

March 29, 2000

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

DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT
1999 ANNUAL RADIOACTIVE EFFLUENT RELEASE AND WASTE DISPOSAL
REPORT

The enclosed 1999 Annual Radioactive Effluent Release and Disposal Report for the Palisades Plant is submitted in accordance with 10 CFR 50.36a(a)(2) and Palisades Technical Specification 6.6.3.

This report provides a summary of the quantities of radioactive liquid and gaseous effluent releases and solid radioactive waste processed during the period of January 1, 1999, through December 31, 1999.

SUMMARY OF COMMITMENT

This letter contains no new commitments and no revisions to existing commitments.



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CC Administrator, Region III, USNRC
Project Manager, NRR, USNRC
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Enclosure

JE48

ENCLOSURE

**CONSUMERS ENERGY COMPANY
PALISADES PLANT
DOCKET 50-255**

**1999 ANNUAL RADIOACTIVE EFFLUENT RELEASE
AND WASTE DISPOSAL REPORT**

246 Pages

PALISADES NUCLEAR PLANT
ANNUAL RADIOACTIVE EFFLUENT RELEASE AND WASTE DISPOSAL REPORT

JANUARY - DECEMBER 1999

This report provides information relating to radioactive effluent releases and solid radioactive waste shipments at the Palisades Nuclear Plant during the period of January 1, 1999 through December 31, 1999. The report is required by 10 CFR 50.36a(a)(2) and Plant Technical Specification 6.6.3. The report format is detailed in the Offsite Dose Calculation Manual (ODCM) Appendix A.

Plant Operating History

Palisades remained in cold shutdown at the start of the year for maintenance, and was synchronized to the grid on January 8, 1999. The Plant was taken off line May 7, 1999, for scheduled maintenance, repairing PCP oil leak, PCP seal replacement, and tube cleaning/plugging of the main condenser. The Plant returned to service on May 18, 1999, and remained on-line until October 15, 1999, when it was taken off-line for refueling. On December 14, 1999, the Plant returned to service and remained in service for the remainder of 1999.

1. Supplemental Information

A. Batch Releases.

Information relating to batch release of gaseous and liquid effluents is provided in Attachment 1.

B. Abnormal releases.

None

C. Lower Limits of Detection (LLD's) for gaseous and liquid effluents are provided in Attachment 5.

D. Results of the 1999 Radiochemistry Cross Check Program with Analytics are shown in Attachment 6. All but two results (Cr-51) in the fourth quarter were in agreement. The two effected geometries are not utilized for sample analysis in the Radiological Effluent Release Program.

E. Radioactive Effluent Monitoring Instrumentation:

1. Service Water Monitor (RIA 0833), Out of Service For 69 days.

The ODCM, Appendix A, Table C-1 requires that when a radioactive liquid effluent monitoring instrument channel becomes inoperable, best efforts must be made to return the instrument to operable status within 30 days and, if unsuccessful, report the incident in the next Radioactive Effluent Release Report. The ODCM, Appendix A, Table C-1 further

stipulates that effluent releases via this pathway may continue to be made with less than the required amount of operable channels providing that, at least once per 24 hours, grab samples are collected and analyzed for radioactivity for principle gamma emitters and I-131.

On September 26, 1999, RIA-0833 was declared inoperable due to a downward trend of the background count rate. On September 28, 1999, RIA-0833 detector was removed from its well and found to be extremely corroded as a result of water intrusion into the sample well. Further trouble shooting on October 1, 1999, found the mother board non-functional, with no replacement in stock (WO#24912639).

On October 22, 1999, the replacement mother board was received. During setup, the new board would not perform functions properly. It was determined that the IC U93 (part of the count circuit) was inadvertently left out. This board was returned to the vendor and the entire readout was ordered.

On November 26, 1999, the new readout was received, and work began to configure it to match the old unit. Work was completed on December 2, 1999, and the unit was tested, calibrated and declared operational on December 4, 1999.

During this period of RIA-0833 inoperability, all of the ODCM 24 hour sampling and analysis requirements as stated in Table C-1 were met with one exception. On October 3, 1999, a sample was not collected within the 24 hour requirement; however, a subsequent representative sample (composite sample of the effluent pathway over the missing time period) was collected and analyzed with no activity detected.

2. Service Water Monitor (RIA 0833) Non-Conservative Alert and High Alarm Setpoints

In January, 2000, during a Self Assessment on Process Monitor setpoints, calculations determined that the alert and alarm setpoints have been set non-conservatively for RIA-0833 since December, 1992. This event is being documented in the 1999 report, since the alert and alarm setpoints were affected throughout this reporting period.

ODCM Appendix A Section III F (2a) required action with a radioactive liquid effluent monitoring instrument channel alarm/trip setpoint less conservative than required, without delay suspend the release of radioactive liquid effluents monitored by the affected channel or declare the channel inoperable, or change the setpoint so it is acceptably conservative.

Upon discovery (January 27, 2000), RIA-0833 was declared inoperable, and actions initiated to change the setpoints to the correct values. Setpoints were reset and the monitor returned to service on February 1, 2000. During this period of RIA-0833 inoperability, all of the ODCM 24 hour sampling and analysis requirements as stated in Table C-1 were met.

It should be noted that the Service Water System also has a continuous composite sampler that collects representative samples 24 hours per day. These composite samples are analyzed weekly for gamma emitters, and monthly for Tritium and gross beta. Since January 1, 1985, when the RETS requirements went into effect at Palisades, Radioactivity has never been detected in the Service Water Effluent pathway.

2. Gaseous Effluents

Attachment 2 lists and summarizes all gaseous radioactive effluents released during the reporting period. The unidentified beta was 4.48E-05% of the total release.

Gaseous effluents (noble gasses and iodines) released during 1999 were double that of the previous year. During mid-year the Plant experienced one rod failure in a second cycle fuel cell which contributed to the increased iodines. I-131 and I-133 Curies released increased over 70 % per quarter after the failed rod.

Approximately half the Gaseous Effluents were released during the first three weeks of the Refueling outage (in the fourth quarter). Purging the Containment Building and other outage activities resulted in 57% of the total noble gas release for 1999 (primarily Xe-133). While breaching the Primary System, and normal outage activities resulted in 43% of the I-131 annual release.

3. Liquid Effluents

Attachment 3 lists and summarizes all liquid radioactive effluents released during the reporting period. The unidentified beta was 5.69E-05 % of the total release.

