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SACRAMENTO MUNICIPAL UTILITY DISTRICT P. O. Box 15830, Sacramento CA 95852-1830, (916) 452-3211
AN ELECTRIC SYSTEM SERVING THE HEART OF CALIFORNIA

MPC&D 00-035

February 28, 2000

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

Docket No. 50-312
Rancho Seco Nuclear Station
License No. DPR-54

1999 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

Attention: Dick Dudley

In accordance with 10 CFR 50.36a(a)(2) and Rancho Seco Permanently Defueled Technical Specification D6.9.3, the District submits the enclosed Rancho Seco Annual Radioactive Effluent Release Report for the period January 1 through December 31, 1999.

Members of your staff requiring additional information or clarification may contact Walter Partridge at (916) 732-4811.

Sincerely,

Tom Tucker for

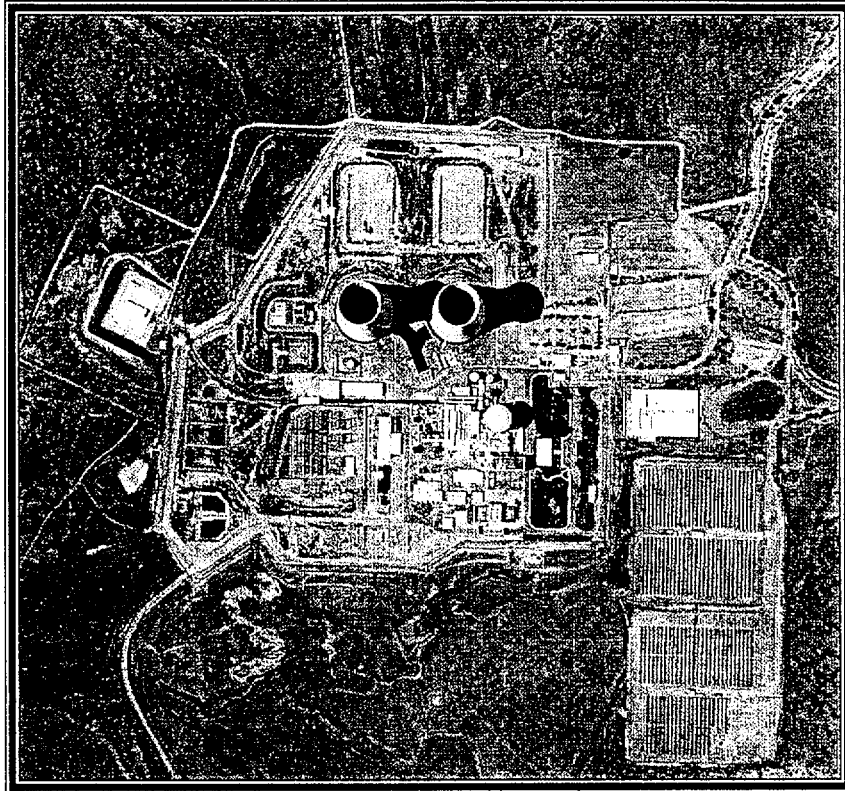
Steve J. Redeker
Manager, Plant Closure & Decommissioning

Attachment

cc w/atch: E.W. Merschoff, NRC, Region IV, Arlington

IE48

RANCHO SECO NUCLEAR GENERATING STATION



LICENSE NUMBER DPR-54

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

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INTRODUCTION

Rancho Seco Nuclear Generating Station (RSNGS) Unit No. 1 is located in Sacramento County, California approximately 25 miles southeast of Sacramento and 26 miles north-northeast of Stockton. Rancho Seco Unit No. 1 began commercial operation on April 17, 1975. The single unit on the Rancho Seco site is a pressurized water reactor supplied by Babcock and Wilcox. The rated capacity is 963 gross megawatts electrical. Because of a public vote on June 6, 1989, the District shutdown the Rancho Seco Nuclear Generating Station and completed defueling operations on December 8, 1989.

This Annual Radioactive Effluent Release Report (ARERR) provides a summary of gaseous and liquid effluent releases made from Rancho Seco during the period January 1 through December 31, 1999. Also presented in this report is the projected radiological impact from these releases and a summary of solid radioactive waste shipments.

This report has been prepared by the Sacramento Municipal Utility District to meet the requirements of Rancho Seco Technical Specification D6.9.3 and Offsite Dose Calculation Manual (ODCM) Step 6.15. It is presented in accordance with the format of USNRC Regulatory Guide 1.21. The radiation doses reported in this ARERR are calculated for a hypothetical individual who receives the maximum possible exposure at or beyond the applicable Site Boundary.

Releases of radioactivity in gaseous and liquid effluents during this report period did not exceed the limits of 10 CFR 20 or the numerical guidelines of 10 CFR 50, Appendix I. A 40 CFR 190 dose evaluation is not required because radioactive effluent releases did not exceed twice the numerical guidelines of 10 CFR 50, Appendix I.

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I. SUPPLEMENTAL INFORMATION

A. REGULATORY LIMITS & GUIDELINES FOR EFFLUENT RELEASES

1. Gaseous Effluents

- a. Noble Gas dose rate limit at or beyond the Site Boundary for Gaseous Effluents (Offsite Dose Calculation Manual (ODCM) Technical Requirement 6.14.6):

500 mrem/year to the total body
3000 mrem/year to the skin

- b. Noble Gas air dose limit at or beyond the Site Boundary for Gaseous Effluents (ODCM Technical Requirement 6.14.7, numerical guidelines of 10 CFR 50, Appendix I):

5 mrad per calendar quarter for gamma radiation
10 mrad per calendar quarter for beta radiation
10 mrad per calendar year for gamma radiation
20 mrad per calendar year for beta radiation

- c. Dose rate limit at or beyond the Site Boundary for Gaseous Effluents for Tritium and radioactive material in particulate form with half-lives greater than 8 days (ODCM Technical Requirement 6.14.6):

1500 mrem/year to any organ

- d. Dose commitment to a member of the public at or beyond the Site Boundary for Gaseous Effluents from Tritium and radioactive material in particulate form with half-lives greater than 8 days (ODCM Technical Requirement 6.14.8, numerical guidelines of 10 CFR 50, Appendix I):

7.5 mrem per calendar quarter to any organ
15 mrem per calendar year to any organ

2. Liquid Effluents

- a. The concentration of radioactive material in liquid effluents released beyond the Site Boundary for Liquid Effluents shall not exceed the limits of 10 CFR 20, Appendix B, Table 2, Column 2. This applies to all radionuclides except dissolved or entrained noble gases (ODCM Technical Requirement 6.14.2).

- b. Dose commitment to a member of the public at or beyond the Site Boundary for Liquid Effluents from radioactive materials in liquid effluents shall be limited to (ODCM Technical Requirement 6.14.3, numerical guidelines of 10 CFR 50, Appendix I):

1.5 mrem per calendar quarter to the total body
5 mrem per calendar quarter to any organ
3 mrem per calendar year to the total body
10 mrem per calendar year to any organ

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B. MAXIMUM EFFLUENT CONCENTRATIONS

1. Gaseous Effluents

The concentrations listed in 10 CFR 20, Appendix B, Table 2, Column 1 (air) are not directly used in calculations for determining permissible gaseous effluent release rates. The annual dose limits of 10 CFR 20 for unrestricted areas are the doses associated with the concentrations of 10 CFR 20, Appendix B, Table 2, Column 1. ODCM Technical Requirement dose rate limits (mrem/yr) for gaseous effluents are provided to ensure that the dose rate from gaseous effluents at any time at the Site Boundary for Gaseous Effluents will be within the annual dose limits of 10 CFR 20 for unrestricted areas. These dose rate limits (listed above in part A) are used for determining permissible gaseous effluent release rates.

2. Liquid Effluents

The concentration values listed in 10 CFR 20, Appendix B, Table 2, Column 2 are used in calculations to determine permissible liquid discharge flow rates. The most conservative Maximum Effluent Concentration (MEC) value for each radionuclide detected in the liquid effluent sample (excluding dissolved or entrained noble gases) is used in the calculations.

C. MEASUREMENT METHODS FOR TOTAL RADIOACTIVITY

1. Fission and Activation Gases

Gamma Spectroscopy (HPGe)

Liquid Scintillation (H-3)

2. Particulates

Gamma Spectroscopy (HPGe)

Beta Proportional (Sr-90, gross beta)

Alpha Proportional (gross alpha)

3. Liquid Effluents

Gamma Spectroscopy (HPGe)

Liquid Scintillation (H-3)

Beta Proportional (Sr-90, gross beta)

Alpha Proportional (gross alpha)

NOTE: HPGe refers to Hyper-Pure Germanium

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D. BATCH RELEASES (via monitored pathways)

1. Liquid (RHUT Releases)	<u>Quarter 1</u>	<u>Quarter 2</u>	<u>Quarter 3</u>	<u>Quarter 4</u>
a. Number of batch releases	1	0	1	3
b. Total time period for batch releases (hours)	3.7		2.4	6.1
c. Maximum time period for a batch release (hours)	3.7		2.4	2.4
d. Average time period for a batch release (hours)	3.7		2.4	2.0
e. Minimum time period for a batch release (hours)	3.7		2.4	1.7
 2. Liquid (Retention Basin Discharges)				
a. Number of batch releases	2	1	1	4
b. Total time period for batch releases (hours)	26.7	8.1	7.2	40.7
c. Maximum time period for a batch release (hours)	16.7	8.1	7.2	13.7
d. Average time period for a batch release (hours)	13.3	8.1	7.2	10.2
e. Minimum time period for a batch release (hours)	9.9	8.1	7.2	6.7
f. Average stream flow during periods of release of effluent into a flowing stream (cfs)	18.8	17.7	19.0	20.1

NOTE: The Regenerant Holdup Tanks (RHUTs) are released to the Retention Basins. The Retention Basins are discharged offsite. All 10 CFR 50, Appendix I dose calculations are based on the RHUT releases. All 10 CFR 20 calculations are based on the Retention Basin discharges.

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E. UNPLANNED RELEASES

This section describes unplanned releases of radioactivity in liquid and gaseous effluent.

Gaseous

None

Liquid

None

F. RADIOACTIVE EFFLUENT MONITORING INSTRUMENTATION INOPERABLE FOR GREATER THAN 30 DAYS

On August 3, 1999 the Auxiliary Building Grade Level Vent Radiation Monitor, R-15546A, was declared out of service due to problems with the sampling instrumentation. Plant Management made a decision to abandon the system during the problem evaluation process. On December 22, 1999 the Plant Review Committee approved the removal of the Auxiliary Building Grade Level Vent System from the Ventilation Exhaust Treatment System. The last release from the Auxiliary Building Grade Level Vent System occurred on August 18, 1999.

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II. ESTIMATION OF ERROR

The methods for establishing error estimates included review of applicable station procedures, inspection of sampling equipment, engineering estimates, statistical applications, review of calibration setpoint data, and communication with plant personnel. The various sources of error (s) in reported values of gaseous effluents, liquid effluents, and solid waste are assumed to be independent, and thus the total error is calculated according to the formula:

$$\text{Total Error} = \sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_3^2 \dots + \sigma_i^2}$$

where: σ_i = relative error associated with component i

Sources of error for gaseous effluents include fan error (flow), grab sampling, collection, filter efficiency, counting, and calibration.

Sources of error for liquid effluents include RHUT volume, dilution water flow rate, grab sampling, counting, and calibration.

Sources of error for solid waste include offsite lab smear analysis, dose rate meter calibration, dose rate meter reading, computer program dose-to-curie calculation, sample volume measurement, gamma spec counting, gamma spec calibration, and waste volume determination.

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III. GASEOUS EFFLUENTS

Table III-A, Gaseous Effluents - Summation of All Releases, provides a detailed summary of gaseous effluent releases per quarter. This table summarizes releases of fission and activation gases, particulates with half-lives greater than 8 days, and tritium. The methodology used to calculate the Percent of ODCM Technical Requirement limit is as follows:

$$\% \text{ Tech Req Limit} = \frac{\sum_i [(F_i)(\text{Avg Rel Rate})(X/Q)(\text{Dose Factor})]}{(\text{Dose Rate Limit})} \times 100\%$$

where:

F_i = The fraction of the total number of Curies of nuclide i out of the total curies in that category for that quarter (unitless).

NOTE: F_i always equals 1.0 for H-3 because it is the only nuclide in the category.

$$\text{Avg Rel Rate} = \frac{(\text{Total Curies per category per quarter}) \left(\frac{1 \text{ E} + 06 \mu\text{Ci}}{\text{Ci}} \right)}{(\# \text{ seconds in the quarter})}$$

X/Q = A default dispersion factor determined to be conservative when compared to the use of actual data (sec/m³).

Dose Factor = The values derived for each nuclide i from NRC Regulatory Guide 1.109 (K_i , $L_i+1.1M_i$, or R_{aij}). [Units in (mrem/yr)/($\mu\text{Ci}/\text{m}^3$)]

Dose Rate Limit = The Technical Requirement (i.e., Regulatory) limits for dose rate listed in Section I of this report (mrem/yr).

NOTE: Particulates with half-lives less than 8 days are not included in this calculation.

The methodology used to calculate the Estimated Total Error (%) in Table III-A is presented in Section II of this report.

Table III-B, Gaseous Effluents - Ground Level Releases, provides a complete quarterly summary of the amount of radioactivity (Ci) released per radionuclide in each quarter. Data from continuous and batch releases are provided for fission gases, particulates, and tritium. Data reported for batch releases results only from unplanned releases.

Table III-C, Gaseous Effluents - Typical Lower Limits of Detection, provides a listing of the typical lower limit of detection (LLD) concentrations in $\mu\text{Ci}/\text{cc}$ for various radionuclides.

Table III-D, Radiological Impact on Man Due to Gaseous Effluent Releases, provides a summary of calculated radiation doses delivered to a maximum exposed hypothetical individual at the Site Boundary for Gaseous Effluents (actual doses will be assessed in the 1998 Annual REMP Report). The maximum calculated organ dose, gamma air dose, and beta air dose are listed for each quarter along with an annual total. The dose due to direct radiation based on Thermoluminescent Dosimeter (TLD) results is also listed. Presented in this table for each category is a comparison versus ODCM Technical Requirement dose limits with the exception of direct radiation measurements.

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TABLE III-A

GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

	<u>Unit</u>	<u>Quarter 1</u>	<u>Quarter 2</u>	<u>Quarter 3</u>	<u>Quarter 4</u>	<u>Est. Total Error, %</u>
A. Fission & Activation Gases (i.e. Noble Gases)						
1. Total Release ¹	Ci	2.84E-02	0.00 E+00	0.00 E+00	0.00 E+00	2.3 E+01
2. Average Release Rate for period	μCi/sec	3.65E-03	0.00 E+00	0.00 E+00	0.00 E+00	
3. Percent of Tech Req limit	%	1.00E-04	N/A	N/A	N/A	
B. Particulates						
1. Particulates with half-lives>8 days	Ci	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	2.3 E+01
2. Average Release Rate for period	μCi/sec	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	
3. Percent of Tech Req limit	%	N/A	N/A	N/A	N/A	
4. Gross Alpha radioactivity ²	Ci	8.89E-09	7.11E-08	5.39E-08	1.01E-07	
C. Tritium						
1. Total Release	Ci	5.37E-01	4.50E-01	6.84E-01	2.68E-01	2.3 E+01
2. Average Release Rate for period	μCi/sec	6.91E-02	5.72E-02	8.61E-02	3.37E-02	
3. Percent of Tech Req limit	%	5.85E-04	4.85E-04	7.29E-04	2.85E-04	

¹ First Quarter activity is from residual Kr-85 gas that was released from Waste Decay Tank System when the system was dismantled.

² Gross alpha activity has been determined to be naturally occurring and not the result of the fuel cycle.

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TABLE III-B

GASEOUS EFFLUENTS - GROUND LEVEL RELEASES

Nuclides Released	Unit	Continuous Mode			
		Quarter 1	Quarter 2	Quarter 3	Quarter 4
1. Fission Gases (i.e., Noble Gases)					
Kr-85	Ci	2.84E-02	0.00E+00	0.00E+00	0.00E+00
2. Particulates					
None					
3. Tritium					
H-3	Ci	5.37E-01	4.50E-01	6.84E-01	2.68E-01

NOTE: . The first quarter Kr-85 activity was residual activity released when the Waste Gas Decay Tanks were dismantled. Batch releases of gaseous effluent are no longer planned to be made from Rancho Seco Nuclear Generating Station

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TABLE III-C

GASEOUS EFFLUENTS - TYPICAL LOWER LIMITS OF DETECTION

<u>RADIONUCLIDES</u>	<u>LLD ($\mu\text{Ci/cc}$)</u>
1. Tritium (H-3)	2.27 E-10
2. Fission & Activation Gases:	
Krypton-85	3.47 E-06
3. Particulates:	
Manganese-54	2.08 E-12
Cobalt-58	2.29 E-12
Iron-59	5.89 E-12
Cobalt-60	3.11 E-12
Strontium-89	2.00 E-15
Strontium-90	5.00 E-15
Cesium-134	1.52 E-12
Cesium-137	1.88 E-12
Barium-140	3.06 E-12
Cerium-141	1.15 E-12
Cerium-144	3.69 E-12

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TABLE III-D

RADIOLOGICAL IMPACT ON MAN DUE TO GASEOUS EFFLUENT RELEASES

CALCULATED RADIATION DOSES AT THE SITE BOUNDARY FOR GASEOUS EFFLUENTS:

	<u>Unit</u>	<u>Quarter 1</u>	<u>Quarter 2</u>	<u>Quarter 3</u>	<u>Quarter 4</u>	<u>1999 Annual</u>
A. Tritium, Particulate						
1. Maximum Organ Dose	mrem	1.74E-02 (a)	1.46E-02 (a)	2.52E-02 (a)	8.68E-03 (a)	6.59E-02 (a)
Percent Tech Req limit	%	2.32E-01	1.95E-01	3.36E-01	1.16E-01	4.39E-01
B. Noble Gas						
1. Gamma Air Dose	mrad	1.55E-06	0.00 E+00	0.00 E+00	0.00 E+00	1.55E-06
Percent Tech Req limit	%	3.10E-05	N/A	N/A	N/A	1.55E-05
2. Beta Air Dose	mrad	1.76E-04	0.00 E+00	0.00 E+00	0.00 E+00	1.76E-04
Percent Tech Req limit	%	3.52E-03	N/A	N/A	N/A	1.76E-03
C. Direct Radiation						
1. Dose (TLD results)	mrem	0.00 E+00*	0.00 E+00*	0.00 E+00*	0.00 E+00*	0.00 E+00*
2. Percent of Tech Req limit	%	N/A	N/A	N/A	N/A	N/A

NOTE: The quarterly doses listed above were calculated using dose factors from GASPARD and default meteorological data for each quarter. Annual doses are the sum of quarterly doses.

^(a) Child - All Except Bone

* None of the Indicator stations indicate significant radiation attributable to Plant operations.

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IV. LIQUID EFFLUENTS

Table IV-A, Liquid Effluents - Summation of All Releases, provides a detailed summary of liquid effluent releases per quarter. This table summarizes releases of fission and activation products, tritium, dissolved and entrained gases, and gross alpha radioactivity. Also listed is the volume of waste released prior to dilution and the volume of dilution water used during each quarter.

The following methodology is used to calculate the Average Diluted Concentration and the Percent of ODCM Technical Requirement Limit in Table IV-A:

$$\% \text{ Tech Req Limit} = \sum_i^n \left[\frac{C_i}{\text{MEC}_i} \right]$$

where: n = The total number of radionuclides identified
C_i = The average diluted concentration of radionuclide i
= $\frac{(\text{Total Release per Category per Quarter in } \mu\text{Ci})}{(\text{Total Release Volume (part F in Table IV - A) in ml)}$

MEC_i = The MEC of the ith radionuclide, from 10 CFR 20, Appendix B, Table 2, Column 2

The methodology used to calculate the estimated total error in Table IV-A is presented in Section II of this report.

Table IV-B, Liquid Effluents, provides a complete quarterly summary of the amount of radioactivity (Ci) released per radionuclide in each quarter. Data is provided for fission and activation products, and for dissolved and entrained gases. Tritium and gross alpha are not included in this table (they are listed in Table IV-A). Since no continuous releases of liquid radioactive effluent are made from RSNGS, data is provided only for batch releases.

Table IV-C, Liquid Effluents - Typical Lower Limits of Detection, provides a listing of the typical lower limit of detection (LLD) concentrations in $\mu\text{Ci/ml}$ for various radionuclides.

Table IV-D, Radiological Impact on Man Due To Liquid Effluent Releases, provides a summary of calculated radiation doses delivered to a maximum exposed hypothetical individual at the Site Boundary for Liquid Effluents (actual doses will be assessed in the 1998 Annual REMP Report). The maximum calculated total body dose and organ dose are listed for each quarter along with an annual total. A comparison versus ODCM Technical Requirement dose limits is also presented.

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TABLE IV-A

LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

	<u>Unit</u>	<u>Quarter 1</u>	<u>Quarter 2</u>	<u>Quarter 3</u>	<u>Quarter 4</u>	<u>Est. Total Error, %</u>
A. Fission & Activation Products						
1. Total Release (not including tritium, gases, alpha)	Ci	3.27E-06	0.00E+00	2.39E-04	3.23E-04	2.3 E+01
2. Average diluted concentration during period	µCi/ml	7.90E-13	N/A	5.59E-11	7.15E-11	
3. Percent of Tech Req limit	%	7.90E-05	N/A	4.91E-03	6.39E-03	
B. Tritium						
1. Total Release	Ci	3.67E-02	0.00 E+00	1.81E-02	4.98E-01	2.3 E+01
2. Average diluted concentration during period	µCi/ml	8.87E-09	N/A	4.24E-09	1.10E-07	
3. Percent of Tech Req limit	%	8.87E-04	N/A	4.24E-04	1.10E-02	
C. Dissolved and Entrained Gases (i.e., Noble Gases)						
1. Total Release	Ci	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	N/A
2. Average diluted concentration during period	µCi/ml	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	
D. Gross Alpha radioactivity						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.3 E+01
E. Volume of Waste Released						
Retention Basins (prior to dilution)	Liters	1.88 E+06	1.16 E+06	9.35 E+05	4.24 E+06	5.0 E+00
RHUTs (prior to dilution)	Liters	1.28 E+05	0.00 E+00	3.65 E+05	5.64 E+05	5.0 E+00
F. Volume of dilution water used during period						
	Liters	4.14E+09	3.95E+09	4.27E+09	4.52E+09	2.0 E+01

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TABLE IV-B

LIQUID EFFLUENTS

<u>Nuclides Released</u>	<u>Batch Mode</u>				
	<u>Unit</u>	<u>Quarter 1</u>	<u>Quarter 2</u>	<u>Quarter 3</u>	<u>Quarter 4</u>
1. <u>Fission and activation products (excluding tritium, gases alpha)</u>					
Co-60	Ci	0.00E+00	0.00E+00	4.45E-05	5.20E-05
Sr-90 ³	Ci	0.00E+00	0.00E+00	2.52E-07	2.53E-07
Cs-134	Ci	0.00E+00	0.00E+00	1.96E-06	1.93E-06
Cs-137	Ci	3.27E-06	0.00E+00	1.92E-04	2.69E-04
Total (for quarter)	Ci	3.27E-06	0.00E+00	2.39E-04	3.23E-04
2. <u>Dissolved and entrained gases</u>					
None					

³ The Sr-90 activity is most likely the result of draining the Component Cooling Water (CCW) system when the system was removed from service in the third quarter. The CCW was previously contaminated with reactor coolant due to a letdown cooler leak.

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NOTE: No continuous releases of liquid radioactive effluent are made from Rancho Seco Nuclear Generating Station.

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TABLE IV-C

LIQUID EFFLUENTS - TYPICAL LOWER LIMITS OF DETECTION

<u>RADIONUCLIDES</u>	<u>BATCH MODE: LLD ($\mu\text{Ci/ml}$)</u>
1. Tritium (H-3)	2.60 E-06
2. Particulates:	
Manganese-54	2.11 E-09
Iron-59	3.71 E-09
Cobalt-57	2.12 E-09
Cobalt-58	1.93 E-09
Cobalt-60	1.98 E-09
Zinc-65	4.34 E-09
Strontium-90	5.00 E-10
Ruthenium-106	1.79 E-08
Silver-110m	1.94 E-09
Antimony-125	5.78 E-09
Cesium-134	1.93 E-09
Cesium-136	2.23 E-09
Cesium-137	2.30 E-09
Barium-140	7.75 E-09
Cerium-141	3.60 E-09
Cerium-144	1.59 E-08
3. Dissolved and Entrained Gases:	
Krypton-85	4.87 E-07

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TABLE IV-D

RADIOLOGICAL IMPACT ON MAN DUE TO LIQUID EFFLUENT RELEASES

CALCULATED RADIATION DOSE COMMITMENTS FOR LIQUID EFFLUENTS:

	<u>Unit</u>	<u>Quarter 1</u>	<u>Quarter 2</u>	<u>Quarter 3</u>	<u>Quarter 4</u>	<u>1999 Annual</u>
A. Maximum Total Body Dose	mrem	1.13E-03 (a)	0.00E+00	5.37E-02 (a)	7.34E-02 (a)	1.28E-01 (a)
Percent Tech Req limit	%	7.53E-02	0.00E+00	3.58E+00	4.89E+00	4.27E+00
B. Maximum Organ Dose	mrem	2.23E-03 (b)	0.00E+00	1.14E-01 (c)	1.50E-01 (c)	2.66E-01 (c)
Percent Tech Req limit	%	4.46E-02	0.00E+00	2.28E+00	3.00E+00	2.66E+00

Note: The quarterly doses listed above were calculated using dose factors from LADTAP and the average dilution flow (cfs) for each respective quarter. Annual doses are the sum of quarterly doses.

-
- (a) Adult
 - (b) Child - Liver
 - (c) Child - Bone

RSNGS ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
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V. SOLID WASTE

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (Not irradiated fuel)

1. Type of Waste:

	Volume (m ³)	Total Activity (Curies)	Est. Total Error (%)
A. Spent Resins, filter sludges, evaporator bottoms, etc.	4.65E+01	8.67E-01	2.5E+01
B. Dry compressible waste, contaminated equipment, etc	4.34E+02	8.90E-01	2.5E+01
C. Irradiated components, control rods, etc.	N/A	N/A	
D. Other	8.90E-01	5.04E-02	2.5E+01

2. Estimate of major nuclide composition Category A and Category B waste

Radionuclide	Category A		Category B	
	Activity (Ci)	Percentage (%)	Activity (Ci)	Percentage (%)
H-3	1.60E-01	1.85E+01	1.83E-01	2.05E+01
C-14	1.50E-02	1.73E+00	2.19E-02	2.46E+00
Mn-54			5.22E-06	5.86E-04
Fe-55	9.89E-03	1.14E+00	6.36E-02	7.15E+00
Co-58	1.76E-05	2.03E-03		
Co-60	1.52E-02	1.75E+00	5.42E-02	6.09E+00
Ni-63	2.33E-01	2.69E+01	4.07E-01	4.57E+01
Sr-90	1.50E-02	1.73E+00	4.63E-03	5.20E-01
Nb-94	1.90E-04	2.19E-02		
Ag-110m	7.45E-06	8.59E-04		
Sb-125	5.77E-04	6.65E-02	8.02E-04	9.01E-02
Cs-134	4.83E-03	5.57E-01	1.82E-03	2.04E-01
Cs-137	4.09E-01	4.72E+01	1.45E-01	1.63E+01
Pu-238	1.12E-04	1.29E-02	1.89E-04	2.12E-02
Pu-239	9.12E-05	1.05E-02	1.39E-04	1.56E-02
Pu-241	3.48E-03	4.01E-01	7.87E-03	8.84E-01
Pu-242	4.42E-07	5.10E-05	7.47E-07	8.39E-05
Am-241	4.09E-04	4.71E-02	4.77E-04	5.35E-02
Cm-242	2.95E-07	3.40E-05	5.55E-08	6.24E-06
Cm-244	6.74E-05	7.77E-03	1.58E-04	1.77E-02

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3. Estimate of major nuclide composition Category C and Category D waste

Radionuclide	Category C		Category D	
	Activity (Ci)	Percentage (%)	Activity (Ci)	Percentage (%)
H-3			4.58E-02	9.10E+01
C-14			1.23E-04	2.45E-01
Mn-54				
Fe-55			3.10E-04	6.15E-01
Co-58				
Co-60			2.45E-04	4.87E-01
Ni-63			2.28E-03	4.53E+00
Sr-90			6.11E-05	1.21E-01
Nb-94				
Ag-110m				
Sb-125				
Cs-134			1.43E-05	2.85E-02
Cs-137			1.47E-03	2.92E+00
Pu-238			1.07E-06	2.12E-03
Pu-239			7.85E-07	1.56E-03
Pu-241			4.34E-05	8.61E-02
Pu-242			4.24E-09	8.41E-06
Am-241			2.73E-06	5.41E-03
Cm-242			2.24E-11	4.45E-08
Cm-244			8.80E-07	1.75E-03

4. Solid Waste Disposition

<u>Number of Shipments</u>	<u>Mode of Transportation</u>	<u>Destination</u>
44	Highway	Envirocare of Utah, Inc.

B. IRRADIATED FUEL SHIPMENTS (Disposition)

Number of Shipments

None

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ATTACHMENT 1

MANUAL:	CHEMISTRY ADMINISTRATIVE PROCEDURES MANUAL	NUMBER:	CAP-0002
TITLE:	OFF-SITE DOSE CALCULATION MANUAL	REVISION:	10
LEAD DEPARTMENT:	RADIATION PROTECTION/CHEMISTRY	PAGE:	1 of 74
		EFFECTIVE DATE:	03-08-99

SCOPE OF REVISION:

1. Incorporate TC-01.
2. Added caption "(This drawing for information only)" to Attachment 1 and Attachment 2.
3. Minor editorial correction to Step 6.1.1 to clarify Attachment 1 is for information only.

THIS PROCEDURE IS ISSUED FOR INFORMATION ONLY AND
SHALL NOT BE USED FOR WORK OR DESIGN.

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1.0 PURPOSE

The Off-site Dose Calculation Manual (ODCM) contains the methodology and parameters used in the calculation of off-site doses due to radioactive gaseous and liquid effluents. Also, the ODCM contains the methodology for determining effluent monitoring instrumentation alarm/trip setpoints. Methods are described for assessing compliance with the Technical Requirements in the ODCM as they apply to 10 CFR Parts 20.1301 and 20.1302, 10 CFR Part 50, Appendix I, and 40 CFR 190.10a for liquid and gaseous effluents. Additionally, the ODCM contains the Technical Requirements which provide the Specifications, Applicabilities, Actions, and Surveillance Requirements.

2.0 SCOPE

This procedure functions as a manual that provides the basis for development of detailed implementing procedures that address dose calculations for liquid/gaseous releases and monitor setpoints. Additionally, this manual provides the Technical Requirements that govern releases of liquid and gaseous radioactive releases off-site.

3.0 REFERENCES/COMMITMENT DOCUMENTS

3.1 Commitment Documents

- 3.1.1 Code of Federal Regulations, Title 10, Chapter 1, Parts 20, 50.36a and Part 50, Appendix I
- 3.1.2 Rancho Seco Permanently Defueled Technical Specifications (PDTs)
- 3.1.3 EPA 40 CFR Parts 302, 355 Reporting Requirements
- 3.1.4 40 CFR 190, Environmental Radiation Protection Standards for Nuclear Power Plant Operations

3.2 Reference Documents

- 3.2.1 USNRC Regulatory Guide 1.109, Rev. 1, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, October 1977
- 3.2.2 W. C. Burke, et. al., Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants, NUREG-0133, USNRC:NRR, October 1978
- 3.2.3 ORNL, User's Manual for LADTAP II, NUREG/CR-1276, May 1980
- 3.2.4 D. L. Strange, et. al., LADTAP-II, Technical Reference and User Guide, NUREG/CR-4013, Pacific Northwest Laboratory, April 1986
- 3.2.5 Eckerman, K. F., et. al., User's Guide to GASPARD Code, NUREG-0597, USNRC:NRR, June 1980, in RSIC CCC-463

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- 3.2.6 USNRC Regulatory Guide 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors
- 3.2.7 USNRC Regulatory Guide 1.21, Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants
- 3.2.8 USNRC Regulatory Guide 4.1, Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants
- 3.2.9 REIMS Software Life Cycle Documents (Software Requirement Specification, Design Document, Acceptance Test Plan)
- 3.2.10 USNRC & Pacific Northwest Laboratory, TDMC Computer Code/Data Collections, XOQDOQ-82, Radiological Assessment Code System Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations
- 3.2.11 1992 Rancho Seco Land Use Census
- 3.2.12 RSNGS USAR Chapters 11.1-11.5
- 3.2.13 RSNGS P&ID Drawing M-563, M-551, M-552, M-503
- 3.2.14 Pacific Northwest Laboratory, XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations
- 3.2.15 Congel, F. J., Methods for Demonstrating LWR Compliance with the EPA Uranium Fuel Cycle Standard (40 CFR Part 190), NUREG-0543, USNRC:NRR, February 1980
- 3.2.16 USNRC Generic Letter, 89-01, Dated January 31, 1989.
- 3.2.17 Rancho Seco REMP Manual
- 3.2.18 Engineering Calculation Z-RDM-I0279, Interim On-site Storage (IOS) Building Effluent Radiation Monitor (R15106) Setpoint Determination
- 3.2.19 PDQ 92-063
- 3.2.20 RP.312.I.14, Occupational Radiation Exposure Limits and Extensions
- 3.2.21 DQ 96-0055, ABGLV flow rate measured above default value

4.0 DEFINITIONS

4.1 Member of the Public

Member of the Public means any individual except when that individual is receiving an occupational dose.

4.2 Occupational Dose

Occupational Dose means the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation and/or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the public.

4.3 Public Dose

Public Dose means the dose received by a Member of the Public from exposure to radiation and/or radioactive material released by a licensee, or to any other source of radiation under the control of a licensee. It does not include occupational dose or doses received from background radiation, as a patient from medical practices, or from voluntary participation in medical research programs.

4.4 Batch Release

A Liquid Batch Release for 10 CFR 50 Appendix I considerations is a transfer of a discrete volume of radioactive liquid from a RHUT to a retention basin. A Liquid Batch Release for 10 CFR 20 considerations is a transfer of a discrete volume of radioactive liquid from a retention basin to the Waste Water discharge canal (the Environmental Release Point).

A Gaseous Batch Release is the discharge of gaseous radioactive wastes of discrete volume. Batch releases for the gaseous pathway are no longer planned.

4.5 Continuous Release

A continuous radioactive gaseous release is the discharge of gaseous wastes of a nondiscrete volume from a system that may have an input flow during the release. These include the Auxiliary Building Stack (ABS), Auxiliary Building Grade Level Vent (ABGLV), and continuing Reactor Building purges.

Continuous radioactive liquid releases are not planned to be made from Rancho Seco Nuclear Generating Station (RSNGS).

4.6 Default Radionuclide Mix

A historical mixture of radionuclides that may be used to determine monitor setpoints.

4.7 Dilution Flow

The volume or volume rate of fluid (liquid or gas) which is added to a radiological release stream for the purpose of decreasing the instantaneous concentration of the stream.

4.8 Maximum Exposed (Hypothetical) Individual

The Maximum Exposed Individual is characterized as "maximum" with regard to food consumption, occupancy, and other usage or exposure pathway parameters in the vicinity of Rancho Seco that would represent an individual with habits greater than usually expected for the average of the population in general.

Maximum dose factor parameters will be determined using site specific data from the Land Use Census. If information needed to determine a parameter is not available, RG 1.109 parameters will be used. All dose factor parameters used are listed in Attachment 3.

4.9 RSNGS

Rancho Seco Nuclear Generating Station.

4.10 Site Boundaries

The Site Boundaries are defined by the drawings in Attachments 5 and 6.

4.11 Nuisance Pathways

- (1) Secondary system gaseous pathways where the calculated dose totals contribute less than 5% of the annual limits and do not need to be tracked for dose calculational purposes unless secondary activity reaches a predetermined Action Level.
- (2) Sources of trace levels of radioactivity in liquid effluents where the calculated dose totals contribute less than 1% of the annual limits and do not need to be tracked for dose calculational purposes. Trace levels are defined to be less than $1E-8$ $\mu\text{Ci/ml}$ for the nuclides typically released from RSNGS. Examples include the oily water separator, plant effluent inlet, and storm drains.

4.12 Unplanned Release

The unexpected release of radioactive materials to unrestricted areas in gaseous and liquid effluent. All unplanned releases shall be discussed in the Annual Radiological Effluent Release Report (ARERR) to the NRC.

4.13 Miscellaneous Release

Release pathways which are considered planned but are not defined explicitly with monitoring requirements in this procedure. These pathways contribute a relatively small percentage (<5%) to the annual dose limits but shall be tracked for effluent activity accounting and dose calculation purposes. Miscellaneous releases shall not be reported in the ARERR as abnormal or unplanned releases. The IOS Building is an example of a Miscellaneous Release.

4.14 Safety Factor (SF)

A number greater than unity used in calculations to introduce greater conservatism (larger margin of safety) to offset various uncertainties in instrumentation and methods. Safety factors are set by Radiation Protection/Chemistry Supervision based on either analysis or professional judgment. Unless otherwise specified, the default value is two (2).

4.15 Liquid Effluent Radwaste Treatment System (LERTS)

The Liquid Effluent Radwaste Treatment System is a system designed to reduce the quantity of radioactive materials in liquid effluents by collecting liquid effluent and providing processing for the purpose of reducing the total radioactivity prior to its release to the environment.

4.16 Ventilation Exhaust Treatment System (VETS)

The Ventilation Exhaust Treatment System is the Reactor Building Purge Exhaust Filtering System and Auxiliary and Spent Fuel Building Filter Systems. These systems are designed and installed to reduce radioactive material in exhaust gases through HEPA filters for the purpose of removing particulates from the gaseous exhaust stream prior to the release to the environment (such a system is not considered to have any effect on noble gas effluents). Engineered Safety Feature (ESF) atmospheric cleanup systems are not considered to be Ventilation Exhaust Treatment System components.

4.17 Instrument Surveillance

(1) Source Check

A source check is the qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.

(2) Channel Test

A channel test is the injection of an internal or external test signal into the channel to verify its proper response, including alarm and/or trip initiating action, where applicable.

(3) Instrument Channel Check

An instrument channel check is a verification of acceptable instrument performance by observation of its behavior and/or state; this verification includes comparison of output and/or state of independent channels measuring the same variable.

(4) Instrument Channel Calibration

An instrument channel calibration is a test, and adjustment (if necessary), to establish that the channel output responds with acceptable range and accuracy to known values of the parameter which the channel measures or an accurate simulation of these values. Calibration shall encompass the entire channel, including equipment actuation, alarm, or trip and shall be deemed to include the channel test.

4.18 Surveillance Intervals

The Surveillance Interval may be extended to a maximum of +25% to accommodate operations scheduling. The frequency notation (which follows the name of the Surveillance Interval in parenthesis) specified for the performance of Surveillance Requirements shall correspond to the Surveillance Intervals defined below.

- (1) Shift (S): A time period covering at least once per twelve (12) hours.
- (2) Daily (D): A time period spaced to occur at least once per twenty four (24) hours.
- (3) Weekly (W): A time period spaced to occur at least once per seven (7) days.
- (4) Monthly (M): A time period spaced to occur at least once per thirty one (31) days.
- (5) Quarterly (Q): A time period spaced to occur at least once per ninety two (92) days.
- (6) Semiannually (SA): A time period spaced to occur at least once per six (6) months.
- (7) Annually (A): A time period spaced to occur at least once per twelve (12) months.
- (8) Refueling Interval (R): A time period spaced to occur at least once per eighteen (18) months.
- (9) Each Release (P): This surveillance will be completed prior to each release.

4.19 Radiological Effluent Information Management System (REIMS)

The computer software and database that tracks the volume and activity of released radioactive effluents. In addition, the software provides the basis for the permitting process, calculates dose to man, and summarizes data for inclusion into the ARERR.

4.20 Operable/Operability

A component or system is Operable when it is capable of performing its intended function within the required range. The component or system shall be considered to have this capability when: (1) it satisfies the Specifications in Section 6.14, (2) it has been tested periodically in accordance with the Surveillance Requirement in Section 6.14 and has met its performance requirements, (3) the system has available its source of power, and (4) its required auxiliaries are maintained available and capable of performing their intended function.

5.0 RESPONSIBILITIES

5.1 Radiation Protection/Chemistry Superintendent

It is the responsibility of the RP/Chem Superintendent for the following:

- 1) ODCM Revisions and Reporting the Revisions in the Annual Radioactive Effluent Release Report (ARERR)
- 2) ARERR Preparation and Submittal
- 3) REIMS Database
- 4) LADTAP, GASPAP, and XOQDOQ Computer Program Verifications and Changes

5.2 PRC

The PRC is responsible for reviewing and accepting all changes to the ODCM with approval by the Plant Manager per Permanently Defueled Technical Specifications.

