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March 30, 2021

PG&E Letter HBL-21-004

10 CFR 50, Appendix I
10 CFR 50.36a

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Docket No. 50-133, OL-DPR-7
Humboldt Bay Power Plant Unit 3
Annual Radioactive Effluent Release Report for 2020

Dear Commissioners and Staff:

Enclosure 1 contains the Humboldt Bay Power Plant Unit 3, "Annual Radioactive Effluent Release Report," covering the period January 1 through December 31, 2020. This report is required by Appendix B, Section 6.3 of the Humboldt Bay Quality Assurance Plan.

Enclosure 2 contains Revision 32 to the "SAFSTOR/Decommissioning Offsite Dose Calculation Manual" as required by Section 4.2 of the "SAFSTOR/Decommissioning Offsite Dose Calculation Manual."

There are no new or revised regulatory commitments (as defined by NEI 99-04) made in this letter.

If you have any questions regarding this submittal, please contact Mr. Philippe Soenen at 805-459-3701.

Sincerely,

Eric P. Nelson

Eric Nelson

Enclosures
cc: HBPP Humboldt Distribution
cc/enc: Amy Snyder, NRC Project Manager
Scott A. Morris, NRC Region IV Administrator

PACIFIC GAS AND ELECTRIC COMPANY
HUMBOLDT BAY POWER PLANT
DOCKET NO. 50-133, LICENSE NO. DPR-7

HUMBOLDT BAY POWER PLANT UNIT 3
ANNUAL RADIOACTIVE
EFFLUENT RELEASE REPORT

January 1 through December 31, 2020

TABLE OF CONTENTS

INTRODUCTION

This report summarizes gaseous and liquid radioactive effluent releases from Humboldt Bay Power Plant (HBPP) Unit 3 for the four quarters of 2020. The report includes calculated potential radiation doses and a comparison with the numerical guidelines of 10 CFR 50, Appendix I, as well as a summary of shipments of solid radioactive waste. The concentrations of plant effluent releases during the reporting period were well below Offsite Dose Calculation Manual (ODCM) limits.

The HBPP Main Plant Stack, a ground level release path, and stack particulate airborne monitoring system (SPAMS), the real time effluent monitor, were shut down on October 14, 2015, and permanently removed from service to facilitate partial demolition of the Reactor Building.

The information is reported as required by Appendix B, Section 6.3 of the Humboldt Bay Quality Assurance Plan and Section 4.2 of the ODCM, and it is presented in the general format of Regulatory Guide 1.21, Appendix B (except for the topics identified below).

Meteorology

The meteorological data logging system was removed from service in 1967, so the information specified by Regulatory Guide 1.21 is not available. Previous HBPP Annual Radioactive Effluent Release Reports summarized the cumulative joint frequency distribution of wind speed, direction, and atmospheric stability for the period April 1962 through June 1967, when the meteorological data logging system was in service.

Short-lived Nuclides, Iodine, and Noble Gasses

The Unit was last operated on July 2, 1976. Due to the long decay time since operation, short-lived radionuclides are neither expected nor reported. This includes iodines and noble gases other than Kr-85. During 2008, the spent nuclear fuel was transferred from the spent fuel pool to the independent spent fuel storage installation (ISFSI), so there is now no source term for Kr-85.

Air Particulate Filter Composites – Sr-90 and Am-241

No modular high-efficiency particulate air (HEPA) ventilation units were used during the reporting period. No weekly sampling was required for monitoring effluents by the ODCM.

Gaseous Effluents – Tritium

Tritium sampling is not required by the HBPP ODCM. No tritium samples were collected during this reporting period.

Liquid Effluents

The last batch discharge of radioactive liquid effluent occurred on December 11, 2013. Subsequent radioactive liquid effluent batches were transported to US Ecology for offsite disposal under the 10 CFR 20.2002 exemption. There were no liquid shipments during this reporting period.

Average Energy

Calculations for the average energy of gaseous releases of fission and activation gases are not required for HBPP.

I. SUPPLEMENTAL INFORMATION

A. Regulatory Limits

1. Gaseous Effluents

a. Noble Gas Release Rate Limit

Noble gases are no longer an issue since the spent nuclear fuel has been relocated to the ISFSI.

b. Iodine Release Rate Limit

Due to the long decay time since the Unit was shut down, the license does not define an iodine release rate limit.

c. Particulate Release Rate Limit

The radioactive particulate release rate limit is based on concentration limits from 10 CFR 20, an effluent flow rate and an annual average dispersion factor for the sector with the least favorable atmospheric dispersion. There were no operable effluent paths and no particulate samples were collected during the reporting period.

The applicable annual average dispersion factor for incidental releases is 6.59E-3 seconds per cubic meter.

2. Liquid Effluents

a. Concentration Limit

Concentration limits for liquid effluent radioactivity released to Humboldt Bay are taken from 10 CFR 20.

B. Effluent Concentration Limits

1. Gaseous Effluents

Effluent concentration limits for gaseous effluents are taken from 10 CFR 20, Appendix B, Table 2, Column 1.

2. Liquid Effluents

   Effluent concentration limits for liquid effluents are taken from 10 CFR 20, Appendix B, Table 2, Column 2.

C. Measurements and Approximations of Total Radioactivity

1. Gaseous Effluents – Elevated Release

   Elevated releases did not occur at HBPP during the reporting period.

2. Gaseous Effluents – Ground-level Release

   a. Fission and Activation Gases

      Fission and activation gases are no longer an issue since the spent fuel has been relocated to the ISFSI.

   b. Iodines

      Due to the long decay time since operation (shutdown July 2, 1976), no detectable releases of radioactive Iodine can be expected. Therefore, neither the Technical Specifications nor the ODCM require that these radionuclides be monitored.

   c. Particulates

      Radioactive particulates released from modular HEPA ventilation units are monitored by continuous sample collection on particulate filters when used. No areas involving elevated airborne radioactivity were identified, so no modular HEPA ventilation units were used during the reporting period.

3. Liquid Effluents

   a. Batch Releases

      There were no batch liquid effluent releases during this report period.

   b. Continuous Releases

      There were no continuous liquid effluent releases during this report period.

D. Batch Release Statistics

1. Liquid

   a. Number of batch releases 0
   b. Total time period for batch releases ..... N/A
   c. Maximum time period for a batch release..... N/A
   d. Average time period for a batch release..... N/A
   e. Minimum time period for a batch release..... N/A

2. Gaseous
   a. Number of batch releases 0
   b. Total time period for batch releases ..... N/A
   c. Maximum time period for a batch release..... N/A
   d. Average time period for a batch release..... N/A
   e. Minimum time period for a batch release..... N/A

E. Abnormal Release Statistics

1. Liquid
   a. Number of abnormal releases 0
   b. Total activity released..... N/A
2. Gaseous
   a. Number of abnormal releases 0
   b. Total activity released..... N/A

II. GASEOUS AND LIQUID EFFLUENTS

A. Gaseous Effluents

Table 1 summarizes the total quantities of radioactive gaseous effluents released.

Section A of Table 1, 2A, and 2B have been omitted as fission and activation gases are neither expected or measured.

Table 2A is for reporting the quantities of each of these nuclides determined to be released from an elevated release point (there are none).

Table 2B presents the quantities of each of the nuclides determined to be released by ground level release points (there are none).

There were no “Batch Mode” gaseous releases during this report period.

B. Liquid Effluents

Table 3 summarizes the total quantities of radioactive liquid effluents. Table 4 presents the quantities of each of the nuclides determined to be released.

There were no batch liquid effluent releases during this report period.

TABLE 1

GASEOUS EFFLUENTS – SUMMATION OF ALL RELEASES

	Units	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Est. Total Error, %
B. Particulates						
1. Total release	Ci	N/A	N/A	N/A	N/A	N/A
2. Average release rate	μCi/sec	N/A	N/A	N/A	N/A	
3. Percent of applicable limit	%	N/A	N/A	N/A	N/A	
4. Applicable limit	μCi/cc	N/A	N/A	N/A	N/A	
5. Gross alpha radioactivity	Ci	N/A	N/A	N/A	N/A	

Table Notes:

N/A – There were no gaseous effluent releases during the reporting period.

	Units	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Stack Release Path	%	N/A	N/A	N/A	N/A
Incidental Release Path	%	N/A	N/A	N/A	N/A

No operating modular HEPA units after June 7, 2016.

TABLE 2A

GASEOUS EFFLUENTS – ELEVATED RELEASE – PARTICULATES CONTINUOUS MODE - NUCLIDES RELEASED

Nuclides Released	Unit	Continuous Mode			
		First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Particulates					
Cobalt-60	Ci	N/A	N/A	N/A	N/A
Strontium-90	Ci	N/A	N/A	N/A	N/A
Cesium-137	Ci	N/A	N/A	N/A	N/A
Am-241	Ci	N/A	N/A	N/A	N/A
Total for period	Ci	N/A	N/A	N/A	N/A

Table Notes:

N/A – There were no elevated gaseous effluents during the report period.

TABLE 2B

GASEOUS EFFLUENTS – GROUND-LEVEL RELEASES NUCLIDES RELEASED

Nuclides Released	Unit	Continuous Mode			
		First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Particulates					
Cobalt-60	Ci	N/A	N/A	N/A	N/A
Strontium-90	Ci	N/A	N/A	N/A	N/A
Cesium-137	Ci	N/A	N/A	N/A	N/A
Americium-241	Ci	N/A	N/A	N/A	N/A
Total for period	Ci	N/A	N/A	N/A	N/A

Table Notes:

N/A - There were no ground-level gaseous effluents during the report period.

TABLE 3

LIQUID EFFLUENTS – SUMMATION OF ALL RELEASES

	Units	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Est. Total Error, %
A. Fission & Activation Products						
1. Total release (not including tritium, gases, alpha)	Ci	N/A	N/A	N/A	N/A	N/A
2. Average diluted concentration	μCi/ml	N/A	N/A	N/A	N/A	
3. Percent of applicable limit	%	N/A	N/A	N/A	N/A	
4. Applicable limit	μCi/ml	N/A	N/A	N/A	N/A	
B. Tritium						
1. Total release	Ci	N/A	N/A	N/A	N/A	N/A
2. Average diluted concentration	μCi/ml	N/A	N/A	N/A	N/A	
3. Percent of applicable limit	%	N/A	N/A	N/A	N/A	
4. Applicable limit	μCi/ml	N/A	N/A	N/A	N/A	
C. Gross Alpha Radioactivity						
1. Total release	Ci	N/A	N/A	N/A	N/A	N/A
D. Volume of waste released (prior to dilution)	Liters	N/A	N/A	N/A	N/A	N/A
E. Volume of dilution water	Liters	N/A	N/A	N/A	N/A	N/A

Table Notes:

There were no batch liquid effluent releases during the report period.

TABLE 4

LIQUID EFFLUENTS – NUCLIDES RELEASED

Nuclides Released	Unit	Batch Mode			
		First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Strontium-90	Ci	N/A	N/A	N/A	N/A
Cesium-137	Ci	N/A	N/A	N/A	N/A
Cobalt-60	Ci	N/A	N/A	N/A	N/A
Americium-241	Ci	N/A	N/A	N/A	N/A
Nickel-63	Ci	N/A	N/A	N/A	N/A
Tritium	Ci	N/A	N/A	N/A	N/A
Total for period	Ci	N/A	N/A	N/A	N/A

Table Notes:

There were no batch liquid effluent releases during the report period.

III. SOLID RADIOACTIVE WASTE

TABLE 5

SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

A. Solid Waste Shipped Offsite for Burial or Disposal

1. Type of Waste	Unit	12 Month Period	Estimated Total Error, %
a. Spent resins, filter sludges, evaporator bottoms, etc.	There were no spent resins, filter sludges, evaporator bottoms, etc. shipments during this reporting period.		
b. Dry compressible waste, soils, contaminated equipment, etc. (2)	There were no dry compressible waste, soils, contaminated equipment, etc. shipments during this report period.		
c. Irradiated components, control rods, etc.	There were no irradiated components, control rods, etc. shipments during this reporting period.		
d. Other (processed waste from HBPP via processor to burial)	Cubic Meter	2.12E-01	1.00E1
	Ci	4.40E-05	5.60E1

2. Estimate of major nuclide composition (by type of waste)	Unit	Nuclide	12 Month Period
a. Spent resins, filter sludges, evaporator bottoms, etc.	There were no spent resins, filter sludges, evaporator bottoms, etc. shipments during this reporting period.		
b. Dry compressible waste, soils, contaminated equipment, etc. (1)	There were no dry compressible waste, soils, contaminated equipment, etc. shipments during this report period.		
c. Irradiated components, control rods, etc.	There were no irradiated components, control rods, etc. shipments during this reporting period.		

