SMUD
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 02-023

February 27, 2002

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

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

2001 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

Attention: John Hickman

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, 2001.

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

Sincerely,

FOR
SJR

Steve J. Redeker
Manager, Plant Closure & Decommissioning

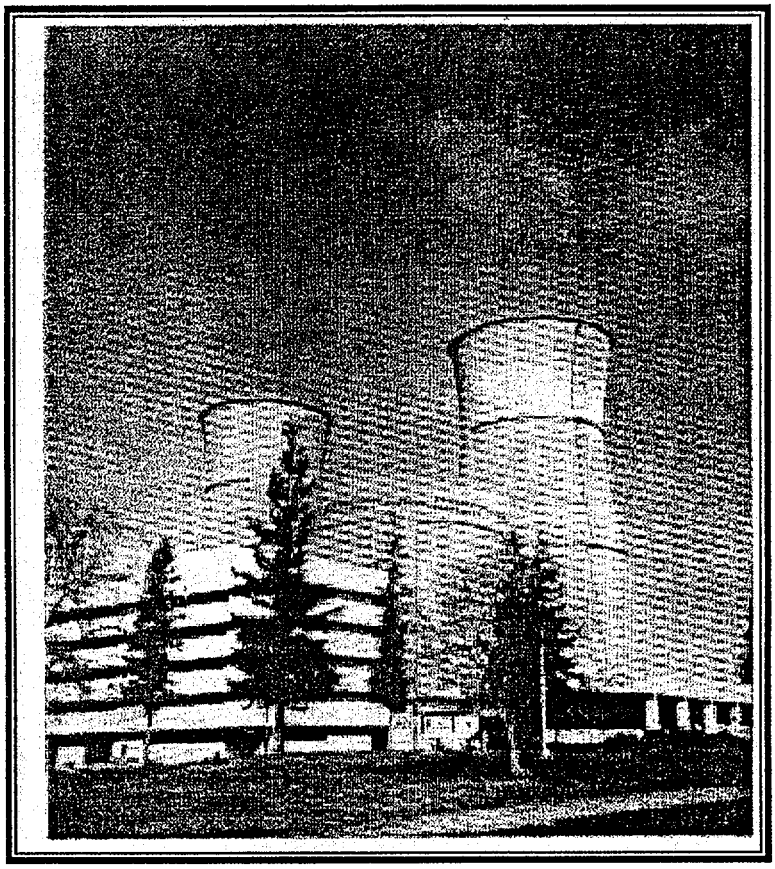
Attachment

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

IE46

RANCHO SECO
NUCLEAR GENERATING STATION

LICENSE NUMBER DPR-54



ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

JANUARY – DECEMBER 2001

TABLE OF CONTENTS

ATTACHMENTS

1. Radiological Environmental Monitoring Program Manual, Revision 13

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 was a pressurized water reactor supplied by Babcock and Wilcox. The rated capacity was 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, 2001. 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.

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 for 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

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

D. BATCH RELEASES (via monitored pathways)

1. Liquid (RHUT Releases)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
a. Number of batch releases	1	9	6	8
b. Total time period for batch releases (hours)	7.70	34.48	13.80	28.88
c. Maximum time period for a batch release (hours)	7.70	5.82	3.23	5.67
d. Average time period for a batch release (hours)	7.70	3.83	2.30	3.61
e. Minimum time period for a batch release (hours)	7.70	1.43	1.67	1.92
2. Liquid (Retention Basin Discharges)				
a. Number of batch releases	0	9	5	6
b. Total time period for batch releases (hours)	-	128.38	70.95	87.42
c. Maximum time period for a batch release (hours)	-	16.83	17.22	21.17
d. Average time period for a batch release (hours)	-	14.26	14.19	14.57
e. Minimum time period for a batch release (hours)	-	11.70	12.00	9.70
f. Average stream flow during periods of release of effluent into a flowing stream (cfs)	-	17.0	17.2	17.3

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.

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

None

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:

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

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.

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:

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

where:

Fi = 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 (Ki, Li+1.1Mi, or Raij). [Units in (mrem/yr)/(μCi/m3)]

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 μCi/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 2000 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 direct radiation dose results, based on monitoring badge dosimetry, are 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.

RSNGS ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
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TABLE III-A

GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Est. Total Error, %
A. Fission & Activation 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	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	
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[a]	Ci	1.71E-07	6.47E-08	1.23E-07	5.36E-07	
C. Tritium						
1. Total Release	Ci	2.32E-01	2.81E-01	1.52E-01	2.39E-01	2.3 E+01
2. Average Release Rate for period	µCi/sec	2.95E-02	3.57E-02	1.91E-02	3.01E-02	
3. Percent of Tech Req limit	%	2.50E-04	3.03E-04	1.62E-04	2.55E-04	

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

TABLE III-B

GASEOUS EFFLUENTS - GROUND LEVEL RELEASES

		Continuous Mode			
Nuclides Released	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
1. Fission Gases (i.e., Noble Gases)					
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Particulates					
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Tritium					
H-3	Ci	2.32E-01	2.81E-01	1.52E-01	2.39E-01

TABLE III-C

GASEOUS EFFLUENTS - TYPICAL LOWER LIMITS OF DETECTION

RADIONUCLIDES		LLD (µCi/cc)
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

TABLE III-D

RADIOLOGICAL IMPACT ON MAN DUE TO GASEOUS EFFLUENT RELEASES

CALCULATED RADIATION DOSES AT THE SITE BOUNDARY FOR GASEOUS EFFLUENTS:

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	2001 Annual
A. Tritium, Particulate						
1. Maximum Organ Dose	mrem	7.51E-03 (a)	9.10E-03 (a)	4.94E-03 (a)	7.74E-03 (a)	3.00E-02 (a)
Percent Tech Req limit	%	1.00E-01	1.21E-01	6.59E-02	1.03E-01	2.00E-01
B. Noble Gas						
1. Gamma Air Dose	mrad	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Percent Tech Req limit	%	N/A	N/A	N/A	N/A	N/A
2. Beta Air Dose	mrad	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Percent Tech Req limit	%	N/A	N/A	N/A	N/A	N/A
C. Direct Radiation						
1. Dose (Monitoring Badges)	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 GASPAR 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 associated with gaseous effluent releases indicate significant radiation attributable to Plant operations.