6.0 PROCEDURE

6.1 General Considerations

6.1.1 Liquid Effluent Pathways

10→←

Attachment 1 provides an information only simplified diagram of the liquid effluent produced by RSNGS. The liquid effluent discharge of RSNGS forms the headwaters of Clay Creek.

Dilution of the liquid effluent occurs off-site at the confluence of Clay and Hadselville Creeks, and of Hadselville and Laguna Creeks, and at the confluence of Laguna Creek and the Cosumnes River.

Planned radioactive liquid releases are directed through the A or B RHUTs to give reasonable assurance of compliance with 10 CFR 50 Appendix I prior to their discharge to the retention basins (North or South). Prior to discharge from the retention basins to the plant effluent (off-site), the discharge rate from the retention basins and the amount of dilution from Folsom South Canal are controlled to ensure compliance with the concentration requirements in 10 CFR 20.

6.1.2 Gaseous Effluent Pathways

Airborne radioactive material in the various rooms and systems at RSNGS is routed and discharged in airborne effluent as illustrated schematically in Attachment 2. The figure shows the functional arrangements of these streams, treatment and controls, radioactivity monitoring points, and effluent release points.

Potential release pathways other than those specified in Attachment 2 have been identified. These release pathways are classified as NUISANCE pathways and include the following:

- 1) Auxiliary Boiler Vents/Reliefs
- 2) Miscellaneous Secondary System Steam Discharges
- 3) Tank Atmospheric Vents

Past experience has shown that the above release pathways do not contribute to the dose totals because of the small quantities released and the low concentration of radioactive materials. Therefore, Action Levels may be established for the secondary system concentrations of radioactive material to trigger when the above routine gaseous effluent releases shall be evaluated for off-site dose impact. The Action Levels shall be based on levels that could contribute more than 5% to the most restrictive yearly dose limit. Action Levels shall be maintained through RSNGS procedures.

Unplanned releases shall be evaluated on a case by case basis.

The Interim On-site Storage (IOS) Building is a miscellaneous release.

6.1.3 Meteorological Data

The atmospheric dispersion (X/Q) and deposition (D/Q) factors used in calculations involving airborne effluent are conservative default values. The default X/Q value is $1.0E-4 \text{ sec/m}^3$, and the default D/Q value is $1.0E-6 \text{ m}^{-2}$. These factors should be used to determine monitor setpoints, assess compliance with the gaseous effluent requirements in Section 6.14, and calculate the gaseous effluent dose reported in the ARERR.

Attachment 4 contains dispersion and deposition factors calculated using actual meteorological data. These factors should not be used for dose calculations. They are presented for historical information only. The factors are based on a 10-year annual average of meteorological data taken from January 1978 to December 1987. The raw data was converted to X/Q and D/Q factors using the XOQDOQ computer program.

6.1.4 Boundaries

The Site Boundary for Gaseous Effluents as shown in Attachment 5 is for all calculations involving gaseous effluents. The Site Boundary for Liquid Effluents as shown in Attachment 6 is for all calculations involving liquid effluents. (Although the RHUTs are used as the dose accountability points for liquid effluents, the dose is considered to be received downstream of the boundary.)

6.1.5 40 CFR 190 Compliance

For the purposes of assessing compliance with 40 CFR 190, the MEMBER OF THE PUBLIC which received the most exposure may be determined using actual food consumption, actual occupancy rates, and dilution off-site from additional converging

streams (verses assumptions used for a HYPOTHETICAL MAXIMUM EXPOSED INDIVIDUAL based on Land Use Census data).

6.1.6 Computers vs. Manual Calculations

Computer systems such as REIMS should be used for calculations in order to minimize error and hasten the release process. However, in the event computers are not available for calculations, manual pre-release calculations should be done based on the most historically restrictive receptor.

6.2 Liquid Monitor Setpoints

The High alarm setpoint for the Retention Basin Effluent Discharge Monitor (R15017A) is based upon preventing the limits of the Specification in Step 6.14.2 from being exceeded. When the high alarm level is reached, any effluent discharges in progress are terminated or diverted to the Retention Basins.

A SAFETY FACTOR is included in the setpoint calculations to incorporate a margin of conservatism.

When a batch release is not occurring or the calculated setpoint is so low that it will cause spurious alarms, the monitor setpoint should be set close to background without causing spurious alarms or as determined by Radiation Protection/Chemistry Supervision.

The conversion factor and setpoint calculations should be performed based on the same radionuclide mix.

6.2.1 Conversion Factors for R15017A

Provided here is the methodology to determine the conversion factor of counts per minute to microcuries per cubic centimeter for the Retention Basin Effluent Discharge Monitor (R15017A). The conversion factor is based on the monitor's efficiency for each nuclide and the abundance of the nuclide. The mix of isotopes used may be based on the historical mix provided in Attachment 7, current mix in the batch release, or as determined by Radiation Protection/Chemistry Supervision. The mix fraction shall be based on gamma emitting isotopes only.

The following equation shall be used to determine the conversion factor for R15017A:

$$CF = \left[\sum_i (f_i \times E_i) \right]^{-1}$$

Where:

$$CF = \mu\text{Ci/cc per cpm}$$

f_i = Fraction of nuclide i to total activity of historical mix (Attachment 7) or batch mix

E_i = Detector efficiency for nuclide i (cpm/ μ Ci/cc) Attachment 8

6.2.2 High Alarm Setpoint for R15017A (μ Ci/ml)

$$\text{High Alarm } (\mu\text{Ci/ml}) = \frac{\sum_g C_g}{\text{SF} \times \sum_i \left(\frac{C_i}{\text{MEC}_i} \right)} + C_{\text{bkgd}}$$

Where:

C_g = The concentration of gamma-emitting nuclide g in μ Ci/ml.

C_i = The concentration of nuclide i in μ Ci/ml. This term includes non-gamma emitters

MEC_i = The MEC of radionuclide i from Appendix B to 10 CFR Part 20, Table 2, Column 2, in μ Ci/ml. The class with the most restrictive Effluent Concentration will be used for each isotope.

SF = A SAFETY FACTOR which may be applied to incorporate a margin of conservatism ($\text{SF} \geq 1$). (Default = 2)

C_{bkg} = The background reading of the monitor (μ Ci/ml).

6.3 Maximum Effluent Concentrations in Liquid Effluents

The Maximum Effluent Concentration Fraction is calculated to determine compliance with 10 CFR 20 requirements and the Specification in Step 6.14.2. Radioactive liquid effluent discharges normally originate in the RHUTs and are discharged into a retention basin. Samples are collected and analyzed from each retention basin prior to discharge to ensure that compliance with the Specification in Step 6.14.2 can be achieved.

In addition, calculations to determine the minimum dilution water flow rate and maximum retention basin discharge flow rate to ensure compliance are provided in this section. Any combination of minimum dilution flow rate and maximum discharge flow rate which satisfy the Specification is acceptable.

6.3.1 Maximum Effluent Concentration Fraction (MECF)

Compliance with the Specification in Step 6.14.2 is anticipated when the MECF is less than or equal to 1.0. The MECF is calculated as follows:

$$MECF = \left[\sum_i \left(\frac{C_i}{MEC_i} \right) \right] \times \frac{F_r}{F_c + F_r}$$

Where:

MECF = The calculated fraction of Maximum Effluent Concentration in the radioactive liquid effluent discharged beyond the Site Boundary for Liquid Effluents (see Attachment 6).

C_i = The concentration (prior to dilution) of radionuclide i in the batch of liquid effluent in $\mu\text{Ci/ml}$.

MEC_i = The MEC of radionuclide i from Appendix B to 10 CFR Part 20, Table 2, Column 2, in $\mu\text{Ci/ml}$. The class with the most restrictive Effluent Concentration will be used for each isotope.

F_r = Discharge flow rate; the flow rate of the radioactive liquid batch release from the retention basin to the Waste Water Discharge Canal (Plant Effluent) in gpm.

F_c = The total available dilution water (Plant Effluent) flow rate at the time of discharge of the radioactive liquid effluent in gpm.

NOTE

$SF \times \sum_i (C_i/MEC_i)$ must be ≥ 1.0

6.3.2 Minimum Dilution Water Flow Rate (F_{cmin})

The minimum dilution water (Plant Effluent) flow rate (F_{cmin}) is calculated as follows:

$$F_{cmin} = F_r \times \left[\left(SF \times \sum_i \left\{ \frac{C_i}{MEC_i} \right\} \right) - 1 \right]$$

Where:

F_r = A fixed effluent discharge flow (gpm) (as required by specific release restrictions).

SF = A factor which may be applied to incorporate a margin of conservatism ($SF \geq 1$).

NOTE

$SF \times \sum_i (C_i/MEC_i)$ must be ≥ 1

6.3.3 Maximum Effluent Discharge Flow Rate (F_{rmax})

The maximum effluent discharge flow rate (F_{rmax}) is calculated as follows:

$$F_{rmax} = \frac{F_c}{\left[SF \times \sum_i \left(\frac{C_i}{MEC_i} \right) \right] - 1}$$

Where:

F_c = A fixed dilution water flow rate (gpm) (as required by specific release restrictions).

6.4 Liquid Dose Calculations

This section provides the methodology to demonstrate compliance with the Specification in Step 6.14.3.

Site specific organ dose factors for liquid effluents have been determined for the MAXIMUM EXPOSED INDIVIDUAL and are listed in Attachment 9. Dose factors (A_{ijap}) were derived using equations and methods in Regulatory Guide 1.109, Rev. 1 and LADTAP. The dose factor parameters used are listed in Attachment 3. As previously stated, site specific parameters should be used based on the Land Use Census in lieu of the values provided in RG 1.109 whenever possible.

The exposure pathways included in the A_{ijap} are those identified by the Land Use Census. The pathways considered for inclusion are:

- fresh water fish
- fresh water invertebrate
- river shoreline deposits
- milk from cows that eat fresh or stored forage irrigated with Clay Creek water
- meat from cows that eat fresh or stored forage irrigated with Clay Creek water
- vegetation

6.4.1 Liquid Effluent Dose Equation

$$D_{aj} = \frac{\sum_i \sum_p (Q_i \times A_{ijap})}{F}$$

Where:

D_{aj} = Annual calculated dose (50 year dose commitment) to the organ (or total body) j of a maximally exposed individual of age group a (mrem/yr).

Q_i = Activity of isotope i released during the year (Ci/yr).

A_{ijap} = Site specific dose factor for an organ (or total body) j for a person of age group a via pathway p due to isotope i (mrem-ft³/Ci-sec).

F = Annual average discharge volumetric flow rate (effluent water plus dilution water) in ft³/sec.

Because the dose rate varies linearly with activity release rate, the dose for a shorter period of time (mrem) may be calculated by substituting the activity released (Ci) during that period for Q_i in the above equation. However, volumetric flow rates should not be averaged over a period less than a calendar quarter. More conservative flow rates are acceptable.

6.5 Liquid Dose Projections

31-day dose projections are calculated to show compliance with the Specification in Step 6.14.4. Quarterly and Annual dose projections are calculated in compliance with the Specification in Step 6.14.11.

The following equations shall be used:

31-Day Projection:

$$D_{p31} = 31 \times \frac{D_{Yr}}{t_{Yr}}$$

Quarterly Projection:

$$D_{pQtr} = 91.3 \times \frac{D_{Qtr}}{t_{Qtr}}$$

Yearly Projection:

$$D_{pYr} = 365.25 \times \frac{D_{Yr}}{t_{Yr}}$$

Where:

D_{p31} = 31-day dose projection.

D_{Yr} = Cumulative annual dose to date.

t_{Yr} = Number of days into the year.

D_{pQtr} = Quarterly dose projection.

D_{Qtr} = Cumulative quarterly dose to date.

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t_{Qr} = Number of days into the quarter.

D_{pYr} = Annual dose projection.

6.6 Gaseous Monitor Setpoints

This step does not apply to the IOS Building vent monitor (R15106). The calculations used to determine the setpoints for this monitor are contained in Reference 3.2.18.

The Gaseous Effluent Radiation Monitors have the capability to monitor gaseous effluents over three general ranges (high, middle and low) using four channels. In the permanently defueled mode, the middle and high ranges (Channels 2 and 3) are no longer necessary, and are no longer used or maintained. Channels 1 and 4 both operate in the low range and are the monitor channels which are considered in this procedure.

The Specification in Step 6.14.5 states that the gaseous effluent monitors shall have their alarm/trip setpoints set to ensure the limits of the Specification in Step 6.14.6 are not exceeded. The conservative default atmospheric dispersion (X/Q) factor from Step 6.1.3 is used. Compliance with the dose rate limits for noble gases specified in Step 6.14.6 is demonstrated by setting each gaseous effluent monitor alarm/trip setpoint so that an alarm/trip will occur at or before the dose rate limit is reached.

A SAFETY FACTOR is included in the setpoint calculations to incorporate a margin of conservatism.

Maximum design flow rates for each release point will be used to calculate setpoints.

6.6.1 Conversion Factors for R15044, R15045, and R15546A

Provided here is the methodology to determine the conversion factor of counts per minute to microcuries per cubic centimeter for the Auxiliary Building Stack Monitor (R15045), Reactor Building Stack Monitor (R15044), and the Auxiliary Building Grade Level Vent Monitor (R15546A). The conversion factor is based on the monitor's efficiency of detection for each nuclide and the mix of the nuclide. The mix of isotopes used should be based on Kr-85, but may be based on the current mix in the continuous release, or as determined by Radiation Protection/Chemistry Supervision. The mix used for setpoint calculations and conversion factor calculations should be the same.

The following equation shall be used to determine the conversion factor for R15044, R15045 and R15546A:

$$CF = \left[\sum_i (f_i \times E_i) \right]^{-1}$$

Where:

CF = μ Ci/cc per cpm

f_i = Fraction of nuclide *i* to total activity of the mix used

E_i = Detector efficiency for nuclide *i*, in cpm per μ Ci/cc, Attachment 10

6.6.2 Gaseous Effluent Flow Rates

Flow rates used in routine gaseous effluent calculations for the pathways listed below are conservative default values. These flow rates should be used to determine monitor setpoints, assess compliance with the gaseous effluent requirements in Section 6.14, and calculate the gaseous effluent dose reported in the ARERR.

Gaseous effluent release points and maximum design flow rates used at RSNGS are as follows:

Reactor Building Stack	74,000 CFM
Auxiliary Building Stack	90,000 CFM
Auxiliary Building Grade Level Vent	31,000 CFM
Interim On-site Storage Building Ventilation*	8,050 CFM

* The Interim On-site Storage (IOS) Building is not subject to continuous discharges of radioactivity. Because of the infrequency of a radioactive release, assessment will be done on each release according to administrative procedures.

6.6.3 Determination of Partition Factor (P_v)

The Specification in Step 6.14.6 applies to the entire site, not just one vent or monitor. Consequently, the total release rate must be partitioned among the three major vents (ABS, ABGLV, RBS). For routine operations, the partition factor may be calculated by assuming that the effluent concentration is the same for all pathways and using a ratio of flow rates. The total volume flow rate for all three vents is 195,000 CFM. Therefore:

$$P_{rbs} = \frac{74,000 \text{ CFM}}{195,000 \text{ CFM}} = 0.38$$

10→

$$P_{abs} = \frac{90,000 \text{ CFM}}{195,000 \text{ CFM}} = 0.46$$

$$P_{abglv} = \frac{31,000 \text{ CFM}}{195,000 \text{ CFM}} = 0.16$$

←

Radiation Protection/Chemistry Supervision may elect to use a different set of partition factors based on plant conditions. However, the sum of all the partition factors for the site must be less than or equal to unity (1).

6.6.4 Channel 4 Noble Gas Setpoint for R15044, R15045, and R15546A in $\mu\text{Ci}/\text{sec}$

$$M_v = \frac{3000 \times P_v \times \sum_i C_i}{SF \times (X/Q) \times \sum_i [C_i \times (L_i + 1.1 \times M_i)]} + \text{Bkgd}$$

Where:

M_v = Monitor setpoint for vent v (i.e., RBS, ABS, or ABGLV) in $\mu\text{Ci}/\text{sec}$

3000 = Step 6.14.6 Specification limit for skin dose rate in mrem/yr

P_v = Partition factor for vent v , dimensionless, which distributes the total site release rate among the three vents

C_i = Concentration of isotope i in gaseous effluent in $\mu\text{Ci}/\text{cc}$. The mix of isotopes used may be based on Kr-85, the current mix, or as determined by Radiation Protection/Chemistry Supervision.

SF = Safety Factor, dimensionless, ($SF \geq 1$)

X/Q = A conservative default atmospheric dispersion factor for a ground level release to a sector at or beyond the Site Boundary for Gaseous Effluents in sec/m^3 . The default value in Step 6.1.3 will be used.

L_i = A factor converting gamma radiation from noble gas radionuclide i to skin dose ($\text{mrem}\text{-m}^3/\mu\text{Ci}\text{-yr}$). See Attachment 11.

M_i = A factor converting gamma radiation from noble gas radionuclide i to air dose ($\text{mrad}\text{-m}^3/\mu\text{Ci}\text{-yr}$). See Attachment 11.

Bkgd = Monitor background reading in $\mu\text{Ci}/\text{sec}$

6.6.5 Channel 1 Noble Gas Setpoint for R15044, R15045, and R15546A in $\mu\text{Ci/cc}$

$$MC_v = \frac{MR_v}{472 \times F_v} + \text{Bkgd}$$

Where:

MC_v = Monitor setpoint for vent v based on concentration in $\mu\text{Ci/cc}$

MR_v = Monitor setpoint for vent v based on release rate in $\mu\text{Ci/sec}$ excluding the background term. That is, $M_v - \text{Bkgd}$

F_v = Maximum design volumetric flow rate for vent v in CFM as indicated in Step 6.6.2.

472 = $28317 \text{ ml/ft}^3 * 1 \text{ min/60 sec}$

Bkgd = Monitor background reading in $\mu\text{Ci/cc}$

NOTE

Channel 1 does not cause any automatic terminations or audible alarms.

6.7 Maximum Effluent Concentrations (MECs) in Gaseous Effluents

In order to demonstrate compliance with 10 CFR 20.1301, which requires that the total MEC fraction not exceed 1 when averaged over an entire year, the calculation is included in the Annual Radioactive Effluent Release Report. In addition, a four hour reporting requirement exists when the total MEC fraction exceeds 20 when averaged over one hour per 10 CFR 50.72. The following provides guidance on how to perform this calculation.

Maximum Effluent Concentration Fraction (MECF) Equation

$$\text{MECF} = \sum_i \left(\frac{C_i}{\text{MEC}_i} \right) \times F \times 4.72\text{E}-4 \times X/Q \times \text{TR}$$

Where:

C_i = The concentration of nuclide i in mCi/cc .

F = Maximum design volumetric flow rate in CFM as indicated in 6.6.2.

X/Q = A conservative default atmospheric dispersion factor for a ground level release to a sector at or beyond the Site Boundary for Gaseous Effluents in sec/m^3 . The default value in Step 6.1.3 will be used.

MEC_i = The MEC for nuclide i from Appendix B to 10 CFR Part 20, Table 2, Column 2 ($\mu\text{Ci/cc}$). The class with the most restrictive Effluent Concentration will be used for each isotope.

TR = If the time of release is less than one hour, then this value is the duration of the transient in minutes divided by sixty. Otherwise, the Time Ratio (TR) is one. Dimensionless.

$4.72\text{E-}4$ = The conversion factor in $\text{min} \cdot \text{m}^3 / \text{sec} \cdot \text{ft}^3$.

6.8 Dose Rate Calculations

Compliance with the dose rate limits for noble gases in the Specification in Step 6.14.6 is demonstrated by setting each gaseous effluent monitor alarm setpoint so that an alarm will occur at or before either dose rate limit Specification in Step 6.14.6 is reached. In addition, the Specification in Step 6.14.6 provides a maximum limit on organ dose rate equivalent beyond the Site Boundary for Gaseous Effluents from tritium and all radioactive materials in particulate form with half-lives greater than 8 days. Compliance is determined by calculating the organ dose rate for the MAXIMUM EXPOSED INDIVIDUAL for the inhalation pathway only.

The dose rate due to noble gas is evaluated as follows:

Total Body:

$$\dot{D}_{tb} = (X/Q) \times \sum_v \sum_i (Q_{vi} \times K_i)$$

Skin:

$$\dot{D}_s = (X/Q) \times \sum_v \sum_i [Q_{vi} \times (L_i + 1.1M_i)]$$

Where:

D_{tb} = The total body dose rate from noble gases (mrem/yr)

D_s = The skin dose rate from noble gases (mrem/yr)

X/Q = A conservative default atmospheric dispersion factor for a ground level release to a sector at or beyond the Site Boundary for Gaseous Effluents in sec/m^3 . The default value in Step 6.1.3 will be used.

Q_{vi} = The release rate of noble gas radionuclide i from effluent vent v during the time of the release ($\mu\text{Ci}/\text{sec}$)

K_i = A factor converting time integrated, ground-level concentration of noble gas radionuclide i to total body dose from its gamma radiation (mrem- $\text{m}^3/\mu\text{Ci-yr}$). See Attachment 11.

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- L_i = A factor converting gamma radiation from noble gas radionuclide i to skin dose (mrem-m³/μCi-yr). See Attachment 11.
- M_i = A factor converting gamma radiation from noble gas radionuclide i to air dose (mrad-m³/μCi-yr). See Attachment 11.
- 1.1 = A factor converting air dose from gamma radiation to skin dose equivalent (mrem/mrad)

The organ dose rate resulting from inhalation is calculated with the equation:

Organ:

$$\dot{D}O_{aj} = (X/Q) \times \sum_v \sum_i (Q_{vi} \times R_{aji})$$

Where:

- DO_{aj} = The dose commitment rate to organ j of a person in age group a (mrem/yr)
- R_{aji} = The factor to convert air concentration of radionuclide i to organ j dose commitment rate of a person in age group a exposed by inhalation (mrem-m³/μCi-yr). See Attachment 12.
- Q_{vi} = The release rate of radionuclide i (not including Noble Gas nuclides), via effluent vent v during the time of the release (μCi/sec)

Exposure to dose rate factors, R_{aji} , for inhalation are derived by using equation 13 in RG 1.109, Rev. 1. Tables E-5, E-7, E-8, E-9, and E-10 are assumed to represent the Maximum Exposed Individual in the equation to derive R_{aji} .

6.9 Air Dose Calculations

The Surveillance Requirement in Step 6.14.7 requires cumulative dose to air from radioactive effluent noble gases to be determined in order to assess compliance with the Specification in Step 6.14.7. The air dose is evaluated in the sector of the maximum exposure at or beyond the Site Boundary for Gaseous Effluent.

Air dose from noble gas gamma radiation is calculated cumulatively with the equation:

$$D_g = 3.17E-8 \times \sum_v \left[(X/Q) \times \sum_i \sum_n (Q_{vni} \times M_i) \right]$$

Air dose from noble gas beta radiation is calculated cumulatively with the equation:

$$D_b = 3.17E-8 \times \sum_v \left[(X/Q) \times \sum_i \sum_n (Q_{vni} \times N_i) \right]$$

Where:

- D_g = The noble gas gamma dose to air (mrad)
- D_b = The noble gas beta dose to air (mrad)
- X/Q = A conservative default atmospheric dispersion factor for a ground level release to a sector at or beyond the Site Boundary for Gaseous Effluents in sec/m^3 . The default value in Step 6.1.3 will be used.
- M_i = A factor converting ground-level concentration to gamma radiation from noble gas radionuclide i to air dose ($\text{mrad}\cdot\text{m}^3/\mu\text{Ci}\cdot\text{yr}$)
- N_i = A factor converting ground-level concentration to beta radiation from noble gas radionuclide i to air dose ($\text{mrad}\cdot\text{m}^3/\mu\text{Ci}\cdot\text{yr}$)
- Q_{vni} = The quantity of each noble gas radionuclide i in batch n released via effluent stream v (μCi)
- $3.17\text{E}-8 = 1 \text{ yr}/3.156\text{E}+7 \text{ sec}$

Factors M_i and N_i are 10^6 pCi/ μCi times the values in RG 1.109, Rev. 1, Table B-1, Columns 4 and 2, respectively. The computer codes GASPARG and REIMS may be used to perform these calculations.

6.10 Organ Dose Calculations for Gaseous Effluents

The Surveillance Requirement in Step 6.14.8 requires the radiation dose or dose commitment to the Maximum Exposed (Hypothetical) Individual accumulated from exposure to tritium and radioactive materials in particulate form having half-lives greater than 8.0 days, that originate in effluent air, be determined at least every month. The radiation dose or dose commitment accumulated during a calendar quarter and a year may not exceed values stated in the Specification in Step 6.14.8.

A person may be exposed to effluent radioactive material of this type in air by inhalation or indirectly via environmental pathways that involve deposition onto vegetation and the ground. The exposure pathways evaluated will include the following:

p	Exposure Pathway
1	Air - inhalation
2	Deposition onto ground - irradiation
3	Deposition onto vegetation - ingestion
4	Deposition onto forage - cow - milk - ingestion
5	Deposition onto forage - meat animal - meat - ingestion
6	Deposition onto forage - goat - milk - ingestion

The equation used to calculate the dose commitment to the Maximum Exposed (Hypothetical) Individual from radionuclides other than tritium is:

$$D_{aj} = \sum_{p=1} \left[(X/Q)_p \times \sum_v \sum_i (Q_{vi} \times R_{ajip}) \right] + \sum_{p=2}^6 \left[(D/Q)_p \times \sum_v \sum_i (Q_{vi} \times R_{ajip}) \right]$$

Where:

$p = 1$, i.e., air-inhalation, in the first term, and $p = 2, 3, 4, 5,$ and 6 in the second term of the equation

i excludes H-3

D_{aj} = The dose commitment to organ j of a person in age group a (mrem)

Q_{vi} = The quantity of each radionuclide i , in particulate form having a half-life greater than 8.0 days, in air discharged via effluent stream v (μCi)

X/Q = A conservative default atmospheric dispersion factor for a ground level release to a sector at or beyond the Site Boundary for Gaseous Effluents in sec/m^3 . The default value in Step 6.1.3 will be used.

D/Q = A conservative default deposition factor. A Factor converting a ground-level or building wake discharge in air to deposition on land (m^2). The D/Q value in Step 6.1.3 will be used.

R_{ajip} = A factor converting time integrated concentration of radionuclide i in air or deposited on vegetation and/or ground to radiation dose commitment to organ j , including total body, of a person in age group a who is exposed via pathway p .

When $p=1$, representing air-inhalation, R_{ajip} has units of $\text{mrem}\cdot\text{m}^3/\mu\text{Ci}\cdot\text{yr}$. When $p=2,3,4,5$ or 6 in the second term of the equation above, representing pathways involving deposition, R_{ajip} has units of $\text{mrem}\cdot\text{m}^2\cdot\text{sec}/\text{yr}\cdot\mu\text{Ci}$. When the radionuclide is H-3, R_{ajip} has units of $\text{mrem}\cdot\text{m}^3/\mu\text{Ci}\cdot\text{yr}$.

Tritium is assumed not to deposit onto vegetation or the ground. Hence, the concentration in vegetation is assumed to be related to the local atmospheric concentration as described in RG 1.109, Rev. 1, Appendix C. The dose commitment to the Maximum Exposed (Hypothetical) Individual from tritium in gaseous effluent is calculated with the equation:

$$D_{aj} = 3.17E-8 \times \sum_p \left[(X/Q)_p \times \sum_v (Q_{vi} \times R_{ajip}) \right]$$

Where:

p = 1, 3, 4, 5, and 6

i includes H-3 only

X/Q = A conservative default atmospheric dispersion factor for a ground level release to a sector at or beyond the Site Boundary for Gaseous Effluents in sec/m³. The default value in Step 6.1.3 will be used.

3.17E-8 = years/sec

Other terms as defined above.

Dose factors R_{ajip} for RSNGS are derived using the equations and methods in RG 1.109, Rev. 1, Appendix C. Values of parameters in RG 1.109, Rev. 1, Table E-5 are assumed to represent the Maximum Exposed (Hypothetical) Individual unless Land Use Census data justify a different value. Any different values from default values will be justified and added as a table to the ODCM. Values of other parameters recommended in RG 1.109, Rev. 1, including those recommended in the absence of site-specific data, are used in the equations to derive the dose factors. (GASPAR or REIMS may be used to perform the calculations.)

6.11 Gas Dose Projections

31-Day Dose projections are calculated to show compliance with Step 6.14.9. Quarterly and Annual dose projections are calculated in compliance with the Specification in Step 6.14.11. The dose projection equations are the same as used for liquid per Step 6.5.

6.12 Fuel Cycle Dose

If a calculated dose exceeds twice the limit of the Specification in Step 6.14.3, 6.14.7, 6.14.8, or a level in Table 3 of the REMP Manual is exceeded, an assessment of compliance with the Specification in Step 6.14.10 must be made.

Liquid dose calculations shall be made using the general methodology of Step 6.4. Gas dose calculations shall be made using the general methodology of Steps 6.9 and 6.10. These methodologies are to be used as a guide and strict adherence is not required because the Fuel Cycle Dose Calculation is done to determine the actual dose received, not a hypothetical maximum. Therefore, parameters such as dilution beyond the site boundary and residential shielding may be factored into the calculation.

The total body and organ doses shall be the result of summing the individual contributions from liquid, gas, and direct radiation sources for the affected Member of the Public.

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Irradiation, i.e., exposure to an external source of radiation, directly from the RSNGS normally will be evaluated with the aid of environmental dosimetry such as thermoluminescent dosimetry (TLD) or portable ion chamber (PIC) measurements.

6.13 EPA Reporting Requirements

If a calculated dose exceeds the Specification limit of Step 6.14.2, 6.14.3, 6.14.6, 6.14.7, or 6.14.8, an assessment of compliance with 40 CFR Parts 302 and 355, Reportable Quantity Adjustment - Radionuclides, must be made.

This involves determining the maximum quantity of radionuclides released in a 24 hour period and comparing the quantities to the values listed in 40 CFR 302 Appendix B. The "sum of the ratios" method shall be used to determine compliance. If the "sum of the ratios" is greater than one, the National Response Center shall be notified.

Since Rancho Seco's systems and procedures are set up to normally operate within the above limits, this condition is not expected to occur, therefore, specific implementation procedures to determine compliance are not required.

6.14 Technical Requirements

6.14.1 Liquid Effluent Monitoring Instrumentation

Specifications:

The radioactive liquid effluent monitoring instrumentation channels shown in Attachment 13 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Step 6.14.2 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with Step 6.2.

Applicability:

During releases via the retention basin effluent discharge.

Action:

- 1) With a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than a value which will ensure that the limits of Step 6.14.2 are met, immediately suspend the release of radioactive effluents monitored by the affected channel, or declare the channel inoperable, or change the setpoint so it is acceptably conservative.
- 2) With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the Action shown on Attachment 13.

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Surveillance Requirements:

- 1) The maximum setpoint shall be determined in accordance with methodology as described in Step 6.2 and shall be recorded on the release permits.
- 2) Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the INSTRUMENT CHANNEL CHECK, SOURCE CHECK, INSTRUMENT CHANNEL CALIBRATION, AND CHANNEL TEST at the frequencies shown in Attachment 14.
- 3) Records shall be maintained in accordance with the Process Standards of all radioactive liquid effluent monitoring instrumentation alarm/trip setpoints. Maximum setpoints and calculations shall be available for review to ensure that the limits of Step 6.14.2 are met.

Bases:

During continuing operations leading to decontamination and decommissioning of the site, radioactively contaminated water will be processed, as necessary, to remove the activity according to the Process Control Program (PCP). After being processed as necessary, the water may be transferred to the 'A' and 'B' Regenerant Holdup Tanks (RHUTs). Pathways for water to reach the RHUTs are shown in Attachment 1, Liquid Effluent Flow Diagram. Administrative controls provide reasonable assurance that any waste water that is radioactive is processed through the RHUTs prior to their release.

Water which is in the 'A' and 'B' RHUTs is transferred to the North or South Retention Basin. The water in a Retention Basin is released off-site as a batch release. These releases are monitored by the Retention Basin Effluent Discharge Monitor.

Radioactive liquid effluent monitoring instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of radioactive liquid effluents. The alarm/trip setpoints for these instruments shall be calculated in accordance with the methodology contained in this manual to ensure that the alarm/trip will occur prior to exceeding the limits of Step 6.14.2. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

6.14.2 Maximum Effluent Concentrations in Liquid Effluents

Specifications:

The concentration of radioactive material released in liquid effluents at any time beyond the Site Boundary for Liquid Effluents (see Attachment 6) shall be limited to the concentrations specified in Appendix B to 10 CFR Part 20, Table 2, Column 2.

Applicability:

This is applicable at all times.

Action:

With the concentration of radioactive material released from the site to areas beyond the Site Boundary for Liquid Effluents exceeding the above Specifications, immediately restore concentration within the required limits and report the event in the next Annual Radioactive Effluent Release Report.

Surveillance Requirements:

The concentration of radioactive material at any time in liquid effluents released from the site to areas beyond the Site Boundary for Liquid Effluents shall be continuously monitored in accordance with Attachment 13.

The liquid effluent continuous monitor having provisions for automatic termination of liquid releases, as listed in Attachment 13, shall be used to limit the concentration of radioactive material released at any time from the site to areas beyond the Site Boundary for Liquid Effluents to the limits given in the above Specifications.

The radioactivity concentration of each Retention Basin to be discharged shall be determined prior to release by sampling and analysis in accordance with Attachment 15, Item A. The results of Retention Basin pre-release sample analyses shall be used with the calculational methods described in Step 6.3 to ensure that the concentration at the point of release is within the limits of the above Specification.

Bases:

This Specification is provided to ensure that the concentration of radioactive materials released in liquid waste effluents from the site to areas beyond the Site Boundary For Liquid Effluents (see Attachment 6) will be less than the concentration levels specified in Appendix B to 10 CFR Part 20, Table 2, Column 2. This limitation provides additional assurance that the levels of radioactive materials in bodies of water outside the site will result in exposures within the limits of 10 CFR Part 20.1301 to a MEMBER OF THE PUBLIC.

There are no continuous releases of radioactive material in liquid effluents from the plant. All radioactive liquid effluent releases from the plant are by batch method.

6.14.3 Liquid Dose Calculations

Specifications:

The dose or dose commitment to a MAXIMUM EXPOSED (HYPOTHETICAL) INDIVIDUAL from radioactive materials in liquid effluents released beyond the Site Boundary for Liquid Effluents (see Attachment 6) shall be limited to:

1) Less than or equal to 1.5 mrem to the total body and to less than or equal to 5.0 mrem to any organ during any calendar quarter; and,

2) Less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ during any calendar year.

Applicability:

At all times.

Action:

With the calculated dose or dose commitment from the release of radioactive materials in liquid effluents exceeding any of the above Specifications, prepare and submit to the Commission within 30 days a Special Report. This Report will identify the cause(s) for exceeding the limit(s) and define the corrective actions to be taken to reduce the releases of radioactive material in liquid effluents and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above Specifications.

Surveillance Requirements:

Cumulative dose assessments associated with the release of radioactive liquid effluent shall be determined by sampling and analysis in accordance with Attachment 15, Item B or Item C, and calculations performed in accordance with the methodology described in Step 6.4 at the following frequencies:

- 1) Prior to the initiation of a release of radioactive liquid effluent from the A or B RHUT; and,
- 2) Upon verification of monthly composite analysis results for radioactive liquid effluent released from the A and B RHUTs.

A dose tracking system and administrative dose limits shall be established and maintained. With the 31-day dose projection in excess of the limits in Step 6.14.4, adjust liquid effluent operating parameters to give reasonable assurance of compliance with the dose limits of this Specification (10 CFR 50, Appendix I dose guidelines) and maintain radioactive liquid releases as low as is reasonably achievable.

Bases:

ODCM Step 6.14.3 is provided to implement the requirements of Sections II.A, III.A, and IV.A of Appendix I, 10 CFR Part 50. This step implements the guides set forth in Section II.A of 10 CFR 50, Appendix I. The Action statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of 10 CFR 50, Appendix I to assure that the releases of radioactive material in liquid effluents will be kept "as low as is reasonably achievable." The dose calculation methodology in this manual implement the requirements in Section III.A of 10 CFR 50, Appendix I that conformance with the guides of 10 CFR 50, Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The equations specified in this

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manual for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977. There is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in finished drinking water that are in excess of the requirements of 40 CFR 141.

The Lower Limits of Detection established in Attachment 15, Item B are based on an estimated maximum annual effluent outflow of 2 million gallons with a minimum annual average flow rate in the plant effluent stream of 6,000 gallons per minute. The RHUT pre-release and monthly composite Lower Limits of Detection equate to an off-site dose of less than 10 percent of the 10 CFR 50, Appendix I guidelines. These Lower Limits of Detection, along with the dose tracking system, give reasonable assurance that the dose limits prescribed in ODCM Step 6.14.3 (the 10 CFR 50, Appendix I dose guidelines) will be met.

6.14.4 Liquid Effluent Radwaste Treatment

Specifications:

The LIQUID EFFLUENT RADWASTE TREATMENT SYSTEM shall be OPERABLE. The appropriate portions of the system shall be used to reduce the quantity of radioactive materials in liquid effluents prior to their discharge when projected doses due to the liquid effluent beyond the Site Boundary for Liquid Effluents (see Attachment 6), when averaged over 31 days, would exceed 0.25 mrem to the total body or 0.83 mrem to any organ (8.33% of the 10 CFR 50, Appendix I annual guidelines).

Applicability:

At all times.

Action:

With the LIQUID EFFLUENT RADWASTE TREATMENT SYSTEM inoperable for more than 31 days or with radioactive liquid waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days a Special Report which includes the following information:

- 1) Explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability; and,

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- 2) Action(s) taken to restore the inoperable equipment to OPERABLE status; and,
- 3) Summary description of action(s) taken to prevent a recurrence.

Surveillance Requirements:

Doses due to liquid releases to areas beyond the Site Boundary for Liquid Effluents shall be projected prior to each RHUT release in accordance with the methodology described in Step 6.5 when LIQUID EFFLUENT RADWASTE TREATMENT SYSTEMS are not being fully utilized. The installed LIQUID EFFLUENT RADWASTE TREATMENT SYSTEM shall be considered OPERABLE by meeting the Specifications in Steps 6.14.2 and 6.14.3.

Bases:

The OPERABILITY of the LIQUID EFFLUENT RADWASTE TREATMENT SYSTEM ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment. The requirement that the appropriate portions of this system be used, when specified, provides reasonable assurance that the releases of radioactive materials in liquid effluents are maintained "as low as is reasonably achievable."

This specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR 50. The specified limits governing the use of appropriate portions of the LIQUID EFFLUENT RADWASTE TREATMENT SYSTEM are the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

6.14.5 Gaseous Effluent Monitoring Instrumentation

Specifications:

The radioactive gaseous effluent monitoring instrumentation channels shown in Attachment 16 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Step 6.14.6 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the methodology contained in this procedure. Continuous samples of the gaseous effluent for radioactive particulate material shall be taken as indicated in Attachment 16.

Applicability:

This is applicable at all times.

Action:

- 1) With a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than a value which will ensure that the limits of Step 6.14.6 are met, immediately suspend the release of radioactive gaseous effluents monitored by the affected channel, or declare the channel inoperable, or change the setpoint so it is acceptably conservative.

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2) With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE, take the Action shown in Attachment 16. Exert best efforts to return the instrument to OPERABLE status within 30 days and if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.

Surveillance Requirements:

The maximum setpoints shall be determined by procedures implementing the methodology presented in this procedure and shall be recorded on release permits.

Each gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the INSTRUMENT CHANNEL CHECK, SOURCE CHECK, INSTRUMENT CHANNEL CALIBRATION, AND CHANNEL TEST at the frequencies shown in Attachment 17.

Records shall be maintained in accordance with the Process Standards of all radioactive gaseous effluent monitoring instrument alarm/trip setpoints. Maximum setpoints and setpoint calculations shall be available for review to ensure that the limits of Step 6.14.6 are met.

Bases:

The radioactive gaseous effluent monitoring instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of radioactive gaseous effluents. The alarm/trip setpoints for these instruments, except for the Interim On-site Storage (IOS) Building vent monitor (R15106), shall be calculated in accordance with the methodology contained in this manual to ensure that the alarm/trip will occur prior to exceeding the limits of ODCM Step 6.14.6. The monitor setpoints for R15106 are set statistically high enough above background to prevent spurious alarms, yet stop potential radioactive releases when detected (Reference 3.2.18). The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

The IOS Building has a ventilation system which provides protection against radioactive airborne releases. Operation of the ventilation system produces a negative pressure in the building. During operation, the ventilation exhaust flow is continuously monitored for particulate activity. Upon an alarm, the exhaust duct closes and the supply and exhaust fans stop, minimizing any chance of an airborne release. Although no planned airborne radioactive releases are anticipated from this pathway, the ventilation exhaust monitor is included in Attachment 16.

Fuel Storage Building exhaust is directed to the Auxiliary Building Stack where the exhaust is filtered and monitored for any activity prior to release to the atmosphere.

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6.14.6 Gaseous Dose Rates

Specifications:

The dose rate due to radioactive materials released in gaseous effluents from the site to areas at or beyond the Site Boundary for Gaseous Effluents (see Attachment 5) shall be limited to the following values:

- 1) The dose rate limit for noble gases shall be less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin; and,
- 2) The dose rate limit for tritium and for all radioactive materials in particulate form with half-lives greater than 8 days shall be less than or equal to 1500 mrem/yr to any organ.