TABLE 5 – Continued

2. Estimate of major nuclide composition (by type of waste)	Unit	Nuclide	12 Month Period
d. Other (processed waste)	%	H-3	1.45
	%	Co-60	0.24
	%	Sr-90	59.22
	%	Tc-99	0.10
	%	Cd-109	0.53
	%	Cs-137	36.13
	%	Am241	2.29

3.a. Solid waste disposition from HBPP	Number of Shipments	Mode of Transportation	Destination
	N/A	N/A	N/A
3.b. Solid waste disposition via processor to disposal	1(2)	N/A	via Toxco
B.1 Irradiated fuel shipments	None	N/A	N/A

Table Notes:

[1] Radionuclides contributing less than 0.1% to the total activity are not listed in Table 5.2.b.

[2] 1 shipment of check sources was made to Toxco in 2020.

IV. RADIOLOGICAL IMPACT ON MAN

A comparison of calculated doses from various paths has shown that the offsite doses are due to direct radiation. Maximum doses to individuals (for the maximally exposed organs and age groups) are summarized in Table 6. Doses from noble gases are not reported, as noble gas releases were neither expected nor measured. There are no airborne or liquid dose pathways from the adjacent ISFSI, and the direct radiation measurement locations for HBPP include the contribution from the ISFSI. Therefore, these doses comply with 40 CFR 190 as there are no other uranium fuel cycle facilities within 8 km of the HBPP and ISFSI.

A. Dose to the average individual in the population, based on the guidance of Regulatory Guide 1.109, from all receiving-water-related pathways is not calculated for 2020, because there were no batch liquid effluent releases during this report period. The last batch liquid effluent discharge occurred on December 11, 2013.

   With no batch liquid effluent discharge, doses continue to be well below the 10 CFR 50, Appendix I numerical guidelines for limiting effluents as low as is reasonably achievable (3 millirem per year (mrem/yr)) to the total body and 10 mrem/yr to any organ.

B. Total body dose to the average individual in the population from gaseous effluents to a distance of 50 miles from the site is not calculated, but this dose is less than the total body dose to an average individual present at the maximally exposed location. For an average individual at the maximally exposed location, the total body dose (determined with the same dispersion and deposition parameters as used to calculate maximum exposure) is not calculated, since there were no releases.

C. Total body dose (to the average individual in unrestricted areas from direct radiation from the facility) is based on thermoluminescent dosimeter (TLD) results of stations at the site boundary, using the shoreline occupancy factors given in Regulatory Guide 1.109 for the highest average potential individual (teenage group). For this group, direct radiation would result in an exposure of 0.02 mrem/yr, calculated as follows:

   Specification 2.10 of the ODCM limits the calendar year dose or dose commitment to any MEMBER OF THE PUBLIC, due to releases of radioactivity and radiation, from uranium fuel cycle sources to less than or equal to 25 mrem to the total body or any organ (except the thyroid, which shall be limited to less than or equal to 75 mrem).

   Potential direct radiation exposure to an individual at the site boundary is highest at the north boundary of the site. Due to the possibility that an individual at the shoreline (fishing, bird watching, etc.) may use the path along the Coastal Trail, TLD Stations T8, T9, and T10 along the path have been historically used to estimate an annual radiation exposure. TLD locations at the perimeter continue to

conservatively represent the areas of the site accessible to the public. The ODCM calculation model for the direct radiation exposure pathway assumes a maximum occupancy factor of 67 hours per year, based on regulatory guidance for shoreline recreation for the teenage group.

All area TLD monitoring ceased at the end of Q1 2020. T-1 was the highest perimeter monitoring point Q1 of 2020 at 15.7 mrem total. The Q1 average of all perimeter monitoring points (T1 through T-16) before background subtraction was 13.5 mrem with a variability from 12.7 mrem at location T-3 to 15.7 mrem at location T-1.

Total background dose for the year based on Q1 dose from offsite TLDs 1, 2, 14, 25, and 17 = (13.7 + 15.0 + 12.7 + 12.0 + 12.7)/5 = 13.2 mrem

Subtracting the yearly background dose from the maximum dose at T1:

15.7 mrem – 13.2 mrem = 2.5 mrem above background for Q1.

2.5 mrem corrected for Q1 of the 67-hour/yr occupancy factor:

$$Q1\ occupancy\ fencline\ dose = 2.5\ \text{mrem}\frac{67\ hr}{8760\ hr} = 0.02\ mrem$$

This maximum potential dose is well below the 10 CFR 20.1302(b)(2)(ii) limit of 50 mrem/yr from external sources necessary to demonstrate compliance with the 10 CFR 20.1301 dose limit for individual members of the public. It is also well below the 25 mrem annual dose limitations in ODCM Specification 2.10 and 40 CFR 190.

TABLE 6

RADIATION DOSE FOR MAXIMALLY EXPOSED INDIVIDUALS

	Dose, milli-rem				
Dose Source	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Annual Total
Liquid Effluents					
Water-Related Pathways (1)	-	-	-	-	-
	-	-	-	-	-
Airborne Effluents					
Particulates (2)	-	-	-	-	-
	-	-	-	-	-
Direct Radiation (3)	0.02	-	-	-	0.02

Notes

1. Maximum total body and organ doses to individuals in unrestricted areas from receiving-water-related exposure pathways is not calculated since there were no batch liquid effluent releases during this report period. The last batch liquid effluent discharge occurred on December 11, 2013.
2. Maximum total body and organ dose to individuals in unrestricted areas from airborne effluent-related exposure pathways is not calculated since there were no airborne effluent releases during this report period. The plant stack was shut down in October 2015. Modular HEPA ventilation units were not used during the reporting period because no elevated airborne radioactivity areas were observed.
3. Total body dose (to the maximum individual in the population) is based on TLD results at locations near the site boundary, using the shoreline occupancy factors of Regulatory Guide 1.109 for the maximum potential individual (teenage group). All area TLD monitoring ceased at the end of Q1 2020.

V. CHANGES TO THE OFFSITE DOSE CALCULATION MANUAL

As decommissioning proceeds at HBPP, system changes or removal may require changes to the ODCM. Changes were made to the ODCM during the reporting period. ODCM, Revisions 32, is attached as Enclosures 2, with a summary of changes that occurred during the reporting period.

VI. CHANGES TO THE PROCESS CONTROL PROGRAM

There were no changes to the Process Control Program during the reporting period.

VII. CHANGES TO RADIOACTIVE WASTE TREATMENT SYSTEMS

HBPP no longer performs batch liquid effluent discharges.

VIII. INOPERABLE EFFLUENT MONITORING INSTRUMENTATION

Liquid Effluent Monitoring

Effective December 23, 2013, HBPP no longer uses outfall canal dilution for liquid effluents. There were no batch liquid effluent releases during this report period.

Airborne Effluent Monitoring Instrumentation

No airborne radioactivity areas were identified in 2020, so no modular HEPA ventilation units were used during the reporting period.

SPAMS was removed from service on October 14, 2015.

IX. ERRATA

2019 Annual Radioactive Effluent Release Report Errata:

None

PACIFIC GAS AND ELECTRIC COMPANY
NUCLEAR POWER GENERATION
HUMBOLDT BAY POWER PLANT

SAFSTOR/Decommissioning Offsite Dose Calculation Manual
Revision 32

Summary of Changes Included in Revision 32 of the SAFSTOR/Decommissioning Offsite Dose Calculation Manual

Summary of Changes:

Section	Change Date	Change in Rev. 32	Reason
Introduction	Rev. 32	Added statement about changes	Clarify the periodic changes made due to changing needs during decommissioning progression.
Introduction	Rev. 32	3rd paragraph deleted	No longer necessary discussion
Introduction	Rev. 32	4th paragraph modified	Modified to current status and retained history statement
Introduction	Rev. 32	7th paragraph modified	Shortened the change process description
Introduction	Rev. 32	3rd paragraph deleted	Information redundant to the procedure body
1.8	Rev. 32	Deleted	No frequencies now required
1.11	Rev. 32	Deleted	No instantaneous concentrations needed
1.13	Rev. 32	Deleted	No modular HEPA ventilation units left on site
1.15	Rev. 32	Deleted	No operable units left on site
1.23	Rev. 32	Deleted	No longer required
1.24	Rev. 32	Deleted	No Ventilation exhaust treatment system on site
Table 1-1	Rev. 32	Deleted, pointed to bases	No frequencies now specified in procedure
2.2	Rev. 32	Deleted, pointed to bases	No longer radioactive gaseous effluent monitoring equipment in use on site
2.3	Rev. 32	Deleted, pointed to bases	No liquid effluent to require concentration measurement
2.6	Rev. 32	Deleted, pointed to bases	No gaseous effluents to require dose rate limiting conditions
Table 2.6	Rev. 32	Deleted, pointed to bases	No sampling and analysis program required
2.8.2	Rev. 32	Deleted	No changes occurring to be surveilled
2.9	Rev. 32	Deleted, pointed to bases	No solid radioactive waste retained on site
2.10.2	Rev. 32	Deleted, pointed to bases	No gaseous dose contribution to

			be considered
2.11.2	Rev. 32	Deleted, pointed to bases	No samples required to be collected
Table 2.7	Rev. 32	Deleted, pointed to bases	No radiological monitoring program remaining
Table 2.9	Rev. 32	Deleted	Data no longer collected
Table 2.10	Rev. 32	Deleted	Monitoring locations removed
Figure 2-1	Rev. 32	Deleted	TLD locations removed
Figure 2-3	Rev. 32	Deleted	Offsite monitoring removed
Figure 2-4	Rev. 32	Deleted	Offsite monitoring removed
Figure 2-5	Rev. 32	Deleted	Offsite monitoring removed
2.12	Rev. 32	Deleted	On site laboratory no longer in use
2.13	Rev. 32	Deleted, pointed to bases	No radioactive waste left to inventory
3.1	Rev. 32	Modified	Added additional information
3.2	Rev. 32	Deleted last sentence	No liquid to be sent
3.5	Rev. 32	Mostly deleted, some historical information retained	Redundant or out of date information deleted, so current data added
3.8	Rev. 32	Modified	Simplified the bases
3.9	Rev. 32	Modified	Simplified the bases
3.10	Rev. 32	Deleted specific references	Specific references no longer applied
3.11	Rev. 32	Modified	Simplified the bases
3.12	Rev. 32	Modified	Simplified the bases
3.13	Rev. 32	Modified	Simplified the bases
4.1	Rev. 32	Deleted and modified sections	Corrections to data to be incorporated into the Annual Radiological Environmental Monitoring Report
4.2 d	Rev. 32	Clarified	Discussed discontinuing use of monitoring equipment
5.1 b	Rev. 32	Deleted	Added reason
5.1 d	Rev. 32	Deleted	Corrected language
5.2 b	Rev. 32	Deleted	Added more reason
5.2 C	Rev. 32	Deleted	Corrected language
5.2 d	Rev. 32	Deleted	Added reason
5.3 b	Rev. 32	Deleted	Added reason
5.3 C	Rev. 32	Deleted	Corrected language
5.3 d	Rev. 32	Deleted	Added reason
8.2	Rev. 32	Deleted	Added reason for deletion
9.1	Rev. 32	Deleted	Not required any longer
9.2	Rev. 32	Modified	Wording changed to better describe changes to the ODCM
Appendix A	Rev. 32	Deleted	Baseline data no longer required
Appendix B	Rev. 32	Deleted	Dispersion and deposition no longer required

(Procedure Classification - Quality Related)

INTRODUCTION

The SAFSTOR/DECOMMISSIONING Off-site Dose Calculation Manual (ODCM) is provided to support implementation of the Humboldt Bay Power Plant (HBPP) Unit 3 radiological effluent controls and radiological environmental monitoring. The ODCM is divided into two parts, Part I - Specifications and Part II - Calculational Methods and Parameters.

Part I contains the specifications for liquid and gaseous radiological effluents (RETS) developed in accordance with NUREG-0473, *Draft Radiological Effluent Technical Specifications - BWR*, by License Amendment Request (LAR) 96-02 and the radiological environmental monitoring program (REMP). Both the RETS and the REMP were relocated from the Technical Specifications by LAR 96-02 in accordance with the provisions of Generic Letter 89-01, *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 Offsite Dose Calculation Manual or to the Process Control Program*, issued by the NRC in January, 1989. Changes to the ODCM based on decommissioning status have been periodically performed and documented to align the manual with the radiological monitoring needs. 02/2020

As of December 31, 2013, HBPP ceased liquid radioactive effluent discharges via the discharge canal to Humboldt Bay. The Main Plant stack was shut down in October 2015. As of June 2016, use of modular HEPA units to control elevated airborne radioactivity and effluents was no longer required. As of December 2019, no more analyses are anticipated. Analysis capability, if required, remains available through an offsite laboratory. With no more analysis to be performed, the interlaboratory comparison program is no longer being used. 02/2020 02/2020

Part II of the ODCM contains the calculational methods developed, following the above guidance, to be used in determining the dose to members of the public resulting from routine radioactive effluents released from HBPP during the decommissioning period. Part II of the ODCM contains the calculational methods for gaseous and liquid effluents to preserve site specific data although the gaseous effluent pathway and the liquid discharge pathway has been terminated.

