NUSCALE POWER™

RAIO-0618-60288

June 04, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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One White Flint North
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Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 329 (eRAI No. 9270) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 329 (eRAI No. 9270)," dated January 08, 2018

The purpose of this letter is to provide the NuScale Power, LLC (NuScale) response to the referenced NRC Request for Additional Information (RAI).

The Enclosure to this letter contains NuScale's response to the following RAI Questions from NRC eRAI No. 9270:

- 12.02-19
- 12.02-20

This letter and the enclosed response make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Steven Mirsky at 240-833-3001 or at smirsky@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9270

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9270

Response to Request for Additional Information
Docket No. 52-048

eRAI No.: 9270
Date of RAI Issue: 01/08/2018

NRC Question No.: 12.02-19

Regulatory Basis

10 CFR 52.47(a)(5) requires applicants to identify the kinds and quantities of radioactive materials expected to be produced during operation and the means for controlling and limiting radiation exposures within the limits set forth in 10 CFR Part 20. 10 CFR 20.1101(b) and 10 CFR 20.1003, require the use of engineering controls to maintain exposures to radiation as far below the dose limits in 10 CFR Part 20 as is practical. 10 CFR 20.1204, “Determination of Internal Exposure” and 10 CFR 20.1702, “Use of Other Controls,” requires occupational radiation exposure (ORE) be the sum of external and internal radiation exposure. 10 CFR 20.1701, “Use of Process or Other Engineering Controls” requires the use of engineering controls (e.g., ventilation,) to control the amount of radioactive material in air.

NuScale Design Specific Review Standard (DSRS) section 12.2 “Radiation Source,” regarding the identification of isotopes and the methods, models and assumptions used to determine dose rates. The Acceptance Criteria provided in NuScale DSRS section 12.3 “Radiation Protection Design Feature,” provides guidance to the staff for evaluating the potential for airborne radioactivity areas within the facility.

NuScale DSRS section 12.2 “Acceptance Criteria,” states in part, that for nuclear power plants designed for the recycling of tritiated water, tritium concentrations in contained sources and airborne concentrations should be based on a primary coolant concentration of 1.3x10+5 Bq/gm (3.5 μCi/gm), or an alternate value for which the methods, models, and assumptions have been provided in the application.

Background

NuScale Design Control Document (DCD) Tier 2 Revision 0, subsection 12.2.1 “Contained Sources,” states that the contained radiation sources are developed for normal operation and shutdown conditions and are based on the design basis primary coolant activity concentrations from DCD Tier 2, Section 11.1. DCD Tier 2 Revision 0, Table 12.2-32: “Input Parameters for Determining Facility Airborne Concentrations,” states that the primary coolant source terms are derived from DCD Tier 2 Revision 0, Table 11.1- 4.

NuScale Technical Report (TR) TR-1116-52065 Revision 0, “Effluent Release (GALE

Replacement) Methodology and Results," Figure 4-2, "Tritium reactor coolant system balance," shows a peak Reactor Coolant System (RCS) tritium content of about 75 Ci. DCD Tier 2 Revision 0, Table 11.1-2: "Parameters Used to Calculate Coolant Source Terms," list the Reactor coolant system mass as 117,400 lbm (5.325174e+007 grams.) Based on the listed RCS mass, and the shown RCS tritium content, the peak RCS tritium concentration would be about 1.4 µCi/gm. TR-1116-52065 subsection 4.1.1 "Water Activation Products ," uses RCS makeup water (for boron dilution) over the operating cycle (as shown in Figure 4-2, "Tritium reactor coolant system balance,") to calculate a time weighted RCS tritium concentration of 0.97 µCi/ml. This is shown in TR-1116-52065 Figure 4-3, "Tritium concentration and time weighted average," which provides "Tritium Concentration in RCS - No Recycle (uCi/g)" versus "Time (years)." Consistent with this analysis DCD Tier 2 Revision 0, Table 11.1-4, "Primary Coolant Design Basis Source Term," lists the RCS tritium (H3) concentration as 9.7000E-01 µCi/g. Based on information made available to the staff during the RPAC Chapter 12 audit, the staff determined that the RCS tritium concentration listed in Table 11.1-4 was derived by assuming no recycling of RCS, that is, all make up water supplied to the RCS during the operating cycle was assumed to contain zero radioactivity, including tritium.

Multiple statements in DCD Section 11.2, "Liquid Waste Management System," state that processed RCS liquids may be recycled for use in the RCS. The description of the Chemical and volume control system (CVCS) provided in DCD Section 9.3.4.2.1, "General Description," states recycled, degassed reactor coolant from the LRWS can also be added back to the CVCS by a supply line upstream of the makeup pumps. DCD Tier 2, Revision 0, Figure 9.3.4-1: "Chemical and Volume Control System Diagram," shows a return from the LRWS (liquid radioactive waste system).

TR-1116-52065 does not provide a discussion about the impact of recycled RCS on the RCS tritium concentration. The most immediate impact is that the concentration of the RCS tritium will be higher because the makeup water will be supplied at the tritium concentration previously in the RCS. The longer term impact is from the change in the macroscopic cross section of deuterium used to determine the amount of tritium produced by activation of water. The macroscopic cross section of deuterium is based on the microscopic cross section of deuterium (which does not change) and the relative atomic abundance of deuterium. With recycling, the relative atomic abundance of deuterium will increase over time due to activation of mono-nucleon hydrogen contained in the water. Based on the review of documents made available to the staff during the RPAC Chapter 12 Audit, the staff determined that the applicant assumed a constant cross section for the production of tritium from the neutron activation of water in the reactor core.

Key Issue 1:

Because the methodology used by the applicant to calculate the tritium production rate in the RCS does not account for the change in atomic abundance of deuterium in the RCS over time, it underestimates the total production of tritium due to neutron activation of water. Since airborne activity concentrations in equipment cubicles is more dependent on RCS activity concentrations, and less on ultimate heat sink (UHS) pool tritium concentration, the airborne tritium activity concentrations in equipment cells may be underestimated by over a factor of 3.

Question 1:

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions with respect to the potential production of tritium in the RCS, the staff requests that the applicant:

- In light of the information above, describe, with regard to the production of tritium, how NuScale accounts for the buildup of deuterium over the operating life of the facility,
- Describe the methods, models, and assumptions used to evaluate and account for the increased production of tritium due to the buildup of deuterium,
- As necessary, revise DCD Table 11.1-2 to reflect the methods, models and assumptions related to the buildup of deuterium and resultant increased tritium production rate over time,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

A study of the consequence of deuterium buildup in the reactor coolant system (RCS) over the life of the plant (60 years) from recycling primary coolant through the liquid radioactive waste system back to the reactor coolant system as makeup water was performed.