No liquid batch releases occurred during the third quarter of 1999; therefore, the total release (not including tritium, and gases) was zero. Since only tritium was released in the third quarter, the resultant calculated organ dose was the same value as calculated for the whole body dose.

Overall dose from liquid effluents released during 1999 were slightly higher (25%) than those of 1998. 1999 liquid release volumes and total fission and activation Curies released were nearly identical to 1998 results. The major difference between the two years is the amount of dilution flow, which was much lower in 1999 due to an extended outage (flow) when upgrading dilution water pumps. This accounts for the effluent increase in 1999.

4. Estimate of Uncertainty

Both the Gaseous and Liquid Summation of Release data sheets include an estimate of the uncertainty associated with the measurement of radioactive effluents. These estimates are based on a statistical analysis of a series of sample results as described in the ODCM Appendix A. These results are listed in the Est Total Error % columns on the Gaseous and Liquid Summation Report.

5. Solid Waste

Attachment 4 summarizes all solid radwaste classification, sources, volume shipped, Curie and nuclide content. Radwaste shipments were made either to Barnwell Waste Management Facility in Barnwell, South Carolina, or to Envirocare of Utah, Inc. The 1999 waste volume and Curies shipped were greater in 1999 than that of the previous year. Volume increase was a result of the burial of approximately 3000 cubic feet of very low levels of contaminated soil, and secondary side resins. The Curie increase is a result of a shipment of irradiated hardware (incore wires) in 1999. This shipment contained 99.9% of the activity shipped to disposal facilities in 1999.

6. Summary of Radiological Impact on Man

Potential doses to individuals and populations were calculated using GASPAP and LADTAP computer program codes. The quarterly values for Curies released were input for each nuclide and summarized as follows:

- A. The maximum total body dose to an individual in unrestricted water-related exposure pathways was:

First Quarter -	1.60 E-03 millirem (adult)
Second Quarter-	1.52 E-03 millirem (adult)
Third Quarter -	1.44 E-07 millirem (adult)
Fourth Quarter -	1.71 E-03 millirem (adult).

The maximum organ doses were:

First Quarter -	2.50 E-03 millirem (teenage liver)
Second Quarter-	2.22 E-03 millirem (teenage liver)
Third Quarter -	1.44 E-07 millirem(adult)
Fourth Quarter -	2.67 E-03 millirem (teenage liver)

- B. The offsite air doses at the site boundary (0.48 SSE) due to noble gases were:

First Quarter -	3.26 E-04 millirad beta and 1.11 E-04 millirad gamma
Second Quarter -	8.81 E-04 millirad beta and 3.09 E-04 millirad gamma
Third Quarter -	2.66 E-04 millirad beta and 9.25 E-05 millirad gamma
Fourth Quarter -	2.65 E-03 millirad beta and 9.59 E-04 millirad gamma

The maximum noble gas offsite air dose to the nearest residence (0.50 mi S) for beta and gamma occurred during the fourth quarter, being 1.72 E-03 millirads beta and 6.25E-04 millirads for gamma.

- C. The most restrictive organ dose to an individual in an unrestricted area (based on identified critical receptors) from gaseous effluent releases were:

First Quarter -	3.96 E-03 millirem (child thyroid)
Second Quarter -	4.90 E-03 millirem (child thyroid)
Third Quarter -	4.70 E-03 millirem (child thyroid)
Fourth Quarter -	1.06 E-02 millirem (child thyroid)

- D. Integrated total body doses to the general population and average doses to individuals within the population from liquid effluent release pathways to a distance of 50-miles from the site boundary were:

First Quarter -	6.32 E-03 person-Rem and 5.45 E-06 millirem
Second Quarter-	6.25 E-03 person-Rem and 5.39 E-06 millirem
Third Quarter -	1.66 E-06 person-Rem and 1.43 E-09 millirem
Fourth Quarter -	6.89 E-03 person-Rem and 5.94 E-06 millirem.

- E. Integrated total body doses to the general population and average doses to individuals within the population from gaseous effluent release pathways to a distance of 50 miles from the site boundary were:

First Quarter -	1.17 E-02 person-Rem and 1.01 E-05 millirem
Second Quarter-	1.40 E-02 person-Rem and 1.20 E-05 millirem
Third Quarter -	1.30 E-02 person-Rem and 1.10 E-05 millirem
Fourth Quarter -	2.24 E-02 person-Rem and 1.93 E-05 millirem.

7. Process Control Program (PCP)

Attachment 7 contains Revision 7 of the Process Control Program, along with the safety evaluations. The PCP was entirely revised in 1999 to incorporate the use of a new Volume Reduction System, the RVR-200. The new system description and theory is detailed in the enclosed Attachment.

8. Offsite Dose Calculation Manual (ODCM)

Attachment 8 contains the ODCM, Revision 13, along with the safety evaluation per the requirements of Technical Specification 6.5.1.c.3.

There were several changes to the ODCM during this reporting period as a result of use of the 1998 Land Use Survey. The Land Use Survey is utilized to ensure that the impact of effluent dose is accurate. These changes (detailed in numbers 1-3 below) will maintain the level of radioactive effluent control required by 10 CFR 20.1301, 4 CFR Part 190, 10 CFR 50.36a, and Appendix I to 10 CFR Part 50 and do not affect any monitor or release set point calculations.

In addition, Attachment 8 also contains Revision 9 to the ODCM Appendix A "Relocated Technical Specifications Per NRC Generic Letter 89-01" (TAC NO 75060). During 1999 two revisions (8 & 9) were issued to ODCM Appendix A, but only Revision 9 will be included in the report. Changes (detailed in numbers 4-6 below) were made to Section III A and C. These changes do not effect radioactive effluent control, and do not effect any monitor or release set point calculations.

- 1) Update of Table 1.4, 1998 Palisades Land Use Census.
- 2) Update of Table 1.4a; 1998 Palisades Land Use Census - Critical Receptor Items.
- 3) Update of Table 1.9; 1999 Palisades Gaseous Design - Objective Annual Quantities.
- 4) Added "applicability column" to Table C-1, RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION to denote "For Effluent Releases" as the appropriate applicability for the Liquid Release Monitors (Rev 8).
- 5) Added note to Action 2 to clarify Steam Generator Blowdown Monitor action statement (Rev 8).
- 6) Removed surveillance requirements for FI-0632 on Table A-1, Radioactive Gaseous Effluent Monitoring Instrumentation. Brooks rotometer installed, never requires calibration (Rev 9).