The ODCM also contains the Process Control Program (PCP) for solid radioactive wastes, administrative controls regarding the content of the Annual Radiological Environmental Monitoring Program Report, administrative controls regarding the content of the Annual Radioactive Effluent Release Report, and administrative controls regarding major changes to radioactive waste treatment systems. Since there are no remaining liquid process systems onsite, the requirement for a Process Control Program is effectively reduced to ensuring the receiving disposal site acceptance criteria is satisfied.

02/2020 The ODCM shall become effective after approval by the HB Director. The change process for the ODCM is described in Part II Section 9.0.

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PART I – SPECIFICATIONS

PART I - SPECIFICATIONS - (Continued)

PART II - CALCULATIONAL METHODS AND PARAMETERS

PART II - CALCULATIONAL METHODS AND PARAMETERS - (Continued)

02/2020

02/2020

LIST OF TABLES - PART I

LIST OF TABLES - PART II

LIST OF FIGURES - PART I

PART I - SPECIFICATIONS

1.0 DEFINITIONS

1.1 ACTION

ACTION shall be that part of a control that prescribes remedial measures required under designated conditions.

1.2 BASELINE COMPARISON

A BASELINE COMPARISON shall be a comparison of cumulative radioactivity releases for a stated period with the baseline radioactivity release conditions established by the ENVIRONMENTAL REPORT.

1.3 Deleted

1.4 Deleted

1.5 Deleted

1.6 ENVIRONMENTAL REPORT

Submitted as Attachment 6 to the SAFSTOR license amendment request, the ENVIRONMENTAL REPORT established baseline radiological environmental conditions for soil, biota and sediments.

1.7 Deleted

02/2020 1.8 Deleted

1.9 Deleted

1.10 INDEPENDENT VERIFICATION

INDEPENDENT VERIFICATION is a separate act of confirming or substantiating that an activity or condition has been completed or implemented, in accordance with specified requirements, by an individual not associated with the original determination that the activity or condition was completed or implemented in accordance with specified requirements.

02/2020 1.11 Deleted

1.12 MEMBER OF THE PUBLIC

MEMBER OF THE PUBLIC means an individual in any area located beyond the boundary of the restricted area controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials and within, at, or beyond the SITE BOUNDARY. However, an individual is not a member of the public during any period in which the individual receives an onsite occupational dose.

02/2020

1.13 Deleted

1.14 OFFSITE DOSE CALCULATION MANUAL

The OFFSITE DOSE CALCULATION MANUAL contains the methodology and parameters used in the calculation of offsite doses resulting from radioactive gaseous and liquid effluents, and in the conduct of the Radiological Environmental Monitoring Program. The ODCM also contains the Radioactive Effluent Controls and Radiological Environmental Monitoring Program and descriptions of the information that should be included in the Annual Radiological Environmental Monitoring Report and the Annual Radioactive Effluent Release Report. The ODCM also contains the Process Control Program (PCP) for solid radioactive wastes.

02/2020

1.15 Deleted

1.16 PROCESS CONTROL PROGRAM

The PROCESS CONTROL PROGRAM (PCP) shall contain the current formulas, sampling, analyses, tests, and determinations to be made to ensure that processing and packaging of solid radioactive wastes based on demonstrated processing of actual or simulated wet solid wastes will be accomplished in such a way as to assure compliance with 10 CFR Parts 20, 61, and 71, State regulations, disposal site(s) requirements, and other requirements governing the disposal of solid radioactive waste.

1.17 Deleted

1.18 RESTRICTED AREA

The RESTRICTED AREA is defined by 10CFR20.1003. The physical location(s) of the RESTRICTED AREA shall be defined in plant procedures.

1.19 SITE BOUNDARY

The SITE BOUNDARY shall be the boundary of the UNRESTRICTED AREA used in the offsite dose calculations for gaseous and liquid effluents. The SITE BOUNDARY is shown in Figure 1-1. Ingress and egress through the SITE BOUNDARY are controlled by the Company.

1.20 Deleted

1.21 Deleted

1.22 UNRESTRICTED AREA

An UNRESTRICTED AREA shall be any area located beyond the boundary of the restricted area controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials and within, at, or beyond the SITE BOUNDARY.

02/2020 1.23 Deleted

02/2020 1.24 Deleted

1.25 Deleted

02/2020

Table 1-1
Deleted

Figure 1-1
SITE BOUNDARY

2.0 SPECIFICATIONS

2.1 **Deleted**

02/2020

Table 2-1 - Deleted
Table 2.2 - Deleted

2.2 Deleted (See BASES Section 3.1)

02/2020

Table 2-3 - Deleted
Table 2-4 - Deleted

2.3 Deleted (See BASES Section 3.2)

Table 2-5 - Deleted

02/2020 2.4 Deleted (See BASES Section 3.3)

02/2020 2.5 Deleted - (See BASES Section 3.4)

2.6 Deleted (See BASES Section 3.5)

Table 2-6 - Deleted

02/2020

2.7 Deleted

2.8 GASEOUS EFFLUENTS: DOSE - RADIONUCLIDES IN PARTICULATE FORM

LIMITING CONDITIONS

2.8.1 The dose to a MEMBER OF THE PUBLIC from the release of radioactive materials in particulate form with half-lives greater than 8 days in gaseous effluents released beyond the SITE BOUNDARY shall be limited as follows:

a. During any calendar quarter: less than or equal to 7.5 mrem to any organ, and

b. During any calendar year: less than or equal to 15 mrem to any organ.

APPLICABILITY: At all times.

ACTION:

With the calculated dose from the release of radioactive materials in particulate form with half-lives greater than 8 days in gaseous effluents exceeding any of the

above limits, prepare and submit to the Commission, within 30 days, a Special Report, pursuant to Administrative Control 4.3, which includes:

a. Identification of the cause for exceeding the limit(s).

b. Corrective action taken to reduce the release of radioactive materials in particulate form with half-lives greater than 8 days in gaseous effluents during the remainder of the current calendar quarter and during the remainder of the current calendar year so that the average dose to any organ is less than or equal to 15 mrem.

2.8.2 Deleted (See BASES Section 3.8)

2.9 Deleted (See BASES Section 3.9)

02/2020

2.10 TOTAL DOSE

LIMITING CONDITIONS

2.10.1 The calendar year dose or dose commitment to any MEMBER OF THE PUBLIC, due to releases of radioactivity and 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 shall be limited to less than or equal to 75 mrem).

APPLICABILITY: At all times.

ACTION:

With the calculated doses from the release of radioactive materials in gaseous effluents exceeding twice the limits of Specification 2.8.1.a, or 2.8.1.b, calculations should be made, which include direct radiation contributions from Unit No. 3, to determine whether the above limits of Specification 2.10 have been exceeded. If such is the case, prepare and submit to the Commission within 30 days, pursuant to Administrative Control 4.3, 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, 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, for the 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. If the estimated dose(s) exceeds the above limits, and if the release condition resulting in 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 provisions of 40 CFR Part 190. Submittal of the report is considered a timely request, and a variance is considered granted until staff action on the request is complete.

02/2020

2.10.2 Deleted

2.11 REMP MONITORING PROGRAM

LIMITING CONDITIONS

2.11.1 A radiological environmental monitoring program shall be provided to monitor the radiation and radionuclides in the environs of the facility. The program shall be conducted as specified in Table 2-7.

APPLICABILITY: At all times.

ACTION:

a. With the radiological environmental monitoring program not being conducted as specified in Table 2-7, prepare and submit to the Commission, in the Annual Radiological Environmental Monitoring Program Report, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

b. A Special Report pursuant to Administrative Control 4.3, shall be submitted if the potential annual dose to a MEMBER OF THE PUBLIC is greater than or equal to the calendar year limits of Specification 2.8. Prepare and submit to the Commission within 30 days of obtaining analytical results from the affected sampling period which includes an evaluation of release conditions, environmental factors or other aspects which caused the dose limits to be exceeded. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Monitoring Program Report.

02/2020

2.11.2 Deleted (See BASES Section 3.11)

Table 2-7
HBPP RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	PROGRAM DESCRIPTION: Number of Samples and Locations[a]	Sampling and Collection Frequency	Type of Analysis	PROGRAM BASIS: ODCM Specs (QR)
AIRBORNE	None	N/A	N/A	
DIRECT RADIATION	None	N/A	N/A	
WATERBORNE	None	N/A	N/A	
INGESTION	None	N/A	N/A	
TERRESTRIAL	None	N/A	N/A	

02/20

Table Notations

02/20 QR - Quality Related

02/20

02/2020

Table 2-8 - Deleted

Table 2-9 - Deleted

Table 2-10 - Deleted

Figure 2-1 - Deleted

Figure 2-2 - Deleted

Figure 2-3 - Deleted

Figure 2-4 - Deleted

Figure 2-5 - Deleted

2.12 Deleted (See BASES Section 3.12)

2.13 Deleted (See BASES Section 3.13)

3.0 SPECIFICATION BASES

3.1 Radioactive Gaseous Effluent Monitoring Instrumentation Basis

02/2020

Deleted – The plant stack ceased operation in 2015. Use of modular HEPA Units to monitor gaseous effluent was discontinued in February 2018. Additionally, at present remaining radioactive material on site is indistinguishable from background, the radiological clearance criteria of 10 CFR 20 has been met, and there is no credible release pathway to be measured.

3.2 Liquid Effluent Concentration Basis

Deleted - Liquid effluents are no longer discharged to Humboldt Bay. Effective December 31, 2013, discharge of processed radioactive liquid effluents to Humboldt Bay was terminated. Any remaining or incidental radioactive liquid in concentrations exceeding 10 times 10 CFR 20, Appendix B, Table 2 Column 2 are manifested for disposal at a licensed disposal site.

02/2020

3.3 Liquid Effluent Dose Basis

Deleted - Liquid effluents are no longer discharged to Humboldt Bay.

3.4 Liquid Effluent Treatment Basis

Deleted - Liquid effluents are no longer discharged to Humboldt Bay.

3.5 Gaseous Effluents Dose Rate Basis

Stack operation and monitoring ceased operation in 2015, so the reporting period for 2015 includes the dose contribution from the plant stack prior to ceasing operation. Use of Modular HEPA Ventilation Units to sample gaseous effluent pathways was discontinued in February 2018. Additionally, at present radioactivity remaining on site is indistinguishable from background, the radiological clearance criteria of 10 CFR 20 has been met, and there is no credible release pathway to be measured.

02/2020

3.6 Deleted - Gaseous effluent monitoring is not required for noble gases because the spent fuel (noble gas source term) has been transferred to the ISFSI.

3.7 Deleted

3.8 Deleted - Remaining radioactive material on site is indistinguishable from background, the radiological clearance criteria of 10 CFR 20 has been met, and there is no credible release pathway to be measured.

02/2020

02/2020 3.9 Solid Radioactive Waste Basis

02/2020 Delete – No radioactive material meeting the definition of radioactive material, based on DOT transportation regulations, remains on the site.

3.10 Total Dose Basis

This specification is provided to meet the dose limitations of 40 CFR Part 190 that have now been incorporated into 10 CFR Part 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 design objective doses of Appendix I. The Special Report will describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR Part 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 8 km must be considered. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR part 190.11 and 10 CFR Part 20.2203a4, is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190 and does not apply in any way to the 02/2020 other requirements for dose limitation of 10 CFR Part 20. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

3.11 REMP Monitoring Program Basis

02/2020 Deleted – Radiological dose rates and radioactive material remaining on site are indistinguishable from background. Since there are no longer credible radiological release or dose pathways from the site, this basis is no longer required.

3.12 REMP Interlaboratory Comparison Program Basis

02/2020 Deleted – With no more analyses to be performed, this basis is no longer required.

3.13 Radioactive Waste Inventory Basis

02/2020 Deleted – Because the site has been remediated to the 10 CFR 20 radiological release criteria, no tanks have a credible process to accumulate sufficient quantities of radioactive material to satisfy this waste inventory basis.

4.0 ADMINISTRATIVE CONTROLS

4.1 Annual Radiological Environmental Monitoring Report

A report on the Decommissioning Radiological Environmental Monitoring Program shall be prepared annually in accordance with the NRC Branch Technical Position and submitted to the NRC by May 1 of each year.

02/2020 Since the radiological clearance criteria of 10 CFR 20 for the HBPP site has been met, there is no credible release pathway to be measured. As a result, monitoring of sample locations were discontinued in February 2020.