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:

$$\%\ \text{Tech Req Limit} = \sum_{i}^{n}\left[\frac{C_i}{MEC_i}\right]$$

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 i^{th} 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 µCi/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 2000 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

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Est. Total Error, %
A. Fission & Activation Products						
1. Total Release (not including tritium, gases, alpha)	Ci	4.69E-06	1.85E-05	4.58E-06	1.00E-04	2.3 E+01
2. Average diluted concentration during period	µCi/ml	1.10E-12	4.88E-12	1.18E-12	2.57E-11	
3. Percent of Tech Req limit	%	1.02E-04	4.36E-04	7.49E-05	2.53E-03	
B. Tritium						
1. Total Release	Ci	5.76E-03	1.51E+00	9.23E-01	1.08E+00	2.3 E+01
2. Average diluted concentration during period	µCi/ml	1.35E-09	3.99E-07	2.38E-07	2.77E-07	
3. Percent of Tech Req limit	%	1.35E-04	3.99E-02	2.38E-02	2.77E-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	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	N/A
E. Volume of Waste Released						
Retention Basins (prior to dilution)	Liters	0.00 E+00	1.17E+07	5.56E+06	8.02E+06	5.0 E+00
RHUTs (prior to dilution)	Liters	1.28E+05	4.35E+06	2.15E+06	3.19E+06	5.0 E+00
F. Volume of dilution water used during period	Liters	4.27E+09	3.79E+09	3.88E+09	3.90E+09	2.0 E+01

TABLE IV-B

LIQUID EFFLUENTS

Nuclides Released		Batch Mode			
1. Fission and activation products (excluding tritium, gases alpha)	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Co-60	Ci	4.97E-07	2.97E-06	2.51E-06	2.46E-06
Cs-137	Ci	4.19E-06	1.55E-05	2.07E-06	9.77E-05
Total (for quarter)	Ci	4.69E-06	1.85E-05	4.58E-06	1.00E-04
2. Dissolved and entrained gases					
None					

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

TABLE IV-C

LIQUID EFFLUENTS - TYPICAL LOWER LIMITS OF DETECTION

	RADIONUCLIDES	BATCH MODE: LLD (µCi/ml)
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

TABLE IV-D

RADIOLOGICAL IMPACT ON MAN DUE TO LIQUID EFFLUENT RELEASES

CALCULATED RADIATION DOSE COMMITMENTS FOR LIQUID EFFLUENTS:

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	2001 Annual
A. Maximum Total Body Dose	mrem	1.15E-03 (a)	1.98E-02 (b)	7.61E-03 (c)	3.66E-02 (a)	6.52E-02 (b)
Percent Tech Req limit	%	7.67E-02	1.32E+00	5.07E-01	2.44E+00	2.17E+00
B. Maximum Organ Dose	mrem	2.37E-03 (d)	6.28E-03 (e)	1.23E-02 (f)	7.22E-02 (f)	9.32E-02 (f)
Percent Tech Req limit	%	4.74E-02	1.26E-01	2.46E-01	1.44E+00	9.32E-01

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
(c) Teen
(d) Child - Bone
(e) Teen - Bone
(f) Child - Liver

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.	2.61E+01	3.01E-02	2.5E+01
B. Dry compressible waste, contaminated equipment, etc	4.22E+02	3.99E+00	2.5E+01
C. Irradiated components, control rods, etc.	N/A	N/A	
D. Other	1.16E+02	1.02E+00	2.5E+01

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

	Category A		Category B	
Radionuclide	**Activity (Ci)**	**Percentage (%)**	**Activity (Ci)**	**Percentage (%)**
H-3	1.68E-02	5.57E+01	1.30E-02	3.27E-01
C-14	1.80E-04	5.97E-01	5.76E-02	1.44E+00
Fe-55	3.33E-04	1.11E+00	2.06E-01	5.17E+00
Co-60	3.06E-04	1.02E+00	3.05E-01	7.65E+00
Ni-63	3.30E-03	1.10E+01	2.23E+00	4.30E+01
Sr-90	3.62E-04	1.20E+00	4.64E-02	1.16E+00
Nb-94			1.23E-03	3.08E-02
Tc-99	0.00E+00	0.00E+00	9.19E-05	2.31E-03
Sb-125			3.24E-03	8.12E-02
Cs-134	6.84E-05	2.27E-01	3.71E-03	9.31E-02
Cs-137	8.73E-03	2.90E+01	1.11E+00	2.78E+01
Pu-238	1.54E-06	5.12E-03	3.37E-04	8.46E-03
Pu-239	1.15E-06	3.80E-03	3.30E-04	8.27E-03
Pu-241	6.00E-05	1.99E-01	1.44E-02	3.60E-01
Pu-242	6.20E-09	2.06E-05	5.56E-07	1.39E-05
Am-241	3.97E-06	1.32E-02	7.34E-04	1.84E-02
Cm-242	4.44E-12	1.47E-08	4.36E-07	1.09E-05
Cm-244	1.23E-06	4.07E-03	1.56E-04	3.92E-03

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			1.62E-03	1.59E-01
C-14			1.75E-02	1.72E+00
Fe-55			6.75E-02	6.63E+00
Co-60			1.11E-01	1.09E+01
Ni-63			8.09E-01	7.96E+01
Sr-90			3.63E-04	3.57E-02
Nb-94			5.15E-04	5.06E-02
Tc-99			3.86E-05	3.79E-03
Sb-125			1.21E-03	1.19E-01
Cs-134			8.63E-06	8.48E-04
Cs-137			3.95E-03	3.88E-01
Pu-238			8.39E-05	8.25E-03
Pu-239			9.57E-05	9.41E-03
Pu-241			3.77E-03	3.71E-01
Pu-242			1.45E-09	1.42E-07
Am-241			1.61E-04	1.58E-02
Cm-242			5.81E-08	5.72E-06
Cm-244			2.04E-05	2.00E-03

4. Solid Waste Disposition

Number of Shipments	Mode of Transportation	Destination
37	Highway	Envirocare of Utah, Inc.

B. IRRADIATED FUEL SHIPMENTS (Disposition)

Number of Shipments

None

ATTACHMENT 1

LEAD DEPARTMENT:
RP/ CHEMISTRY

EFFECTIVE DATE:
4-9-01

REVISION SUMMARY:

1. Editorial change to Table 2 (page 23 of 31). Editorially changed the word "position" to "positive", in the first sentence under the text for footnote "a"

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0.0 POLICY

The Sacramento Municipal Utility District (SMUD) and the Rancho Seco Nuclear Station recognize their responsibility to comply with the Technical Specifications (10 CFR 50 and 10 CFR 72) and the applicable regulations, codes, standards and industry-wide criteria for establishing and maintaining a viable Radiological Environmental Monitoring Program. We are committed to operating the Rancho Seco Nuclear Station in such a manner that will assure proper radiation protection to all employees, contractors and the general public. To this end, we have committed to performing an environmental sampling program, which meets the intent of the applicable regulations while providing an accurate assessment of the radiological environment in and around the environs of the Rancho Seco site.