Applicability:

This is applicable at all times.

Action:

With the dose rate(s) exceeding the above limits, immediately restore the release rate to within the limit(s) specified and report the event in the next Annual Radioactive Effluent Release Report.

Surveillance Requirements:

The noble gas effluent continuous monitors, as listed in Attachment 16, shall use monitor setpoints to limit the dose rate in unrestricted areas to the limits in the above Specification.

In the event a noble gas effluent exceeds the setpoint of its monitor, an assessment of compliance with the Specification above shall be made in accordance with the methodology contained in this manual.

The release rate of radioactive materials, other than noble gases, in gaseous effluents shall be determined by obtaining representative samples and performing analyses in accordance with the sampling analyses program specified in Attachment 18.

The dose rate due to tritium and all radioactive material in particulate form with half-lives greater than 8 days, released in gaseous effluents, shall be determined to be within the limits of this Specification by using the results of the sampling and analysis program specified in Attachment 18 and the methodology described in Step 6.8.

Bases:

Step 6.14.6 is provided to ensure that the dose rate from gaseous effluents due to immersion or inhalation at any time at the Site Boundary for Gaseous Effluents (see Attachment 5) will be within the annual dose limits of 10 CFR Part 20 for MEMBERS OF THE PUBLIC. The annual dose limits are the doses associated with the concentrations of Appendix B to 10

CFR Part 20, Table 2, Column 1. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of an individual at or beyond the Site Boundary for Gaseous Effluents to annual average concentrations exceeding the dose rate equivalent, on which the limits specified in Appendix B, Table 2 of 10 CFR Part 20 were derived. For individuals who may at times be within the Site Boundary for Gaseous Effluents, the occupancy of the individual will be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the boundary. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to an individual at or beyond the Site Boundary for Gaseous Effluents to less than or equal to 500 mrem/yr to the total body or to less than or equal to 3,000 mrem/yr to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a person of any age group via the inhalation pathway to less than or equal to 1,500 mrem/yr.

6.14.7 Gamma and Beta Air Dose

Specifications:

The air dose due to noble gases released in gaseous effluents to areas at or beyond the Site Boundary for Gaseous Effluents (see Attachment 5) shall be limited to the following:

- 1) During any calendar quarter, to less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation; and,
- 2) During any calendar year, to less than or equal to 10 mrad for gamma radiation and to less than or equal to 20 mrad for beta radiation.

Applicability:

This is applicable at all times.

Action:

With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days a Special Report. This Report will identify the cause(s) for exceeding the limit(s) and define the corrective action(s) taken to reduce the release of radioactive noble gases on gaseous effluents, and the corrective action(s) to be taken to assure that subsequent releases will be in compliance with the above limits.

Surveillance Requirements:

Cumulative air dose contributions for the current calendar quarter and calendar year shall be determined in accordance with the methodology in Step 6.9 at least monthly.

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Bases:

Step 6.14.7 is provided to implement the requirements of Sections II.B, III.A, and IV.A of Appendix I, 10 CFR Part 50. This step implements the guides set forth in Section II.B of Appendix I. The Action statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low as is reasonably achievable." The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of an individual through the appropriate pathways is unlikely to be substantially underestimated. The dose calculations established in this manual for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. The equations in this manual provide for determining that the air doses at the Site Boundary for Gaseous Effluents (see Attachment 5) are based upon the historical average atmospheric conditions.

6.14.8 Gaseous Organ Dose

Specifications:

The dose or dose commitment to a **MAXIMUM EXPOSED (HYPOTHETICAL) INDIVIDUAL** from tritium and radioactive materials in particulate form with half-lives greater than eight days in gaseous effluents released to areas at or beyond the Site Boundary for Gaseous Effluents (see Attachment 5) shall be limited to the following:

- 1) During any calendar quarter, to less than or equal to 7.5 mrem to any organ; and,
- 2) During any calendar year, to less than or equal to 15 mrem to any organ.

Applicability:

This is applicable at all times.

Action:

With the calculated dose or dose commitment from the release of tritium and radioactive materials in particulate form with half-lives greater than eight days in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days a Special Report. This Report will identify the cause(s) for exceeding the limit and define the corrective actions to be taken to reduce the releases and the proposed corrective action(s) to be taken to assure that subsequent releases will be in compliance with the above annual limits.

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Surveillance Requirements:

Cumulative dose contributions for the current calendar quarter and calendar year period shall be determined in accordance with the methodology described in Step 6.10 at least monthly.

Bases:

Step 6.14.8 is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Specifications are the guides set forth in Section II.C of 10 CFR 50, Appendix I. The Action statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of 10 CFR 50, Appendix I to assure that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." The calculational methods specified in the Surveillance Requirements implement the requirements in Section III.A of 10 CFR 50, Appendix I that conformance with the guides of 10 CFR 50, Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. For individuals who may at times be within the Site Boundary for Gaseous Effluents, the occupancy of the individual will be sufficiently low to compensate for any increase in the atmospheric dispersion factor above that for the boundary.

The calculational methods for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculating of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for estimating doses based upon the historical average atmospheric conditions.

The release rate specifications for radioactive materials in particulate form are dependent on the existing radionuclide pathways to man in areas at or beyond the Site Boundary for Gaseous Effluents (see Attachment 5). The pathways which were examined in the development of these calculations are: (1) individual inhalation of airborne radionuclides, (2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, (3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and (4) deposition on the ground with subsequent exposure of man.

6.14.9 Ventilation Exhaust Treatment System

Specifications:

The VENTILATION EXHAUST TREATMENT SYSTEM shall be OPERABLE. The installed VENTILATION EXHAUST TREATMENT SYSTEM shall be considered OPERABLE by meeting the Specifications in Steps 6.14.6, 6.14.7, and 6.14.8.

Also, the following two conditions shall not exist simultaneously:

- 1) Gaseous waste is being discharged without treatment, and;
- 2) The projected doses due to gaseous effluent releases from the site (see Attachment 5), when averaged over 31 days, would exceed 2% of the 10 CFR 50, Appendix I annual dose guidelines (0.3 mrem to any organ, or air doses of 0.2 mrad from gamma radiation or 0.4 mrad from beta radiation).

Applicability:

This is applicable at all times.

Action:

If both parts 1) and 2) of the Specification are satisfied, prepare and submit to the Commission within 30 days a Special Report pursuant to Technical Specification D6.9.7 which includes the following information:

- a. Explanation of why gaseous radwaste was being discharged without treatment, and identification of the equipment or subsystems not OPERABLE and the reason for inoperability.
- b. Action(s) taken to restore the inoperable equipment to OPERABLE STATUS.
- c. Summary description of action(s) taken to prevent a recurrence.

Surveillance Requirements:

Doses due to gaseous releases to areas at and beyond the Site Boundary for Gaseous Effluents (see Attachment 5) shall be projected at least once per 31 days in accordance with the methodology and parameters in Step 6.11.

DOP tests will be performed on the HEPA filters in the Ventilation Exhaust Treatment Systems every 18 months, or after any work has been performed on the HEPA filter systems which could alter their integrity.

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Bases:

The OPERABILITY of the VENTILATION EXHAUST TREATMENT SYSTEM ensures that the systems are available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents are maintained "as low as is reasonably achievable." Step 6.14.9 implements the requirements of 10 CFR 50.36a, General Design Criterion 60 of Appendix A to 10 CFR 50, and the design objectives given in Section II.D of Appendix I to 10 CFR 50. The specified limits governing the use of appropriate portions of the systems and the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR 50, for gaseous effluents.

6.14.10 Fuel Cycle Dose

Specification:

The dose or dose commitment to any real MEMBER OF THE PUBLIC due to releases of radioactive material in gaseous and liquid effluents and to direct radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 mrem to the total body or any organ (except the thyroid, which is limited to less than or equal to 75 mrem) in a calendar year.

Applicability:

At all times.

Action:

- 1) With the calculated doses from the release of radioactive material in liquid or gaseous effluents exceeding twice the limits of Specifications in Steps 6.14.3, 6.14.7, 6.14.8 or exceeding the reporting levels in Table 3 of the REMP Manual, calculations shall be made including direct radiation contributions (including outside storage tanks, etc.) to determine whether the above specifications have been exceeded.
- 2) If the above limits have been exceeded, prepare and submit to the Commission within 30 days, a Special Report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report, as defined in 10 CFR Part 20.2203(a)(4), shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, in a calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations.
- 3) If the estimated dose(s) exceed the above limits, and if the release condition resulting in the violation of 40 CFR Part 190 has not already been corrected, the

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Special Report shall include a request for a variance in accordance with the provision of 40 CFR Part 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

Surveillance Requirements:

Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with the Step 6.14.3, 6.14.7, and 6.14.8 Surveillance Requirements.

Cumulative dose contributions from direct radiation (including outside storage tanks, etc.) shall be determined in accordance with Step 6.12. This requirement is applicable only under the conditions set forth in the above Action statements.

Bases:

Step 6.14.10 is provided to meet the dose limitations of 40 CFR 190 that have been incorporated into 10 CFR 20 by 46 FR 18525. The specification requires the preparation and submittal of a Special Report whenever the calculated doses from plant radioactive effluents exceed twice the numerical guides for design objective doses of 10 CFR 50, Appendix I or exceeds the reporting levels of the Radiological Environmental Monitoring Program. For the Rancho Seco site, it is unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR 190 if the plant remains within twice the numerical guides for design objectives of 10 CFR 50, Appendix I and if direct radiation (outside storage tanks, etc.) is kept small. The Special Report will describe a course of action which should result in the limitation of the dose to a MEMBER OF THE PUBLIC for a calendar year to within the 40 CFR 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 5 miles must be considered. If the dose to any MEMBER OF THE PUBLIC is evaluated to exceed the requirements of 40 CFR 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR 190 have not already been corrected), in accordance with the provisions of 40 CFR 190 is considered to be a timely request and fulfills the requirements of 40 CFR 190 until NRC staff action is completed. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation which is part of the uranium fuel cycle.

6.14.11 Quarter/Annual Dose Projections

Specifications:

The projected dose contributions from liquid and gaseous effluents for the current calendar quarter and current calendar year shall be calculated according to the methodology in Steps 6.5 and 6.11 at least every 31 days.

Applicability:

At all times.

Action:

With the required dose calculations not being performed, best effort will be exerted to perform the calculations once the deficiency has been identified. Corrective actions will be taken and documented to prevent reoccurrence.

Surveillance Requirements

1) Liquid Effluents

Projected dose contributions shall be determined at least every 31 days.

2) Gaseous Effluents

Projected dose contributions shall be determined at least every 31 days.

Bases:

This step is provided to implement the requirement of Technical Specification D6.8.3.a.5. Dose projections provide a means of determining if current release practices will be within the dose limits of 10 CFR 50, Appendix I. Calculating projected dose totals every 31 days provides information which can be used to keep effluent releases "as low as is reasonably achievable".

Calculations performed during the first 15 days of the calendar year or calendar quarter will result in artificially high dose projections which provide no usable information.

6.15 Reports

6.15.1 Annual Radioactive Effluent Release Report (ARERR)

The ARERR covering the activities of the unit during the previous 12 months shall be submitted within 60 days after January 1 of each year. The report shall include the following:

- (1) Summary of the quantities of radioactive liquid and gaseous effluents released from the unit.
- (2) Summary of solid waste shipped from the unit.
- (3) All unplanned releases of radioactive materials in gaseous and liquid effluents to unrestricted areas shall include a description of the event and equipment involved, cause(s), action(s) taken to prevent recurrence, and consequences.

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- (4) Dose or dose commitment assessments to ensure compliance with the specifications in 6.14.3, 6.14.7, and 6.14.8.
- (5) Complete, legible copy of the entire ODCM and/or REMP Manual if changes occurred during the ARERR reporting period. The copy may be part of the ARERR or sent concurrently.
- (6) The ARERR shall also include events described in 6.14.2, 6.14.5, and 6.14.6.

6.15.2 30 Day Reports

The following 30 day reports should be submitted if the criteria are met as stated in the following areas:

- (1) 6.14.3 - Liquid Dose Calculations
- (2) 6.14.4 - Liquid Dose Projections
- (3) 6.14.7 - Gamma and Beta Air Dose
- (4) 6.14.8 - Gaseous Organ Dose
- (5) 6.14.9 - Gaseous Dose Projections
- (6) 6.14.10 - Fuel Cycle Dose

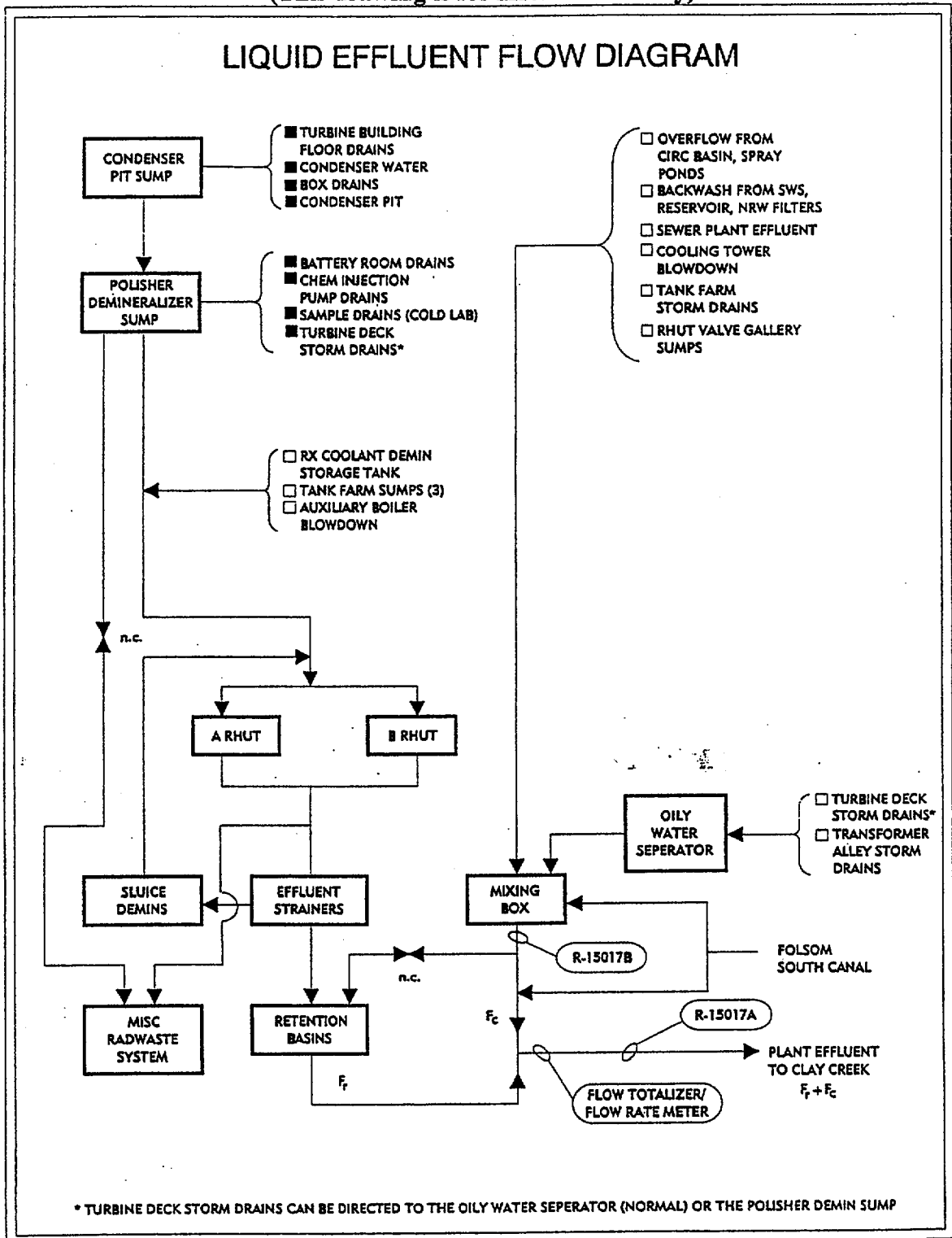
7.0 RECORDS

The individual/packaged documents and related correspondence completed as a result of the performance or implementation of this procedure are records. They shall be transmitted to Records Management in accordance with RSAP-0601, Nuclear Records Management.

LIQUID EFFLUENT FLOW DIAGRAM

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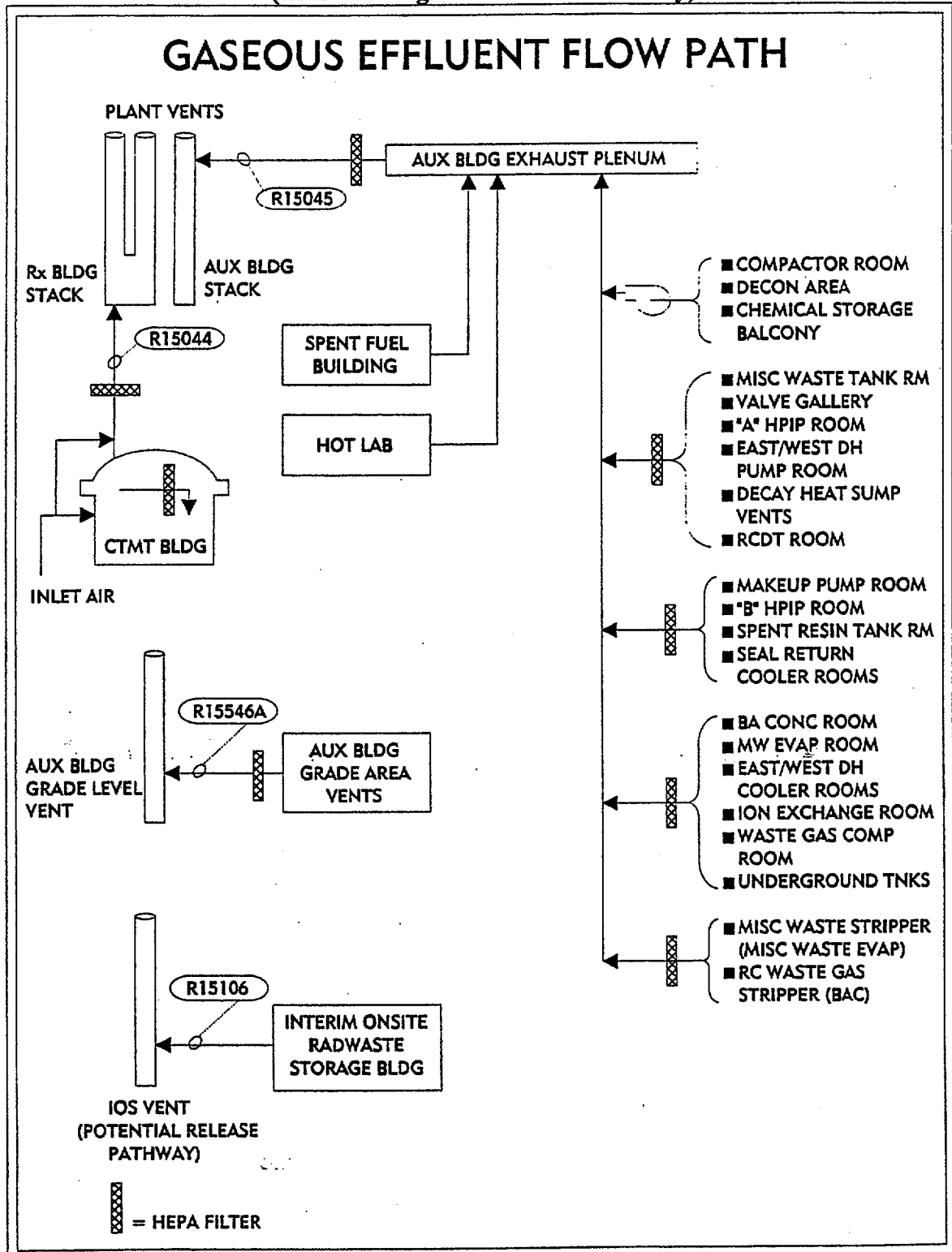
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GASEOUS EFFLUENT FLOW DIAGRAM

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DOSE FACTOR PARAMETERSCONSUMPTION AND USAGE PARAMETERS

<u>PATHWAY</u>	<u>AGE</u>	<u>1.109 DEFAULT</u>	<u>RSNGS</u>
Irrigated Stored Vegetables	Adult	520 kg/yr	520 kg/yr
	Teen	630 kg/yr	630 kg/yr
	Child	520 kg/yr	520 kg/yr
	Infant	0 kg/yr	0 kg/yr
Irrigated Fresh Vegetables	Adult	64 kg/yr	64 kg/yr
	Teen	42 kg/yr	42 kg/yr
	Child	26 kg/yr	26 kg/yr
	Infant	0 kg/yr	0 kg/yr
Irrigated Milk	Adult	310 kg/yr	310 kg/yr
	Teen	400 kg/yr	400 kg/yr
	Child	330 kg/yr	330 kg/yr
	Infant	330 kg/yr	330 kg/yr
Irrigated Meat & Poultry	Adult	110 kg/yr	110 kg/yr
	Teen	65 kg/yr	65 kg/yr
	Child	41 kg/yr	41 kg/yr
	Infant	0 kg/yr	0 kg/yr
Fish	Adult	21 kg/yr	21 kg/yr
	Teen	16 kg/yr	16 kg/yr
	Child	6.9 kg/yr	6.9 kg/yr
	Infant	0 kg/yr	0 kg/yr
Other Seafood Invertebrate (Crayfish)	Adult	5.0 kg/yr	6.9 kg/yr
	Teen	3.8 kg/yr	5.2 kg/yr
	Child	1.7 kg/yr	2.2 kg/yr
	Infant	0 kg/yr	0 kg/yr
Algae	Adult	None	0 kg/yr
	Teen	None	0 kg/yr
	Child	None	0 kg/yr
	Infant	None	0 kg/yr
Water Usage (Drinking Water)	Adult	730 l/yr	0 l/yr
	Teen	510 l/yr	0 l/yr
	Child	510 l/yr	0 l/yr
	Infant	330 l/yr	0 l/yr

DOSE FACTOR PARAMETERS (Continued)

CONSUMPTION AND USAGE PARAMETERS (continued)

<u>PATHWAY</u>	<u>AGE</u>	<u>1.109 DEFAULT</u>	<u>RSNGS</u>
Shoreline Recreation	Adult	12 hr/yr	200 hr/yr
	Teen	67 hr/yr	100 hr/yr
	Child	14 hr/yr	14 hr/yr
	Infant	0 hr/yr	0 hr/yr
Swimming	Adult	None	100 hr/yr
	Teen	None	100 hr/yr
	Child	None	14 hr/yr
	Infant	None	0 hr/yr
Boating	Adult	None	0 hr/yr
	Teen	None	0 hr/yr
	Child	None	0 hr/yr
	Infant	None	0 hr/yr
Inhalation	Adult	8000 m ³	8000 m ³
	Teen	8000 m ³	8000 m ³
	Child	3700 m ³	3700 m ³
	Infant	1400 m ³	1400 m ³

IRRIGATION RATES AND FRACTION OF IRRIGATION

	<u>1.109 DEFAULT</u>	<u>RSNGS</u>
Irrigation Rate	263 l/m ² /month	263 l/m ² /month
Time field has been irrigated prior to crop of interest	15 years	15 years
Fraction of the year field is irrigated	None	None
Fraction of animal water intake not obtained from the irrigation system (Irrigated Meat)	None	0
Fraction of animal water intake not obtained from the irrigation system (Irrigated Milk)	None	1

DOSE FACTOR PARAMETERS (Continued)

TRANSIT, TRANSFER, AND HOLDUP TIMES

	<u>1.109 DEFAULT</u>	<u>RSNGS</u>
Irrigated Stored Vegetables Holdup Time	1440 hrs	1440 hrs
Irrigated Fresh Vegetables Holdup Time	24 hrs	24 hrs
Irrigated Milk Holdup Time	48 hrs	48 hrs
Irrigated Meat Holdup Time	480 hrs	480 hrs
Transit Time From Time Of Sample To Time Of Release	None	72 hrs
Transit Time To Drinking Water	None	0 hrs

DILUTIONS

	<u>1.109 DEFAULT</u>	<u>RSNGS</u>
All Pathways	None	1 (None)
Shore-Width Factor	0.2	0.2

MISCELLANEOUS

	<u>1.109 DEFAULT</u>	<u>RSNGS</u>
Fraction Of Leafy Vegetables Grown In Garden Of Interest	1.0	1.0
Fraction Of Produce Ingested Grown In Garden Of Interest	0.76	0.76
Crop Growing Time For Leafy Vegetables Ingested By Man	60 Days	30 Days
Crop Growing Time For Pasture Grass	30 Days	30 Days
Crop Yield For Leafy Vegetables Ingested By Man	2.0 kg/m ²	2.0 kg/m ²
Crop Yield For Pasture Grass	0.7 kg/m ²	2.0 kg/m ²

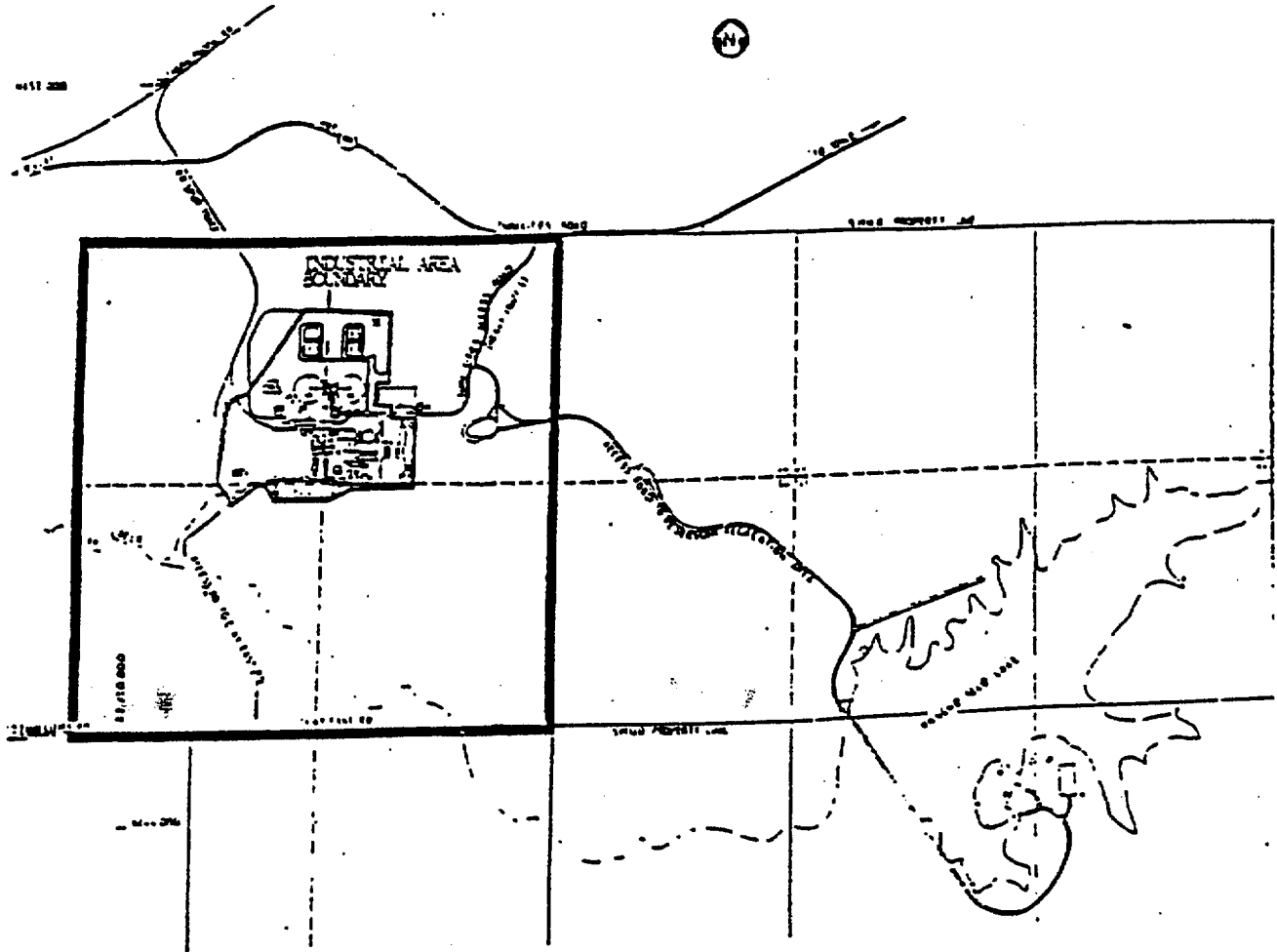
ATMOSPHERIC DISPERSION AND DEPOSITION PARAMETERS
GASEOUS EFFLUENT PATHWAYS
1994 CONTROLLING LOCATIONS**

<u>PATHWAY</u>	<u>DIRECTION</u>	<u>DISTANCE</u>	<u>X/Q*</u> (sec/m ³)	<u>D/Q*</u> (m ⁻²)
Inhalation	ENE	1038 M	8.1E-06	--
Ground	ENE	1038 M	--	4.8E-08
Vegetation	SSW	670 M	1.4E-05	2.8E-08
Cow Milk	ENE	1038 M	8.1E-06	4.8E-08
Meat Animal	S	195 M	1.2E-04	--
Meat Animal	SSE	198 M	--	3.4E-07
Goat Milk	SSW	2500 M	1.0E-06	1.7E-09
Site Boundary for Gaseous Effluents	NNW	670 M	2.1E-05	--

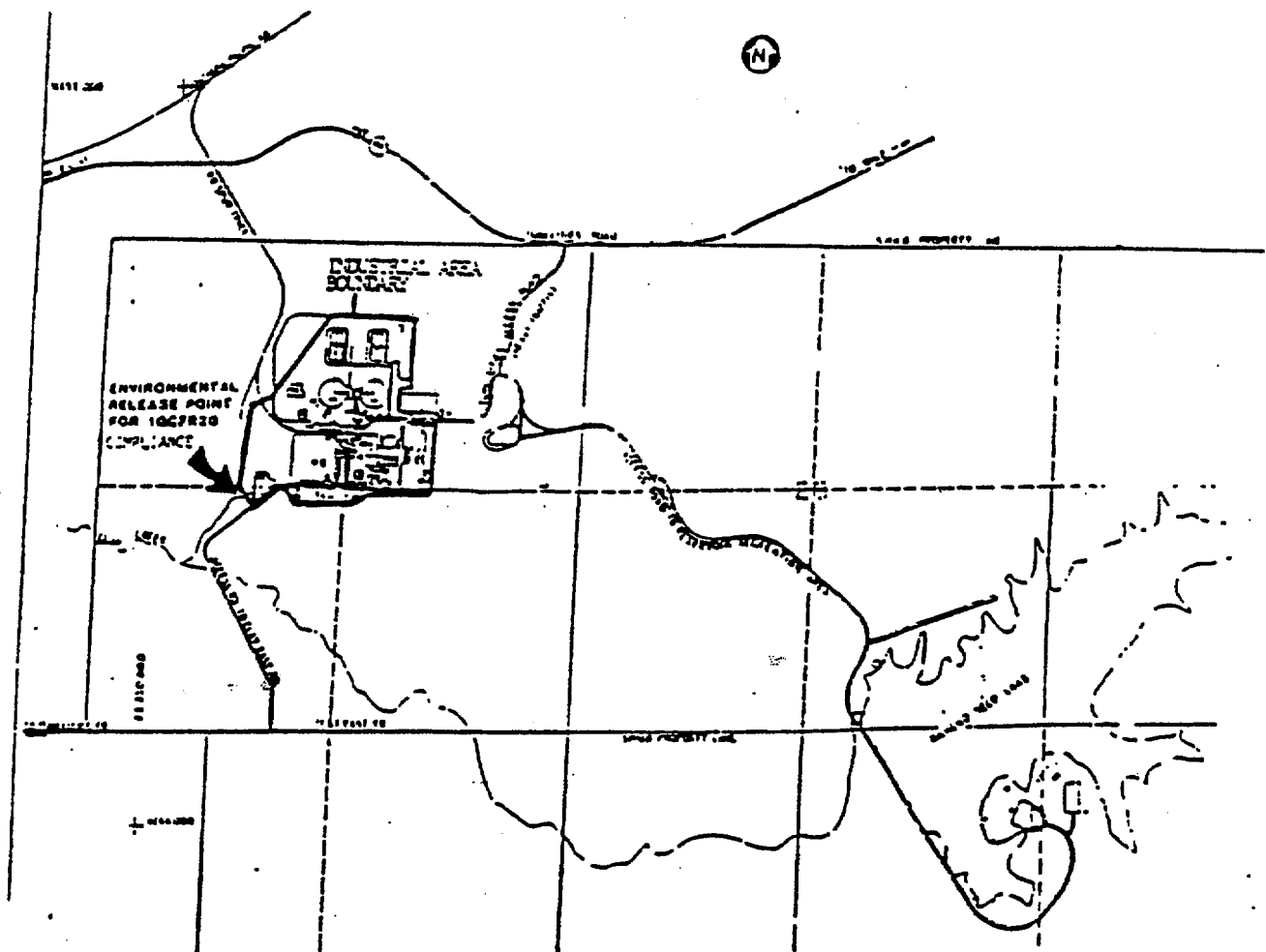
* Based on meteorological data from January 1978 to December 1987.

** Based on 1994 Land Use Census.

SITE BOUNDARY FOR GASEOUS EFFLUENTS



SITE BOUNDARY FOR LIQUID EFFLUENTS



HISTORICAL LIQUID SOURCE TERMS

Nuclide	Ci ($\mu\text{Ci/ml}$)	Of Gamma Emitters		Of All Nuclides	
		Relative %	Relative Fraction	Relative %	Relative Fraction
H-3	4.45 E-04	n/a	n/a	100.00	1.00
Cs-137	1.23 E-08	100.00	1.00	2.76 E-05	2.76 E-05
TOTAL	4.45 E-04	100.00	1.00	100.00	1.00

Note Based on Retention Basin Effluent History of Rancho Seco from January 1, 1993 through December 31, 1994

LIQUID MONITOR DETECTOR EFFICIENCIES

R15017A & R15017B*
(Detector Model RD-53)

Nuclide	Efficiency cpm/ μ Ci/cc
MO-99	3.47 E+07
I-131	1.90 E+08
I-132	4.17 E+08
I-133	1.53 E+08
I-135	1.74 E+08
CS-134	3.25 E+08
CS-137	1.28 E+08
CR-51	1.85 E+07
MN-54	1.30 E+08
FE-59	1.26 E+08
CO-58	1.85 E+08
CO-60	2.40 E+08
ZN-65	6.49 E+07
SB-124	2.66 E+08
BA-140	8.98 E+07
LA-140	2.69 E+08
CE-141	7.68 E+07
CE-144	1.80 E+07

* From Calculation Z-RDM-I0261

ORGAN DOSE FACTORS FOR LIQUID EFFLUENTS

DOSE FACTOR TABLE: A(i) - Adult

Units are mrem/hr per $\mu\text{Ci/ml}$

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	1.21E+01	1.21E+01	1.21E+01	1.21E+01	1.21E+01	1.21E+01
C-14	3.82E+05	7.63E+04	7.63E+04	7.63E+04	7.63E+04	7.63E+04	7.63E+04
NA-24	4.32E+01	4.32E+01	4.32E+01	4.32E+01	4.32E+01	4.32E+01	4.32E+01
P-32	4.07E+07	2.53E+06	1.57E+06	6.31E-02	6.31E-02	6.31E-02	4.50E+06
CR-51	3.08E+00	3.08E+00	8.89E+00	6.56E+00	4.36E+00	1.08E+01	1.46E+03
MN-54	8.23E+02	3.31E+05	6.38E+04	8.23E+02	9.90E+04	8.23E+02	1.01E+06
MN-56	0.00E+00	2.13E-04	3.79E-05	0.00E+00	2.70E-04	0.00E+00	6.79E-03
FE-55	1.18E+04	8.17E+03	1.91E+03	7.29E-04	7.29E-04	4.56E+03	4.69E+03
FE-59	1.47E+04	3.42E+04	1.32E+04	1.77E+02	1.77E+02	9.69E+03	1.14E+05
CO-58	2.36E+02	9.91E+02	1.93E+03	2.36E+02	2.36E+02	2.36E+02	1.55E+04
CO-60	1.26E+04	1.61E+04	2.02E+04	1.26E+04	1.26E+04	1.26E+04	7.73E+04
NI-63	3.42E+05	2.37E+04	1.15E+04	0.00E+00	0.00E+00	0.00E+00	4.95E+03
NI-65	8.65E-04	1.12E-04	5.13E-05	0.00E+00	0.00E+00	0.00E+00	2.85E-03
CU-64	8.90E-02	7.02E-01	3.77E-01	8.90E-02	1.64E+00	8.90E-02	5.24E+01
ZN-65	7.63E+04	2.42E+05	1.10E+05	4.46E+02	1.62E+05	4.46E+02	1.52E+05
ZN-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	4.84E-05	0.00E+00	0.00E+00	0.00E+00	6.98E-05
BR-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	6.46E+00	1.21E+05	5.62E+04	6.46E+00	6.46E+00	6.46E+00	2.38E+04
RB-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	2.01E+05	6.25E-02	5.75E+03	6.25E-02	6.25E-02	6.25E-02	3.26E+04
SR-90	5.71E+06	6.16E-03	1.53E+06	6.16E-03	6.16E-03	6.16E-03	3.26E+05
SR-91	5.59E+00	1.19E-01	3.40E-01	1.19E-01	1.19E-01	1.19E-01	2.62E+01
SR-92	5.95E-03	0.00E+00	2.58E-04	0.00E+00	0.00E+00	0.00E+00	1.18E-01
Y-90	3.15E+00	6.94E-02	1.52E-01	6.94E-02	6.94E-02	6.94E-02	3.27E+04
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	1.95E+02	6.82E-01	5.89E+00	6.82E-01	6.82E-01	6.82E-01	1.07E+05
Y-92	1.72E-05	4.24E-06	4.62E-06	4.24E-06	4.24E-06	4.24E-06	2.76E-01
Y-93	2.16E-02	1.61E-02	1.63E-02	1.61E-02	1.61E-02	1.61E-02	1.73E+02
ZR-95	1.82E+02	1.64E+02	1.62E+02	1.56E+02	1.69E+02	1.56E+02	2.67E+04
ZR-97	9.87E-01	9.83E-01	9.82E-01	9.82E-01	9.83E-01	9.82E-01	3.26E+02
NB-95	5.16E+02	3.27E+02	2.17E+02	8.92E+01	3.24E+02	8.92E+01	1.44E+06
MO-99	1.27E+00	3.04E+02	5.89E+01	1.27E+00	6.87E+02	1.27E+00	7.03E+02
TC-99M	8.23E-04	1.03E-03	4.74E-03	7.11E-04	5.51E-03	8.66E-04	1.88E-01
TC-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RU-103	6.76E+02	7.02E+01	3.31E+02	7.02E+01	2.38E+03	7.02E+01	7.08E+04
RU-105	9.35E-04	1.83E-04	4.80E-04	1.83E-04	9.91E-03	1.83E-04	4.60E-01
RU-106	1.61E+04	2.95E+02	2.30E+03	2.95E+02	3.08E+04	2.95E+02	1.02E+06
AG-110M	2.63E+03	2.59E+03	2.37E+03	2.06E+03	3.10E+03	2.06E+03	2.17E+05
TE-125M	1.86E+04	6.75E+03	2.49E+03	5.60E+03	7.57E+04	9.21E-01	7.43E+04
TE-127M	5.26E+04	1.88E+04	6.41E+03	1.34E+04	2.14E+05	5.57E-02	1.76E+05
TE-127	6.06E-01	2.18E-01	1.31E-01	4.49E-01	2.47E+00	1.62E-04	4.78E+01
TE-129M	7.19E+04	2.68E+04	1.14E+04	2.47E+04	3.00E+05	1.31E+01	3.62E+05
TE-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-131M	1.11E+03	5.44E+02	4.54E+02	5.85E+02	5.45E+03	5.64E+00	5.34E+04
TE-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-132	6.30E+03	4.07E+03	3.82E+03	4.50E+03	3.92E+04	3.73E+00	1.93E+05
I-130	3.14E+00	7.62E+00	3.51E+00	5.76E+02	1.14E+01	8.37E-01	6.68E+00
I-131	7.06E+02	1.00E+03	5.82E+02	3.24E+05	1.71E+03	1.47E+01	2.76E+02
I-132	1.60E-04	4.29E-04	1.50E-04	1.50E-02	6.83E-04	0.00E+00	8.05E-05
I-133	1.68E+01	2.84E+01	9.45E+00	4.01E+03	4.88E+01	1.13E+00	2.57E-01
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	1.59E-01	4.14E-01	1.53E-01	2.73E+01	6.63E-01	8.91E-04	4.68E-01
CS-134	4.44E+05	1.05E+06	8.59E+05	4.03E+03	3.43E+05	1.16E+05	2.23E+04
CS-136	3.16E+04	1.24E+05	8.95E+04	1.15E+02	6.92E+04	9.59E+03	1.42E+04
CS-137	5.85E+05	7.98E+05	5.25E+05	6.06E+03	2.75E+05	9.54E+04	2.14E+04
CS-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-140	4.90E+03	2.11E+01	3.35E+02	1.50E+01	1.71E+01	1.85E+01	1.01E+04
BA-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA-140	4.14E+00	3.92E+00	3.76E+00	3.71E+00	3.71E+00	3.71E+00	1.61E+04
LA-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29E-06
CE-141	1.87E+01	1.56E+01	9.66E+00	8.90E+00	1.20E+01	8.90E+00	2.54E+04
CE-143	1.93E+00	1.42E+02	1.76E+00	1.74E+00	1.81E+00	1.74E+00	5.24E+03
CE-144	8.99E+02	4.00E+02	8.76E+01	4.15E+01	2.54E+02	4.15E+01	2.90E+05
PR-143	7.38E+00	2.96E+00	3.66E-01	0.00E+00	1.71E+00	0.00E+00	3.23E+04
PR-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ND-147	9.62E+00	1.03E+01	5.27E+00	4.95E+00	8.11E+00	4.95E+00	2.59E+04
W-187	2.03E+01	1.72E+01	6.89E+00	1.35E+00	1.35E+00	1.35E+00	5.20E+03
NP-239	1.70E+00	1.56E+00	1.56E+00	1.55E+00	1.59E+00	1.55E+00	2.92E+03