ATTACHMENT 1

**CONSUMERS ENERGY COMPANY
PALISADES PLANT
DOCKET 50-255**

**RADIOACTIVE EFFLUENT RELEASE REPORT
BATCH RELEASES**

January - December 1999

TABLE HP 10.5-1

PALISADES PLANT RADIOACTIVE
EFFLUENT REPORT

BATCH RELEASES

January 1, 1999 to December 31, 1999

A. GASEOUS	Units	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Number of Releases		6	4	7	7
Total Release Time	Minutes	657	352	989	818
Maximum Release Time	Minutes	145	125	213	234
Average Release Time	Minutes	110	88	141	117
Minimum Release Time	Minutes	62	64	60	76

B. LIQUID	Units	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Number of Releases		1	1	0	1
Total Release Time	Minutes	512	557	N/A	468
Maximum Release Time	Minutes	512	557	N/A	468
Average Release Time	Minutes	512	557	N/A	468
Minimum Release Time	Minutes	512	557	N/A	468

ATTACHMENT 2

**CONSUMER ENERGY COMPANY
PALISADES PLANT
DOCKET 50-255**

**RADIOACTIVE EFFLUENT RELEASE REPORT
GASEOUS EFFLUENTS - SUMMATION OF RELEASES**

January - December 1999

3 Pages

TABLE HP 10.5-2

PALISADES PLANT RADIOACTIVE
EFFLUENT REPORT

GASEOUS EFFLUENTS - SUMMATION OF RELEASES

January 1, 1999 to December 31, 1999

A. FISSION AND ACTIVATION GASES	Units	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Est Total Error %
1. Total release	Ci	4.61E+00	1.22E+01	3.73E+00	3.55E+01	19.66
2. Average release rate for period	μCi/sec	5.93E-01	1.56E+00	4.70E-01	4.47E+00	
3. Percent of annual avg EC	%	2.54E-04	6.23E-04	2.23E-04	2.25E-03	
B. IODINES						
1. Total Iodine *	Ci	4.25E-04	7.21E-04	9.76E-04	1.75E-03	7.6
2. Average release rate for period	μCi/sec	5.47E-05	9.19E-05	1.23E-04	2.20E-04	
3. Percent of annual avg EC	%	2.85E-05	4.86E-05	5.78E-05	1.76E-04	
C. PARTICULATES						
1. Particulates with half-life > 8 days	Ci	5.97E-06	9.64E-06	9.52E-06	2.69E-05	12.9
2. Average release rate for period	μCi/sec	7.66E-07	1.23E-06	1.20E-06	3.38E-06	
3. Percent of annual avg EC	%	1.91E-05	3.66E-05	3.47E-05	3.48E-05	
4. Gross alpha radioactivity	Ci	6.43E-07	1.25E-06	1.43E-06	1.43E-06	
D. TRITIUM						
1. Total Release	Ci	3.35E+00	3.80E+00	3.58E+00	6.12E+00	
2. Average release rate for period	μCi/sec	4.31E-01	4.83E-01	4.50E-01	7.70E-01	
3. Percent of annual avg EC	%	9.17E-04	1.03E-03	9.57E-04	1.64E-03	
E.						
1. Beta Airdose at Site Boundary Due to Noble Gases (ODCM App A III.C)	mrads	3.26E-04	8.81E-04	2.66E-04	2.65E-03	
2. Percent limit	%	3.26E-03	8.81E-03	2.66E-03	2.65E-02	
3. Gamma Airdose at Site Boundary Due to Noble Gases (ODCM App A III.C)	mrads	1.11E-04	3.09E-04	9.25E-05	9.59E-04	
4. Percent limit	%	2.22E-03	6.18E-03	1.85E-03	1.92E-02	
F.						
1. Maximum Organ Dose to Public Based on Critical Receptors (ODCM App A III.D)	mrem	3.96E-03	4.90E-03	4.70E-03	1.06E-02	
2. Percent of limit	%	5.28E-02	6.53E-02	6.27E-02	1.41E-01	

*NOTE: Data is reported for I-131 and I-133 only.

TABLE HP 10.5-2

PALISADES PLANT RADIOACTIVE
EFFLUENT REPORT

GASEOUS EFFLUENTS

January 1, 1999 to December 31, 1999

1. FISSION GASES	Units	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Argon-41	Ci	<LLD	1.16E-03	1.62E-03	3.62E-04
Krypton-85	Ci	<LLD	<LLD	1.51E-02	3.54E-01
Krypton-85m	Ci	<LLD	6.20E-04	7.29E-04	1.20E-02
Krypton-87	Ci	<LLD	8.46E-04	1.47E-03	2.34E-04
Krypton-88	Ci	<LLD	<LLD	<LLD	<LLD
Xenon-131m	Ci	1.01E-02	7.40E-03	3.62E-03	1.64E-02
Xenon-133	Ci	4.59E+00	1.20E+01	3.68E+00	3.38E+01
Xenon-133m	Ci	9.27E-05	4.36E-02	<LLD	1.66E-01
Xenon-135	Ci	4.53E-03	1.60E-01	8.44E-03	1.18E+00
Xenon-135m	Ci	8.83E-03	1.25E-02	1.66E-02	2.54E-03
Xenon-138	Ci	<LLD	3.02E-03	4.76E-03	1.01E-03
Total for Period	Ci	4.61E+00	1.22E+01	3.73E+00	3.55E+01

2. IODINES					
Iodine-131	Ci	1.53E-04	2.68E-04	2.96E-04	1.21E-03
Iodine-132	Ci	<LLD	<LLD	<LLD	1.50E-03
Iodine-133	Ci	2.72E-04	4.53E-04	6.80E-04	5.37E-04
Iodine-134	Ci	<LLD	<LLD	<LLD	<LLD
Iodine-135	Ci	<LLD	<LLD	<LLD	5.84E-04
Total for Period	Ci	4.25E-04	7.21E-04	9.76E-04	3.83E-03

TABLE HP 10.5-2

**PALISADES PLANT RADIOACTIVE
EFFLUENT REPORT**

3. PARTICULATES*	Units	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Manganese-54	Ci	<LLD	<LLD	<LLD	<LLD
Cobalt-58	Ci	<LLD	<LLD	<LLD	4.82E-06
Iron-59	Ci	<LLD	<LLD	<LLD	<LLD
Cobalt-60	Ci	1.34E-06	<LLD	<LLD	<LLD
Zinc-65	Ci	<LLD	<LLD	<LLD	<LLD
Strontium-89	Ci	6.40E-07	9.25E-07	7.00E-07	8.35E-07
Strontium-90	Ci	4.75E-07	4.40E-07	4.45E-07	4.60E-07
Molybdenum-99	Ci	<LLD	<LLD	<LLD	<LLD
Cesium-134	Ci	<LLD	<LLD	<LLD	5.68E-06
Cesium-137	Ci	<LLD	7.00E-07	1.13E-06	8.26E-06
Cerium-141	Ci	<LLD	<LLD	<LLD	<LLD
Cerium-144	Ci	<LLD	<LLD	<LLD	<LLD
Net unidentified beta	Ci	3.51E-06	7.57E-06	7.24E-06	6.81E-06
Total		5.97E-06	9.64E-06	9.52E-06	2.69E-05

*Particulates with half-lives > 8 days.