This study conservatively balanced the production of deuterium in 12 NuScale Power Modules (NPMs) with the dilution by the pool water each refueling event (effectively half of the total primary coolant inventory by mass every year, assuming six refueling outages per year in a 12 unit facility).

This calculation also accounted for the increase of deuterium in the pool as described in the Response to RAI 9259. Assuming the simultaneous operation of 12 NPMs, the maximum deuterium concentration in the RCS was calculated to be 8.72E18 atoms/gram, based on a natural deuterium concentration of 7.7E18 atoms/gram. This peak deuterium concentration was used in the activation calculation of deuterium to determine the production rate of tritium from deuterium. The production rate of tritium from deuterium activation in the core increased from 6.9E-3 µCi/second to 7.81E-3 µCi/second, representing an increased tritium production of 9.1E-4 µCi/second due to deuterium buildup. The production rate of tritium from the $B^{10}(n, H^3)B^8$ reaction in the core is 1.36 µCi/second, over three orders of magnitude greater than this small increase. The increased tritium product rate from deuterium buildup is too small to have any impact on the tritium values reported in FSAR Chapters 11 and 12. No change to FSAR Table 11.1-2 is required as a result of this RAI.

Impact on DCA:

There are no impacts to the DCA as a result of this response.

Response to Request for Additional Information
Docket No. 52-048

eRAI No.: 9270
Date of RAI Issue: 01/08/2018

NRC Question No.: 12.02-20

The Regulatory Basis and Background are in RAI-9270 Quesiton 31001

Key Issue 2:

The methodology used by the applicant to calculate the tritium concentration in the RCS does not account for the buildup of tritium due to recycling of previously used RCS, therefore RCS tritium concentration appears to be underestimated. NuScale has proposed an alternative and potentially non-conservative design basis RCS tritium concentration value, which is used for determining airborne activity concentrations within the plant, without demonstrating that the health and safety of occupational workers is maintained and that the potential doses are ALARA for compliance with 10 CFR Part 20. Since airborne activity concentrations in equipment cubicles is more dependent on RCS activity concentrations, and less on ultimate heat sink (UHS) pool tritium concentration, the airborne tritium activity concentrations in equipment cells may be underestimated by over a factor of 3

Question 2:

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions with respect to the potential production of tritium in the RCS, the staff requests that the applicant:

- Explain the use of an apparent non-conservative tritium value as discussed above, and
- Revise DCD Chapter 12.2 to use an RCS tritium concentration value of 1.3x10+5 Bq/gm (3.5 μCi/gm), or revise DCD Chapter 12.2 to use a calculated RCS tritium concentration supported by the associated, including methods, models and assumptions, for determining the RCS coolant concentration of tritium, consistent with the system description provided in DCD Tier 2 Revision 0, including sections in Chapters 9 and sections in Chapter 11,

AND

- Revise DCD Section 12.2.2 “Airborne Radioactive Material Sources,” to reflect the changes to RCS tritium concentration and the associated bases,

AND

- Revise DCD Table 12.2-32: “Input Parameters for Determining Facility Airborne Concentrations,” to reflect the revised methods, models and assumptions,

AND

- Revised DCD Table 12.2-33: “Reactor Building Airborne Concentrations,” to reflect the changes to tritium concentrations,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

NuScale revised the airborne source term calculation to evaluate two different primary coolant recycling modes of operation related to the primary coolant letdown so that the radionuclide concentrations, particularly tritium, are maximized in the fluid of interest. The first recycling mode of operation models the recycling of primary coolant letdown as pool water makeup, resulting in the maximum buildup of tritium in the reactor pool water, and the greatest tritium release as gaseous effluents and airborne concentrations above the pool due to reactor pool water evaporation. The second recycling mode of operation models the recycling of primary coolant letdown as makeup back to the primary coolant system. This second recycling mode results in the maximum tritium buildup in the primary coolant, which results in the highest radionuclide airborne concentration in plant spaces due to primary coolant leaks from CVCS and the degasifier. FSAR Section 12.2.2.1 and Section 11.1.1.2 have been revised to describe these recycling modes. The primary and secondary coolant source terms listed in FSAR Section 11.1 have also been revised.

The results from the first recycling mode of operation are used to report the radionuclide airborne concentrations in the air spaces above the reactor pool, based on a revised reactor pool liquid source term, provided in FSAR Table 12.2-10, and input assumptions provided in Table 12.2-32. The results from the second recycling mode of operation are used to report the radionuclide airborne concentrations in the occupied air spaces where primary coolant leaks could occur. These revised results are provided in FSAR Table 12.2-33.

Impact on DCA:

FSAR Section 11.1.1.2, Section 12.2.2.1, Tables 11.1-4 through 11.4-7, Table 11.1-8, Table 12.2-10, Table 12.2-32, and Table 12.2-33 have been revised as described in the response above and as shown in the markup provided in this response.

isotopes. The resultant equation used to calculate the activity of the daughter fission products in the primary coolant is,

$$A_{cd} = \frac{A_{fd} \times f \times R_p + A_{cp} \times \lambda_d \times f_p}{\lambda_d + \lambda_L + \lambda_U} \qquad \text{Eq. 11.1-4}$$

where,

A_{cd} = The activity of the daughter nuclide in the primary coolant (Ci),

A_{fd} = The activity of the daughter nuclide in the fuel (Ci),

f_p = The branching fraction of the parent nuclide that decays to the daughter isotope, and

λ_d = The decay constant of the daughter isotope (s^{-1}).

11.1.1.2 Activation Products

The tritium in the RCS originating from the fuel is handled differently. Instead of using a core inventory and escape rate coefficient, the permeation of tritium from the fuel to the primary coolant is modeled using the EPRI Tritium Management Model (Reference 11.1-4). The tritium permeation rate of 0.0003 Curies per minute is linearly scaled from 4100 MWt to 160 MWt, and adjusted for a 95 percent unit capacity factor.

In the primary coolant system, neutron activation of various constituents in the water forms activation products. These activation products are independent of the failed fuel fraction. The neutron activation products include N-16, H-3, Ar-41, and C-14.