ORGAN DOSE FACTORS FOR LIQUID EFFLUENTS (Continued)

DOSE FACTOR TABLE: A(i) - Teen
Units are mrem/hr per μ Ci/ml

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	1.37E+01	1.37E+01	1.37E+01	1.37E+01	1.37E+01	1.37E+01
C-14	5.64E+05	1.13E+05	1.13E+05	1.13E+05	1.13E+05	1.13E+05	1.13E+05
NA-24	6.36E+01	6.36E+01	6.36E+01	6.36E+01	6.36E+01	6.36E+01	6.36E+01
P-32	4.44E+07	2.75E+06	1.72E+06	6.31E-02	6.31E-02	6.31E-02	3.73E+06
CR-51	1.82E+00	1.82E+00	8.10E+00	5.31E+00	3.19E+00	1.08E+01	1.06E+03
MN-54	4.20E+02	3.24E+05	6.45E+04	4.20E+02	9.69E+04	4.20E+02	6.63E+05
MN-56	0.00E+00	1.92E-04	3.43E-05	0.00E+00	2.43E-04	0.00E+00	1.26E-02
FE-55	1.37E+04	9.69E+03	2.26E+03	7.29E-04	7.29E-04	6.15E+03	4.19E+03
FE-59	1.55E+04	3.61E+04	1.40E+04	1.00E+02	1.00E+02	1.15E+04	8.53E-04
CO-58	1.28E+02	1.08E+03	2.32E+03	1.28E+02	1.28E+02	1.28E+02	1.33E+04
CO-60	6.35E+03	1.10E+04	1.69E+04	6.35E+03	6.35E+03	6.35E+03	6.71E+04
NI-63	4.50E+05	3.19E+04	1.53E+04	0.00E+00	0.00E+00	0.00E+00	5.06E+03
NI-65	8.19E-04	1.05E-04	4.77E-05	0.00E+00	0.00E+00	0.00E+00	5.67E-03
CU-64	8.55E-02	9.25E-01	4.80E-01	8.55E-02	2.21E+00	8.55E-02	6.52E+01
ZN-65	7.56E+04	2.62E+05	1.22E+05	2.29E+02	1.68E+05	2.29E+02	1.11E+05
ZN-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	4.93E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	4.10E+00	1.40E+05	6.56E+04	4.10E+00	4.10E+00	4.10E+00	2.07E+04
RB-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	2.93E+05	5.64E-02	8.38E+03	5.64E-02	5.64E-02	5.64E-02	3.85E+05
SR-90	7.40E+06	6.16E-03	1.98E+06	6.16E-03	6.16E-03	6.16E-03	3.85E+05
SR-91	5.73E+00	1.16E-01	3.39E-01	1.16E-01	1.16E-01	1.16E-01	2.56E+01
SR-92	5.55E-03	0.00E+00	2.37E-04	0.00E+00	0.00E+00	0.00E+00	1.42E-01
Y-90	3.35E+00	6.87E-02	1.57E-01	6.87E-02	6.87E-02	6.87E-02	2.71E+04
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	2.46E+02	3.78E-01	6.97E+00	3.78E-01	3.78E-01	3.78E-01	1.01E+05
Y-92	1.64E-05	4.20E-06	4.55E-06	4.20E-06	4.20E-06	4.20E-06	3.35E-01
Y-93	2.13E-02	1.57E-02	1.59E-02	1.57E-02	1.57E-02	1.57E-02	1.70E+02
ZR-95	1.19E+02	9.67E+01	9.34E+01	8.62E+01	1.02E+02	8.62E+01	2.42E+04
ZR-97	9.41E-01	9.37E-01	9.37E-01	9.36E-01	9.38E-01	9.36E-01	2.63E+02
NB-95	4.73E+02	2.82E+02	1.75E+02	4.46E+01	2.75E+02	4.46E+01	1.02E+06
MO-99	6.36E-01	4.32E+02	8.28E+01	6.36E-01	9.87E+02	6.36E-01	7.73E+02
TC-99M	8.54E-04	1.13E-03	6.35E-03	6.98E-04	7.20E-03	9.40E-04	2.87E-01
TC-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RU-103	5.86E+02	3.51E+01	2.71E+02	3.51E+01	1.98E+03	3.51E+01	4.61E+04
RU-105	8.80E-04	1.81E-04	4.52E-04	1.81E-04	9.00E-03	1.81E-04	5.65E-01
RU-106	1.59E+04	1.48E+02	2.14E+03	1.48E+02	3.06E+04	1.48E+02	7.57E+05
AG-110M	1.87E+03	1.83E+03	1.53E+03	1.06E+03	2.53E+03	1.06E+03	2.17E+05
TE-125M	2.06E+04	7.42E+03	2.75E+03	5.75E+03	4.81E-01	4.81E-01	6.07E+04
TE-127M	5.93E+04	2.10E+04	7.05E+03	1.41E+04	2.40E+05	2.93E-02	1.48E+05
TE-127	6.53E-01	2.32E-01	1.41E-01	4.51E-01	2.64E+00	1.57E-04	5.04E+01
TE-129M	7.75E+04	2.88E+04	1.23E+04	2.50E+04	3.24E+05	7.70E+00	2.91E+05
TE-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-131M	1.18E+03	5.67E+02	4.74E+02	8.50E+02	5.86E+03	5.20E+00	4.51E+04
TE-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-132	6.58E+03	4.17E+03	3.92E+03	4.40E+03	4.00E+04	3.07E+00	1.32E+05
I-130	3.80E+00	9.45E+00	4.26E+00	7.06E+02	1.41E+01	8.08E-01	7.45E+00
I-131	9.72E+02	1.36E+03	7.33E+02	3.93E+05	2.33E+03	1.08E+01	2.77E+02
I-132	1.46E-04	3.81E-04	1.37E-04	1.29E-02	6.01E-04	0.00E+00	1.66E-04
I-133	2.27E+01	3.77E+01	1.22E+01	5.12E+03	6.54E+01	1.06E+00	2.88E+01
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	1.85E-01	4.76E-01	1.77E-01	3.06E+01	7.52E-01	4.45E-04	5.28E-01
CS-134	5.04E+05	1.18E+06	5.50E+05	2.03E+03	3.77E+05	1.45E+05	1.67E+04
CS-136	3.27E+04	1.28E+05	8.62E+04	7.75E+01	6.99E+04	1.11E+04	1.04E+04
CS-137	6.99E+05	9.30E+05	3.26E+05	3.03E+03	3.18E+05	1.26E+05	1.62E+04
CS-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.94E-06
BA-140	5.34E+03	1.64E+01	3.53E+02	9.87E+00	1.21E+01	1.43E+01	8.23E+03
BA-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA-140	2.30E+00	2.08E+00	1.91E+00	1.85E+00	1.85E+00	1.85E+00	1.27E+04
LA-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.35E-05
CE-141	1.69E+01	1.30E+01	6.05E+00	5.15E+00	8.84E+00	5.15E+00	2.25E+04
CE-143	1.79E+00	1.48E+02	1.61E+00	1.59E+00	1.66E+00	1.59E+00	4.41E+03
CE-144	1.20E+03	5.10E+02	8.47E+01	2.12E+01	3.13E+02	2.12E+01	2.97E+05
FR-143	7.98E+00	3.18E+00	3.97E-01	0.00E+00	1.85E+00	0.00E+00	2.62E+04
FR-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ND-147	7.72E+00	8.17E+00	2.82E+00	2.47E+00	5.82E+00	2.47E+00	2.06E+04
W-187	2.17E+01	1.79E+01	7.11E+00	1.26E+00	1.26E+00	1.26E+00	4.51E+03
NP-239	1.50E+00	1.36E+00	1.35E+00	1.34E+00	1.39E+00	1.34E+00	2.41E+03

ORGAN DOSE FACTORS FOR LIQUID EFFLUENTS (Continued)

DOSE FACTOR TABLE: A(i) - Child
Units are mrem/hr per $\mu\text{Ci/ml}$

Nuclide	Bone	Liver	Thody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	2.10E+01	2.10E+01	2.10E+01	2.10E+01	2.10E+01	2.10E+01
C-14	1.28E+06	2.56E+05	2.56E+05	2.56E+05	2.56E+05	2.56E+05	2.56E+05
NA-24	1.16E+02	1.16E+02	1.16E+02	1.16E+02	1.16E+02	1.16E+02	1.16E+02
P-32	5.74E+07	2.69E+06	2.21E+06	8.84E-03	8.84E-03	8.84E-03	1.59E+06
CR-51	2.54E-01	2.54E-01	7.95E+00	4.52E+00	1.42E+00	8.05E+00	4.08E+02
MN-54	5.88E+01	2.53E+05	6.74E+04	5.88E+01	7.10E+04	5.88E+01	2.12E+05
MN-56	0.00E+00	2.51E-04	5.68E-05	0.00E+00	3.04E-04	0.00E+00	3.64E-02
FE-55	2.40E+04	1.27E+04	3.94E+03	1.02E-04	1.02E-04	7.19E+03	2.35E+03
FE-59	2.21E+04	3.58E+04	1.78E+04	1.40E+01	1.40E+01	1.04E+04	3.72E+04
CO-58	1.79E+01	1.28E+03	3.88E+03	1.79E+01	1.79E+01	1.79E+01	7.38E+03
CO-60	8.89E+02	7.51E+03	2.04E+04	8.89E+02	8.89E+02	8.89E+02	3.76E+04
NI-63	1.02E+06	5.48E+04	3.48E+04	0.00E+00	0.00E+00	0.00E+00	3.69E+03
NI-65	1.52E-03	1.43E-04	8.35E-05	0.00E+00	0.00E+00	0.00E+00	1.75E-02
CU-64	1.20E-02	1.27E+00	7.70E-01	1.20E-02	3.05E+00	1.20E-02	5.89E+01
ZN-65	9.53E+04	2.54E+05	1.58E+05	3.21E+01	1.60E+05	3.21E+01	4.46E+04
ZN-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	9.58E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	5.74E-01	1.61E+05	9.88E+04	5.74E-01	5.74E-01	5.74E-01	1.03E+04
RB-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	6.48E+05	7.90E-03	1.85E+04	7.90E-03	7.90E-03	7.90E-03	2.51E+04
SR-90	1.47E+07	8.62E-04	3.93E+06	8.62E-04	8.62E-04	8.62E-04	2.97E+05
SR-91	1.04E+01	1.62E-02	4.06E-01	1.62E-02	1.62E-02	1.62E-02	2.28E+01
SB-92	1.02E-02	0.00E+00	4.09E-04	0.00E+00	0.00E+00	0.00E+00	1.93E-01
Y-90	4.28E+00	9.62E-03	1.24E-01	9.62E-03	9.62E-03	9.62E-03	1.22E+04
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	4.49E+02	5.29E-02	1.21E+01	5.29E-02	5.29E-02	5.29E-02	5.98E+04
Y-92	2.31E-05	0.00E+00	1.23E-06	0.00E+00	0.00E+00	0.00E+00	6.50E-01
Y-93	1.05E-02	2.20E-03	2.43E-03	2.20E-03	2.20E-03	2.20E-03	1.24E+02
ZR-95	8.32E+01	2.77E+01	2.60E+01	1.21E+01	3.45E+01	1.21E+01	1.63E+04
ZR-97	1.40E-01	1.32E-01	1.32E-01	1.31E-01	1.33E-01	1.31E-01	1.90E+02
NB-95	5.20E+02	2.06E+02	1.49E+02	6.25E+00	1.94E+02	6.25E+00	3.70E+05
MO-99	8.90E-02	7.01E+02	1.73E+02	8.90E-02	1.50E+03	8.90E-02	5.80E+02
TC-99M	4.34E-04	7.58E-04	1.10E-02	9.77E-05	9.69E-03	4.33E-04	3.76E-01
TC-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RU-103	1.02E+03	4.92E+00	3.96E+02	4.92E+00	2.57E+03	4.92E+00	2.63E+04
RU-105	1.31E-03	2.53E-05	4.90E-04	2.53E-05	1.13E-02	2.53E-05	8.35E-01
RU-106	3.18E+04	2.07E+01	3.98E+03	2.07E+01	4.29E+04	2.07E+01	4.94E+05
AG-110M	1.79E+03	1.26E+03	1.04E+03	1.48E+02	2.22E+03	1.48E+02	1.32E+05
TE-125M	3.04E+04	8.25E+03	4.06E+03	8.54E+03	6.73E-02	6.73E-02	2.94E+04
TE-127M	9.30E+04	2.50E+04	1.10E+04	2.22E+04	2.65E+05	4.10E-03	7.53E+04
TE-127	8.94E-01	2.41E-01	1.92E-01	6.19E-01	2.54E+00	2.20E-05	3.49E-01
TE-129M	1.09E+05	3.05E+04	1.70E+04	3.52E+04	3.21E+05	1.08E+00	1.33E+05
TE-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E-06
TE-131M	1.48E+03	5.13E+02	5.46E+02	1.05E+03	4.96E+03	7.28E-01	2.08E+04
TE-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-132	8.15E+03	3.61E+03	4.36E+03	5.26E+03	3.35E+04	4.30E-01	3.63E+04
I-130	6.36E+00	1.27E+01	6.62E+00	1.39E+03	1.90E+01	1.13E-01	6.02E+00
I-131	2.06E+03	2.07E+03	1.18E+03	6.84E+05	3.40E+03	1.51E+00	1.86E+02
I-132	2.60E-04	4.78E-04	2.20E-04	2.22E-02	7.32E-04	0.00E+00	5.63E-04
I-133	4.65E+01	5.74E+01	2.18E+01	1.06E+04	9.56E+01	1.49E-01	2.32E+01
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	3.79E-01	6.82E-01	3.23E-01	6.04E+01	1.05E+00	6.24E-05	5.20E-01
CS-134	7.61E+05	1.25E+06	2.64E+05	2.85E+02	3.87E+05	1.39E+05	7.02E+03
CS-136	4.14E+04	1.14E+05	7.37E+04	1.09E+01	6.06E+04	9.05E+03	4.01E+03
CS-137	1.12E+06	1.07E+06	1.59E+05	4.25E+02	3.50E+05	1.26E+05	7.15E+03
CS-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E-05
BA-140	8.64E+03	8.95E+00	5.05E+02	1.38E+00	3.85E+00	5.89E+00	4.38E+03
BA-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA-140	8.30E-01	4.59E-01	3.27E-01	2.59E-01	2.59E-01	2.59E-01	5.56E+03
LA-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.99E-04
CE-141	2.04E+01	1.05E+01	2.18E+00	7.21E-01	5.03E+00	7.21E-01	1.23E+04
CE-143	4.85E-01	1.42E+02	2.44E-01	2.23E-01	2.83E-01	2.23E-01	2.08E+03
CE-144	2.39E+03	7.51E+02	1.30E+02	2.97E+00	4.17E+02	2.97E+00	1.95E+05
FR-143	1.11E+01	3.33E+00	5.51E-01	0.00E+00	1.80E+00	0.00E+00	1.20E+04
FR-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ND-147	7.38E+00	6.04E+00	7.88E-01	3.47E-01	3.47E+00	3.47E-01	9.02E+03
W-187	2.65E+01	1.58E+01	7.17E+00	1.77E-01	1.77E-01	1.77E-01	2.19E+03
NP-239	4.00E-01	2.03E-01	1.99E-01	1.88E-01	2.32E-01	1.88E-01	1.13E+03

ORGAN DOSE FACTORS FOR LIQUID EFFLUENTS (Continued)

DOSE FACTOR TABLE: A(i) - Infant
Units are mrem/hr per $\mu\text{Ci/ml}$

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	1.14E+01	1.14E+01	1.14E+01	1.14E+01	1.14E+01	1.14E+01
C-14	5.80E+05	1.24E+05	1.24E+05	1.24E+05	1.24E+05	1.24E+05	1.24E+05
NA-24	1.76E+02	1.76E+02	1.76E+02	1.76E+02	1.76E+02	1.76E+02	1.76E+02
P-32	9.00E+05	5.29E+04	3.49E+04	0.00E+00	0.00E+00	0.00E+00	1.22E+04
CR-51	0.00E+00	0.00E+00	7.82E-01	5.10E-01	1.12E-01	9.93E-01	2.28E+01
MN-54	0.00E+00	1.68E+02	3.82E+01	0.00E+00	3.73E+01	0.00E+00	6.18E+01
MN-56	0.00E+00	1.22E-06	0.00E+00	0.00E+00	1.05E-06	0.00E+00	1.11E-04
FE-55	5.61E+02	3.63E+02	9.69E+01	0.00E+00	0.00E+00	1.77E+02	4.61E+01
FE-59	1.04E+03	1.81E+03	7.14E+02	0.00E+00	0.00E+00	5.36E+02	8.66E+02
CO-58	0.00E+00	1.08E+02	2.70E+02	0.00E+00	0.00E+00	0.00E+00	2.70E+02
CO-60	0.00E+00	3.81E+02	8.99E+02	0.00E+00	0.00E+00	0.00E+00	9.06E+02
NI-63	1.72E+05	1.06E+04	5.97E+03	0.00E+00	0.00E+00	0.00E+00	5.29E+02
NI-65	1.47E-04	1.66E-05	7.56E-06	0.00E+00	0.00E+00	0.00E+00	1.27E-03
CU-64	0.00E+00	2.29E+00	1.06E+00	0.00E+00	3.87E+00	0.00E+00	4.70E+01
ZN-65	3.02E+04	1.03E+05	4.77E+04	0.00E+00	5.02E+04	0.00E+00	8.74E+04
ZN-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	4.15E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	1.14E+05	5.65E+04	0.00E+00	0.00E+00	0.00E+00	2.92E+03
RB-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	5.77E+04	0.00E+00	1.66E+03	0.00E+00	0.00E+00	0.00E+00	1.19E+03
SR-90	3.91E+05	0.00E+00	1.05E+05	0.00E+00	0.00E+00	0.00E+00	7.22E+03
SR-91	4.01E+00	0.00E+00	1.45E-01	0.00E+00	0.00E+00	0.00E+00	4.75E+00
SR-92	1.84E-04	0.00E+00	6.83E-06	0.00E+00	0.00E+00	0.00E+00	1.98E-03
Y-90	4.55E-03	0.00E+00	1.22E-04	0.00E+00	0.00E+00	0.00E+00	6.28E+00
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	3.32E-01	0.00E+00	8.83E-03	0.00E+00	0.00E+00	0.00E+00	2.38E+01
Y-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.31E-04
Y-93	3.06E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.42E-01
ZR-95	3.06E-02	7.45E-03	5.28E-03	0.00E+00	8.03E-03	0.00E+00	3.71E+00
ZR-97	4.31E-05	7.40E-06	3.38E-06	0.00E+00	7.46E-06	0.00E+00	4.72E-01
NB-95	2.81E+00	1.16E+00	6.70E-01	0.00E+00	8.11E-01	0.00E+00	9.78E+02
MO-99	0.00E+00	1.38E+03	2.69E+02	0.00E+00	2.06E+03	0.00E+00	4.55E+02
TC-99M	5.61E-04	1.16E-03	1.49E-02	0.00E+00	1.25E-02	6.05E-04	3.36E-01
TC-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RU-103	4.08E-02	0.00E+00	1.37E-02	0.00E+00	8.50E-02	0.00E+00	4.97E-01
RU-105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.52E-06	0.00E+00	8.25E-05
RU-106	8.40E-01	0.00E+00	1.05E-01	0.00E+00	9.94E-01	0.00E+00	6.38E+00
AG-110M	1.81E+03	1.32E+03	8.74E+02	0.00E+00	1.89E+03	0.00E+00	6.85E+04
TE-125M	8.48E+02	2.83E+02	1.15E+02	2.85E+02	0.00E+00	0.00E+00	4.04E+02
TE-127M	2.62E+03	8.69E+02	3.17E+02	7.57E+02	6.45E+03	0.00E+00	1.06E+03
TE-127	9.61E-02	3.22E-02	2.07E-02	7.82E-02	2.34E-01	0.00E+00	2.02E+00
TE-129M	3.05E+03	1.05E+03	4.70E+02	1.17E+03	7.63E+03	0.00E+00	1.82E+03
TE-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-131M	2.87E+01	1.16E+01	9.55E+00	2.34E+01	7.96E+01	0.00E+00	1.95E+02
TE-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-132	1.41E+02	6.98E+01	6.51E+01	1.03E+02	4.36E+02	0.00E+00	2.58E+02
I-130	8.92E+00	1.96E+01	7.88E+00	2.20E+03	2.16E+01	0.00E+00	4.21E+00
I-131	3.07E+03	3.61E+03	1.59E+03	1.19E+06	4.22E+03	0.00E+00	1.29E+02
I-132	1.30E-05	2.64E-05	9.41E-06	1.24E-03	2.95E-05	0.00E+00	2.14E-05
I-133	6.99E+01	1.02E+02	2.98E+01	1.85E+04	1.20E+02	0.00E+00	1.72E+01
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	4.23E-01	8.41E-01	3.07E-01	7.54E+01	9.38E-01	0.00E+00	3.04E-01
CS-134	1.55E+05	2.89E+05	2.92E+04	0.00E+00	7.43E+04	3.05E+04	7.84E+02
CS-136	1.05E+04	3.08E+04	1.15E+04	0.00E+00	1.23E+04	2.51E+03	4.67E+02
CS-137	2.32E+05	2.71E+05	1.92E+04	0.00E+00	7.27E+04	2.94E+04	8.47E+02
CS-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-140	1.28E+03	1.28E+00	6.61E+01	0.00E+00	3.05E-01	7.88E-01	3.15E+02
BA-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA-140	3.05E-04	1.20E-04	3.09E-05	0.00E+00	0.00E+00	0.00E+00	1.41E+00
LA-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CE-141	2.07E-01	1.26E-01	1.49E-02	0.00E+00	3.89E-02	0.00E+00	6.52E+01
CE-143	3.20E-03	2.12E+00	2.42E-04	0.00E+00	6.18E-04	0.00E+00	2.24E+01
CE-144	9.82E+00	4.02E+00	5.50E-01	0.00E+00	1.62E+00	0.00E+00	5.63E+02
PR-143	7.86E-03	2.94E-03	3.90E-04	0.00E+00	1.09E-03	0.00E+00	4.15E+00
PR-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ND-147	4.81E-03	4.94E-03	3.02E-04	0.00E+00	1.90E-03	0.00E+00	3.13E+00
W-187	5.55E-01	3.86E-01	1.33E-01	0.00E+00	0.00E+00	0.00E+00	2.27E+01
NP-239	2.51E-04	2.24E-05	1.27E-05	0.00E+00	4.47E-05	0.00E+00	6.48E-01

GASEOUS MONITOR DETECTOR EFFICIENCIES

R15044, R15045, and R15546A
(Detector Model RD-52)

Nuclide	Efficiency* cpm/ μ Ci/cc
KR-83M	0.0
KR-85M	7.30 E+07
KR-85	7.19 E+07
KR-87	8.70 E+07
KR-88	8.70 E+07
KR-89	8.70 E+07
KR-90	8.70 E+07
XE-131M	0.0
XE-133M	0.0
XE-133	2.94 E+07
XE-135M	0.0
XE-135	7.75 E+07
XE-137	8.70 E+07
XE-138	8.70 E+07
AR-41	7.80 E+07

* From Calculation Z-RDM-I0261

DOSE FACTORS FOR NOBLE GASES AND DAUGHTERS

FACTORS FOR EXPOSURE TO A SEMI-INFINITE CLOUD
OF NOBLE GASES

Nuclide	Dose to People†		Dose to Air†	
	Gamma-Body	Beta-Skin	Gamma	Beta
	K(i)	L(i)	M(i)	N(i)
AR-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03
KR-83M	7.56E-02	0.00E+00	1.93E+01	2.88E+02
KR-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
KR-85M	1.17E+03	1.46E+03	1.23E+03	1.97E+03
KR-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
KR-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
KR-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
KR-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
XE-131M	9.15E+01	4.76E+02	1.56E+02	1.11E+03
XE-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
XE-133M	2.51E+02	9.94E+02	3.27E+02	1.48E+03
XE-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
XE-135M	3.12E+03	7.11E+02	3.36E+03	7.39E+02
XE-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
XE-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03

† -- mrem/yr per $\mu\text{Ci}/\text{m}^3$

† -- mrad/yr per $\mu\text{Ci}/\text{m}^3$

ORGAN DOSE FACTORS FOR GASEOUS EFFLUENTS

DOSE FACTOR TABLE: R(i) - Adult, inhalation

Units are mrem/yr per $\mu\text{Ci}/\text{m}^3$

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03
CR-51	0.00E+00	0.00E+00	1.00E+02	5.95E+01	2.28E+01	1.44E+04	3.32E+03
MN-54	0.00E+00	3.96E+04	6.30E+03	0.00E+00	9.84E+03	1.40E+06	7.74E+04
FE-55	2.46E+04	1.70E+04	3.95E+03	0.00E+00	0.00E+00	7.21E+04	6.03E+03
FE-59	1.18E+04	2.78E+04	1.06E+04	0.00E+00	0.00E+00	1.02E+06	1.88E+05
CO-58	0.00E+00	1.58E+03	2.07E+03	0.00E+00	0.00E+00	9.28E+05	1.06E+05
CO-60	0.00E+00	1.15E+04	1.48E+04	0.00E+00	0.00E+00	5.97E+06	2.85E+05
ZN-65	3.24E+04	1.03E+05	4.66E+04	0.00E+00	6.90E+04	8.64E+05	5.35E+04
SR-89	3.04E+05	0.00E+00	8.72E+03	0.00E+00	0.00E+00	1.40E+06	3.50E+05
SR-90	9.92E+07	0.00E+00	6.10E+06	0.00E+00	0.00E+00	9.60E+06	7.22E+05
ZR-95	1.07E+05	3.44E+04	2.33E+04	0.00E+00	5.42E+04	1.77E+06	1.50E+05
I-131	2.52E+04	3.58E+04	2.05E+04	1.19E+07	6.13E+04	0.00E+00	6.28E+03
I-133	8.64E+03	1.48E+04	4.52E+03	2.15E+06	2.59E+04	0.00E+00	8.88E+03
CS-134	3.73E+05	8.48E+05	7.28E+05	0.00E+00	2.87E+05	9.76E+04	1.04E+04
CS-136	3.91E+04	1.46E+05	1.10E+05	0.00E+00	8.56E+04	1.20E+04	1.17E+04
CS-137	4.79E+05	6.21E+05	4.28E+05	0.00E+00	2.23E+05	7.52E+04	8.40E+03
BA-140	3.91E+04	4.91E+01	2.57E+03	0.00E+00	1.67E+01	1.27E+06	2.18E+05
CE-141	1.99E+04	1.35E+04	1.53E+03	0.00E+00	6.27E+03	3.62E+05	1.20E+05
CE-144	3.43E+06	1.43E+06	1.84E+05	0.00E+00	8.48E+05	7.78E+06	8.16E+05

DOSE FACTOR TABLE: R(i) - Teen, inhalation,

Units are mrem/yr per $\mu\text{Ci}/\text{m}^3$

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03
CR-51	0.00E+00	0.00E+00	1.35E+02	7.50E+01	3.07E+01	2.10E+04	3.00E+03
MN-54	0.00E+00	5.11E+04	8.40E+03	0.00E+00	1.27E+04	1.98E+06	6.68E+04
FE-55	3.35E+04	2.39E+04	5.55E+03	0.00E+00	0.00E+00	1.24E+05	6.39E+03
FE-59	1.59E+04	3.70E+04	1.43E+04	0.00E+00	0.00E+00	1.53E+06	1.78E+05
CO-58	0.00E+00	2.07E+03	2.78E+03	0.00E+00	0.00E+00	1.34E+06	9.52E+04
CO-60	0.00E+00	1.51E+04	1.98E+04	0.00E+00	0.00E+00	8.72E+06	2.59E+05
ZN-65	3.86E+04	1.34E+05	6.24E+04	0.00E+00	8.64E+04	1.24E+06	4.67E+04
SR-89	4.35E+05	0.00E+00	1.25E+04	0.00E+00	0.00E+00	2.42E+06	3.71E+05
SR-90	1.08E+08	0.00E+00	6.68E+06	0.00E+00	0.00E+00	1.65E+07	7.65E+05
ZR-95	1.46E+05	4.59E+04	3.15E+04	0.00E+00	6.74E+04	2.69E+06	1.49E+05
I-131	3.55E+04	4.91E+04	2.64E+04	1.46E+07	8.40E+04	0.00E+00	6.49E+03
I-133	1.22E+04	2.05E+04	6.23E+03	2.92E+06	3.59E+04	0.00E+00	1.03E+04
CS-134	5.03E+05	1.13E+06	5.49E+05	0.00E+00	3.75E+05	1.46E+05	9.76E+03
CS-136	5.15E+04	1.94E+05	1.37E+05	0.00E+00	1.10E+05	1.78E+04	1.09E+04
CS-137	6.71E+05	8.48E+05	3.11E+05	0.00E+00	3.04E+05	1.21E+05	8.48E+03
BA-140	5.47E+04	6.71E+01	3.52E+03	0.00E+00	2.28E+01	2.03E+06	2.29E+05
CE-141	2.84E+04	1.90E+04	2.17E+03	0.00E+00	8.88E+03	6.14E+05	1.26E+05
CE-144	4.89E+06	2.02E+06	2.63E+05	0.00E+00	1.21E+06	1.34E+07	8.64E+05

ORGAN DOSE FACTORS FOR GASEOUS EFFLUENTS (Continued)

DOSE FACTOR TABLE: R(i) - Child, inhalation

Units are mrem/yr per $\mu\text{Ci}/\text{m}^3$

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	1.13E+03	1.13E+03	1.13E+03	1.13E+03	1.13E+03	1.13E+03
CR-51	0.00E+00	0.00E+00	1.54E+02	8.55E+01	2.43E+01	1.70E+04	1.08E+03
MN-54	0.00E+00	4.29E+04	9.51E+03	0.00E+00	1.00E+04	1.58E+06	2.29E+04
FE-55	4.74E+04	2.52E+04	7.77E+03	0.00E+00	0.00E+00	1.11E+05	2.87E+03
FE-59	2.07E+04	3.35E+04	1.67E+04	0.00E+00	0.00E+00	1.27E+06	7.07E+04
CO-58	0.00E+00	1.77E+03	3.16E+03	0.00E+00	0.00E+00	1.11E+06	3.44E+04
CO-60	0.00E+00	1.31E+04	2.27E+04	0.00E+00	0.00E+00	7.07E+06	9.62E+04
ZN-65	4.26E+04	1.13E+05	7.03E+04	0.00E+00	7.14E+04	9.96E+05	1.63E+04
SR-89	6.00E+05	0.00E+00	1.72E+04	0.00E+00	0.00E+00	2.16E+06	1.67E+05
SR-90	1.01E+08	0.00E+00	6.44E+06	0.00E+00	0.00E+00	1.48E+07	3.44E+05
ZR-95	1.90E+05	4.18E+04	3.70E+04	0.00E+00	5.96E+04	2.23E+06	6.11E+04
I-131	4.81E+04	4.81E+04	2.73E+04	1.63E+07	7.88E+04	0.00E+00	2.84E+03
I-133	1.66E+04	2.03E+04	7.70E+03	3.85E+06	3.38E+04	0.00E+00	5.48E+03
CS-134	6.51E+05	1.01E+06	2.25E+05	0.00E+00	3.31E+05	1.21E+05	3.85E+03
CS-136	6.51E+04	1.71E+05	1.16E+05	0.00E+00	9.55E+04	1.45E+04	4.18E+03
CS-137	9.07E+05	8.25E+05	1.28E+05	0.00E+00	2.82E+05	1.04E+05	3.62E+03
BA-140	7.40E+04	6.48E+01	4.33E+03	0.00E+00	2.11E+01	1.74E+06	1.02E+05
CE-141	3.92E+04	1.95E+04	2.90E+03	0.00E+00	8.55E+03	5.44E+05	5.66E+04
CE-144	6.77E+06	2.12E+06	3.62E+05	0.00E+00	1.17E+06	1.20E+07	3.89E+05

DOSE FACTOR TABLE: R(i) - Infant, inhalation

Units are mrem/yr per $\mu\text{Ci}/\text{m}^3$

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02
CR-51	0.00E+00	0.00E+00	8.95E+01	5.76E+01	1.32E+01	1.28E+04	3.57E+02
MN-54	0.00E+00	2.54E+04	4.99E+03	0.00E+00	4.99E+03	1.00E+06	7.06E+03
FE-55	1.97E+04	1.18E+04	3.33E+03	0.00E+00	0.00E+00	8.70E+04	1.10E+03
FE-59	1.36E+04	2.35E+04	9.48E+03	0.00E+00	0.00E+00	1.02E+06	2.48E+04
CO-58	0.00E+00	1.22E+03	1.82E+03	0.00E+00	0.00E+00	7.77E+05	1.11E+04
CO-60	0.00E+00	8.03E+03	1.18E+04	0.00E+00	0.00E+00	4.51E+06	3.19E+04
ZN-65	1.93E+04	6.26E+04	3.11E+04	0.00E+00	3.25E+04	6.47E+05	5.14E+04
SR-89	3.98E+05	0.00E+00	1.14E+04	0.00E+00	0.00E+00	2.03E+06	6.40E+04
SR-90	4.09E+07	0.00E+00	2.59E+06	0.00E+00	0.00E+00	1.12E+07	1.31E+05
ZR-95	1.15E+05	2.79E+04	2.03E+04	0.00E+00	3.11E+04	1.75E+06	2.17E+04
I-131	3.80E+04	4.44E+04	1.96E+04	1.48E+07	5.18E+04	0.00E+00	1.06E+03
I-133	1.32E+04	1.92E+04	5.60E+03	3.56E+06	2.24E+04	0.00E+00	2.16E+03
CS-134	3.96E+05	7.03E+05	7.45E+04	0.00E+00	1.90E+05	7.97E+04	1.33E+03
CS-136	4.83E+04	1.35E+05	5.29E+04	0.00E+00	5.64E+04	1.18E+04	1.43E+03
CS-137	5.49E+05	6.12E+05	4.55E+04	0.00E+00	1.72E+05	7.13E+04	1.33E+03
BA-140	5.60E+04	5.60E+01	2.90E+03	0.00E+00	1.34E+01	1.60E+06	3.84E+04
CE-141	2.77E+04	1.67E+04	1.99E+03	0.00E+00	5.25E+03	5.17E+05	2.16E+04
CE-144	3.19E+06	1.21E+06	1.76E+05	0.00E+00	5.38E+05	9.85E+06	1.48E+05

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Instrument	Minimum Number of Channels Operable	Action
<p>1. Gross Radioactivity Monitors Providing Automatic Termination of Release</p> <p>Retention Basin Effluent Discharge Monitor (R15017A)</p>	1	<p>With the monitor inoperable, effluent releases may be resumed provided that prior to initiating a release from the retention basin:</p> <ol style="list-style-type: none"> 1) At least two independent samples are analyzed in accordance with Step 6.14.2. 2) At least two technically qualified members of the Facility Staff independently verify the release rate calculations and discharge line valving. <p>Otherwise, suspend release of radioactive effluents via the pathway. Exert best efforts to return the monitor to OPERABLE status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperable monitor was not restored in a timely manner.</p>
<p>2. Flow Measurement Devices</p> <p>Waste Water Flow Rate and Totalizer (FIRQ95108)</p>	1	<p>With the flow measurement device inoperable, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours during retention basin releases by a level device in the discharge stream.</p>
<p>Retention Basin Discharge Flow Rate (FI95001)</p>	1	<p>With the flow rate measurement device inoperable, effluent releases via this pathway may continue provided that the Retention Basin discharge flow rate is estimated using the Waste Water Flow Rate instrument.</p>

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE
REQUIREMENTS

<u>Instrument</u>	<u>Instrument Channel Check</u>	<u>Source Check</u>	<u>Instrument Channel Calibration</u>	<u>Channel Test</u>
1. Gross Radioactivity Monitors Providing Alarm and Automatic Termination Isolation				
Retention Basin Effluent Discharge Monitor (R15017A)	D ⁽¹⁾	P	R ⁽²⁾	Q ⁽³⁾
2. Flow Monitors				
Waste Water Flow Rate and Totalizer (FIRQ95108)	D ⁽⁴⁾	N/A	R	Q
Retention Basin Discharge Flow Rate (FI95001)	D ⁽⁴⁾	N/A	R	Q

Table Notation

- (1) During releases via this pathway, a check shall be performed at least once per 24 hours. Normally, checks are automatically performed once every eight (8) hours.
- (2) The Instrument Channel Calibration for radioactivity measurement instrumentation shall be performed using one or more reference standards.
- (3) The Channel Test shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occurs if any of the following conditions exist:
 - A. Instrumentation indicates measured levels above the alarm/trip setpoint.
 - B. Circuit failure.
 - C. Instrument indicates a downscale failure.
 - D. Instrument controls not set in operate mode.
- (4) The Instrument Channel Check shall consist of verifying indication of flow during periods of release. The Instrument Channel Check shall be made at least once daily on any day in which batch releases are made.

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity	Lower Limit of Detection (LLD) ^(a) (µCi/ml)
A. Retention Basin (N/S) ^(b)	Each Batch	Each Batch	Mn-54, Co-60, Zn-65, Cs-134, Cs-137, Ce-144	3.00 E-07
	P	P	H-3	1.00 E-05
B. Regenerant Holdup Tank (A/B) ^(c,d) Standard Release Scenario ^(f)	Each Batch P	Each Batch P	Mn-54, Co-60	4.00 E-09
			Zn-65	6.00 E-09
			Cs-134, Cs-137	3.00 E-09
			Ce-144	6.00 E-08
	Each Batch P	Composite ^(e) M	Sr-90	1.00 E-09
			Gross Alpha	1.00 E-07
C. Regenerant Holdup Tank (A/B) ^(c,d) Rapid Release Scenario ^(f)	Each Batch P	Each Batch P	Mn-54, Co-60, Zn-65, Cs-134, Cs-137	2.00 E-08
			Ce-144	6.00 E-08
			H-3	1.00 E-05
	Each Batch P	Composite ^(e) M	Mn-54, Co-60	4.00 E-09
			Zn-65	6.00 E-09
			Cs-134, Cs-137	3.00 E-09
			Sr-90	1.00 E-09
			Gross Alpha	1.00 E-07

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

(Continued)

Table Notation

- (a) 1. The Lower Limits of Detection (LLDs) for the radionuclides presented in this table are the smallest concentrations (expressed in microcuries per milliliter) which are required to be detected, if present, in order to achieve compliance with the limits of Step 6.14.3 (10 CFR 50, Appendix I) for a RHUT transfer to a retention basin and assurance of compliance with the limits of Step 6.14.2 (10 CFR 20, Appendix B, Table 2, Column 2) for a Retention Basin Discharge.
2. The LLD of a radioanalysis system is that value which will indicate the presence or absence of radioactivity in a sample when the probability of a false positive and of a false negative determination is stated. The probabilities of the false positive and false negative are taken as equal at 0.05. The general equation for estimating the maximum LLD in microcuries per milliliter is given by the following:

$$LLD = \frac{2.71/t_s + 3.29 \times S_b}{(3.70 \text{ E} + 04)(Y \times E \times V)e^{(-\lambda t_c)}}$$

Where:

- 2.71 = factor to account for Poisson statistics at very low background count rates.
- 3.29 = two times the constant used to establish the one sided 0.95 confidence interval
- 3.70 E+04 = disintegrations/second/microcurie
- Y = yield of radiochemical process, i.e., the product of all factors such as emission fraction, chemical yield, etc.
- E = counting efficiency (count/disintegrations)
- V = sample volume (milliliters)
- λ = the radioactive decay constant for the particular nuclide (seconds⁻¹)
- t_c = the elapsed time from midpoint of collection to the midpoint of counting

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM (Continued)Table Notation (Continued)

S_b = the standard deviation of the background counting rate

$$S_b = \left(\frac{B}{t_b t_s} + \frac{B}{t_b^2} \right)^{0.5}$$

Where:

B = background counts

t_b = background counting interval (seconds)

t_s = sample counting interval (seconds)

3. The LLD is defined as an a priori (before the fact) estimate and is not to be calculated for each sample analyzed on an a posteriori (after the fact) basis.
- (b) A batch release is the discharge of liquid wastes of discrete volume from the north or south Retention Basin. The Retention Basins are the maximum permissible concentration accountability points for 10 CFR 20, Appendix B compliance.
- (c) A RHUT will be isolated and its contents thoroughly mixed to assure representative sampling prior to transferring the contents to a Retention Basin. The A and B RHUTs are the dose equivalent accountability points for 10 CFR 50, Appendix I compliance.
- (d) Isotopic peaks which are measurable and identifiable from a RHUT sample analysis shall be reported and included in ODCM evaluations. Nuclides which are not observed in the analysis shall be reported as "less than" the nuclide's a posteriori minimum detectable concentration and shall not be reported as being present. The "less than" results shall be considered "zero" for the purposes of ODCM evaluations; however, if a nuclide is measured and identified at a value less than the Attachment 15 LLD value, it shall be reported and entered in ODCM evaluations.
- (e) A composite sample shall be obtained by mixing liquid aliquot volumes in proportion to the volume of liquid released from each RHUT. Preparation of the composite is identical no matter which release scenario, or combination of scenarios, was used to release the RHUTs. If any RHUT which is part of the composite was released using the Rapid Release Scenario, the composite will be analyzed according to the Rapid Release Scenario.