The Annual Radiological Environmental Monitoring Report shall include:

a. 02/2020 Deleted - Since the radiological clearance criteria of 10 CFR 20 for the HBPP site has been met, there is no credible release pathway to be measured. As a result, monitoring of sample locations were discontinued in February 2020.

b. 02/2020 Deleted - Since the radiological clearance criteria of 10 CFR 20 for the HBPP site has been met, there is no credible release pathway to be measured. As a result, monitoring of sample locations were discontinued in February 2020

c. 02/2020 Deleted - Since the radiological clearance criteria of 10 CFR 20 for the HBPP site has been met, there is no credible release pathway to be measured. As a result, monitoring of sample locations were discontinued in February 2020.

d. A summary description of the Decommissioning Radiological Environmental Monitoring Program.

e. 02/2020 Deleted - Since the radiological clearance criteria of 10 CFR 20 for the HBPP site has been met, there is no credible release pathway to be measured. As a result, monitoring of sample locations were discontinued in February 2020.

f. 02/2020 Deleted – With no more analyses to be performed, the Interlaboratory Comparison Program is no longer being used.

g. The reason for not conducting the quality related portion of the Radiological Environmental Monitoring Program as required, and discussion of all deviations from the quality related sampling schedule of Table 2-7, including plans for preventing a recurrence in accordance with Specification 2.11.

h. Deleted – water samples are not collected as a part of the REMP.

02/2020 i. Deleted

Table 4-1
RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT ANNUAL SUMMARY - EXAMPLE

Name of Facility: Humboldt Bay Power Plant Unit 3 — Docket No.: 50-133, OL-DPR-7

Location of Facility: Humboldt County, California (County, State) — Reporting Period: January 1 - December 31, 1997

Medium or Pathway Sampled [Unit of Measurement]	Type and Total Number of Analyses Performed	Lower Limit of Detection[a] (LLD)	All Indicator Locations Mean, (Fraction) & [Range][b]	Location with Highest Annual Mean Name, Distance and Direction	Location with Highest Annual Mean Mean, (Fraction) & [Range][b]	Control Locations Mean, (Fraction) & [Range][b]	Number of Nonroutine Reported Measurements
AIRBORNE Particulates	Not Required	N/A	N/A	N/A	N/A	Not Required	N/A
DIRECT RADIATION [mR/quarter]	Direct radiation	N/A	N/A	N/A	N/A	N/A	N/A
WATERBORNE Surface Water	Not Required	N/A	N/A	N/A	N/A	Not Required	N/A
Groundwater	Not Required	N/A	N/A	N/A	N/A	Not Required	N/A
Drinking Water	Not Required	N/A	N/A	N/A	N/A	Not Required	N/A
Sediment	Not Required	N/A	N/A	N/A	N/A	Not Required	N/A
Algae	Not Required	N/A	N/A	N/A	N/A	Not Required	N/A
INGESTION Milk	Not Required	N/A	N/A	N/A	N/A	Not Required	N/A
Fish and invertebrates	Not Required	N/A	N/A	N/A	N/A	Not Required	N/A
TERRESTRIAL Soil	Not Required	N/A	N/A	N/A	N/A	Not Required	N/A

02/20

TABLE 4-1 (Continued)
RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT ANNUAL SUMMARY

[a] The LLD is defined as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95 percent probability with only 5 percent probability of falsely concluding that a blank observation represents a "real" signal.
LLD is defined as the a priori lower limit of detection (as pCi per unit mass or volume) representing the capability of a measurement system and not as the a posteriori (after the fact) limit for a particular measurement. (Current literature defines the LLD as the detection capability for the instrumentation only, and the MDA, minimum detectable concentration, as the detection capability for a given instrument, procedure and type of sample.) The actual MDA for these analyses was at or below the LLD.

[b] The mean and the range are based on detectable measurements only. The fraction of detectable measurements at specified locations is indicated in parentheses; e.g., (10/12) means that 10 out of 12 samples contained detectable activity. The range of detected results is indicated in brackets; e.g., [23-34].

Not Required - not required by the HBPP Offsite Dose Calculation Manual. Baseline environmental conditions for this parameter were established in the Environmental Report as referenced by the SAFSTOR Decommissioning Plan.

N/A - Not applicable
Note: The example data are based on the 1997 monitoring results and are provided for illustrative purposes only.

4.2 Annual Radioactive Effluent Release Report

This report shall be submitted prior to April 1 of each year. The following information shall be included:

a. A summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the plant as outlined in 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*, (Rev. 1, 1974) with data summarized on a quarterly basis following the format of Appendix B thereof. The material provided shall be consistent with the objectives outlined in the ODCM and in conformance with 10CFR 50.36a and 10CFR Part 50, Appendix I, Section IV.B.I. Beginning in the reporting year 2014, liquid effluents shipped for processing or disposal at a regulated disposal site are included in the annual report.

b. For each type of solid waste shipped off-site:

   1. Container Volume

   2. Total Curie Quantity (specified as measured or estimated)

   3. Principal Radionuclides (specified as measured or estimated)

   4. Type of Waste (e.g., spent resin, compacted dry waste)

   5. Solidification Agent (e.g., cement)

c. A list and description of unplanned releases beyond the SITE BOUNDARY.

d. Information on the reasons for inoperability and lack of timely corrective action for any radioactive gaseous monitoring instrumentation inoperable for greater than 30 days in accordance with Specification 2.2. Beginning the reporting year 2015, following cessation of the plant stack operation, the effluent monitoring instrumentation associated with Specification 2.2 ceased operation. Monitoring effluent from Modular HEPA Ventilation systems was discontinued in February 2018. Therefore there is no data to report.

02/2020

e. A summary description of changes made to:

   1. Process Control Program (PCP)

   2. Radioactive Waste Treatment Systems

f. A complete, legible copy of the entire ODCM if any change to the ODCM was made during the reporting period. Each change shall be identified by markings in the margin of the affected pages, clearly indicating the area of the page that was changed, and shall indicate the date (e.g., month/year) the change was implemented.

4.3 Special Reports

The originals of Special Reports shall be submitted to the Document Control Desk with a copy sent to the Regional Administrator, NRC Region IV, within the time period specified for each report. These reports shall be submitted covering the activities identified below to the requirements of the applicable Specification.

a. Radioactive Effluents - Specifications 2.8 and 2.10.

b. Radiological Environmental Monitoring - Specification 2.11.

4.4 Major Changes to Radioactive Waste Treatment Systems

a. Licensee initiated major changes to the radioactive waste systems (liquid, gaseous and solid) shall be reported to the NRC in the Annual Radioactive Effluent Release Report for the period in which the evaluation was reviewed. The changes shall be approved by the HB Director.

b. The following information shall be available for review:

1. A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR 50.59,

2. Sufficient information to totally support the reason for the change,

3. A description of the equipment, components and processes involved and the interfaces with other plant systems,

4. A evaluation of the change which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously estimated in the Environmental Report submitted to the NRC as Attachment 6 to the SAFSTOR license amendment request,

5. An evaluation of the change which shows the expected maximum exposures to an individual in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the Environmental Report,

6. An estimate of the exposure to plant personnel as a result of the change, and

7. Documentation of the fact that the change was reviewed and approved in accordance with plant procedures.

4.5 Process Control Program Changes

a. Changes to the Process Control Program (PCP) shall be documented and records of reviews performed shall be retained as required for the duration of Decommissioning.

b. The following information shall be available for review:

1. Sufficient information to support the change together with the appropriate analyses or evaluations justifying the change(s) and,

2. A determination that the change will maintain the overall conformance of the solidified waste product to existing requirements of Federal, State, or other applicable regulations.

3. A description of the equipment, components and processes involved and the interfaces with other plant systems.

c. The change shall become effective after approval of the HB Director.

PART II - CALCULATIONAL METHODS AND PARAMETERS

1.0 UNRESTRICTED AREA EFFLUENT CONCENTRATIONS

1.1 LIQUID EFFLUENT UNRESTRICTED AREA CONCENTRATIONS

Specification 2.3.1 requires that the Radioactive Liquid Effluent Sample concentrations (RLES) are calculated to ensure that the limits of Specification 2.3 are not exceeded (the instantaneous concentration of radioactive material released to UNRESTRICTED AREAS shall be less than or equal to 10 times the concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2). This requirement is defined by the following relationship.

$$\sum_i \frac{C_{i,\,Canal}}{10 \times ECL_i} \leq 1 \qquad (1\text{-}1)$$

where:

$C_{i\text{-}Canal}$ = The concentration of isotope " i " in the canal discharge point to Humboldt Bay.

ECL_i = Effluent Concentration Limit for radionuclide " i " from 10 CFR 20, Appendix B, Table 2, Column, 2 (µCi/ml)

1.1.1 If the outfall location is not at the furthermost portion of the canal from the entrance to the Bay the concentration of the isotope $C_{i\text{-}Canal}$ is equal to the concentration being discharged at the outfall.

1.2 UNRESTRICTED AREA GASEOUS EFFLUENT CONCENTRATIONS

1.2.1 Equation C-4 of Regulatory Guide 1.109 demonstrates how to calculate dose from inhalation:

The annual dose associated with inhalation of all radionuclides, to organ j *of an individual in age group* a*, is then:*

$$D_{ja}(r,\theta) = R_a \Sigma x_i(r,\theta) DFA_{ija}$$

where

D_{ja} *is the annual dose rate to organ* j *of an individual in age group* a

R_a *is the breathing rate for age group* a

$x_i(r,\theta)$ *is the* a*nnual average ground-level concentration of nuclide* i *in air in sector* θ *at distance* r*, in* pCi/m^3

DFA_{ija} *is the dose factor for nuclide* i *to organ* j *of age group* a

To calculate $x_i(r,\theta)$ the annual average ground-level concentration of nuclide i in air in sector θ at distance r, in pCi/m^3 the equation must be rearranged to:

$$D_{ja}(r,\theta)/(DFAija\, R_a) = x_i(r,\theta)$$

Assuming that:

Americium-241 is the primary nuclide

The maximally exposed group is the Teen based on breathing rates and DFAija

The DFAija to the bone of a Teen from Am-241 is 1.77 mrem/pCi

The DFAija are taken from: NRC NUREG/CR-4013, "*LADTAP-II Technical Reference and User Guide*"

The Teen breathing rate is 8000 m^3/year

Therefore the ground-level concentration of Am-241 in air in sector θ at distance r, in pCi/m^3 that will produce a dose rate of 1500 mrem/year to the bone of a Teen is:

(1500 mrem/year) / (1.77 mrem/pCi) / (8000 m^3/year) = 1.06E-1 pCi/ m^3

1.06E-1pCi/ m^3 =

(1.06E-1 pCi/m^3) / (1E6 pCi /µCi) / (1E6 ml/m^3) = 1.06E-13 µCi/ml

1.2.2 Quantity of radioactive material released

Equation C-3 of Regulatory Guide 1.109 demonstrates how to calculate the quantity of material that must be released to produce a given airborne concentration:

The annual average airborne concentration of radionuclide i at the location (r, θ) with respect to the release point may be determined as

$x_i(r,\theta) = 3.17 \times 10^4 Q_i(\chi/Q)^D(r,\theta)$

where

$x_i(r,\theta)$ *is the annual average ground-level concentration of nuclide* i *in air in sector* θ *at distance* r, *in* pCi/m^3

3.17×10^4 *is the number of pCi/Ci divided by the number of sec/yr*

$(\chi/Q)^D(r,\theta)$ *is the annual average atmosphere dispersion factor, in sec/m^3.*

Q_i *is the release rate of nuclide I to the atmosphere, in Ci/yr*

A value of 6.59E-3 sec/m^3 was used for the incidental release path atmosphere dispersion factor at the site boundary $(\chi/Q)^D(r,\theta)$ for releases from Modular HEPA Units. This is based on a release rate of 2000 cfm. (Ref: Safstor ODCM, Appendix B, 2.0) This factor is based on the atmospheric models of Regulatory Guide 1.145, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*.

To determine the release rate that will result in an average ground-level concentration the above equation must be rearranged to:

$Q_i = x_i(r,\theta) / (3.17 \times 10^4(\chi/Q)^D(r,\theta))$

Therefore the Modular HEPA Unit release rate of Am-241 required to equal the incidental ground-level concentration at the site boundary calculated above is:

1.06E-1 pCi/m^3 / ((3.17E4 (pCi/Ci)/ (sec/yr)) * (6.59E-3 sec/m^3)) =

5.07E-4 Ci/yr or 5.07E2 uCi/yr

1.2.3 Transmission Fraction

Deleted – no on line monitoring provided.

1.2.4 Effluent Concentration

The Modular HEPA Unit concentration that would result in a release rate of 5.07E-4 Ci/yr is equal to:

Total release (Curies/year) / Release rate (cc/year)

The average annual Modular HEPA Unit flow rate is 2,000 cfm

This results in a total volume of 2.98E13 cc/yr

This is based on (2000 ft^3/min * 525,600 minutes/yr * 28,317 cc/ft^3).

(5.07E-4 Ci * 1E6 µCi/Ci) / (2.98E13 cc/yr) = 1.70E-11 µCi/cc

Therefore an indicated Modular HEPA concentration of 1.70E-11 µCi/cc at 2000 cfm for one calendar year would result in a dose of 1500 mrem to a member of the public at the site boundary.