1.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM BASES

The Sacramento Municipal Utility District and the Rancho Seco Nuclear Station have instituted a Radiological Environmental Monitoring Program (REMP) which this manual serves to implement. The REMP is based upon the information contained in Title 10 of the Code of Federal Regulations, Part 20, Section 1302 (10 CFR 20.1302). That Regulatory basis and associated guidelines have been the foundation of the REMP and its programmatic elements which:

1. Provide the technological basis of, and the instruction for, monitoring the site and environs for radioactivity of all sources, including:

    a. naturally occurring background

    b. releases during normal operations

    c. operational occurrences and postulated accidents

    d. weapons testing and major nuclear accidents, which contribute to detectable radioactivity in the environs.

1. Ensures the annual dose equivalent to any real individual located outside the Independent Spent Fuel Storage Installation (ISFSI) controlled area does not exceed the annual dose limits in 10 CFR 72.104(a).

3. Provide the means to verify the radiological effluent control program of the Rancho Seco Nuclear Station.

4. Meet minimum limits for detecting radioactive isotopes in samples collected from the environs or direct measurements in the field.

5. Provide measurements of radiation and radioactive materials in those exposure pathways, (i.e., liquid, gaseous, and direct radiation), and for those radionuclides, (i.e., cesium, and cobalt), which lead to the highest potential radiation exposure of individuals resulting from station operation.

This Manual contains the minimum requirements for the conduct of the Rancho Seco Radiological Environmental Monitoring Program (REMP). The requirements are consistent with USNRC regulations, the Branch Technical Position (BTP), Radiological Effluent Technical Specifications (RETS) for PWRs (NUREG-0472), the Rancho Seco Permanently Defueled Technical Specifications (PDTS), and the ISFSI Technical Specifications as Administrative Controls.

2.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM DESCRIPTION

The Radiological Environmental Monitoring Program is under the cognizance of the Nuclear Plant Closure Manager, with the responsibility for the administration and oversight of the program assigned to the Radiation Protection/ Chemistry Superintendent (RP/ Chem Superintendent).

The design of the program is consistent with the intent of Title 10 Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation" Section 1302. To implement these requirements, the Permanently Defueled Technical Specifications, ISFSI Technical Specifications, Off-site Dose Calculation Manual, Health Physics Implementing Procedures, and Surveillance Procedures have been developed. The implementing procedures address specific areas in the program that require direct attention for completion.

2.1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM PARAMETERS

The monitoring and sampling aspects of the program are:

- Identification of the effluent release pathways,
- Identification of the human exposure pathways,
- Identification of the land usage parameters by the population within a two mile radius of the site.

Three principal release pathways at Rancho Seco Nuclear Station are:

Gaseous Effluents:
Discharges from the Reactor Building Stack and the Auxiliary Building Stack.

Liquid Effluents:
Discharges which are released from the retention basins via the waste water disposal system [Regenerant Hold Up Tanks (RHUT) A and B].

Direct Radiation:
Radiation that emanates from the ISFSI, plant systems, or radioactive material contained within tanks or other containers, which are within the site boundary to humans outside of the site boundary.

The pathways to human exposure to radioactive materials in the effluent release pathways from Rancho Seco are:

Gaseous

- Inhalation of airborne radioactive material by humans, or by animals that inhale and retain the material in animal products that are consumed by humans, i.e., meat or milk.
- Consumption of radioactive particulate material which, although carried by air currents, is deposited onto or is taken up by water sources or plants consumed by humans, or by animals that provide products that are consumed by humans, i.e., milk or meat.
- Exposure from being immersed in air containing radioactive materials as a gas and/ or particulates.
- Exposure to the direct radiation from radioactive materials that have been deposited onto surfaces from airborne releases.

Liquid

- Drinking of water from the release pathway by humans, or by animals that are a food source for humans.
- The consumption of fish or other animals that have eaten fish or shellfish taken from water within the liquid release pathway.
- The consumption of products of animals that have eaten vegetation that has been irrigated with water from the release pathway.
- The consumption by humans of fruit or vegetation grown in soil irrigated with water from the release pathway.

Direct Radiation

- The exposure to radiation emitted from radioactive materials within the Rancho Seco site boundary. Sources include, but are not limited to, the Borated Water Storage Tank, Demineralized Reactor Coolant Storage Tank, the Interim Onsite Storage Building (IOSB), and the Independent Spent Fuel Storage Installation (ISFSI).

- The exposure from being immersed in the release pathway water, to radiation emanating from material contained in the water.

2.2 ANALYSIS OF EXPOSURE PATHWAYS

Exposure pathways are analyzed through a systematic process, which identifies a sample medium or organism that is found in the effluent pathways. Usage factors are determined that will suitably represent biological concentration, retention or uptake which may ultimately represent a contribution to human exposure. The pathways to human exposure are evaluated through the analysis of data obtained from the performance of a land use census. The performance of the land use census is required by the Permanently Defueled Technical Specifications Section D6.8.3b.2. The analysis of the effluent and exposure pathways enables the selection of sampling and monitoring locations that fall into one of two classes, those which are, and those which are not, influenced by effluent pathways. Those in the pathways are referred to as indicator locations. Several of the unaffected locations are selected to represent baseline or control locations.

Indicator locations provide data from the surrounding environment that may be influenced by the operation of the plant because they are nearby, downwind or downstream in the release pathway. Such data can be used to calculate doses to verify compliance with 40 CFR 190, using methodology contained in the ODCM. [This is referred to as the MEMBER OF THE PUBLIC. The MEMBER OF THE PUBLIC is defined as any individual except when that individual is receiving an occupational dose. A MEMBER OF THE PUBLIC who, based upon the land use census, is expected to receive the maximum off-site dose to real individuals, may be used to calculate doses to demonstrate compliance with 40 CFR 190.]

Control sample locations are to provide data that should not be influenced by the operations of Rancho Seco. These locations are selected based upon the distance from the plant, being upwind, or upstream of the release pathways. Data from these locations help discriminate between Rancho Seco releases and other natural or manmade events that may impact human exposure.

