Mark-ups to COLA ER Section 3.5

Liquid effluent annual average radioactivity releases due to anticipated operational occurrences are summarized in Table 3.5-14. The additional unplanned liquid release due to anticipated operational occurrences is estimated to be 0.16 Ci/year for the U.S. EPR design based on reactor operating data presented in NUREG 0017 (NRC, 1985). These releases were evaluated to determine the frequency and extent of unplanned liquid release and are assumed to have the same isotopic distributions for the calculated source term of the liquid wastes. The total releases from the anticipated operational occurrences are shown in Table 3.5-15 and are included as part of the "total liquid release source term".

Summary of Radioactive Liquid Release from Normal Operations

Discharge concentrations are listed in Table 3.5-15 and are calculated using a 8,665 gpm (32, 797 lpm) discharge flow rate. The discharge concentrations are compared with effluent concentration limits given in Table 2, column 2 of 10CFR20, Appendix B (CFR, 2007d).

Due to the impracticality of removing tritium on the scale necessary, some tritium present in the reactor coolant system will be released to the environment during plant life time. From the experiences gained at operating PWRs, the total tritium release is estimated to about 0.4 Curies/MWt/year (NRC, 1985). The quantity of tritium released through the liquid pathway is based on the calculated volume of liquid released, excluding secondary system waste, with a primary coolant tritium concentration of 1 μCi/ml up to a maximum of 90% of the total quantity of tritium calculated to be available for release. It is assumed that the remainder of tritium produced is released as a gas from building ventilation exhaust systems. Hence, 1,660 curies (6.14E13 Bq) of tritium are expected to be released to the environment via liquid effluents from BBNPP each year.

RAI 101 Question 11.02-2

Insert 3.5.2.3-1

3.5.2.3 Liquid Waste System Cost-Benefit Analysis

~~In addition to meeting the numerical As Low As Reasonably Achievable (ALARA) design objective dose values for effluents released from a light water reactor as stipulated in 10CFR50, Appendix I (CFR, 2007a), the regulation also requires that plant designs include all items of reasonably demonstrated cleanup technology that when added to the liquid waste processing system sequentially and in order of diminishing cost-benefit return, can, at a favorable cost-benefit ratio, effect reductions in dose to the population reasonably expected to be within 50 mi (80 km) of the reactor. Although not required by NRC Regulations, values of $2,000 per person-rem, and $2,000 per person-thyroid-rem are conservatively used as a favorable cost benefit threshold based on NUREG-1530 (NRC, 1995). The source term for each equipment configuration option was generated using the same GALE code as described in Section 3.5.1 along with the same plant specific parameters modified only to accommodate the changes in the waste stream decontamination factor afforded by the design options simulated.~~

~~For BBNPP, the dose reduction effects for the sequential addition of the next logical liquid waste processing component (i.e., waste demineralizer) results in a reduction in the 50 mi (80 km) population total body exposure of 0.23 person-rem (0.0023 person-sievert).Section 5.4 describes the population dose calculation for both the base system case of processing liquid waste with an evaporator and centrifuge for Group I and II waste streams, and the augmented system configuration that adds a vendor supplied waste demineralizer for additional processing of the distillate produced by the evaporator and centrifuge. Table 3.5-16 illustrates the relative population dose associated with both base equipment configuration and that associated with the addition of the waste demineralizer subsystem. Table 3.5-17 compares the estimated total body dose reduction or savings achieved for the addition of the demineralizer~~

subsystem along with a conservative estimated cost for the purchase, operating and maintenance (O&M) of the equipment. The cost basis for the equipment option is taken from Regulatory Guide 1.110 (NRC, 1976) and reported in 1975 non-escalated dollars which provides a conservatively low estimate of the equipment cost to today's dollars. A 40 year operating time frame is used although the U.S. EPR is designed for a 60 year operating life. The BBNPP plant license submittal is for 40 years. The site area population within 50 mi (80 km) is based on a projected population in 2060, over 40 years from the estimated start of plant operations. Using the population at the end of plant life is conservative in that it maximizes the collective dose from plant effluents.

For the total body dose reduction, Table 3.5-17 illustrates that the favorable benefit in reduced dose associated with the addition of waste demineralizer system had a dollar equivalent benefit value of $18,400. However, the estimated cost to purchase, operate and maintain this equipment over its operating life was approximately $534,000, thereby resulting in a total body effective benefit to cost ratio of less than 1.0 (not justified on an ALARA basis of dose savings to the public).

In consideration of the collective thyroid dose reduction, Table 3.5-18 illustrates that the favorable benefit in reduced dose associated with the addition of waste demineralizer system had a dollar equivalent benefit value of $12,000. However, the estimated cost to purchase, operate and maintain this equipment over its operating life is the same as shown for the total body dose assessment above, approximately $534,000. This result in a thyroid effective benefit to cost ratio of also less than 1.0 (not justified on an ALARA basis of dose savings to the public).

In assessing if there are any demonstrated technologies that could be added to the plant design at a favorable cost-benefit ratio, a bounding assessment has also been performed which demonstrates that there is insufficient collective dose available to be saved that would warrant additional equipment cost. For the bounding total body collective dose estimate, if an equipment option could reduce the base case population dose to zero, the maximum potential savings in collective dose would be equivalent to $2,000 per person-rem (reference value for favorable benefit from NUREG-1530 (NRC, 1995)) times the life time integrated total body population dose associated with base condition (i.e., 0.385 person-rem/yr x 40 yrs x $2,000 per person-rem = $30,800). For the thyroid collective dose, the savings would be equivalent to $2,000 per person-rem times the life time integrated thyroid population dose associated with base condition (i.e., 0.291 person-rem/yr x 40 yrs x $2,000 per person-rem = $23,280). The assumption of achieving a zero dose does not take into account that tritium in effluents contributes to the dose and that currently available treatment options are ineffective to remove it.

Since the benefit value for both the total body and thyroid to reduce the dose to zero is significantly less than the direct and 40 year O&M cost of the waste demineralizer subsystem option or other options from Regulatory Guide 1.110 (NRC, 1976) not already incorporated in the plant design, the bounding assessment indicates that there are no likely equipment additions that could be justified on an ALARA basis for liquid waste processing.

It should be noted that even though not warranted on a population dose savings basis, a vendor supplied waste demineralizer subsystem skid has been added to the plant design to provide plant operators greater flexibility to process waste liquids by different processes to best match waste stream characteristics, such as chemical form, with the waste process treatment method that best handles the waste from an economics standpoint.

Insert 3.5.2.3-1

10 CFR Part 50, Appendix I, Section II.D requires that plant designs consider additional items based on a cost-benefit analysis. Specifically, the design must include all items of reasonably demonstrated cleanup technology that, when added to the liquid waste processing system sequentially and in order of diminishing cost-benefit return, can, at a favorable cost-benefit ratio, reduce the dose to the population reasonably expected to be within 50 miles of the reactor. The guidance used to make this decision is that the cumulative dose to a population within a 50-mile (80 km) radius of the reactor site cannot be reduced at an annual cost of no more than $1000 per person-rem or $1000 per person-thyroid rem. The methodology of Regulatory Guide 1.110 was used to perform a site-specific cost benefit analysis to satisfy these requirements. Regulatory Guide 1.110 provides values in 1975 dollars and instructs that these values not be adjusted for inflation.

The following parameters used in determining the Total Annual Cost (TAC) for the cost-benefit analysis are fixed and are provided in Regulatory Guide 1.110 for each radwaste system augment: the Direct Cost of Equipment, Materials and Labor (Table A-1 of Regulatory Guide 1.110), the Annual Operating Cost (AOC) (Table A-2 of Regulatory Guide 1.110), and the Annual Maintenance Cost (AMC) (Table A-3 of Regulatory Guide 1.110). The following variable parameters were used in the cost-benefit analysis:

- Labor Cost Correction Factor (LCCF) – This factor accounts for the differences in relative labor costs between geographical regions and is take from Table A-4 of Regulatory Guide 1.110. The lowest LCCF value of 1.0 was conservatively used in the analysis.
- Indirect Cost Factor (ICF) – This factor takes into account whether the radwaste system is unitized or shared (in the case of a multi-unit site) and is taken from Table A-5 of Regulatory Guide 1.110. A value of 1.75 was used for the ICF since the radwaste system for BBNPP is for a single unit site.
- Capital Recovery Factor (CRF) – This factor reflects the cost of money for capital expenditures. A cost-of-money value of 7% per year was assumed in the analysis, consistent with NUREG/BR-0058 (NRC, 2004). From Table A-6 of Regulatory Guide 1.110, the corresponding CRF is 0.0806.

If it is conservatively assumed that each radwaste system augment is a "perfect" technology that would reduce the effluent dose by 100 percent, the annual cost of the augment can be determined and the lowest annual cost can be considered a threshold value. The lowest cost option for the liquid radwaste treatment system augments was determined to be a 20-gpm (75.7 lpm) cartridge filter at $11,390 per year. Dividing this cost by $1000 per person-rem results in a threshold value of 11.39 person-rem total body or thyroid dose from liquid effluents.

Population dose impacts within a 50 mile (80 km) radius of the BBNPP site are listed in FSAR Table 11.2-15. The input parameters used in calculating the population doses are provided in FSAR Table 11.2-14. As shown by the results in Table FSAR11.2-15, the total body and thyroid population doses for liquid effluents are a small fraction of the threshold value of 11.39 person-rem. It is therefore concluded that no further cost-benefit analysis is needed to demonstrate compliance with 10 CFR Part 50, Appendix I, Section II.D.

iodine-adsorbent activated charcoal delay beds and the filtered air is sent to the stack. The charcoal beds each have a downstream HEPA filter to remove potentially radioactive charcoal dust and particulates. The ventilation systems are shown in Figure 3.5-7.

3.5.3.2 Gaseous Release to the Environment

All gaseous effluents are released at the top of the plant stack. The stack height is approximately 203 ft (62 m) above plant grade, or about 6.56 ft (2 m) above the height of the adjacent Reactor Building. The normal stack flow rate is conservatively estimated at 260,000 cfm (7,362 m^3/min) (sum of exhaust ventilation flow rates from the Nuclear Auxiliary Building of 157,000 cfm (4,446 m^3/min), Radioactive Waste Processing Building of 94,000 cfm (2,662 m^3/min) and Access Building of 9,000 cfm (255 m^3/min)) with no credit for thermal buoyancy of the exit gas assumed (ambient temperature) and the low flow purge system assumed to not be operating. For the purpose of analyzing the effective stack height, a conservative stack flow rate of 242,458 cfm (6,865 m^3/min) was utilized in the atmospheric dispersion calculations. The stack diameter is 12.5 ft (3.8 m). The releases of radioactive effluent to the plant stack include contributions from:

- Gaseous Waste Processing System discharges via the carbon delay beds for noble gas holdup and decay.
- Containment purge ventilation discharges.
- Ventilation discharges from (1) the four Safeguards and Access Building controlled areas, (2) the Fuel Building, (3) the Radwaste Building and (4) the Nuclear Auxiliary Building.
- Main Condenser air evacuation exhaust.

RAI 101 Question 11.02-5

10%

The annual average airborne releases of radionuclides from the plant were determined using the PWR GALE code (NRC, 1985). The GALE code models releases using realistic source terms derived from the experiences of many operating reactors, field and laboratory tests, and plant-specific design considerations incorporated to reduce the quantity of radioactive materials that may be released to the environment during normal operation, including anticipated operational occurrences. The code input values used in the analysis are provided in Table 3.5-9. There are two deviations from the U.S. EPR FSAR reflected in this COLA, the shim bleed and C-14 production. The shim bleed is adjusted to 2,160 gpd (8176 L/d) to reflect total letdown flow for boron control with ~~all~~ of the reactor coolant liquid being recycled. This deviates from the U.S. EPR FSAR where it is assumed that 5% of the letdown flow is sent to the liquid waste system for processing. This results in the calculated annual release of Kr-85 to drop from a very conservative estimate of 34,000 Ci (1.26E+15 Bq) to 2,800 Ci (1.04E+14 Bq) in gaseous effluents for BBNPP. The GALE code has a fixed annual release value for C-14 of 7.3 Ci (2.70E+11 Bq) regardless of the power output of the reactor and with no identification of the chemical form of the carbon in the waste gas. C-14 is primarily produced by the activation of O-17 in the coolant. The quantity released is proportional to the reactor core neutron flux. The larger power rating of the U.S. EPR results in a much higher C-14 production than the GALE code estimate. As a result, the annual release of C-14 is increased to 18.9 Ci (7.0E+11 Bq) and the chemical form is estimated to be ~~80% methane and 20%~~ carbon dioxide. The expected annual releases from the plant are presented in Table 3.5-8 and the annual releases due to anticipated operational occurrences are presented in Table 3.5-19.

RAI 101 Question 11.02-3(1-4)

100%

RAI 106 Question 11.03-1

Insert 3.5.3.3-1

3.5.3.3 Gaseous Waste System Cost-Benefit Analysis

As with the liquid waste processing systems, the ALARA design objective dose values for effluents released from a light water reactor as stipulated in 10 CFR 50, Appendix I (CFR, 2007a) also requires that plant designs include all items of reasonably demonstrated cleanup technology that when added to the gaseous waste processing system sequentially and in order of diminishing cost-benefit return, can, at a favorable cost-benefit ratio, effect reductions in dose to the population reasonably expected to be within 50 mi (80 km) of the reactor. Although not required by NRC Regulations, values of $2,000 per person-rem, and $2,000 per person-thyroid-rem are conservatively used as a favorable cost benefit threshold based on NRC NUREG-1530 (NRC, 1995). The source term for each equipment configuration option was generated using the same GALE code as described in Section 3.5.1 along with the same plant specific parameters modified only to accommodate the changes in the waste stream decontamination factor afforded by the design options simulated.

For BBNPP, the dose reduction effects for the sequential addition of the next logical gaseous waste processing component (i.e., addition of an additional charcoal delay bed to the waste gas holdup subsystem)) results in a reduction in the 50 mi (80 km) population total body exposure of 0.05 person-rem (0.0005 person-sievert). Section 5.4 describes the population dose calculation for both the base case augmented charcoal delay bed holdup system for processing gaseous waste. Table 3.5-20 illustrates the relative population dose associated with both the base equipment configuration and that associated with the augmented holdup system. Table 3.5-21 compares the estimated total body and thyroid dose reduction or savings achieved for the addition of the extra delay bed along with a conservative estimated cost for the purchase. Operating and maintenance cost associated with this passive subsystem is negligible. The cost basis for the equipment option is taken from Regulatory Guide 1.110 (NRC, 1976) and reported in 1975 non-escalated dollars which provides a conservatively low estimate of the equipment cost to todays dollars. The site area population within 50 mi (80 km) is based a projected population in 2060, over 40 years from the estimated start of plant operations. Using the population at the end of plant life is conservative in that it maximizes the collective dose from plant effluents.

For both the total body and thyroid dose reduction, Table 3.5-21 illustrates that the favorable benefit in reduced dose associated with the additional charcoal delay bed had a dollar equivalent benefit value of $4,000. However, the estimated cost to purchase this equipment was approximately $67,000, thereby resulting in a total body effective benefit to cost ratio of less than 1.0 (not justified on an ALARA basis of dose savings to the public).

The total gas release from the plant is made up of several sources, of which the charcoal delay bed subsystem provides treatment for the process gas from primary side reactor system components only. As a consequence, assuming that the process gas stream release has a zero value does not result in a zero dose to the population. Ventilation system exhaust from the reactor building and other controlled area buildings, along with any secondary side process gas releases if primary to secondary leaks occur also contribute to the total release. Because these sources are distributed throughout the plant, no single system can be added that effectively reduces all sources of gas releases. However, beyond the waste gas processing that is accomplished by the charcoal delay beds, the existing controlled area ventilation systems already provide for HEPA filtration, and as needed charcoal filtration, to the major sources of gas released to the environment. As a result, no other treatment options not in use are available that could treat a significant fraction of the total release at a favorable cost to that shown for the charcoal delay bed.

Insert 3.5.3.3-1

10 CFR Part 50, Appendix I Section II.D requires that plant designs consider additional items based on a cost-benefit analysis. Specifically, the design must include all items of reasonably demonstrated cleanup technology that, when added to the gaseous waste processing system sequentially and in order of diminishing cost-benefit return, can, at a favorable cost-benefit ratio, reduce the dose to the population reasonably expected to be within 50 miles (80 km) of the reactor. The guidance used to make this decision is that the cumulative dose to a population within a 50-mile (80 km) radius of the reactor site cannot be reduced at an annual cost of no more than $1000 per person-rem or $1000 per person-thyroid rem. The methodology of Regulatory Guide 1.110 was used to perform a site-specific cost benefit analysis to satisfy these requirements. Regulatory Guide 1.110 provides values in 1975 dollars and instructs that these values not be adjusted for inflation.

The following parameters used in determining the Total Annual Cost (TAC) for the cost-benefit analysis are fixed and are provided in Regulatory Guide 1.110 for each radwaste system augment: the Direct Cost of Equipment, Materials and Labor (Table A-1 of Regulatory Guide 1.110), the Annual Operating Cost (AOC) (Table A-2 of Regulatory Guide 1.110), and the Annual Maintenance Cost (AMC) (Table A-3 of Regulatory Guide 1.110). The following variable parameters were used in the cost-benefit analysis:

- Labor Cost Correction Factor (LCCF) – This factor accounts for the differences in relative labor costs between geographical regions and is take from Table A-4 of Regulatory Guide 1.110. The lowest LCCF value of 1.0 was conservatively used in the analysis.
- Indirect Cost Factor (ICF) – This factor takes into account whether the radwaste system is unitized or shared (in the case of a multi-unit site) and is taken from Table A-5 of Regulatory Guide 1.110. A value of 1.75 was used for the ICF since the radwaste system for BBNPP is for a single unit site.
- Capital Recovery Factor (CRF) – This factor reflects the cost of money for capital expenditures. A cost-of-money value of 7% per year was assumed in the analysis, consistent with NUREG/BR-0058 (NRC, 2004). From Table A-6 of Regulatory Guide 1.110, the corresponding CRF is 0.0806.

If it is conservatively assumed that each radwaste system augment is a "perfect" technology that would reduce the effluent dose by 100 percent, the annual cost of the augment can be determined and the lowest annual cost can be considered a threshold value. The lowest cost option for the gaseous radwaste treatment system was determined to be the steam generator flash tank vent to main condenser augment at $6,650 per year. Dividing this cost by $1000 per person-rem results in a threshold value of 6.65 person-rem total body or thyroid dose from liquid effluents.

Population dose impacts within a 50 mile (80 km) radius of the BBNPP site are listed in FSAR Table 11.3-8. The input parameters used in calculating the population doses are provided in FSAR Table 11.3-2 and FSAR Tables 11.3-10 – 11.3-13. The total body and thyroid dose from gaseous effluents are 8.25 person-rem and 8.57 person-rem, respectively. Since these doses exceed the 6.65 person-rem threshold value, the system augments with a total annual cost less than $8,250 are further evaluated below. For use in the evaluation, the dose breakdown from noble gases, iodines, particulates, C-14 and H-3 as taken from the GASPAR-2 output is provided in FSAR Table 11.3-9.