Nitrogen-16 results from neutron reaction of oxygen-16 in the primary water. Nitrogen-16 has an energetic gamma, but a very short half-life. Because of its short half-life (7.1 seconds), N-16 is not of concern for offsite dose considerations. Given the low flow velocity of the primary coolant and the resulting longer transport time, N-16 is also not a shielding issue outside of the NPM. Table 12.2-5 lists the N-16 concentration at various locations in the primary coolant loop.

Tritium is produced in the primary coolant by neutron activation from several different reactions. The predominant tritium production reactions are high-energy neutron interactions with lithium and boron isotopes. Tritium is also produced by ternary fission of U-235, but only a small fraction of the total tritium produced in the fuel diffuses through the cladding into the coolant. Once the tritium is generated, it will move throughout the plant systems, until ultimately being released via both the liquid and gaseous effluent pathways.

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The concentration of tritium in the coolant streams will vary depending on whether the primary coolant letdown to LRWS is recycled to the reactor pool, recycled back to CVCS makeup, or discharged through LRWS. The various tritium concentrations are presented in Table 11.1-8.

Argon-41 results from the neutron activation of Ar-40, which is a natural component of air. The primary reactor coolant is degassed early in the operating cycle to minimize the content of dissolved air. There is a small amount of Ar-41produced as a fission product that may leak into the primary coolant through an assumed defect in the fuel cladding. Argon-41 could also be produced in the space surrounding the reactor vessel, however this potential is significantly reduced due to the reduced air environment resulting from the vacuum maintained in this area during operations. Although argon-41 can also be produced by the neutron activation of the reactor pool water surrounding the NPMs, the neutron flux outside the NPM is approximately six orders of magnitude less that the average core flux, and therefore, the small amount of pool water activation is negligible in comparison to the radioactivity that gets released to the pool water from the reactor coolant system during refueling outages. In the absence of significant N-16 in the primary coolant near the steam generators, natural argon can be injected into the primary coolant to improve the sensitivity of primary-to-secondary leak rate calculations. When the injected argon is activated in the reactor core, Ar-41 is produced, which can be used to detect leakage from the primary system. Operators may inject argon into the primary system to maintain a consistent level of Ar-41 in the primary coolant.

Carbon-14 results from the activation of carbon, nitrogen, or oxygen. The predominant reactions in a light water reactor are:

- $^{14}N(n,p)\ ^{14}C$, and
- $^{17}O(n,\alpha)\ ^{14}C$.

The equilibrium amount of C-14 activity in the primary coolant is dependent on the fraction of C-14 retained in the coolant, which is a function of the removal rate by the chemical and volume control system (CVCS) demineralizers, and the letdown removal rate through the degasifier.

It is conservatively assumed that 1% of the C-14 produced is retained in the primary coolant. As an additional conservatism, it is also assumed that the removal of C-14 by the CVCS demineralizers is zero.

The majority of C-14 produced is from the activation of O-17 in the primary coolant. The C-14 primary coolant equilibrium activity is calculated using the following equation:

$$A_{C14} = \frac{P_{C14} \times f}{\lambda_d + \lambda_L + \lambda_U} \qquad \text{Eq. 11.1-5}$$

where,

A_{C14} = The equilibrium activity of C-14 in the primary coolant (Ci),

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Table 11.1-4: Primary Coolant Design Basis Source Term

Nuclide	Primary Coolant Concentrations (Ci/g)	Nuclide	Primary Coolant Concentrations (Ci/g)
Noble Gases		Other FPs (continued)	
Kr83m	4.9E-09	Mo101	2.7E-10
Kr85m	2.1E-08	Tc99m	6.7E-09
Kr85	6.1E-06	Tc99	2.1E-13
Kr87	1.1E-08	Ru103	6.9E-12
Kr88	3.3E-08	Ru105	2.3E-12
Kr89	7.5E-10	Ru106	4.5E-12
Xe131m	8.0E-08	Rh103m	6.8E-12
Xe133m	7.3E-08	Rh105	4.8E-12
Xe133	5.4E-06	Rh106	4.5E-12
Xe135m	7.0E-09	Ag110	5.2E-12
Xe135	1.8E-07	Sb124	1.0E-14
Xe137	2.4E-09	Sb125	8.9E-14
Xe138	8.3E-09	Sb127	3.9E-13
Halogens		Sb129	4.8E-13
Br82	1.4E-10	Te125m	1.3E-11
Br83	7.8E-10	Te127m	4.2E-11
Br84	3.6E-10	Te127	1.7E-10
Br85	4.4E-11	Te129m	1.2E-10
I129	3.4E-15	Te129	1.7E-10
I130	1.1E-09	Te131m	4.0E-10
I131	2.8E-08	Te131	1.9E-10
I132	1.3E-08	Te132	2.9E-09
I133	4.3E-08	Te133m	2.5E-10
I134	7.6E-09	Te134	3.5E-10
I135	2.7E-08	Ba137m	1.9E-08
Rubidium, Cesium		Ba139	6.5E-12
Rb86m	3.2E-14	Ba140	3.5E-11
Rb86	1.9E-10	La140	1.0E-11
Rb88	3.3E-08	La141	2.0E-12
Rb89	1.5E-09	La142	9.6E-13
Cs132	3.7E-12	Ce141	5.5E-12
Cs134	3.3E-08	Ce143	4.1E-12
Cs135m	2.5E-11	Ce144	4.6E-12
Cs136	7.1E-09	Pr143	4.9E-12
Cs137	2.0E-08	Pr144	4.5E-12
Cs138	1.2E-08	Np239	8.7E-11
Other FPs		Corrosion/Activation Products - Crud	
P32	5.5E-16	Na24	9.1E-09
Co57	4.1E-18	Cr51	5.2E-10
Sr89	2.5E-11	Mn54	2.7E-10
Sr90	5.5E-12	Fe55	2.0E-10
Sr91	1.3E-11	Fe59	5.0E-11
Sr92	6.8E-12	Co58	7.7E-10

Table 11.1-4: Primary Coolant Design Basis Source Term

Nuclide	Primary Coolant Concentrations (Ci/g)	Nuclide	Primary Coolant Concentrations (Ci/g)
Y90	1.3E-12	Co60	8.8E-11
Y91m	6.8E-12	Ni63	4.4E-11
Y91	3.6E-12	Zn65	8.5E-11
Y92	5.8E-12	Zr95	6.5E-11
Y93	2.7E-12	Ag110m	2.2E-10
Zr97	4.0E-12	W187	4.7E-10
Nb95	5.8E-12	Water Activation Products	
Mo99	7.2E-09	C14	2.2E-10
		Ar41	2.1E-07