At Rancho Seco, potentially radioactive liquid effluent is discharged into Clay Creek. A continuous flow of Folsom South Canal water is released above the discharge point. The continuous minimum flow and the liquid effluent release are the major effluent release pathway, and thus the exposure pathway for the station during normal operations. Prior to the minimum release rate being established, Clay Creek was a seasonal stream, formed as the confluence of three and one half square miles of drainage runoff upstream of the site. The now continuous flow of Clay Creek intersects Hadselville Creek north and west of California State Highway 104. Hadselville Creek intersects Laguna Creek just east of the Folsom South Canal. Laguna Creek flows into the Cosumnes River approximately 20 miles from Rancho Seco.

Hadselville and Laguna Creeks are also seasonal streams and also receive irrigation runoff during periods when irrigation is used. These streams are the major release pathways for liquid effluents from the site.

The gaseous pathway analysis is related to the land use census. This pathway is not confined by creek banks, but is subject to the meteorological conditions during the time of the release. While not a significant release or exposure pathway, weekly air sampling is performed to determine the dose due to radioactive gaseous releases.

The direct radiation exposure pathway is measured with the use of monitoring devices, which monitor continuously and passively. The dose is integrated over three months to accumulate a statistically significant exposure. The vast majority of the dose integrated by these devices is delivered from primordial elements in the geological surface of the Earth, which contain naturally radioactive elements. A smaller fraction of the dose is delivered by cosmic radiation, which has penetrated the Earth's atmosphere.

3.0 RADIOLOGICAL ENVIRONMENTAL MONITORING

The REMP shall be conducted AT ALL TIMES as specified in Table 1

3.1 With the REMP not being conducted as specified in Table 1, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report (AREOR) required by Section 8.1, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions or seasonal unavailability.

3.2 With the level of radioactivity in an environmental sampling medium exceeding the Reporting Level of Table 3 when averaged over any calendar quarter, in addition to complying with the requirements of Section 5.0, FUEL CYCLE DOSE, prepare and submit to the Commission within 30 days after the level of radioactivity has been determined, a Special Report which includes an evaluation of any release conditions, environmental factors or other aspects which caused the Reporting Levels to be exceeded. This report will define corrective actions to reduce emissions such that potential exposures will meet the 10 CFR 50, Appendix I dose guidelines. When more than one of the radionuclides in Table 3 are detected in the sampling medium, the Special Report shall be submitted if the Reporting Level fraction summation equals or exceeds unity (1.0).

When radionuclides other than those in Table 3 are detected and are the result of plant effluents, this Special Report shall be submitted if the potential annual dose to an individual is greater than or equal to the calendar year guidelines of 10 CFR 50, Appendix I. This Special Report is not required if the measured level of radioactivity was not the result of plant effluents; however, the condition shall be reported and described in the AREOR.

3.3 With fresh vegetation samples unavailable from any of the sample locations required by Table 1, identify the cause of the unavailability of samples and the locations for obtaining replacement samples in the next AREOR. The locations from which samples were unavailable may then be deleted from Table 6 provided the locations from which the replacement samples were obtained are added to Table 6 as replacement locations, if available.

3.4 The radiological environmental monitoring samples shall be collected per Table 1 from the locations shown in Table 6. These samples shall be analyzed to the requirements of Table 1 and Table 2.

3.5 The flow measuring devices on the environmental air monitors used for sampling the Table 1 AIRBORNE EXPOSURE PATHWAY shall be subject to a MONTHLY function check and shall be calibrated ONCE EVERY 12 MONTHS.

3.6 The REMP required by Section 1.0 provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides, which lead to the highest potential radiation exposures of individuals resulting from the Station operation. This monitoring program thereby implements Section IV.B.2 of Appendix I to 10 CFR 50 and supplements the REMP by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and Off-site Dose Calculation Manual (ODCM) modeling of the environmental exposure pathways.

Guidance for Section 3.0 was provided by References 9.12 and 9.29. REMP changes may be initiated based on operational experience and changes in the regional population or agricultural practices. The detection capabilities required by Table 2 are state of the art for routine environmental measurements in industrial laboratories. The LLDs for drinking water meet the requirements of 40 CFR 141.

4.0 LAND USE CENSUS

A Land Use Census shall be conducted biennially and shall identify the location of the nearest milk animal, the nearest residence and the nearest garden of greater than 500 square feet producing fresh leafy vegetation in each of the 16 meteorological sectors within a distance of two (2) miles. The location of the nearest milk animal is not required if the Offsite Dose Calculation Manual (ODCM) dose calculations are using conservative dose factors which assume the presence of milk animals within the vicinity of Rancho Seco Nuclear Station. Vegetation sampling may be performed at the Station Site Boundary in lieu of the garden census.

The Land Use Census shall also include information relevant to the liquid effluent pathway and gaseous effluent pathway such that the ODCM and the REMP Manual can be kept current with existing environmental and societal use of land surrounding Rancho Seco.

4.1 The Land Use Census shall be conducted biennially by using methods that will provide the best results, such as door-to-door survey, aerial survey, or by consulting local agriculture authorities The Land Use Census, or portions thereof, shall be conducted during the appropriate time of the year to provide the best results. The results of the Land Use Census shall be included in the AREOR covering the census year as required by Section 8.1.2.

4.2 With the Land Use Census identifying a location(s) which yields a calculated dose or dose commitment greater than the values currently being calculated in the ODCM for compliance with 10 CFR 50, Appendix I, identify the new location(s) in the next AREOR.

4.3 With the Land Use Census identifying a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) 20 percent greater than at a location from which samples are currently being obtained in accordance with Section 3.0, Radiological Environmental Monitoring, add the new location(s) to Table 6 within 30 days or submit a Special Report to the Commission that identifies the cause(s) for exceeding these requirements and the proposed corrective actions for precluding recurrence.

The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment(s) [via the same exposure pathway] may be deleted from Table 6 after October 31 of the census year. Identify the new location(s) in the next AREOR including a revised figure(s) and table for the REMP Manual reflecting the new location(s).

4.4 The Section 4.0 requirements are provided to ensure that changes in the use of unrestricted areas are identified and that modifications to the REMP and the ODCM are made if required by the results of the Land Use Census. These requirements also satisfy the requirements of Section IV.B.3 of Appendix I to 10 CFR 50.

Restricting the Land Use Census to gardens of greater than 500 square feet provides assurance that significant exposure pathway via leafy vegetation consumption will be identified and monitored. Gardens of this size are the minimum required to produce the quantity (26 kg/ year) of leafy vegetation assumed (reference 9.14) to be consumed by a child. In specifying this minimum garden size, it was further assumed that 20 percent of the garden was used for growing broad leaf vegetation (e.g./ lettuce or cabbage) and that the productivity was two- (2) kg/ m^2.