Main Condenser Vacuum Pump Charcoal/HEPA Filtration System

The total annual cost for this system augment is $8,170. Therefore, in order to be beneficial at $1000 per person-rem, this augment must remove sufficient activity to decrease the population dose by at least 8.17 person-rem, thereby decreasing the total body dose from 8.25 person-rem to 0.08 person-rem and the thyroid dose from 8.57 person-rem to 0.40 person-rem. However, as shown in FSAR Table 11.2-7, for the noble gases, which make up nearly half of the dose, only a small fraction (<1%) are released through the condenser air removal system. Therefore, it would be impossible to achieve the necessary dose reduction, and this augment is not cost-beneficial.

1,000-cfm (28.31 cubic meters per minute) Charcoal/HEPA Filtration System

The total annual cost for this system augment is $7,960. Therefore, in order to be beneficial at $1000 per person-rem, this augment must remove sufficient activity to decrease the population dose by at least 7.96 person-rem, thereby decreasing the total body dose from 8.25 person-rem to 0.29 person-rem and the thyroid dose from 8.57 person-rem to 0.61 person-rem. However, this augment would not be effective in reducing the noble gases or C-14 release, which make up over 90% of the population. Therefore, it would be impossible to achieve the necessary dose reduction, and this augment is not cost-beneficial.

600-ft^3 (16.99 m^3) Gas Decay Tank

The total annual cost for this system augment is $8,040. Therefore, in order to be beneficial at $1000 per person-rem, this augment must remove sufficient activity to decrease the population dose by at least 8.04 person-rem, thereby decreasing the total body dose from 8.25 person-rem to 0.21 person-rem and the thyroid dose from 8.57 person-rem to 0.53 person-rem. However, this augment would not be effective in reducing the C-14 release, which makes up 50% of the population dose. Therefore, it would be impossible to achieve the necessary dose reduction, and this augment is not cost-beneficial.

Steam Generator Flash Tank Vent to Main Condenser

The total annual cost for this system augment is $6,650. Therefore, in order to be beneficial at $1000 per person-rem, this augment must remove sufficient activity to decrease the population dose by at least 6.65 person-rem, thereby decreasing the total body dose from 8.25 person-rem to 1.6 person-rem and the thyroid dose from 8.57 person-rem to 1.92 person-rem. However, the current design for the U.S. EPR already includes a steam generator flash tank/condenser. Also, as shown in FSAR Table 11.2-7, none of the noble gases (which make up almost 50% of the dose) are released via the blowdown vent offgas. Therefore, it would be impossible to achieve the necessary dose reduction, and this augment is not cost-beneficial.

Based on the above evaluation, none of the radwaste augments are cost-beneficial in reducing the total body or thyroid dose from gaseous effluent.

CFR, 2007a. Title 10, Code of Federal Regulations, Part 50.34a, Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents - Nuclear Power Reactors, and Appendix I, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents, 2007.

CFR, 2007b. Title 40, Code of Federal Regulations, Part 190, Radiation Protection Programs, 2007.

CFR, 2007c. Title 10, Code of Federal Regulations, Part 20.1301, Dose Limits for Individual Members of the Public, 2007.

CFR, 2007d. Title 10, Code of Federal Regulations, Part 20, Appendix B, Table 2, Radionuclides, Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewage, 2007.

CFR, 2007e. Title 49, Code of Federal Regulations, Parts 171 through 180, Hazardous Materials Regulations, 2007.

CFR, 2007f. Title 10, Code of Federal Regulations, Part 71, Packaging of Radioactive Materials for Transport, 2007.

EPRI, 2007a. Operational Strategies to Reduce Class B/C Wastes, 1014707, Electric Power Research Institute, April, 2007.

EPRI, 2007b. Waste Class B/C Reduction Guide, 1015115, Electric Power Research Institute, November, 2007.

NRC, 1976. Cost-Benefit Analysis for Radwaste Systems for Light Water-Cooled Nuclear Power Reactors, Regulatory Guide 1.110 (For Comment), Nuclear Regulatory Commission, March 1976.

NRC, 1985. Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors, PWR-GALE Code, NUREG-0017, Revision 1, Nuclear Regulatory Commission, April 1985.

RAI 101 Question 11.02-2

NRC, 1995. Reassessment of NRC's Dollar Per Person-Rem Conversion Factor Policy, NUREG-1530, Nuclear Regulatory Commission, 1995.

Insert 3.5.6-1

NRC, 2007a. Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Nuclear Power Reactors, Regulatory Guide 1.112, Revision 1, Nuclear Regulatory Commission, March 2007.

NRC, 2007b. Standard Review Plan (SRP) for the Review of Safety Analysis Reports for Power Plants, NUREG-0800, Nuclear Regulatory Commision, March 2007.

PPL, 2006. Susquehanna Steam Electric Station Annual Radiological Environmental Operating Report PLA-6054, PPL Susquehanna, LLC, May 2006

Insert 3.5.6-1

NRC, 2004. NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" Revision 4, September, 2004.

Table 3.5-4— Principal Parameters Used In Estimating Realistic Releases of Radioactive Materials in Effluents (GALE Code Input Parameters)

(Page 1 of 4)

Item	GALE Input Parameter	Value
1	Thermal Power Level (MWth) (4,590 MWth + 22 MWth measurement uncertainty)	4,612 MWth (4,612E9 J/sec)
2	Mass of Coolant in Primary System (RCS dry nominal volume - not including the pressurizer) (13,596 ft^3/0.02290 ft^3/lbm)	5.937E5 lbm (2.693E5 kg)
3	Primary System Letdown Rate (7.94E+04 lbm/h x 0.0229 ft^3/lbm x 7.48 gal/ft^3 x 1 min/60 sec = 226.7 gpm)	226.7 gpm (0.858 m^3/min)
4	Letdown Cation Demineralizer Flow Rate (No purification system cation demineralizer)	0 gpm (0 l/min)
5	Number of steam generators	4
6	Total steam flow rate (Nominal 4 x 5.168E+06 = 20.67E+06 lbm/hr Increase by 1.05 to account for higher thermal power = 21.71E+06 lbm/hr)	2.171E7 lbm/hr (9.845E6 kg/hr)
7	Mass of liquid in secondary side of each steam generator (SG)	1.6977E5 lbm (7.7006E5 kg)
8	SG Blowdown rate (Nominal 4 x 0.052E+06 lbm/hr = 208E+03 lbm/hr Adjust by 1.05 to account for higher thermal power 208 x 1.05 = 218.4E+03)	2.184E5 lbm/hr (9.906E4 kg/hr)
9	Blowdown Treatment Method (Full blowdown flow processed by Blowdown System and recycled to condensate system.)	0
10	Condensate Demineralizer Regeneration Time (days) (Regeneration not used)	0
11	Condensate Demineralizer Flow Fraction	0.33
12	Shim Bleed Flow Rate (gpd) (Shim bleed is letdown flow for boron control ~~and the liquid is recycled~~ [RAI 101, Question 11.02-5]. The nominal flow is: 500 lbm/hr x 0.0229 ft^3/lbm x 7.48 gal/ft^3 x 24 hr/day = 2,056 gpd Adjusting by 1.05 to account for higher thermal power yields 2,158 gpd.	2160 gpd (8170 l/day)
13	Shim Bleed DF for Iodine (With Liquid Waste Storage and Processing System Demineralizer)	1.0E4
14	Shim Bleed DF for Cesium and Rubidium (With Liquid Waste Storage and Processing System Demineralizer)	1.0E7
15	Shim Bleed DF for Other Nuclides (With Liquid Waste Storage and Processing System Demineralizer)	1.0E7
16	Shim Bleed Collection Time(days) $\frac{18500\ gal}{\left(\frac{(1728)\ gal}{day}\right)} \times 0.8 = 8.56$ [RAI 101, Question 11.02-5: ~~8.56~~ → 4.03; ~~(1728) gal~~ → (2160 x 0.9 + 1728) gal] (The collection time is for one tank. The collection time includes 1,728 gpd (6,541 lpd) from equipment drains.) [RAI 101, Question 11.02-5: Note: 18500 gallons ~ 70 m^3]	~~8.56~~ 4.03 days
17	Shim Bleed Processing and Discharge Times (days) $\frac{18500\ gal}{\left(\frac{1.1 kg}{sec}\right) \times \left(\frac{1E\text{-}3m^3}{1\ kg}\right) \times \left(\frac{8.64E4\ sec}{d}\right)} \times 0.8 = 0.589\ days$	0.589 days
18	Shim Bleed Average Fraction of Waste to be Discharged ~~(Shim Bleed liquid is recycled.)~~ [RAI 101, Question 11.02-5]	0.90 → ~~0.0~~
19	Equipment Drains Input (gpd) (Based on U.S. EPR Standard Technical Specification limit on unidentified leakage of 1 gpm (3.79 lpm). Assumes collected by floor drains. Twenty percent added for conservatism.)	1,728 gal/day 6,541 l/day

Table 3.5-4— Principal Parameters Used In Estimating Realistic Releases of Radioactive Materials in Effluents (GALE Code Input Parameters)
(Page 2 of 4)

Item	GALE Input Parameter	Value
20	Equipment Drains Primary Coolant Activity (PCA)	1.0
21	Equipment Drains DF for Iodine (With Liquid Waste Storage and Processing System Demineralizer)	1.0E4
22	Equipment Drains DF for Cesium and Rubidium (With Liquid Waste Storage and Processing System Demineralizer)	1.0E7
23	Equipment Drains DF for Other Nuclides (With Liquid Waste Storage and Processing System Demineralizer)	1.0E7
24	Equipment Drains Collection Time (days) (from Item 16 above) ~~(Includes 110 gpd (416.4 lpd) from shim bleed.)~~ ~~$\frac{70\ m^3}{\left(\frac{1728\ gal}{day}\right)\times\left(\frac{m^3}{264.17\ gal}\right)}\times 0.8 = 8.56\ days$~~ RAI 101, Question 11.02-5	~~8.56 days~~ 4.03
25	Equipment Drains Processing and Discharge Times (days) $\frac{70\ m^3}{\left(\frac{1.1\ kg}{sec}\right)\times\left(\frac{1E-3m^3}{1\ kg}\right)\times\left(\frac{8.64E4\ sec}{day}\right)}\times 0.8 = 0.589\ days$	0.589 days
26	Equipment Drains Average Fraction of Waste to be Discharged (There is no recycling of liquid radioactive waste.)	1.0
27	Clean Waste Input (gpd) (Clean Waste included as Group II.) (Conservative - 66,000 gal/week / 7 day/week = 9,428 gallons per day)	9,428 gal/day 35,690 l/day
28	Clean Waste PCA	0.001
29	Clean Waste DF for Iodine (With Liquid Waste Storage and Processing System Demineralizer)	1.0E2
30	Clean Waste DF for Cesium and Rubidium (With Liquid Waste Storage and Processing System Demineralizer)	1.0E2
31	Clean Waste DF for Other Nuclides (With Liquid Waste Storage and Processing System Demineralizer)	1.0E2
32	Clean Waste Collection Time (days) $\frac{70\ m^3}{\left(\frac{250\ m^3}{week}\right)\times\left(\frac{week}{7\ d}\right)}\times 0.8 = 1.6\ days$	1.6 days
33	Clean Waste Processing and Discharge Times (days) $\frac{70\ m^3}{\left(\frac{1.4\ kg}{sec}\right)\times\left(\frac{1E-3m^3}{1\ kg}\right)\times\left(\frac{8.64E4\ sec}{day}\right)}\times 0.8 = 0.463\ days$	0.463
34	Clean Waste Average Fraction of Waste to be Discharged (There is no recycling of liquid radioactive waste.)	1.0
35	Dirty Waste Input (gpd) (Group III waste is normally not radioactive and it is neglected to maximize concentrations)	0 gal/day (0 l/day)
36	Dirty Waste PCA (N/A since input is 0 gallons.per day)	0.1

Table 3.5-6— Liquid Waste Release Source Term Inputs

Liquid Waste Inputs								
Stream	Flow Rate gal/day (l/day)	Fraction of Primary Coolant Activity	Fraction Discharged	Collection Time (days)	Decay Time (days)	Decontamination Factors		
						I	Cs	Others
Shim Bleed Rate	2.16E+03 (8.18 E+03)	1.0	~~0.0~~	~~8.6~~	0.589	1.0E+04	1.0E+07	1.0E+07
Equipment Drains	1.73E+03 (6.55E+03)	1.0	1.0	~~8.6~~	0.589	1.0E+04	1.0E+07	1.0E+07
Clean Waste Input	9.43E+03 (3.57E+04)	0.001	1.0	1.6	0.463	1.0E+02	1.0E+02	1.0E+02
Dirty Wastes	0.00E+00 (0.00E+00)	0.1	1.0	0.0	0.0	1.0E+02	1.0E+03	1.0E+03
Blowdown	6.28E+05 (2.38E+06)		0.0	0.0	0.0	1.0E+02	1.0E+02	1.0E+03
Untreated Blowdown	0.00E+00 (0.00E+00)		1.0	0.0	0.0	1.0E+00	1.0E+00	1.0E+00
Regenerant Sols.	0.00E+00 (0.00E+00)		0.0	0.0	0.0	1.0E+00	1.0E+00	1.0E+00

0.9

RAI 101, Question 11.02-5

4.03

RAI 101, Question 11.02-5

Table 3.5-7— Annual Liquid Effluent Releases (English Units)

(Page 1 of 2)

Radionuclide	Half-Life (days)	Primary µCi per ml	Secondary µCi per ml	Boron Recovery System (Ci)	Misc Wastes (Ci)	Secondary (Ci)	Turbine Building (Ci)	Total Liquid Waste Sources (Ci)	Adjusted Total (Ci/yr)	Detergent Wastes (Ci/yr)	Total (Ci/yr)
Activated Corrosion Products											
Na-24	6.25E-01	2.84E-02	3.40E-07	.00000	.00104	.00000	.00001	.00105	.00616	.00000	.00620
Cr-51	2.78E+01	1.39E-03	1.96E-08	.00000	.00018	.00000	.00000	.00018	.00104	.00000	.00100
Mn-54	3.03E+02	7.09E-04	9.66E-09	.00000	.00009	.00000	.00000	.00009	.00054	.00000	.00054
Fe-55	9.50E+02	5.31E-04	7.28E-09	.00000	.00007	.00000	.00000	.00007	.00041	.00000	.00041
Fe-59	4.50E+01	1.34E-04	1.80E-09	.00000	.00002	.00000	.00000	.00002	.00010	.00000	.00010
Co-58	7.13E+01	2.04E-03	2.84E-08	.00000	.00026	.00000	.00000	.00027	.00156	.00000	.00160
Co-60	1.92E+03	2.35E-04	3.27E-09	.00000	.00003	.00000	.00000	.00003	.00018	.00000	.00018
Zn-65	2.45E+02	2.26E-04	3.12E-09	.00000	.00003	.00000	.00000	.00003	.00017	.00000	.00017
W-187	9.96E-01	1.38E-03	1.73E-08	.00000	.00008	.00000	.00000	.00008	.00047	.00000	.00047
Np-239	2.35E+00	1.08E-03	1.44E-08	.00000	.00010	.00000	.00000	.00010	.00058	.00000	.00058
Fission Products											
Sr-89	5.20E+01	6.23E-05	8.52E-10	.00000	.00001	.00000	.00000	.00001	.00005	.00000	.00005
Sr-91	4.03E-01	6.41E-04	7.35E-09	.00000	.00001	.00000	.00000	.00001	.00008	.00000	.00008
Y-91M	3.47E-02	5.09E-04	2.01E-09	.00000	.00001	.00000	.00000	.00001	.00005	.00000	.00005
Y- 93	4.25E-01	2.77E-03	3.09E-08	.00000	.00006	.00000	.00000	.00006	.00036	.00000	.00036
Zr-95	6.50E+01	1.73E-04	2.39E-09	.00000	.00002	.00000	.00000	.00002	.00013	.00000	.00013
Nb-95	3.50E+01	1.25E-04	1.65E-09	.00000	.00002	.00000	.00000	.00002	.00010	.00000	.00010
Mo-99	2.79E+00	3.11E-03	4.19E-08	.00000	.00030	.00000	.00000	.00030	.00176	.00000	.00180
Tc-99m	2.50E-01	3.54E-03	3.47E-08	.00000	.00029	.00000	.00000	.00029	.00171	.00000	.00170
Ru-103	3.96E+01	3.34E-03	4.64E-08	.00000	.00043	.00000	.00000	.00043	.00252	.00000	.00250
Rh-103m	3.96E-02	0.00E+00	0.00E+00	.00000	.00043	.00000	.00000	.00043	.00252	.00000	.00250
Ru-106	3.67E+02	3.99E-02	5.50E-07	.00001	.00518	.00000	.00003	.00522	.03065	.00000	.03100
Rh-106	3.47E-04	0.00E+00	0.00E+00	.00001	.00518	.00000	.00003	.00522	.03065	.00000	.03100
Ag-110m	2.53E+02	5.76E-04	7.88E-09	.00000	.00007	.00000	.00000	.00008	.00044	.00000	.00044
Ag-110	2.82E-04	0.00E+00	0.00E+00	.00000	.00001	.00000	.00000	.00001	.00006	.00000	.00006
Te-129m	3.40E+01	8.48E-05	1.17E-09	.00000	.00001	.00000	.00000	.00001	.00006	.00000	.00006
Te-129	4.79E-02	2.55E-02	1.28E-07	.00000	.00001	.00000	.00000	.00001	.00004	.00000	.00004
Te-131m	1.25E+00	7.98E-04	1.02E-08	.00000	.00005	.00000	.00000	.00005	.00032	.00000	.00032
Te-131	1.74E-02	9.04E-03	2.07E-08	.00000	.00001	.00000	.00000	.00001	.00006	.00000	.00006
I-131	8.05E+00	2.07E-02	2.49E-07	.00334	.00243	.00000	.00002	.00580	.03406	.00000	.03400

Table 3.5-7— Annual Liquid Effluent Releases (English Units)
(Page 2 of 2)

Radionuclide	Half-Life (days)	Primary µCi per ml	Secondary µCi per ml	Boron Recovery System (Ci)	Misc Wastes (Ci)	Secondary (Ci)	Turbine Building (Ci)	Total Liquid Waste Sources (Ci)	Adjusted Total (Ci/yr)	Detergent Wastes (Ci/yr)	Total (Ci/yr)
Te-132	3.25E+00	8.15E-04	1.09E-08	.00000	.00008	.00000	.00000	.00008	.00048	.00000	.00048
I-132	9.58E-02	1.98E-01	1.34E-06	.00001	.00016	.00000	.00002	.00020	.00116	.00000	.00120
I-133	8.75E-01	7.92E-02	8.87E-07	.00175	.00405	.00000	.00007	.00587	.03447	.00000	.03400
Cs-134	7.49E+02	3.43E-03	4.84E-08	.00000	.00045	.00000	.00000	.00045	.00264	.00000	.00260
I-135	2.79E-01	1.90E-01	1.81E-06	.00050	.00194	.00000	.00010	.00253	.01487	.00000	.01500
Cs-136	1.30E+01	4.36E-04	6.12E-09	.00000	.00005	.00000	.00000	.00005	.00031	.00000	.00031
Cs-137	1.10E+04	4.54E-03	6.45E-08	.00000	.00059	.00000	.00000	.00060	.00350	.00000	.00350
Ba-137m	1.77E-03	0.00E+00	0.00E+00	.00000	.00055	.00000	.00000	.00056	.00327	.00000	.00330
Ba-140	1.28E+01	5.88E-03	7.94E-08	.00000	.00072	.00000	.00000	.00072	.00423	.00000	.00420
La-140	1.68E+00	1.28E-02	1.67E-07	.00000	.00130	.00000	.00001	.00131	.00767	.00000	.00770
Ce-141	3.24E+01	6.70E-05	9.16E-10	.00000	.00001	.00000	.00000	.00001	.00005	.00000	.00005
Ce-143	1.38E+00	1.47E-03	1.86E-08	.00000	.00010	.00000	.00000	.00010	.00062	.00000	.00062
Pr-143	1.37E+01	0.00E+00	0.00E+00	.00000	.00001	.00000	.00000	.00001	.00005	.00000	.00005
Ce-144	2.84E+02	1.73E-03	2.38E-08	.00000	.00022	.00000	.00000	.00023	.00133	.00000	.00130
Pr-144	1.20E-02	0.00E+00	0.00E+00	.00000	.00022	.00000	.00000	.00023	.00133	.00000	.00130
All Others		6.25E-01	1.89E-06	.00000	.00000	.00000	.00000	.00000	.00002	.00000	.00002
Total (Except Tritium)		1.27E+00	7.93E-06	.00563	.02689	.00000	.00033	.03284	.19284	.00000	.19000
Tritium Release		1.66E+03 Curies per year									
Note: 0.00000 indicates that the value is less than 1.0E-05.											