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM (Continued)Table Notation (Continued)

- (f) Release of each RHUT may proceed along either of two separate scenarios depending on operational requirements. Normally, the Standard Release Scenario will be used for RHUT releases. The Rapid Release Scenario will be used when operational requirements dictate expediting the release process. In either scenario, the sample must eventually be analyzed to an LLD level which equates to an off-site dose of less than 10 percent of the 10 CFR 50, Appendix I guidelines. Preparation of the Monthly Composite is independent of the scenario used to release each RHUT during a calendar month: the composite must be prepared for either scenario, only the analysis requirements differ. These Lower Limits of Detection for either or both scenario may change as the maximum annual effluent outflow or the minimum annual average flow rate in the plant effluent stream changes.
1. Standard Release Scenario. This scenario uses the lower LLDs on a pre-release basis, resulting in correspondingly longer analysis intervals. In this scenario, the monthly composite does not need to be analyzed for gamma emitters. The pre-release and post-release (monthly composite) LLDs equate to an off-site dose of less than 10 percent of the 10 CFR 50, Appendix I guidelines.
 2. Rapid Release Scenario. This scenario allows the use of higher LLDs for pre-release dose calculations, resulting in correspondingly shorter analysis intervals. The pre-release LLDs equate to an off-site dose of less than 20 percent of the 10 CFR 50, Appendix I guidelines. The post-release (monthly composite) LLDs equate to an off-site dose of less than 10 percent of the 10 CFR 50, Appendix I guidelines. H-3 and Ce-144 analyses are specifically required only on a pre-release basis. The LLDs for H-3 and Ce-144 are required for the pre-release analysis only, however, these LLDs were included in the determination of post-release LLDs which meet the 10 percent criteria.

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

<u>Instrument</u>	<u>Minimum Number of Channels Operable</u>	<u>Action</u>
1. Reactor Building Stack		
a. Noble Gas Activity Monitor providing alarm and automatic termination of release.	1	With the monitor channel alarm/trip setpoint less conservative than the setpoint calculated as described in Step 6.6, immediately suspend the release or declare the channel inoperable. With the monitor inoperable, effluent releases via this pathway may continue provided grab samples are taken at least daily and these samples are analyzed in accordance with Attachment 18. Increase grab sample frequency as necessary during unusual plant conditions.
b. Particulate Sampler	1	With the collection device inoperable, effluent releases via this pathway may continue provided continuous samples are taken within 1 hour after the monitor is declared inoperable and these samples are analyzed in accordance with Attachment 18*.
c. Sampler Flow Rate Measurement Device	1	With the flow rate device inoperable, effluent releases via this pathway may continue provided the flow rate is estimated and recorded daily.

* Interruption of continuous sampling is allowed for periods not to exceed 1 hour.

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
(Continued)

<u>Instrument</u>	<u>Minimum Number of Channels Operable</u>	<u>Action</u>
2. Auxiliary Building Stack		
a. Noble Gas Activity Monitor	1	With the monitor alarm/trip setpoint less conservative than the setpoint calculated as described in Step 6.6, immediately suspend the release or declare the channel inoperable. With the monitor inoperable, effluent releases via this pathway may continue provided grab samples are taken at least daily (every 12 hours during fuel handling activities) and these samples are analyzed in accordance with Attachment 18. Increase grab sample frequency as necessary during unusual plant conditions.
b. Particulate Sampler	1	With the collection device inoperable, effluent releases via this pathway may continue provided continuous samples are taken within 1 hour after the monitor is declared inoperable and these samples are analyzed in accordance with Attachment 18*.
c. Sampler Flow Rate Measurement Device	1	With the flow rate device inoperable, effluent releases via this pathway may continue provided the flow rate is estimated and recorded daily.

* Interruption of continuous sampling is allowed for periods not to exceed 1 hour.

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
(Continued)

<u>Instrument</u>	<u>Minimum Number of Channels Operable</u>	<u>Action</u>
3. Auxiliary Building Grade Level Vent		
a. Noble Gas Activity Monitor	1	With the monitor alarm/trip setpoint less conservative than the setpoint calculated as described in Step 6.6, immediately suspend the release or declare the channel inoperable. With the monitor inoperable, effluent releases via this pathway may continue provided grab samples are taken at least daily and these samples are analyzed in accordance with Attachment 18. Increase grab sample frequency as necessary during unusual plant conditions.
b. Particulate Sampler	1	With the collection device inoperable, effluent releases via this pathway may continue provided continuous samples are taken within 1 hour after the monitor is declared inoperable and these samples are analyzed in accordance with Attachment 18*.
c. Sampler Flow Rate Measurement Device	1	With the flow rate device inoperable, effluent releases via this pathway may continue provided the flow rate is estimated and recorded daily.
4. IOS Building Vent		
a. Particulate Monitor	1	With the monitor inoperable, ventilation flow shall be halted or continuous particulate samples shall be taken in accordance with Attachment 18, Section D, for particulate samples.

* Interruption of continuous sampling is allowed for periods not to exceed 1 hour.

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE
REQUIREMENTS

Instrument	Instrument Channel Check	Source Check	Instrument Channel Calibration	Channel Test
1. Reactor Building Stack				
a. Noble Gas Activity Monitor	D	M ⁽⁴⁾	R ⁽³⁾	Q ⁽¹⁾
b. Particulate Sampler	W	NA	NA	NA
c. Sampler Monitor Flow Rate Measurement Device	D	NA	R	Q
2. Auxiliary Building Stack				
a. Noble Gas Activity Monitor	D	M	R ⁽³⁾	Q
b. Particulate Sampler	W	NA	NA	NA
c. Sampler Monitor Flow Rate Measurement Device	D	NA	R	Q
3. Auxiliary Building Grade Level Vent				
a. Noble Gas Activity Monitor	D	M	R ⁽³⁾	Q ⁽²⁾
b. Particulate Sampler	W	NA	NA	NA
c. Sampler Monitor Flow Rate Measurement Device	D	NA	R	Q
4. IOS Building Vent				
a. Particulate Sampler	M	NA	R	SA

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE
REQUIREMENTS (Continued)

Table Notation

- (1) The CHANNEL TEST shall also demonstrate that automatic termination of the purge and control room alarm annunciation occurs if any of the following conditions exist:
 - Instrument indicates measured levels above the alarm/trip setpoint.
 - Circuit failure.
 - Instrument indicates a downscale failure.
 - Instrument controls not set in operate mode.
- (2) The CHANNEL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exist:
 - Instrument indicate measured levels above the alarm/trip setpoint.
 - Circuit failure.
 - Instrument indicates a downscale failure.
 - Instrument controls not set in operate mode.
- (3) The INSTRUMENT CHANNEL CALIBRATION shall be performed using one or more reference standards.
- (4) A check shall be performed prior to each release and monthly during periods of continuous purging.

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) ^(a) (μCi/ml)
A. Reactor Building Stack	M Grab Sample	M	Kr-85	1.00 E-04
			H-3	1.00 E-06
B. Auxiliary Building Stack	M ^(b) Grab Sample	M	Kr-85	1.00 E-04
			H-3	1.00 E-06
C. Auxiliary Building Grade Level Vent	M Grab Sample	M	Kr-85	1.00 E-04
			H-3	1.00 E-06
D. All Release Types as listed in A, B, C above	Continuous	M Particulate Sample	Principal Gamma Emitters ^(c)	1.00 E-11
			Gross Alpha ^(e)	1.00 E-11
	Continuous	Continuous (Noble Gas Monitor)	Noble Gases, Gross Beta and Gamma	1.00 E-04 as Xe-133

Table Notation

- (a) 1. The Lower Limits of Detection (LLDs) for the radionuclides presented in this table are the smallest concentration (expressed in microcuries per unit volume) which are required to be detected, if present, in order to achieve compliance with the limits of the Specifications in Steps 6.14.6, 6.14.7, and 6.14.8.
2. The LLD of a radioanalysis system is that value which will indicate the presence or absence of radioactivity in a sample when the probability of a false positive and of a false negative determination is stated. The probabilities of the false positive and false negative are taken as equal at 0.05. The general equation for estimating the maximum LLD in microcuries per milliliter is given by the following:

$$LLD = \frac{2.71/t_s + 3.29 \times S_b}{(3.70 \text{ E} + 04)(Y \times E \times V)e^{(-\lambda t_c)}}$$

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM
(Continued)

Where:

2.71 = factor to account for Poisson statistics at very low background count rates

3.29 = two times the constant used to establish the one sided 0.95 confidence interval

3.70 E+04 = disintegrations/second/microcurie

Y = yield of radiochemical process, i.e., the product of all factors such as emission fraction, chemical yield, etc.

E = counting efficiency (count/disintegrations)

V = sample volume (milliliters)

λ = the radioactive decay constant for the particular nuclide (seconds⁻¹)

t_c = the elapsed time from midpoint of collection to the midpoint of counting

S_b = the standard deviation of the background counting rate

$$S_b = \left(\frac{B}{t_b t_s} + \frac{B}{t_b^2} \right)^{0.5}$$

Where:

B = background counts

t_b = background counting interval (seconds)

t_s = sample counting interval (seconds)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM (Continued)Table Notation (Continued)

3. The LLD is defined as an a priori (before the fact) estimate and is not to be calculated for each sample analyzed on an a posteriori (after the fact) basis.
- (b) Tritium grab samples shall be taken at least once per seven days from the ventilation exhaust from the auxiliary building stack anytime fuel is in the spent fuel pool and the pool temperature exceeds 110°F. Below 110°F there is essentially no evaporation from this source.
- (c) Principal gamma emitters for which the LLD applies are: Kr-85 for gaseous samples and Mn-54, Co-60, Zn-65, Cs-134, Cs-137, and Ce-144 for particulate samples. This does not mean only these nuclides will be detected and reported. Other peaks that are measurable and identifiable shall be reported in the Annual Radioactive Effluent Release Report, pursuant to Step 6.15.1. All peaks which are measurable and identifiable shall be reported and entered into the ODCM evaluations. Nuclides which are not observed for the analysis shall be reported as "less than" the nuclide's a posteriori minimum detectable concentration and shall not be reported as being present. The "less than" results shall be considered "zero" for the ODCM evaluations; however, if a nuclide is measured and identified at a value less than the Attachment 18 LLD value, it shall be reported and entered into ODCM evaluations.
- (d) A gross beta analysis is performed on a monthly basis for each environmental release particulate sample. If any one of these samples indicates greater than $1.0E-11$ $\mu\text{Ci/cc}$ gross beta Sr-90 activity, then an analysis will be performed on those samples exceeding this value.
- (e) A gross alpha analysis is performed on a monthly basis for each environmental release particulate sample. This fulfills the requirements of performing a monthly composite.

ODCM REVISION REVIEW REQUIREMENTS

ODCM REVISION REVIEW REQUIREMENTS

Whenever the ODCM is revised, no matter what the changes are, several reviews must be performed. These reviews must also be documented. The documentation is often included as an attachment to the 50.59 Safety Determination. This form lists the minimum reviews and documentation required for each change. Initial each requirement as it is completed. Sign the bottom of the form when all review requirements are completed.

Initials

I. Determination that the level of control of radioactive effluents is being maintained.

This determination is made by review of the following documents:

- 10 CFR 20.1301 and 20.1302
- 10 CFR 50.36a
- Appendix I to 10 CFR 50
- 40 CFR 190

II. Determination that the change(s) will not adversely affect the accuracy or reliability of effluent dose calculations or effluent monitor setpoint determinations.

This determination is made by directly reviewing each change to the ODCM. Although each change must be evaluated, changes that directly involve calculations should be more carefully considered.

III. Supporting information.

Full justification including analyses and evaluations to support the change(s) must be included in the review and approval package.

IV. Notification of NRC.

The NRC is notified of all changes to the ODCM by including a complete, legible copy as part of, or concurrent with, the Annual Radioactive Effluent Release Report (ARERR). To ensure inclusion in the ARERR, a TS item should be initiated whenever the ODCM is revised.

V. Implementing Documents.

The following documents should be reviewed for impact whenever the ODCM is revised:

- CAP-0008, Offsite Releases of Radioactivity in Liquid Effluents
- CAP-0009, Offsite Releases of Radioactivity in Liquid Effluents
- CAP-0013, Preparation of the Annual Radioactive Effluent Release Report
- CHM-5107, Compositing of Liquid Samples
- CHM-5109, Effluent Monitor Alarm Response Procedure

VI. Multidiscipline Review

Ensure all areas that may be affected by the revision, or have an interest in the changes made in the revision, are included in the multidiscipline review. Areas that are affected by the ODCM and could be included in this review are: Technical Services, Surveillance Scheduler, Quality Assurance, Licensing, and Operations.

All Reviews Complete: _____
 Reviewer Signature Date

RSNGS ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
JANUARY - DECEMBER 1999

ATTACHMENT 2

MANUAL: CHEMISTRY ADMINISTRATIVE
PROCEDURES MANUAL

NUMBER: CAP-0002

TITLE: OFF-SITE DOSE CALCULATION MANUAL

REVISION: 11

PAGE: 1 of 76

LEAD DEPARTMENT:
RADIATION PROTECTION/CHEMISTRY

EFFECTIVE DATE:
12-30-99

SCOPE OF REVISION:

1. Allow minor repairs to Ventilation Exhaust Treatment System Filters without immediate aerosol particulate testing.

**THIS PROCEDURE IS ISSUED FOR INFORMATION ONLY AND
SHALL NOT BE USED FOR WORK OR DESIGN.**

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1.0 PURPOSE

The Off-site Dose Calculation Manual (ODCM) contains the methodology and parameters used in the calculation of off-site doses due to radioactive gaseous and liquid effluents. Also, the ODCM contains the methodology for determining effluent monitoring instrumentation alarm/trip setpoints. Methods are described for assessing compliance with the Technical Requirements in the ODCM as they apply to 10 CFR Parts 20.1301 and 20.1302, 10 CFR Part 50, Appendix I, and 40 CFR 190.10a for liquid and gaseous effluents. Additionally, the ODCM contains the Technical Requirements which provide the Specifications, Applicabilities, Actions, and Surveillance Requirements.

2.0 SCOPE

This procedure functions as a manual that provides the basis for development of detailed implementing procedures that address dose calculations for liquid/gaseous releases and monitor setpoints. Additionally, this manual provides the Technical Requirements that govern releases of liquid and gaseous radioactive releases off-site.

3.0 REFERENCES/COMMITMENT DOCUMENTS

3.1 Commitment Documents

- 3.1.1 Code of Federal Regulations, Title 10, Chapter 1, Parts 20, 50.36a and Part 50, Appendix I
- 3.1.2 Rancho Seco Permanently Defueled Technical Specifications (PDTS)
- 3.1.3 EPA 40 CFR Parts 302, 355 Reporting Requirements
- 3.1.4 40 CFR 190, Environmental Radiation Protection Standards for Nuclear Power Plant Operations

3.2 Reference Documents

- 3.2.1 USNRC Regulatory Guide 1.109, Rev. 1, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, October 1977
- 3.2.2 W. C. Burke, et. al., Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants, NUREG-0133, USNRC:NRR, October 1978
- 3.2.3 ORNL, User's Manual for LADTAP II, NUREG/CR-1276, May 1980
- 3.2.4 D. L. Strange, et. al., LADTAP-II, Technical Reference and User Guide, NUREG/CR-4013, Pacific Northwest Laboratory, April 1986
- 3.2.5 Eckerman, K. F., et. al., User's Guide to GASPAR Code, NUREG-0597, USNRC:NRR, June 1980, in RSIC CCC-463

3.2.6 USNRC Regulatory Guide 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors

3.2.7 USNRC Regulatory Guide 1.21, Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants

3.2.8 USNRC Regulatory Guide 4.1, Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants

3.2.9 REIMS Software Life Cycle Documents (Software Requirement Specification, Design Document, Acceptance Test Plan)

3.2.10 USNRC & Pacific Northwest Laboratory, TDMC Computer Code/Data Collections, XOQDOQ-82, Radiological Assessment Code System Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations

3.2.11 1992 Rancho Seco Land Use Census

3.2.12 RSNRS USAR Chapters 11.1-11.5

3.2.13 RSNRS P&ID Drawing M-563, M-551, M-552, M-503

3.2.14 Pacific Northwest Laboratory, XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations

3.2.15 Congel, F. J., Methods for Demonstrating LWR Compliance with the EPA Uranium Fuel Cycle Standard (40 CFR Part 190), NUREG-0543, USNRC:NRR, February 1980

3.2.16 USNRC Generic Letter, 89-01, Dated January 31, 1989.

3.2.17 Rancho Seco REMP Manual

3.2.18 Engineering Calculation Z-RDM-I0279, Interim On-site Storage (IOS) Building Effluent Radiation Monitor (R15106) Setpoint Determination

3.2.19 PDQ 92-063

3.2.20 RP.312.I.14, Occupational Radiation Exposure Limits and Extensions

3.2.21 DQ 96-0055, ABGLV flow rate measured above default value

4.0 DEFINITIONS

4.1 Member of the Public

Member of the Public means any individual except when that individual is receiving an occupational dose.

4.2 Occupational Dose

Occupational Dose means the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation and/or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the public.

4.3 Public Dose

Public Dose means the dose received by a Member of the Public from exposure to radiation and/or radioactive material released by a licensee, or to any other source of radiation under the control of a licensee. It does not include occupational dose or doses received from background radiation, as a patient from medical practices, or from voluntary participation in medical research programs.

4.4 Batch Release

A Liquid Batch Release for 10 CFR 50 Appendix I considerations is a transfer of a discrete volume of radioactive liquid from a RHUT to a retention basin. A Liquid Batch Release for 10 CFR 20 considerations is a transfer of a discrete volume of radioactive liquid from a retention basin to the Waste Water discharge canal (the Environmental Release Point).

A Gaseous Batch Release is the discharge of gaseous radioactive wastes of discrete volume. Batch releases for the gaseous pathway are no longer planned.

4.5 Continuous Release

A continuous radioactive gaseous release is the discharge of gaseous wastes of a nondiscrete volume from a system that may have an input flow during the release. These include the Auxiliary Building Stack (ABS), Auxiliary Building Grade Level Vent (ABGLV), and continuing Reactor Building purges.

Continuous radioactive liquid releases are not planned to be made from Rancho Seco Nuclear Generating Station (RSNGS).

4.6 Default Radionuclide Mix

A historical mixture of radionuclides that may be used to determine monitor setpoints.

4.7 Dilution Flow

The volume or volume rate of fluid (liquid or gas) which is added to a radiological release stream for the purpose of decreasing the instantaneous concentration of the stream.

4.8 Maximum Exposed (Hypothetical) Individual

The Maximum Exposed Individual is characterized as "maximum" with regard to food consumption, occupancy, and other usage or exposure pathway parameters in the vicinity of Rancho Seco that would represent an individual with habits greater than usually expected for the average of the population in general.

Maximum dose factor parameters will be determined using site specific data from the Land Use Census. If information needed to determine a parameter is not available, RG 1.109 parameters will be used. All dose factor parameters used are listed in Attachment 3.

4.9 RSNGS

Rancho Seco Nuclear Generating Station.

4.10 Site Boundaries

The Site Boundaries are defined by the drawings in Attachments 5 and 6.

4.11 Nuisance Pathways

- (1) Secondary system gaseous pathways where the calculated dose totals contribute less than 5% of the annual limits and do not need to be tracked for dose calculational purposes unless secondary activity reaches a predetermined Action Level.
- (2) Sources of trace levels of radioactivity in liquid effluents where the calculated dose totals contribute less than 1% of the annual limits and do not need to be tracked for dose calculational purposes. Trace levels are defined to be less than $1E-8$ $\mu\text{Ci/ml}$ for the nuclides typically released from RSNGS. Examples include the oily water separator, plant effluent inlet, and storm drains.

4.12 Unplanned Release

The unexpected release of radioactive materials to unrestricted areas in gaseous and liquid effluent. All unplanned releases shall be discussed in the Annual Radiological Effluent Release Report (ARERR) to the NRC.

4.13 Miscellaneous Release

Release pathways which are considered planned but are not defined explicitly with monitoring requirements in this procedure. These pathways contribute a relatively small percentage (<5%) to the annual dose limits but shall be tracked for effluent activity accounting and dose calculation purposes. Miscellaneous releases shall not be reported in the ARERR as abnormal or unplanned releases. The IOS Building is an example of a Miscellaneous Release.

4.14 Safety Factor (SF)

A number greater than unity used in calculations to introduce greater conservatism (larger margin of safety) to offset various uncertainties in instrumentation and methods. Safety factors are set by Radiation Protection/Chemistry Supervision based on either analysis or professional judgment. Unless otherwise specified, the default value is two (2).

4.15 Liquid Effluent Radwaste Treatment System (LERTS)

The Liquid Effluent Radwaste Treatment System is a system designed to reduce the quantity of radioactive materials in liquid effluents by collecting liquid effluent and providing processing for the purpose of reducing the total radioactivity prior to its release to the environment.

4.16 Ventilation Exhaust Treatment System (VETS)

The Ventilation Exhaust Treatment System is the Reactor Building Purge Exhaust Filtering System and Auxiliary and Spent Fuel Building Filter Systems. These systems are designed and installed to reduce radioactive material in exhaust gases through HEPA filters for the purpose of removing particulates from the gaseous exhaust stream prior to the release to the environment (such a system is not considered to have any effect on noble gas effluents). Engineered Safety Feature (ESF) atmospheric cleanup systems are not considered to be Ventilation Exhaust Treatment System components.

4.17 Instrument Surveillance

(1) Source Check

A source check is the qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.

(2) Channel Test

A channel test is the injection of an internal or external test signal into the channel to verify its proper response, including alarm and/or trip initiating action, where applicable.

(3) Instrument Channel Check

An instrument channel check is a verification of acceptable instrument performance by observation of its behavior and/or state; this verification includes comparison of output and/or state of independent channels measuring the same variable.

(4) Instrument Channel Calibration

An instrument channel calibration is a test, and adjustment (if necessary), to establish that the channel output responds with acceptable range and accuracy to known values of the parameter which the channel measures or an accurate simulation of these values. Calibration shall encompass the entire channel, including equipment actuation, alarm, or trip and shall be deemed to include the channel test.

4.18 Surveillance Intervals

The Surveillance Interval may be extended to a maximum of +25% to accommodate operations scheduling. The frequency notation (which follows the name of the Surveillance Interval in parenthesis) specified for the performance of Surveillance Requirements shall correspond to the Surveillance Intervals defined below.

- (1) Shift (S): A time period covering at least once per twelve (12) hours.
- (2) Daily (D): A time period spaced to occur at least once per twenty four (24) hours.
- (3) Weekly (W): A time period spaced to occur at least once per seven (7) days.
- (4) Monthly (M): A time period spaced to occur at least once per thirty one (31) days.
- (5) Quarterly (Q): A time period spaced to occur at least once per ninety two (92) days.
- (6) Semiannually (SA): A time period spaced to occur at least once per six (6) months.
- (7) Annually (A): A time period spaced to occur at least once per twelve (12) months.
- (8) Refueling Interval (R): A time period spaced to occur at least once per eighteen (18) months.
- (9) Each Release (P): This surveillance will be completed prior to each release.

4.19 Radiological Effluent Information Management System (REIMS)

The computer software and database that tracks the volume and activity of released radioactive effluents. In addition, the software provides the basis for the permitting process, calculates dose to man, and summarizes data for inclusion into the ARERR.

4.20 Operable/Operability

A component or system is Operable when it is capable of performing its intended function within the required range. The component or system shall be considered to have this capability when: (1) it satisfies the Specifications in Section 6.14, (2) it has been tested periodically in accordance with the Surveillance Requirement in Section 6.14 and has met its performance requirements, (3) the system has available its source of power, and (4) its required auxiliaries are maintained available and capable of performing their intended function.

5.0 RESPONSIBILITIES

5.1 Radiation Protection/Chemistry Superintendent

It is the responsibility of the RP/Chem Superintendent for the following:

- 1) ODCM Revisions and Reporting the Revisions in the Annual Radioactive Effluent Release Report (ARERR)
- 2) ARERR Preparation and Submittal
- 3) REIMS Database
- 4) LADTAP, GASPAP, and XOQDOQ Computer Program Verifications and Changes

5.2 PRC

The PRC is responsible for reviewing and accepting all changes to the ODCM with approval by the Plant Manager per Permanently Defueled Technical Specifications.

6.0 PROCEDURE

6.1 General Considerations

6.1.1 Liquid Effluent Pathways

Attachment 1 provides an information only simplified diagram of the liquid effluent produced by RSNGS. The liquid effluent discharge of RSNGS forms the headwaters of Clay Creek.

Dilution of the liquid effluent occurs off-site at the confluence of Clay and Hadselville Creeks, and of Hadselville and Laguna Creeks, and at the confluence of Laguna Creek and the Cosumnes River.

Planned radioactive liquid releases are directed through the A or B RHUTs to give reasonable assurance of compliance with 10 CFR 50 Appendix I prior to their discharge to the retention basins (North or South). Prior to discharge from the retention basins to the plant effluent (off-site), the discharge rate from the retention basins and the amount of dilution from Folsom South Canal are controlled to ensure compliance with the concentration requirements in 10 CFR 20.

6.1.2 Gaseous Effluent Pathways

Airborne radioactive material in the various rooms and systems at RSNGS is routed and discharged in airborne effluent as illustrated schematically in Attachment 2. The figure shows the functional arrangements of these streams, treatment and controls, radioactivity monitoring points, and effluent release points.

Potential release pathways other than those specified in Attachment 2 have been identified. These release pathways are classified as NUISANCE pathways and include the following:

- 1) Auxiliary Boiler Vents/Reliefs
- 2) Miscellaneous Secondary System Steam Discharges
- 3) Tank Atmospheric Vents

Past experience has shown that the above release pathways do not contribute to the dose totals because of the small quantities released and the low concentration of radioactive materials. Therefore, Action Levels may be established for the secondary system concentrations of radioactive material to trigger when the above routine gaseous effluent releases shall be evaluated for off-site dose impact. The Action Levels shall be based on levels that could contribute more than 5% to the most restrictive yearly dose limit. Action Levels shall be maintained through RSNGS procedures.

Unplanned releases shall be evaluated on a case by case basis.

The Interim On-site Storage (IOS) Building is a miscellaneous release.

6.1.3 Meteorological Data

The atmospheric dispersion (X/Q) and deposition (D/Q) factors used in calculations involving airborne effluent are conservative default values. The default X/Q value is $1.0E-4 \text{ sec/m}^3$, and the default D/Q value is $1.0E-6 \text{ m}^{-2}$. These factors should be used to determine monitor setpoints, assess compliance with the gaseous effluent requirements in Section 6.14, and calculate the gaseous effluent dose reported in the ARERR.

Attachment 4 contains dispersion and deposition factors calculated using actual meteorological data. These factors should not be used for dose calculations. They are presented for historical information only. The factors are based on a 10-year annual average of meteorological data taken from January 1978 to December 1987. The raw data was converted to X/Q and D/Q factors using the XOQDOQ computer program.

6.1.4 Boundaries

The Site Boundary for Gaseous Effluents as shown in Attachment 5 is for all calculations involving gaseous effluents. The Site Boundary for Liquid Effluents as shown in Attachment 6 is for all calculations involving liquid effluents. (Although the RHUTs are used as the dose accountability points for liquid effluents, the dose is considered to be received downstream of the boundary.)

6.1.5 40 CFR 190 Compliance

For the purposes of assessing compliance with 40 CFR 190, the MEMBER OF THE PUBLIC which received the most exposure may be determined using actual food consumption, actual occupancy rates, and dilution off-site from additional converging streams (verses assumptions used for a HYPOTHETICAL MAXIMUM EXPOSED INDIVIDUAL based on Land Use Census data).

6.1.6 Computers vs. Manual Calculations

Computer systems such as REIMS should be used for calculations in order to minimize error and hasten the release process. However, in the event computers are not available for calculations, manual pre-release calculations should be done based on the most historically restrictive receptor.

6.2 Liquid Monitor Setpoints

The High alarm setpoint for the Retention Basin Effluent Discharge Monitor (R15017A) is based upon preventing the limits of the Specification in Step 6.14.2 from being exceeded. When the high alarm level is reached, any effluent discharges in progress are terminated or diverted to the Retention Basins.

A SAFETY FACTOR is included in the setpoint calculations to incorporate a margin of conservatism.

When a batch release is not occurring or the calculated setpoint is so low that it will cause spurious alarms, the monitor setpoint should be set close to background without causing spurious alarms or as determined by Radiation Protection/Chemistry Supervision.

The conversion factor and setpoint calculations should be performed based on the same radionuclide mix.

6.2.1 Conversion Factors for R15017A

Provided here is the methodology to determine the conversion factor of counts per minute to microcuries per cubic centimeter for the Retention Basin Effluent Discharge Monitor (R15017A). The conversion factor is based on the monitor's efficiency for each nuclide and the abundance of the nuclide. The mix of isotopes used may be based on the historical mix provided in Attachment 7, current mix in the batch release, or as determined by Radiation Protection/Chemistry Supervision. The mix fraction shall be based on gamma emitting isotopes only.

The following equation shall be used to determine the conversion factor for R15017A:

$$CF = \left[\sum_i (f_i \times E_i) \right]^{-1}$$

Where:

CF = $\mu\text{Ci/cc}$ per cpm

f_i = Fraction of nuclide i to total activity of historical mix (Attachment 7) or batch mix

E_i = Detector efficiency for nuclide i (cpm/ $\mu\text{Ci/cc}$) Attachment 8

6.2.2 High Alarm Setpoint for R15017A ($\mu\text{Ci/ml}$)

$$\text{High Alarm } (\mu\text{Ci/ml}) = \frac{\sum_g C_g}{SF \times \sum_i \left(\frac{C_i}{\text{MEC}_i} \right)} + C_{\text{bkgd}}$$

Where:

C_g = The concentration of gamma-emitting nuclide g in $\mu\text{Ci/ml}$.

C_i = The concentration of nuclide i in $\mu\text{Ci/ml}$. This term includes non-gamma emitters

MEC_i = The MEC of radionuclide i from Appendix B to 10 CFR Part 20, Table 2, Column 2, in $\mu\text{Ci/ml}$. The class with the most restrictive Effluent Concentration will be used for each isotope.

SF = A SAFETY FACTOR which may be applied to incorporate a margin of conservatism ($SF \geq 1$). (Default = 2)

C_{bkg} = The background reading of the monitor ($\mu\text{Ci/ml}$).

6.3 Maximum Effluent Concentrations in Liquid Effluents

The Maximum Effluent Concentration Fraction is calculated to determine compliance with 10 CFR 20 requirements and the Specification in Step 6.14.2. Radioactive liquid effluent discharges normally originate in the RHUTs and are discharged into a retention basin. Samples are collected and analyzed from each retention basin prior to discharge to ensure that compliance with the Specification in Step 6.14.2 can be achieved.

In addition, calculations to determine the minimum dilution water flow rate and maximum retention basin discharge flow rate to ensure compliance are provided in this section. Any combination of minimum dilution flow rate and maximum discharge flow rate which satisfy the Specification is acceptable.

6.3.1 Maximum Effluent Concentration Fraction (MECF)

Compliance with the Specification in Step 6.14.2 is anticipated when the MECF is less than or equal to 1.0. The MECF is calculated as follows:

$$\text{MECF} = \left[\sum_i \left(\frac{C_i}{\text{MEC}_i} \right) \right] \times \frac{F_r}{F_c + F_r}$$

Where:

- MECF = The calculated fraction of Maximum Effluent Concentration in the radioactive liquid effluent discharged beyond the Site Boundary for Liquid Effluents (see Attachment 6).
- C_i = The concentration (prior to dilution) of radionuclide i in the batch of liquid effluent in $\mu\text{Ci/ml}$.
- MEC_i = The MEC of radionuclide i from Appendix B to 10 CFR Part 20, Table 2, Column 2, in $\mu\text{Ci/ml}$. The class with the most restrictive Effluent Concentration will be used for each isotope.
- F_r = Discharge flow rate; the flow rate of the radioactive liquid batch release from the retention basin to the Waste Water Discharge Canal (Plant Effluent) in gpm.
- F_c = The total available dilution water (Plant Effluent) flow rate at the time of discharge of the radioactive liquid effluent in gpm.

NOTE

$\text{SF} \times \sum_i (C_i/\text{MEC}_i)$ must be ≥ 1.0

6.3.2 Minimum Dilution Water Flow Rate (F_{cmin})

The minimum dilution water (Plant Effluent) flow rate (F_{cmin}) is calculated as follows:

$$F_{cmin} = F_r \times \left[\left(SF \times \sum_i \left\{ \frac{C_i}{MEC_i} \right\} \right) - 1 \right]$$

Where:

F_r = A fixed effluent discharge flow (gpm) (as required by specific release restrictions).

SF = A factor which may be applied to incorporate a margin of conservatism ($SF \geq 1$).

NOTE

$SF \times \sum_i (C_i/MEC_i)$ must be ≥ 1

6.3.3 Maximum Effluent Discharge Flow Rate (F_{rmax})

The maximum effluent discharge flow rate (F_{rmax}) is calculated as follows:

$$F_{rmax} = \frac{F_c}{\left[SF \times \sum_i \left(\frac{C_i}{MEC_i} \right) \right] - 1}$$

Where:

F_c = A fixed dilution water flow rate (gpm) (as required by specific release restrictions).

6.4 Liquid Dose Calculations

This section provides the methodology to demonstrate compliance with the Specification in Step 6.14.3.

Site specific organ dose factors for liquid effluents have been determined for the MAXIMUM EXPOSED INDIVIDUAL and are listed in Attachment 9. Dose factors (A_{ijap}) were derived using equations and methods in Regulatory Guide 1.109, Rev. 1 and LADTAP. The dose factor parameters used are listed in Attachment 3. As previously stated, site specific parameters should be used based on the Land Use Census in lieu of the values provided in RG 1.109 whenever possible.

The exposure pathways included in the A_{ijap} are those identified by the Land Use Census. The pathways considered for inclusion are:

- fresh water fish
- fresh water invertebrate
- river shoreline deposits
- milk from cows that eat fresh or stored forage irrigated with Clay Creek water
- meat from cows that eat fresh or stored forage irrigated with Clay Creek water
- vegetation

6.4.1 Liquid Effluent Dose Equation

$$D_{aj} = \frac{\sum_i \sum_p (Q_i \times A_{ijap})}{F}$$

Where:

- D_{aj} = Annual calculated dose (50 year dose commitment) to the organ (or total body) j of a maximally exposed individual of age group a (mrem/yr).
- Q_i = Activity of isotope i released during the year (Ci/yr).
- A_{ijap} = Site specific dose factor for an organ (or total body) j for a person of age group a via pathway p due to isotope i (mrem-ft³/Ci-sec).
- F = Annual average discharge volumetric flow rate (effluent water plus dilution water) in ft³/sec.

Because the dose rate varies linearly with activity release rate, the dose for a shorter period of time (mrem) may be calculated by substituting the activity released (C_i) during that period for Q_i in the above equation. However, volumetric flow rates should not be averaged over a period less than a calendar quarter. More conservative flow rates are acceptable.

6.5 Liquid Dose Projections

31-day dose projections are calculated to show compliance with the Specification in Step 6.14.4. Quarterly and Annual dose projections are calculated in compliance with the Specification in Step 6.14.11.

The following equations shall be used:

31-Day Projection:

$$D_{p31} = 31 \times \frac{D_{Yr}}{t_{Yr}}$$

Quarterly Projection:

$$D_{pQtr} = 91.3 \times \frac{D_{Qtr}}{t_{Qtr}}$$

Yearly Projection:

$$D_{pYr} = 365.25 \times \frac{D_{Yr}}{t_{Yr}}$$

Where:

D_{p31} = 31-day dose projection.

D_{Yr} = Cumulative annual dose to date.

t_{Yr} = Number of days into the year.

D_{pQtr} = Quarterly dose projection.

D_{Qtr} = Cumulative quarterly dose to date.

t_{Qtr} = Number of days into the quarter.

D_{pYr} = Annual dose projection.

6.6 Gaseous Monitor Setpoints

This step does not apply to the IOS Building vent monitor (R15106). The calculations used to determine the setpoints for this monitor are contained in Reference 3.2.18.

The Gaseous Effluent Radiation Monitors have the capability to monitor gaseous effluents over three general ranges (high, middle and low) using four channels. In the permanently defueled mode, the middle and high ranges (Channels 2 and 3) are no longer necessary, and are no longer used or maintained. Channels 1 and 4 both operate in the low range and are the monitor channels which are considered in this procedure.

The Specification in Step 6.14.5 states that the gaseous effluent monitors shall have their alarm/trip setpoints set to ensure the limits of the Specification in Step 6.14.6 are not exceeded. The conservative default atmospheric dispersion (X/Q) factor from Step 6.1.3 is used. Compliance with the dose rate limits for noble gases specified in Step 6.14.6 is demonstrated by setting each gaseous effluent monitor alarm/trip setpoint so that an alarm/trip will occur at or before the dose rate limit is reached.

A SAFETY FACTOR is included in the setpoint calculations to incorporate a margin of conservatism.

Maximum design flow rates for each release point will be used to calculate setpoints.

6.6.1 Conversion Factors for R15044, R15045, and R15546A

Provided here is the methodology to determine the conversion factor of counts per minute to microcuries per cubic centimeter for the Auxiliary Building Stack Monitor (R15045), Reactor Building Stack Monitor (R15044), and the Auxiliary Building Grade Level Vent Monitor (R15546A). The conversion factor is based on the monitor's efficiency of detection for each nuclide and the mix of the nuclide. The mix of isotopes used should be based on Kr-85, but may be based on the current mix in the continuous release, or as determined by Radiation Protection/Chemistry Supervision. The mix used for setpoint calculations and conversion factor calculations should be the same.

The following equation shall be used to determine the conversion factor for R15044, R15045 and R15546A:

$$CF = \left[\sum_i (f_i \times E_i) \right]^{-1}$$

Where:

CF = $\mu\text{Ci/cc}$ per cpm

f_i = Fraction of nuclide i to total activity of the mix used

E_i = Detector efficiency for nuclide i , in cpm per $\mu\text{Ci/cc}$, Attachment 10

6.6.2 Gaseous Effluent Flow Rates

Flow rates used in routine gaseous effluent calculations for the pathways listed below are conservative default values. These flow rates should be used to determine monitor setpoints, assess compliance with the gaseous effluent requirements in Section 6.14, and calculate the gaseous effluent dose reported in the ARERR.

Gaseous effluent release points and maximum design flow rates used at RSNRS are as follows:

Reactor Building Stack	74,000 CFM
Auxiliary Building Stack	90,000 CFM
Auxiliary Building Grade Level Vent	31,000 CFM
Interim On-site Storage Building Ventilation*	8,050 CFM

* The Interim On-site Storage (IOS) Building is not subject to continuous discharges of radioactivity. Because of the infrequency of a radioactive release, assessment will be done on each release according to administrative procedures.

6.6.3 Determination of Partition Factor (P_v)

The Specification in Step 6.14.6 applies to the entire site, not just one vent or monitor. Consequently, the total release rate must be partitioned among the three major vents (ABS, ABGLV, RBS). For routine operations, the partition factor may be calculated by assuming that the effluent concentration is the same for all pathways and using a ratio of flow rates. The total volume flow rate for all three vents is 195,000 CFM. Therefore:

$$P_{rbs} = \frac{74,000 \text{ CFM}}{195,000 \text{ CFM}} = 0.38$$

$$P_{abs} = \frac{90,000 \text{ CFM}}{195,000 \text{ CFM}} = 0.46$$

$$P_{abglv} = \frac{31,000 \text{ CFM}}{195,000 \text{ CFM}} = 0.16$$

Radiation Protection/Chemistry Supervision may elect to use a different set of partition factors based on plant conditions. However, the sum of all the partition factors for the site must be less than or equal to unity (1).