Two times the indicated release rate is equal to3.4E-11 µCi/cc.
Two hundred times the indicated release rate is equal to 3.4E-9 µCi/cc.

1.2.5 Relationship to EPA PAG

To compare the release rates calculated above the following assumptions were made:

Am-241 dose conversion factor in rem / cm^{-3} µCi hr, from EPA 400 = 5.3E8

Since no credit is taken for an elevated release point or an annual average χ/Q the same atmospheric dispersion factor is used in the calculations below.

Assuming that an unplanned release occurs at two times the ODCM release rate for one hour the total activity released is equal to:

3.4E-11 µCi/cc * 2000 ft^3/min * 28,317 cc/ft^3 * 60 min = 1.16E-1 µCi

(1.16E-1 µCi) * (5.3E8 rem / cm^{-3} uCi hr) * (6.59E-3 sec/m^3) / (1E6 cm^3/m^3) / (3600 sec/hour) = 1.13E-4 rem

This is much less than the EPA PAG of 1 Rem

Assuming that an unplanned release occurs at two hundred times the ODCM release rate for 15 minutes the total activity released is equal to:

3.4E-9 µCi/cc * 2000 ft^3/min * 28,317 cc/ft^3 * 15 min = 2.89E0 µCi

This results in a dose of:

(2.89E0 µCi) * (5.3E8 rem / cm^{-3} uCi hr) * (6.59E-3 sec/m^3) / (1E6 cm^3/m^3) / (3600 sec/hour) =

2.80E-3 rem

This is much less than the EPA PAG of 1 Rem.

1.2.6 Relationship to 10CFR20 Appendix B Table 2 Effluent Concentration limits

The 10CFR20 Appendix B Table 2 Effluent Concentration limit for Am-241 is 2E-14 µCi/ml.

The average annual ground-level concentration in air (x_i) in pCi/m^3 is equal to:

x_i = (3.17E4 (pCi/Ci)/ (sec/year)) * Q * (X/Q)

Where Q is equal to the quantity of radioactive material released in a year in Curies/year

ODCM Modular HEPA Unit incidental release X/Q = 6.59E-3 sec/ m^3

If x_i = 2E-14 µCi/ml then:

Q = (2E-14 µCi/ml * 1E6 ml/m^3 * 1E6 pCi/µCi) / ((3.17E4 (pCi/Ci)/ (sec/yr)*(6.59E-3 sec/ m^3))

Q = 9.57E-5 Ci/yr

The average annual Modular HEPA Unit volume based on the ODCM is 2.98E13 cc/yr.

This is based on (2000 cfm * 525,600 minutes/yr * 28,317 cc/cfm).

Therefore, the Modular HEPA Unit effluent concentration required to result in a fence-line concentration of 2E-14 µCi/ml is:

(9.57E-5 Ci/yr * 1E6 µCi/Ci) / (2.98E13 cc/yr * 1 cc/ml) = 3.2E-12 µCi/ml

1.2.7 Conversion Factor from Effluent Concentration to µCi/day

The release rate in µCi/day = Modular HEPA Unit concentration in µCi/cc * 2000 ft^3/min * 1440 minutes/day * 28317 cc/ ft^3

The release rate in µCi/day = Modular HEPA Unit concentration in µCi/cc * 8.16E10 cc/day

1.2.8 Conversion Factor from µCi/day to % of NUE
An NUE is equal to a release rate of 3000 mrem/year

%NUE = (Offsite dose rate / NUE threshold) * 100

%NUE = ((Conversion Factor * Release Rate) / NUE threshold) * 100

%NUE = ((Conversion Factor * 100) / NUE threshold) * Release Rate

The Conversion Factor is equal to (1.77E6 mrem/µCi) * (6.59E-3 sec/ m^3) * (8000 m^3/year) / (8.64E4 sec/day)

This is equal to1.08E3 mrem/year per µCi/day

1.2.9 Results

The 10CFR20 Appendix B Table 2 Effluent Concentration limit for Am-241 is 2E-14 µCi/ml. The Modular HEPA Unit effluent concentration that would result in a fence-line concentration of 2E-14 µCi/ml is 3.2E-12 µCi/ml.

3.2E-12 uCi/ml * 8.16E10 cc/day * 1ml/cc * 1.08E3 mrem-day/uCi-yr = 4.70E2 mrem/yr.
470 mrem/yr / 8760 hr/yr = 5.365E-2 mrem/hr

Assuming that an unplanned release occurs at two times the ODCM release rate for one hour the offsite dose corresponding to an NUE would be 1.07E-4 rem (0.107 mrem) which is much less than the EPA PAG.

Assuming that an unplanned release occurs at two hundred times the ODCM release rate for fifteen minutes the offsite dose corresponding to an Alert would be 2.675E-3 rem (2.7 mrem) which is much less than the EPA PAG.

Note that Am-241 is used in the example calculations and is expected to be limiting. Other alpha emitting isotopes such as Pu-238, Pu-239/240 and Cm-243/244 are evident in the contamination at HBPP. Since the Effluent Concentration Limits (ECLs), Derived Air Concentration (DAC) values and organ Dose Conversion Factors (DCFs) are similar, the Am-241 values may be assumed to be gross alpha with appropriate compensation for naturally occurring isotopes.

Other radionuclides (Co-60, Sr-90, Cs-137, etc.) are important in determining actual offsite dose and in demonstrating compliance with the ECL using the sum of the fractions rule. The example calculations are used similarly for each isotope in the mix with their respective ECL, DCF and exposure pathway (inhalation, ingestion, and submersion).

Although not relevant to the hypothetical offsite dose calculation in the ECL and NUE analysis above, assumed effluent concentrations are approximately 1 DAC, 2 DAC, and 200 DAC for Am-241 at the point of release. Airborne radioactivity control measures to control worker dose, also limits the potential offsite dose.

2.0 LIQUID EFFLUENT DOSE CALCULATIONS

2.1 MONTH (31 DAY PERIOD) Deleted

2.2 CALENDAR QUARTER - Deleted

2.3 CALENDAR YEAR - Deleted

2.4 LIQUID EFFLUENT DOSE CALCULATION METHODOLOGY

As of December 31, 2013, HBPP has ceased liquid radioactive effluent discharges via the discharge canal to Humboldt Bay. Any remaining processed liquid radioactive waste is transported offsite for land disposal at an authorized disposal facility. The following calculation methodology is preserved as a part of the ODCM for ease of reference to site specific parameters in the event of an accidental release of liquid radioactive effluent. No recurring liquid effluent dose calculations are expected for the remainder of decommissioning.

The equations specified in this section 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.

Equation (2) of Regulatory Guide 1.109 provides for the use of a site specific mixing ratio (i.e. reciprocal of the dilution factor) that describes the near term and near field mixing of the tidal flow from the Discharge Canal into Humboldt Bay. A two-dimensional numerical analysis, depth-averaged, finite element hydrodynamic model (reference 12.1) was developed by CH2MHILL and used to estimate the dispersion of the canal discharge in the Bay. The analysis indicated that an additional dilution factor of 80 for batch release applications or a dilution factor of 20 for continuous release applications can conservatively be used to describe the Bay dilution. A factor of 20 will be applied in this calculation to address any combination of release modes.

Since the intake canal contains a larger volume of water, use of the above dilution factors for effluent releases to the intake canal provides a simplified, conservative methodology for calculating annual dose from effluent releases to the intake canal.

The dose contribution to the total body and each individual organ (bone, liver, kidney, lung and GI-LLI) of the maximum and average exposed individual (adult, teen, child, and infant) will be calculated for the nuclides detected in effluents. The dose to an organ of an individual from the release of a mixture of radionuclides will be calculated as follows:

$$D = \sum_{i=1}^{n} \left[C_{i\text{ - Bay diluted}} \times DF \times \left\{ \left(B_{Fish,i} \times U_{Fish} \right) + \left(B_{Inv,i} \times U_{Inv} \right) \right\} \right] \quad (2\text{-}1)$$

where:

D = The dose commitment, mrem per year, to an organ (or to the whole body) due to consumption of aquatic foods.

$C_{i\text{-Bay diluted}}$ = The average diluted Bay concentration, pico-Curie/liter, for radionuclide, i. If the outfall to the canal is at the furthest most portion of the canal from the entrance to the Bay, this will be estimated by calculating the total activity released (e.g. effluent concentration $C_{i\text{ effluent}}$ in pCi/L times the discharge volume V_D in Liters) then dividing the total activity of the nuclide discharged during the period, pico-Curies, by the dilution volume (e.g. total discharged volume V_D plus total tidal flow V_{TD} during the period in liters), and by the Bay dilution factor of 20. The total annual tidal flow for the outfall canal is 2.47E+9 Liters/year (e.g., 6.77E+6 Liters/day). If Gross Alpha radioactivity is determined to be in the effluent , Pu-241 will be considered to be present at 3.25 times the amount of detected Gross Alpha radioactivity. Note that the resulting dose commitment is the annual dose rate (mrem per year) for a time frame with this average concentration. Doses (NOT dose rates) for periods shorter than a year must be proportionately reduced.

$$C_{i\text{ - Bay diluted}} = \frac{C_{i\text{ - Effluent}} \times V_D}{(V_D + V_{TD}) \times 20} \quad (2\text{-}2)$$

If the outfall is not located in the furthest most portion of the canal from the entrance to the Bay, no credit for tidal dilution of the canal will be taken and the diluted Bay concentration will be calculated using the following equation.

$$C_{i\text{ - Bay diluted}} = \frac{C_{i\text{ - Effluent}}}{20} \quad (2\text{-}3)$$

DF = The dose conversion factor, mrem/pico-Curie for the nuclide, organ, and age group being calculated. This factor is taken from Tables 2-1, 2-2, and 2-3.

$B_{Fish,i}$ = The bioaccumulation factor, pico-Curie/kilogram per pico-Curie/liter, in fish for the radionuclide in question. This value is taken from Table 2-4.

$B_{Inv,i}$ = The bioaccumulation factor, pico-Curie/kilogram per pico-Curie/liter, in invertebrates for the radionuclide in question. This value is taken from Table 2-4.

U_{Fish} = Usage factor (consumption) of fish, kilogram/year, for the age group and individual (average or maximum) in question. This factor is derived from Table 2-5 or 2-6.

U_{Inv} = Usage factor of invertebrates, kilogram/year, for the applicable age group and individual (average or maximum). This factor is from Table 2-5 or 2-6.

The total exposure to an organ (or whole body) is found from the summation of the contributions of each of the individual nuclides calculated. Note that the infant age group is not considered to consume either fish or other seafood, and exposure to this age group need therefore not be calculated.

Dose calculations can be performed using the above methodology for the current month, quarter, or year.

Table 2-1
Ingestion Dose Factors for Adult Age Group
(mrem/pico-Curie ingested)
Selected Nuclides from NUREG/CR-4013 (LADTAP II input values)

	Organ					
Nuclide	Bone	Liver	Total Body	Kidney	Lung	GI-LLI
H-3	No Data	5.99×10^{-8}	5.99×10^{-8}	5.99×10^{-8}	5.99×10^{-8}	5.99×10^{-8}
Co-60	No Data	2.14×10^{-6}	4.72×10^{-6}	No Data	No Data	4.02×10^{-5}
Ni-63	1.30×10^{-4}	9.01×10^{-6}	4.36×10^{-6}	No Data	No Data	1.88×10^{-6}
Sr-90	8.71×10^{-3}	No Data	1.75×10^{-4}	No Data	No Data	2.19×10^{-4}
Cs-137	7.97×10^{-5}	1.09×10^{-4}	7.14×10^{-5}	3.70×10^{-5}	1.23×10^{-5}	2.11×10^{-6}
Y-90	9.62×10^{-9}	No Data	2.58×10^{-10}	No Data	No Data	1.02×10^{-4}
Pu-241	1.57×10^{-5}	7.45×10^{-7}	3.32×10^{-7}	1.53×10^{-6}	No Data	1.40×10^{-6}
Am-241	7.55×10^{-4}	7.05×10^{-4}	5.41×10^{-5}	4.07×10^{-4}	No Data	7.42×10^{-5}
Gross α	7.55×10^{-4}	7.05×10^{-4}	5.41×10^{-5}	4.07×10^{-4}	No Data	7.42×10^{-5}

Table 2-2
Ingestion Dose Factors for Teen Age Group
(mrem/pico-Curie ingested)
Selected Nuclides from NUREG/CR-4013 (LADTAP II input values)