ATTACHMENT 3

**CONSUMER ENERGY COMPANY
PALISADES PLANT
DOCKET 50-255**

**RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENTS - SUMMATION OF RELEASES**

January - December 1999

TABLE HP 10.5-3
PALISADES PLANT RADIOACTIVE
EFFLUENT REPORT

LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

January 1, 1999 to December 31, 1999

A. FISSION AND ACTIVATION PRODUCTS	Units	Ist Qtr	2nd Qtr	3rd Qtr	4th Qtr	Est Total Error %
1. Total release (not including tritium, gases, alpha)	Ci	7.07E-04	6.75E-04	0.000	6.10E-04	11.3
2. Average release rate for period	$\mu\text{Ci}/\text{ml}$	2.91E-11	2.81E-11	N/A	3.24E-11	
3. Percent of EC	%	2.85E-03	3.09E-03	N/A	2.99E-03	
B. TRITIUM						
1. Total Release	Ci	4.23E+01	5.03E+01	6.89E-02	4.09E+01	4.01
2. Average diluted concentration during period	$\mu\text{Ci}/\text{ml}$	1.74E-06	2.10E-06	2.75E-09	2.18E-06	
3. Percent of EC	%	1.74E-01	2.10E-01	2.75E-03	2.18E-01	
C. DISSOLVED AND ENTRAINED GASES						
1. Total Release	Ci	0.000	0.000	0.000	0.000	N/A
2. Average diluted concentration during period	$\mu\text{Ci}/\text{ml}$	N/A	N/A	N/A	N/A	
3. Percent of EC	%	N/A	N/A	N/A	N/A	
D. GROSS ALPHA RADIOACTIVITY (Total Release)	Ci	3.33E-07	2.43E-07	<LLD	2.14E-07	
E. VOLUME OF WASTE RELEASED (Prior to Dilution)	Liters	1.85E+05	1.87E+05	0.000	1.53E+05	
F. VOLUME OF DILUTION WATER USED DURING PERIOD	Liters	2.43E+10	2.40E+10	2.51E+10	1.88E+10	
G. MAXIMUM DOSE COMMITMENT - WHOLEBODY	mrem	1.60E-03	1.52E-03	1.44E-07	1.71E-03	
Percent of ODCM App A III.H limit	%	1.07E-01	1.01E-01	9.60E-06	1.14E-01	
H. MAXIMUM DOSE COMMITMENT - ORGAN	mrem	2.50E-03	2.22E-03	1.44E-07	2.67E-03	
Percent of ODCM App A III.H limit	%	5.00E-02	4.44E-02	2.88E-06	5.34E-02	

TABLE HP 10.5-3
PALISADES PLANT RADIOACTIVE
EFFLUENT REPORT

LIQUID EFFLUENTS
January 1, 1999 to December 31, 1999

1. NUCLIDES RELEASED	Units	Ist Qtr	2nd Qtr	3rd Qtr	4th Qtr
Manganese-54	Ci	<LLD	<LLD	<LLD	<LLD
Cobalt-58	Ci	<LLD	<LLD	<LLD	2.53E-05
Iron-59	Ci	<LLD	<LLD	<LLD	<LLD
Cobalt-60	Ci	4.17E-05	3.15E-05	<LLD	4.78E-05
Zirconium-95	Ci	<LLD	<LLD	<LLD	<LLD
Strontium-89	Ci	5.55E-07	6.55E-07	<LLD	6.89E-07
Strontium-90	Ci	3.33E-06	5.42E-07	<LLD	2.14E-06
Molybdenum-99	Ci	<LLD	<LLD	<LLD	<LLD
Iodine-131	Ci	<LLD	<LLD	<LLD	<LLD
Cesium-134	Ci	9.12E-05	9.82E-05	<LLD	6.53E-05
Cesium-137	Ci	5.70E-04	4.68E-04	<LLD	4.69E-04
Niobium-95	Ci	<LLD	<LLD	<LLD	<LLD
Silver-110m	Ci	<LLD	<LLD	<LLD	<LLD
Antimony-125	Ci	<LLD	<LLD	<LLD	<LLD
Net unidentified beta	Ci	<LLD	7.60E-05	<LLD	<LLD
Fission & Activation Product Total	Ci	7.07E-04	6.75E-04	<LLD	6.10E-04
Tritium	Ci	4.23E+01	5.03E+01	6.89E-02	4.09E+01
Grand Total	Ci	4.23E+01	5.03E+01	6.89E-02	4.09E+01

ATTACHMENT 4

**CONSUMER ENERGY COMPANY
PALISADES PLANT
DOCKET 50-255**

**RADIOACTIVE EFFLUENT RELEASE REPORT
SOLID WASTE**

January - December 1999

SOLID WASTE

January 1, 1999 To December 31, 1999

Waste Class	Source of Waste	Solidification Agent	Container Type	Volume (cu ft)	*Total Curies	*Principal Radionuclides
AU	DAW	N/A	LSA	2521.2	0.4	Co-60, Cs-137, Co-58, Cs-134, Mn-54, Fe-55, Cr-51, Ag-110m, Zr-95, Ce-144, Ni-63
AS	DAW	N/A	HIC	194.1	2.0	Same as above
AS	Evap Bottoms	N/A	HIC	256.0	0.8	Co-60, Cs-137, Co-58, Cs-134, Mn-54, Fe-55,
AU	Resins	N/A	Steel Liner	707.4	0.0	Cs-137, H-3, Cs-134
C	Irr Hardware	N/A	Steel Liner	14.6	4928.0	Co-60, Co-58, Mn-54, Fe-55, Ni-63, Ni-59
			TOTAL	3693.3	4931.2	

*NOTE: Gamma isotopes are measured quantities; all other isotopes are estimated.