In addition, by gathering information on the liquid effluent pathway and the gaseous effluent pathway, the Land Use Census provides assurance that proper radiological environmental monitoring and radioactive effluent controls are in place for the adequate protection of the health and safety of the general public.

5.0 FUEL CYCLE DOSE

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 AT ALL TIMES be limited to less than or equal to 25 mrem (total body or any organ), and 75 mrem (thyroid), in a calendar year.

5.1 With any of the Reporting Levels of Table 3 being exceeded, calculations shall be made to determine whether the Section 5.0 fuel cycle dose/dose commitment limits have been exceeded. Contributions from direct radiation sources (including outside storage tanks, etc.) shall be included in this calculation.

5.2 If the Section 5.0 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 Section 5.0 limits. This Special Report shall also include a schedule for achieving conformance with the Section 5.0 limits.

This Special Report, as defined in 10 CFR 20.2203, 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 Special Report. This Special Report shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations.

5.3 If the estimated dose(s) exceeds Section 5.0 limits, and if the release condition resulting in the violation of 40 CFR 190 has not already been corrected, the Special Report shall also include a request for a variance in accordance with the provision of 40 CFR 190. Submittal of the Special Report is considered a timely request, and a variance is granted until USNRC staff action on the request is complete.

5.4 The Section 5.0 requirements are provided, in part, to meet the dose limitations of 40 CFR 190 that have been incorporated into 10 CFR 20. 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 Station remains within twice the numerical guides for design objectives of 10 CFR 50, Appendix I and if direct radiation 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 five (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 along with a request for a variance (provided the release conditions resulting in violation of 40 CFR 190 have not already been corrected) is considered to be a timely request and fulfills the requirements of 40 CFR 190 until USNRC staff action is completed.

An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she receives an occupational dose.

6.0 INTERLABORATORY COMPARISON PROGRAM

The laboratory performing analyses of Table 6 samples pursuant to the requirements of Table 1 shall AT ALL TIMES participate in an Interlaboratory Comparison Program (ICP) approved by the Commission. The ICP approved by the Commission may not always supply tests for the analyses required by Table 6.

Since no Commission approved ICP exists for Monitoring Devices; the laboratory performing analyses of the REMP environmental monitoring devices shall AT ALL TIMES participate in a licensee approved comparison program.

6.1 With ICP analyses not being performed as required in Section 6.0, report the corrective actions taken to prevent a recurrence to the Commission in the AREOR as required by Section 8.1.

6.2 A summary of the results obtained, as a participant in the ICP shall be included in the AREOR as required by Section 8.1.

6.3 The requirement to participate in an ICP is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR 50.

7.0 DEFINITIONS

7.1 FORTNIGHTLY - Once per fourteen (14) days

7.2 INDUSTRIAL AREA - That portion of the Station property, access to which is controlled as described in the NRC approved Security Plan by security fencing, equipment and personnel.

7.3 SITE BOUNDARY - That line beyond which the land is neither owned, nor leased, nor otherwise controlled by the licensee.

7.4 RESTRICTED AREA - An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

7.5 CONTROLLED AREA - An area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.

7.6 UNRESTRICTED AREA - An area, access to which is neither limited nor controlled by the licensee.

7.7 MEMBER(S) OF THE PUBLIC - Any individual except when that individual is receiving an occupational dose.

8.0 RADIOLOGICAL REPORT REQUIREMENTS

8.1 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT (AREOR)

8.1.1 An AREOR covering the operation of the Station during the previous calendar year shall be submitted to the USNRC prior to May 1 of each year in accordance with Permanently Defueled Technical Specification D6.9.2.3.

8.1.2 The AREOR shall include summaries and statistical evaluations of the results of the radiological environmental surveillance activities for the report period, including (as appropriate) a comparison with operational controls. The AREOR shall also include the results of the Land Use Census required by Section 4.0, LAND USE CENSUS. In the event a radionuclide concentration should be confirmed in excess of the Reporting Level in Table 3 by environmental measurements, the AREOR shall describe a planned course of corrective action.

8.1.3 The AREOR shall include summarized and tabulated results of all radiological environmental samples taken during the AREOR period. In the event that some results are not available for inclusion, the AREOR shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

8.1.4 The AREOR shall include a summary description of the REMP (including a map of all sampling locations keyed to a table giving distances and directions from the Reactor Building) and the results of participation in the Interlaboratory Comparison Program required by Section 6.0. The AREOR shall also include information related to Section 5.0, Fuel Cycle Dose.

8.2 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (ARERR)

Any changes made to the REMP MANUAL during the ARERR reporting period shall be included in that ARERR. The complete REMP manual, in its revised form, shall be submitted with the ARERR.

9.0 REFERENCES

The following documents pertain to the design and conduct of radiological environmental monitoring programs:

9.1 American National Standards Institute (ANSI), Performance, Testing and Procedural Specifications for Thermoluminesence Dosimetry (Environmental Applications), ANSI Standard N545 (1975).

9.2 American Nuclear Insurers and Mutual Atomic Energy Liability Underwriters (ANI/MAELU), Environmental Monitoring Programs, Information Bulletin 86-1 (1986).

9.3 ANI/MAELU, Engineering Inspection Criteria for Radiological Environmental Monitoring, Section 5.2, Revision 2.

9.4 ANI/MAELU, Nuclear Liability Insurance Records Retention, Information Bulletin 80-1 A, Rev. 2 (1986).

9.5 Committee on the Biological Effects of Ionizing Radiations (BEIR), The Effects on Populations of Exposure to Low Levels of Ionizing Radiation: BEIR V Report (1990).

9.6 National Council on Radiation Protection (NCRP), A Handbook of Radioactivity Measurements Procedures, NCRP Report No. 58, Second Edition (1985).

9.7 NCRP, Radiological Assessment: Predicting the Transport, Bioaccumulation and Uptake by Man of Radionuclides Released to the Environment, NCRP Report No. 76 (1984).

9.8 USEPA, Environmental Standards for the Uranium Fuel Cycle, 40 CFR 190, Subpart B (1993).

9.9 USEPA, Upgrading Environmental Radiation Data, Health Physics Society Committee Report HPSR-1, EPA 520/1-80-012 (1980).

9.10 USNRC, Criterion 64 - Monitoring Radioactive Releases, 10 CFR 50, Appendix A (1993).

9.11 USNRC, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low As Is Reasonably Achievable' for Radioactive Material In Light Water Cooled Nuclear Power Reactor Effluents, 10 CFR 50, Appendix I (1993).