6.6.4 Channel 4 Noble Gas Setpoint for R15044, R15045, and R15546A in $\mu\text{Ci}/\text{sec}$

$$M_v = \frac{3000 \times P_v \times \sum_i C_i}{\text{SF} \times (X/Q) \times \sum_i [C_i \times (L_i + 1.1 \times M_i)]} + \text{Bkgd}$$

Where:

- M_v = Monitor setpoint for vent v (i.e., RBS, ABS, or ABGLV) in $\mu\text{Ci}/\text{sec}$
- 3000 = Step 6.14.6 Specification limit for skin dose rate in mrem/yr
- P_v = Partition factor for vent v , dimensionless, which distributes the total site release rate among the three vents
- C_i = Concentration of isotope i in gaseous effluent in $\mu\text{Ci}/\text{cc}$. The mix of isotopes used may be based on Kr-85, the current mix, or as determined by Radiation Protection/Chemistry Supervision.
- SF = Safety Factor, dimensionless, ($\text{SF} \geq 1$)

- X/Q = A conservative default atmospheric dispersion factor for a ground level release to a sector at or beyond the Site Boundary for Gaseous Effluents in sec/m^3 . The default value in Step 6.1.3 will be used.
- L_i = A factor converting gamma radiation from noble gas radionuclide i to skin dose ($\text{mrem}\text{-m}^3/\mu\text{Ci}\text{-yr}$). See Attachment 11.
- M_i = A factor converting gamma radiation from noble gas radionuclide i to air dose ($\text{mrad}\text{-m}^3/\mu\text{Ci}\text{-yr}$). See Attachment 11.
- Bkgd = Monitor background reading in $\mu\text{Ci}/\text{sec}$

6.6.5 Channel 1 Noble Gas Setpoint for R15044, R15045, and R15546A in $\mu\text{Ci}/\text{cc}$

$$MC_v = \frac{MR_v}{472 \times F_v} + \text{Bkgd}$$

Where:

- MC_v = Monitor setpoint for vent v based on concentration in $\mu\text{Ci}/\text{cc}$
- MR_v = Monitor setpoint for vent v based on release rate in $\mu\text{Ci}/\text{sec}$ excluding the background term. That is, $M_v - \text{Bkgd}$
- F_v = Maximum design volumetric flow rate for vent v in CFM as indicated in Step 6.6.2.
- 472 = $28317 \text{ ml}/\text{ft}^3 * 1 \text{ min}/60 \text{ sec}$
- Bkgd = Monitor background reading in $\mu\text{Ci}/\text{cc}$

NOTE

Channel 1 does not cause any automatic terminations or audible alarms.

6.7 Maximum Effluent Concentrations (MECs) in Gaseous Effluents

In order to demonstrate compliance with 10 CFR 20.1301, which requires that the total MEC fraction not exceed 1 when averaged over an entire year, the calculation is included in the Annual Radioactive Effluent Release Report. In addition, a four hour reporting requirement exists when the total MEC fraction exceeds 20 when averaged over one hour per 10 CFR 50.72. The following provides guidance on how to perform this calculation.

Maximum Effluent Concentration Fraction (MECF) Equation

$$\text{MECF} = \sum_i \left(\frac{C_i}{\text{MEC}_i} \right) \times F \times 4.72\text{E}-4 \times X/Q \times \text{TR}$$

Where:

C_i = The concentration of nuclide i in mCi/cc.

F = Maximum design volumetric flow rate in CFM as indicated in 6.6.2.

X/Q = A conservative default atmospheric dispersion factor for a ground level release to a sector at or beyond the Site Boundary for Gaseous Effluents in sec/m^3 . The default value in Step 6.1.3 will be used.

MEC_i = The MEC for nuclide i from Appendix B to 10 CFR Part 20, Table 2, Column 2 ($\mu\text{Ci}/\text{cc}$). The class with the most restrictive Effluent Concentration will be used for each isotope.

TR = If the time of release is less than one hour, then this value is the duration of the transient in minutes divided by sixty. Otherwise, the Time Ratio (TR) is one. Dimensionless.

$4.72\text{E}-4$ = The conversion factor in $\text{min} \cdot \text{m}^3 / \text{sec} \cdot \text{ft}^3$.

6.8 Dose Rate Calculations

Compliance with the dose rate limits for noble gases in the Specification in Step 6.14.6 is demonstrated by setting each gaseous effluent monitor alarm setpoint so that an alarm will occur at or before either dose rate limit Specification in Step 6.14.6 is reached. In addition, the Specification in Step 6.14.6 provides a maximum limit on organ dose rate equivalent beyond the Site Boundary for Gaseous Effluents from tritium and all radioactive materials in particulate form with half-lives greater than 8 days. Compliance is determined by calculating the organ dose rate for the MAXIMUM EXPOSED INDIVIDUAL for the inhalation pathway only.

The dose rate due to noble gas is evaluated as follows:

Total Body:

$$\dot{D}_{\text{tb}} = (X/Q) \times \sum_v \sum_i (Q_{vi} \times K_i)$$

Skin:

$$\dot{D}_s = (X/Q) \times \sum_v \sum_i [Q_{vi} \times (L_i + 1.1M_i)]$$

Where:

- D_{tb} = The total body dose rate from noble gases (mrem/yr)
- D_s = The skin dose rate from noble gases (mrem/yr)
- X/Q = A conservative default atmospheric dispersion factor for a ground level release to a sector at or beyond the Site Boundary for Gaseous Effluents in sec/m^3 . The default value in Step 6.1.3 will be used.
- Q_{vi} = The release rate of noble gas radionuclide i from effluent vent v during the time of the release ($\mu\text{Ci}/\text{sec}$)
- K_i = A factor converting time integrated, ground-level concentration of noble gas radionuclide i to total body dose from its gamma radiation (mrem- $\text{m}^3/\mu\text{Ci}\text{-yr}$). See Attachment 11.
- L_i = A factor converting gamma radiation from noble gas radionuclide i to skin dose (mrem- $\text{m}^3/\mu\text{Ci}\text{-yr}$). See Attachment 11.
- M_i = A factor converting gamma radiation from noble gas radionuclide i to air dose (mrad- $\text{m}^3/\mu\text{Ci}\text{-yr}$). See Attachment 11.
- 1.1 = A factor converting air dose from gamma radiation to skin dose equivalent (mrem/mrad)

The organ dose rate resulting from inhalation is calculated with the equation:

Organ:

$$\dot{D}O_{aj} = (X/Q) \times \sum_v \sum_i (Q_{vi} \times R_{aji})$$

Where:

- DO_{aj} = The dose commitment rate to organ j of a person in age group a (mrem/yr)
- R_{aji} = The factor to convert air concentration of radionuclide i to organ j dose commitment rate of a person in age group a exposed by inhalation (mrem- $\text{m}^3/\mu\text{Ci}\text{-yr}$). See Attachment 12.
- Q_{vi} = The release rate of radionuclide i (not including Noble Gas nuclides), via effluent vent v during the time of the release ($\mu\text{Ci}/\text{sec}$)

Exposure to dose rate factors, R_{aji} , for inhalation are derived by using equation 13 in RG 1.109, Rev. 1. Tables E-5, E-7, E-8, E-9, and E-10 are assumed to represent the Maximum Exposed Individual in the equation to derive R_{aji} .

6.9 Air Dose Calculations

The Surveillance Requirement in Step 6.14.7 requires cumulative dose to air from radioactive effluent noble gases to be determined in order to assess compliance with the Specification in Step 6.14.7. The air dose is evaluated in the sector of the maximum exposure at or beyond the Site Boundary for Gaseous Effluent.

Air dose from noble gas gamma radiation is calculated cumulatively with the equation:

$$D_g = 3.17E-8 \times \sum_v \left[(X/Q) \times \sum_i \sum_n (Q_{vni} \times M_i) \right]$$

Air dose from noble gas beta radiation is calculated cumulatively with the equation:

$$D_b = 3.17E-8 \times \sum_v \left[(X/Q) \times \sum_i \sum_n (Q_{vni} \times N_i) \right]$$

Where:

D_g = The noble gas gamma dose to air (mrad)

D_b = The noble gas beta dose to air (mrad)

X/Q = A conservative default atmospheric dispersion factor for a ground level release to a sector at or beyond the Site Boundary for Gaseous Effluents in sec/m^3 . The default value in Step 6.1.3 will be used.

M_i = A factor converting ground-level concentration to gamma radiation from noble gas radionuclide i to air dose ($\text{mrad}\cdot\text{m}^3/\mu\text{Ci}\cdot\text{yr}$)

N_i = A factor converting ground-level concentration to beta radiation from noble gas radionuclide i to air dose ($\text{mrad}\cdot\text{m}^3/\mu\text{Ci}\cdot\text{yr}$)

Q_{vni} = The quantity of each noble gas radionuclide i in batch n released via effluent stream v (μCi)

$3.17E-8 = 1 \text{ yr}/3.156E+7 \text{ sec}$

Factors M_i and N_i are 10^6 pCi/ μCi times the values in RG 1.109, Rev. 1, Table B-1, Columns 4 and 2, respectively. The computer codes GASPARG and REIMS may be used to perform these calculations.

6.10 Organ Dose Calculations for Gaseous Effluents

The Surveillance Requirement in Step 6.14.8 requires the radiation dose or dose commitment to the Maximum Exposed (Hypothetical) Individual accumulated from exposure to tritium and radioactive materials in particulate form having half-lives greater than 8.0 days, that originate in effluent air, be determined at least every month. The radiation dose or dose commitment accumulated during a calendar quarter and a year may not exceed values stated in the Specification in Step 6.14.8.

A person may be exposed to effluent radioactive material of this type in air by inhalation or indirectly via environmental pathways that involve deposition onto vegetation and the ground. The exposure pathways evaluated will include the following:

p	Exposure Pathway
1	Air - inhalation
2	Deposition onto ground - irradiation
3	Deposition onto vegetation - ingestion
4	Deposition onto forage - cow - milk - ingestion
5	Deposition onto forage - meat animal - meat - ingestion
6	Deposition onto forage - goat - milk - ingestion

The equation used to calculate the dose commitment to the Maximum Exposed (Hypothetical) Individual from radionuclides other than tritium is:

$$D_{aj} = \sum_{p=1} \left[(X/Q)_p \times \sum_v \sum_i (Q_{vi} \times R_{ajip}) \right] + \sum_{p=2}^6 \left[(D/Q)_p \times \sum_v \sum_i (Q_{vi} \times R_{ajip}) \right]$$

Where:

p = 1, i.e., air-inhalation, in the first term, and p = 2, 3, 4, 5, and 6 in the second term of the equation

i excludes H-3

D_{aj} = The dose commitment to organ *j* of a person in age group *a* (mrem)

Q_{vi} = The quantity of each radionuclide *i*, in particulate form having a half-life greater than 8.0 days, in air discharged via effluent stream *v* (μ Ci)

X/Q = A conservative default atmospheric dispersion factor for a ground level release to a sector at or beyond the Site Boundary for Gaseous Effluents in sec/m^3 . The default value in Step 6.1.3 will be used.

D/Q = A conservative default deposition factor. A Factor converting a ground-level or building wake discharge in air to deposition on land (m^{-2}). The D/Q value in Step 6.1.3 will be used.

R_{ajip} = A factor converting time integrated concentration of radionuclide i in air or deposited on vegetation and/or ground to radiation dose commitment to organ j , including total body, of a person in age group a who is exposed via pathway p .

When $p=1$, representing air-inhalation, R_{ajip} has units of $mrem \cdot m^3 / \mu Ci \cdot yr$. When $p=2,3,4,5$ or 6 in the second term of the equation above, representing pathways involving deposition, R_{ajip} has units of $mrem \cdot m^2 \cdot sec / yr \cdot \mu Ci$. When the radionuclide is H-3, R_{ajip} has units of $mrem \cdot m^3 / \mu Ci \cdot yr$.

Tritium is assumed not to deposit onto vegetation or the ground. Hence, the concentration in vegetation is assumed to be related to the local atmospheric concentration as described in RG 1.109, Rev. 1, Appendix C. The dose commitment to the Maximum Exposed (Hypothetical) Individual from tritium in gaseous effluent is calculated with the equation:

$$D_{aj} = 3.17E-8 \times \sum_p \left[(X/Q)_p \times \sum_v (Q_{vi} \times R_{ajip}) \right]$$

Where:

$p = 1, 3, 4, 5,$ and 6

i includes H-3 only

X/Q = A conservative default atmospheric dispersion factor for a ground level release to a sector at or beyond the Site Boundary for Gaseous Effluents in sec/m^3 . The default value in Step 6.1.3 will be used.

$3.17E-8 =$ years/sec

Other terms as defined above.

Dose factors R_{ajip} for RSNRS are derived using the equations and methods in RG 1.109, Rev. 1, Appendix C. Values of parameters in RG 1.109, Rev. 1, Table E-5 are assumed to represent the Maximum Exposed (Hypothetical) Individual unless Land Use Census data justify a different value. Any different values from default values will be justified and added as a table to the ODCM. Values of other parameters recommended in RG 1.109, Rev. 1, including those recommended in the absence of site-specific data, are used in the equations to derive the dose factors. (GASPAR or REIMS may be used to perform the calculations.)

6.11 Gas Dose Projections

31-Day Dose projections are calculated to show compliance with Step 6.14.9. Quarterly and Annual dose projections are calculated in compliance with the Specification in Step 6.14.11. The dose projection equations are the same as used for liquid per Step 6.5.

6.12 Fuel Cycle Dose

If a calculated dose exceeds twice the limit of the Specification in Step 6.14.3, 6.14.7, 6.14.8, or a level in Table 3 of the REMP Manual is exceeded, an assessment of compliance with the Specification in Step 6.14.10 must be made.

Liquid dose calculations shall be made using the general methodology of Step 6.4. Gas dose calculations shall be made using the general methodology of Steps 6.9 and 6.10. These methodologies are to be used as a guide and strict adherence is not required because the Fuel Cycle Dose Calculation is done to determine the actual dose received, not a hypothetical maximum. Therefore, parameters such as dilution beyond the site boundary and residential shielding may be factored into the calculation.

The total body and organ doses shall be the result of summing the individual contributions from liquid, gas, and direct radiation sources for the affected Member of the Public. Irradiation, i.e., exposure to an external source of radiation, directly from the RSNGS normally will be evaluated with the aid of environmental dosimetry such as thermoluminescent dosimetry (TLD) or portable ion chamber (PIC) measurements.

6.13 EPA Reporting Requirements

If a calculated dose exceeds the Specification limit of Step 6.14.2, 6.14.3, 6.14.6, 6.14.7, or 6.14.8, an assessment of compliance with 40 CFR Parts 302 and 355, Reportable Quantity Adjustment - Radionuclides, must be made.

This involves determining the maximum quantity of radionuclides released in a 24 hour period and comparing the quantities to the values listed in 40 CFR 302 Appendix B. The "sum of the ratios" method shall be used to determine compliance. If the "sum of the ratios" is greater than one, the National Response Center shall be notified.

Since Rancho Seco's systems and procedures are set up to normally operate within the above limits, this condition is not expected to occur, therefore, specific implementation procedures to determine compliance are not required.

6.14 Technical Requirements

6.14.1 Liquid Effluent Monitoring Instrumentation

Specifications:

The radioactive liquid effluent monitoring instrumentation channels shown in Attachment 13 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Step 6.14.2 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with Step 6.2.

Applicability:

During releases via the retention basin effluent discharge.

Action:

- 1) With a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than a value which will ensure that the limits of Step 6.14.2 are met, immediately suspend the release of radioactive effluents monitored by the affected channel, or declare the channel inoperable, or change the setpoint so it is acceptably conservative.
- 2) With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the Action shown on Attachment 13.

Surveillance Requirements:

- 1) The maximum setpoint shall be determined in accordance with methodology as described in Step 6.2 and shall be recorded on the release permits.
- 2) Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the INSTRUMENT CHANNEL CHECK, SOURCE CHECK, INSTRUMENT CHANNEL CALIBRATION, AND CHANNEL TEST at the frequencies shown in Attachment 14.
- 3) Records shall be maintained in accordance with the Process Standards of all radioactive liquid effluent monitoring instrumentation alarm/trip setpoints. Maximum setpoints and calculations shall be available for review to ensure that the limits of Step 6.14.2 are met.

Bases:

During continuing operations leading to decontamination and decommissioning of the site, radioactively contaminated water will be processed, as necessary, to remove the activity according to the Process Control Program (PCP). After being processed as necessary, the water may be transferred to the 'A' and 'B' Regenerant Holdup Tanks (RHUTs). Pathways for water to reach the RHUTs are shown in Attachment 1, Liquid Effluent Flow Diagram.

Administrative controls provide reasonable assurance that any waste water that is radioactive is processed through the RHUTs prior to their release.

Water which is in the 'A' and 'B' RHUTs is transferred to the North or South Retention Basin. The water in a Retention Basin is released off-site as a batch release. These releases are monitored by the Retention Basin Effluent Discharge Monitor.

Radioactive liquid effluent monitoring instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of radioactive liquid effluents. The alarm/trip setpoints for these instruments shall be calculated in accordance with the methodology contained in this manual to ensure that the alarm/trip will occur prior to exceeding the limits of Step 6.14.2. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

6.14.2 Maximum Effluent Concentrations in Liquid Effluents

Specifications:

The concentration of radioactive material released in liquid effluents at any time beyond the Site Boundary for Liquid Effluents (see Attachment 6) shall be limited to the concentrations specified in Appendix B to 10 CFR Part 20, Table 2, Column 2.

Applicability:

This is applicable at all times.

Action:

With the concentration of radioactive material released from the site to areas beyond the Site Boundary for Liquid Effluents exceeding the above Specifications, immediately restore concentration within the required limits and report the event in the next Annual Radioactive Effluent Release Report.

Surveillance Requirements:

The concentration of radioactive material at any time in liquid effluents released from the site to areas beyond the Site Boundary for Liquid Effluents shall be continuously monitored in accordance with Attachment 13.

The liquid effluent continuous monitor having provisions for automatic termination of liquid releases, as listed in Attachment 13, shall be used to limit the concentration of radioactive material released at any time from the site to areas beyond the Site Boundary for Liquid Effluents to the limits given in the above Specifications.

The radioactivity concentration of each Retention Basin to be discharged shall be determined prior to release by sampling and analysis in accordance with Attachment 15, Item A. The results of Retention Basin pre-release sample analyses shall be used with the calculational methods described in Step 6.3 to ensure that the concentration at the point of release is within the limits of the above Specification.

Bases:

This Specification is provided to ensure that the concentration of radioactive materials released in liquid waste effluents from the site to areas beyond the Site Boundary For Liquid Effluents (see Attachment 6) will be less than the concentration levels specified in Appendix B to 10 CFR Part 20, Table 2, Column 2. This limitation provides additional assurance that the levels of radioactive materials in bodies of water outside the site will result in exposures within the limits of 10 CFR Part 20.1301 to a MEMBER OF THE PUBLIC.

There are no continuous releases of radioactive material in liquid effluents from the plant. All radioactive liquid effluent releases from the plant are by batch method.

6.14.3 Liquid Dose Calculations

Specifications:

The dose or dose commitment to a MAXIMUM EXPOSED (HYPOTHETICAL) INDIVIDUAL from radioactive materials in liquid effluents released beyond the Site Boundary for Liquid Effluents (see Attachment 6) shall be limited to:

- 1) Less than or equal to 1.5 mrem to the total body and to less than or equal to 5.0 mrem to any organ during any calendar quarter; and,
- 2) Less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ during any calendar year.

Applicability:

At all times.

Action:

With the calculated dose or dose commitment from the release of radioactive materials in liquid effluents exceeding any of the above Specifications, prepare and submit to the Commission within 30 days a Special Report. This Report will identify the cause(s) for exceeding the limit(s) and define the corrective actions to be taken to reduce the releases of radioactive material in liquid effluents and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above Specifications.

Surveillance Requirements:

Cumulative dose assessments associated with the release of radioactive liquid effluent shall be determined by sampling and analysis in accordance with Attachment 15, Item B or Item C, and calculations performed in accordance with the methodology described in Step 6.4 at the following frequencies:

- 1) Prior to the initiation of a release of radioactive liquid effluent from the A or B RHUT; and,
- 2) Upon verification of monthly composite analysis results for radioactive liquid effluent released from the A and B RHUTs.

A dose tracking system and administrative dose limits shall be established and maintained. With the 31-day dose projection in excess of the limits in Step 6.14.4, adjust liquid effluent operating parameters to give reasonable assurance of compliance with the dose limits of this Specification (10 CFR 50, Appendix I dose guidelines) and maintain radioactive liquid releases as low as is reasonably achievable.

Bases:

ODCM Step 6.14.3 is provided to implement the requirements of Sections II.A, III.A, and IV.A of Appendix I, 10 CFR Part 50. This step implements the guides set forth in Section II.A of 10 CFR 50, Appendix I. The Action statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of 10 CFR 50, Appendix I to assure that the releases of radioactive material in liquid effluents will be kept "as low as is reasonably achievable." The dose calculation methodology in this manual implement the requirements in Section III.A of 10 CFR 50, Appendix I that conformance with the guides of 10 CFR 50, Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The equations specified in this manual for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977. There is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in finished drinking water that are in excess of the requirements of 40 CFR 141.

The Lower Limits of Detection established in Attachment 15, Item B are based on an estimated maximum annual effluent outflow of 2 million gallons with a minimum annual average flow rate in the plant effluent stream of 6,000 gallons per minute. The RHUT pre-release and monthly composite Lower Limits of Detection equate to an off-site dose of less than 10 percent of the 10 CFR 50, Appendix I guidelines. These Lower Limits of Detection, along with the dose tracking system, give reasonable assurance that the dose limits prescribed in ODCM Step 6.14.3 (the 10 CFR 50, Appendix I dose guidelines) will be met.

6.14.4 Liquid Effluent Radwaste Treatment

Specifications:

The LIQUID EFFLUENT RADWASTE TREATMENT SYSTEM shall be OPERABLE. The appropriate portions of the system shall be used to reduce the quantity of radioactive materials in liquid effluents prior to their discharge when projected doses due to the liquid effluent beyond the Site Boundary for Liquid Effluents (see Attachment 6), when averaged over 31 days, would exceed 0.25 mrem to the total body or 0.83 mrem to any organ (8.33% of the 10 CFR 50, Appendix I annual guidelines).

Applicability:

At all times.

Action:

With the LIQUID EFFLUENT RADWASTE TREATMENT SYSTEM inoperable for more than 31 days or with radioactive liquid waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days a Special Report which includes the following information:

- 1) Explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability; and,
- 2) Action(s) taken to restore the inoperable equipment to OPERABLE status; and,
- 3) Summary description of action(s) taken to prevent a recurrence.

Surveillance Requirements:

Doses due to liquid releases to areas beyond the Site Boundary for Liquid Effluents shall be projected prior to each RHUT release in accordance with the methodology described in Step 6.5 when LIQUID EFFLUENT RADWASTE TREATMENT SYSTEMS are not being fully utilized. The installed LIQUID EFFLUENT RADWASTE TREATMENT SYSTEM shall be considered OPERABLE by meeting the Specifications in Steps 6.14.2 and 6.14.3.

Bases:

The OPERABILITY of the LIQUID EFFLUENT RADWASTE TREATMENT SYSTEM ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment. The requirement that the appropriate portions of this system be used, when specified, provides reasonable assurance that the releases of radioactive materials in liquid effluents are maintained "as low as is reasonably achievable."

This specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR 50. The specified limits governing the use of appropriate portions of the LIQUID EFFLUENT RADWASTE TREATMENT SYSTEM are the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

6.14.5 Gaseous Effluent Monitoring Instrumentation

Specifications:

The radioactive gaseous effluent monitoring instrumentation channels shown in Attachment 16 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Step 6.14.6 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the methodology contained in this procedure. Continuous samples of the gaseous effluent for radioactive particulate material shall be taken as indicated in Attachment 16.

Applicability:

This is applicable at all times.

Action:

- 1) With a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than a value which will ensure that the limits of Step 6.14.6 are met, immediately suspend the release of radioactive gaseous effluents monitored by the affected channel, or declare the channel inoperable, or change the setpoint so it is acceptably conservative.
- 2) With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE, take the Action shown in Attachment 16. Exert best efforts to return the instrument to OPERABLE status within 30 days and if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.

Surveillance Requirements:

The maximum setpoints shall be determined by procedures implementing the methodology presented in this procedure and shall be recorded on release permits.

Each gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the INSTRUMENT CHANNEL CHECK, SOURCE CHECK, INSTRUMENT CHANNEL CALIBRATION, AND CHANNEL TEST at the frequencies shown in Attachment 17.

Records shall be maintained in accordance with the Process Standards of all radioactive gaseous effluent monitoring instrument alarm/trip setpoints. Maximum setpoints and setpoint calculations shall be available for review to ensure that the limits of Step 6.14.6 are met.

Bases:

The radioactive gaseous effluent monitoring instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of radioactive gaseous effluents. The alarm/trip setpoints for these instruments, except for the Interim On-site Storage (IOS) Building vent monitor (R15106), shall be calculated in accordance with the methodology contained in this manual to ensure that the alarm/trip will occur prior to exceeding the limits of ODCM Step 6.14.6. The monitor setpoints for R15106 are set statistically high enough above background to prevent spurious alarms, yet stop potential radioactive releases when detected (Reference 3.2.18). The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

The IOS Building has a ventilation system which provides protection against radioactive airborne releases. Operation of the ventilation system produces a negative pressure in the building. During operation, the ventilation exhaust flow is continuously monitored for particulate activity. Upon an alarm, the exhaust duct closes and the supply and exhaust fans stop, minimizing any chance of an airborne release. Although no planned airborne radioactive releases are anticipated from this pathway, the ventilation exhaust monitor is included in Attachment 16.

Fuel Storage Building exhaust is directed to the Auxiliary Building Stack where the exhaust is filtered and monitored for any activity prior to release to the atmosphere.

6.14.6 Gaseous Dose Rates

Specifications:

The dose rate due to radioactive materials released in gaseous effluents from the site to areas at or beyond the Site Boundary for Gaseous Effluents (see Attachment 5) shall be limited to the following values:

- 1) The dose rate limit for noble gases shall be less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin; and,
- 2) The dose rate limit for tritium and for all radioactive materials in particulate form with half-lives greater than 8 days shall be less than or equal to 1500 mrem/yr to any organ.

Applicability:

This is applicable at all times.

Action:

With the dose rate(s) exceeding the above limits, immediately restore the release rate to within the limit(s) specified and report the event in the next Annual Radioactive Effluent Release Report.

Surveillance Requirements:

The noble gas effluent continuous monitors, as listed in Attachment 16, shall use monitor setpoints to limit the dose rate in unrestricted areas to the limits in the above Specification.

In the event a noble gas effluent exceeds the setpoint of its monitor, an assessment of compliance with the Specification above shall be made in accordance with the methodology contained in this manual.

The release rate of radioactive materials, other than noble gases, in gaseous effluents shall be determined by obtaining representative samples and performing analyses in accordance with the sampling analyses program specified in Attachment 18.

The dose rate due to tritium and all radioactive material in particulate form with half-lives greater than 8 days, released in gaseous effluents, shall be determined to be within the limits of this Specification by using the results of the sampling and analysis program specified in Attachment 18 and the methodology described in Step 6.8.

Bases:

Step 6.14.6 is provided to ensure that the dose rate from gaseous effluents due to immersion or inhalation at any time at the Site Boundary for Gaseous Effluents (see Attachment 5) will be within the annual dose limits of 10 CFR Part 20 for MEMBERS OF THE PUBLIC. The annual dose limits are the doses associated with the concentrations of Appendix B to 10 CFR Part 20, Table 2, Column 1. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of an individual at or beyond the Site Boundary for Gaseous Effluents to annual average concentrations exceeding the dose rate equivalent, on which the limits specified in Appendix B, Table 2 of 10 CFR Part 20 were derived. For individuals who may at times be within the Site Boundary for Gaseous Effluents, the occupancy of the individual will be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the boundary. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to an individual at or beyond the Site Boundary for Gaseous Effluents to less than or equal to 500 mrem/yr to the total body or to less than or equal to 3,000 mrem/yr to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a person of any age group via the inhalation pathway to less than or equal to 1,500 mrem/yr.

6.14.7 Gamma and Beta Air Dose

Specifications:

The air dose due to noble gases released in gaseous effluents to areas at or beyond the Site Boundary for Gaseous Effluents (see Attachment 5) shall be limited to the following:

- 1) During any calendar quarter, to less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation; and,
- 2) During any calendar year, to less than or equal to 10 mrad for gamma radiation and to less than or equal to 20 mrad for beta radiation.

Applicability:

This is applicable at all times.

Action:

With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days a Special Report. This Report will identify the cause(s) for exceeding the limit(s) and define the corrective action(s) taken to reduce the release of radioactive noble gases on gaseous effluents, and the corrective action(s) to be taken to assure that subsequent releases will be in compliance with the above limits.

Surveillance Requirements:

Cumulative air dose contributions for the current calendar quarter and calendar year shall be determined in accordance with the methodology in Step 6.9 at least monthly.

Bases:

Step 6.14.7 is provided to implement the requirements of Sections II.B, III.A, and IV.A of Appendix I, 10 CFR Part 50. This step implements the guides set forth in Section II.B of Appendix I. The Action statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low as is reasonably achievable." The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of an individual through the appropriate pathways is unlikely to be substantially underestimated. The dose calculations established in this manual for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. The equations in this manual provide for determining that the air doses at the Site Boundary for Gaseous Effluents (see Attachment 5) are based upon the historical average atmospheric conditions.

6.14.8 Gaseous Organ Dose

Specifications:

The dose or dose commitment to a MAXIMUM EXPOSED (HYPOTHETICAL) INDIVIDUAL from tritium and radioactive materials in particulate form with half-lives greater than eight days in gaseous effluents released to areas at or beyond the Site Boundary for Gaseous Effluents (see Attachment 5) shall be limited to the following:

- 1) During any calendar quarter, to less than or equal to 7.5 mrem to any organ; and,
- 2) During any calendar year, to less than or equal to 15 mrem to any organ.

Applicability:

This is applicable at all times.

Action:

With the calculated dose or dose commitment from the release of tritium and radioactive materials in particulate form with half-lives greater than eight days in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days a Special Report. This Report will identify the cause(s) for exceeding the limit and define the corrective actions to be taken to reduce the releases and the proposed corrective action(s) to be taken to assure that subsequent releases will be in compliance with the above annual limits.

Surveillance Requirements:

Cumulative dose contributions for the current calendar quarter and calendar year period shall be determined in accordance with the methodology described in Step 6.10 at least monthly.

Bases:

Step 6.14.8 is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Specifications are the guides set forth in Section II.C of 10 CFR 50, Appendix I. The Action statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of 10 CFR 50, Appendix I to assure that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." The calculational methods specified in the Surveillance Requirements implement the requirements in Section III.A of 10 CFR 50, Appendix I that conformance with the guides of 10 CFR 50, Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. For individuals who may at times be within the Site Boundary for Gaseous Effluents, the occupancy of the individual will be sufficiently low to compensate for any increase in the atmospheric dispersion factor above that for the boundary.

The calculational methods for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculating of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for estimating doses based upon the historical average atmospheric conditions.

The release rate specifications for radioactive materials in particulate form are dependent on the existing radionuclide pathways to man in areas at or beyond the Site Boundary for Gaseous Effluents (see Attachment 5). The pathways which were examined in the development of these calculations are: (1) individual inhalation of airborne radionuclides, (2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, (3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and (4) deposition on the ground with subsequent exposure of man.

6.14.9 Ventilation Exhaust Treatment System

Specifications:

The VENTILATION EXHAUST TREATMENT SYSTEM shall be OPERABLE. The installed VENTILATION EXHAUST TREATMENT SYSTEM shall be considered OPERABLE by meeting the Specifications in Steps 6.14.6, 6.14.7, and 6.14.8.

Also, the following two conditions shall not exist simultaneously:

- 1) Gaseous waste is being discharged without treatment, and;
- 2) The projected doses due to gaseous effluent releases from the site (see Attachment 5), when averaged over 31 days, would exceed 2% of the 10 CFR 50, Appendix I annual dose guidelines (0.3 mrem to any organ, or air doses of 0.2 mrad from gamma radiation or 0.4 mrad from beta radiation).

Applicability:

This is applicable at all times.

Action:

If both parts 1) and 2) of the Specification are satisfied, prepare and submit to the Commission within 30 days a Special Report pursuant to Technical Specification D6.9.7 which includes the following information:

- a. Explanation of why gaseous radwaste was being discharged without treatment, and identification of the equipment or subsystems not OPERABLE and the reason for inoperability.
- b. Action(s) taken to restore the inoperable equipment to OPERABLE STATUS.
- c. Summary description of action(s) taken to prevent a recurrence.

Surveillance Requirements:

Doses due to gaseous releases to areas at and beyond the Site Boundary for Gaseous Effluents (see Attachment 5) shall be projected at least once per 31 days in accordance with the methodology and parameters in Step 6.11.

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Aerosol particulate testing will be performed on the HEPA filters in the Ventilation Exhaust Treatment Systems every 18 months, or after any work has been performed on the HEPA filter systems which could alter their integrity. For minor HEPA filter integrity repairs (up to ~ 0.1% of HEPA filter bank surface area), immediate testing is not required. HEPA filter integrity is ensured through visual observations and effluent sampling.

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Bases:

The OPERABILITY of the VENTILATION EXHAUST TREATMENT SYSTEM ensures that the systems are available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents are maintained "as low as is reasonably achievable." Step 6.14.9 implements the requirements of 10 CFR 50.36a, General Design Criterion 60 of Appendix A to 10 CFR 50, and the design objectives given in Section II.D of Appendix I to 10 CFR 50. The specified limits governing the use of appropriate portions of the systems and the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR 50, for gaseous effluents.

6.14.10 Fuel Cycle Dose

Specification:

The dose or dose commitment to any real MEMBER OF THE PUBLIC due to releases of radioactive material in gaseous and liquid effluents and to direct radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 mrem to the total body or any organ (except the thyroid, which is limited to less than or equal to 75 mrem) in a calendar year.

Applicability:

At all times.

Action:

- 1) With the calculated doses from the release of radioactive material in liquid or gaseous effluents exceeding twice the limits of Specifications in Steps 6.14.3, 6.14.7, 6.14.8 or exceeding the reporting levels in Table 3 of the REMP Manual, calculations shall be made including direct radiation contributions (including outside storage tanks, etc.) to determine whether the above specifications have been exceeded.
- 2) If the above limits have been exceeded, prepare and submit to the Commission within 30 days, a Special Report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report, as defined in 10 CFR Part 20.2203(a)(4), shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, in a calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations.
- 3) If the estimated dose(s) exceed the above limits, and if the release condition resulting in the violation of 40 CFR Part 190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provision of 40 CFR Part 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

Surveillance Requirements:

Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with the Step 6.14.3, 6.14.7, and 6.14.8 Surveillance Requirements.

Cumulative dose contributions from direct radiation (including outside storage tanks, etc.) shall be determined in accordance with Step 6.12. This requirement is applicable only under the conditions set forth in the above Action statements.

Bases:

Step 6.14.10 is provided to meet the dose limitations of 40 CFR 190 that have been incorporated into 10 CFR 20 by 46 FR 18525. The specification requires the preparation and submittal of a Special Report whenever the calculated doses from plant radioactive effluents exceed twice the numerical guides for design objective doses of 10 CFR 50, Appendix I or exceeds the reporting levels of the Radiological Environmental Monitoring Program. For the Rancho Seco site, it is unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR 190 if the plant remains within twice the numerical guides for design objectives of 10 CFR 50, Appendix I and if direct radiation (outside storage tanks, etc.) is kept small. The Special Report will describe a course of action which should result in the limitation of the dose to a MEMBER OF THE PUBLIC for

a calendar year to within the 40 CFR 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 5 miles must be considered. If the dose to any MEMBER OF THE PUBLIC is evaluated to exceed the requirements of 40 CFR 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR 190 have not already been corrected), in accordance with the provisions of 40 CFR 190 is considered to be a timely request and fulfills the requirements of 40 CFR 190 until NRC staff action is completed. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation which is part of the uranium fuel cycle.

6.14.11 Quarter/Annual Dose Projections

Specifications:

The projected dose contributions from liquid and gaseous effluents for the current calendar quarter and current calendar year shall be calculated according to the methodology in Steps 6.5 and 6.11 at least every 31 days.

Applicability:

At all times.

Action:

With the required dose calculations not being performed, best effort will be exerted to perform the calculations once the deficiency has been identified. Corrective actions will be taken and documented to prevent reoccurrence.

Surveillance Requirements

1) Liquid Effluents

Projected dose contributions shall be determined at least every 31 days.

2) Gaseous Effluents

Projected dose contributions shall be determined at least every 31 days.

Bases:

This step is provided to implement the requirement of Technical Specification D6.8.3.a.5. Dose projections provide a means of determining if current release practices will be within the dose limits of 10 CFR 50, Appendix I. Calculating projected dose totals every 31 days provides information which can be used to keep effluent releases "as low as is reasonably achievable".

Calculations performed during the first 15 days of the calendar year or calendar quarter will result in artificially high dose projections which provide no usable information.

6.15 Reports

6.15.1 Annual Radioactive Effluent Release Report (ARERR)

The ARERR covering the activities of the unit during the previous 12 months shall be submitted within 60 days after January 1 of each year. The report shall include the following:

- (1) Summary of the quantities of radioactive liquid and gaseous effluents released from the unit.
- (2) Summary of solid waste shipped from the unit.
- (3) All unplanned releases of radioactive materials in gaseous and liquid effluents to unrestricted areas shall include a description of the event and equipment involved, cause(s), action(s) taken to prevent recurrence, and consequences.
- (4) Dose or dose commitment assessments to ensure compliance with the specifications in 6.14.3, 6.14.7, and 6.14.8.
- (5) Complete, legible copy of the entire ODCM and/or REMP Manual if changes occurred during the ARERR reporting period. The copy may be part of the ARERR or sent concurrently.
- (6) The ARERR shall also include events described in 6.14.2, 6.14.5, and 6.14.6.

