table 12.2-204, "Chemical and Volume Control System Radiation Sources Degasifier Source Strength (Vapor Phase)."

A typographical error was identified in FSAR Table 12.2-1R involving the cylinder length of the approximate source geometry for the degasifier vapor phase. This has been corrected to 192 in.

Proposed COLA Revision

FSAR Table 12.2-1R and FSAR Section 12.2.1.1.3 will be revised as indicated on the attached markup.

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.

12.2 Radiation Sources

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

12.2.1.1.3 Chemical and Volume Control System

B. CVCS demineralizer

NAPS DEP 9.2(1)

Replace the second paragraph with the following.

The degasifier feed demineralizer is a mixed-bed style demineralizer and is provided to remove ionic impurities from the reactor coolant.

C. CVCS filters

NAPS DEP 9.2(1)

Replace the second sentence of the second paragraph with the following.

The source strength for the remaining filters corresponds to a dose rate of 100 rem/h at contact.

NAPS DEP 9.2(1)

Replace Section E with the following.

E. Degasifier

The degasifier is used to remove the dissolved noble gases (xenon and krypton) and other gases (hydrogen, iodine, oxygen, and nitrogen) from the primary coolant in order to meet the discharge limits for radionuclide concentrations in liquid effluents. Effluent from the holdup tanks is processed by the degasifier feed demineralizer and then sent to the degasifier, where dissolved gasses in the coolant are separated from the liquid phase to the gaseous phase. After degasification, the coolant is sent to the LWMS. The separated gases are sent to the degasifier vent condenser to remove the steam, and then transferred to the GWMS. The source terms for the degasifier and degasifier vent condenser are tabulated in Tables 12.2-201 through 12.2-206.

The source concentrations for the activity contained within the degasifier vapor phase, as shown in Table 12.2-203, are calculated based on the nuclide activities for the degasifier feed demineralizer tabulated in Table 12.2-75R, taking into account the decay of the noble gas radionuclides. The complete removal of the noble gas nuclides from the liquid feed stream is assumed in order to be conservative with respect to the vapor phase source terms. Therefore, a degasification coefficient of

1 is applied for the noble gas nuclides and a degasification coefficient of 0 is applied for all other nuclides which will remain in the liquid phase.

- NAPS DEP 9.2(1)** Delete DCD Section F.
- NAPS DEP 9.2(1)** Delete DCD Table 12.2-51.
- NAPS DEP 9.2(1)** Delete DCD Tables 12.2-66 through 12.2-69.
- NAPS DEP 9.2(1)** Delete DCD Table 12.2-77.

12.2.1.1.10 Miscellaneous Sources

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- NAPS DEP 9.2(1)** Replace the first three paragraphs of DCD Section 12.2.1.1.10 with the following.

The principal source of activity outside the buildings but inside the tank house is the refueling water storage auxiliary tank.

The content of the refueling water storage auxiliary tank is processed by the SFP purification system until the activity in the fluids is sufficiently low to result in dose rates less than 0.25 mrem/h at 2 meters from the surface of the tank.

Radionuclide inventory of the refueling water storage auxiliary tank is presented in DCD Table 12.2-50. There are no other significant amounts of radioactive fluids permanently stored outside the buildings.

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- NAPS COL 12.2(2)** Replace the second and third sentences of the sixth paragraph in DCD Subsection 12.2.1.1.10 with the following.

The IRSF described in Appendix 11AA will provide storage space for Class B and C low level radioactive waste. Information on the radiation protection aspects of the IRSF is included in Appendix 11AA. The radiation protection program (see Section 12.5) associated with this additional radwaste storage space is in place to ensure compliance with 10 CFR 20, 40 CFR 190 and to be consistent with the recommendations of RG 8.8.

Appendix 11AA contains radiation sources information for the IRSF.

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- STD COL 12.2(2)** Replace the second sentence of the seventh paragraph in DCD Subsection 12.2.1.1.10 with the following.

There are no additional radwaste facilities for dry active waste.

Table 12.2-1R Radiation Source Parameters (Sheet 3 of 6) (continued)

		Assumed Shielding Sources						
		Source Approximate Geometry as Cylinder Volume		Source Characteristics				
Components		Radius (in.)	Length (in.)	Type	Material	Density (lb/ft ³)	Equipment Self- Shielding (in.)	Quantity
NAPS DEP 9.2(1)	B.A. evaporator	26.0	188.5					
	<u>Degasifier</u>	<u>27.0</u>	<u>264.0</u>				ignored	1
	<u>Liquid Phase</u>		<u>72.0</u>	Homogeneous	Water	62.4		
	<u>Vapor Phase</u>		<u>192.0</u>	<u>Homogeneous</u>	<u>Air</u>	<u>7.6E-02</u>		
NAPS DEP 9.2(1)	B.A. evaporator <u>Degasifier vent condenser</u>	5.0	78.1	Homogeneous	Air	7.6E-02	ignored	<u>4 2</u>
NAPS DEP 9.2(1)	Boric acid tank	418.1	361.5	Homogeneous	Water	62.4	ignored	2

* Parameters from the US-APWR demineralizers are tabulated in Table 12.2-73.