9.12 USNRC, An Acceptable Radiological Environmental Monitoring Program, Branch Technical Position, Rev. 1 (November 1979).

9.13 USNRC, Implementation of Programmatic Controls for Radiological Effluent Technical Specifications in the Administrative Controls Section of the Technical Specifications and the Relocation of Procedural Details of RETS to the Off-site Dose Calculation Manual or the Process Control Program, Generic Letter 89-01 (January 31, 1989).

9.14 USNRC, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I, Regulatory Guide 1.109 (1977).

9.15 USNRC, Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I, Regulatory Guide 1.113 (1977).

9.16 USNRC, Measuring and Reporting of Radioactivity in the Environs of Nuclear Power Plants, Regulatory Guide 4.1 (1973).

9.17 USNRC, Preparation of Environmental Reports for Nuclear Power Stations, Regulatory Guide 4.2, Rev. 2 (1976).

9.18 USNRC, Performance. Testing and Procedural Specifications for Thermoluminesence Dosimetry: Environmental Applications," Regulatory Guide 4.13.

9.19 USNRC, Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment, Regulatory Guide 4.15, Rev. 1 (1979).

9.20 USNRC, Radiological Assessment: A Textbook on Environmental Dose NUREG/CR-3332 (1983).

9.21 USNRC, Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements, NUREG/CR-4007 (1984).

9.22 USNRC, Radiological Effluent Technical Specifications for PWRs, NUREG-0472, Rev. 2 (July 1979).

9.23 USNRC, Radiological Monitoring by NRC Licensees for Routine Operations of Nuclear Facilities, NUREG-0475 (1978).

9.24 USNRC, Methods for Demonstrating LWR Compliance With the EPA Uranium Fuel Cycle Standard (40 CFR 190), NUREG-O543 (1980).

9.25 USNRC, Dose Limits for individual members of the public, 10 CFR 20.1301 (1993).

9.26 USNRC, Reports of exposures, radiation levels, and concentrations of radioactive material exceeding the limits, 10 CFR 2O.2203 (1993).

9.27 Merril Eisenbud, Environmental Radioactivity From Natural, Industrial. and Military Sources, Third Edition (1987).

9.28 Rancho Seco Permanently Defueled Technical Specifications.

9.29 USNRC, Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station, NUREG/CR-0130 (June 1978)

9.30 USNRC, Air Sampling in the Workplace, Regulatory Guide 8.25, Rev. 1 (June 1992)

9.31 Rancho Seco Independent Spent Fuel Storage Installation Technical Specifications.

10.0 IDENTIFICATION CONVENTION FOR TABLE 6 SAMPLE LOCATIONS

Sampling and monitoring sites designated in Table 6 are identified using the following convention:

10.1 To establish the fact that the Table 6 samples originate from the Rancho Seco REMP, the letter "R" precedes every sample site designator.

10.2 The next two (2) letters are selected to identify SAMPLE TYPE. Refer to Table 4 for a listing of the SAMPLE TYPES and the associated two-letter abbreviation.

10.3 The numbers following the SAMPLE TYPE abbreviation reflect the straight-line distance (miles) to the sample site, referenced to the center of the Reactor Building.

10.4 Following the distance, a SECTOR DESIGNATOR letter is included to specify which of the 16 meteorological sectors the sample site is encompassed. Refer to Table 5 for a listing of the sector designators.

10.5 The final character in the sample site designation is the letter "O" or the letter "P". The letter "O" designates the sample as one being added to the REMP following Station initial criticality. The letter "P" designates the sample as one being added during the post operational period following the issuance of the Possession Only License.

10.6 The present identification convention has been selected in preference to the system originally used to identify samples and sites. Since it is desirable to retain the ability to identify, and continue to use data from, previously collected samples, the former identification convention is also shown parenthetically in Table 6.

11.0 REPORTING RESULTS OF RADIOLOGICAL ENVIRONMENTAL DATA

The requirements for reporting radiological environmental data are specified in Section 8.0 of this manual. Those subsections which require supporting data from the Radiological Environmental Monitoring Program address the Annual Radiological Environmental Operating Report and the Annual Radioactive Effluent Release Report. Special Reports are made specific in HPIP-2050, Radiological Environmental Monitoring Program Reports. Specified therein are conditions requiring special reports, and reporting requirements in days for submittal. This includes those calculations to provide rapid assurance of the degree of compliance with 10 CFR 50 Appendix I, and 40 CFR 190 calculations after releases of any origin.

12.0 SELECTION OF RADIOLOGICAL ENVIRONMENTAL MONITORING LOCATIONS

In conjunction with the data base established from the land use census, the requirements of the Permanently Defueled Technical Specifications, and the guidance described in Section 2.0 of this Manual, the selection of sampling and monitoring sites is performed. These selected locations provide at least the minimum number of locations specified in Table 1.

Data was gathered from the land use census, Lawrence Livermore National Laboratory Rancho Seco Study Reports, Oak Ridge National Laboratory Study Reports, and from additional sampling sites from which materials have been collected. The information gathered was used to determine indicator sites. Presently, a number of control sites have been selected and are not anticipated to be increased in number.

The second column of Table 6 identifies the Sample Class of a particular sample as either an Indicator (IND) or a Control (CON) Sample. Additional sample locations designated as Special (Spec) are used to perform initial radiological evaluations.

Environmental monitoring devices are placed in the environs around the site. These devices passively monitor radiation in the immediate environs. Data from monitoring devices is trended to establish variations, which are influenced by seasonal, meteorological, local and global sources. The monitoring devices will also respond to radiation in the effluents of the plant if they pass in near proximity. The data is included in each quarterly environmental report.

Sample locations for the collection of the flora and fauna are concentrated in the liquid effluent pathway to the West. Representative samples of all the pathways and suitable locations are established in all directions. Air samplers are distributed to achieve a sampling of air from major wind directions across the site.

The Radiological Environmental Monitoring Program maintains at least those minimum sampling locations and type of samples to meet the requirements listed in Table 1.

A site has been established for a vegetable garden. The garden is at the site boundary alongside Clay Creek, and irrigated with water from the effluent stream. This data is considered essential for comparisons to vegetation not irrigated with effluent stream water for determination of bioaccumulation for soil types common to the environs.

All of the environmental sample locations required for the Radiological Environmental Monitoring Program are designated in Table 6. Additional sampling locations are listed in HPIP-2070, REMP Routes and Sample Locations.