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Table 11.1-5: Secondary Coolant Design Basis Source Term

Nuclide	Secondary Coolant Concentrations (Ci/g)	Nuclide	Secondary Coolant Concentrations (Ci/g)
Noble Gases		Other FPs (continued)	
Kr83m	2.9E-14	Mo101	1.2E-15
Kr85m	1.2E-13	Tc99m	3.9E-14
Kr85	3.6E-11	Tc99	1.2E-18
Kr87	6.6E-14	Ru103	4.1E-17
Kr88	1.9E-13	Ru105	1.3E-17
Kr89	4.4E-15	Ru106	2.6E-17
Xe131m	4.7E-13	Rh103m	3.7E-17
Xe133m	4.3E-13	Rh105	2.8E-17
Xe133	3.2E-11	Rh106	2.7E-18
Xe135m	4.1E-14	Ag110	2.6E-18
Xe135	1.1E-12	Sb124	6.0E-20
Xe137	1.4E-14	Sb125	5.3E-19
Xe138	4.8E-14	Sb127	2.3E-18
Halogens		Sb129	2.8E-18
Br82	8.1E-16	Te125m	7.8E-17
Br83	4.5E-15	Te127m	2.5E-16
Br84	1.9E-15	Te127	9.9E-16
Br85	1.0E-16	Te129m	7.2E-16
I129	2.0E-20	Te129	9.6E-16
I130	6.5E-15	Te131m	2.3E-15
I131	1.7E-13	Te131	9.8E-16
I132	7.4E-14	Te132	1.7E-14
I133	2.5E-13	Te133m	1.4E-15
I134	4.2E-14	Te134	1.9E-15
I135	1.6E-13	Ba137m	4.2E-14
Rubidium, Cesium		Ba139	3.7E-17
Rb86m	3.7E-20	Ba140	2.1E-16
Rb86	1.3E-15	La140	6.1E-17
Rb88	1.7E-13	La141	1.2E-17
Rb89	7.5E-15	La142	5.5E-18
Cs132	2.4E-17	Ce141	3.2E-17
Cs134	2.2E-13	Ce143	2.4E-17
Cs135m	1.5E-16	Ce144	2.7E-17
Cs136	4.6E-14	Pr143	2.9E-17
Cs137	1.3E-13	Pr144	2.2E-17
Cs138	6.8E-14	Np239	5.1E-16
Other FPs		Corrosion/Activation Products - Crud	
P32	3.3E-21	Na24	5.4E-14
Co57	2.4E-23	Cr51	3.1E-15
Sr89	1.5E-16	Mn54	1.6E-15
Sr90	3.3E-17	Fe55	1.2E-15
Sr91	7.5E-17	Fe59	3.0E-16
Sr92	3.9E-17	Co58	4.6E-15

Table 11.1-5: Secondary Coolant Design Basis Source Term

Nuclide	Secondary Coolant Concentrations (Ci/g)	Nuclide	Secondary Coolant Concentrations (Ci/g)
Y90	7.9E-18	Co60	5.2E-16
Y91m	3.7E-17	Ni63	2.6E-16
Y91	2.1E-17	Zn65	5.0E-16
Y92	3.4E-17	Zr95	3.9E-16
Y93	1.6E-17	Ag110m	1.3E-15
Zr97	2.4E-17	W187	2.7E-15
Nb95	3.4E-17	Water Activation Products	
Mo99	4.3E-14	C14	1.3E-15
		Ar41	1.2E-12

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Table 11.1-6: Primary Coolant Realistic Source Term

Nuclide	**Primary Coolant Concentrations (Ci/g)**	**Nuclide**	**Primary Coolant Concentrations (Ci/g)**
Noble Gases		Other FPs (continued)	
Kr83m	4.9E-10	Mo101	2.7E-11
Kr85m	2.1E-09	Tc99m	6.7E-10
Kr85	1.8E-07	Tc99	2.1E-14
Kr87	1.1E-09	Ru103	6.9E-13
Kr88	3.3E-09	Ru105	2.3E-13
Kr89	7.5E-11	Ru106	4.5E-13
Xe131m	7.4E-09	Rh103m	6.8E-13
Xe133m	7.2E-09	Rh105	4.8E-13
Xe133	5.3E-07	Rh106	4.5E-13
Xe135m	7.0E-10	Ag110	3.2E-12
Xe135	1.8E-08	Sb124	1.0E-15
Xe137	2.4E-10	Sb125	8.9E-15
Xe138	8.3E-10	Sb127	3.9E-14
Halogens		Sb129	4.8E-14
Br82	1.4E-11	Te125m	1.3E-12
Br83	7.8E-11	Te127m	4.2E-12
Br84	3.6E-11	Te127	1.7E-11
Br85	4.4E-12	Te129m	1.2E-11
I129	3.4E-16	Te129	1.7E-11
I130	1.1E-10	Te131m	4.0E-11
I131	2.8E-09	Te131	1.9E-11
I132	1.3E-09	Te132	2.9E-10
I133	4.3E-09	Te133m	2.5E-11
I134	7.6E-10	Te134	3.5E-11
I135	2.7E-09	Ba137m	1.9E-09
Rubidium, Cesium		Ba139	6.5E-13
Rb86m	3.2E-15	Ba140	3.5E-12
Rb86	1.9E-11	La140	1.0E-12
Rb88	3.3E-09	La141	2.0E-13
Rb89	1.5E-10	La142	9.6E-14
Cs132	3.7E-13	Ce141	5.5E-13
Cs134	3.3E-09	Ce143	4.1E-13
Cs135m	2.5E-12	Ce144	4.6E-13
Cs136	7.0E-10	Pr143	4.9E-13
Cs137	2.0E-09	Pr144	4.5E-13
Cs138	1.2E-09	Np239	8.7E-12
Other FPs		Corrosion/Activation Products - Crud	
P32	5.5E-17	Na24	9.1E-09
Co57	4.1E-19	Cr51	5.2E-10
Sr89	2.5E-12	Mn54	2.7E-10
Sr90	5.5E-13	Fe55	2.0E-10
Sr91	1.3E-12	Fe59	5.0E-11
Sr92	6.8E-13	Co58	7.7E-10