ATTACHMENT 5

**CONSUMER ENERGY COMPANY
PALISADES PLANT
DOCKET 50-255**

**RADIOACTIVE EFFLUENT RELEASE REPORT
LOWER LIMITS OF DETECTION FOR PALISADES EFFLUENTS**

January - December 1999

LOWER LIMITS OF DETECTION (LLDs) FOR PALISADES EFFLUENTS

<u>Gaseous Effluents</u>	<u>Nuclide</u>	<u>LLD (uci/cc)*</u>
99-036-St 99-010-G	<u>Mn-54</u>	<u>2.38E-14</u>
	<u>Co-58</u>	<u>1.34E-14</u>
	<u>Fe-59</u>	<u>3.97E-14</u>
	<u>Co-60</u>	<u>3.80E-14</u>
	<u>Zn-65</u>	<u>3.67E-14</u>
	<u>Zr-95</u>	<u>3.92E-14</u>
	<u>Mo-99</u>	<u>1.00E-13</u>
	<u>I-131</u>	<u>1.73E-14</u>
	<u>I-133</u>	<u>2.34E-14</u>
	<u>Cs-134</u>	<u>2.29E-14</u>
	<u>Cs-137</u>	<u>2.78E-14</u>
	<u>Ce-141</u>	<u>1.63E-14</u>
	<u>Ce-144</u>	<u>7.46E-14</u>
	<u>Kr-87</u>	<u>7.80E-07</u>
	<u>Kr-88</u>	<u>1.02E-06</u>
	<u>Xe-133</u>	<u>7.50E-07</u>
	<u>Xe-133m</u>	<u>2.35E-06</u>
<u>Xe-135</u>	<u>2.43E-07</u>	
<u>Xe-138</u>	<u>4.37E-06</u>	

<u>Liquid Effluents</u>	<u>Nuclide</u>	<u>LLD (uci/ml)**</u>
Liquid Batch Release 99-001-R	<u>Mn-54</u>	<u>8.96E-08</u>
	<u>Fe-59</u>	<u>2.30E-07</u>
	<u>Co-58</u>	<u>9.44E-08</u>
	<u>Co-60</u>	<u>1.62E-07</u>
	<u>Zn-65</u>	<u>2.70E-07</u>
	<u>Mo-99</u>	<u>8.65E-06</u>
	<u>I-131</u>	<u>1.30E-07</u>
	<u>Cs-134</u>	<u>4.79E-08</u>
	<u>Cs-137</u>	<u>1.17E-07</u>
	<u>Ce-141</u>	<u>1.21E-07</u>
<u>Ce-144</u>	<u>5.18E-07</u>	

* From a typical Stack release analysis.

** From a typical Liquid release analysis.

ATTACHMENT 6

**CONSUMER ENERGY COMPANY
PALISADES PLANT
DOCKET 50-255**

**RADIOACTIVE EFFLUENT RELEASE REPORT
RESULTS OF 1999 RADIOCHEMISTRY CROSS CHECK PROGRAM**



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**RESULTS OF RADIOCHEMISTRY
CROSS CHECK PROGRAM**

CONSUMERS POWER COMPANY

PALISADES PLANT

First Quarter 1999

 4-12-99

Daniel M. Montgomery, QA Manager

SAMPLE	ANALYSIS	PALISADES	ANALYTICS	RATIO		
		VALUE	VALUE	PALISADES:	RESOLUTION	COMPARISON
		microCi/cc	microCi/cc	ANALYTICS		

A11589-66	Ce-141	1.66E-05	1.78E-05	0.93	20	AGREEMENT
SOLID	Cr-51	4.58E-05	4.42E-05	1.04	20	AGREEMENT
1000 ML	Cs-134	5.93E-06	6.60E-06	0.90	20	AGREEMENT
DETECTOR 1	Cs-137	1.34E-05	1.36E-05	0.99	20	AGREEMENT
	Mn-54	9.45E-06	9.15E-06	1.03	20	AGREEMENT
	Fe-59	7.31E-06	6.79E-06	1.08	20	AGREEMENT
	Zn-65	1.18E-05	1.19E-05	0.99	20	AGREEMENT
	Co-60	9.88E-06	1.03E-05	0.96	20	AGREEMENT

A11589-66	Ce-141	1.68E-05	1.78E-05	0.94	20	AGREEMENT
SOLID	Cr-51	4.31E-05	4.42E-05	0.98	20	AGREEMENT
1000 ML	Cs-134	6.06E-06	6.60E-06	0.92	20	AGREEMENT
DETECTOR 2	Cs-137	1.29E-05	1.36E-05	0.95	20	AGREEMENT
	Mn-54	9.09E-06	9.15E-06	0.99	20	AGREEMENT
	Fe-59	7.34E-06	6.79E-06	1.08	20	AGREEMENT
	Zn-65	1.24E-05	1.19E-05	1.04	20	AGREEMENT
	Co-60	1.05E-05	1.03E-05	1.02	20	AGREEMENT

A11589-66	Ce-141	1.63E-05	1.78E-05	0.91	20	AGREEMENT
SOLID	Cr-51	4.41E-05	4.42E-05	1.00	20	AGREEMENT
1000 ML	Cs-134	6.77E-06	6.60E-06	1.03	20	AGREEMENT
DETECTOR 3	Cs-137	1.36E-05	1.36E-05	1.00	20	AGREEMENT
	Mn-54	9.99E-06	9.15E-06	1.09	20	AGREEMENT
	Fe-59	6.92E-06	6.79E-06	1.02	20	AGREEMENT
	Zn-65	1.24E-05	1.19E-05	1.04	20	AGREEMENT
	Co-60	9.73E-06	1.03E-05	0.94	20	AGREEMENT

SAMPLE	ANALYSIS	PALISADES	ANALYTICS	RATIO		COMPARISON
		VALUE microCi/cc	VALUE microCi/cc	PALISADES: ANALYTICS	RESOLUTION	

A11590-66	Ce-141	4.39E-05	4.33E-05	1.01	20	AGREEMENT
SIMULATED	Cr-51	1.07E-04	1.07E-04	1.00	20	AGREEMENT
1000 ML	Cs-134	1.58E-05	1.60E-05	0.99	20	AGREEMENT
DETECTOR 1	Cs-137	3.36E-05	3.30E-05	1.02	20	AGREEMENT
	Mn-54	2.31E-05	2.22E-05	1.04	20	AGREEMENT
	Fe-59	1.75E-05	1.65E-05	1.06	20	AGREEMENT
	Zn-65	2.97E-05	2.90E-05	1.03	20	AGREEMENT
	Co-60	2.52E-05	2.51E-05	1.00	20	AGREEMENT