	Organ					
Nuclide	Bone	Liver	Total Body	Kidney	Lung	GI-LLI
H-3	No Data	6.04×10^{-8}	6.04×10^{-8}	6.04×10^{-8}	6.04×10^{-8}	6.04×10^{-8}
Co-60	No Data	2.81×10^{-6}	6.33×10^{-6}	No Data	No Data	3.66×10^{-5}
Ni-63	1.77×10^{-4}	1.25×10^{-5}	6.00×10^{-6}	No Data	No Data	1.99×10^{-6}
Sr-90	1.02×10^{-2}	No Data	2.04×10^{-4}	No Data	No Data	2.33×10^{-4}
Cs-137	1.12×10^{-4}	1.49×10^{-4}	5.19×10^{-5}	5.07×10^{-5}	1.97×10^{-5}	2.12×10^{-6}
Y-90	1.37×10^{-8}	No Data	3.69×10^{-10}	No Data	No Data	1.13×10^{-4}
Pu-241	1.75×10^{-5}	8.40×10^{-7}	3.69×10^{-7}	1.71×10^{-6}	No Data	1.48×10^{-6}
Am-241	7.98×10^{-4}	7.53×10^{-4}	5.75×10^{-5}	4.31×10^{-4}	No Data	7.87×10^{-5}
Gross α	7.98×10^{-4}	7.53×10^{-4}	5.75×10^{-5}	4.31×10^{-4}	No Data	7.87×10^{-5}

Table 2-3
Ingestion Dose Factors for Child Age Group
(mrem/pico-Curie ingested)
Selected Nuclides from NUREG/CR-4013 (ladTAP II input values)

Nuclide	Organ					
	Bone	Liver	Total Body	Kidney	Lung	GI-LLI
H-3	No Data	1.16×10^{-7}	1.16×10^{-7}	1.16×10^{-7}	1.16×10^{-7}	1.16×10^{-7}
Co-60	No Data	5.29×10^{-6}	1.56×10^{-5}	No Data	No Data	2.93×10^{-5}
Ni-63	5.38×10^{-4}	2.88×10^{-5}	1.83×10^{-5}	No Data	No Data	1.94×10^{-6}
Sr-90	2.56×10^{-2}	No Data	5.15×10^{-4}	No Data	No Data	2.29×10^{-4}
Cs-137	3.27×10^{-4}	3.13×10^{-4}	4.62×10^{-5}	1.02×10^{-4}	3.67×10^{-5}	1.96×10^{-6}
Y-90	4.11×10^{-8}	No Data	1.10×10^{-9}	No Data	No Data	1.17×10^{-4}
Pu-241	3.87×10^{-5}	1.58×10^{-6}	8.04×10^{-7}	2.96×10^{-6}	No Data	1.44×10^{-6}
Am-241	1.36×10^{-3}	1.17×10^{-3}	1.02×10^{-4}	6.23×10^{-4}	No Data	7.64×10^{-5}
Gross α	1.36×10^{-3}	1.17×10^{-3}	1.02×10^{-4}	6.23×10^{-4}	No Data	7.64×10^{-5}

Table 2-4
Bioaccumulation Factors for Saltwater Environment
(pCi/kg per pCi/liter)
Selected Nuclides from Regulatory Guide 1.109, Table A-1 and from NUREG/CR-4013

Element	Fish	Invertebrate
H	9.0×10^{-1}	9.3×10^{-1}
Co	1.0×10^{2}	1.0×10^{3}
Ni	1.0×10^{2}	2.5×10^{2}
Sr	2.0	2.0×10^{1}
Cs	4.0×10^{1}	2.5×10^{1}
Y	2.5×10^{1}	1.0×10^{3}
Pu	3.0	2.0×10^{2}
Am	2.5×10^{1}	1.0×10^{3}
Gross α	2.5×10^{1}	1.0×10^{3}

Table 2-5
Average Individual Foods Consumption for Various Age Groups
(kilo-gram/year or liters/year)
From Regulatory Guide 1.109, Table E-4

Age Group	Fish	Other Seafood (Invertebrates)	Fruits and Vegetables	Milk	Meat
Adult	6.9	1.0	190	110	95
Teen	5.2	0.75	240	200	59
Child	2.2	0.33	200	170	37
Infant	0	0	0	0	0

Table 2-6
Maximum Individual Foods Consumption for Various Age Groups
(kilo-gram/year or liters/year)
From Regulatory Guide 1.109, Table E-5

Age Group	Fish	Other Seafood (Invertebrates)	Fruits and Vegetables	Milk	Meat
Adult	21	5.0	520	310	110
Teen	16	3.8	630	400	65
Child	6.9	1.7	520	330	41
Infant	0	0	0	330	0

3.0 LIQUID EFFLUENT TREATMENT

3.1 TREATMENT REQUIREMENTS

3.1.1 Deleted

3.1.2 Deleted

3.2 Deleted

4.0 GASEOUS EFFLUENT DOSE CALCULATIONS

4.1 DOSE RATE

4.1.1 Deleted

As explained in Specification Bases 3.7, Noble Gases are not required to be monitored, and the corresponding dose rate need not be calculated.

4.1.2 Tritium and Radioactive Particulates

There are no short-lived radioactive particulates in the effluent, so radioactive decay can be neglected. Meteorological parameters are assumed to be constant, and applied for the most conservative location. Therefore, the radioactive particulates dose rate calculation methodology is the same as the radioactive particulates dose calculation methodology. Refer to sections 4.3.3 through 4.3.8 for the appropriate equations.

As explained in Specification Bases 3.5, Tritium is not required to be monitored, and the corresponding dose rate need not be calculated. Nevertheless, if such a calculation is required, refer to sections 4.3.9 through 4.3.13 for the appropriate equations.

4.2 Deleted

4.3 DOSE - TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM

4.3.1 Calendar Quarter

The methodology for calendar quarter calculations is the same as for the calendar year calculations provided by section 4.3.3, and discussed in section 4.3.2, with the exception that the resulting values for D (annual dose commitment, mrem/year) must be divided by 4 to convert them to quarterly dose commitment, mrem/quarter.

4.3.2 Calendar Year

The methods for calculating the dose due to release rates of the subject materials 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 provided for determining the doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

4.3.3 Particulate Organ Dose Calculation Summation Methodology

The release rate specifications for radioactive particulates with half-life greater than eight days are dependent on the existing radionuclide pathways to man, in areas at and beyond the SITE BOUNDARY. The pathways which were examined in the development of these calculations were: 1) Individual inhalation of airborne radionuclides, 2) deposition of radionuclides onto green leaf 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.

The releases of radioactive materials in particulate form with half-lives greater than 8 days in gaseous effluents will be essentially limited to Cs-137, Co-60, and Sr-90. Radioactive decay may result in the dose from Transuranic radionuclides becoming significant. If Gross Alpha radioactivity is determined to be released, Pu-241 will be considered to be present at 3.25 times the amount of detected Gross Alpha radioactivity. The annual dose commitment will be calculated for any organ of an individual age group as follows:

$$D = \sum_{i=1}^{n} \left[Q_i \times \left(R_{Inh,i} + R_{GP,i} + R_{Meat,i} + R_{Milk,i} + R_{Veg,i} \right) \right] \qquad (4\text{-}3)$$

where:

D = Annual dose commitment, mrem/year.

Q_i = The average release rate of the nuclide in question, pico-Curies/second.

$R_{Inh,i}$ = The dose factor for the inhalation pathway for the radionuclide, i, in units of mrem/year per pico-Curie/sec.

$R_{GP,i}$ = The dose factor for the ground plane (direct exposure from deposition) pathway for the radionuclide, i, in units of mrem/year per pico-Curie/sec.

$R_{Meat,i}$ = The dose factor for the grass-cow-meat pathway for the radionuclide, i, in units of mrem/year per pico-Curie/sec.

$R_{Milk,i}$ = The dose factor for the grass-cow-milk pathway for the radionuclide, i, in units of mrem/year per pico-Curie/sec.

$R_{Veg,i}$ = The dose factor for the pathway of deposition on vegetation for the radionuclide, i, in units of mrem/year per pico-Curie/sec.

In general, the calculations for these pathways give results that represent trivial radiation exposure. The values calculated for typical anticipated Decommissioning releases range from about 0.002 mrem/year (fruit/vegetable consumption pathway) to less than 1×10^{-6} mrem/year (for direct radiation exposure from material deposited on the ground).

4.3.4 Particulate Inhalation Pathway Dose Calculation Methodology

$$R_{Inh,i} = (\chi/Q) \times BR_a \times DF_{i,a} \qquad (4\text{-}3a)$$

where:

χ/Q = The atmospheric dispersion parameter, seconds/cubic meter.
= 1.0×10^{-5} seconds/cubic meter for releases from the 50 foot stack. Refer to Appendix B, 1.2.
= 6.59×10^{-3} seconds per cubic meter for releases other than from the 50 foot stack. Refer to Appendix B, 2.1.

BR_a = The breathing rate of the receptor age group (a), cubic meters per year. The values to be used are 1400, 3700, 8000, and 8000 cubic meters/year for the infant, child, teen and adult age groups, respectively.

$DF_{i,a}$ = The organ (or total body) inhalation dose factor, mrem/pico-Curie, for the receptor age group, a, for the radionuclide, i. The dose factors are given in Tables 4-1, 4-2, 4-3, and 4-4.

4.3.5 Particulate Ground Plane Pathway Dose Calculation Methodology

$$R_{GP,i} = (D/Q) \times SF \times DF_i \times K \times W \qquad (4\text{-}3b)$$

where:

K = unit conversion constant, 8760 hr/yr.

DF_i = The ground plane dose conversion factor for radionuclide, i, in mrem/hr per pCi/m^2 from Table 4-5. No values are provided for Transuranic radionuclides, as their dose contribution to this pathway is negligible.

SF = The shielding factor (dimensionless). Table E-15 of Regulatory Guide 1.109 suggests values of 0.7 for the maximum individual.

D/Q = The atmospheric deposition factor, with units of inverse square meters.
= 3.0×10^{-8} inverse square meters for releases from the 50 foot stack. Refer to Appendix B, 1.3.
= 5.39×10^{-6} inverse square meters for releases other than from the 50 foot stack. Refer to Appendix B, 2.2.

W = Weathering factor. This is the reciprocal of the weathering time constant given in Regulatory Guide 1.109, for a 14 day removal half-life. In this equation, W has the value of 1.74×10^6 seconds.

4.3.6 Particulate Grass-Cow-Milk Pathway Dose Calculation Methodology

$$R_{Milk,\,i} = (D/Q) \times \left(\frac{Q_F \times U_a \times F_m \times DF_{i,\,a} \times W}{Y} \right) \qquad (4\text{-}3c)$$

where:

Q_F = The cow's vegetation consumption rate. This is given as 50 kg/day per Regulatory Guide 1.109, Table E-3.

U_a = The receptor's milk consumption rate, liters/year for the age group in question. See Tables 4-6 and 4-7.

Y = The agricultural productivity by unit area of pasture. This parameter is 0.7 kg/m^2 per Regulatory Guide 1.109, Table E-15.

$DF_{i,\,a}$ = The ingestion dose factor for radionuclide, i, for the receptor in age group (a), in units of mrem/pico-Curie, from Tables 4-8, 4-9, 4-10, or 4-11.

F_m = The fraction of the cow's intake of a nuclide which appears in a liter of milk, with units of days/liter. This parameter is given by Table 4-12.

D/Q = The atmospheric deposition factor, with units of inverse square meters.

= 3.0×10^{-8} inverse square meters for releases from the 50 foot stack. Refer Appendix B, 1.3.

= 3.29×10^{-6} inverse square meters for releases other than from the 50 foot stack. Refer to Appendix B, 2.2.

W = Weathering factor. This is the reciprocal of the weathering time constant given in Regulatory Guide 1.109, for a 14 day removal half-life. In this equation, W has the value of 1.74×10^6 seconds.

4.3.7 Particulate Grass-Cow-Meat Pathway Dose Calculation Methodology

$$R_{Meat,\,i} = \left(D/Q\right) \times \left(\frac{Q_F \times U_a \times F_f \times DF_{i,\,a} \times W}{Y}\right) \qquad (4\text{-}3d)$$

where:

Q_F = The cow's vegetation consumption rate of 50 kg/day per Regulatory Guide 1.109, Table E-3.

U_a = The receptor's meat consumption rate, kilogram/year. Refer to Tables 4-5 and 4-7.

Y = The agricultural productivity by unit area of pasture. This parameter is 0.7 kg/m^2 per Regulatory Guide 1.109, Table E-15.

$DF_{i,\,a}$ = The ingestion dose factor for radionuclide, i, for the receptor in age group (a), in mrem/pCi, from Tables 4-8, 4-9, or 4-10, as appropriate. Note that this path is not considered to apply to the infant age group.

F_f = The fraction of the animal's intake of a nuclide which finally appears in meat, days/kilogram. This parameter is given in Table 4-13.

D/Q = The atmospheric deposition factor, with units of inverse square meters.

= 3.0×10^{-8} inverse square meters for releases from the 50 foot stack. Refer to Appendix B, 1.3.