Table 11.1-6: Primary Coolant Realistic Source Term

Nuclide	Primary Coolant Concentrations (Ci/g)	Nuclide	Primary Coolant Concentrations (Ci/g)
Y90	1.3E-13	Co60	8.8E-11
Y91m	6.8E-13	Ni63	4.4E-11
Y91	3.6E-13	Zn65	8.5E-11
Y92	5.8E-13	Zr95	6.5E-11
Y93	2.7E-13	Ag110m	2.2E-10
Zr97	4.0E-13	W187	4.7E-10
Nb95	1.0E-12	Water Activation Products	
Mo99	7.2E-10	C14	2.2E-10
		Ar41	1.4E-07

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Table 11.1-7: Secondary Coolant Realistic Source Term

Nuclide	Secondary Coolant Concentrations (Ci/g)	Nuclide	Secondary Coolant Concentrations (Ci/g)
Noble Gases		Other FPs (continued)	
Kr83m	1.4E-16	Mo101	5.8E-18
Kr85m	5.7E-16	Tc99m	1.8E-16
Kr85	5.0E-14	Tc99	5.7E-21
Kr87	3.1E-16	Ru103	1.9E-19
Kr88	9.1E-16	Ru105	6.2E-20
Kr89	2.1E-17	Ru106	1.2E-19
Xe131m	2.1E-15	Rh103m	1.8E-19
Xe133m	2.0E-15	Rh105	1.3E-19
Xe133	1.5E-13	Rh106	1.3E-20
Xe135m	1.9E-16	Ag110	7.6E-20
Xe135	5.1E-15	Sb124	2.8E-22
Xe137	6.7E-17	Sb125	2.5E-21
Xe138	2.3E-16	Sb127	1.1E-20
Halogens		Sb129	1.3E-20
Br82	3.8E-18	Te125m	3.7E-19
Br83	2.1E-17	Te127m	1.2E-18
Br84	8.9E-18	Te127	4.6E-18
Br85	4.9E-19	Te129m	3.4E-18
I129	9.4E-23	Te129	4.5E-18
I130	3.0E-17	Te131m	1.1E-17
I131	7.9E-16	Te131	4.6E-18
I132	3.5E-16	Te132	8.0E-17
I133	1.2E-15	Te133m	6.4E-18
I134	2.0E-16	Te134	8.8E-18
I135	7.4E-16	Ba137m	2.0E-16
Rubidium, Cesium		Ba139	1.7E-19
Rb86m	1.7E-22	Ba140	9.9E-19
Rb86	5.9E-18	La140	2.9E-19
Rb88	7.9E-16	La141	5.5E-20
Rb89	3.5E-17	La142	2.6E-20
Cs132	1.1E-19	Ce141	1.5E-19
Cs134	1.0E-15	Ce143	1.2E-19
Cs135m	7.1E-19	Ce144	1.3E-19
Cs136	2.2E-16	Pr143	1.4E-19
Cs137	6.2E-16	Pr144	1.0E-19
Cs138	3.2E-16	Np239	2.4E-18
Other FPs		Corrosion/Activation Products - Crud	
P32	1.5E-23	Na24	2.5E-15
Co57	1.1E-25	Cr51	1.4E-16
Sr89	6.8E-19	Mn54	7.5E-17
Sr90	1.5E-19	Fe55	5.6E-17
Sr91	3.5E-19	Fe59	1.4E-17
Sr92	1.9E-19	Co58	2.1E-16

Table 11.1-7: Secondary Coolant Realistic Source Term

Nuclide	Secondary Coolant Concentrations (Ci/g)	Nuclide	Secondary Coolant Concentrations (Ci/g)
Y90	3.7E-20	Co60	2.5E-17
Y91m	1.8E-19	Ni63	1.2E-17
Y91	9.9E-20	Zn65	2.4E-17
Y92	1.6E-19	Zr95	1.8E-17
Y93	7.5E-20	Ag110m	6.1E-17
Zr97	1.1E-19	W187	1.3E-16
Nb95	2.9E-19	Water Activation Products	
Mo99	2.0E-16	C14	6.2E-17
		Ar41	3.8E-14

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Table 11.1-8: Tritium Concentrations versus Primary Coolant Recycling Modes

Recycle Mode	Primary Coolant Average Concentration (Ci/g)	RCS Letdown / CVCS Outlet (Ci/g)	Realistic Secondary Coolant Concentration (Ci/g)	Design Basis Secondary Coolant Concentration (Ci/g)
No recycle (discharge)	9.6E-07	7.2E-07	1.8E-09	---
Recycle to reactor pool makeup	9.9E-07	7.4E-07	1.8E-09	---
Recycle back to CVCS makeup	2.8E-06	2.8E-06	---	5.2E-09

envelope at the technical specification leak rate and remains in the envelope's volume for the duration of the event. Table 12.2-36 provides the maximum post-accident activity concentrations in the NPM on a mass basis. These concentrations apply to both the liquid and vapor spaces. Other major assumptions for the post-accident source term are listed in Table 12.2-29. ~~The release fractions and containment aerosol removal rates are shown in Table 12.2-30 and Table 12.2-31, respectively.~~ Plateout of activity onto containment surfaces is neglected due to the small containment volume and the lack of surface coatings inside containment. There is also no aerosol removal assumed. The containment air and water volumes are determined based on the reactor vessel being initially full of water and the reactor vessel and containment vessel water levels being in equilibrium. There are ~~four~~three volumes that are evaluated ~~for~~, which includes the post-accident source term. Table 12.2-32 lists the integrated post-accident source energy deposition versus time for both photons and electrons for these ~~four~~three volumes. Table 12.2-32 also tabulates the integrated doses for various times post-accident. For additional details on equipment qualification, see Section 3.11 and Appendix 3.C.

12.2.1.14 Other Contained Sources

There are no other identified contained sources that exceed 100 mCi, including HVAC filters. To evaluate the accumulation of radioactive material on the Reactor Building HVAC system HEPA filters, the airborne radioactivity in the Reactor Building due to pool evaporation and primary coolant leaks was deposited on filters assuming a 99 percent particulate efficiency and two years of operation. For the pool evaporation portion, the Reactor Building HVAC system provides a ventilation flow rate equivalent to one air volume change per hour. For the primary coolant leakage portion, the activity that becomes airborne is captured and filtered by the ventilation system. The resultant accumulation of radioactive material is less than 100 mCi.