A11590-66	Ce-141	4.42E-05	4.33E-05	1.02	20	AGREEMENT
SIMULATED	Cr-51	1.08E-04	1.07E-04	1.01	20	AGREEMENT
1000 ML	Cs-134	1.54E-05	1.60E-05	0.96	20	AGREEMENT
DETECTOR 2	Cs-137	3.35E-05	3.30E-05	1.01	20	AGREEMENT
	Mn-54	2.35E-05	2.22E-05	1.06	20	AGREEMENT
	Fe-59	1.68E-05	1.65E-05	1.02	20	AGREEMENT
	Zn-65	2.91E-05	2.90E-05	1.00	20	AGREEMENT
	Co-60	2.44E-05	2.51E-05	0.97	20	AGREEMENT

A11590-66	Ce-141	4.27E-05	4.33E-05	0.99	20	AGREEMENT
SIMULATED	Cr-51	1.09E-04	1.07E-04	1.02	20	AGREEMENT
1000 ML	Cs-134	1.63E-05	1.60E-05	1.02	20	AGREEMENT
DETECTOR 3	Cs-137	3.39E-05	3.30E-05	1.03	20	AGREEMENT
	Mn-54	2.28E-05	2.22E-05	1.03	20	AGREEMENT
	Fe-59	1.78E-05	1.65E-05	1.08	20	AGREEMENT
	Zn-65	3.02E-05	2.90E-05	1.04	20	AGREEMENT
	Co-60	2.52E-05	2.51E-05	1.00	20	AGREEMENT

SAMPLE	ANALYSIS	PALISADES	ANALYTICS	RATIO		COMPARISON
		VALUE	VALUE	PALISADES:	RESOLUTION	
		microCi/cc	microCi/cc	ANALYTICS		

A11591-66	Ce-141	2.70E-04	2.76E-04	0.98	20	AGREEMENT
SOLID	Cr-51	6.88E-04	6.85E-04	1.00	20	AGREEMENT
50 ML	Cs-134	9.53E-05	1.02E-04	0.93	20	AGREEMENT
DETECTOR 1	Cs-137	2.09E-04	2.11E-04	0.99	20	AGREEMENT
	Mn-54	1.42E-04	1.42E-04	1.00	20	AGREEMENT
	Fe-59	1.09E-04	1.05E-04	1.04	20	AGREEMENT
	Zn-65	1.82E-04	1.85E-04	0.98	20	AGREEMENT
	Co-60	1.52E-04	1.60E-04	0.95	20	AGREEMENT

A11591-66	Ce-141	2.59E-04	2.76E-04	0.94	20	AGREEMENT
SOLID	Cr-51	6.29E-04	6.85E-04	0.92	20	AGREEMENT
50 ML	Cs-134	9.62E-05	1.02E-04	0.94	20	AGREEMENT
DETECTOR 2	Cs-137	2.06E-04	2.11E-04	0.98	20	AGREEMENT
	Mn-54	1.36E-04	1.42E-04	0.96	20	AGREEMENT
	Fe-59	1.08E-04	1.05E-04	1.03	20	AGREEMENT
	Zn-65	1.87E-04	1.85E-04	1.01	20	AGREEMENT
	Co-60	1.51E-04	1.60E-04	0.94	20	AGREEMENT

A11591-66	Ce-141	2.60E-04	2.76E-04	0.94	20	AGREEMENT
SOLID	Cr-51	6.66E-04	6.85E-04	0.97	20	AGREEMENT
50 ML	Cs-134	9.78E-05	1.02E-04	0.96	20	AGREEMENT
DETECTOR 3	Cs-137	2.08E-04	2.11E-04	0.99	20	AGREEMENT
	Mn-54	1.42E-04	1.42E-04	1.00	20	AGREEMENT
	Fe-59	1.05E-04	1.05E-04	1.00	20	AGREEMENT
	Zn-65	1.88E-04	1.85E-04	1.02	20	AGREEMENT
	Co-60	1.52E-04	1.60E-04	0.95	20	AGREEMENT

A11592-66	Gross Beta	9.74E-04	9.65E-04	1.01	17	AGREEMENT
LIQUID	#8428-01141					

A11592-66	Gross Beta	9.26E-04	9.65E-04	0.96	17	AGREEMENT
LIQUID	#PR101466					

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**RESULTS OF RADIOCHEMISTRY
CROSS CHECK PROGRAM**

CONSUMERS POWER COMPANY

PALISADES PLANT

Second Quarter 1999

 7-12-99
Daniel M. Montgomery, QA Manager

SAMPLE	ANALYSIS	PALISADES	ANALYTICS	RATIO		COMPARISON
		VALUE	VALUE	PALISADES:	RESOLUTION	
		microCi/cc	microCi/cc	ANALYTICS		

A11949-66	Ce-141	5.91E-02	5.99E-02	0.99	20	AGREEMENT
FILTER	Cr-51	8.67E-02	8.94E-02	0.97	20	AGREEMENT
DET. 1	Cs-134	1.59E-02	1.77E-02	0.90	20	AGREEMENT
	Cs-137	2.93E-02	2.81E-02	1.04	20	AGREEMENT
	Mn-54	1.48E-02	1.38E-02	1.07	20	AGREEMENT
	Fe-59	1.42E-02	1.35E-02	1.05	20	AGREEMENT
	Zn-65	2.15E-02	2.04E-02	1.05	20	AGREEMENT
	Co-60	3.13E-02	3.23E-02	0.97	20	AGREEMENT

A11949-66	Ce-141	5.82E-02	5.99E-02	0.97	20	AGREEMENT
FILTER	Cr-51	8.56E-02	8.94E-02	0.96	20	AGREEMENT
DET. 2	Cs-134	1.62E-02	1.77E-02	0.91	20	AGREEMENT
	Cs-137	2.93E-02	2.81E-02	1.04	20	AGREEMENT
	Mn-54	1.44E-02	1.38E-02	1.04	20	AGREEMENT
	Fe-59	1.36E-02	1.35E-02	1.01	20	AGREEMENT
	Zn-65	2.13E-02	2.04E-02	1.04	20	AGREEMENT
	Co-60	3.12E-02	3.23E-02	0.97	20	AGREEMENT