Insert 3.5-7-1

RAI 101, Question 11.02-5(a)

Insert 3.5.7-1

Radionuclide	Half-Life (days)	Primary µCi per ml	Secondary µCi per ml	Boron Recovery (Ci)	Misc. Wastes (Ci)	Secondary (Ci)	Turbine Buidling (Ci)	Total Liquid Waste (Ci)	Adjusted Total (Ci/yr)	Detergent Wastes (Ci/yr)	Total (Ci/yr)
Corrosion And Activation Products											
Na-24	6.25E-01	2.84E-02	3.40E-07	0.00000	0.00104	0.00000	0.00001	0.00105	0.00572	0.00000	0.0057
Cr-51	2.78E+01	1.39E-03	1.96E-08	0.00000	0.00018	0.00000	0.00000	0.00018	0.00096	0.00000	0.00096
Mn-54	3.03E+02	7.09E-04	9.66E-09	0.00000	0.00009	0.00000	0.00000	0.00009	0.00051	0.00000	0.00051
Fe-55	9.50E+02	5.31E-04	7.28E-09	0.00000	0.00007	0.00000	0.00000	0.00007	0.00038	0.00000	0.00038
Fe-59	4.50E+01	1.34E-04	1.80E-09	0.00000	0.00002	0.00000	0.00000	0.00002	0.00009	0.00000	0.00009
Co-58	7.13E+01	2.04E-03	2.84E-08	0.00000	0.00026	0.00000	0.00000	0.00027	0.00144	0.00000	0.0014
Co-60	1.92E+03	2.35E-04	3.27E-09	0.00000	0.00003	0.00000	0.00000	0.00003	0.00017	0.00000	0.00017
Zn-65	2.45E+02	2.26E-04	3.12E-09	0.00000	0.00003	0.00000	0.00000	0.00003	0.00016	0.00000	0.00016
W-187	9.96E-01	1.38E-03	1.73E-08	0.00000	0.00008	0.00000	0.00000	0.00008	0.00043	0.00000	0.00043
Np-239	2.35E+00	1.08E-03	1.44E-08	0.00000	0.0001	0.00000	0.00000	0.0001	0.00054	0.00000	0.00054
Fission Products											
Sr-89	5.20E+01	6.23E-05	8.52E-10	0.00000	0.00001	0.00000	0.00000	0.00001	0.00004	0.00000	0.00004
Sr-91	4.03E-01	6.41E-04	7.35E-09	0.00000	0.00001	0.00000	0.00000	0.00001	0.00007	0.00000	0.00007
Y-91m	3.47E-02	5.09E-04	2.01E-09	0.00000	0.00001	0.00000	0.00000	0.00001	0.00005	0.00000	0.00005
Y-93	4.25E-01	2.77E-03	3.09E-08	0.00000	0.00006	0.00000	0.00000	0.00006	0.00033	0.00000	0.00033
Zr-95	6.50E+01	1.73E-04	2.39E-09	0.00000	0.00002	0.00000	0.00000	0.00002	0.00012	0.00000	0.00012
Nb-95	3.50E+01	1.25E-04	1.65E-09	0.00000	0.00002	0.00000	0.00000	0.00002	0.00009	0.00000	0.00009
Mo-99	2.79E+00	3.11E-03	4.19E-08	0.00000	0.00030	0.00000	0.00000	0.00030	0.00163	0.00000	0.00160
Tc-99m	2.50E-01	3.54E-03	3.47E-08	0.00000	0.00029	0.00000	0.00000	0.00029	0.00159	0.00000	0.00160
Ru-103	3.96E+01	3.34E-03	4.64E-08	0.00000	0.00043	0.00000	0.00000	0.00043	0.00234	0.00000	0.00230
Rh-103m	3.96E-02	0.00E+00	0.00E+00	0.00000	0.00043	0.00000	0.00000	0.00043	0.00234	0.00000	0.00230
Ru-106	3.67E+02	3.99E-02	5.50E-07	0.00001	0.00518	0.00000	0.00003	0.00522	0.02844	0.00000	0.02800
Rh-106	3.47E-04	0.00E+00	0.00E+00	0.00001	0.00518	0.00000	0.00003	0.00522	0.02844	0.00000	0.02800
Ag-110m	2.53E+02	5.76E-04	7.88E-09	0.00000	0.00007	0.00000	0.00000	0.00008	0.00041	0.00000	0.00041
Ag-110	2.82E-04	0.00E+00	0.00E+00	0.00000	0.00001	0.00000	0.00000	0.00001	0.00005	0.00000	0.00005
Te-129m	3.40E+01	8.48E-05	1.17E-09	0.00000	0.00001	0.00000	0.00000	0.00001	0.00006	0.00000	0.00006
Te-129	4.79E-02	2.55E-02	1.28E-07	0.00000	0.00001	0.00000	0.00000	0.00001	0.00004	0.00000	0.00004
Te-131m	1.25E+00	7.98E-04	1.02E-08	0.00000	0.00005	0.00000	0.00000	0.00005	0.00029	0.00000	0.00029

Radionuclide	Half-Life (days)	Primary µCi per ml	Secondary µCi per ml	Boron Recovery (Ci)	Misc. Wastes (Ci)	Secondary (Ci)	Turbine Buidling (Ci)	Total Liquid Waste (Ci)	Adjusted Total (Ci/yr)	Detergent Wastes (Ci/yr)	Total (Ci/yr)
Te-131	1.74E-02	9.04E-03	2.07E-08	0.00000	0.00001	0.00000	0.00000	0.00001	0.00005	0.00000	0.00005
I-131	8.05E+00	2.07E-02	2.49E-07	0.00403	0.00243	0.00000	0.00002	0.00649	0.03536	0.00000	0.03500
Te-132	3.25E+00	8.15E-04	1.09E-08	0.00000	0.00008	0.00000	0.00000	0.00008	0.00045	0.00000	0.00045
I-132	9.58E-02	1.98E-01	1.34E-06	0.00003	0.00016	0.00000	0.00002	0.00021	0.00114	0.00000	0.00110
I-133	8.75E-01	7.92E-02	8.87E-07	0.00360	0.00405	0.00000	0.00007	0.00773	0.04209	0.00000	0.04200
Cs-134	7.49E+02	3.43E-03	4.84E-08	0.00000	0.00045	0.00000	0.00000	0.00045	0.00245	0.00000	0.00250
I-135	2.79E-01	1.90E-01	1.81E-06	0.00106	0.00194	0.00000	0.00010	0.00310	0.01689	0.00000	0.01700
Cs-136	1.30E+01	4.36E-04	6.12E-09	0.00000	0.00005	0.00000	0.00000	0.00005	0.00029	0.00000	0.00029
Cs-137	1.10E+04	4.54E-03	6.45E-08	0.00000	0.00059	0.00000	0.00000	0.00060	0.00325	0.00000	0.00330
Ba-137m	1.77E-03	0.00E+00	0.00E+00	0.00000	0.00055	0.00000	0.00000	0.00056	0.00304	0.00000	0.00300
Ba-140	1.28E+01	5.88E-03	7.94E-08	0.00000	0.00072	0.00000	0.00000	0.00072	0.00393	0.00000	0.00390
La-140	1.68E+00	1.28E-02	1.67E-07	0.00000	0.00130	0.00000	0.00001	0.00131	0.00712	0.00000	0.00710
Ce-141	3.24E+01	6.70E-05	9.16E-10	0.00000	0.00001	0.00000	0.00000	0.00001	0.00005	0.00000	0.00005
Ce-143	1.38E+00	1.47E-03	1.86E-08	0.00000	0.00010	0.00000	0.00000	0.00010	0.00057	0.00000	0.00057
Pr-143	1.37E+01	0.00E+00	0.00E+00	0.00000	0.00001	0.00000	0.00000	0.00001	0.00005	0.00000	0.00005
Ce-144	2.84E+02	1.73E-03	2.38E-08	0.00000	0.00022	0.00000	0.00000	0.00023	0.00123	0.00000	0.00120
Pr-144	1.20E-02	0.00E+00	0.00E+00	0.00000	0.00022	0.00000	0.00000	0.00023	0.00123	0.00000	0.00120
ALL Others		6.25E-01	1.89E-06	0.00000	0.00000	0.00000	0.00000	0.00000	0.00002	0.00000	0.00002
Total (Except For Tritium)		1.27E+00	7.93E-06	0.00876	0.02689	0.00000	0.00033	0.03597	0.19597	0.00000	0.19000
Tritium Releases		1660 Curies Per Year									
Note: 0.00000 Indicates That The Values Is Less Than 1.0E-05.											

Table 3.5-7— Annual Liquid Effluent Releases (SI Units)
(Page 1 of 2)

Radionuclide	Half-Life (days)	Primary Bq/ml	Secondary Bq/ml	Boron Recovery System (Bq)	Misc Wastes (Bq)	Secondary (Bq)	Turbine Building (Bq)	Total Liquid Waste Sources (Bq)	Adjusted Total (Bq/yr)	Detergent Wastes (Bq/yr)	Total (Bq/yr)
Activated Corrosion Products											
Na-24	6.25E-01	1.05E+03	1.26E-02	0.00E+00	3.85E+07	0.00E+00	3.70E+05	3.89E+07	2.28E+08	0.00E+00	2.29E+08
Cr-51	2.78E+01	5.14E+01	7.25E-04	0.00E+00	6.66E+06	0.00E+00	0.00E+00	6.66E+06	3.85E+07	0.00E+00	3.70E+07
Mn-54	3.03E+02	2.62E+01	3.57E-04	0.00E+00	3.33E+06	0.00E+00	0.00E+00	3.33E+06	2.00E+07	0.00E+00	2.00E+07
Fe-55	9.50E+02	1.96E+01	2.69E-04	0.00E+00	2.59E+06	0.00E+00	0.00E+00	2.59E+06	1.52E+07	0.00E+00	1.52E+07
Fe-59	4.50E+01	4.96E+00	6.66E-05	0.00E+00	7.40E+05	0.00E+00	0.00E+00	7.40E+05	3.70E+06	0.00E+00	3.70E+06
Co-58	7.13E+01	7.55E+01	1.05E-03	0.00E+00	9.62E+06	0.00E+00	0.00E+00	9.99E+06	5.77E+07	0.00E+00	5.92E+07
Co-60	1.92E+03	8.70E+00	1.21E-04	0.00E+00	1.11E+06	0.00E+00	0.00E+00	1.11E+06	6.66E+06	0.00E+00	6.66E+06
Zn-65	2.45E+02	8.36E+00	1.15E-04	0.00E+00	1.11E+06	0.00E+00	0.00E+00	1.11E+06	6.29E+06	0.00E+00	6.29E+06
W-187	9.96E-01	5.11E+01	6.40E-04	0.00E+00	2.96E+06	0.00E+00	0.00E+00	2.96E+06	1.74E+07	0.00E+00	1.74E+07
Np-239	2.35E+00	4.00E+01	5.33E-04	0.00E+00	3.70E+06	0.00E+00	0.00E+00	3.70E+06	2.15E+07	0.00E+00	2.15E+07
Fission Products											
Sr-89	5.20E+01	2.31E+00	3.15E-05	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.85E+06	0.00E+00	1.85E+06
Sr-91	4.03E-01	2.37E+01	2.72E-04	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	2.96E+06	0.00E+00	2.96E+06
Y-91M	3.47E-02	1.88E+01	7.44E-05	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.85E+06	0.00E+00	1.85E+06
Y- 93	4.25E-01	1.02E+02	1.14E-03	0.00E+00	2.22E+06	0.00E+00	0.00E+00	2.22E+06	1.33E+07	0.00E+00	1.33E+07
Zr-95	6.50E+01	6.40E+00	8.84E-05	0.00E+00	7.40E+05	0.00E+00	0.00E+00	7.40E+05	4.81E+06	0.00E+00	4.81E+06
Nb-95	3.50E+01	4.63E+00	6.11E-05	0.00E+00	7.40E+05	0.00E+00	0.00E+00	7.40E+05	3.70E+06	0.00E+00	3.70E+06
Mo-99	2.79E+00	1.15E+02	1.55E-03	0.00E+00	1.11E+07	0.00E+00	0.00E+00	1.11E+07	6.51E+07	0.00E+00	6.66E+07
Tc-99m	2.50E-01	1.31E+02	1.28E-03	0.00E+00	1.07E+07	0.00E+00	0.00E+00	1.07E+07	6.33E+07	0.00E+00	6.29E+07
Ru-103	3.96E+01	1.24E+02	1.72E-03	0.00E+00	1.59E+07	0.00E+00	0.00E+00	1.59E+07	9.32E+07	0.00E+00	9.25E+07
Rh-103m	3.96E-02	0.00E+00	0.00E+00	0.00E+00	1.59E+07	0.00E+00	0.00E+00	1.59E+07	9.32E+07	0.00E+00	9.25E+07
Ru-106	3.67E+02	1.48E+03	2.04E-02	3.70E+05	1.92E+08	0.00E+00	1.11E+06	1.93E+08	1.13E+09	0.00E+00	1.15E+09
Rh-106	3.47E-04	0.00E+00	0.00E+00	3.70E+05	1.92E+08	0.00E+00	1.11E+06	1.93E+08	1.13E+09	0.00E+00	1.15E+09
Ag-110m	2.53E+02	2.13E+01	2.92E-04	0.00E+00	2.59E+06	0.00E+00	0.00E+00	2.96E+06	1.63E+07	0.00E+00	1.63E+07
Ag-110	2.82E-04	0.00E+00	0.00E+00	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	2.22E+06	0.00E+00	2.22E+06
Te-129m	3.40E+01	3.14E+00	4.33E-05	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	2.22E+06	0.00E+00	2.22E+06
Te-129	4.79E-02	9.44E+02	4.74E-03	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.48E+06	0.00E+00	1.48E+06
Te-131m	1.25E+00	2.95E+01	3.77E-04	0.00E+00	1.85E+06	0.00E+00	0.00E+00	1.85E+06	1.18E+07	0.00E+00	1.18E+07
Te-131	1.74E-02	3.34E+02	7.66E-04	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	2.22E+06	0.00E+00	2.22E+06

Table 3.5-7— Annual Liquid Effluent Releases (SI Units)

(Page 2 of 2)

Radionuclide	Half-Life (days)	Primary Bq/ml	Secondary Bq/ml	Boron Recovery System (Bq)	Misc Wastes (Bq)	Secondary (Bq)	Turbine Building (Bq)	Total Liquid Waste Sources (Bq)	Adjusted Total (Bq/yr)	Detergent Wastes (Bq/yr)	Total (Bq/yr)
I-131	8.05E+00	7.66E+02	9.21E-03	1.24E+08	8.99E+07	0.00E+00	7.40E+05	2.15E+08	1.26E+09	0.00E+00	1.26E+09
Te-132	3.25E+00	3.02E+01	4.03E-04	0.00E+00	2.96E+06	0.00E+00	0.00E+00	2.96E+06	1.78E+07	0.00E+00	1.78E+07
I-132	9.58E-02	7.33E+03	4.96E-02	3.70E+05	5.92E+06	0.00E+00	7.40E+05	7.40E+06	4.29E+07	0.00E+00	4.44E+07
I-133	8.75E-01	2.93E+03	3.28E-02	6.48E+07	1.50E+08	0.00E+00	2.59E+06	2.17E+08	1.28E+09	0.00E+00	1.26E+09
Cs-134	7.49E+02	1.27E+02	1.79E-03	0.00E+00	1.67E+07	0.00E+00	0.00E+00	1.67E+07	9.77E+07	0.00E+00	9.62E+07
I-135	2.79E-01	7.03E+03	6.70E-02	1.85E+07	7.18E+07	0.00E+00	3.70E+06	9.36E+07	5.50E+08	0.00E+00	5.55E+08
Cs-136	1.30E+01	1.61E+01	2.26E-04	0.00E+00	1.85E+06	0.00E+00	0.00E+00	1.85E+06	1.15E+07	0.00E+00	1.15E+07
Cs-137	1.10E+04	1.68E+02	2.39E-03	0.00E+00	2.18E+07	0.00E+00	0.00E+00	2.22E+07	1.30E+08	0.00E+00	1.30E+08
Ba-137m	1.77E-03	0.00E+00	0.00E+00	0.00E+00	2.04E+07	0.00E+00	0.00E+00	2.07E+07	1.21E+08	0.00E+00	1.22E+08
Ba-140	1.28E+01	2.18E+02	2.94E-03	0.00E+00	2.66E+07	0.00E+00	0.00E+00	2.66E+07	1.57E+08	0.00E+00	1.55E+08
La-140	1.68E+00	4.74E+02	6.18E-03	0.00E+00	4.81E+07	0.00E+00	3.70E+05	4.85E+07	2.84E+08	0.00E+00	2.85E+08
Ce-141	3.24E+01	2.48E+00	3.39E-05	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.85E+06	0.00E+00	1.85E+06
Ce-143	1.38E+00	5.44E+01	6.88E-04	0.00E+00	3.70E+06	0.00E+00	0.00E+00	3.70E+06	2.29E+07	0.00E+00	2.29E+07
Pr-143	1.37E+01	0.00E+00	0.00E+00	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.85E+06	0.00E+00	1.85E+06
Ce-144	2.84E+02	6.40E+01	8.81E-04	0.00E+00	8.14E+06	0.00E+00	0.00E+00	8.51E+06	4.92E+07	0.00E+00	4.81E+07
Pr-144	1.20E-02	0.00E+00	0.00E+00	0.00E+00	8.14E+06	0.00E+00	0.00E+00	8.51E+06	4.92E+07	0.00E+00	4.81E+07
All Others		2.31E+04	6.99E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.40E+05	0.00E+00	7.40E+05
Total (Except Tritium)		4.70E+04	2.93E-01	2.08E+08	9.95E+08	0.00E+00	1.22E+07	1.22E+09	7.14E+09	0.00E+00	7.03E+09
Tritium Release		6.14E+13 Becquerel per year									
Note: 0.00000 indicates that the value is less than 1.0E-05.											