COL Item 12.2-1: A COL applicant that references the NuScale Power Plant design certification will describe additional site-specific contained radiation sources that exceed 100 millicuries (including sources for instrumentation and radiography) not identified in Section 12.2.1.

12.2.2 Airborne Radioactive Material Sources

This section describes the airborne radioactive material sources that form part of the basis for design of ventilation systems and personnel protective measures, and also are considered in personnel dose assessment.

12.2.2.1 Reactor Building Atmosphere

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Airborne radioactivity may be present in the RXB atmosphere due to reactor pool evaporation or primary coolant leakage. The airborne concentration is modeled as a buildup to an equilibrium concentration based on Bevelacqua (Reference 12.2-1) given the production rate and removal rate. The concentration of tritium in the reactor pool water is developed assuming the primary coolant letdown in recycled to the reactor pool. The concentration of tritium in the primary coolant leakage is developed assuming the primary coolant letdown is recycled back to the reactor coolant system. Each case maximizes the tritium concentration in the fluid of interest. These values are reported in Table 11.1-8. The airborne concentration in the air space above the reactor pool is determined by using the peak reactor pool water source term. The input parameters are listed in Table 12.2-33.

$$A(\infty) = (C_{pool} \times p_f \times F_{evap}) / (\lambda + (F_{air} / V_{air}))$$

where,

$A(\infty)$ = equilibrium airborne concentration,

C_{pool} = pool water concentration,

p_f = partition fraction,

F_{evap} = pool evaporation rate,

λ = decay constant, and

F_{air}/V_{air} = air change rate.

Primary coolant leaks can occur in the RXB from the CVCS. In areas that are routinely occupied, the RXB heating ventilation and air conditioning system provides sufficient air flow to maintain airborne concentrations to acceptable levels where CVCS leaks are a potential. The airborne concentrations in the RXB cubicles are determined using the same equilibrium model as the reactor pool area, but using CVCS leaks for the production term.

$$A(\infty) = (PCA \times p_{leak} \times p_f \times F_{leak}) / (\lambda + (F_{air}/V_{air}))$$

where,

$A(\infty)$ = equilibrium airborne concentration,

PCA = primary coolant activity concentration,

p_{leak} = leak flashing fraction,

p_f = partition fraction,

F_{leak} = primary coolant leak rate,

λ = radioactive decay constant, and

F_{air}/V_{air} = air change rate.

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Table 12.2-10: Reactor Pool Cooling, Spent Fuel Pool Cooling, Pool Cleanup and Pool Surge Control System Component Source Terms - Radionuclide Content

Isotope	RPCS Heat Exchanger (Ci)	Spent Fuel Pool Cooling Heat Exchanger (Ci)	PCUS Demineralizer (Ci)	Reactor Pool Water (Ci/g)	PSC Surge Tank (Ci/g)	PCU Filter (Ci)
Br82	9.09E-08	9.09E-08	2.34E-05	2.34E-14	2.34E-16	-
Br83	2.86E-12	2.86E-12	5.00E-11	7.36E-19	-	-
Br84	-	-	-	-	-	-
Br85	-	-	-	-	-	-
I129	5.44E-12	5.44E-12	4.82E-07	1.40E-18	1.40E-20	-
I130	1.42E-07	1.42E-07	1.28E-05	3.67E-14	3.67E-16	-
I131	3.89E-03	3.89E-03	5.46E+00	1.00E-09	1.00E-11	-
I132	3.24E-06	3.24E-06	1.82E-03	8.36E-13	8.36E-15	-
I133	4.61E-04	4.61E-04	6.99E-02	1.19E-10	1.19E-12	-
I134	-	-	3.05E-20	-	-	-
I135	3.76E-07	3.76E-07	1.80E-05	9.69E-14	9.69E-16	-
Rb86m	-	-	-	-	-	-
Rb86	5.71E-07	5.71E-07	1.80E-03	1.47E-13	7.35E-14	-
Rb88	-	-	-	-	-	-
Rb89	-	-	-	-	-	-
Cs132	9.64E-09	9.64E-09	1.06E-05	2.48E-15	1.24E-15	-
Cs134	1.05E-04	1.05E-04	6.59E+00	2.72E-11	1.36E-11	-
Cs135m	-	-	-	-	-	-
Cs136	2.03E-05	2.03E-05	4.52E-02	5.22E-12	2.61E-12	-
Cs137	6.47E-05	6.47E-05	5.43E+00	1.67E-11	8.33E-12	-
Cs138	-	-	-	-	-	-
P32	8.23E-13	8.23E-13	2.05E-09	2.12E-19	-	-
Co57	6.69E-15	6.69E-15	2.69E-10	-	-	-
Sr89	3.97E-08	3.97E-08	3.51E-04	1.02E-14	2.05E-16	-
Sr90	9.04E-09	9.04E-09	7.82E-04	2.33E-15	4.66E-17	-
Sr91	8.19E-10	8.19E-10	5.75E-08	2.11E-16	4.22E-18	-
Sr92	9.02E-14	9.02E-14	1.75E-12	2.33E-20	-	-
Y90	4.83E-09	4.83E-09	7.80E-04	1.25E-15	2.49E-17	-
Y91m	5.22E-10	5.22E-10	3.67E-08	1.35E-16	2.69E-18	-
Y91	5.77E-09	5.77E-09	5.91E-05	1.49E-15	2.98E-17	-
Y92	6.17E-12	6.17E-12	1.61E-10	1.59E-18	3.18E-20	-
Y93	2.08E-10	2.08E-10	1.54E-08	5.36E-17	1.07E-18	-
Zr97	1.02E-09	1.02E-09	1.24E-07	2.63E-16	5.25E-18	-
Nb95	3.81E-06	3.81E-06	1.06E+00	9.83E-13	1.97E-14	-
Mo99	7.34E-06	7.34E-06	3.53E-03	1.89E-12	3.78E-14	-
Mo101	-	-	-	-	-	-
Tc99m	7.08E-06	7.08E-06	3.41E-03	1.83E-12	3.65E-14	-
Tc99	3.37E-10	3.37E-10	2.99E-05	8.69E-17	1.74E-18	-
Ru103	1.09E-08	1.09E-08	7.49E-05	2.81E-15	5.62E-17	-
Ru105	3.29E-12	3.29E-12	1.07E-10	8.48E-19	1.70E-20	-
Ru106	7.28E-09	7.28E-09	3.53E-04	1.88E-15	3.75E-17	-
Rh103m	1.08E-08	1.08E-08	7.40E-05	2.78E-15	5.55E-17	-
Rh105	3.48E-09	3.48E-09	8.97E-07	8.96E-16	1.79E-17	-