= 3.29×10^{-6} inverse square meters for releases other than from the 50 foot stack. Refer to Appendix B, 2.2.

W = Weathering factor. This is the reciprocal of the weathering time constant given in Regulatory Guide 1.109, for a 14 day removal half-life. In this equation, W has the value of 1.74×10^6 seconds.

4.3.8 Particulate Vegetation Pathway Dose Calculation Methodology

$$R_{Veg,\,i} = (D/Q) \times \left(\frac{U_T \times DF_{i,\,a} \times W}{Y} \right) \qquad (4\text{-}3e)$$

where:

U_T = The total consumption rate of fruits and vegetables, kilogram/year. This parameter is determined with the default values from Regulatory Guide 1.109, as reproduced in Tables 4-6 and 4-7.

D/Q = The atmospheric deposition factor, with units of inverse square meters.
= 3.0×10^{-8} inverse square meters for releases from the 50 foot stack. Refer to Appendix B, 1.3.
= 3.29×10^{-6} inverse square meters for releases other than from the 50 foot stack. Refer to Appendix B, 2.2.

W = Weathering factor. This is the reciprocal of the weathering time constant given in Regulatory Guide 1.109, for a 14 day removal half-life. In this equation, W has the value of 1.74×10^6 seconds.

Y = The agricultural productivity by unit area of pasture. This parameter is 0.7 kg/m^2 per Regulatory Guide 1.109, Table E-15.

Note: this equation probably overestimates exposures, since it assumes that all of the deposition on a plant remains on the plant, while the Regulatory Guide allows a factor of 0.25. Also, the quantities assumed consumed include grain (none is grown in the vicinity of the plant), as well as vegetables and fruit grown in other areas (imported to Humboldt county).

4.3.9 Tritium Organ Dose Calculation Methodology

The annual dose commitment may be calculated for any organ of an individual age group as follows:

$$D = Q_{H3} \times \left(R_{Inh,\,H3} + R_{GP,\,H3} + R_{Meat,\,H3} + R_{Milk,\,H3} + R_{Veg,\,H3}\right) \quad (4\text{-}4)$$

where:

D = Annual dose commitment, mrem/year.

Q_{H3} = The average release rate of H-3, pico-Curies/second.

$R_{Inh,\,H3}$ = The dose factor for the inhalation pathway for H-3, mrem/year per pico-Curie/sec.

$R_{Meat,\,H3}$ = The dose factor for the grass-cow-meat pathway for H-3, mrem/year per pico-Curie/sec.

$R_{Milk,\,H3}$ = The dose factor for the grass-cow-milk pathway for H-3, mrem/year per pico-Curie/sec.

$R_{Veg,\,H3}$ = The dose factor for the vegetation consumption pathway, mrem/year per pico-Curie/sec.

This pathway results in trivial offsite calculated radiation exposures. A very conservative assumption of Tritium release is that Spent Fuel Pool water at 1×10^{-2} micro-Curies/ml H-3 is lost to the stack at a rate of 50 gallons/day. With this assumption, the calculated maximum offsite exposure is 0.0013 mrem/year. Once the spent fuel pool is emptied, this source term and exposure pathway is no longer evaluated.

4.3.10 Tritium Inhalation Pathway Dose Calculation Methodology

$$R_{Inh,\,H3} = \left(\chi/Q\right) \times BR_a \times DF_{H3,\,a} \qquad (4\text{-}4a)$$

where:

χ/Q = The atmospheric dispersion parameter, seconds/cubic meter.
= 1.0×10^{-5} seconds/cubic meter for releases from the 50 foot stack. Refer to Appendix B, 1.2.
= 6.59×10^{-3} seconds per cubic meter for releases other than from the 50 foot stack. Refer to Appendix B, 2.1.

BR_a = The breathing rate of the receptor age group (a), cubic meters per year. The values to be used are 1400, 3700, 8000, and 8000 cubic meters/year for the infant, child, teen, and adult age groups, respectively.

$DF_{H3,a}$ = The organ (or total body) inhalation dose factor for the receptor age group, a, for H-3. This is given in units of mrem/pico-Curie by Tables 4-1, 4-2, 4-3, and 4-4.

Once the spent fuel pool is emptied, this source term and exposure pathway is no longer evaluated.

4.3.11 Tritium Grass-Cow-Milk Pathway Dose Calculation Methodology

The concentration of tritium in milk is based on the airborne concentration rather than the deposition:

$$R_{Milk,\,H3} = \left(\frac{\chi}{Q}\right) \times \left(\frac{0.75 \times 0.5}{H}\right) \times Q_F \times U_a \times F_m \times DF_a \qquad (4\text{-}4b)$$

where:

Q_F = The cow's vegetation consumption rate. This is 50 kg/day per Regulatory Guide 1.109, Table E-3.

U_a = The receptor's milk consumption rate for age group, a, from Regulatory Guide 1.109. See Tables 4-6 or 4-7.

DF_a = The ingestion dose factor for H-3, for the reference group, mrem/pico-Curie, from Tables 4-8, 4-9, 4-10, and 4-11.

F_m = The fraction of the cow's intake of a nuclide which appears in a liter of milk, with units of days/liter. This parameter is given by Table 4-12.

0.75 = The fraction of total feed that is water.

0.5 = The ratio of specific activity of the feed grass to the atmospheric water.

H = Absolute humidity of the atmosphere, 0.008 kilograms/cubic meter, according to Regulatory Guide 1.109.

χ/Q = The atmospheric dispersion parameter, seconds/cubic meter.
= 1.0×10^{-5} seconds/cubic meter for releases from the 50 foot stack. Refer to Appendix B, 1.2.
= 6.59×10^{-3} seconds per cubic meter for releases other than from the 50 foot stack. Refer to Appendix B, 2.1.

Once the spent fuel pool is emptied, this source term and exposure pathway is no longer evaluated.

4.3.12 Tritium Grass-Cow-Meat Pathway Dose Calculation Methodology

$$R_{Meat,\,H3} = \left(\frac{\chi}{Q}\right) \times \left(\frac{0.75 \times 0.5}{H}\right) \times Q_F \times U_a \times F_M \times DF_a \qquad (4\text{-}4\ c)$$

Equation (C-9) from Regulatory Guide 1.109

where:

Q_F = The cow's vegetation consumption rate: 50 kg/day per Regulatory Guide 1.109, Table E-3.

U_a = The receptor's meat consumption rate. See Table 4-6 and Table 4-7.

DF_a = The ingestion dose factor for H-3, for the receptor in age group (a), in mrem/pCi, from Tables 4-8 through 4-11.

F_M = The fraction of the animal's intake of H-3 which appears in a kilogram of meat, with units of days/kilogram. This parameter is given by Table 4-13.

0.75 = The fraction of total feed that is water.

0.5 = The ratio of specific activity of the feed grass to the atmospheric water.

H = Absolute humidity of the atmosphere, 0.008 kilograms/cubic meter, according to Regulatory Guide 1.109.

χ/Q = The atmospheric dispersion parameter, seconds/cubic meter.
= 1.0×10^{-5} seconds/cubic meter for releases from the 50 foot stack. Refer to Appendix B, 1.2.
= 6.59×10^{-3} seconds per cubic meter for releases other than from the 50 foot stack. Refer to Appendix B, 2.1.

Once the spent fuel pool is emptied, this source term and exposure pathway is no longer evaluated.

4.3.13 Tritium Vegetation Pathway Dose Calculation Methodology

The concentration of tritium is based on the airborne concentration rather than the deposition:

$$R_{Veg,\,H3} = \left(\chi/Q\right) \times \left(\frac{0.75 \times 0.5}{H}\right) \times U_T \times DF_a \qquad (4\text{-}4d)$$

where:

U_T = The total consumption rate of fruits and vegetables, kilogram/year. This parameter is given in Tables 4-6 and 4-7.

H = Absolute humidity of the atmosphere, 0.008 gm/m^3 per Regulatory Guide 1.109.

0.75 = The fraction of total feed that is water.

0.5 = The ratio of specific activity of H-3 in the feed grass to the specific activity in atmospheric water.

DF_a = The ingestion dose factor for H-3, for the receptor in age group (a), in mrem/pCi, from Tables 4-8 through 4-11.

χ/Q = The atmospheric dispersion parameter, seconds/cubic meter.
= 1.0×10^{-5} seconds/cubic meter for releases from the 50 foot stack. Refer to Appendix B, 1.2.
= 6.59×10^{-3} seconds per cubic meter for releases other than from the 50 foot stack. Refer to Appendix B, 2.1.

Once the spent fuel pool is emptied, this source term and exposure pathway is no longer evaluated.

Table 4-1
Inhalation Dose Factors for Adult Age Group
(mrem/pico-Curie inhaled)
Selected Nuclides from Regulatory Guide 1.109, Table E-7 and from NUREG/CR-4013

	Organ					
Nuclide	Bone	Liver	Total Body	Kidney	Lung	GI-LLI
H-3	No Data	1.58×10^{-7}	1.58×10^{-7}	1.58×10^{-7}	1.58×10^{-7}	1.58×10^{-7}
Co-60	No Data	1.44×10^{-6}	1.85×10^{-6}	No Data	7.46×10^{-4}	3.56×10^{-5}
Sr-90	1.24×10^{-2}	No Data	7.62×10^{-4}	No Data	1.20×10^{-3}	9.02×10^{-5}
Cs-137	5.98×10^{-5}	7.76×10^{-5}	5.35×10^{-5}	2.78×10^{-5}	9.40×10^{-6}	1.05×10^{-6}
Y-90	2.61×10^{-7}	No Data	7.01×10^{-9}	No Data	2.12×10^{-5}	6.32×10^{-5}
Pu-241	3.42×10^{-2}	8.69×10^{-3}	1.29×10^{-3}	5.93×10^{-3}	1.52×10^{-4}	8.65×10^{-7}
Gross α	1.68	1.13	7.75×10^{-2}	5.04×10^{-1}	1.82×10^{-1}	4.84×10^{-5}

Table 4-2
Inhalation Dose Factors for Teen Age Group
(mrem/pico-Curie inhaled)
Selected Nuclides from Regulatory Guide 1.109, Table E-8 and from NUREG/CR-4013

	Organ					
Nuclide	Bone	Liver	Total Body	Kidney	Lung	GI-LLI
H-3	No Data	1.59×10^{-7}	1.59×10^{-7}	1.59×10^{-7}	1.59×10^{-7}	1.59×10^{-7}
Co-60	No Data	1.89×10^{-6}	2.48×10^{-6}	No Data	1.09×10^{-3}	3.24×10^{-5}
Sr-90	1.35×10^{-2}	No Data	8.35×10^{-4}	No Data	2.06×10^{-3}	9.56×10^{-5}
Cs-137	8.38×10^{-5}	1.06×10^{-4}	3.89×10^{-5}	3.80×10^{-5}	1.51×10^{-5}	1.06×10^{-6}
Y-90	3.73×10^{-7}	No Data	1.00×10^{-8}	No Data	3.66×10^{-5}	6.99×10^{-5}
Pu-241	3.74×10^{-2}	9.56×10^{-3}	1.40×10^{-3}	6.47×10^{-3}	2.60×10^{-4}	9.17×10^{-7}
Gross α	1.77	1.20	8.05×10^{-2}	5.32×10^{-1}	3.12×10^{-1}	5.13×10^{-5}

Table 4-3
Inhalation Dose Factors for Child Age Group
(mrem/pico-Curie inhaled)
Selected Nuclides from Regulatory Guide 1.109, Table E-9 and from NUREG/CR-4013

	Organ					
Nuclide	Bone	Liver	Total Body	Kidney	Lung	GI-LLI
H-3	No Data	3.04×10^{-7}	3.04×10^{-7}	3.04×10^{-7}	3.04×10^{-7}	3.04×10^{-7}
Co-60	No Data	3.55×10^{-6}	6.12×10^{-6}	No Data	1.91×10^{-3}	2.60×10^{-5}
Sr-90	2.73×10^{-2}	No Data	1.74×10^{-3}	No Data	3.99×10^{-3}	9.28×10^{-5}
Cs-137	2.45×10^{-4}	2.23×10^{-4}	3.47×10^{-5}	7.63×10^{-5}	2.81×10^{-5}	9.78×10^{-7}
Y-90	1.11×10^{-6}	No Data	2.99×10^{-8}	No Data	7.07×10^{-5}	7.24×10^{-5}
Pu-241	7.94×10^{-2}	1.75×10^{-2}	2.93×10^{-3}	1.10×10^{-2}	5.06×10^{-4}	8.90×10^{-7}
Gross α	2.97	1.84	1.28×10^{-1}	7.63×10^{-1}	6.08×10^{-1}	4.98×10^{-5}

Table 4-4
Inhalation Dose Factors for Infant Age Group
(mrem/pico-Curie inhaled)
Selected Nuclides from Regulatory Guide 1.109, Table E-10 and from NUREG/CR-4013

	Organ					
Nuclide	Bone	Liver	Total Body	Kidney	Lung	GI-LLI
H-3	No Data	4.62×10^{-7}	4.62×10^{-7}	4.62×10^{-7}	4.62×10^{-7}	4.62×10^{-7}
Co-60	No Data	5.73×10^{-6}	8.41×10^{-6}	No Data	3.22×10^{-3}	2.28×10^{-5}
Sr-90	2.92×10^{-2}	No Data	1.85×10^{-3}	No Data	8.03×10^{-3}	9.36×10^{-5}
Cs-137	3.92×10^{-4}	4.37×10^{-4}	3.25×10^{-5}	1.23×10^{-4}	5.09×10^{-5}	9.53×10^{-7}
Y-90	2.35×10^{-6}	No Data	6.30×10^{-8}	No Data	1.92×10^{-4}	7.43×10^{-5}
Pu-241	8.43×10^{-2}	1.85×10^{-2}	3.11×10^{-3}	1.15×10^{-2}	7.62×10^{-4}	8.97×10^{-7}
Gross α	3.15	1.95	1.34×10^{-1}	7.94×10^{-1}	9.03×10^{-1}	5.02×10^{-5}

Table 4-5
External Dose Factors for Standing on Contaminated Ground
(mrem/hour per pico-Curie/square meter)
Selected Nuclides from Regulatory Guide 1.109, Table E-6

Nuclide	Total	
	Skin	Body
H-3	0	0
Co-60	2.00×10^{-8}	1.70×10^{-8}
Sr-90	2.60×10^{-12}	2.20×10^{-12}
Cs-137	4.90×10^{-9}	4.20×10^{-9}
Y-90	2.60×10^{-12}	2.20×10^{-12}

Values are not provided for Transuranic radionuclides, as their dose contribution to this pathway is negligible.