Insert 3.5-7-2

RAI 101, Question 11.02.5(a)

Insert 3.5.7-2

Radionuclide	Half-Life (days)	Primary Bq per ml	Secondary Bq per ml	Boron Recovery (Bq)	Misc. Wastes (Bq)	Secondary (Bq)	Turbine Buidling (Bq)	Total Liquid Waste (Bq)	Adjusted Total (Bq/yr)	Detergent Wastes (Bq/yr)	Total (Bq/yr)
Corrosion And Activation Products											
Na-24	6.25E-01	1.05E+03	1.26E-02	0.00E+00	3.85E+07	0.00E+00	3.70E+05	3.89E+07	2.12E+08	0.00E+00	2.11E+08
Cr-51	2.78E+01	5.14E+01	7.25E-04	0.00E+00	6.66E+06	0.00E+00	0.00E+00	6.66E+06	3.55E+07	0.00E+00	3.55E+07
Mn-54	3.03E+02	2.62E+01	3.57E-04	0.00E+00	3.33E+06	0.00E+00	0.00E+00	3.33E+06	1.89E+07	0.00E+00	1.89E+07
Fe-55	9.50E+02	1.96E+01	2.69E-04	0.00E+00	2.59E+06	0.00E+00	0.00E+00	2.59E+06	1.41E+07	0.00E+00	1.41E+07
Fe-59	4.50E+01	4.96E+00	6.66E-05	0.00E+00	7.40E+05	0.00E+00	0.00E+00	7.40E+05	3.33E+06	0.00E+00	3.33E+06
Co-58	7.13E+01	7.55E+01	1.05E-03	0.00E+00	9.62E+06	0.00E+00	0.00E+00	9.99E+06	5.33E+07	0.00E+00	5.18E+07
Co-60	1.92E+03	8.70E+00	1.21E-04	0.00E+00	1.11E+06	0.00E+00	0.00E+00	1.11E+06	6.29E+06	0.00E+00	6.29E+06
Zn-65	2.45E+02	8.36E+00	1.15E-04	0.00E+00	1.11E+06	0.00E+00	0.00E+00	1.11E+06	5.92E+06	0.00E+00	5.92E+06
W-187	9.96E-01	5.11E+01	6.40E-04	0.00E+00	2.96E+06	0.00E+00	0.00E+00	2.96E+06	1.59E+07	0.00E+00	1.59E+07
Np-239	2.35E+00	4.00E+01	5.33E-04	0.00E+00	3.70E+06	0.00E+00	0.00E+00	3.70E+06	2.00E+07	0.00E+00	2.00E+07
Fission Products											
Sr-89	5.20E+01	2.31E+00	3.15E-05	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.48E+06	0.00E+00	1.48E+06
Sr-91	4.03E-01	2.37E+01	2.72E-04	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	2.59E+06	0.00E+00	2.59E+06
Y-91m	3.47E-02	1.88E+01	7.44E-05	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.85E+06	0.00E+00	1.85E+06
Y-93	4.25E-01	1.02E+02	1.14E-03	0.00E+00	2.22E+06	0.00E+00	0.00E+00	2.22E+06	1.22E+07	0.00E+00	1.22E+07
Zr-95	6.50E+01	6.40E+00	8.84E-05	0.00E+00	7.40E+05	0.00E+00	0.00E+00	7.40E+05	4.44E+06	0.00E+00	4.44E+06
Nb-95	3.50E+01	4.63E+00	6.11E-05	0.00E+00	7.40E+05	0.00E+00	0.00E+00	7.40E+05	3.33E+06	0.00E+00	3.33E+06
Mo-99	2.79E+00	1.15E+02	1.55E-03	0.00E+00	1.11E+07	0.00E+00	0.00E+00	1.11E+07	6.03E+07	0.00E+00	5.92E+07
Tc-99m	2.50E-01	1.31E+02	1.28E-03	0.00E+00	1.07E+07	0.00E+00	0.00E+00	1.07E+07	5.88E+07	0.00E+00	5.92E+07
Ru-103	3.96E+01	1.24E+02	1.72E-03	0.00E+00	1.59E+07	0.00E+00	0.00E+00	1.59E+07	8.66E+07	0.00E+00	8.51E+07
Rh-103m	3.96E-02	0.00E+00	0.00E+00	0.00E+00	1.59E+07	0.00E+00	0.00E+00	1.59E+07	8.66E+07	0.00E+00	8.51E+07
Ru-106	3.67E+02	1.48E+03	2.04E-02	3.70E+05	1.92E+08	0.00E+00	1.11E+06	1.93E+08	1.05E+09	0.00E+00	1.04E+09
Rh-106	3.47E-04	0.00E+00	0.00E+00	3.70E+05	1.92E+08	0.00E+00	1.11E+06	1.93E+08	1.05E+09	0.00E+00	1.04E+09
Ag-110m	2.53E+02	2.13E+01	2.92E-04	0.00E+00	2.59E+06	0.00E+00	0.00E+00	2.96E+06	1.52E+07	0.00E+00	1.52E+07

Radionuclide	Half-Life (days)	Primary Bq per ml	Secondary Bq per ml	Boron Recovery (Bq)	Misc. Wastes (Bq)	Secondary (Bq)	Turbine Buidling (Bq)	Total Liquid Waste (Bq)	Adjusted Total (Bq/yr)	Detergent Wastes (Bq/yr)	Total (Bq/yr)
Ag-110	2.82E-04	0.00E+00	0.00E+00	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.85E+06	0.00E+00	1.85E+06
Te-129m	3.40E+01	3.14E+00	4.33E-05	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	2.22E+06	0.00E+00	2.22E+06
Te-129	4.79E-02	9.44E+02	4.74E-03	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.48E+06	0.00E+00	1.48E+06
Te-131m	1.25E+00	2.95E+01	3.77E-04	0.00E+00	1.85E+06	0.00E+00	0.00E+00	1.85E+06	1.07E+07	0.00E+00	1.07E+07
Te-131	1.74E-02	3.34E+02	7.66E-04	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.85E+06	0.00E+00	1.85E+06
I-131	8.05E+00	7.66E+02	9.21E-03	1.49E+08	8.99E+07	0.00E+00	7.40E+05	2.40E+08	1.31E+09	0.00E+00	1.30E+09
Te-132	3.25E+00	3.02E+01	4.03E-04	0.00E+00	2.96E+06	0.00E+00	0.00E+00	2.96E+06	1.67E+07	0.00E+00	1.67E+07
I-132	9.58E-02	7.33E+03	4.96E-02	1.11E+06	5.92E+06	0.00E+00	7.40E+05	7.77E+06	4.22E+07	0.00E+00	4.07E+07
I-133	8.75E-01	2.93E+03	3.28E-02	1.33E+08	1.50E+08	0.00E+00	2.59E+06	2.86E+08	1.56E+09	0.00E+00	1.55E+09
Cs-134	7.49E+02	1.27E+02	1.79E-03	0.00E+00	1.67E+07	0.00E+00	0.00E+00	1.67E+07	9.07E+07	0.00E+00	9.25E+07
I-135	2.79E-01	7.03E+03	6.70E-02	3.92E+07	7.18E+07	0.00E+00	3.70E+06	1.15E+08	6.25E+08	0.00E+00	6.29E+08
Cs-136	1.30E+01	1.61E+01	2.26E-04	0.00E+00	1.85E+06	0.00E+00	0.00E+00	1.85E+06	1.07E+07	0.00E+00	1.07E+07
Cs-137	1.10E+04	1.68E+02	2.39E-03	0.00E+00	2.18E+07	0.00E+00	0.00E+00	2.22E+07	1.20E+08	0.00E+00	1.22E+08
Ba-137m	1.77E-03	0.00E+00	0.00E+00	0.00E+00	2.04E+07	0.00E+00	0.00E+00	2.07E+07	1.12E+08	0.00E+00	1.11E+08
Ba-140	1.28E+01	2.18E+02	2.94E-03	0.00E+00	2.66E+07	0.00E+00	0.00E+00	2.66E+07	1.45E+08	0.00E+00	1.44E+08
La-140	1.68E+00	4.74E+02	6.18E-03	0.00E+00	4.81E+07	0.00E+00	3.70E+05	4.85E+07	2.63E+08	0.00E+00	2.63E+08
Ce-141	3.24E+01	2.48E+00	3.39E-05	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.85E+06	0.00E+00	1.85E+06
Ce-143	1.38E+00	5.44E+01	6.88E-04	0.00E+00	3.70E+06	0.00E+00	0.00E+00	3.70E+06	2.11E+07	0.00E+00	2.11E+07
Pr-143	1.37E+01	0.00E+00	0.00E+00	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.85E+06	0.00E+00	1.85E+06
Ce-144	2.84E+02	6.40E+01	8.81E-04	0.00E+00	8.14E+06	0.00E+00	0.00E+00	8.51E+06	4.55E+07	0.00E+00	4.44E+07
Pr-144	1.20E-02	0.00E+00	0.00E+00	0.00E+00	8.14E+06	0.00E+00	0.00E+00	8.51E+06	4.55E+07	0.00E+00	4.44E+07
ALL Others		2.31E+04	6.99E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.40E+05	0.00E+00	7.40E+05
Total (Except For Tritium)		4.70E+04	2.93E-01	3.24E+08	9.95E+08	0.00E+00	1.22E+07	1.33E+09	7.25E+09	0.00E+00	7.03E+09
Tritium Releases		6.14E+13									
Note: 0.00000 Indicates That The Values Is Less Than 1.0E-05.											

RAI 101, Question 11.02-3(1-4)

Table 3.5-8— Annual Gaseous Effluent Releases (English Units)[1]
(Page 1 of 4)

Radionuclide	Primary Coolant	Secondary Coolant	Building Ventilation: Fuel	Building Ventilation: Reactor	Building Ventilation: Nuclear Auxiliary	Building Ventilation: Turbine	Blowdown Vent. Offgas	Main Condenser Removal	Total
	(µCi/gm)	(µCi/gm)	(Ci/yr)	(Ci/yr)	(Ci/yr)	(Ci/yr)	(Ci/yr)	(Ci/yr)	(Ci/yr)
I-131	2.070E-02	2.510E-07	2.7E-04	1.9E-03	6.6E-03	0.0E+00	0.0E+00	0.0E+00	8.8E-03
I-133	7.917E-02	8.929E-07	1.0E-03	5.9E-03	2.5E-02	0.0E+00	0.0E+00	0.0E+00	3.2E-02
H-3	Released via Gaseous Pathway								1.8E+02
C-14	Released via Gaseous Pathway								1.89E+01 ~~(3.8E+00)~~[2]
Ar-41	Released via Gaseous Pathway								3.4E+01

Radionuclide	Primary Coolant	Secondary Coolant	Gas Stripping: Shutdown	Gas Stripping: Continuous	Building Ventilation: Reactor	Building Ventilation: Nuclear Auxiliary	Building Ventilation: Turbine	Blowdown Vent. Offgas	Main Condenser Removal	Total
	(µCi/gm)	(µCi/gm)	(Ci/yr)	(Ci/yr)	(Ci/yr)	(Ci/yr)	(Ci/yr)	(Ci/yr)	(Ci/yr)	(Ci/yr)
Kr-85m	2.006E-01	2.945E-08	0.0E+00	2.0E+00	1.4E+02	4.0E+00	0.0E+00	0.0E+00	2.0E+00	1.5E+02
Kr-85	3.854E-01	5.512E-08	2.1E+02	1.7E+03	9.1E+02	8.0E+00	0.0E+00	0.0E+00	4.0E+00	2.8E+03
Kr-87	1.884E-01	2.603E-08	0.0E+00	0.0E+00	5.0E+01	4.0E+00	0.0E+00	0.0E+00	2.0E+00	5.6E+01
Kr-88	3.513E-01	5.115E-08	0.0E+00	0.0E+00	1.8E+02	7.0E+00	0.0E+00	0.0E+00	4.0E+00	1.9E+02
Xe-131m	8.272E-01	1.174E-07	8.8E+01	7.0E+02	1.9E+03	1.8E+01	0.0E+00	0.0E+00	8.0E+00	2.7E+03
Xe-133m	8.568E-02	1.269E-08	0.0E+00	0.0E+00	1.7E+02	2.0E+00	0.0E+00	0.0E+00	0.0E+00	1.7E+02
Xe-133	3.090E+00	4.435E-07	4.4E+01	3.5E+02	6.8E+03	6.6E+01	0.0E+00	0.0E+00	3.1E+01	7.3E+03
Xe-135m	1.633E-01	2.344E-08	0.0E+00	0.0E+00	1.0E+01	3.0E+00	0.0E+00	0.0E+00	2.0E+00	1.5E+01
Xe-135	1.063E+00	1.555E-07	0.0E+00	0.0E+00	1.2E+03	2.3E+01	0.0E+00	0.0E+00	1.1E+01	1.2E+03
Xe-137	4.272E-02	6.164E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xe-138	1.508E-01	2.170E-08	0.0E+00	0.0E+00	8.0E+00	3.0E+00	0.0E+00	0.0E+00	1.0E+00	1.2E+01
Total Noble Gases										1.5+04

RAI 101, Question 11.02-3(1-4)

Table 3.5-8— Annual Gaseous Effluent Releases (SI Units)[1]

(Page 3 of 4)

Radionuclide	Primary Coolant	Secondary Coolant	Building Ventilation: Fuel	Building Ventilation: Reactor	Building Ventilation: Nuclear Auxiliary	Building Ventilation: Turbine	Blowdown Vent. Offgas	Main Condenser Removal	Total
	(Bq/gm)	(Bq/gm)	(Bq/yr)	(Bq/yr)	(Bq/yr)	(Bq/yr)	(Bq/yr)	(Bq/yr)	(Bq/yr)
I-131	7.66E+02	9.29E-03	1.00E+07	7.00E+07	2.40E+08	0.00E+00	0.00E+00	0.00E+00	3.30E+08
I-133	2.93E+03	3.30E-02	3.70E+07	2.20E+08	9.30E+08	0.00E+00	0.00E+00	0.00E+00	1.20E+09
H-3	Released via Gaseous Pathway								6.70E+12
C-14	Released via Gaseous Pathway								7.0E+11 ~~1.40E+11~~[2]
Ar-41	Released via Gaseous Pathway								1.30E+12

Radionuclide	Primary Coolant	Secondary Coolant	Gas Stripping: Shutdown	Gas Stripping: Continuous	Building Ventilation: Reactor	Building Ventilation: Nuclear Auxiliary	Building Ventilation: Turbine	Blowdown Vent. Offgas	*Main Condenser Removal*	Total
	(Bq/gm)	(Bq/gm)	(Bq/yr)	(Bq/yr)	(Bq/yr)	(Bq/yr)	(Bq/yr)	(Bq/yr)	(Bq/yr)	(Bq/yr)
Kr-85m	7.42E+03	1.09E-03	0.00E+00	7.40E+10	5.18E+12	1.48E+11	0.00E+00	0.00E+00	7.40E+10	5.55E+12
Kr-85	1.43E+04	2.04E-03	7.77E+12	6.29E+13	3.37E+13	2.96E+11	0.00E+00	0.00E+00	1.48E+11	1.04E+14
Kr-87	6.97E+03	9.63E-04	0.00E+00	0.00E+00	1.85E+12	1.48E+11	0.00E+00	0.00E+00	7.40E+10	2.07E+12
Kr-88	1.30E+04	1.89E-03	0.00E+00	0.00E+00	6.66E+12	2.59E+11	0.00E+00	0.00E+00	1.48E+11	7.03E+12
Xe-131m	3.06E+04	4.34E-03	3.26E+12	2.59E+13	7.03E+13	6.66E+11	0.00E+00	0.00E+00	2.96E+11	9.99E+13
Xe-133m	3.17E+03	4.70E-04	0.00E+00	0.00E+00	6.29E+12	7.40E+10	0.00E+00	0.00E+00	0.00E+00	6.29E+12
Xe-133	1.14E+05	1.64E-02	1.63E+12	1.30E+13	2.52E+14	2.44E+12	0.00E+00	0.00E+00	1.15E+12	2.70E+14
Xe-135m	6.04E+03	8.67E-04	0.00E+00	0.00E+00	3.70E+11	1.11E+11	0.00E+00	0.00E+00	7.40E+10	5.55E+11
Xe-135	3.93E+04	5.75E-03	0.00E+00	0.00E+00	4.44E+13	8.51E+11	0.00E+00	0.00E+00	4.07E+11	4.44E+13
Xe-137	1.58E+03	2.28E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-138	5.58E+03	8.03E-04	0.00E+00	0.00E+00	2.96E+11	1.11E+11	0.00E+00	0.00E+00	3.70E+10	4.44E+11
Total Noble Gases										5.60E+14

Table 3.5-8— Annual Gaseous Effluent Releases (SI Units)(1)
(Page 4 of 4)

Radionuclide	Airborne Particulate Release Rate (Bq/yr)				
	Waste Gas System	Reactor Building	Nuclear Auxiliary Building	Fuel Building	Total
Cr-51	5.2E+03	3.4E+06	1.2E+05	6.7E+04	3.6E+06
Mn-54	7.8E+02	2.0E+06	2.9E+04	1.1E+05	2.1E+06
Co-57	0.0E+00	3.0E+05	0.0E+00	0.0E+00	3.0E+05
Co-58	3.2E+03	9.3E+06	7.0E+05	7.8E+06	1.8E+07
Co-60	5.2E+03	9.6E+05	1.9E+05	3.0E+06	4.1E+06
Fe-59	6.7E+02	1.0E+06	1.9E+04	0.0E+00	1.0E+06
Sr-89	1.6E+04	4.8E+06	2.8E+05	7.8E+05	5.9E+06
Sr-90	6.3E+03	1.9E+06	1.1E+05	3.0E+05	2.3E+06
Zr-95	1.8E+03	0.0E+00	3.7E+05	1.3E+03	3.7E+05
Nb-95	1.4E+03	6.7E+05	1.1E+04	8.9E+05	1.6E+06
Ru-103	1.2E+03	5.9E+05	8.5E+03	1.4E+04	6.3E+05
Ru-106	1.0E+03	0.0E+00	2.2E+03	2.6E+04	2.9E+04
Sb-125	0.0E+00	0.0E+00	1.4E+03	2.1E+04	2.3E+04
Cs-134	1.2E+04	9.3E+05	2.0E+05	6.3E+05	1.8E+06
Cs-136	2.0E+03	1.2E+06	1.8E+04	0.0E+00	1.2E+06
Cs-137	2.8E+04	2.0E+06	2.7E+05	1.0E+06	3.3E+06
Ba-140	8.5E+03	0.0E+00	1.5E+05	0.0E+00	1.6E+05
Ce-141	8.1E+02	4.8E+05	9.6E+03	1.6E+02	4.8E+05

Notes:

(1) 0.0E+00 appearing in the table indicates release is less than 1.0 Ci/year (less than 3.7E+10 Bq/year) for Noble Gases and less than 0.0001 Ci/year (less than 3.7E+06 Bq/year) for Iodine.