A11949-66	Ce-141	5.72E-02	5.99E-02	0.95	20	AGREEMENT
FILTER	Cr-51	8.58E-02	8.94E-02	0.96	20	AGREEMENT
DET. 3	Cs-134	1.64E-02	1.77E-02	0.92	20	AGREEMENT
	Cs-137	2.97E-02	2.81E-02	1.06	20	AGREEMENT
	Mn-54	1.47E-02	1.38E-02	1.06	20	AGREEMENT
	Fe-59	1.44E-02	1.35E-02	1.07	20	AGREEMENT
	Zn-65	2.16E-02	2.04E-02	1.06	20	AGREEMENT
	Co-60	3.16E-02	3.23E-02	0.98	20	AGREEMENT

SAMPLE	ANALYSIS	PALISADES	ANALYTICS	RATIO	RESOLUTION	COMPARISON
		VALUE microCi/cc	VALUE microCi/cc	PALISADES: ANALYTICS		

A11950-66	Ce-141	5.86E-02	6.15E-02	0.95	20	AGREEMENT
CHARCOAL	Cr-51	8.74E-02	9.17E-02	0.95	20	AGREEMENT
CARTRIDGE	Cs-134	1.62E-02	1.82E-02	0.89	20	AGREEMENT
DET. 1	Cs-137	2.92E-02	2.88E-02	1.01	20	AGREEMENT
	Mn-54	1.47E-02	1.42E-02	1.04	20	AGREEMENT
	Fe-59	1.50E-02	1.38E-02	1.09	20	AGREEMENT
	Zn-65	2.16E-02	2.09E-02	1.03	20	AGREEMENT
	Co-60	3.19E-02	3.31E-02	0.96	20	AGREEMENT

A11950-66	Ce-141	5.74E-02	6.15E-02	0.93	20	AGREEMENT
CHARCOAL	Cr-51	8.48E-02	9.17E-02	0.92	20	AGREEMENT
CARTRIDGE	Cs-134	1.60E-02	1.82E-02	0.88	20	AGREEMENT
DET. 2	Cs-137	2.77E-02	2.88E-02	0.96	20	AGREEMENT
	Mn-54	1.41E-02	1.42E-02	0.99	20	AGREEMENT
	Fe-59	1.38E-02	1.38E-02	1.00	20	AGREEMENT
	Zn-65	2.09E-02	2.09E-02	1.00	20	AGREEMENT
	Co-60	3.15E-02	3.31E-02	0.95	20	AGREEMENT

A11950-66	Ce-141	5.60E-02	6.15E-02	0.91	20	AGREEMENT
CHARCOAL	Cr-51	8.37E-02	9.17E-02	0.91	20	AGREEMENT
CARTRIDGE	Cs-134	1.56E-02	1.82E-02	0.86	20	AGREEMENT
DET. 3	Cs-137	2.73E-02	2.88E-02	0.95	20	AGREEMENT
	Mn-54	1.37E-02	1.42E-02	0.97	20	AGREEMENT
	Fe-59	1.36E-02	1.38E-02	0.98	20	AGREEMENT
	Zn-65	2.08E-02	2.09E-02	0.99	20	AGREEMENT
	Co-60	3.14E-02	3.31E-02	0.95	20	AGREEMENT

SAMPLE	ANALYSIS	PALISADES	ANALYTICS	RATIO		COMPARISON
		VALUE microCi/cc	VALUE microCi/cc	PALISADES: ANALYTICS	RESOLUTION	

A11951-66	Ce-141	4.01E-03	4.15E-03	0.97	20	AGREEMENT
SIMULATED	Cr-51	5.95E-03	6.18E-03	0.96	20	AGREEMENT
GAS	Cs-134	1.14E-03	1.23E-03	0.93	20	AGREEMENT
DET. 1	Cs-137	2.03E-03	1.95E-03	1.04	20	AGREEMENT
	Mn-54	1.02E-03	9.56E-04	1.07	20	AGREEMENT
	Fe-59	9.85E-04	9.32E-04	1.06	20	AGREEMENT
	Zn-65	1.49E-03	1.41E-03	1.06	20	AGREEMENT
	Co-60	2.20E-03	2.23E-03	0.98	20	AGREEMENT

A11951-66	Ce-141	4.04E-03	4.15E-03	0.97	20	AGREEMENT
SIMULATED	Cr-51	5.80E-03	6.18E-03	0.94	20	AGREEMENT
GAS	Cs-134	1.12E-03	1.23E-03	0.91	20	AGREEMENT
DET. 2	Cs-137	1.95E-03	1.95E-03	1.00	20	AGREEMENT
	Mn-54	9.66E-04	9.56E-04	1.01	20	AGREEMENT
	Fe-59	9.71E-04	9.32E-04	1.04	20	AGREEMENT
	Zn-65	1.46E-03	1.41E-03	1.03	20	AGREEMENT
	Co-60	2.17E-03	2.23E-03	0.97	20	AGREEMENT

A11951-66	Ce-141	4.10E-03	4.15E-03	0.99	20	AGREEMENT
SIMULATED	Cr-51	6.16E-03	6.18E-03	1.00	20	AGREEMENT
GAS	Cs-134	1.17E-03	1.23E-03	0.95	20	AGREEMENT
DET. 3	Cs-137	1.96E-03	1.95E-03	1.01	20	AGREEMENT
	Mn-54	9.70E-04	9.56E-04	1.01	20	AGREEMENT
	Fe-59	1.02E-03	9.32E-04	1.09	20	AGREEMENT
	Zn-65	1.46E-03	1.41E-03	1.03	20	AGREEMENT
	Co-60	2.25E-03	2.23E-03	1.01	20	AGREEMENT

A11952-66	Tritium	1.04E-03	9.67E-04	1.08	12.5	AGREEMENT
LIQUID						



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**RESULTS OF RADIOCHEMISTRY
CROSS CHECK PROGRAM
CONSUMERS POWERS COMPANY
PALISADES PLANT**

Third Quarter 1999

Daniel M. Montgomery, QA Manager

SAMPLE	ANALYSIS	PALISADES	ANALYTICS	RATIO	RESOLUTION	COMPARISON
		VALUE microCi/cc	VALUE microCi/cc	PALISADES: ANALYTICS		

A12233-66	Ce-141	6.95E-04	6.78E-04	1.03	20	AGREEMENT
SIMULATED	Cr-51	6.03E-04	5.94E-04	1.02	20	AGREEMENT
GAS	Cs-134	1.33E-04	1.43E-04	0.93	20	AGREEMENT
DET. 1	Cs-137	3.26E-04	3.12E-04	1.05	20	AGREEMENT
	Mn-54	2.92E-04	2.66E-04	1.10	20	AGREEMENT
	Fe-59	2.31E-04	2.07E-04	1.12	20	AGREEMENT
	Zn-65	2.88E-04	2.63E-04	1.09	20	AGREEMENT
	Co-60	1.97E-04	1.87E-04	1.05	20	AGREEMENT