6.15.2 30 Day Reports

The following 30 day reports should be submitted if the criteria are met as stated in the following areas:

- (1) 6.14.3 - Liquid Dose Calculations
- (2) 6.14.4 - Liquid Dose Projections
- (3) 6.14.7 - Gamma and Beta Air Dose

MANUAL: CHEMISTRY ADMINISTRATIVE
PROCEDURES MANUAL

NUMBER: CAP-0002

TITLE: OFF-SITE DOSE CALCULATION MANUAL

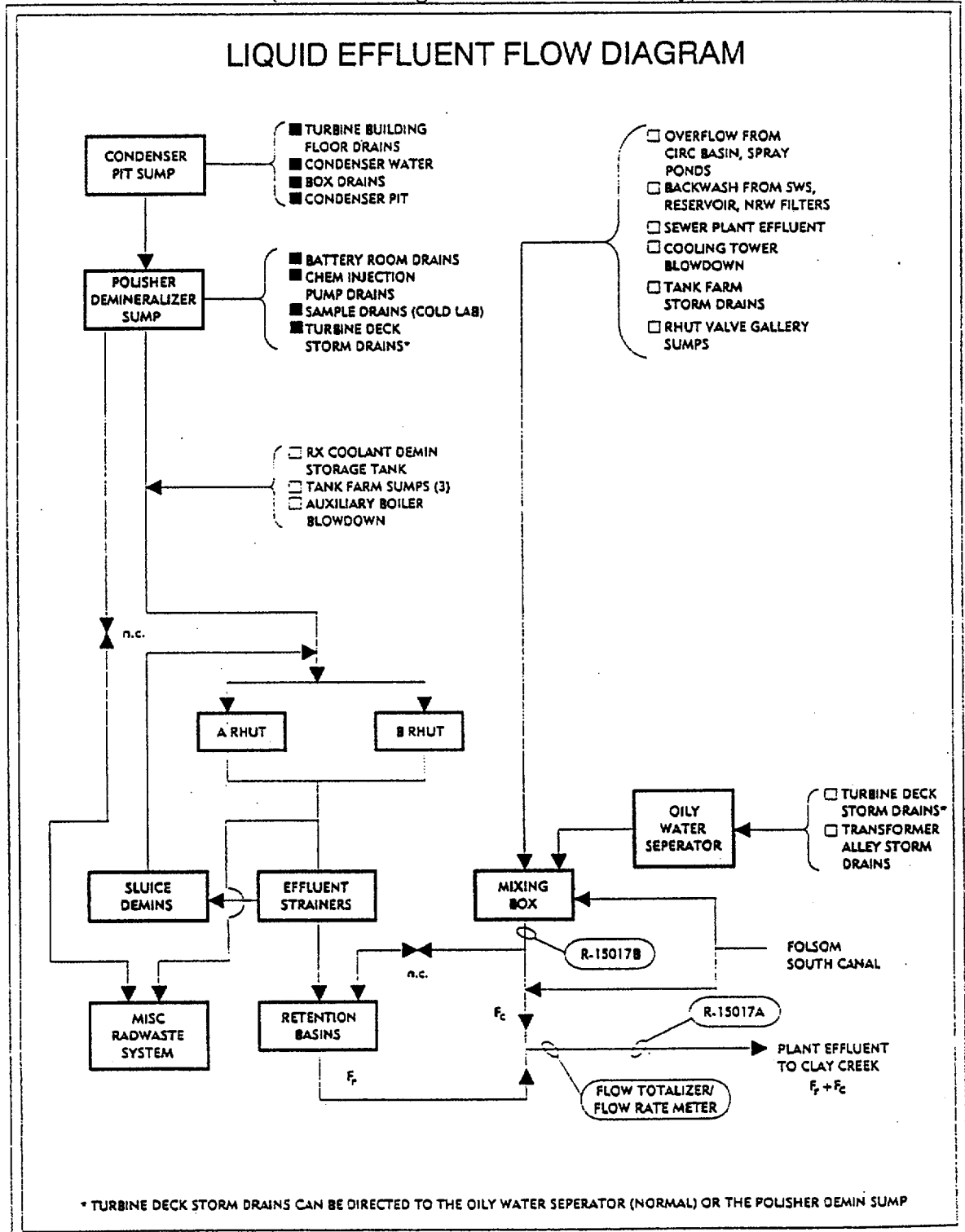
REVISION: 11
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- (4) 6.14.8 - Gaseous Organ Dose
- (5) 6.14.9 - Gaseous Dose Projections
- (6) 6.14.10 - Fuel Cycle Dose

7.0 RECORDS

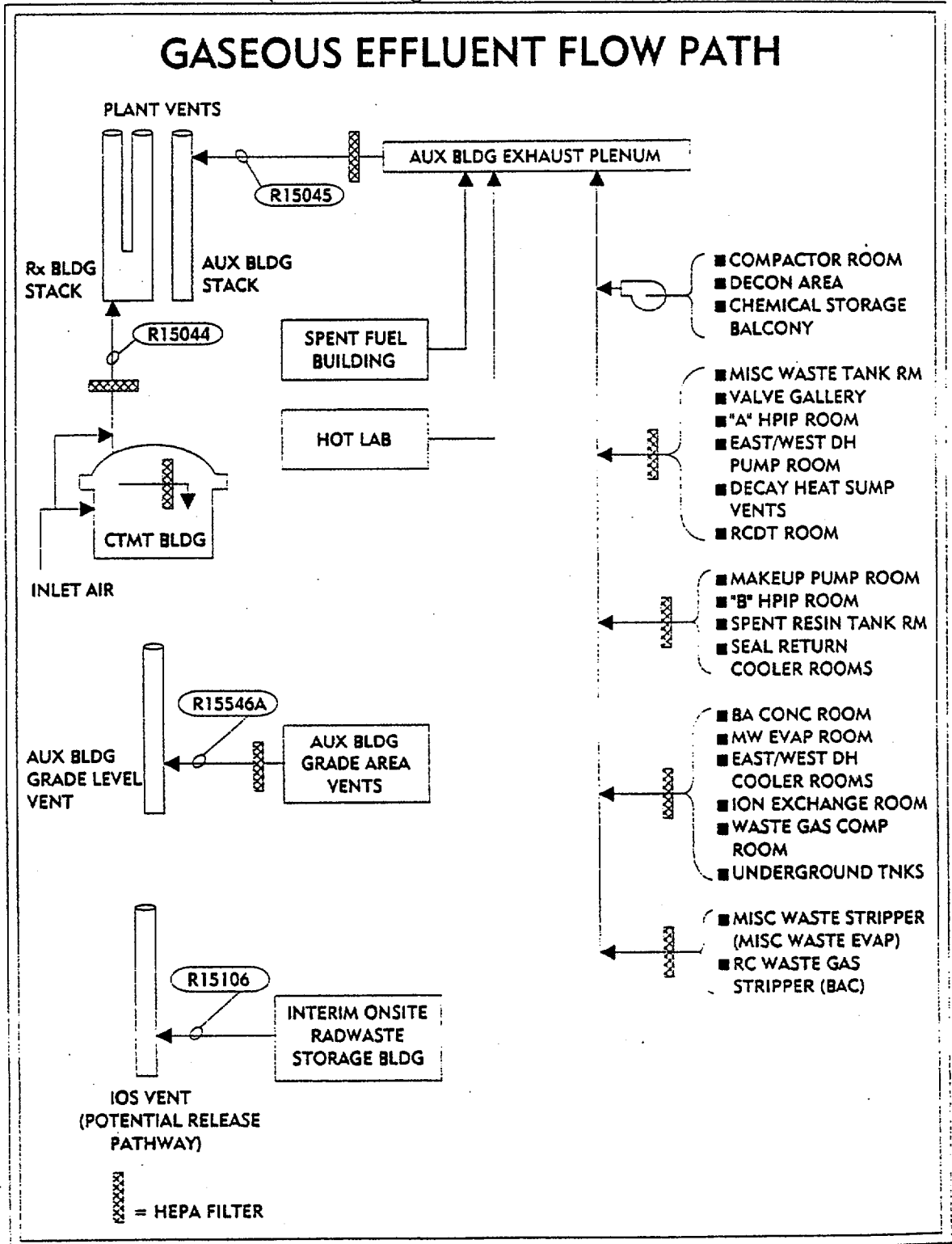
The individual/packaged documents and related correspondence completed as a result of the performance or implementation of this procedure are records. They shall be transmitted to Records Management in accordance with RSAP-0601, Nuclear Records Management.

LIQUID EFFLUENT FLOW DIAGRAM
(This drawing is for information only)



(This drawing is for information only)

GASEOUS EFFLUENT FLOW DIAGRAM
(This drawing is for information only)



(This drawing is for information only)

DOSE FACTOR PARAMETERS

CONSUMPTION AND USAGE PARAMETERS

<u>PATHWAY</u>	<u>AGE</u>	<u>1.109 DEFAULT</u>	<u>RSNGS</u>
Irrigated Stored Vegetables	Adult	520 kg/yr	520 kg/yr
	Teen	630 kg/yr	630 kg/yr
	Child	520 kg/yr	520 kg/yr
	Infant	0 kg/yr	0 kg/yr
Irrigated Fresh Vegetables	Adult	64 kg/yr	64 kg/yr
	Teen	42 kg/yr	42 kg/yr
	Child	26 kg/yr	26 kg/yr
	Infant	0 kg/yr	0 kg/yr
Irrigated Milk	Adult	310 kg/yr	310 kg/yr
	Teen	400 kg/yr	400 kg/yr
	Child	330 kg/yr	330 kg/yr
	Infant	330 kg/yr	330 kg/yr
Irrigated Meat & Poultry	Adult	110 kg/yr	110 kg/yr
	Teen	65 kg/yr	65 kg/yr
	Child	41 kg/yr	41 kg/yr
	Infant	0 kg/yr	0 kg/yr
Fish	Adult	21 kg/yr	21 kg/yr
	Teen	16 kg/yr	16 kg/yr
	Child	6.9 kg/yr	6.9 kg/yr
	Infant	0 kg/yr	0 kg/yr
Other Seafood Invertebrate (Crayfish)	Adult	5.0 kg/yr	6.9 kg/yr
	Teen	3.8 kg/yr	5.2 kg/yr
	Child	1.7 kg/yr	2.2 kg/yr
	Infant	0 kg/yr	0 kg/yr
Algae	Adult	None	0 kg/yr
	Teen	None	0 kg/yr
	Child	None	0 kg/yr
	Infant	None	0 kg/yr
Water Usage (Drinking Water)	Adult	730 l/yr	0 l/yr
	Teen	510 l/yr	0 l/yr
	Child	510 l/yr	0 l/yr
	Infant	330 l/yr	0 l/yr

DOSE FACTOR PARAMETERS (Continued)

CONSUMPTION AND USAGE PARAMETERS (continued)

<u>PATHWAY</u>	<u>AGE</u>	<u>1.109 DEFAULT</u>	<u>RSNGS</u>
Shoreline Recreation	Adult	12 hr/yr	200 hr/yr
	Teen	67 hr/yr	100 hr/yr
	Child	14 hr/yr	14 hr/yr
	Infant	0 hr/yr	0 hr/yr
Swimming	Adult	None	100 hr/yr
	Teen	None	100 hr/yr
	Child	None	14 hr/yr
	Infant	None	0 hr/yr
Boating	Adult	None	0 hr/yr
	Teen	None	0 hr/yr
	Child	None	0 hr/yr
	Infant	None	0 hr/yr
Inhalation	Adult	8000 m ³	8000 m ³
	Teen	8000 m ³	8000 m ³
	Child	3700 m ³	3700 m ³
	Infant	1400 m ³	1400 m ³

IRRIGATION RATES AND FRACTION OF IRRIGATION

	<u>1.109 DEFAULT</u>	<u>RSNGS</u>
Irrigation Rate	263 l/m ² /month	263 l/m ² /month
Time field has been irrigated prior to crop of interest	15 years	15 years
Fraction of the year field is irrigated	None	None
Fraction of animal water intake not obtained from the irrigation system (Irrigated Meat)	None	0
Fraction of animal water intake not obtained from the irrigation system (Irrigated Milk)	None	1

DOSE FACTOR PARAMETERS (Continued)

TRANSIT, TRANSFER, AND HOLDUP TIMES

	<u>1.109 DEFAULT</u>	<u>RSNGS</u>
Irrigated Stored Vegetables Holdup Time	1440 hrs	1440 hrs
Irrigated Fresh Vegetables Holdup Time	24 hrs	24 hrs
Irrigated Milk Holdup Time	48 hrs	48 hrs
Irrigated Meat Holdup Time	480 hrs	480 hrs
Transit Time From Time Of Sample To Time Of Release	None	72 hrs
Transit Time To Drinking Water	None	0 hrs

DILUTIONS

	<u>1.109 DEFAULT</u>	<u>RSNGS</u>
All Pathways	None	1 (None)
Shore-Width Factor	0.2	0.2

MISCELLANEOUS

	<u>1.109 DEFAULT</u>	<u>RSNGS</u>
Fraction Of Leafy Vegetables Grown In Garden Of Interest	1.0	1.0
Fraction Of Produce Ingested Grown In Garden Of Interest	0.76	0.76
Crop Growing Time For Leafy Vegetables Ingested By Man	60 Days	30 Days
Crop Growing Time For Pasture Grass	30 Days	30 Days
Crop Yield For Leafy Vegetables Ingested By Man	2.0 kg/m ²	2.0 kg/m ²
Crop Yield For Pasture Grass	0.7 kg/m ²	2.0 kg/m ²

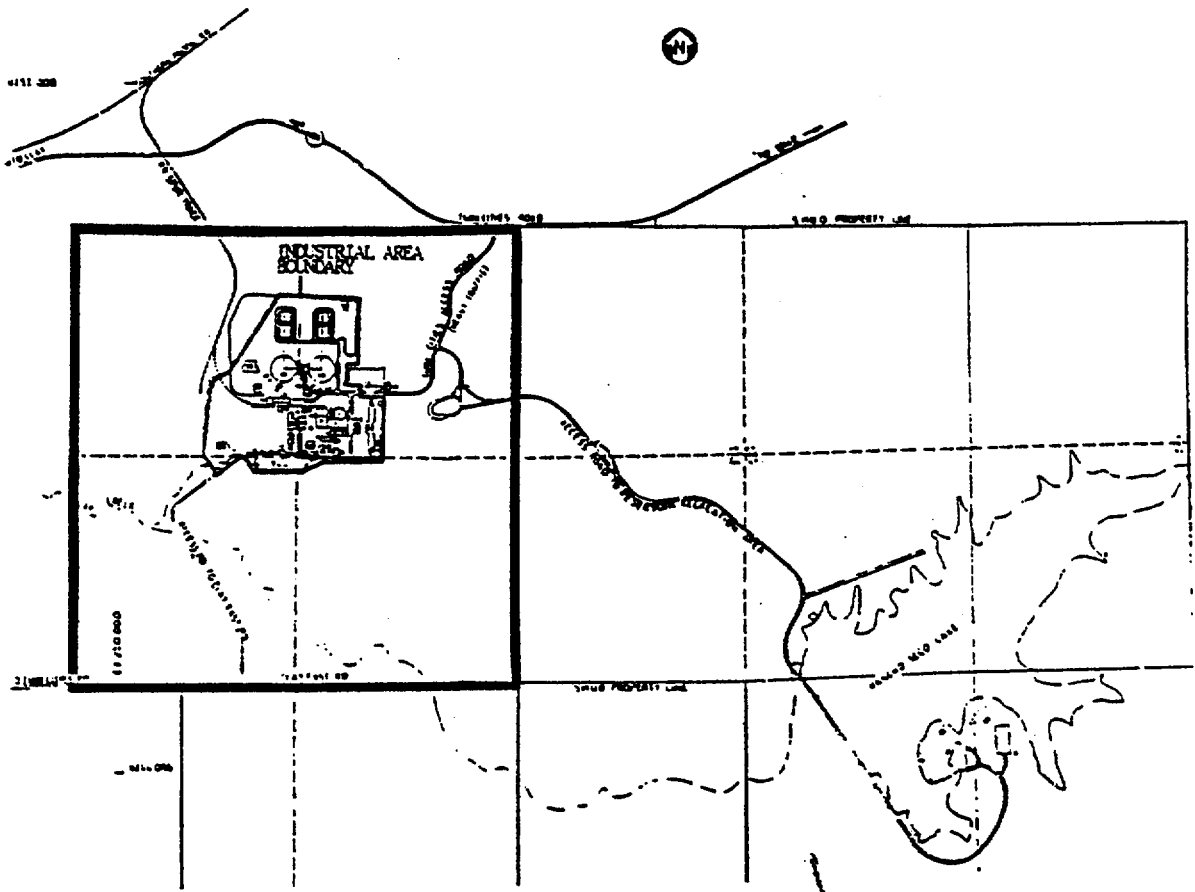
ATMOSPHERIC DISPERSION AND DEPOSITION PARAMETERS
GASEOUS EFFLUENT PATHWAYS
1994 CONTROLLING LOCATIONS**

<u>PATHWAY</u>	<u>DIRECTION</u>	<u>DISTANCE</u>	<u>X/Q*</u> (sec/m ³)	<u>D/Q*</u> (m ⁻²)
Inhalation	ENE	1038 M	8.1E-06	--
Ground	ENE	1038 M	--	4.8E-08
Vegetation	SSW	670 M	1.4E-05	2.8E-08
Cow Milk	ENE	1038 M	8.1E-06	4.8E-08
Meat Animal	S	195 M	1.2E-04	--
Meat Animal	SSE	198 M	--	3.4E-07
Goat Milk	SSW	2500 M	1.0E-06	1.7E-09
Site Boundary for Gaseous Effluents	NNW	670 M	2.1E-05	--

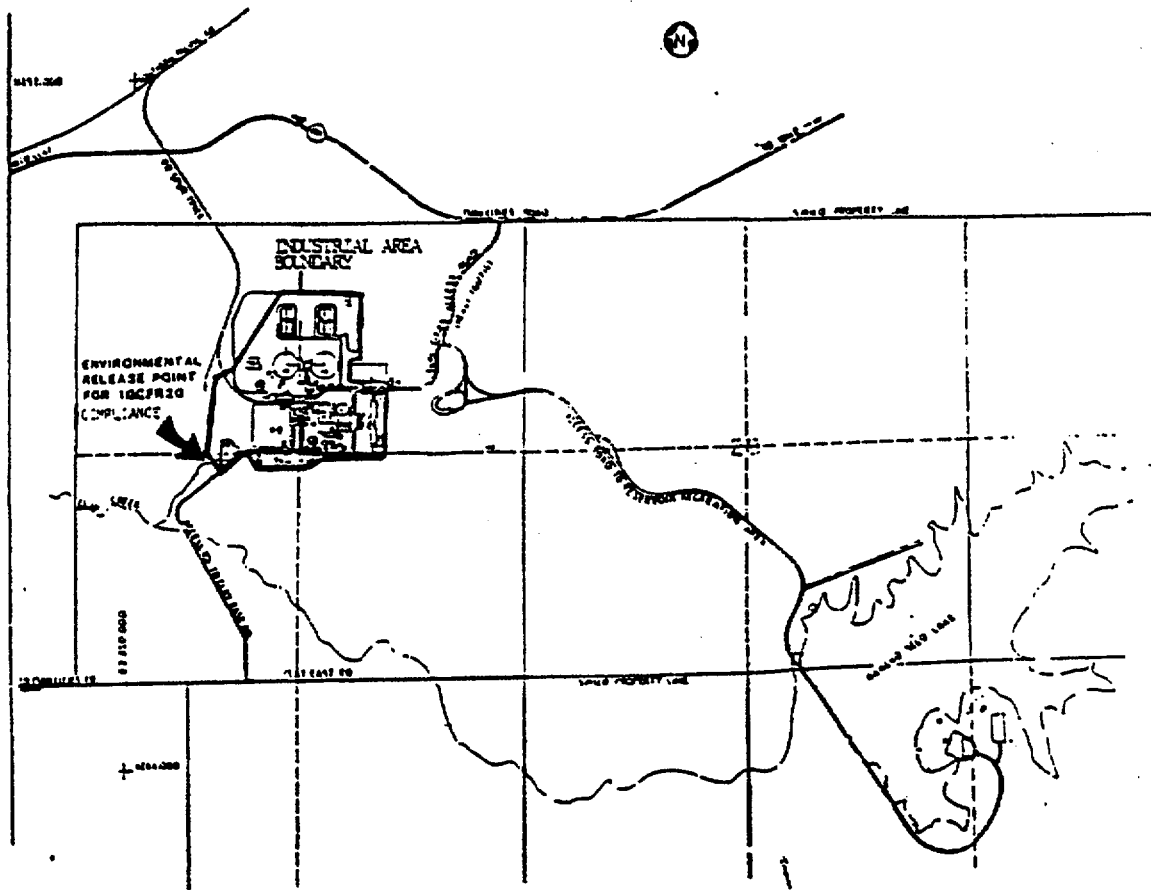
* Based on meteorological data from January 1978 to December 1987.

** Based on 1994 Land Use Census.

SITE BOUNDARY FOR GASEOUS EFFLUENTS



SITE BOUNDARY FOR LIQUID EFFLUENTS



HISTORICAL LIQUID SOURCE TERMS

Nuclide	Ci ($\mu\text{Ci/ml}$)	Of Gamma Emitters		Of All Nuclides	
		Relative %	Relative Fraction	Relative %	Relative Fraction
H-3	4.45 E-04	n/a	n/a	100.00	1.00
Cs-137	1.23 E-08	100.00	1.00	2.76 E-05	2.76 E-05
TOTAL	4.45 E-04	100.00	1.00	100.00	1.00

Note Based on Retention Basin Effluent History of Rancho Seco from January 1, 1993 through December 31, 1994

LIQUID MONITOR DETECTOR EFFICIENCIES

R15017A & R15017B*
(Detector Model RD-53)

<u>Nuclide</u>	<u>Efficiency cpm/μCi/cc</u>
MO-99	3.47 E+07
I-131	1.90 E+08
I-132	4.17 E+08
I-133	1.53 E+08
I-135	1.74 E+08
CS-134	3.25 E+08
CS-137	1.28 E+08
CR-51	1.85 E+07
MN-54	1.30 E+08
FE-59	1.26 E+08
CO-58	1.85 E+08
CO-60	2.40 E+08
ZN-65	6.49 E+07
SB-124	2.66 E+08
BA-140	8.98 E+07
LA-140	2.69 E+08
CE-141	7.68 E+07
CE-144	1.80 E+07

* From Calculation Z-RDM-I0261

ORGAN DOSE FACTORS FOR LIQUID EFFLUENTS

DOSE FACTOR TABLE: A(i) - Adult

Units are mrem/hr per $\mu\text{Ci}/\text{ml}$

Nuclide	Bone	Liver	Body	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	1.21E-01	1.21E-01	1.21E-01	1.21E-01	1.21E-01	1.21E-01
C-14	3.32E-05	7.63E-04	7.63E-04	7.63E-04	7.63E-04	7.63E-04	7.63E-04
NA-24	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01	4.32E-01
P-32	4.07E-07	2.53E-06	1.57E-06	6.31E-02	6.31E-02	6.31E-02	4.58E-06
CR-51	3.08E-00	3.08E-00	8.89E-00	6.56E-00	3.96E-00	1.08E-01	1.46E-03
MN-54	8.23E-03	1.11E-05	6.18E-04	8.23E-02	9.90E-04	8.23E-02	1.01E-06
MN-56	0.00E-00	2.13E-04	3.79E-05	0.00E-00	2.70E-04	0.00E-00	6.79E-03
FE-55	1.18E-04	8.17E-03	1.91E-03	7.29E-04	7.29E-04	4.56E-03	4.69E-03
FE-59	1.47E-04	3.42E-04	1.32E-04	1.77E-02	1.77E-02	9.89E-03	1.14E-05
CO-58	2.36E-02	9.91E-02	1.93E-03	2.36E-02	2.36E-02	2.36E-02	1.55E-04
CO-60	1.26E-04	1.61E-04	2.02E-04	1.26E-04	1.26E-04	1.26E-04	7.71E-04
NI-63	3.43E-05	2.37E-04	1.15E-04	0.00E-00	0.30E-00	0.00E-00	4.95E-03
NI-65	8.65E-04	1.12E-04	5.13E-05	0.00E-00	0.00E-00	0.00E-00	2.85E-03
CU-64	8.90E-02	7.02E-01	1.77E-01	8.90E-02	1.64E-00	8.90E-02	5.24E-01
ZN-65	7.63E-04	2.42E-05	1.10E-05	4.45E-02	1.62E-05	4.45E-02	1.52E-05
ZN-69	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00
BR-83	0.00E-00	0.00E-00	4.84E-05	0.00E-00	0.30E-00	0.00E-00	6.98E-05
BR-84	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00
BR-85	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00
BR-86	6.46E-00	1.21E-05	5.62E-04	6.46E-00	6.46E-00	6.46E-00	2.38E-04
RB-88	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00
RB-89	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00
SR-89	2.01E-05	6.35E-02	5.75E-01	6.25E-02	5.75E-02	6.25E-02	3.22E-04
SR-90	3.71E-06	6.16E-03	1.53E-06	1.66E-03	1.53E-03	1.66E-03	1.22E-05
SR-91	5.95E-03	1.19E-01	1.40E-01	1.19E-01	1.19E-01	1.19E-01	2.52E-01
SR-92	1.15E-00	6.94E-02	2.58E-04	0.00E-00	2.30E-00	0.00E-00	1.18E-01
Y-90	0.00E-00	0.00E-00	1.52E-01	6.94E-02	5.94E-02	6.94E-02	3.27E-04
Y-91	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00
Y-92	1.72E-05	4.24E-06	6.82E-01	5.82E-01	5.82E-01	5.82E-01	1.07E-05
Y-93	2.16E-02	1.61E-02	1.63E-02	1.61E-02	1.61E-02	1.61E-02	2.38E-01
ZR-95	8.87E-01	9.83E-01	9.82E-01	9.82E-01	9.82E-01	9.82E-01	3.26E-02
ZR-97	5.16E-02	3.27E-02	2.17E-02	3.27E-02	3.27E-02	3.27E-02	1.44E-06
MO-99	8.23E-04	1.03E-03	4.74E-03	7.11E-04	5.51E-03	8.66E-04	1.88E-01
TC-99M	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00
TC-101	6.76E-02	7.82E-01	3.13E-02	7.02E-01	2.18E-01	7.02E-01	7.08E-04
RU-103	9.35E-04	1.83E-04	4.80E-04	1.83E-04	3.92E-03	1.83E-04	4.60E-01
RU-106	1.61E-04	2.95E-02	2.30E-01	2.95E-02	3.32E-04	2.95E-02	1.02E-06
AG-110M	2.63E-03	2.59E-03	2.37E-03	2.06E-03	3.13E-03	2.06E-03	2.17E-05
TE-125M	1.86E-04	6.75E-03	2.49E-03	5.60E-03	4.57E-04	9.21E-01	7.43E-04
TE-127	5.26E-04	1.88E-04	6.41E-03	1.14E-03	2.4E-05	5.57E-02	1.76E-05
TE-127M	5.06E-01	2.18E-01	1.31E-01	4.49E-01	2.47E-00	1.65E-04	4.78E-01
TE-129M	7.19E-04	2.88E-04	2.13E-04	2.47E-04	3.30E-05	1.31E-01	3.62E-05
TE-130	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.30E-00	0.00E-00	0.00E-00
TE-131M	1.11E-03	5.44E-02	4.54E-02	8.58E-02	5.43E-03	0.00E-00	0.00E-00
TE-132	6.30E-03	4.07E-03	3.82E-03	4.50E-03	3.2E-04	3.71E-00	1.91E-05
I-130	3.14E-00	7.62E-00	3.51E-00	5.76E-02	1.4E-01	8.37E-01	6.68E-00
I-131	7.06E-02	1.00E-01	5.82E-02	3.24E-05	1.71E-03	1.47E-01	2.76E-02
I-132	1.60E-04	4.29E-04	1.50E-04	1.50E-02	6.81E-04	0.00E-00	8.05E-05
I-133	1.68E-01	2.84E-01	9.45E-00	4.01E-03	4.88E-01	1.13E-00	2.57E-01
I-134	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00
I-135	1.59E-01	4.14E-01	1.53E-01	2.73E-01	6.81E-01	8.91E-04	4.58E-01
CS-134	4.44E-05	1.05E-06	8.59E-05	4.03E-03	1.43E-05	1.18E-05	2.32E-04
CS-136	3.16E-04	1.24E-05	8.95E-04	1.15E-02	6.22E-04	9.54E-04	2.14E-04
CS-137	5.85E-05	7.98E-05	5.25E-05	6.06E-03	7.5E-05	9.54E-04	0.00E-00
CS-138	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00
BA-139	3.00E-00	0.00E-00	0.00E-00	0.00E-00	0.30E-00	0.00E-00	0.00E-00
BA-140	4.90E-03	2.11E-01	3.35E-02	1.50E-01	2.71E-01	1.85E-01	1.91E-04
BA-141	0.00E-00	0.00E-00	0.00E-00	0.00E-00	3.00E-00	0.00E-00	0.00E-00
BA-142	0.00E-00	0.00E-00	0.00E-00	0.00E-00	3.00E-00	0.00E-00	0.00E-00
LA-140	4.14E-00	3.92E-00	1.76E-00	3.71E-00	3.71E-00	3.71E-00	1.62E-04
CA-141	3.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	6.29E-06
CE-141	1.37E-01	1.56E-02	3.60E-00	3.90E-00	1.2E-01	3.90E-00	2.54E-00
CE-143	1.31E-00	1.42E-02	1.76E-00	1.74E-00	3.2E-00	1.74E-00	5.4E-03
CE-144	3.99E-02	4.00E-02	3.75E-01	4.15E-01	2.52E-02	4.15E-01	2.90E-05
FR-143	7.38E-00	2.96E-00	3.66E-01	0.00E-00	0.00E-00	0.00E-00	0.00E-00
FR-144	3.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00	0.00E-00
ND-147	9.62E-00	1.03E-01	5.27E-00	4.95E-00	9.22E-00	4.95E-00	2.89E-04
W-187	2.03E-01	1.72E-01	6.89E-00	1.35E-00	1.35E-00	1.35E-00	5.20E-03
NP-239	1.70E-00	1.56E-00	1.56E-00	1.56E-00	1.56E-00	1.56E-00	2.92E-03

ORGAN DOSE FACTORS FOR LIQUID EFFLUENTS (Continued)

DOSE FACTOR TABLE: A(i) - Teen
Units are mrem/hr per $\mu\text{Ci/ml}$

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	1.37E+01	1.37E+01	1.37E+01	1.37E+01	1.37E+01	1.37E+01
C-14	5.64E+05	1.13E+05	1.13E+05	1.13E+05	1.13E+05	1.13E+05	1.13E+05
NA-24	6.36E-01	6.36E+01	6.36E+01	6.36E+01	6.36E+01	6.36E+01	6.36E+01
P-32	4.44E+07	2.75E+06	1.72E+06	6.31E-02	6.31E-02	6.31E-02	3.73E+06
CR-51	1.82E+00	1.82E+00	8.10E+00	5.31E+00	3.19E+00	1.08E+01	1.06E+03
MN-54	4.20E+02	3.24E+05	6.45E+04	4.20E+02	9.69E+04	4.20E+02	6.63E+05
MN-56	0.00E+00	1.92E+04	3.43E+05	0.00E+00	2.43E+04	0.00E+00	1.26E+02
FE-55	1.37E+04	9.69E+03	2.26E+03	7.29E+04	7.29E+04	6.15E+03	4.19E+03
FE-59	1.55E+04	3.61E+04	1.40E+04	1.00E+02	1.00E+02	1.15E+04	8.53E+04
CO-58	1.28E+02	1.08E+03	2.32E+03	1.28E+02	1.28E+02	1.28E+02	1.33E+04
CO-60	6.35E+03	1.10E+04	1.69E+04	6.35E+03	6.35E+03	6.35E+03	6.71E+04
NI-63	4.50E+05	3.18E+04	1.53E+04	0.00E+00	0.00E+00	0.00E+00	5.06E+03
NI-65	8.19E+04	1.05E+04	4.77E+05	0.00E+00	0.00E+00	0.00E+00	5.67E+03
CU-64	8.55E+02	9.25E+01	4.80E+01	8.55E+02	2.21E+00	8.55E+02	6.52E+01
ZN-65	7.56E+04	2.62E+05	1.22E+05	2.29E+02	1.68E+05	2.29E+02	1.11E+05
ZN-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	4.93E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	4.10E+00	1.40E+05	6.56E+04	4.10E+00	4.10E+00	4.10E+00	2.07E+04
RB-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-89	3.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	2.93E+05	5.64E+02	8.38E+03	5.64E+02	5.64E+02	5.64E+02	3.48E+04
SR-90	7.40E+06	6.16E+03	1.98E+06	6.16E+03	6.16E+03	6.16E+03	3.85E+05
SR-91	5.71E+00	1.16E+01	3.39E+01	1.16E+01	1.16E+01	1.16E+01	2.56E+01
SR-92	5.55E+03	0.00E+00	2.37E+04	0.00E+00	0.00E+00	0.00E+00	1.42E+01
Y-90	3.35E+00	6.87E+02	1.57E+01	6.87E+02	6.87E+02	6.87E+02	2.71E+04
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	2.46E+02	3.78E+01	6.97E+00	3.78E+01	3.78E+01	3.78E+01	1.01E+05
Y-92	1.64E+05	4.20E+06	4.55E+06	4.20E+06	4.20E+06	4.20E+06	3.35E+01
Y-92	2.13E+02	1.57E+02	1.59E+02	1.57E+02	1.57E+02	1.57E+02	1.70E+02
ZR-95	1.19E+02	9.67E+01	9.34E+01	8.62E+01	1.02E+02	8.62E+01	2.42E+04
ZR-97	9.41E+01	9.37E+01	9.37E+01	9.36E+01	9.38E+01	9.36E+01	2.63E+02
NB-95	4.73E+02	2.82E+02	1.75E+02	4.46E+01	2.75E+02	4.46E+01	1.02E+06
MO-99	6.36E-01	4.32E+02	8.28E+01	6.36E-01	9.87E+02	6.36E-01	7.73E+02
TC-99M	8.54E+04	1.13E+03	6.35E+03	6.98E+04	7.20E+03	9.40E+04	2.87E+01
TC-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RU-103	5.86E+02	3.51E+01	2.71E+02	3.51E+01	1.98E+03	3.51E+01	4.61E+04
RU-105	8.80E+04	1.81E+04	4.52E+04	1.81E+04	9.00E+03	1.81E+04	5.65E+01
RU-106	1.59E+04	1.48E+02	2.14E+03	1.48E+02	3.06E+04	1.48E+02	7.57E+05
AG-110M	1.87E+03	1.83E+03	1.53E+03	1.06E+03	2.53E+03	1.06E+03	2.17E+05
TE-125M	2.06E+04	7.42E+03	2.75E+03	5.75E+03	4.81E+01	4.81E+01	6.07E+04
TE-127M	5.93E+04	2.10E+04	7.05E+03	1.41E+04	2.40E+05	2.93E+02	1.48E+05
TE-127	6.53E+01	2.32E+01	1.41E+01	4.51E+01	2.64E+00	1.57E+04	5.04E+01
TE-129M	7.75E+04	2.88E+04	1.23E+04	2.50E+04	1.24E+05	7.70E+00	2.91E+05
TE-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-131M	1.18E+03	5.67E+02	4.74E+02	8.50E+02	5.86E+03	5.20E+00	4.51E+04
TE-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-132	6.58E+03	4.17E+03	3.92E+03	4.40E+03	4.00E+04	3.07E+00	1.32E+05
I-130	3.80E+00	9.45E+00	4.26E+00	7.06E+02	1.41E+01	8.08E+01	7.45E+00
I-131	9.72E+02	1.36E+03	7.33E+02	3.93E+05	2.33E+03	1.08E+01	2.77E+02
I-132	1.46E+04	3.81E+04	1.37E+04	1.29E+02	6.01E+04	0.00E+00	1.66E+04
I-133	2.27E+01	3.77E+01	1.22E+01	5.12E+03	6.54E+01	1.06E+00	2.88E+01
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	1.85E+01	4.76E+01	1.77E+01	3.06E+01	7.52E+01	4.45E+04	5.28E+01
CS-134	5.04E+05	1.18E+06	5.50E+05	2.03E+03	3.77E+05	1.45E+05	1.67E+04
CS-136	3.27E+04	1.28E+05	8.62E+04	7.75E+01	6.99E+04	1.11E+04	1.04E+04
CS-137	6.99E+05	9.30E+05	3.26E+05	3.03E+03	3.18E+05	1.26E+05	1.62E+04
CS-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.94E+06
BA-140	5.34E+03	1.64E+03	3.53E+02	9.87E+00	1.21E+01	1.43E+01	8.23E+03
BA-141	0.00E+00	0.00E+00	0.00E+00	0.30E+00	0.00E+00	0.00E+00	0.00E+00
BA-142	3.00E+00	0.30E+00	0.00E+00	0.30E+00	0.30E+00	0.30E+00	0.30E+00
LA-140	2.30E+00	2.08E+00	2.91E+00	1.35E+00	1.35E+00	1.35E+00	1.27E+04
LA-142	3.00E+00	0.30E+00	0.00E+00	3.00E+00	0.00E+00	0.30E+00	2.35E+05
CE-141	1.59E+01	1.30E+01	6.05E+00	5.15E+00	3.84E+00	5.15E+00	2.25E+04
CE-143	1.79E+00	1.48E+02	1.61E+00	1.59E+00	1.66E+00	1.59E+00	4.41E+03
CE-144	1.20E+03	5.10E+02	8.47E+01	2.12E+01	3.13E+02	2.12E+01	2.97E+05
PR-143	7.98E+00	3.18E+00	3.97E+01	0.00E+00	1.85E+00	0.00E+00	2.62E+04
PR-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ND-147	7.72E+00	8.17E+00	2.82E+00	2.47E+00	5.82E+00	2.47E+00	2.06E+04
W-187	2.17E+01	1.79E+01	7.11E+00	1.26E+00	1.26E+00	1.26E+00	4.51E+03
NP-239	1.50E+00	1.36E+00	1.35E+00	1.14E+00	1.39E+00	1.34E+00	2.41E+03

ORGAN DOSE FACTORS FOR LIQUID EFFLUENTS (Continued)

DOSE FACTOR TABLE: A(i) - Child
Units are mrem/hr per $\mu\text{Ci/ml}$

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	2.10E+01	2.10E+01	2.10E+01	2.10E+01	2.10E+01	2.10E+01
C-14	1.28E+06	2.56E+05	2.56E+05	2.56E+05	2.56E+05	2.56E+05	2.56E+05
NA-24	1.16E+02	1.16E+02	1.16E+02	1.16E+02	1.16E+02	1.16E+02	1.16E+02
P-32	5.74E+07	2.69E+06	2.21E+06	8.84E+03	8.84E+03	8.84E+03	1.59E+06
CR-51	2.54E+01	2.54E+01	7.95E+00	4.52E+00	1.42E+00	8.05E+00	4.08E+02
MN-54	5.88E+01	2.51E+05	6.74E+04	5.88E+01	7.10E+04	5.88E+01	2.12E+05
MN-56	0.00E+00	2.51E+04	5.68E+05	0.00E+00	3.04E+04	0.00E+00	1.64E+02
FE-55	2.40E+04	1.27E+04	3.94E+03	1.02E+04	1.02E+04	7.19E+03	2.35E+03
FE-59	2.21E+04	3.58E+04	1.78E+04	1.40E+01	1.40E+01	1.04E+04	3.72E+04
CO-58	1.79E+01	1.24E+03	3.88E+03	1.79E+01	1.79E+01	1.79E+01	7.38E+03
CO-60	8.89E+02	7.51E+03	2.04E+04	8.89E+02	8.89E+02	8.89E+02	3.76E+04
NI-63	1.02E+06	5.48E+04	1.48E+04	0.00E+00	0.00E+00	0.00E+00	3.69E+03
NI-65	1.52E+03	1.41E+04	8.35E+05	0.00E+00	0.00E+00	0.00E+00	1.75E+02
CU-64	1.20E+02	1.27E+00	7.70E+01	1.20E+02	3.05E+00	1.20E+02	5.89E+01
ZN-65	9.51E+04	2.54E+05	1.58E+05	3.21E+01	1.60E+05	3.21E+01	4.46E+04
ZN-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	9.58E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	5.74E+01	1.61E+05	9.88E+04	5.74E+01	5.74E+01	5.74E+01	1.03E+04
RB-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	5.48E+05	7.90E+01	1.85E+04	7.90E+01	7.90E+01	7.90E+01	2.51E+04
SR-90	1.47E+07	8.62E+04	3.91E+06	8.62E+04	8.62E+04	8.62E+04	2.97E+05
SR-91	1.04E+01	1.62E+02	4.06E+01	1.62E+02	1.62E+02	1.62E+02	2.28E+01
SR-92	1.02E+02	0.00E+00	4.09E+04	0.00E+00	0.00E+00	0.00E+00	1.93E+01
Y-90	4.28E+00	9.62E+03	1.24E+01	9.62E+03	9.62E+03	9.62E+03	1.22E+04
Y-91M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	4.49E+02	5.29E+02	1.21E+01	5.29E+02	5.29E+02	5.29E+02	5.98E+04
Y-92	2.31E+05	0.00E+00	1.23E+06	0.00E+00	0.00E+00	0.00E+00	6.50E+01
Y-93	1.05E+02	2.20E+03	2.43E+03	2.20E+03	2.20E+03	2.20E+03	1.24E+02
ZR-95	3.32E+01	2.77E+01	2.60E+01	1.21E+01	3.45E+01	1.21E+01	1.63E+04
ZR-97	1.40E+01	1.32E+01	1.32E+01	1.31E+01	1.33E+01	1.31E+01	1.90E+02
NB-95	5.20E+02	2.06E+02	1.49E+02	6.25E+00	1.94E+02	6.25E+00	3.70E+05
MO-99	8.90E+02	7.01E+02	1.73E+02	8.90E+02	1.50E+03	8.90E+02	5.80E+02
TC-99M	4.34E+04	7.58E+04	1.10E+02	9.77E+05	9.69E+01	4.33E+04	3.76E+01
TC-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RU-103	1.02E+03	4.92E+00	3.96E+02	4.92E+00	2.57E+01	4.92E+00	2.61E+04
RU-105	1.31E+03	2.53E+05	4.90E+04	2.53E+05	1.13E+02	2.53E+05	8.35E+01
RU-106	3.18E+04	2.07E+01	3.98E+03	2.07E+01	4.29E+04	2.07E+01	4.94E+05
AG-110M	1.79E+03	1.26E+03	1.04E+03	1.48E+02	2.22E+03	1.48E+02	1.32E+05
TE-125M	3.04E+04	8.25E+03	4.06E+03	8.54E+03	6.73E+02	6.73E+02	2.94E+04
TE-127M	9.30E+04	2.50E+04	1.10E+04	2.22E+04	2.65E+05	4.10E+03	7.53E+04
TE-127	8.94E+01	2.41E+01	1.92E+01	6.19E+01	2.54E+00	3.20E+05	3.49E+01
TE-129M	1.09E+05	1.05E+04	1.70E+04	3.52E+04	3.21E+05	1.08E+00	1.31E+05
TE-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E+06
TE-131M	1.48E+03	5.13E+02	5.46E+02	1.05E+03	4.96E+03	7.28E+01	2.08E+04
TE-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-132	8.15E+03	3.61E+03	4.36E+03	5.26E+03	3.35E+04	4.30E+01	3.63E+04
I-130	6.36E+00	1.27E+01	6.62E+00	1.39E+03	1.90E+01	1.13E+01	6.02E+00
I-131	2.06E+03	2.07E+03	1.18E+03	6.84E+05	3.40E+03	1.51E+00	1.86E+02
I-132	2.60E+04	4.78E+04	2.20E+04	2.22E+02	7.32E+04	0.00E+00	5.63E+04
I-133	4.65E+01	5.74E+01	2.18E+01	1.06E+04	9.56E+01	1.49E+01	2.32E+01
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	3.79E+01	6.82E+01	3.23E+01	6.04E+01	1.05E+00	6.24E+05	5.20E+01
CS-134	7.61E+05	1.25E+06	2.64E+05	2.85E+02	3.87E+05	1.19E+05	7.02E+03
CS-136	4.14E+04	1.14E+05	7.37E+04	1.09E+01	6.06E+04	9.05E+03	4.01E+03
CS-137	1.12E+06	1.07E+06	1.59E+05	4.25E+02	3.50E+05	1.26E+05	7.15E+03
CS-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E+05
BA-140	8.64E+03	9.95E+00	5.05E+02	1.18E+00	1.85E+00	5.89E+00	4.38E+03
BA-141	3.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-142	3.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA-140	8.30E+01	4.59E+01	1.27E+01	2.59E+01	2.59E+01	2.59E+01	5.56E+03
LA-142	3.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.99E+04
CE-141	2.04E+01	1.05E+01	2.18E+02	7.31E+01	5.33E+00	7.21E+01	1.23E+04
CE-143	4.35E+01	1.42E+02	2.44E+01	2.33E+01	2.83E+01	2.23E+01	2.08E+03
CE-144	2.39E+03	7.51E+02	1.30E+02	2.97E+00	4.17E+02	2.97E+00	1.95E+05
PR-143	1.11E+01	3.33E+00	5.51E+01	0.00E+00	1.80E+00	0.00E+00	1.20E+04
PR-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ND-147	7.38E+00	6.04E+00	7.98E+01	3.47E+01	3.47E+00	3.47E+01	9.02E+03
W-187	2.65E+01	1.58E+01	7.17E+00	1.77E+01	1.77E+01	1.77E+01	2.19E+03
NP-239	4.00E+01	2.03E+01	1.99E+01	1.38E+01	2.32E+01	1.38E+01	1.13E+03