(2) The GALE code produces a fixed value of 7.3 curies (2.7E+11 Bq) of C-14 regardless of plant size or process cleanup design capabilities. A departure from GALE is applied for the estimation of C-14 releases to 18.9 curies/year (7.0E+11 Bq/year) to account for the larger power level of the U.S. EPR from those plants used in the development of the GALE code. ~~If a CO_2 fraction of 0.20 is assumed (e.g., for ingestion dose assessments), a value of 3.8 curies/year (1.4E+11 Bq/year) would be appropriate.~~

RAI 101 Question 11.02-3(1-4)

Table 3.5-14— Radioactive Liquid Releases Due to Anticipated Operational Occurrences
(Page 1 of 2)

Radionuclide	Adjusted Total	
	(Ci/yr)	(Bq/yr)
Corrosion and Activation Products		
Na-24	6.16E-03	2.28E+08
Cr-51	1.04E-03	3.85E+07
Mn-54	5.40e-04	2.00E+07
Fe-55	4.10E-04	1.52E+07
Fe-59	1.00E-04	3.70E+06
Co-58	1.56E-03	5.77E+07
Co-60	1.80E-04	6.66E+06
Zn-65	1.70E-04	6.29E+06
W-187	4.70E-04	1.74E+07
Np-239	5.80E-04	2.15E+07
Fission Products		
Sr-89	5.00E-05	1.85E+06
Sr-91	8.00E-05	2.96E+06
Y-91M	5.00E-05	1.85E+06
Y-93	3.60E-04	1.33E+07
Zr-95	1.30E-04	4.81E+06
Nb-95	1.00E-04	3.70E+06
Mo-99	1.76E-03	6.51E+07
Tc-99M	1.71E-03	6.33E+07
Ru-103	2.52E-03	9.32E+07
Rh-103M	2.52E-03	9.32E+07
Ru-106	3.07E-02	1.14E+09
Rh-106	3.07E-02	1.14E+09
Ag-110M	4.40E-04	1.63E+07
Ag-110	6.00E-05	2.22E+06
Te-129M	6.00E-05	2.22E+06
Te-129	4.00E-05	1.48E+06
Te-131M	3.20E-04	1.18E+07
Te-131	6.00E-05	2.22E+06
I131	3.41E-02	1.26E+09
TE132	4.80E-04	1.78E+07
I132	1.16E-03	4.29E+07
I133	3.45E-02	1.28E+09
CS134	2.64E-03	9.77E+07
I135	1.49E-02	5.51E+08
CS136	3.10E-04	1.15E+07
CS137	3.50E-03	1.30E+08
BA137M	3.27E-03	1.21E+08
BA140	4.23E-03	1.57E+08
LA140	7.67E-03	2.84E+08
CE141	5.00E-05	1.85E+06
CE143	6.20E-04	2.29E+07
PR143	5.00E-05	1.85E+07
CE144	1.33E-03	4.92E+07

Table 3.5-14— Radioactive Liquid Releases Due to Anticipated Operational Occurrences
(Page 2 of 2)

~~Radionuclide~~	~~Adjusted Total~~	
	~~(Ci/yr)~~	~~(Bq/yr)~~
~~PR144~~	~~1.33E-03~~	~~4.92E+07~~
~~All Others~~	~~2.00E-05~~	~~7.40E+05~~
~~Total (except H-3)~~	~~1.93E-01~~	~~7.14E+09~~
~~H-3~~	~~1.66E+03~~	~~6.14E+13~~

Insert 3.5-14-1

RAI 101, Question 11.02-5(a)

Insert 3.5-14-1

Radionuclide	Adjusted Total	
	(Ci/yr)	(Bq/yr)
Corrosion and Activation Products		
Na-24	5.72E-03	2.12E+08
Cr-51	9.60E-04	3.55E+07
Mn-54	5.10E-04	1.89E+07
Fe-55	3.80E-04	1.41E+07
Fe-59	9.00E-05	3.33E+06
Co-58	1.44E-03	5.33E+07
Co-60	1.70E-04	6.29E+06
Zn-65	1.60E-04	5.92E+06
W-187	4.30E-04	1.59E+07
Np-239	5.40E-04	2.00E+07
Fission Products		
Sr-89	4.00E-05	1.48E+06
Sr-91	7.00E-05	2.59E+06
Y-91m	5.00E-05	1.85E+06
Y-93	3.30E-04	1.22E+07
Zr-95	1.20E-04	4.44E+06
Nb-95	9.00E-05	3.33E+06
Mo-99	1.63E-03	6.03E+07
Tc-99m	1.59E-03	5.88E+07
Ru-103	2.34E-03	8.66E+07
Rh-103m	2.34E-03	8.66E+07
Ru-106	2.84E-02	1.05E+09
Rh-106	2.84E-02	1.05E+09
Ag-110m	4.10E-04	1.52E+07
Ag-110	5.00E-05	1.85E+06
Te-129m	6.00E-05	2.22E+06
Te-129	4.00E-05	1.48E+06
Te-131m	2.90E-04	1.07E+07
Te-131	5.00E-05	1.85E+06
I-131	3.54E-02	1.31E+09
Te-132	4.50E-04	1.67E+07
I-132	1.14E-03	4.22E+07
I-133	4.21E-02	1.56E+09
Cs-134	2.45E-03	9.07E+07
I-135	1.69E-02	6.25E+08
Cs-136	2.90E-04	1.07E+07
Cs-137	3.25E-03	1.20E+08
Ba-137m	3.04E-03	1.12E+08
Ba-140	3.93E-03	1.45E+08
La-140	7.12E-03	2.63E+08
Ce-141	5.00E-05	1.85E+06
Ce-143	5.70E-04	2.11E+07
Pr-143	5.00E-05	1.85E+06
Ce-144	1.23E-03	4.55E+07
Pr-144	1.23E-03	4.55E+07
Others	2.00E-05	7.40E+05
Total (except H-3)	1.96E-01	7.25E+09
H-3	1.66E+03	6.14E+13

Table 3.5-15— Summary of Radioactive Liquid Releases Including Anticipated Operational Occurrences
(Page 1 of 2)

Radio-nuclide	Total		Discharge Concentration		10 CFR 20 Appendix B Limits		Discharge Fraction of Limit
	(Ci/yr)	(Bq/yr)	(µCi/ml)	(Bq/ml)	(µCi/ml)	(Bq/ml)	
Activated Corrosion Products							
Na-24	6.2E-03	2.3E+08	3.6E-10	1.3E-05	5.0E-05	1.9E+00	7.2E-06
Cr-51	1.0E-03	3.9E+07	6.0E-11	2.2E-06	5.0E-04	1.9E+01	1.2E-07
Mn-54	5.4E-04	2.0E+07	3.1E-11	1.2E-06	3.0E-05	1.1E+00	1.0E-06
Fe-55	4.1E-04	1.5E+07	2.4E-11	8.8E-07	1.0E-04	3.7E+00	2.4E-07
Fe-59	1.0E-04	3.7E+06	5.8E-12	2.2E-07	1.0E-05	3.7E-01	5.8E-07
Co-58	1.6E-03	5.8E+07	9.1E-11	3.4E-06	2.0E-05	7.4E-01	4.5E-06
Co-60	1.8E-04	6.7E+06	1.0E-11	3.9E-07	3.0E-06	1.1E-01	3.5E-06
Zn-65	1.7E-04	6.3E+06	9.9E-12	3.7E-07	5.0E-06	1.9E-01	2.0E-06
W-187	4.7E-04	1.7E+07	2.7E-11	1.0E-06	3.0E-05	1.1E+00	9.1E-07
Np-239	5.8E-04	2.2E+07	3.4E-11	1.2E-06	2.0E-05	7.4E-01	1.7E-06
Fission Products							
Sr-89	5.0E-05	1.9E+06	2.9E-12	1.1E-07	8.0E-06	3.0E-01	3.6E-07
Sr-91	8.0E-05	3.0E+06	4.6E-12	1.7E-07	2.0E-05	7.4E-01	2.3E-07
Y-91m	5.0E-05	1.9E+06	2.9E-12	1.1E-07	2.0E-03	7.4E+01	1.5E-09
Y-93	3.6E-04	1.3E+07	2.1E-11	7.7E-07	2.0E-05	7.4E-01	1.0E-06
Zr-95	1.3E-04	4.8E+06	7.5E-12	2.8E-07	2.0E-05	7.4E-01	3.8E-07
N-95	1.0E-04	3.7E+06	5.8E-12	2.2E-07	3.0E-05	1.1E+00	1.9E-07
Mo-99	1.8E-03	6.5E+07	1.0E-10	3.8E-06	2.0E-05	7.4E-01	5.1E-06
Tc-99m	1.7E-03	6.3E+07	9.9E-11	3.7E-06	1.0E-03	3.7E+01	9.9E-08
Ru-103	2.5E-03	9.3E+07	1.5E-10	5.4E-06	3.0E-05	1.1E+00	4.9E-06
Rh-103m	2.5E-03	9.3E+07	1.5E-10	5.4E-06	6.0E-03	2.2E+02	2.4E-08
Ru-106	3.1E-02	1.1E+09	1.8E-09	6.6E-05	3.0E-06	1.1E-01	5.9E-04
Ag-110m	4.4E-04	1.6E+07	2.6E-11	9.4E-07	6.0E-06	2.2E-01	4.3E-06
Te-129m	6.0E-05	2.2E+06	3.5E-12	1.3E-07	7.0E-06	2.6E-01	5.0E-07
Te-129	4.0E-05	1.5E+06	2.3E-12	8.6E-08	4.0E-04	1.5E+01	5.8E-09
Te-131m	3.2E-04	1.2E+07	1.9E-11	6.9E-07	8.0E-06	3.0E-01	2.3E-06
Te-131	6.0E-05	2.2E+06	3.5E-12	1.3E-07	8.0E-05	3.0E+00	4.4E-08
I-131	3.4E-02	1.3E+09	2.0E-09	7.3E-05	1.0E-06	3.7E-02	2.0E-03
Te-132	4.8E-04	1.8E+07	2.8E-11	1.0E-06	9.0E-06	3.3E-01	3.1E-06
I-132	1.2E-03	4.3E+07	6.7E-11	2.5E-06	1.0E-04	3.7E+00	6.7E-07
I-133	3.5E-02	1.3E+09	2.0E-09	7.4E-05	7.0E-06	2.6E-01	2.9E-04
Cs-134	2.6E-03	9.8E+07	1.5E-10	5.7E-06	9.0E-07	3.3E-02	1.7E-04
I-135	1.5E-02	5.5E+08	8.6E-10	3.2E-05	3.0E-05	1.1E+00	2.9E-05
Cs-136	3.1E-04	1.2E+07	1.8E-11	6.7E-07	6.0E-06	2.2E-01	3.0E-06
Cs-137	3.5E-03	1.3E+08	2.0E-10	7.5E-06	1.0E-06	3.7E-02	2.0E-04
Ba-140	4.2E-03	1.6E+08	2.5E-10	9.1E-06	8.0E-06	3.0E-01	3.1E-05
La-140	7.7E-03	2.8E+08	4.5E-10	1.7E-05	9.0E-06	3.3E-01	4.9E-05
Ce-141	5.0E-05	1.9E+06	2.9E-12	1.1E-07	3.0E-05	1.1E+00	9.7E-08
Ce-143	6.2E-04	2.3E+07	3.6E-11	1.3E-06	2.0E-05	7.4E-01	1.8E-06
Pr-143	5.0E-05	1.9E+06	2.9E-12	1.1E-07	2.0E-05	7.4E-01	1.5E-07
Ce-144	1.3E-03	4.9E+07	7.7E-11	2.9E-06	3.0E-06	1.1E-01	2.6E-05
Pr-144	1.3E-03	4.9E+07	7.7E-11	2.9E-06	6.0E-04	2.2E+01	1.3E-07

Table 3.5-15— Summary of Radioactive Liquid Releases Including Anticipated Operational Occurrences
(Page 2 of 2)

Radio-nuclide	Total		Discharge Concentration		10 CFR 20 Appendix B Limits		Discharge Fraction of Limit
	(Ci/yr)	(Bq/yr)	(μCi/ml)	(Bq/ml)	(μCi/ml)	(Bq/ml)	
~~H-3~~	~~1.7E+03~~	~~6.1E+13~~	~~9.6E-05~~	~~3.6E+00~~	~~1.0E-03~~	~~3.7E+01~~	~~9.6E-02~~

Insert 3.5-15-1

RAI 101, Question 11.02-5

Insert 3.5-15-1

Radio-nuclide	Total		Discharge Concentration		10 CFR 20 Appendix B Limits		Discharge Fraction of Limit
	(Ci/yr)	(Bq/yr)	(µCi/ml)	(Bq/ml)	(µCi/ml)	(Bq/ml)	
Activated Corrosion Products							
Na-24	5.72E-03	2.12E+08	3.32E-10	1.23E-05	5.00E-05	1.85E+00	6.64E-06
Cr-51	9.60E-04	3.55E+07	5.57E-11	2.06E-06	5.00E-04	1.85E+01	1.11E-07
Mn-54	5.10E-04	1.89E+07	2.96E-11	1.09E-06	3.00E-05	1.11E+00	9.86E-07
Fe-55	3.80E-04	1.41E+07	2.20E-11	8.16E-07	1.00E-04	3.70E+00	2.20E-07
Fe-59	9.00E-05	3.33E+06	5.22E-12	1.93E-07	1.00E-05	3.70E-01	5.22E-07
Co-58	1.44E-03	5.33E+07	8.35E-11	3.09E-06	2.00E-05	7.40E-01	4.18E-06
Co-60	1.70E-04	6.29E+06	9.86E-12	3.65E-07	3.00E-06	1.11E-01	3.29E-06
Zn-65	1.60E-04	5.92E+06	9.28E-12	3.43E-07	5.00E-06	1.85E-01	1.86E-06
W-187	4.30E-04	1.59E+07	2.49E-11	9.23E-07	3.00E-05	1.11E+00	8.31E-07
Np-239	5.40E-04	2.00E+07	3.13E-11	1.16E-06	2.00E-05	7.40E-01	1.57E-06
Fission Products							
Sr-89	4.00E-05	1.48E+06	2.32E-12	8.58E-08	8.00E-06	2.96E-01	2.90E-07
Sr-91	7.00E-05	2.59E+06	4.06E-12	1.50E-07	2.00E-05	7.40E-01	2.03E-07
Y-91m	5.00E-05	1.85E+06	2.90E-12	1.07E-07	2.00E-03	7.40E+01	1.45E-09
Y-93	3.30E-04	1.22E+07	1.91E-11	7.08E-07	2.00E-05	7.40E-01	9.57E-07
Zr-95	1.20E-04	4.44E+06	6.96E-12	2.58E-07	2.00E-05	7.40E-01	3.48E-07
Nb-95	9.00E-05	3.33E+06	5.22E-12	1.93E-07	3.00E-05	1.11E+00	1.74E-07
Mo-99	1.63E-03	6.03E+07	9.45E-11	3.50E-06	2.00E-05	7.40E-01	4.73E-06
Tc-99m	1.59E-03	5.88E+07	9.22E-11	3.41E-06	1.00E-03	3.70E+01	9.22E-08
Ru-103	2.34E-03	8.66E+07	1.36E-10	5.02E-06	3.00E-05	1.11E+00	4.52E-06
Rh-103m	2.34E-03	8.66E+07	1.36E-10	5.02E-06	6.00E-03	2.22E+02	2.26E-08
Ru-106	2.84E-02	1.05E+09	1.65E-09	6.10E-05	3.00E-06	1.11E-01	5.49E-04
Ag-110m	4.10E-04	1.52E+07	2.38E-11	8.80E-07	6.00E-06	2.22E-01	3.96E-06
Te-129m	6.00E-05	2.22E+06	3.48E-12	1.29E-07	7.00E-06	2.59E-01	4.97E-07
Te-129	4.00E-05	1.48E+06	2.32E-12	8.58E-08	4.00E-04	1.48E+01	5.80E-09
Te-131m	2.90E-04	1.07E+07	1.68E-11	6.22E-07	8.00E-06	2.96E-01	2.10E-06
Te-131	5.00E-05	1.85E+06	2.90E-12	1.07E-07	8.00E-05	2.96E+00	3.63E-08
I-131	3.54E-02	1.31E+09	2.05E-09	7.60E-05	1.00E-06	3.70E-02	2.05E-03
Te-132	4.50E-04	1.67E+07	2.61E-11	9.66E-07	9.00E-06	3.33E-01	2.90E-06
I-132	1.14E-03	4.22E+07	6.61E-11	2.45E-06	1.00E-04	3.70E+00	6.61E-07
I-133	4.21E-02	1.56E+09	2.44E-09	9.04E-05	7.00E-06	2.59E-01	3.49E-04
Cs-134	2.45E-03	9.07E+07	1.42E-10	5.26E-06	9.00E-07	3.33E-02	1.58E-04
I-135	1.69E-02	6.25E+08	9.80E-10	3.63E-05	3.00E-05	1.11E+00	3.27E-05
Cs-136	2.90E-04	1.07E+07	1.68E-11	6.22E-07	6.00E-06	2.22E-01	2.80E-06
Cs-137	3.25E-03	1.20E+08	1.89E-10	6.98E-06	1.00E-06	3.70E-02	1.89E-04
Ba-140	3.93E-03	1.45E+08	2.28E-10	8.43E-06	8.00E-06	2.96E-01	2.85E-05
La-140	7.12E-03	2.63E+08	4.13E-10	1.53E-05	9.00E-06	3.33E-01	4.59E-05
Ce-141	5.00E-05	1.85E+06	2.90E-12	1.07E-07	3.00E-05	1.11E+00	9.67E-08
Ce-143	5.70E-04	2.11E+07	3.31E-11	1.22E-06	2.00E-05	7.40E-01	1.65E-06
Pr-143	5.00E-05	1.85E+06	2.90E-12	1.07E-07	2.00E-05	7.40E-01	1.45E-07
Ce-144	1.23E-03	4.55E+07	7.13E-11	2.64E-06	3.00E-06	1.11E-01	2.38E-05
Pr-144	1.23E-03	4.55E+07	7.13E-11	2.64E-06	6.00E-04	2.22E+01	1.19E-07
H-3	1.66E+03	6.14E+13	9.63E-05	3.56E+00	1.00E-03	3.70E+01	9.63E-02
						TOTAL	9.98E-02

Table 3.5-16— Obtainable Dose Benefits for Liquid Waste System Augment

Cases	Population Total Body Dose - Person-Rem (Person-Sievert)(1)	Population Thyroid Dose Person-Rem (Person-Sievert)(1)
Base Case Evaporator/Centrifuge only, no Waste Demineralizer	3.85E-01 (3.85E-03)	2.91E-01 (2.91E-03)
Additional Waste Demineralizer	1.54E-01 (1.54E-03)	1.37E-01 (1.37E-03)
Obtainable dose benefit	2.31E-01 (2.31E-03)	1.54E-01 (1.54E-03)

Note:
(1)Population dose estimates described in Section 5.4.

Delete Table

RAI 101 Question 11.02-2

Table 3.5-17— Liquid Waste System Augment Total-Body Dose Cost-Benefit Analysis

Parameter	Value
Annual Total-body collective dose benefit to the population within 50 miles of the BBNPP site.	0.23 person-rem (0.0023 person-sievert)
Nominal total collective dose over 40 years of operation (0.23 person-rem x 40 yr = 9.2 person- rem)	9.2 person-rem (0.092 person-sievert)
Value for estimating impact based on NUREG-1530	\$2,000 per person-rem (\$200,000 per person-sievert)
Obtainable benefit from addition of radwaste processing and control option (9.2 person-rem x \$2,000/person-rem = \$18,400)	\$18,400
Cost Options for radwaste processing and control technology upgrade from Regulatory Guide 1.110	400 gpm demineralizer for clean waste processing [(a)]
Direct cost for option using methodology in Regulatory Guide 1.110, Table A-1 based on 1975 Dollars	\$146,000
Total O&M Annual Cost (From Regulatory Guide 1.110, Table A-2 based on 1975 Dollars)	\$9,700
Total cost over 40 years of operation (direct cost + O&M×40 years)	\$534,000
Benefit/Cost Ratio (Values greater than 1 should be included in plant system design) \$18,400 / \$534,000 = 0.03)	0.03

Note:
(a) The clean waste reflects the nomenclature in GALE and the sizing is based on the EPR GALE input Table 3.5-4.