Table 12.2-10: Reactor Pool Cooling, Spent Fuel Pool Cooling, Pool Cleanup and Pool Surge Control System Component Source Terms - Radionuclide Content

Isotope	RPCS Heat Exchanger (Ci)	Spent Fuel Pool Cooling Heat Exchanger (Ci)	PCUS Demineralizer (Ci)	Reactor Pool Water (Ci/g)	PSC Surge Tank (Ci/g)	PCU Filter (Ci)
Rh106	7.28E-09	7.28E-09	3.53E-04	1.88E-15	3.75E-17	-
Ag110	4.81E-06	4.81E-06	1.64E-01	1.24E-12	2.48E-14	-
Sb124	1.63E-11	1.63E-11	1.71E-07	4.19E-18	8.38E-20	-
Sb125	1.46E-10	1.46E-10	1.02E-05	3.77E-17	7.53E-19	-
Sb127	4.52E-10	4.52E-10	3.05E-07	1.17E-16	2.33E-18	-
Sb129	6.50E-13	6.50E-13	2.09E-11	1.68E-19	-	-
Te125m	2.10E-08	2.10E-08	2.13E-04	5.41E-15	1.08E-16	-
Te127m	6.83E-08	6.83E-08	1.29E-03	1.76E-14	3.52E-16	-
Te127	7.47E-08	7.47E-08	1.27E-03	1.93E-14	3.85E-16	-
Te129m	1.91E-07	1.91E-07	1.12E-03	4.92E-14	9.83E-16	-
Te129	1.20E-07	1.20E-07	7.08E-04	3.10E-14	6.20E-16	-
Te131m	2.29E-07	2.29E-07	5.01E-05	5.91E-14	1.18E-15	-
Te131	5.16E-08	5.16E-08	1.13E-05	1.33E-14	2.66E-16	-
Te132	3.15E-06	3.15E-06	1.76E-03	8.11E-13	1.62E-14	-
Te133m	-	-	-	-	-	-
Te134	-	-	-	-	-	-
Ba137m	6.11E-05	6.11E-05	5.12E+00	1.57E-11	3.15E-13	-
Ba139	1.75E-18	1.75E-18	1.76E-17	-	-	-
Ba140	5.25E-08	5.25E-08	1.17E-04	1.35E-14	2.70E-16	-
La140	3.73E-08	3.73E-08	1.28E-04	9.62E-15	1.93E-16	-
La141	1.16E-12	1.16E-12	3.31E-11	2.98E-19	-	-
La142	1.89E-18	1.89E-18	2.09E-17	-	-	-
Ce141	8.61E-09	8.61E-09	4.90E-05	2.22E-15	4.44E-17	-
Ce143	2.64E-09	2.64E-09	6.35E-07	6.79E-16	1.36E-17	-
Ce144	7.48E-09	7.48E-09	3.10E-04	1.93E-15	3.86E-17	-
Pr143	7.63E-09	7.63E-09	1.88E-05	1.97E-15	3.93E-17	-
Pr144	7.41E-09	7.41E-09	3.07E-04	1.91E-15	3.82E-17	-
Np239	8.19E-08	8.19E-08	3.38E-05	2.11E-14	4.22E-16	-
Na24	1.85E-06	1.85E-06	1.82E-04	4.78E-13	9.56E-15	2.05E-05
Cr51	8.11E-04	8.11E-04	3.53E+00	2.09E-10	4.18E-12	3.98E-01
Mn54	4.35E-04	4.35E-04	1.72E+01	1.12E-10	2.24E-12	1.34E+00
Fe55	3.27E-04	3.27E-04	2.04E+01	8.43E-11	1.69E-12	1.30E+00
Fe59	7.97E-05	7.97E-05	5.58E-01	2.05E-11	4.11E-13	6.26E-02
Co58	1.23E-02	1.23E-02	1.38E+02	3.18E-09	6.36E-11	1.51E+01
Co60	1.45E-04	1.45E-04	1.01E+01	3.72E-11	7.45E-13	6.08E-01
Ni63	7.22E-05	7.22E-05	5.71E+00	1.86E-11	3.72E-13	3.23E-01
Zn65	1.38E-04	1.38E-04	4.65E+00	3.57E-11	7.14E-13	3.87E-01
Zr95	1.04E-04	1.04E-04	1.05E+00	2.69E-11	5.38E-13	1.16E-01
Ag110m	3.53E-04	3.53E-04	1.21E+01	9.11E-11	1.82E-12	9.97E-01
W187	2.04E-04	2.04E-04	3.18E-02	5.27E-11	1.05E-12	3.58E-03
H3	3.25E-01	3.25E-01	-	8.37E-08	8.37E-08	-
C14	1.41E-06	1.41E-06	-	3.63E-13	3.63E-13	-

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Table 12.2-32: Input Parameters for Determining Facility Airborne Concentrations

Parameter	Value
Primary coolant leak rate	160 lb/day/unit
Flash fraction of primary coolant leaks	40%
Gas release from primary coolant leaks	100%
Partition coefficients for evaporation and leaks:	
• Noble gases and tritium	1
• Halogens	100
• Particulates	200
• Iodines (pool evaporation only)	2000
Primary coolant source term	Table 11.1-4 Table 11.1-8
Pool water source term	Table 12.2-9 Table 12.2-10 Table 12.2-11
Pool evaporation rate	1705 lb/hour
CVCS pump/valve room leak	~~8~~4 lb/day
Degasifier room leak	~~26~~13 lb/day
Normal ventilation air change rates in RXB:	
• Pool air space (100′ elevation)	1 air-change/hour
• CVCS pump/valve rooms (35′-8″ elevation)	2 air-changes/hour
• Degasifier rooms (24′ elevation)	2 air-changes/hour
Pool air space volume	4.42E+10 ml
CVCS pump/valve room volume	1.12E+08 ml
Degasifier room volume	3.52E+08 ml

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Table 12.2-33: Reactor Building Airborne Concentrations