ORGAN DOSE FACTORS FOR LIQUID EFFLUENTS (Continued)

DOSE FACTOR TABLE: A(i) - Infant
Units are mrem/hr per $\mu\text{Ci/ml}$

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	1.14E+01	1.14E+01	1.14E+01	1.14E+01	1.14E+01	1.14E+01
C-14	5.80E+05	1.24E+05	1.24E+05	1.24E+05	1.24E+05	1.24E+05	1.24E+05
NA-24	1.76E+02	1.76E+02	1.76E+02	1.76E+02	1.76E+02	1.76E+02	1.76E+02
P-32	9.00E+05	5.29E+04	3.49E+04	0.00E+00	0.00E+00	0.00E+00	1.22E+04
CR-51	0.00E+00	0.00E+00	7.82E-01	5.10E-01	1.12E-01	9.93E-01	2.28E-01
MN-54	3.00E+00	1.68E+02	3.82E+01	0.00E+00	3.73E+01	0.00E+00	6.18E-01
MN-56	0.00E+00	1.22E+06	0.00E+00	0.00E+00	1.05E+06	0.00E+00	1.11E+04
FE-55	5.61E+02	3.63E+02	9.69E+01	0.00E+00	0.00E+00	1.77E+02	4.61E+01
FE-59	1.04E+03	1.81E+03	7.14E+02	0.00E+00	0.00E+00	5.36E+02	8.66E+02
CO-58	0.00E+00	1.08E+02	2.70E+02	0.00E+00	0.00E+00	0.00E+00	2.70E+02
CO-60	0.00E+00	3.81E+02	8.99E+02	0.00E+00	0.00E+00	0.00E+00	9.06E+02
NI-63	1.72E+05	1.06E+04	5.97E+03	0.00E+00	0.00E+00	0.00E+00	5.29E+02
NI-65	1.47E+04	1.66E+05	7.56E+06	0.00E+00	0.00E+00	0.00E+00	1.27E+03
CU-64	0.00E+00	2.29E+00	1.06E+00	0.00E+00	3.87E+00	0.00E+00	4.70E+01
ZN-65	3.02E+04	1.03E+05	4.77E+04	0.00E+00	5.02E+04	0.00E+00	8.74E+04
ZN-69	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-83	0.00E+00	0.00E+00	4.15E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	1.14E+05	5.65E+04	0.00E+00	0.00E+00	0.00E+00	2.92E+03
RB-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-89	3.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-89	5.77E+04	0.00E+00	1.66E+03	0.00E+00	3.00E+00	0.00E+00	1.19E+03
SR-90	3.91E+05	0.00E+00	1.05E+05	0.00E+00	0.00E+00	0.00E+00	7.22E+03
SR-91	4.01E+00	0.00E+00	1.45E+01	0.00E+00	0.00E+00	0.00E+00	4.75E+00
SR-92	1.34E+04	0.00E+00	6.83E+06	0.00E+00	0.00E+00	0.00E+00	1.98E+03
Y-90	4.55E+03	0.00E+00	1.22E+04	0.00E+00	0.00E+00	0.00E+00	6.28E+00
Y-91M	3.00E+00	0.00E+00	3.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-91	3.32E-01	0.00E+00	8.81E-03	0.00E+00	0.00E+00	0.00E+00	2.38E-01
Y-92	3.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.11E-04
Y-93	3.06E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.42E-01
ZR-95	3.06E+02	7.45E+03	5.28E+03	0.00E+00	8.03E+03	0.00E+00	3.71E+00
ZR-97	4.31E+05	7.40E+06	3.38E+06	0.00E+00	7.46E+06	0.00E+00	4.72E-01
NB-95	2.81E+00	1.16E+00	6.70E-01	0.00E+00	8.11E-01	0.00E+00	9.78E+02
MO-99	3.00E+00	1.38E+03	2.69E+02	0.00E+00	2.06E+02	0.00E+00	4.55E+02
TC-99M	5.61E-04	1.16E-03	1.49E-02	0.00E+00	1.25E-02	6.05E-04	3.36E-01
TC-101	3.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RU-103	4.08E-02	0.00E+00	1.37E-02	0.00E+00	8.50E-02	0.00E+00	4.97E-01
RU-105	3.00E+00	0.00E+00	0.00E+00	0.00E+00	1.52E+06	0.00E+00	8.25E-05
RU-106	8.40E-01	0.00E+00	1.05E-01	0.00E+00	9.94E-01	0.00E+00	6.38E+00
AG-110M	1.81E-03	1.32E-03	8.74E-03	0.00E+00	1.89E-03	0.00E+00	6.85E+04
TE-125M	8.48E+02	2.83E+02	1.15E+02	2.85E+02	0.00E+00	0.00E+00	4.04E+02
TE-127M	2.62E+03	8.69E+02	3.17E+02	7.57E+02	6.45E+03	0.00E+00	1.06E+03
TE-127	9.61E-02	3.22E-02	2.07E-02	7.82E-02	2.34E-01	0.00E+00	2.02E+00
TE-129M	3.05E+03	1.05E+03	4.70E+02	1.17E+03	7.83E+03	0.00E+00	1.82E+03
TE-129	3.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-131M	2.87E+01	1.16E+01	9.55E+00	2.34E+01	7.96E+01	0.00E+00	1.95E+02
TE-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-132	1.41E+02	6.98E+01	6.51E+01	1.03E+02	4.36E+02	0.00E+00	2.58E+02
I-130	8.92E+00	1.96E+01	7.88E+00	2.20E+03	2.16E+01	0.00E+00	4.21E+00
I-131	3.07E+03	3.61E+03	1.59E+03	1.19E+06	4.22E+03	0.00E+00	1.29E+02
I-132	1.30E+05	2.64E+05	9.41E+06	1.24E+03	2.95E+05	0.00E+00	2.14E+05
I-133	6.99E+01	1.02E+02	2.98E+01	1.85E+04	1.20E+02	0.00E+00	1.72E+01
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	4.23E-01	8.41E-01	3.07E-01	7.54E+01	9.38E-01	0.00E+00	3.04E-01
CS-134	1.55E+05	2.89E+05	2.92E+04	0.00E+00	7.43E+04	3.05E+04	7.84E+02
CS-136	1.05E+04	3.08E+04	1.15E+04	0.00E+00	1.23E+04	2.51E+03	4.67E+02
CS-137	2.32E+05	2.71E+05	1.92E+04	0.00E+00	7.27E+04	2.94E+04	8.47E+02
CS-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-139	3.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-140	1.29E+03	1.28E+00	6.61E-01	0.00E+00	3.05E-01	7.38E-01	3.15E+02
BA-141	3.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-142	3.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA-140	3.05E+04	1.20E+04	3.09E+05	0.00E+00	0.00E+00	0.00E+00	1.41E+00
LA-142	3.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CE-141	2.07E-01	1.26E-01	1.49E-02	0.00E+00	3.39E-02	0.00E+00	6.52E-01
CE-143	3.30E-03	3.12E-00	2.42E-04	0.00E+00	6.18E-04	0.00E+00	1.24E-01
CE-144	9.82E-00	4.02E+00	5.50E-01	0.00E+00	1.62E+00	0.00E+00	5.63E+02
PR-143	7.36E-03	2.94E-03	3.90E-04	0.00E+00	1.09E-03	0.00E+00	4.15E+00
PR-144	3.00E+00	0.00E+00	3.00E+00	0.00E+00	3.00E+00	0.00E+00	0.00E+00
ND-147	4.31E+03	4.94E+03	3.02E+04	3.00E+00	1.90E+03	0.00E+00	3.13E+00
W-187	5.55E-01	3.86E-01	1.33E-01	0.00E+00	0.00E+00	0.00E+00	2.27E-01
NP-239	2.51E-04	2.24E-05	2.27E-05	0.00E+00	4.47E-05	0.00E+00	6.48E-01

GASEOUS MONITOR DETECTOR EFFICIENCIES

R15044, R15045, and R15546A
(Detector Model RD-52)

Nuclide	Efficiency* cpm/ μ Ci/cc
KR-83M	0.0
KR-85M	7.30 E+07
KR-85	7.19 E+07
KR-87	8.70 E+07
KR-88	8.70 E+07
KR-89	8.70 E+07
KR-90	8.70 E+07
XE-131M	0.0
XE-133M	0.0
XE-133	2.94 E+07
XE-135M	0.0
XE-135	7.75 E+07
XE-137	8.70 E+07
XE-138	8.70 E+07
AR-41	7.80 E+07

* From Calculation Z-RDM-I0261

DOSE FACTORS FOR NOBLE GASES AND DAUGHTERS

FACTORS FOR EXPOSURE TO A SEMI-INFINITE CLOUD
OF NOBLE GASES

Nuclide	Dose to People†		Dose to Air‡	
	Gamma-Body K(i)	Beta-Skin L(i)	Gamma M(i)	Beta N(i)
AR-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03
KR-83M	7.56E-02	0.00E+00	1.93E+01	2.88E+02
KR-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
KR-85M	1.17E+03	1.46E+03	1.23E+03	1.97E+03
KR-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
KR-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
KR-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
KR-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
XE-131M	9.15E+01	4.76E+02	1.56E+02	1.11E+03
XE-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
XE-133M	2.51E+02	9.94E+02	3.27E+02	1.48E+03
XE-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
XE-135M	3.12E+03	7.11E+02	3.36E+03	7.39E+02
XE-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
XE-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03

† -- mrem/yr per $\mu\text{Ci}/\text{m}^3$

‡ -- mrad/yr per $\mu\text{Ci}/\text{m}^3$

ORGAN DOSE FACTORS FOR GASEOUS EFFLUENTS

DOSE FACTOR TABLE: R(i) - Adult, inhalation

Units are mrem/yr per $\mu\text{Ci}/\text{m}^3$

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03
CR-51	0.00E+00	0.00E+00	1.00E+02	5.95E+01	2.28E+01	1.44E+04	3.32E+03
MN-54	0.00E+00	3.96E+04	6.30E+03	0.00E+00	9.84E+03	1.40E+06	7.74E+04
FE-55	2.46E+04	1.70E+04	3.95E+03	0.00E+00	0.00E+00	7.21E+04	6.03E+03
FE-59	1.18E+04	2.78E+04	1.06E+04	0.00E+00	0.00E+00	1.02E+06	1.88E+05
CO-58	0.00E+00	1.58E+03	2.07E+03	0.00E+00	0.00E+00	9.28E+05	1.06E+05
CO-60	0.00E+00	1.15E+04	1.48E+04	0.00E+00	0.00E+00	5.97E+06	2.85E+05
ZN-65	3.24E+04	1.03E+05	4.66E+04	0.00E+00	6.90E+04	8.64E+05	5.35E+04
SR-89	3.04E+05	0.00E+00	8.72E+03	0.00E+00	0.00E+00	1.40E+06	3.50E+05
SR-90	9.92E+07	0.00E+00	6.10E+06	0.00E+00	0.00E+00	9.60E+06	7.22E+05
ZR-95	1.07E+05	3.44E+04	2.33E+04	0.00E+00	5.42E+04	1.77E+06	1.50E+05
I-131	2.52E+04	3.58E+04	2.05E+04	1.19E+07	6.13E+04	0.00E+00	6.28E+03
I-133	8.64E+03	1.48E+04	4.52E+03	2.15E+06	2.59E+04	0.00E+00	8.88E+03
CS-134	3.73E+05	8.48E+05	7.28E+05	0.00E+00	2.87E+05	9.76E+04	1.04E+04
CS-136	3.91E+04	1.46E+05	1.10E+05	0.00E+00	8.56E+04	1.20E+04	1.17E+04
CS-137	4.79E+05	6.21E+05	4.28E+05	0.00E+00	2.23E+05	7.52E+04	8.40E+03
BA-140	3.91E+04	4.91E+01	2.57E+03	0.00E+00	1.67E+01	1.27E+06	2.18E+05
CE-141	1.99E+04	1.35E+04	1.53E+03	0.00E+00	6.27E+03	3.62E+05	1.20E+05
CE-144	3.43E+06	1.43E+06	1.84E+05	0.00E+00	8.48E+05	7.78E+06	8.16E+05

DOSE FACTOR TABLE: R(i) - Teen, inhalation,

Units are mrem/yr per $\mu\text{Ci}/\text{m}^3$

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03
CR-51	0.00E+00	0.00E+00	1.35E+02	7.50E+01	3.07E+01	2.10E+04	3.00E+03
MN-54	0.00E+00	5.11E+04	8.40E+03	0.00E+00	1.27E+04	1.98E+06	6.68E+04
FE-55	3.35E+04	2.39E+04	5.55E+03	0.00E+00	0.00E+00	1.24E+05	6.39E+03
FE-59	1.59E+04	3.70E+04	1.43E+04	0.00E+00	0.00E+00	1.53E+06	1.78E+05
CO-58	0.00E+00	2.07E+03	2.78E+03	0.00E+00	0.00E+00	1.34E+06	9.52E+04
CO-60	0.00E+00	1.51E+04	1.98E+04	0.00E+00	0.00E+00	8.72E+06	2.59E+05
ZN-65	3.86E+04	1.34E+05	6.24E+04	0.00E+00	8.64E+04	1.24E+06	4.67E+04
SR-89	4.35E+05	0.00E+00	1.25E+04	0.00E+00	0.00E+00	2.42E+06	3.71E+05
SR-90	1.08E+08	0.00E+00	6.68E+06	0.00E+00	0.00E+00	1.65E+07	7.65E+05
ZR-95	1.46E+05	4.59E+04	3.15E+04	0.00E+00	6.74E+04	2.69E+06	1.49E+05
I-131	3.55E+04	4.91E+04	2.64E+04	1.46E+07	8.40E+04	0.00E+00	6.49E+03
I-133	1.22E+04	2.05E+04	6.23E+03	2.92E+06	3.59E+04	0.00E+00	1.03E+04
CS-134	5.03E+05	1.13E+06	5.49E+05	0.00E+00	3.75E+05	1.46E+05	9.76E+03
CS-136	5.15E+04	1.94E+05	1.37E+05	0.00E+00	1.10E+05	1.78E+04	1.09E+04
CS-137	6.71E+05	8.48E+05	3.11E+05	0.00E+00	3.04E+05	1.21E+05	8.48E+03
BA-140	5.47E+04	6.71E+01	3.52E+03	0.00E+00	2.28E+01	2.03E+06	2.29E+05
CE-141	2.84E+04	1.90E+04	2.17E+03	0.00E+00	8.88E+03	6.14E+05	1.26E+05
CE-144	4.89E+06	2.02E+06	2.63E+05	0.00E+00	1.21E+06	1.34E+07	8.64E+05

ORGAN DOSE FACTORS FOR GASEOUS EFFLUENTS (Continued)

DOSE FACTOR TABLE: R(i) - Child, inhalation

Units are mrem/yr per $\mu\text{Ci}/\text{m}^3$

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	1.13E+03	1.13E+03	1.13E+03	1.13E+03	1.13E+03	1.13E+03
CR-51	0.00E+00	0.00E+00	1.54E+02	8.55E+01	2.43E+01	1.70E+04	1.08E+03
MN-54	0.00E+00	4.29E+04	9.51E+03	0.00E+00	1.00E+04	1.58E+06	2.29E+04
FE-55	4.74E+04	2.52E+04	7.77E+03	0.00E+00	0.00E+00	1.11E+05	2.87E+03
FE-59	2.07E+04	3.35E+04	1.67E+04	0.00E+00	0.00E+00	1.27E+06	7.07E+04
CO-58	0.00E+00	1.77E+03	3.16E+03	0.00E+00	0.00E+00	1.11E+06	3.44E+04
CO-60	0.00E+00	1.31E+04	2.27E+04	0.00E+00	0.00E+00	7.07E+06	9.62E+04
ZN-65	4.26E+04	1.13E+05	7.03E+04	0.00E+00	7.14E+04	9.96E+05	1.63E+04
SR-89	6.00E+05	0.00E+00	1.72E+04	0.00E+00	0.00E+00	2.16E+06	1.67E+05
SR-90	1.01E+08	0.00E+00	6.44E+06	0.00E+00	0.00E+00	1.48E+07	3.44E+05
ZR-95	1.90E+05	4.18E+04	3.70E+04	0.00E+00	5.96E+04	2.23E+06	6.11E+04
I-131	4.81E+04	4.81E+04	2.73E+04	1.63E+07	7.88E+04	0.00E+00	2.84E+03
I-133	1.66E+04	2.03E+04	7.70E+03	3.85E+06	3.38E+04	0.00E+00	5.48E+03
CS-134	6.51E+05	1.01E+06	2.25E+05	0.00E+00	3.31E+05	1.21E+05	3.85E+03
CS-136	6.51E+04	1.71E+05	1.16E+05	0.00E+00	9.55E+04	1.45E+04	4.18E+03
CS-137	9.07E+05	8.25E+05	1.28E+05	0.00E+00	2.82E+05	1.04E+05	3.62E+03
BA-140	7.40E+04	6.48E+01	4.33E+03	0.00E+00	2.11E+01	1.74E+06	1.02E+05
CE-141	3.92E+04	1.95E+04	2.90E+03	0.00E+00	8.55E+03	5.44E+05	5.66E+04
CE-144	6.77E+06	2.12E+06	3.62E+05	0.00E+00	1.17E+06	1.20E+07	3.89E+05

DOSE FACTOR TABLE: R(i) - Infant, inhalation

Units are mrem/yr per $\mu\text{Ci}/\text{m}^3$

Nuclide	Bone	Liver	Tbody	Thyroid	Kidney	Lung	Gitract
H-3	0.00E+00	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02
CR-51	0.00E+00	0.00E+00	8.95E+01	5.76E+01	1.32E+01	1.28E+04	3.57E+02
MN-54	0.00E+00	2.54E+04	4.99E+03	0.00E+00	4.99E+03	1.00E+06	7.06E+03
FE-55	1.97E+04	1.18E+04	3.33E+03	0.00E+00	0.00E+00	8.70E+04	1.10E+03
FE-59	1.36E+04	2.35E+04	9.48E+03	0.00E+00	0.00E+00	1.02E+06	2.48E+04
CO-58	0.00E+00	1.22E+03	1.82E+03	0.00E+00	0.00E+00	7.77E+05	1.11E+04
CO-60	0.00E+00	8.03E+03	1.18E+04	0.00E+00	0.00E+00	4.51E+06	3.19E+04
ZN-65	1.93E+04	6.26E+04	3.11E+04	0.00E+00	3.25E+04	6.47E+05	5.14E+04
SR-89	3.98E+05	0.00E+00	1.14E+04	0.00E+00	0.00E+00	2.03E+06	6.40E+04
SR-90	4.09E+07	0.00E+00	2.59E+06	0.00E+00	0.00E+00	1.12E+07	1.31E+05
ZR-95	1.15E+05	2.79E+04	2.03E+04	0.00E+00	3.11E+04	1.75E+06	2.17E+04
I-131	3.80E+04	4.44E+04	1.96E+04	1.48E+07	5.18E+04	0.00E+00	1.06E+03
I-133	1.32E+04	1.92E+04	5.60E+03	3.56E+06	2.34E+04	0.00E+00	2.16E+03
CS-134	3.96E+05	7.03E+05	7.45E+04	0.00E+00	1.90E+05	7.97E+04	1.33E+03
CS-136	4.83E+04	1.35E+05	5.29E+04	0.00E+00	5.64E+04	1.18E+04	1.43E+03
CS-137	5.49E+05	6.12E+05	4.55E+04	0.00E+00	1.72E+05	7.13E+04	1.33E+03
BA-140	5.60E+04	5.60E+01	2.90E+03	0.00E+00	1.34E+01	1.60E+06	3.84E+04
CE-141	2.77E+04	1.67E+04	1.99E+03	0.00E+00	5.25E+03	5.17E+05	2.16E+04
CE-144	3.19E+06	1.21E+06	1.76E+05	0.00E+00	5.38E+05	9.85E+06	1.48E+05

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Instrument	Minimum Number of Channels Operable	Action
1. Gross Radioactivity Monitors Providing Automatic Termination of Release		
Retention Basin Effluent Discharge Monitor (R15017A)	1	<p>With the monitor inoperable, effluent releases may be resumed provided that prior to initiating a release from the retention basin:</p> <ol style="list-style-type: none"> 1) At least two independent samples are analyzed in accordance with Step 6.14.2. 2) At least two technically qualified members of the Facility Staff independently verify the release rate calculations and discharge line valving. <p>Otherwise, suspend release of radioactive effluents via the pathway. Exert best efforts to return the monitor to OPERABLE status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the inoperable monitor was not restored in a timely manner.</p>
2. Flow Measurement Devices		
Waste Water Flow Rate and Totalizer (FIRQ95108)	1	<p>With the flow measurement device inoperable, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours during retention basin releases by a level device in the discharge stream.</p>
Retention Basin Discharge Flow Rate (FI95001)	1	<p>With the flow rate measurement device inoperable, effluent releases via this pathway may continue provided that the Retention Basin discharge flow rate is estimated using the Waste Water Flow Rate instrument.</p>

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE
REQUIREMENTS

<u>Instrument</u>	<u>Instrument Channel Check</u>	<u>Source Check</u>	<u>Instrument Channel Calibration</u>	<u>Channel Test</u>
1. Gross Radioactivity Monitors Providing Alarm and Automatic Termination Isolation				
Retention Basin Effluent Discharge Monitor (R15017A)	D ⁽¹⁾	P	R ⁽²⁾	Q ⁽³⁾
2. Flow Monitors				
Waste Water Flow Rate and Totalizer (FIRQ95108)	D ⁽⁴⁾	N/A	R	Q
Retention Basin Discharge Flow Rate (FI95001)	D ⁽⁴⁾	N/A	R	Q

Table Notation

- (1) During releases via this pathway, a check shall be performed at least once per 24 hours. Normally, checks are automatically performed once every eight (8) hours.
- (2) The Instrument Channel Calibration for radioactivity measurement instrumentation shall be performed using one or more reference standards.
- (3) The Channel Test shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occurs if any of the following conditions exist:
 - A. Instrumentation indicates measured levels above the alarm/trip setpoint.
 - B. Circuit failure.
 - C. Instrument indicates a downscale failure.
 - D. Instrument controls not set in operate mode.
- (4) The Instrument Channel Check shall consist of verifying indication of flow during periods of release. The Instrument Channel Check shall be made at least once daily on any day in which batch releases are made.

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity	Lower Limit of Detection (LLD) ^(a) (µCi/ml)
A. Retention Basin (N/S) ^(b)	Each Batch	Each Batch	Mn-54, Co-60, Zn-65, Cs-134, Cs-137, Ce-144	3.00 E-07
	P	P	H-3	1.00 E-05
B. Regenerant Holdup Tank (A/B) ^(c,d) Standard Release Scenario ^(f)	Each Batch P	Each Batch P	Mn-54, Co-60	4.00 E-09
			Zn-65	6.00 E-09
			Cs-134, Cs-137	3.00 E-09
			Ce-144	6.00 E-08
	Each Batch P	Composite ^(e) M	Sr-90	1.00 E-09
			Gross Alpha	1.00 E-07
C. Regenerant Holdup Tank (A/B) ^(c,d) Rapid Release Scenario ^(f)	Each Batch P	Each Batch P	Mn-54, Co-60, Zn-65, Cs-134, Cs-137	2.00 E-08
			Ce-144	6.00 E-08
			H-3	1.00 E-05
	Each Batch P	Composite ^(e) M	Mn-54, Co-60	4.00 E-09
			Zn-65	6.00 E-09
			Cs-134, Cs-137	3.00 E-09
			Sr-90	1.00 E-09
			Gross Alpha	1.00 E-07

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM
(Continued)

Table Notation

- (a) 1. The Lower Limits of Detection (LLDs) for the radionuclides presented in this table are the smallest concentrations (expressed in microcuries per milliliter) which are required to be detected, if present, in order to achieve compliance with the limits of Step 6.14.3 (10 CFR 50, Appendix I) for a RHUT transfer to a retention basin and assurance of compliance with the limits of Step 6.14.2 (10 CFR 20, Appendix B, Table 2, Column 2) for a Retention Basin Discharge.
2. The LLD of a radioanalysis system is that value which will indicate the presence or absence of radioactivity in a sample when the probability of a false positive and of a false negative determination is stated. The probabilities of the false positive and false negative are taken as equal at 0.05. The general equation for estimating the maximum LLD in microcuries per milliliter is given by the following:

$$LLD = \frac{2.71_{t_s} + 3.29 \times S_b}{(3.70 E + 04)(Y \times E \times V)e^{(-\lambda t_c)}}$$

Where:

- 2.71 = factor to account for Poisson statistics at very low background count rates
- 3.29 = two times the constant used to establish the one sided 0.95 confidence interval
- 3.70 E+04 = disintegrations/second/microcurie
- Y = yield of radiochemical process, i.e., the product of all factors such as emission fraction, chemical yield, etc.
- E = counting efficiency (count/disintegrations)
- V = sample volume (milliliters)
- λ = the radioactive decay constant for the particular nuclide (seconds⁻¹)
- t_c = the elapsed time from midpoint of collection to the midpoint of counting

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM (Continued)

Table Notation (Continued)

S_b = the standard deviation of the background counting rate

$$S_b = \left(\frac{B}{t_b t_s} + \frac{B}{t_b^2} \right)^{0.5}$$

Where:

B = background counts

t_b = background counting interval (seconds)

t_s = sample counting interval (seconds)

3. The LLD is defined as an a priori (before the fact) estimate and is not to be calculated for each sample analyzed on an a posteriori (after the fact) basis.
- (b) A batch release is the discharge of liquid wastes of discrete volume from the north or south Retention Basin. The Retention Basins are the maximum permissible concentration accountability points for 10 CFR 20, Appendix B compliance.
- (c) A RHUT will be isolated and its contents thoroughly mixed to assure representative sampling prior to transferring the contents to a Retention Basin. The A and B RHUTs are the dose equivalent accountability points for 10 CFR 50, Appendix I compliance.
- (d) Isotopic peaks which are measurable and identifiable from a RHUT sample analysis shall be reported and included in ODCM evaluations. Nuclides which are not observed in the analysis shall be reported as "less than" the nuclide's a posteriori minimum detectable concentration and shall not be reported as being present. The "less than" results shall be considered "zero" for the purposes of ODCM evaluations; however, if a nuclide is measured and identified at a value less than the Attachment 15 LLD value, it shall be reported and entered in ODCM evaluations.
- (e) A composite sample shall be obtained by mixing liquid aliquot volumes in proportion to the volume of liquid released from each RHUT. Preparation of the composite is identical no matter which release scenario, or combination of scenarios, was used to release the RHUTs. If any RHUT which is part of the composite was released using the Rapid Release Scenario, the composite will be analyzed according to the Rapid Release Scenario.

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM (Continued)

Table Notation (Continued)

- (f) Release of each RHUT may proceed along either of two separate scenarios depending on operational requirements. Normally, the Standard Release Scenario will be used for RHUT releases. The Rapid Release Scenario will be used when operational requirements dictate expediting the release process. In either scenario, the sample must eventually be analyzed to an LLD level which equates to an off-site dose of less than 10 percent of the 10 CFR 50, Appendix I guidelines. Preparation of the Monthly Composite is independent of the scenario used to release each RHUT during a calendar month: the composite must be prepared for either scenario, only the analysis requirements differ. These Lower Limits of Detection for either or both scenario may change as the maximum annual effluent outflow or the minimum annual average flow rate in the plant effluent stream changes.
1. Standard Release Scenario. This scenario uses the lower LLDs on a pre-release basis, resulting in correspondingly longer analysis intervals. In this scenario, the monthly composite does not need to be analyzed for gamma emitters. The pre-release and post-release (monthly composite) LLDs equate to an off-site dose of less than 10 percent of the 10 CFR 50, Appendix I guidelines.
 2. Rapid Release Scenario. This scenario allows the use of higher LLDs for pre-release dose calculations, resulting in correspondingly shorter analysis intervals. The pre-release LLDs equate to an off-site dose of less than 20 percent of the 10 CFR 50, Appendix I guidelines. The post-release (monthly composite) LLDs equate to an off-site dose of less than 10 percent of the 10 CFR 50, Appendix I guidelines. H-3 and Ce-144 analyses are specifically required only on a pre-release basis. The LLDs for H-3 and Ce-144 are required for the pre-release analysis only, however, these LLDs were included in the determination of post-release LLDs which meet the 10 percent criteria.

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

<u>Instrument</u>	<u>Minimum Number of Channels Operable</u>	<u>Action</u>
1. Reactor Building Stack		
a. Noble Gas Activity Monitor providing alarm and automatic termination of release.	1	With the monitor channel alarm/trip setpoint less conservative than the setpoint calculated as described in Step 6.6, immediately suspend the release or declare the channel inoperable. With the monitor inoperable, effluent releases via this pathway may continue provided grab samples are taken at least daily and these samples are analyzed in accordance with Attachment 18. Increase grab sample frequency as necessary during unusual plant conditions.
b. Particulate Sampler	1	With the collection device inoperable, effluent releases via this pathway may continue provided continuous samples are taken within 1 hour after the monitor is declared inoperable and these samples are analyzed in accordance with Attachment 18*.
c. Sampler Flow Rate Measurement Device	1	With the flow rate device inoperable, effluent releases via this pathway may continue provided the flow rate is estimated and recorded daily.

* Interruption of continuous sampling is allowed for periods not to exceed 1 hour.

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

(Continued)

<u>Instrument</u>	<u>Minimum Number of Channels Operable</u>	<u>Action</u>
2. Auxiliary Building Stack		
a. Noble Gas Activity Monitor	1	<p>With the monitor alarm/trip setpoint less conservative than the setpoint calculated as described in Step 6.6, immediately suspend the release or declare the channel inoperable.</p> <p>With the monitor inoperable, effluent releases via this pathway may continue provided grab samples are taken at least daily (every 12 hours during fuel handling activities) and these samples are analyzed in accordance with Attachment 18. Increase grab sample frequency as necessary during unusual plant conditions.</p>
b. Particulate Sampler	1	<p>With the collection device inoperable, effluent releases via this pathway may continue provided continuous samples are taken within 1 hour after the monitor is declared inoperable and these samples are analyzed in accordance with Attachment 18*.</p>
c. Sampler Flow Rate Measurement Device	1	<p>With the flow rate device inoperable, effluent releases via this pathway may continue provided the flow rate is estimated and recorded daily.</p>

* Interruption of continuous sampling is allowed for periods not to exceed 1 hour.

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

(Continued)

<u>Instrument</u>	<u>Minimum Number of Channels Operable</u>	<u>Action</u>
3. Auxiliary Building Grade Level Vent		
a. Noble Gas Activity Monitor	1	With the monitor alarm/trip setpoint less conservative than the setpoint calculated as described in Step 6.6, immediately suspend the release or declare the channel inoperable. With the monitor inoperable, effluent releases via this pathway may continue provided grab samples are taken at least daily and these samples are analyzed in accordance with Attachment 18. Increase grab sample frequency as necessary during unusual plant conditions.
b. Particulate Sampler	1	With the collection device inoperable, effluent releases via this pathway may continue provided continuous samples are taken within 1 hour after the monitor is declared inoperable and these samples are analyzed in accordance with Attachment 18*.
c. Sampler Flow Rate Measurement Device	1	With the flow rate device inoperable, effluent releases via this pathway may continue provided the flow rate is estimated and recorded daily.
4. IOS Building Vent		
a. Particulate Monitor	1	With the monitor inoperable, ventilation flow shall be halted or continuous particulate samples shall be taken in accordance with Attachment 18, Section D, for particulate samples.

* Interruption of continuous sampling is allowed for periods not to exceed 1 hour.

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE
REQUIREMENTS

Instrument	Instrument Channel Check	Source Check	Instrument Channel Calibration	Channel Test
1. Reactor Building Stack				
a. Noble Gas Activity Monitor	D	M ⁽⁴⁾	R ⁽³⁾	Q ⁽¹⁾
b. Particulate Sampler	W	NA	NA	NA
c. Sampler Monitor Flow Rate Measurement Device	D	NA	R	Q
2. Auxiliary Building Stack				
a. Noble Gas Activity Monitor	D	M	R ⁽³⁾	Q
b. Particulate Sampler	W	NA	NA	NA
c. Sampler Monitor Flow Rate Measurement Device	D	NA	R	Q
3. Auxiliary Building Grade Level Vent				
a. Noble Gas Activity Monitor	D	M	R ⁽³⁾	Q ⁽²⁾
b. Particulate Sampler	W	NA	NA	NA
c. Sampler Monitor Flow Rate Measurement Device	D	NA	R	Q
4. IOS Building Vent				
a. Particulate Sampler	M	NA	R	SA

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE
REQUIREMENTS (Continued)

Table Notation

- (1) The CHANNEL TEST shall also demonstrate that automatic termination of the purge and control room alarm annunciation occurs if any of the following conditions exist:
 - Instrument indicates measured levels above the alarm/trip setpoint.
 - Circuit failure.
 - Instrument indicates a downscale failure.
 - Instrument controls not set in operate mode.
- (2) The CHANNEL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exist:
 - Instrument indicate measured levels above the alarm/trip setpoint.
 - Circuit failure.
 - Instrument indicates a downscale failure.
 - Instrument controls not set in operate mode.
- (3) The INSTRUMENT CHANNEL CALIBRATION shall be performed using one or more reference standards.
- (4) A check shall be performed prior to each release and monthly during periods of continuous purging.

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) ^(a) (μCi/ml)	
A. Reactor Building Stack	M Grab Sample	M	Kr-85	1.00 E-04	
			H-3	1.00 E-06	
B. Auxiliary Building Stack	M ^(b) Grab Sample	M	Kr-85	1.00 E-04	
			H-3	1.00 E-06	
C. Auxiliary Building Grade Level Vent	M Grab Sample	M	Kr-85	1.00 E-04	
			H-3	1.00 E-06	
D. All Release Types as listed in A, B, C above	Continuous	M Particulate Sample	Principal Gamma Emitters ^(c)	1.00 E-11	
			M Particulate Sample	Gross Alpha ^(e)	1.00 E-11
				Sr-90 ^(d)	1.00 E-11
	Continuous	Continuous (Noble Gas Monitor)	Noble Gases, Gross Beta and Gamma	1.00 E-04 as Xe-133	

Table Notation

- (a) 1. The Lower Limits of Detection (LLDs) for the radionuclides presented in this table are the smallest concentration (expressed in microcuries per unit volume) which are required to be detected, if present, in order to achieve compliance with the limits of the Specifications in Steps 6.14.6, 6.14.7, and 6.14.8.
2. The LLD of a radioanalysis system is that value which will indicate the presence or absence of radioactivity in a sample when the probability of a false positive and of a false negative determination is stated. The probabilities of the false positive and false negative are taken as equal at 0.05. The general equation for estimating the maximum LLD in microcuries per milliliter is given by the following:

$$LLD = \frac{2.71 t_s + 3.29 \times S_b}{(3.70 \text{ E} + 04)(Y \times E \times V)e^{(-\lambda t_c)}}$$

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

(Continued)

Where:

2.71 = factor to account for Poisson statistics at very low background count rates

3.29 = two times the constant used to establish the one sided 0.95 confidence interval

3.70 E+04 = disintegrations/second/microcurie

Y = yield of radiochemical process, i.e., the product of all factors such as emission fraction, chemical yield, etc.

E = counting efficiency (count/disintegrations)

V = sample volume (milliliters)

λ = the radioactive decay constant for the particular nuclide (seconds⁻¹)

t_c = the elapsed time from midpoint of collection to the midpoint of counting

S_b = the standard deviation of the background counting rate

$$S_b = \left(\frac{B}{t_b t_s} + \frac{B}{t_b^2} \right)^{0.5}$$

Where:

B = background counts

t_b = background counting interval (seconds)

t_s = sample counting interval (seconds)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM (Continued)

Table Notation (Continued)

3. The LLD is defined as an a priori (before the fact) estimate and is not to be calculated for each sample analyzed on an a posteriori (after the fact) basis.
- (b) Tritium grab samples shall be taken at least once per seven days from the ventilation exhaust from the auxiliary building stack anytime fuel is in the spent fuel pool and the pool temperature exceeds 110°F. Below 110°F there is essentially no evaporation from this source.
- (c) Principal gamma emitters for which the LLD applies are: Kr-85 for gaseous samples and Mn-54, Co-60, Zn-65, Cs-134, Cs-137, and Ce-144 for particulate samples. This does not mean only these nuclides will be detected and reported. Other peaks that are measurable and identifiable shall be reported in the Annual Radioactive Effluent Release Report, pursuant to Step 6.15.1. All peaks which are measurable and identifiable shall be reported and entered into the ODCM evaluations. Nuclides which are not observed for the analysis shall be reported as "less than" the nuclide's a posteriori minimum detectable concentration and shall not be reported as being present. The "less than" results shall be considered "zero" for the ODCM evaluations; however, if a nuclide is measured and identified at a value less than the Attachment 18 LLD value, it shall be reported and entered into ODCM evaluations.
- (d) A gross beta analysis is performed on a monthly basis for each environmental release particulate sample. If any one of these samples indicates greater than $1.0E-11$ $\mu\text{Ci/cc}$ gross beta Sr-90 activity, then an analysis will be performed on those samples exceeding this value.
- (e) A gross alpha analysis is performed on a monthly basis for each environmental release particulate sample. This fulfills the requirements of performing a monthly composite.

ODCM REVISION REVIEW REQUIREMENTS

ODCM REVISION REVIEW REQUIREMENTS

Whenever the ODCM is revised, no matter what the changes are, several reviews must be performed. These reviews must also be documented. The documentation is often included as an attachment to the 50.59 Safety Determination. This form lists the minimum reviews and documentation required for each change. Initial each requirement as it is completed. Sign the bottom of the form when all review requirements are completed.

I. Determination that the level of control of radioactive effluents is being maintained. Initials

This determination is made by review of the following documents:

- 10 CFR 20.1301 and 20.1302
- 10 CFR 50.36a
- Appendix I to 10 CFR 50
- 40 CFR 190

II. Determination that the change(s) will not adversely affect the accuracy or reliability of effluent dose calculations or effluent monitor setpoint determinations.

This determination is made by directly reviewing each change to the ODCM. Although each change must be evaluated, changes that directly involve calculations should be more carefully considered.

III. Supporting information.

Full justification including analyses and evaluations to support the change(s) must be included in the review and approval package.

IV. Notification of NRC.

The NRC is notified of all changes to the ODCM by including a complete, legible copy as part of, or concurrent with, the Annual Radioactive Effluent Release Report (ARERR). To ensure inclusion in the ARERR, a NRC item should be initiated whenever the ODCM is revised.

V. Implementing Documents.

The following documents should be reviewed for impact whenever the ODCM is revised:

- CAP-0008, Offsite Releases of Radioactivity in Liquid Effluents
- CAP-0009, Offsite Releases of Radioactivity in Liquid Effluents
- CAP-0013, Preparation of the Annual Radioactive Effluent Release Report
- CHM-5107, Compositing of Liquid Samples
- CHM-5109, Effluent Monitor Alarm Response Procedure

VI. Multidiscipline Review

Ensure all areas that may be affected by the revision, or have an interest in the changes made in the revision, are included in the multidiscipline review. Areas that are affected by the ODCM and could be included in this review are: Technical Services, Surveillance Scheduler, Quality Assurance, Licensing, and Operations.

All Reviews Complete: _____

Reviewer Signature

Date

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