Delete Table

RAI 101 Question 11.02-2

Table 3.5-18— Liquid Waste System Augment Thyroid Dose Cost-Benefit Analysis

Parameter	Value
Annual thyroid collective dose benefit to the population within 50 miles of the BBNPP site.	0.15 person-rem (0.0015 person-sievert)
Nominal total collective dose over 40 years of operation (0.15 person-rem x 40 yr = 6.0 person- rem)	6.0 person-rem (0.060 person-sievert)
Value for estimating impact based on NUREG-1530 (Note: 10 CFR Part 50, Appendix I has $1,000 per person-rem)	$2,000 per person-rem ($200,000 per person-sievert)
Obtainable benefit from addition of radwaste processing and control options	$12,000
Cost Options for radwaste processing and control technology upgrade from Regulatory Guide 1.110	400 gpm demineralizer for clean waste processing [a]
Direct cost for option using methodology in Regulatory Guide 1.110 based on 1975 Dollars	$146,000
Total O&M Annual Cost (From Regulatory Guide 1.110, Table A-2 based on 1975 Dollars)	$9,700
Total cost over 40 years of operation (Direct cost + (O&M × 40 years))	$534,000
Benefit/Cost Ratio (Values greater than 1 should be included in plant system design) ($12,000 / $534,000 = 0.02)	0.02

Note:
[a] The clean waste reflects the nomenclature in GALE and the sizing is based on the EPR GALE input Table 3.5-4.

Delete Table

RAI 101 Question 11.02-2

Table 3.5-20— Obtainable Dose Benefits for Gaseous Waste System Augment

Cases	Population Total Body Dose[a]- Person-Rem (Person-Sievert)	Population Thyroid Dose[a] Person-Rem (Person-Sievert)
Baseline Configuration	4.00E+00 (4.00E-02)	4.26E+00 (4.26E-02)
Extra Carbon Delay Bed	3.95E+00 (3.95E-02)	4.21E+00 (4.21E-02)
Obtainable dose benefit by augment	5.0E-02 (5.0E-04)	5.0E-02 (5.0E-04)

Note:
[a] Population dose estimates described in Section 5.4

Delete Table

RAI 101 Question 11.02-2

Table 3.5-21— Gaseous Waste System Augment Total-Body / Thyroid Dose Cost Benefit Analysis

Parameter	Value[a]
Annual whole-body / Thyroid collective dose benefit to the population within 50 miles of the BBNPP site.	0.05 person-rem (0.0005 person-sievert)
Nominal total collective dose over 40 years of operation (0.05 person-rem x 40 yr = 2.0 person-rem)	2.0 person-rem (0.02 person-sievert)
Value for estimating impact based on NUREG-1530	$2,000 per person-rem ($200,000 per person-sievert)
Obtainable benefit from addition of radwaste processing and control option (2.0 person-rem x $2000/person-rem =$4,000)	$4,000
Cost Options for radwaste processing and control technology upgrade from Regulatory Guide 1.110	3-ton charcoal absorber
Direct cost for option (using methodology in Regulatory Guide 1.110, Table A-1 based on 1975 Dollars)	$67,000
Total O&M Annual Cost (From Regulatory Guide 1.110, Table A-2 based on 1975 Dollars	Negligible
Total cost over 40 years of operation (direct cost + O&M×40 years)	$67,000
Benefit/Cost Ratio (Values greater than 1 should be included in plant system design) ($4,000 / $67,000 = 0.06)	0.06

Note:
[a] Since the dose reduction benefit for both the total body and the thyroid give the same collective dose savings, the cost benefit results are directly applicable to both the total body and thyroid evaluations.

Delete Table

RAI 101 Question 11.02-2

Mark-ups to COLA ER Section 5.4

5.4 RADIOLOGICAL IMPACTS OF NORMAL OPERATIONS

The radioactive waste management systems, as discussed in Section 3.5, are designed such that the radiological impacts due to the normal operational releases from BBNPP are within guidelines established in Appendix I to 10 CFR 50 (CFR, 2007). This section evaluates the impacts of radioactive effluents on human beings and other biota inhabiting the general vicinity of the BBNPP site resulting from expected routine operations. Primary exposure pathways to man are examined and evaluated according to the mathematical model described in Regulatory Guide 1.109 (NRC, 1977a). The resulting radiological impacts for BBNPP are compared to regulatory limits for a single unit.

In addition, the radiological impact of BBNPP in conjunction with Susquehanna Steam Electric Station (SSES) Units 1 and 2, including direct radiation, is compared to the corresponding regulatory limits under 40 CFR 190 (CFR, 2007b).

The radioactive waste system's cost benefit analysis is provided in ER 3.5. It includes the dose impact to the general population within 50 mi (80 km) radius from routine operations of BBNPP.

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Finally, consideration of the dose impact to biota other than man that appear along the exposure pathways or that are on endangered species lists is presented. Other than the endangered species identified, there are no unusual animals, plants, agricultural practices, game harvest or food operations in the vicinity of BBNPP that need to be considered for radiological impacts. ~~Regulatory guidance is for use of the site boundary for gaseous dose calculations. Site design changes resulted in minor changes to the site boundary during the period dose calculations were performed. Rather than adjust gaseous effluents dose calculations with each change of site boundary, gaseous effluent doses were instead conservatively calculated at the Owner Controlled Area boundary which remained constant.~~

5.4.1 Exposure Pathways

Routine radiological effluent releases from BBNPP are a potential source of radiation exposure to both humans and biota other than man. The major pathways are those that could lead to the highest potential radiological dose to humans and biota. These pathways are determined from the amount and isotopic distribution of activity released in liquids and gases, the environmental transport mechanism, and how the BBNPP site environs are utilized (e.g., location of the Owner Controlled Area (OCA) boundary, residences, gardens, milk animals, beaches, etc.) and the consumption or usage factors applied to exposed individuals. The environmental transport mechanism includes the BBNPP site-specific meteorological dispersion of airborne effluents and aquatic dispersion in the Susquehanna River of liquid releases. This information is used to evaluate how the radionuclides will be distributed within the surrounding area. ~~The gaseous and direct radiation doses are conservatively calculated from the OCA instead of the BBNPP Project Boundary.~~

RAI 101, Question 11.03-2

The potential exposure pathways are impacted by both aquatic (liquid) and gaseous effluents. The radioactive liquid effluent exposure pathways include internal exposure due to ingestion of aquatic foods (fish and invertebrates), external exposure due to recreational activities on the shoreline and in the water (swimming and boating), ingestion of irrigated crops, and drinking water.

The radioactive gaseous effluent exposure pathways include external exposure due to immersion in airborne effluent and exposure to a deposited material on the ground plane.

Internal exposures are due to ingestion of food products grown in areas under influence of atmospheric releases and inhalation.

An additional exposure pathway considered is the direct radiation from the facility structures during normal operation of BBNPP.

The description of the exposure pathways and the calculation methods utilized to estimate doses to the maximally exposed individual and to the population surrounding the BBNPP site are based on Regulatory Guide 1.109 (NRC 1977a) and Regulatory Guide 1.111 (NRC 1977b). The source terms used in estimating exposure pathway doses are based on the projected normal effluent values provided in Section 3.5. The source term for both liquids and gases are calculated using the Nuclear Regulatory Commission GALE code for PWRs (NRC, 1985).

RAI 101, Question 11.02-5

10% of

As indicated in Section 3.5, the liquid and gaseous source term for BBNPP was generated with the a total shim bleed flow rate of 2160 gpd (8176 lpd) to reflect total letdown flow for boron control with ~~all~~ 10% of the reactor coolant liquid being recycled. This deviates from the GALE application in the U.S. EPR FSAR where it was assumed that 5% of the letdown flow was sent to the liquid waste system for processing. This approach better approximates anticipated operations. The primary impact of this input assumption to the GALE code causes the annual release of Kr-85 to drop from a very conservative estimate of 34,000 Ci (1.26E+06 GBq) to 2,800 Ci (1.04E+05 GBq) in gaseous effluents. In addition, the GALE code has a fixed annual release value for C-14 of 7.3 Ci (270 GBq), (NRC, 1985) regardless of size (power output) of the reactor, and with no determination of the chemical form of the carbon in the waste gas. This fixed C-14 production in GALE does not recognize that its production in nuclear power plants is mainly produced by activation of O-17 content of water in the primary coolant circuit. The quantity released is directly linked to energy provided by the reactor. Since the U.S. EPR is significant larger (approximately 1,600 MWe) than the size of power plants when the GALE code was developed, the annual release of C-14 is increased for analysis purposes to 18.9 Ci (0.7 TBq) which is estimated to be in the chemical form of ~~80% methane and only 20%~~ 100% carbon dioxide.

100% RAI 101, Question 11.02-5

5.4.1.1 Liquid Pathways

008831

BB-10-0190 Treated liquid radwaste effluent is released to the Susquehanna River at a flow rate of 11 gpm (42 lpm) (see Section 3.3.1) via the BBNPP discharge line situated downstream of the Combined Waste Water Retention Pond. The average discharge flow rate from the retention pond for waste water streams other than treated liquid radiological waste, is conservatively assumed to be 8,654 gpm (0.5459 m^3/sec), resulting in a total average flow of 8,665 gpm (0.5466 m^3/sec) for all liquid effluents discharged to the river. Retention basin flow provides dilution flow to discharged treated liquid radiological waste. As shown in Table 5.4-1, a near-field dilution factor of 11.8 (a mixing ratio of 0.085) was utilized for calculating the maximum individual dose to man for exposures associated with fish and invertebrate ingestion and boating pathways. For swimming and shoreline exposure pathways, an environmental dilution factor of 44 (a mixing ratio of 0.023) was applied for the maximum impacted shoreline. This value is based upon the maximally impacted shoreline dilution factor. These dilution factors are based on a submerged, multi-port diffuser (with seventy-two nozzles), a discharge line situated near the shoreline with the nozzles directed out into the Susquehanna River. Table 5.4-2 provides far-field dilution factors. The physical description of the cooling water discharge system is provided in Section 3.4. Dilution effects for both near-field and far-field mixing are described in Section 5.3.

A dose assessment for a hypothetical maximum individual, where all applicable receptors were located at the ~~OCA boundary~~ maximum offsite location was also calculated to account for the possibility for future patterns not commonly practiced.

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5.4.3 Impacts to Members of the Public

Appendix I to 10 CFR Part 50 (CFR, 2007a) provides design objectives on the levels of exposure to the general public from routine effluent releases that may be considered to be "as low as reasonably achievable" (ALARA). The estimated doses to individuals in the general public in the site vicinity, for the pathways described in Section 5.4.2.1 and Section 5.4.2.2, demonstrate that the proposed plant design is capable of keeping radiation exposures consistent with the ALARA objectives. In addition to the ALARA dose objectives for individuals, 10 CFR 50 Appendix I also requires that an evaluation of alternate radwaste system designs be made to determine the most cost-benefit effective system to keep total radiation exposures to the public as low as reasonably achievable. This cost-benefit evaluation, comparing costs of alternate radwaste systems against their ability to reduce the population doses from plant effluents, is discussed in Section 3.5.2.3 for liquid waste systems process options, and Section 3.5.3.3 for the gaseous waste system alternative design. The cost-benefit ratios for the alternative radwaste augments investigated indicate that no alternate system to the present plant design can be justified on a cost effective basis.

For gaseous effluent ingestion pathways of exposure, the production of milk, meat and vegetables grown within 50 mi (80 km) has been included in the estimation of dose along with plume, ground plane exposures and inhalation. For liquid pathways, the population that can be supported by the recorded harvest of fish and shellfish (invertebrates) within 50 mi (80 km), along with estimated recreational uses of beaches and boating activities, are factored into the aquatic pathway population dose impact assessment.

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The population dose assessments which were used in the cost-benefit analysis are based on the models and dose factors given in Regulatory Guide 1.109 (NRC, 1977a). The population which is projected to be contained within 50 mi (80 km) of the site for in the year ~~2060~~ 2080 has been used for calculating annual population doses for the gaseous releases.

In addition to the BBNPP dose impacts assessed for the maximum exposed individual and general population, the combined historical dose impacts of SSES Units 1 and 2 and a future projection of the dose impacts of the SSES ISFSI are added to the BBNPP projected impacts to compare to the uranium fuel cycle dose standard of 40 CFR 190 (CFR, 2007b). Since there are no other fuel cycle facilities within 5 mi (8.0 km) of the BBNPP/SSES site, the combined impacts for three units can be used to determine the total impact from liquid and gaseous effluents along with direct radiation from fixed radiation sources onsite to determine compliance with the dose limits of the standard 25 mrem/yr (0.25 mSv/yr) whole body, 75 mrem/yr (0.75 mSv/yr) thyroid, and 25 mrem/yr (0.25 mSv/yr) for any other organ). Table 5.4-23 illustrates the impact from SSES Units 1 and 2 over a recent eight year historical period. Using the highest observed annual dose impact from SSES Units 1 and 2, Table 5.4-24 shows the combined impact along with the projected contributions from BBNPP.

5.4.3.1 Impacts From Liquid Pathways

Release of radioactive materials in liquid effluents to the discharge flow, from where they mix with the Susquehanna River, results in minimal radiological exposure to individuals and the general public. The use of the Susquehanna River for agricultural irrigation is minimal accounting for approximately 1 % of all agriculture in the 50 mi (80 km) radius surrounding BBNPP. As such, water irrigation of farm fields is not assumed for the population pathway

assessments around the BBNPP site. Since it is a possible pathway for a given individual, it was retained for the assessment of the maximally exposed individual.

With respect to drinking water, the Pennsylvania Division of Drinking Water Management has identified a total of three municipal water supplies using the Susquehanna River as a source of water within the 50 mi (80 km) radius, downstream of the BBNPP liquid discharge. Two of the three are in Danville of Montour County, approximately 30 mi (48 km) down river. The third supply is in Sunbury of Northumberland County, approximately 40 mi (64 km) down stream. The annual average dilution for these locations is estimated to be 500 to 1 and the transit time to the nearest public water supply is estimated to be about 63 hours. The combined pumping capacity is recorded as 11.5 million gpd (43.5 million lpd), and is a water supply for a total of 15,940 people.

The BBNPP annual radiation exposures to the maximum exposed individual via the pathways of aquatic foods and shoreline deposits are provided in Table 5.4-16 for total body dose to four age groups (Adult, Teen, Child, Infant) from each dose pathway of exposure, and Table 5.4-17 for the limiting organ dose for each pathway and age group. Table 5.4-18 summarizes the liquid effluent dose to a hypothetical MEI. Population dose impacts within a 50 mi (80 km) radius of the BBNPP site are listed in Table 5.4-19.

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~~For the cost-benefit assessment of liquid radiological waste equipment options, the annual release source terms produced with and without demineralizer processing of evaporator and centrifuge treated liquid waste streams are listed in Section 3.5.2.3. The cost-benefit population dose assessment evaluated the "unadjusted" releases from the two waste processing options in order to assess the relative difference between the two cases of processing with and without a waste demineralizer. However, total expected annual radioactivity release used to determine the expected liquid population dose in Table 5.4-19 includes an adjustment to account for the potential anticipated operational occurrences that add to the expected treated discharge stream. This adjustment factor adds 0.16 curies per year to the normal effluent. The liquid effluent population doses provided in Section 3.5.2.3 uses the unadjusted releases so as not to be dominated by the adjustment factor which is not impacted by any treatment option.~~

As can be seen from Table 5.4-18, the maximum exposed individual annual doses from the discharge of radioactive materials in liquid effluents projected from BBNPP meets the design objectives of Appendix I to 10 CFR Part 50. In addition, Section 3.5 shows that the effluent concentration being discharged to the Susquehanna River also meets the effluent release standards of 10 CFR Part 20, (Appendix B, Table 2, Column 2). The maximally exposed individual dose calculated from liquids was also included in the BBNPP site assessment of 40 CFR 190 criteria as shown in Table 5.4-24.

Based on this, the release of radioactive materials in liquid effluents results in minimal radiological exposure to individuals and the general public. As such, the impacts would be SMALL and do not warrant mitigation.

5.4.3.2 Impacts From Gaseous Pathways

The release of radioactive materials in gaseous effluents from BBNPP to the environment results in minimal radiological impacts. Annual radiation exposures to the maximum exposed individual near the BBNPP site via the pathways of submersion, ground contamination, inhalation and ingestion are provided in Table 5.4-20 for the four age groups of interest. Table 5.4-21 provides a summary of the dose to the MEI compared to the dose limits of 10 CFR

RAI 101, Question 11.02-3(1-4)

40

4.0

50, Appendix I. Table 5.4-21 indicates that the critical organ dose to the current real MEI is ~~2.7~~ mrem/yr (~~27~~ μSv/yr) to a child's bone via the identified exposure pathways in the BBNPP site vicinity. All projected dose impacts are well within the design objects of Appendix I. If a hypothetical individual is postulated to be exposed to all potential pathways (ground plane, inhalation, vegetable gardens, goat's milk and meat) at the same limiting ~~BBNPP OCA boundary~~ offsite location, the maximum critical organ (child bone) dose increases to ~~4.7~~ mrem/yr (~~47~~ μSv/yr) which is still below the dose objective of 10 CFR 50, Appendix I, Section II.C (CFR, 2007a).

RAI 101, Question 11.02-3(1-4)

6.0

60

Population dose impacts within a 50 mi (80 km) radius of the BBNPP site from atmospheric releases from BBNPP are listed in Table 5.4-15. Annual production rates of milk, meat, and vegetables for the 50 mi (80 km) radius are provided in Table 5.4-9 through Table 5.4-12. ~~For the cost-benefit assessment of gaseous radiological waste equipment options, the annual release source terms produced by processing the waste purge gas through the base configuration of three charcoal delay beds, as well as the effect of adding a fourth delay bed in series, are provided in Section 3.5.3.3. The estimated holdup times for decay before release are also provided along with the estimated reduction in the population dose afforded by the treatment option.~~

RAI 101, Question 11.03-2

2080

The estimated population distribution in the year ~~2060~~ within a 50 mi (80 km) radius of the BBNPP site is given in Section 2.5.1. The total effective dose equivalent to individuals living in the U.S. from all sources of natural background radiation averages about 300 mrem/yr (3 mSv/yr) (NCRP, 1987). Therefore, the 50 mi (80 km) population (~~2,456,110~~) in year ~~2060~~ projected in the BBNPP site area will receive a collective population dose of approximately ~~7.4~~E+05 person-rem/yr (~~7,400~~ person-Sv/yr) from natural background radiation.

7900

2,640,368

7.9

The concentrations of radionuclides released as gaseous effluents at BBNPP conform to the limits as specified in Column 1 of Table 2 of 10 CFR Part 20 Appendix B (CFR, 2008). Table 5.4-22 shows that the cumulative air concentrations of all radionuclides released is approximately 2% of the levels permissible under 10 CFR 20 Appendix B.

In addition, the maximally exposed individual dose calculated was also compared to 40 CFR 190 criteria (CFR, 2007b) as shown in Table 5.4-24.