Table 4-6
Average Individual Foods Consumption for Various Age Groups
(kilo-gram/year or liters/year)
From Regulatory Guide 1.109, Table E-4

Age Group	Fish	Other Seafood (Invertebrates)	Fruits and Vegetables	Milk	Meat
Adult	6.9	1.0	190	110	95
Teen	5.2	0.75	240	200	59
Child	2.2	0.33	200	170	37
Infant	0	0	0	0	0

Table 4-7
Maximum Individual Foods Consumption for Various Age Groups
(kilo-gram/year or liters/year)
From Regulatory Guide 1.109, Table E-5

Age Group	Fish	Other Seafood (Invertebrates)	Fruits and Vegetables	Milk	Meat
Adult	21	5.0	520	310	110
Teen	16	3.8	630	400	65
Child	6.9	1.7	520	330	41
Infant	0	0	0	330	0

Table 4-8
Ingestion Dose Factors for Adult Age Group
(mrem/pico-Curie ingested)
Selected Nuclides from Regulatory Guide 1.109, Table E-11 and from NUREG/CR-4013

	Organ					
Nuclide	Bone	Liver	Total Body	Kidney	Lung	GI-LLI
H-3	No Data	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}	1.05×10^{-7}
Co-60	No Data	2.14×10^{-6}	4.72×10^{-6}	No Data	No Data	4.02×10^{-5}
Sr-90	7.58×10^{-3}	No Data	1.86×10^{-3}	No Data	No Data	2.19×10^{-4}
Cs-137	7.97×10^{-5}	1.09×10^{-4}	7.14×10^{-5}	3.70×10^{-5}	1.23×10^{-5}	2.11×10^{-6}
Y-90	9.62×10^{-9}	No Data	2.58×10^{-10}	No Data	No Data	1.02×10^{-4}
Pu-241	1.57×10^{-5}	7.45×10^{-7}	3.32×10^{-7}	1.53×10^{-6}	No Data	1.40×10^{-6}
Gross α	7.55×10^{-4}	7.05×10^{-4}	5.41×10^{-5}	4.07×10^{-4}	No Data	7.81×10^{-5}

Table 4-9
Ingestion Dose Factors for Teen Age Group
(mrem/pico-Curie ingested)
Selected Nuclides from Regulatory Guide 1.109, Table E-12 and from NUREG/CR-4013

	Organ					
Nuclide	Bone	Liver	Total Body	Kidney	Lung	GI-LLI
H-3	No Data	1.06×10^{-7}	1.06×10^{-7}	1.06×10^{-7}	1.06×10^{-7}	1.06×10^{-7}
Co-60	No Data	2.81×10^{-6}	6.33×10^{-6}	No Data	No Data	3.66×10^{-5}
Sr-90	8.30×10^{-3}	No Data	2.05×10^{-3}	No Data	No Data	2.33×10^{-4}
Cs-137	1.12×10^{-4}	1.49×10^{-4}	5.19×10^{-5}	5.07×10^{-5}	1.97×10^{-5}	2.12×10^{-6}
Y-90	1.37×10^{-8}	No Data	3.69×10^{-10}	No Data	No Data	1.13×10^{-4}
Pu-241	1.75×10^{-5}	8.40×10^{-7}	3.69×10^{-7}	1.71×10^{-6}	No Data	1.48×10^{-6}
Gross α	7.98×10^{-4}	7.53×10^{-4}	5.75×10^{-5}	4.31×10^{-4}	No Data	8.28×10^{-5}

Table 4-10
Ingestion Dose Factors for Child Age Group
(mrem/pico-Curie ingested)
Selected Nuclides from Regulatory Guide 1.109, Table E-13 and from NUREG/CR-4013

	Organ					
Nuclide	Bone	Liver	Total Body	Kidney	Lung	GI-LLI
H-3	No Data	2.03×10^{-7}	2.03×10^{-7}	2.03×10^{-7}	2.03×10^{-7}	2.03×10^{-7}
Co-60	No Data	5.29×10^{-6}	1.56×10^{-5}	No Data	No Data	2.93×10^{-5}
Sr-90	1.70×10^{-2}	No Data	4.31×10^{-3}	No Data	No Data	2.29×10^{-4}
Cs-137	3.27×10^{-4}	3.13×10^{-4}	4.62×10^{-5}	1.02×10^{-4}	3.67×10^{-5}	1.96×10^{-6}
Y-90	4.11×10^{-8}	No Data	1.10×10^{-9}	No Data	No Data	1.17×10^{-4}
Pu-241	3.87×10^{-5}	1.58×10^{-6}	8.04×10^{-7}	2.96×10^{-6}	No Data	1.44×10^{-6}
Gross α	1.36×10^{-3}	1.17×10^{-3}	1.02×10^{-4}	6.23×10^{-4}	No Data	8.03×10^{-5}

Table 4-11
Ingestion Dose Factors for Infant Age Group
(mrem/pico-Curie ingested)
Selected Nuclides from Regulatory Guide 1.109, Table E-14 and from NUREG/CR-4013

	Organ					
Nuclide	Bone	Liver	Total Body	Kidney	Lung	GI-LLI
H-3	No Data	3.08×10^{-7}	3.08×10^{-7}	3.08×10^{-7}	3.08×10^{-7}	3.08×10^{-7}
Co-60	No Data	1.08×10^{-5}	2.55×10^{-5}	No Data	No Data	2.57×10^{-5}
Sr-90	1.85×10^{-2}	No Data	4.71×10^{-3}	No Data	No Data	2.31×10^{-4}
Cs-137	5.22×10^{-4}	6.11×10^{-4}	4.33×10^{-5}	1.64×10^{-4}	6.64×10^{-5}	1.91×10^{-6}
Y-90	8.69×10^{-8}	No Data	2.33×10^{-9}	No Data	No Data	1.20×10^{-4}
Pu-241	4.25×10^{-5}	1.76×10^{-6}	8.82×10^{-7}	3.17×10^{-6}	No Data	1.45×10^{-6}
Gross α	1.46×10^{-3}	1.27×10^{-3}	1.09×10^{-4}	6.55×10^{-4}	No Data	8.10×10^{-5}

Table 4-12
Stable Element Transfer Data For Cow-Milk Pathway
(days/liter)
Selected Nuclides from Regulatory Guide 1.109, Table E-1 and from NUREG/CR-4013

Element	F_m
H	1.0×10^{-2}
Co	1.0×10^{-3}
Sr	8.0×10^{-4}
Cs	1.2×10^{-2}
Y	1.0×10^{-5}
Pu	5.0×10^{-6}
Gross α	5.0×10^{-6}

Table 4-13
Stable Element Transfer Data For Cow-Meat Pathway
(days/kilo-gram)
Selected Nuclides from Regulatory Guide 1.109, Table E-1 and from NUREG/CR-4013

Element	F_f
H	1.2×10^{-2}
Co	1.3×10^{-2}
Sr	6.0×10^{-4}
Cs	4.0×10^{-3}
Y	4.6×10^{-3}
Pu	2.0×10^{-4}
Gross α	2.0×10^{-4}

5.0 URANIUM FUEL CYCLE CUMULATIVE DOSE

5.1 WHOLE BODY DOSE

Specification 2.10 limits the whole body dose equivalent from the Uranium fuel to no more than 25 mrem/year. The whole body dose is determined by summing the calculated doses from the following:

a. Deleted

02/2020 b. Deleted. Modular HEPAs are no longer used.

c. Deleted. Tritium is no longer a gaseous effluent source term.

02/2020 d. Deleted. Liquid releases are no longer applicable.

02/2020 ### 5.2 SKIN DOSE

Specification 2.10 limits the dose to any organ (thyroid excepted) to less than or equal to 25 mrem/year. The dose to the skin is determined by summing the calculated doses from the following:

a. Deleted

02/2020 b. Deleted. Modular HEPAs are no longer used. Tritium is no longer a gaseous effluent source term.

02/2020 c. Deleted. Liquid releases are no longer applicable.

02/2020 d. Deleted. TLD stations are no longer monitored.

5.3 DOSE TO OTHER ORGANS

Specification 2.10 limits the dose to any organ (thyroid excepted) to less than or equal to 25 mrem/year. The dose to any individual other than skin organ is determined by summing the calculated doses from the following:

a. Deleted

02/2020 b. Deleted. Modular HEPAs are no longer used.

02/2020 c. Deleted. Liquid releases are no longer applicable.

02/2020 d. Deleted. TLD stations are no longer monitored.

5.4 DOSE TO THE THYROID

Specification 2.10 limits the dose to the thyroid to less than or equal to 75 mrem/year. Since Unit 3 has not operated since July 2, 1976, there is an insufficient radioactive iodine source term remaining onsite to approach this limit. Therefore, calculation of dose to the thyroid is not required.

6.0 PROCESS CONTROL PROGRAM FOR RADIOACTIVE WASTE REQUIRING SOLIDIFICATION

Deleted - Based on the status of decommissioning, HBPP no longer anticipates wastes exceeding a specific activity that is unacceptable to disposal site without solidification or exceeding Class A as defined in 10 CFR 61.

7.0 PROCESS CONTROL PROGRAM FOR RADIOACTIVE WASTE PACKAGED IN HIGH INTEGRITY CONTAINERS

Deleted - HBPP no longer anticipates wastes exceeding a specific activity that is unacceptable to disposal site without solidification or exceeding Class A as defined in 10 CFR 61. HBPP no longer anticipates disposal of wastes requiring stabilization in a High Integrity Container (HIC).

8.0 PROCESS CONTROL PROGRAM FOR LOW ACTIVITY DEWATERED RESINS AND OTHER WET WASTES

8.1 SCOPE

This section pertains to bead-type spent radioactive demineralizer resin, filters and other wet wastes shipped for land burial which contain a total specific activity less than the disposal site(s) criteria for solidification, and which does not exceed the concentration limits for Class A waste as defined in 10 CFR 61.

02/2020 8.2 Deleted – There are no dewatering systems or wet waste at HBPP

02/2020

9.0 PROGRAM CHANGES

02/2020 9.1 Deleted

9.2 CHANGES TO THE OFFSITE DOSE CALCULATION MANUAL

02/2020 Changes to the ODCM shall be reviewed and approved by the HB Director prior to implementation. Records of the reviews performed on change to the ODCM should be documented and retained for the duration of the possession only license.

9.3 HBPP is allowed to modify or reduce environmental requirements in the ODCM provided HBPP considers the modification or reduction from a technical and decommissioning

02/2020 perspective.

10.0 COMMITMENTS

10.1 HBPP does not intend to modify or reduce the environmental monitoring requirements as specified in the ODCM during the period of SAFSTOR and decommissioning activities. This applies to those environmental samples and analysis identified as either quality or non-quality samples. This commitment is to be incorporated into the next revision of the ODCM. NOTE: HBPP is allowed to modify or reduce environmental requirements in the ODCM provided HBPP considers the modification or reduction from a technical and decommissioning perspective.

11.0 RESPONSIBLE ORGANIZATION

Radiation Protection Manager

APPENDIX A

02/2020

Deleted

APPENDIX B

02/2020

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APPENDIX C

Deleted