13.0 Radiological Environmental Monitoring Program (REMP) Manual Changes

As required by the Permanently Defueled Technical Specifications (PDTS) section D6.14.3, changes to the REMP manual shall be documented and the records of the reviews performed for the changes shall be retained as required by the PDTS section D6.10.2.o. The documentation shall contain sufficient information to support the change together with the appropriate analyses or evaluations justifying the change.

The documentation shall also contain a determination that the change will maintain the level of radioactive effluent control that is required by 10 CFR 20.1302, 40CFR190, 10 CFR 50.36a, and Appendix I to 10CFR50 and not adversely impact the accuracy or reliability of effluent dose or setpoint calculations.

Changes to the REMP manual shall become effective after review and acceptance by the PRC and approval by the Plant Manager.

Changes to the REMP manual shall be submitted to the Nuclear Regulatory Commission in the form of a complete, legible copy of the entire REMP Manual as a part of or concurrent with the Annual Radioactive Effluent Release Report for the period of the report in which any change to the REMP Manual was made. Each change shall be identified by markings in the margin of the affected pages, clearly indicating the area of the page that was changes, and shall indicate the date (e.g., month/ year) the change was implemented.

Table 1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/ or Sample	Number of Samples*	Sampling and Collection Frequency	Type and Frequency of Analysis
1. AIRBORNE	3	Continuous operation of sampler with sample collection as required by dust loading but at least once per week	Particulate sampler. Analyze for Gross Beta radioactivity at least 24 hours following filter change. Perform gamma isotopic analysis on each sample where gross beta activity is greater than 10 times the yearly mean of control samples for the same sample period. Perform gamma isotopic analysis on composite (by location) sample at least once per quarter.
2. DIRECT RADIATION	At least 25 locations with 2 monitoring devices at each location	At least once per quarter	Gamma dose. At least once per quarter
3. WATERBORNE			
a. Surface	2	Composite sample collected monthly	Gamma isotopic and tritium analysis of each composite
	3	Grab sample collected monthly	Gamma isotopic and tritium analysis of each sample
b. Runoff	1	Grab sample collected fortnightly	Gamma isotopic and tritium analysis of each sample

* Sample locations are shown in Table 6

Table 1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/ or Sample	Number of Samples*	Sampling and Collection Frequency	Type and Frequency of Analysis
3. WATERBORNE c. Ground	2	Grab sample collected quarterly	Gross Beta, Gamma isotopic, and Tritium analysis of each sample
d. Drinking	2	Grab sample collected monthly	Gross Beta, Gamma isotopic, and Tritium analysis of each sample.
e. Mud and Silt	2	At least quarterly. Sample collected of the top 3" of material 2 ft. from shoreline.	Gamma isotopic analysis of each sample.
4. INGESTION a. Fish	1	At least semiannually. At least one sample of either of the species listed in Table 6	Gamma isotopic analysis of the edible portion of each sample.
b. Food	1	At least semiannually. One sample of vegetable(s) as shown in Table 6	Gamma isotopic analysis of the edible portion of each sample.

* Sample locations are shown in Table 6

Table 2

MAXIMUM VALUES FOR THE LOWER LIMIT OF DETECTION, LLD [a,c]

Analysis	Water (pCi/ l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/ kg-wet)	Food Products (pCi/ kg-wet)	Mud and Silt (pCi/ kg-wet)
Gross Beta	4[b]	0.01			
H-3	2000 (1000[b])				
Mn-54	15		130		
Co-60	15		130		150[(e)]
Zn-65	30		260		
Cs-134	15 (10[b])	0.01[d]	130	60	150
Cs-137	18 (10[b])	0.01[d]	130	60	150

Table 2

MAXIMUM VALUES FOR THE LOWER LIMIT OF DETECTION, LLD [a,c]

[a] The Low Limit of Detection (LLD) values for the radionuclides presented in Table 2 are those recommended in Reference 9.12 (BTP) and Reference 9.22 (RETS).

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 determinations are taken as equal to 0.05. The equation for estimating the maximum LLD is given by the following equation:

$$LLD = \frac{2.71/t_s + 3.29S_b}{3.7E - 2(YEV)\exp(-\lambda t_c)}$$, pCi/ l, pCi/kg-wet, or pCi/M^3

where:

2.71	=	factor to account for Poisson statistics at very low background count rate
3.29	=	twice the constant used to establish the one-sided 0.95 confidence interval
S_b	=	standard deviation of the background count rate
	=	$[B / (t_b t_s) + B / t_b^2]^{0.5}$
B	=	background counts
t_b	=	background count interval, sec
t_s	=	sample count interval, sec
3.7E-2	=	conversion factor, dis/ sec/ pCi
Y	=	radiochemical process yield (product of all factors such as abundance, chemical yield, etc.)
E	=	counting efficiency, cts/ dis
V	=	sample volume or mass, l or kg
λ	=	radioactive decay constant for the associate nuclide

Table 2

MAXIMUM VALUES FOR THE LOWER LIMIT OF DETECTION, LLD [a,d]

t_c = elapsed time from the midpoint of sample collection to the midpoint of counting, sec

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.

Occasionally, unavoidably small sample sizes or other uncontrollable circumstances may result in *a priori* LLD values not being met. In such cases, the contributing factors will be identified and described in the Annual Radiological Environmental Operating Report.

b LLD for Drinking Water samples from Reference 9.22 (RETS).

c Other peaks which are measurable and identifiable, together with the nuclides in Table 2, shall be identified and reported.

d Composite analysis LLD from Reference 9.22 (RETS) is shown; individual sample LLD is 0.05 pCi/m^3. This LLD (0.05 pCi/m^3) is a site specific value.

e LLD for Mud and Silt Co-60 is not required by Reference 9.22 (RETS). This value is consistent with the RETS required LLD for Cs-134 and Cs-137.

Table 3

REPORTING LEVELS FOR REMP MEASUREMENTS

Analysis	Water (pCi/ l)	Airborne Particulate or Gases (pCi/ m^3)	Fish (pCi/ kg-wet)	Food Products (pCi/ kg-wet)
H-3	20000[a]			
Mn-54	1000		30000	
Co-60	300		10000	
Zn-65	300		20000	
Cs-134	30	10	1000	1000
Cs-137	50	20	2000	2000
Gross Beta	40[b]	2[c]		

a Applies to water samples utilized for human consumption only. This value is as specified in 40 CFR 141.

b Gross Beta activity in water of ten times the yearly mean of the control samples is indicated as the level that gamma isotopic analysis should be performed on the individual sample [Reference 9.12 (BTP)]. Gamma isotopic analysis on each water sample is required by Table 1 and therefore this reporting requirement does not apply.

c Gross Beta activity in air of ten (10) times the yearly mean of the control samples is indicated as the level that Gamma Isotopic analysis should be performed on the individual sample. The value indicated is site specific.