Based on this, the release of radioactive materials in gaseous effluents from BBNPP to the environment results in SMALL radiological impacts and do not warrant mitigation.

5.4.3.3 Direct Radiation Doses

Direct radiation doses are discussed in Section 5.4.1.3. Table 5.4-24 includes a projected direct dose (assuming full time occupancy) to the nearest OCA boundary, from BBNPP as part of the total site dose assessment for compliance with the uranium fuel cycle dose standards of 40 CFR 190.

Based on these projections, direct radiation doses from BBNPP to the environment results in SMALL radiological impacts and do not warrant mitigation.

5.4.4 Impacts to Biota other than Members of the Public

Environmental exposure pathways in which biota other than humans could be impacted by plant radiological effluents were examined to determine if doses to biota could be significantly greater than those predicted for humans. This assessment was based on the use of surrogate species that provide representative information on the various dose pathways

NRC, 1987. GASPAR II - Technical Reference and User Guide, NUREG/CR-4653, Nuclear Regulatory Commission (by Pacific Northwest Laboratory), March 1987.

NRC, 1999. Standard Review Plans for Environmental Reviews for Nuclear Power Plants, NUREG-1555, Nuclear Regulatory Commission, October 1999.

ORNL, 1983. Radiological Assessments, A Textbook on Environmental Dose Analysis, NUREG/CR-3332 (ORNL-5968), Nuclear Regulatory Commission, September 1983.

Insert 5.4.4.5-1

RAI 101, Question 11.02-5

Insert 5.4.4.5-1

SSES, 2010. "Susquehanna Steam Electric Station, 2010 Land Use Census," Susquehanna Steam Electric Station, November, 2010.

Table 5.4-13— Distance to Nearest Gaseous Dose Receptors

Sector	OCA[1] Boundary (mi/m)	Residence (mi/km)	Vegetable Garden (mi/km)	Meat Animal[2] (mi/km)	Milk Animal (mi/km)
N	0.26/418	0.78/1.3	0.52/0.83	0.50/0.80	---
NNE	0.26/426	0.79/1.3	0.87/1.4	0.51/0.82	---
NE	0.32/507	1.0/1.7	1.4/2.3	0.62/0.99	---
ENE	0.32/519	1.8/2.9	1.7/2.8	1.4/2.2	---
E	0.30/478	1.4/2.2	1.4/2.3	1.3/2.2	---
ESE	0.20/323	1.4/2.3	1.1/1.8	1.1/1.8	---
SE	0.17/270	0.79/1.3	0.91/1.5	0.58/0.94	---
SSE	0.16/263	1.0/1.6	1.0/1.6	0.51/0.82	---
S	0.16/263	1.1/1.7	0.50/0.81	0.50/0.80	3.0/4.9
SSW	0.17/268	1.0/1.7	0.25/0.41	0.57/0.92	0.74/1.2
SW	0.17/268	0.47/0.76	0.28/0.45	0.39/0.63	~~4.0/6.5[3]~~
WSW	0.16/251	0.63/1.0	0.37/0.60	0.33/0.54	~~4.0/6.4[3]~~
W	0.15/239	0.37/0.60	0.51/0.82	0.33/0.53	4.0/6.5
WNW	0.15/239	0.53/0.85	0.89/1.4	0.34/0.55	4.0/6.5
NW	0.15/244	0.46/0.75	0.45/0.73	0.41/0.66	~~4.2/6.8[3]~~
NNW	0.22/359	0.80/1.3	0.83/1.3	0.50/0.81	4.0/6.4

Distances measured from the plant vent stack.

Notes:

1. "OCA" is the acronym for "Owner Controlled Area."
2. Hypothetical location at nearest Property Boundary in the sector.
3. ~~Hypothetical milk animal location.~~

RAI 101, Question 11.03-2

Table 5.4-14— Receptor Locations for Gaseous Effluent Maximum Dose Evaluations

Insert 5.4-14-1

Location (Distance, Sector)	Dose Pathways Evaluated	Undecayed X/Q (sec/m³)	Depleted X/Q (sec/m³)	D/Q (1/m²)
Nearest[1] OCA[2] Boundary 0.16 mi (0.25 km), WSW	Plume	6.781E-06	6.529E-06	9.765E-09
Nearest[1] Residence 1.0 mi (1.7 km), NE	Ground	8.178E-07	7.743E-07	5.401E-09
Nearest[1] Residence 0.53 mi (0.85 km), WNW	Inhalation	3.234E-06	3.216E-06	1.914E-09
Nearest[1] Garden 0.51 mi (0.82 km), W	Vegetable	5.722E-06	5.695E-06	1.587E-09
Nearest[1] Milk Animal 0.74 mi (1.2 km), SSW	Milk	3.564E-07	3.260E-07	2.686E-09
Nearest[1] Meat Animal 0.51 mi (0.82 km), NNE	Meat	3.075E-06	3.020E-06	7.604E-09

Note:

1. For a given dose pathway (i.e., plume, ground, inhalation, vegetable, milk, or meat), "nearest" refers to the fact that the location in this table was determined to be the maximum dose location for all of the "nearest" receptor locations (i.e., the nearest site boundary, residence, garden, milk animal, or meat animal within each of the 16 meteorological sectors) for that pathway.
2. "OCA" is the acronym for "Owner Controlled Area."

RAI 101, Question 11.03-2

Insert 5.4-14-1

Table 5.4-14— Receptor Locations for Gaseous Effluent Maximum Dose Evaluations

Location (Distance, Sector)	Dose Pathways Evaluated	Undecayed χ/Q (sec/m^3)	Depleted χ/Q (sec/m^3)	D/Q (1/m^2)
Nearest[(1)] OCA[(2)] Boundary (0.16 mi WSW)	Plume	6.781E-06	6.529E-06	9.765E-09
Nearest[(1)] Residence (1.04 mi NE)	Ground	8.178E-07	7.743E-07	5.401E-09
Nearest[(1)] Residence (0.79 mi NNE)	Inhalation	1.417E-06	1.382E-06	3.741E-09
Nearest[(1)] Garden (0.25 mi SSW)	Vegetables	1.472E-06	1.394E-06	9.504E-09
Nearest[(1)] Milk Animal (0.74 mi SSW)	Milk	3.564E-07	3.260E-07	2.686E-09
Nearest[(1)] Meat Animal (0.33 mi WSW)	Meat	1.755E-06	1.639E-06	3.476E-09

Notes:

1. For a given dose pathway (i.e., plume, ground, inhalation, vegetable, milk or meat), "nearest" refers to the fact that the location in this table was determined to be the maximum dose location for all of the "nearest" receptor locations (i.e., the nearest OCA boundary, residence, garden, milk animal, or meat animal within each of the 16 meteorological sectors) for that pathway.
2. "OCA" is the acronym for "Owner Controlled Area"

Insert 5.4-15-1

Table 5.4-15— 50 Mi (80 km) Population Doses from Gaseous Effluents

Pathway	Total Body Person-Rem (Person-Sieverts)	Skin Person-Rem (Person-Sieverts)	Thyroid Person-Rem (Person-Sieverts)	Critical Organ Bone Person-Rem (Person-Sieverts)
Plume	4.37E+00 (4.37E-02)	1.68E+01 (1.68E-01)	4.37E+00 (4.37E-02)	4.37E+00 (4.37E-02)
Ground Plane	8.49E-03 (8.49E-05)	9.96E-03 (9.96E-05)	8.49E-03 (8.49E-05)	8.49E-03 (8.49E-05)
Inhalation	1.32E-01 (1.32E-03)	1.32E-01 (1.32E-03)	3.02E-01 (3.02E-03)	1.99E-03 (1.99E-05)
Vegetable Ingestion	6.02E-01 (6.02E-03)	6.00E-01 (6.00E-03)	6.06E-01 (6.06E-03)	2.36E+00 (2.36E-02)
Milk Ingestion	1.73E-01 (1.73E-03)	1.73E-01 (1.73E-03)	3.35E-01 (3.35E-03)	7.04E-01 (7.04E-03)
Meat Ingestion	2.37E-01 (2.37E-03)	2.37E-01 (2.37E-03)	2.47E-01 (2.47E-03)	1.05E+00 (1.05E-02)
Total	5.52E+00 (5.52E-02)	1.80E+01 (1.80E-01)	5.87E+00 (5.87E-02)	8.50E+00 (8.50E-02)

Notes:
Based on projected 50 mi (80 km) population for the year 2070 (decade after the 40 year operating license period of BBNPP). Food production within the 50 mi (80 km) radius is presented in Table 5.4-9 through Table 5.4-12.

RAI 101, Questions 11.02-3(1-4)

Insert 5.4-15-1

Table 5.4-15— 50 Mi (80 km) Population Doses from Gaseous Effluents

Pathway	Total Body Person-Rem (Person-Sieverts)	Skin Person-Rem (Person-Sieverts)	Thyroid Person-Rem (Person-Sieverts)	Critical Organ Bone Person-Rem (Person-Sieverts)
Plume	3.74E+00 (3.74E-02)	1.44E+01 (1.44E-01)	3.74E+00 (3.74E-02)	3.74E+00 (3.74E-02)
Ground Plane	5.77E-03 (5.77E-05)	6.77E-03 (6.77E-05)	5.77E-03 (5.77E-05)	5.77E-03 (5.77E-05)
Inhalation	1.13E-01 (1.13E-03)	1.13E-01 (1.13E-03)	2.56E-01 (2.56E-03)	1.64E-03 (1.64E-05)
Vegetable Ingestion	2.51E+00 (2.51E-02)	2.51E+00 (2.51E-02)	2.52E+00 (2.52E-02)	1.19E+01 (1.19E-01)
Milk Ingestion	7.58E-01 (7.58E-03)	7.58E-01 (7.58E-03)	9.22E-01 (9.22E-03)	3.62E+00 (3.62E-02)
Meat Ingestion	1.12E+00 (1.12E-02)	1.12E+00 (1.12E-02)	1.13E+00 (1.13E-02)	5.44E+00 (5.44E-02)
Total	8.25E+00 (8.25E-02)	1.89E+01 (1.89E-01)	8.57E+00 (8.57E-02)	2.47E+01 (2.47E-01)

Notes:

1. Based on projected 50 mile (80 km) population for the year 2080. Food production within the 50 mile (80 km) radius is presented in Table 5.4-9 through Table 5.4-12.

Insert 5.4-16-1

Table 5.4-16— Whole Body Dose from Liquid Effluent to MEI

Dose Pathway	Adult mrem/yr (µSv/yr)	Teen mrem/yr (µSv/yr)	Child mrem/yr (µSv/yr)	Infant mrem/yr (µSv/yr)
Fish	1.28E-01 (1.28E+00)	7.52E-02 (7.52E-01)	3.27E-02 (3.27E-01)	0.00E+00 (0.00E+00)
Invertebrates	1.80E-02 (1.80E-01)	1.14E-02 (1.14E-01)	6.57E-03 (6.57E-02)	0.00E+00 (0.00E+00)
Potable Water	3.59E-01 (3.59E+00)	2.53E-01 (2.53E+00)	4.85E-01 (4.85E+00)	4.76E-01 (4.76E+00)
Irrigation	4.08E-02 (4.08E-01)	3.27E-02 (3.27E-01)	3.92E-02 (3.92E-01)	0.00E+00 (0.00E+00)
Shoreline	3.53E-05 (3.53E-04)	1.97E-04 (1.97E-03)	4.12E-05 (4.12E-04)	3.53E-05 (3.53E-04)
Swimming	3.68E-06 (3.68E-05)	2.06E-05 (2.06E-04)	4.30E-06 (4.30E-05)	3.68E-06 (3.68E-05)
Boating	2.97E-05 (2.97E-04)	2.97E-05 (2.97E-04)	1.66E-05 (1.66E-04)	2.97E-05 (2.97E-04)
Total	5.46E-01 (5.46E+00)	3.73E-01 (3.73E+00)	5.64E-01 (5.64E+00)	4.76E-01 (4.76E+00)

RAI 101, Question 11.02-5

Insert 5.4-16-1

Table 5.4-16— Whole Body Dose from Liquid Effluent to MEI

Dose Pathway	Adult mrem/yr (μSv/yr)	Teen mrem/yr (μSv/yr)	Child mrem/yr (μSv/yr)	Infant mrem/yr (μSv/yr)
Fish	1.20E-01 (1.20E+00)	7.03E-02 (7.03E-01)	3.09E-02 (3.09E-01)	0.00E+00 (0.00E+00)
Invertebrates	1.69E-02 (1.69E-01)	1.07E-02 (1.07E-01)	6.23E-03 (6.23E-02)	0.00E+00 (0.00E+00)
Portable Water	3.59E-01 (3.59E+00)	2.53E-01 (2.53E+00)	4.85E-01 (4.85E+00)	4.76E-01 4.76E+00)
Irrigation	3.92E-02 (3.92E-01)	3.17E-02 (3.17E-01)	3.85E-02 (3.85E-01)	0.00E+00 (0.00E+00)
Shoreline	3.28E-05 (3.28E-04)	1.83E-04 (1.83E-03)	3.83E-05 (3.83E-04)	3.28E-05 (3.28E-05)
Swimming	3.78E-06 (3.78E-05)	2.11E-05 (2.11E-04)	4.41E-06 (4.41E-05)	3.78E-06 (3.78E-05)
Boating	3.05E-05 (3.05E-04)	3.05E-05 (3.05E-04)	1.70E-05 (1.70E-04)	3.05E-05 (3.05E-04)
Total	5.35E-01 (5.35E+00)	3.66E-01 (3.66E+00)	5.61E-01 (5.61E+00)	4.76E-01 (4.76E+00)

Insert 5.4-17-1

RAI 101, Question 11.02-5

Table 5.4-17— Limiting Organ Dose from Liquid Effluent to MEI

Dose Pathway	Adult (Thyroid) mrem/yr (μSv/yr)	Teen (Thyroid) mrem/yr (μSv/yr)	Child (Thyroid) mrem/yr (μSv/yr)	Infant (Thyroid) mrem/yr (μSv/yr)
Fish	1.13E-01 (1.13E+00)	1.04E-01 (1.04E+00)	1.08E-01 (1.08E+00)	0.00E+00 (0.00E+00)
Invertebrates	1.06E-02 (1.06E-01)	9.56E-03 (9.56E-02)	1.01E-02 (1.01E-01)	0.00E+00 (0.00E+00)
Potable Water	6.16E-01 (6.16E+00)	4.76E-01 (4.76E+00)	1.03E+00 (1.03E+01)	1.34E+00 (1.34E+01)
Irrigation	8.40E-01 (8.40E+00)	7.39E-01 (7.39E+00)	1.17E+00 (1.17E+01)	0.00E+00 (0.00E+00)
Shoreline	3.53E-05 (3.53E-04)	1.97E-04 (1.97E-03)	4.12E-05 (4.12E-04)	3.53E-05 (3.53E-04)
Swimming	3.68E-06 (3.68E-05)	2.06E-05 (2.06E-04)	4.30E-06 (4.30E-05)	3.68E-06 (3.68E-05)
Boating	2.97E-05 (2.97E-04)	2.97E-05 (2.97E-04)	1.66E-05 (1.66E-04)	2.97E-05 (2.97E-04)
Total	1.58E+00 (1.58E+01)	1.33E+00 (1.33E+01)	2.32E+00 (2.32E+01)	1.34E+00 (1.34E+01)

Insert 5.4-17-1

Table 5.4-17 – Limiting Organ Dose from Liquid Effluent to MEI

Dose Pathway	Adult (Thyroid) mrem/yr (µSv/yr)	Teen (Thyroid) mrem/yr (µSv/yr)	Child (Thyroid) mrem/yr (µSv/yr)	Infant (Thyroid) mrem/yr (µSv/yr)
Fish	1.18E-01 (1.18E+00)	1.09E-01 (1.09E+00)	1.14E-01 (1.14E+00)	0.00E+00 (0.00E+00)
Invertebrates	1.10E-02 (1.10E-01)	9.97E-03 (9.97E-02)	1.05E-02 (1.05E-01)	0.00E+00 (0.00E+00)
Potable Water	6.32E-01 (6.32E-00)	4.89E-01 (4.89E+00)	1.07E+00 (1.07E+01)	1.39E+00 (1.39E+01)
Irrigated	8.74E-01 (8.74E+00)	7.69E-01 (7.69E+00)	1.22E+00 (1.22E+01)	0.00E+00 (0.00E+00)
Shoreline	3.28E-05 (3.28E-04)	1.83E-04 (1.83E-03)	3.83E-05 (3.83E-04)	3.28E-05 (3.28E-04)
Swimming	3.78E-06 (3.78E-05)	2.11E-05 (2.11E-04)	4.41E-06 (4.41E-05)	3.78E-06 (3.78E-05)
Boating	3.05E-05 (3.05E-04)	3.05E-05 (3.05E-04)	1.70E-05 (1.70E-04)	3.05E-05 (3.05E-04)
Total	1.64E+00 (1.64E+01)	1.38E+00 (1.38E+01)	2.41E+00 (2.41E+01)	1.39E+00 (1.39E+01)

Table 5.4-18— Summary Liquid Effluent Annual Dose to MEI i1309560

Assessment Type	BBNPP Calculated Dose mrem (μSv)	10 CFR 50 Appendix I Limit(1) mrem (μSv)	Fraction of Appendix I Objective
Total Body	~~5.64E-01 (5.64E+00)~~ 5.61E-01 (5.61E+00) Child	3 (30)	~~1.88E-01~~ 1.87E-01
Maximum Organ	~~2.32E+00 (2.32E+01)~~ 2.41E+00 (2.41E+01) Thyroid-Child	10 (100)	~~2.32E-01~~ 2.41E-01

Note:
1. Numerical dose objectives from 10 CFR 50 Appendix I, Section II.A.

RAI 101, Question 11.02-5

RAI 101, Question 11.02-5

RAI 101, Question 11.02-5

Table 5.4-19— General Population Doses from Liquid Effluents

Total Body Person-Rem (Person-Sieverts)	Person-Thyroid-Rem (Person-Thyroid-Sieverts)
~~1.64E-01~~ ~~(1.64E-03)~~ 2.89E-01 (2.89E-03)	~~1.67E-01~~ ~~(1.67E-03)~~ 3.43E-01 (3.43E-03)
Includes dose contribution from sport fishing, boating, and consumption of potable water exposures to the 50 mi (80 km) population impacted by water uses of the Susquehanna River 50 mi (80 km) downstream. Based on projected 50 mi (80 km) population for the year ~~2070~~ 2080.	