Radionuclide	CVCS Pump / Valve Room (µCi/ml)	Degasifier Room (µCi/ml)	Air Space above Reactor Pool (µCi/ml)
Noble Gases			
Kr83m	1.49E-09	1.49E-09	1.94E-14
Kr85m	6.92E-09	6.92E-09	-
Kr85	2.21E-06	2.21E-06	-
Kr87	3.20E-09	3.20E-09	-
Kr88	1.06E-08	1.06E-08	-
Kr89	3.56E-11	3.56E-11	-
Xe131m	2.86E-08	2.86E-08	2.07E-09
Xe133m	2.61E-08	2.61E-08	3.32E-09
Xe133	1.95E-06	1.95E-06	4.71E-08
Xe135m	1.07E-09	1.07E-09	9.39E-10
Xe135	6.37E-08	6.37E-08	5.22E-10
Xe137	1.35E-10	1.35E-10	-
Xe138	1.20E-09	1.20E-09	-
Halogens			
Br82	1.95E-13	1.95E-13	2.79E-17
Br83	9.82E-13	9.82E-13	-
Br84	3.16E-13	3.16E-13	-
Br85	7.73E-15	7.73E-15	-
I129	4.86E-18	4.86E-18	-
I130	1.54E-12	1.54E-12	4.37E-17
I131	4.07E-11	4.07E-11	1.19E-12
I132	1.64E-11	1.64E-11	3.00E-15
I133	6.05E-11	6.05E-11	1.41E-13
I134	7.89E-12	7.89E-12	-
I135	3.68E-11	3.68E-11	1.16E-16
Cs, Rb			
Rb86m	1.09E-18	1.09E-18	-
Rb86	1.39E-13	1.39E-13	1.66E-15
Rb88	5.71E-09	5.71E-09	-
Rb89	2.11E-11	2.11E-11	-
Cs132	2.67E-15	2.67E-15	2.80E-17
Cs134	2.40E-11	2.40E-11	3.06E-13
Cs135m	1.30E-14	1.30E-14	-
Cs136	5.08E-12	5.08E-12	5.89E-14
Cs137	1.47E-11	1.47E-11	1.88E-13
Cs138	4.66E-10	4.66E-10	-
Other FP			
P32	3.97E-19	3.97E-19	-
Co57	2.96E-21	2.96E-21	-
Sr89	2.37E-14	2.37E-14	1.21E-16
Sr90	3.98E-15	3.98E-15	2.77E-17
Sr91	8.88E-15	8.88E-15	2.51E-18
Sr92	4.35E-15	4.35E-15	-
Y90	9.82E-16	9.82E-16	1.48E-17

Table 12.2-33: Reactor Building Airborne Concentrations

Radionuclide	CVCS Pump / Valve Room (µCi/ml)	Degasifier Room (µCi/ml)	Air Space above Reactor Pool (µCi/ml)
Y91m	5.00E-15	5.00E-15	1.60E-18
Y91	2.57E-15	2.57E-15	1.77E-17
Y92	4.19E-15	4.19E-15	1.92E-20
Y93	1.90E-15	1.90E-15	6.39E-19
Zr97	2.83E-15	2.83E-15	3.12E-18
Nb95	4.20E-15	4.20E-15	1.17E-13
Mo99	5.16E-12	5.16E-12	2.25E-14
Mo101	8.08E-14	8.08E-14	-
Tc99m	4.79E-12	4.79E-12	2.17E-14
Tc99	1.49E-16	1.49E-16	1.03E-18
Ru103	4.96E-15	4.96E-15	3.34E-17
Ru105	1.51E-15	1.51E-15	1.02E-20
Ru106	3.22E-15	3.22E-15	2.23E-17
Rh103m	4.90E-15	4.90E-15	3.30E-17
Rh105	3.45E-15	3.45E-15	1.06E-17
Rh106	3.22E-15	3.22E-15	2.23E-17
Ag110	2.16E-15	2.16E-15	1.47E-13
Sb124	7.31E-18	7.31E-18	4.97E-20
Sb125	6.44E-17	6.44E-17	4.47E-19
Sb127	2.78E-16	2.78E-16	1.39E-18
Sb129	3.18E-16	3.18E-16	-
Te125m	9.46E-15	9.46E-15	6.43E-17
Te127m	3.05E-14	3.05E-14	2.09E-16
Te127	1.18E-13	1.18E-13	2.29E-16
Te129m	8.73E-14	8.73E-14	5.84E-16
Te129	1.08E-13	1.08E-13	3.68E-16
Te131m	2.82E-13	2.82E-13	7.02E-16
Te131	1.05E-13	1.05E-13	1.58E-16
Te132	2.07E-12	2.07E-12	9.63E-15
Te133m	1.29E-13	1.29E-13	-
Te134	1.68E-13	1.68E-13	-
Ba137m	1.39E-11	1.39E-11	1.77E-13
Ba139	3.75E-15	3.75E-15	-
Ba140	2.56E-14	2.56E-14	1.61E-16
La140	7.58E-15	7.58E-15	1.14E-16
La141	1.34E-15	1.34E-15	-
La142	5.66E-16	5.66E-16	-
Ce141	3.94E-15	3.94E-15	2.64E-17
Ce143	2.95E-15	2.95E-15	8.07E-18
Ce144	3.31E-15	3.31E-15	2.29E-17
Pr143	3.50E-15	3.50E-15	2.34E-17
Pr144	3.28E-15	3.28E-15	2.27E-17
Np239	6.22E-14	6.22E-14	2.51E-16
Crud			
Na24	6.42E-12	6.42E-12	5.69E-14
Cr51	3.74E-13	3.74E-13	2.49E-11

Table 12.2-33: Reactor Building Airborne Concentrations

Radionuclide	**CVCS Pump / Valve Room (µCi/ml)**	**Degasifier Room (µCi/ml)**	**Air Space above Reactor Pool (µCi/ml)**
Mn54	1.93E-13	1.93E-13	1.33E-11
Fe55	1.44E-13	1.44E-13	1.00E-11
Fe59	3.61E-14	3.61E-14	2.44E-12
Co58	5.54E-13	5.54E-13	3.78E-10
Co60	6.37E-14	6.37E-14	4.43E-12
Ni63	3.18E-14	3.18E-14	2.21E-12
Zn65	6.13E-14	6.13E-14	4.24E-12
Zr95	4.69E-14	4.69E-14	3.20E-12
Ag110m	1.56E-13	1.56E-13	1.08E-11
W187	3.30E-13	3.30E-13	6.27E-12
Water Activation Products			
H3	4.04E-07	4.04E-07	1.61E-06
C14	3.21E-11	3.21E-11	7.77E-12
N16	0.00E+00	0.00E+00	-
Ar41	6.28E-08	6.28E-08	-