Table 4

TWO LETTER DESIGNATION TO IDENTIFY THE TYPE OF SAMPLE [a]

Letter Designation	Type of Sample Represented
AG	Algae Sample
AS	Air Sample
FS	Fish Sample
LV	Garden Vegetation
MS	Mud & Silt (Sediment)
RW	Runoff Water
SW	Surface Water[b]
TL	Direct Radiation (Monitoring Badge)
WW	Ground (Well) Water
DW	Drinking Water
SL	Soil

a Additional letter designation may be added as sample designators if additional sample types are collected for analysis.

b The portion of precipitation on the land that ultimately reaches streams is considered to be surface water.

Table 5

SECTOR LETTER DESIGNATIONS USED IN SAMPLE IDENTIFICATION

Sector	Sector Degrees	True North Compass Sector
A	348.75 to 11.25	N
B	11.25 to 33.75	NNE
C	33.75 to 56.25	NE
D	56.25 to 78.75	ENE
E	78.75 to 101.25	E
F	101.25 to 123.75	ESE
G	123.75 to 146.25	SE
H	146.25 to 168.75	SSE
J	168.75 to 191.25	S
K	191.25 to 213.75	SSW
L	213.75 to 236.25	SW
M	236.25 to 258.75	WSW
N	258.75 to 281.25	W
P	281.25 to 303.75	WNW
Q	303.75 to 326.25	NW
R	326.25 to 348.75	NNW

Table 6

RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

Sample Identification (Former ID)	Sample Class	Collection Frequency	Location Identification
AIR (Particulates)			
RASO.1C0 (RAHO)	IND	Weekly	On Site (PAP Building Carport)
RASO.3MO	IND	Weekly	On Site (Effluent Discharge)
RASO.7EO	IND	Weekly	Meteorological Tower
RUNOFF WATER			
RRW0.6MO	IND	Biweekly	Site Boundary
SURFACE WATER			
RSWO.7NO	IND	Monthly	Water Sump
RSW1.3F0 (RSWC0)	IND	Monthly	Rancho Seco Reservoir
RSW3.7N0 (RSWB0)	CON	Monthly	Folsom South Canal (Composite Sample)
RSW1.8N0	IND	Monthly	Confluence of Clay and Hadselville Creeks
RSWO.3M0	IND	Monthly	Effluent Discharge (Composite Sample)

Table 6 (continued)

RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

Sample Identification (Former ID)	Sample Class	Collection Frequency	Location Identification
GROUND (Well) WATER			
RWW0.3EO (RWWAO)	IND	Quarterly	Site Well
RWW0.8DO	CON	Quarterly	Marciel Ranch
DRINKING WATER			
RWD0.1GO	IND	Monthly	Industrial Area Drinking Water Source
RDW1.8FP	CON	Monthly	Rancho Seco Lake Drinking Water Source
MUD AND SILT (Sediment)			
RMS0.3MO	IND	Quarterly	Effluent Discharge
RMS0.6MO (RMSEO)	IND	Quarterly	Site Boundary
FISH*			
RFS0.6MO	IND	Semiannually	Clay Creek near the Site Boundary

NOTE: Include predator (e.g., bass, sunfish) or scavenger (e.g., catfish, sucker) species, as available.

* Other downstream locations may be substituted to meet sampling requirements.

Table 6 (Continued)

RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

Sample Identification (Former ID)	Sample Class	Collection Frequency	Location Identification	
GARDEN VEGETABLES				
RLV0.6MO	IND	Semiannually	Site Boundary Vegetable Irrigation Garden (vegetable samples, depending on availability)	
RLVXX.XX (RLVFO)	CON	Semiannually	Truck Farm, outside 5 mile radius. (locally grown vegetable samples, depending on availability)	
MONITORING DEVICE				
RTL0.3RO	IND	Quarterly	#1	Rancho Seco Site
RTLO.3CO	IND	Quarterly	#2	Rancho Seco Parking Lot
RTLO.3NO	IND	Quarterly	#3	Rancho Seco Site
RTL0.3LO	IND	Quarterly	#4	Rancho Seco Site
RTL0.3HO	IND	Quarterly	#5	Rancho Seco Site
RTL0.4FO	IND	Quarterly	#6	SMUD Photovoltaic Facility
RTL0.5CO	IND	Quarterly	#7	Rancho Seco Entrance
RTLO.6KO	IND	Quarterly	#11	Tokay Substation/ Clay East Rd.
RTL2.7MO	IND	Quarterly	#16	Tipling Residence
RTL8.2KO	CON	Quarterly	#17	Elliot Cemetery
RTL7.8CO	CON	Quarterly	#18	Sam Jaber Residence

Table 6 (Continued)

RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

Sample Identification (Former ID)	Sample Class	Collection Frequency		Location Identification
MONITORING DEVICE				
RTL1.8FO	IND	Quarterly	#19	Rancho Seco Lake
RTL1.5MO	IND	Quarterly	#20	Clay East Road & Kirkwood
RTL3.9KO	IND	Quarterly	#26	Borden Road
RTL7.4MO	CON	Quarterly	#30	Herald Fire Department
RTL3.7NO	IND	Quarterly	#31	Hobay Road
RTL3.8MO	IND	Quarterly	#33	Folsom South Canal Pumping Station
RTL1.9NO	IND	Quarterly	#35	Hadselville Creek and Plant Effluent Water
RTL1.7FO	IND	Quarterly	#43	Rancho Seco Reservoir
RTL1.4DO	IND	Quarterly	#46	Twin Cities Road (Highway 104)
RTL8.0PO	CON	Quarterly	#55	Colony Road
RTL0.8DO	IND	Quarterly	#63	Marciel Ranch
RTL0.6MO	IND	Quarterly	#65	Site Boundary Irrigated Garden
RTL0.3PO	IND	Quarterly	#68	West Fence, adjacent to ISFSI
RTL0.3NP	IND	Quarterly	#88	ISFSI outer Security fence, near inactive West Garden
RTL0.4NP	IND	Quarterly	#89	ISFSI outer Security fence, SW corner
RTL0.5NP	IND	Quarterly	#90	ISFSI outer Security fence, NW corner
RTL0.3QP	IND	Quarterly	#91	ISFSI outer Security fence, NE corner