RAI 101, Question 11.02-5

Insert 5.4-20-1

RAI 101, Question 11.02-5

Table 5.4-20— Gaseous Pathway Doses for Maximally Exposed Individuals (MEI)

Location	Pathway	Total Body mrem/yr (µSv/yr)	Max. Organ mrem/yr (µSv/yr)	Skin mrem/yr (µSv/yr)
Nearest[1] OCA[2] Boundary 0.16 mi (0.25 km), WSW	Plume	1.26E+00 -1.26E+01	1.26E+00 -1.26E+01	3.93E+00 -3.93E+01
Nearest[1] Residence 1.0 mi (1.7 km), NE	Ground	7.62E-04 -7.62E-03	7.62E-04 -7.62E-03	8.95E-04 -8.95E-03
Nearest[1] Residence 0.53 mi (0.85 km), WNW	Inhalation			
	Adult	1.33E-02 (1.33E-01)	2.47E-04 (2.47E-03)	1.33E-02 (1.33E-01)
	Teen	1.34E-02 (1.34E-01)	3.01E-04 (3.01E-03)	1.34E-02 (1.34E-01)
	Child	1.19E-02 (1.19E-01)	3.67E-04 (3.67E-03)	1.18E-02 (1.18E-01)
	Infant	6.83E-03 (6.83E-02)	1.91E-04 (1.91E-03)	6.79E-03 (6.79E-02)
Nearest[1] Garden 0.51 mi (0.82 km), W	Vegetable			
	Adult	1.66E-01 (1.66E+00)	5.90E-01 (5.90E+00)	1.66E-01 (1.66E+00)
	Teen	2.53E-01 (2.53E+00)	9.81E-01 (9.81E+00)	2.52E-01 (2.52E+00)
	Child	5.64E-01 (5.64E+00)	2.38E+00 (2.38E+01)	5.64E-01 (5.64E+00)
	Infant	0.00E+00 (0.00E+00)	0.00E+00 (0.00E+00)	0.00E+00 (0.00E+00)
Nearest[1] Milk Animal 0.74 mi (1.2 km), SSW	Cow Milk			
	Adult	4.35E-03 (4.35E-02)	1.61E-02 (1.61E-01)	4.23E-03 (4.23E-02)
	Teen	7.37E-03 (7.37E-02)	2.95E-02 (2.95E-01)	7.22E-03 (7.22E-02)
	Child	1.67E-02 (1.67E-01)	7.25E-02 (7.25E-01)	1.65E-02 (1.65E-01)
	Infant	3.36E-02 (3.36E-01)	1.42E-01 (1.42E+00)	3.32E-02 (3.32E-01)
Nearest[1] Meat Animal 0.51 mi (0.82 km), NNE	Meat			
	Adult	2.89E-02 (2.89E-01)	1.25E-01 (1.25E+00)	2.89E-02 (2.89E-01)
	Teen	2.34E-02 (2.34E-01)	1.05E-01 (1.05E+00)	2.34E-02 (2.34E-01)
	Child	4.24E-02 (4.24E-01)	1.98E-01 (1.98E+00)	4.24E-02 (4.24E-01)
	Infant	0.00E+00 (0.00E+00)	0.00E+00 (0.00E+00)	0.00E+00 (0.00E+00)

Note:

1. For a given dose pathway (i.e., plume, ground, inhalation, vegetable, milk, or meat), "nearest" refers to the fact that the location in this table was determined to be the maximum dose location for all of the "nearest" receptor locations (i.e., the nearest site boundary, residence, garden, milk animal, or meat animal within each of the 16 meteorological sectors) for that pathway.
2. "OCA" is the acronym for "Owner Controlled Area."

Insert 5.4-20-1

Table 5.4-20 - Gaseous Pathway Doses for Maximally Exposed Individuals (MEI)[1]

Location	Pathway	Total Body (mrem/yr)	Max. Organ (mrem/yr)	Skin (mrem/yr)
Nearest[1] OCA[2] Boundary 0.16 mi, WSW	Plume	1.26E+00	1.26E+00	3.93E+00
Nearest[1] Residence 0.79 mi, NNE	Ground	5.28E-04	5.28E-04	5.28E-04
Nearest[1] Residence 0.79 mi NNE	Inhalation			
	Adult	5.83E-03	1.06E-04	5.81E-03
	Teen	5.88E-03	1.29E-04	5.86E-03
	Child	5.20E-03	1.58E-04	5.18E-03
	Infant	2.99E-03	8.25E-05	2.98E-03
Nearest[1] Garden 0.25 mi SSW	Vegetable			
	Adult	1.64E-01	7.67E-01	1.63E-01
	Teen	2.66E-01	1.27E+00	2.65E-01
	Child	6.32E-01	3.08E+00	6.31E-01
	Infant	0.00E+00	0.00E+00	0.00E+00
Nearest[1] Milk Animal 0.74 mi SSW	Cow Milk			
	Adult	1.69E-02	7.86E-02	1.67E-02
	Teen	3.04E-02	1.45E-01	3.03E-02
	Child	7.35E-02	3.56E-01	7.32E-02
	Infant	1.52E-01	6.97E-01	1.52E-01
Nearest[3] Meat Animal 0.33 mi WSW	Meat			
	Adult	7.30E-02	3.53E-01	7.29E-02
	Teen	6.11E-02	2.99E-01	6.11E-02
	Child	1.14E-01	5.61E-01	1.14E-01
	Infant	0.00E+00	0.00E+00	0.00E+00

Note:
1. For a given dose pathway (i.e., plume, ground, inhalation, vegetable, milk, or meat), "nearest" refers to the fact that the location in this table was determined to be the maximum dose location for all of the "nearest" receptor locations (i.e., the nearest OCA boundary, residence, garden, milk animal, or meat animal within each of the 16 meteorological sectors) for that pathway.
2. "OCA" is the acronym for "Owner Controlled Area."
3. Nearest meat animal assumed to be at limiting site boundary location since actual location of animals within 5 miles is not available (SSES, 2010).

Table 5.4-21— BBNPP Gaseous Effluent MEI Dose Summary

10 CFR 50 Appendix I Section	Dose Assessment	Calculated Dose	10 CFR 50 Appendix I Limit
II.B.1	Beta Air Dose mrad/yr (μGy/yr)	4.5 (45.0)	20 (200)
	Gamma Air Dose mrad/yr (μGy/yr)	2.0 (20.0)	10 (100)
II.B.2	External Total Body Dose mrem/yr (μSv/yr)	1.3 (13.0)	5 (50)
	External Skin Dose mrem/yr (μSv/yr)	3.9 (39.0)	15 (150)
II.C	Organ Dose (Child, Bone) mrem/yr (μSv/yr)	~~2.7 (27.0)~~ 4.0 (40.0)	15 (150)

RAI 101, Question 11.02-3(1-4)

Insert
5.4-23-1

RAI 101,
Questions,
11.02-3(1-4),
11.02-5

Table 5.4-23— Annual Historical Dose Compliance with 40 CFR 190 for SSES Units 1 & 2

Year	Whole Body(1) mrem (μSv)	Thyroid mrem (μSv)	Maximum Organ(2) mrem (μSv)
2000	1.68E-01 (1.68E+00)	1.73E-01 (1.73E+00)	1.73E-01 (1.73E+00)
2001	2.15E-01 (2.15E+00)	2.18E-01 (2.18E+00)	2.23E-01 (2.23E+00)
2002	1.30E+00 (1.30E+01)	1.29E+00 (1.29E+01)	1.31E+00 (1.31E+01)
2003	1.20E+00 (1.20E+01)	1.21E+00 (1.21E+01)	1.21E+00 (1.21E+01)
2004	1.22E+00 (1.22E+01)	1.22E+00 (1.22E+01)	1.22E+00 (1.22E+01)
2005	8.34E-01 (8.34E+00)	8.38E-01 (8.38E+00)	8.34E-01 (8.34E+00)
2006	5.27E-01 (5.27E+00)	5.32E-01 (5.32E+00)	5.32E-01 (5.32E+00)
2007	8.25E-01 (8.25E+00)	8.24E-01 (8.24E+00)	8.28E-01 (8.28E+00)
Maximum Value any Year	1.30E+00 (1.30E+01)	1.29E+00 (1.29E+01)	1.32E+00 (1.32E+01)
SSES ISFSI Projection	4.7E+00 (4.7E+01)	4.7E+00 (4.7E+01)	4.7E+00 (4.7E+01)
Total SSES Dose Contribution	6.01E+00 (6.01E+01)	5.99E+00 (5.99E+01)	6.02E+00 (6.02E+01)

Notes:
1. This is the sum of direct radiation, gaseous and liquid effluents
2. The maximum organ dose from liquids was summed with the thyroid dose from gases and the direct radiation

Insert 5.4-23-1

Table 5.4-23— Annual Historical Dose Compliance with 40 CFR 190 for SSES Units 1 & 2

Year	Whole Body[1] mrem (μSv)	Thyroid[2] mrem (μSv)	Maximum Organ[1] mrem (μSv)
2000	1.68E-01 (1.68E+00)	1.73E-01 (1.73E+00)	1.73E-01 (1.73E+00)
2001	2.15E-01 (2.15E+00)	2.18E-01 (2.18E+00)	2.23E-01 (2.23E+00)
2002	1.30E+00 (1.30E+01)	1.29E+00 (1.29E+01)	1.31E+00 (1.31E+01)
2003	1.20E+00 (1.20E+01)	1.21E+00 (1.21E+01)	1.21E+00 (1.21E+01)
2004	1.22E+00 (1.22E+01)	1.22E+00 (1.22E+01)	1.22E+00 (1.22E+01)
2005	8.34E-01 (8.34E+00)	8.38E-01 (8.38E+00)	8.38E-01 (8.38E+00)
2006	5.22E-01 (5.22E+00)	5.27E-01 (5.27E+00)	5.27E-01 (5.27E+00)
2007	8.25E-01 (8.25E+00)	8.24E-01 (8.24E+00)	8.28E-01 (8.28E+00)
2008	5.49E-01 (5.49E+00)	5.49E-01 (5.49E+00)	5.50E-01 (5.50E+00)
2009	1.03E+00 (1.03E+01)	1.03E+00 (1.03E+01)	1.03E+00 (1.03E+01)
2010	2.29E+00 (2.29E+01)	2.31E+00 (2.31E+01)	7.47E+00 (7.47E+01)
2011	1.19E+00 (1.19E+01)	1.19E+00 (1.19E+01)	1.46E+00 (1.46E+01)
Maximum Value any Year	2.29E+00 (2.29E+01)	2.31E+00 (2.31E+01)	7.47E+00 (7.47E+01)
SSES ISFSI Projection	4.7E+00 (4.7E+01)	4.7E+00 (4.7E+01)	4.7E+00 (4.7E+01)
Total SSES Dose Contributions	6.99E+00 (6.99E+01)	7.01E+00 (7.01E+01)	1.22E+01 (1.22E+02)

Notes:
1. This is the sum of direct radiation, gaseous and liquid effluents
2. The maximum organ dose from liquids was summed with the thyroid dose from gases and the direct radiation

Insert
5.4-24-1

RAI 101, Questions, 11.02-3(1-4), 11.02-5

Table 5.4-24— 40 CFR 190 Annual Site Dose Compliance

Facility	Pathway	Whole Body mrem (µSv)	Thyroid mrem (µSv)	Maximum Organ[(1)] mrem (µSv)
BBNPP	Plume	1.26E+00 (1.26E+01)	1.26E+00 (1.26E+01)	1.26E+00 (1.26E+01)
	Ground	3.20E-03 (3.20E-02)	3.20E-03 (3.20E-02)	3.20E-03 (3.20E-02)
	Inhalation	1.19E-02 (1.19E-01)	3.90E-02 (3.90E-01)	3.67E-04 (3.67E-03)
	Vegetable	5.64E-01 (5.64E+00)	6.18E-01 (6.18E+00)	2.38E+00 (2.38E+01)
	Meat	4.24E-021 (4.24E-01)	4.58E-02 (4.58E-01)	1.98E-01 (1.98E+00)
	Milk	2.59E-02 (2.59E-01)	1.10E-01 (1.10E+00)	1.12E-01 (1.12E+00)
	Fish	3.27E-02 (3.27E-01)	1.08E-01 (1.08E+00)	1.21E-01 (1.21E+00)
	Invertebrate	6.57E-03 (6.57E-02)	1.01E-02 (1.01E-01)	1.71E-02 (1.71E-01)
	Drinking water	4.85E-01 (4.85E+00)	1.03E+00 (1.03E+01)	8.23E-03 (8.23E-02)
	Irrigation	3.92E-02 (3.92E-01)	1.17E+00 (1.17E+01)	6.29E-02 (6.29E-01)
	Shoreline	4.12E-05 (4.12E-04)	4.12E-05 (4.12E-04)	4.12E-05 (4.12E-04)
	Swimming	4.30E-06 (4.30E-05)	4.30E-06 (4.30E-05)	4.30E-06 (4.30E-05)
	Boating	1.66E-05 (1.66E-04)	1.66E-05 (1.66E-04)	1.66E-05 (1.66E-04)
	Fixed Direct	1.87E+00 (1.87E+01)	1.87E+00 (1.87E+01)	1.87E+00 (1.87E+01)
	Total	4.34E+00 (4.34E+01)	6.26E+00 (6.26E+01)	6.03E+00 (6.03E+01)
SSES 1 & 2	Total	6.01E+00 (6.01E+01)	5.99E+00 (5.99E+01)	6.02E+00 (6.02E+01)
All Units	Total	1.04E+01 (1.04E+02)	1.23E+01 (1.23E+02)	1.21E+01 (1.21E+02)

Notes:
1. The critical organ for all pathways was the child bone.

Insert 5.4-24-1

Table 5.4-24— 40 CFR 190 Annual Site Dose Compliance

Facility	Pathway	Whole Body mrem (µSv)	Thyroid mrem (µSv)	Maximum Organ (1) mrem (µSv)
BBNPP	Plume	1.26E+00 (1.26E+01)	1.26E+00 (1.26E+01)	1.26E+00 (1.26E+01)
	Ground	5.28E-04 (5.28E-03)	5.28E-04 (5.28E-03)	5.28E-04 (5.28E-03)
	Inhalation	5.20E-03 (5.20E-02)	1.70E-02 (1.70E-01)	1.58E-04 (1.58E-03)
	Vegetable	6.32E-01 (6.32E+00)	9.52E-01 (9.52E+00)	3.08E+00 (3.08E+01)
	Meat	1.14E-01 (1.14E+00)	1.15E-01 (1.15E+00)	5.61E-01 (5.61E+00)
	Milk	7.35E-02 (7.35E-01)	1.69E-01 (1.69E+00)	3.56E-01 (3.56E+00)
	Fish	3.09E-02 (3.09E-01)	1.14E-01 (1.14E+00)	1.12E-01 (1.12E+00)
	Invertebrates	6.23E-03 (6.23E-02)	1.05E-02 (1.05E-01)	1.59E-02 (1.59E-01)
	Potable Water	4.85E-01 (4.85E+00)	1.07E+00 (1.07E+01)	7.88E-03 (7.88E-02)
	Irrigation	3.85E-02 (3.85E-01)	1.22E+00 (1.22E+01)	5.87E-02 (5.87E-01)
	Shoreline	3.83E-05 (3.83E-04)	3.83E-05 (3.83E-04)	3.83E-05 (3.83E-04)
	Swimming	4.41E-06 (4.41E-05)	4.41E-06 (4.41E-05)	4.41E-06 (4.41E-05)
	Boating	1.70E-05 (1.70E-04)	1.70E-05 (1.70E-04)	1.70E-05 (1.70E-04)
	Fixed Direct	1.87E+00 (1.87E+01)	1.87E+00 (1.87E+01)	1.87E+00 (1.87E+01)
	Total	4.52E+00 (4.52E+01)	6.80E+00 (6.80E+01)	7.32E+00 (7.32E+01)
SSES 1 & 2	Total	6.99E+00 (6.99E+01)	7.01E+00 (7.01E+01)	1.22E+00 (1.22E+01)
All Units	Total	1.15E+01 (1.15E+02)	1.38E+01 (1.38E+02)	1.95E+01 (1.95E+02)

Insert 5.4-29-1

RAI 101, Questions, 11.02-3(1-4), 11.02-5

Table 5.4-29— Dose to Biota from all Sources

Biota	Effluents Liquid		Gaseous Effluents		Fixed Sources	Total
	Internal Dose(1) mrad/yr (µGy/yr)	External Dose(1) mrad/yr (µGy/yr)	Internal Dose mrem/yr (µSv/yr)	External Dose mrem/yr (µSv/yr)	External Dose mrem/yr (µSv/yr)	All Pathways Dose(1) mrad/yr (µGy/yr)
Fish	1.14E-01 (1.14E+00)	8.42E-02 (8.42E-01)	NA	NA	NA	1.98E-01 (1.98E+00)
Invertebrate	5.36E-01 (5.36E+00)	1.67E-01 (1.67E+00)	NA	NA	NA	7.03E-01 (7.03E+00)
Algae	2.29E+00 (2.29E+01)	1.72E-03 (1.72E-02)	NA	NA	NA	2.29E+00 (2.29E+01)
Muskrat	5.86E-01 (5.86E+00)	5.56E-02 (5.56E-01)	2.79E-02 (2.79E-01)	1.27E+00 (1.27E+01)	1.87E+00 (1.87E+01)	3.81E+00 (3.81E+01)
Raccoon	1.32E-01 (1.32E+00)	3.30E-02 (3.30E-01)	2.79E-02 (2.79E-01)	1.27E+00 (1.27E+01)	1.87E+00 (1.87E+01)	3.33E+00 (3.33E+01)
Heron	1.72E+00 (1.72E+01)	4.42E-02 (4.42E-01)	2.79E-02 (2.79E-01)	1.27E+00 (1.27E+01)	1.87E+00 (1.87E+01)	4.93E+00 (4.93E+01)
Duck	5.39E-01 (5.39E+00)	8.30E-02 (8.30E-01)	2.79E-02 (2.79E-01)	1.27E+00 (1.27E+01)	1.87E+00 (1.87E+01)	3.79E+00 (3.79E+01)

Note:

1. For approximations of total doses, assume that 1 µGy = 1 µSv (1 mrad = 1 mrem).

Insert 5.4-29-1

Table 5.4-29— Dose to Biota from all Sources

Biota	Effluents Liquid		Gaseous Effluents		Fixed Sources	Total
	Internal Dose[1] mrad/yr (µGy/yr)	External Dose[1] mrad/yr (µGy/yr)	Internal Dose mrem/yr (µSv/yr)	External Dose mrem/yr (µSv/yr)	External Dose mrem/yr (µSv/yr)	All Pathways Dose[1] mrad/yr (µGy/yr)
Fish	1.09E-01 (1.09E+00)	7.85E-02 (7.85E-01)	NA	NA	NA	1.88E-01 (1.88E+00)
Invertebrate	5.00E-01 (5.00E+00)	1.55E-01 (1.55E+00)	NA	NA	NA	6.55E-01 (6.55E+00)
Algae	2.13E+00 (2.13E+01)	1.77E-03 (1.77E-02)	NA	NA	NA	2.13E+00 (2.13E+01)
Muskrat	5.59E-01 (5.59E+00)	5.18E-02 (5.18E-01)	7.29E-03 (7.29E-02)	1.26E+00 (1.26E+01)	1.87E+00 (1.87E+01)	3.75E+00 (3.75E+01)
Raccoon	1.25E-01 (1.25E+00)	3.07E-02 (3.07E-01)	7.29E-03 (7.29E-02)	1.26E+00 (1.26E+01)	1.87E+00 (1.87E+01)	3.30E+00 (3.30E+01)
Heron	1.61E+00 (1.61E+01)	4.11E-02 (4.11E-01)	7.29E-03 (7.29E-02)	1.26E+00 (1.26E+01)	1.87E+00 (1.87E+01)	4.79E+00 (4.79E+01)
Duck	5.15E-01 (5.15E+00)	7.72E-02 (7.72E-01)	7.29E-03 (7.29E-02)	1.26E+00 (1.26E+01)	1.87E+00 (1.87E+01)	3.73E+00 (3.73E+01)
Note:						
1. For approximations of total doses, assume that 1 µGy = 1 µSv (1 mrad = 1 mrem).						