A12233-66	Ce-141	6.36E-04	6.78E-04	0.94	20	AGREEMENT
SIMULATED	Cr-51	5.51E-04	5.94E-04	0.93	20	AGREEMENT
GAS	Cs-134	1.23E-04	1.43E-04	0.86	20	AGREEMENT
DET. 2	Cs-137	3.09E-04	3.12E-04	0.99	20	AGREEMENT
	Mn-54	2.63E-04	2.66E-04	0.99	20	AGREEMENT
	Fe-59	2.09E-04	2.07E-04	1.01	20	AGREEMENT
	Zn-65	2.60E-04	2.63E-04	0.99	20	AGREEMENT
	Co-60	1.80E-04	1.87E-04	0.96	20	AGREEMENT

A12233-66	Ce-141	7.01E-04	6.78E-04	1.03	20	AGREEMENT
SIMULATED	Cr-51	6.09E-04	5.94E-04	1.03	20	AGREEMENT
GAS	Cs-134	1.37E-04	1.43E-04	0.96	20	AGREEMENT
DET. 3	Cs-137	3.26E-04	3.12E-04	1.05	20	AGREEMENT
	Mn-54	2.97E-04	2.66E-04	1.12	20	AGREEMENT
	Fe-59	2.39E-04	2.07E-04	1.16	20	AGREEMENT
	Zn-65	2.92E-04	2.63E-04	1.11	20	AGREEMENT
	Co-60	2.01E-04	1.87E-04	1.07	20	AGREEMENT

SAMPLE	ANALYSIS	FALISADES	ANALYTICS	RATIO		COMPARISON
		VALUE microCi/cc	VALUE microCi/cc	FALISADES: ANALYTICS	RESOLUTION	

A12234-66	Ce-141	6.53E-05	6.84E-05	0.95	20	AGREEMENT
SAND	Cr-51	6.12E-05	5.99E-05	1.02	20	AGREEMENT
1 LITER	Cs-134	1.36E-05	1.45E-05	0.94	20	AGREEMENT
DET. 1	Cs-137	3.22E-05	3.15E-05	1.02	20	AGREEMENT
	Mn-54	2.72E-05	2.69E-05	1.01	20	AGREEMENT
	Fe-59	2.19E-05	2.09E-05	1.05	20	AGREEMENT
	Zn-65	2.67E-05	2.66E-05	1.00	20	AGREEMENT
	Co-60	1.90E-05	1.89E-05	1.01	20	AGREEMENT

A12234-66	Ce-141	6.44E-05	6.84E-05	0.94	20	AGREEMENT
SAND	Cr-51	5.48E-05	5.99E-05	0.91	20	AGREEMENT
1 LITER	Cs-134	1.37E-05	1.45E-05	0.95	20	AGREEMENT
DET. 2	Cs-137	3.09E-05	3.15E-05	0.98	20	AGREEMENT
	Mn-54	2.54E-05	2.69E-05	0.95	20	AGREEMENT
	Fe-59	2.08E-05	2.09E-05	1.00	20	AGREEMENT
	Zn-65	2.61E-05	2.66E-05	0.98	20	AGREEMENT
	Co-60	1.82E-05	1.89E-05	0.96	20	AGREEMENT

A12234-66	Ce-141	6.36E-05	6.84E-05	0.93	20	AGREEMENT
SAND	Cr-51	5.76E-05	5.99E-05	0.96	20	AGREEMENT
1 LITER	Cs-134	1.36E-05	1.45E-05	0.94	20	AGREEMENT
DET. 3	Cs-137	3.13E-05	3.15E-05	0.99	20	AGREEMENT
	Mn-54	2.69E-05	2.69E-05	1.00	20	AGREEMENT
	Fe-59	2.21E-05	2.09E-05	1.06	20	AGREEMENT
	Zn-65	2.68E-05	2.66E-05	1.01	20	AGREEMENT
	Co-60	1.90E-05	1.89E-05	1.01	20	AGREEMENT

SAMPLE	ANALYSIS	PALISADES VALUE microCi/cc	ANALYTICS VALUE microCi/cc	RATIO PALISADES: ANALYTICS	RESOLUTION	COMPARISON

A12235-66	Ce-141	6.80E-02	6.78E-02	1.00	20	AGREEMENT
CHARCOAL	Cr-51	5.98E-02	5.95E-02	1.01	20	AGREEMENT
CARTRIDGE	Cs-134	1.32E-02	1.44E-02	0.92	20	AGREEMENT
DET. 1	Cs-137	3.37E-02	3.12E-02	1.08	20	AGREEMENT
	Mn-54	2.89E-02	2.67E-02	1.08	20	AGREEMENT
	Fe-59	2.25E-02	2.07E-02	1.09	20	AGREEMENT
	Zn-65	2.80E-02	2.64E-02	1.06	20	AGREEMENT
	Co-60	1.88E-02	1.87E-02	1.00	20	AGREEMENT

A12235-66	Ce-141	6.42E-02	6.78E-02	0.95	20	AGREEMENT
CHARCOAL	Cr-51	5.72E-02	5.95E-02	0.96	20	AGREEMENT
CARTRIDGE	Cs-134	1.31E-02	1.44E-02	0.91	20	AGREEMENT
DET. 2	Cs-137	3.26E-02	3.12E-02	1.04	20	AGREEMENT
	Mn-54	2.76E-02	2.67E-02	1.04	20	AGREEMENT
	Fe-59	2.13E-02	2.07E-02	1.03	20	AGREEMENT
	Zn-65	2.72E-02	2.64E-02	1.03	20	AGREEMENT
	Co-60	1.80E-02	1.87E-02	0.96	20	AGREEMENT

A12235-66	Ce-141	6.79E-02	6.78E-02	1.00	20	AGREEMENT
CHARCOAL	Cr-51	5.94E-02	5.95E-02	1.00	20	AGREEMENT
CARTRIDGE	Cs-134	1.36E-02	1.44E-02	0.95	20	AGREEMENT
DET. 3	Cs-137	3.31E-02	3.12E-02	1.06	20	AGREEMENT
	Mn-54	2.84E-02	2.67E-02	1.07	20	AGREEMENT
	Fe-59	2.30E-02	2.07E-02	1.11	20	AGREEMENT
	Zn-65	2.84E-02	2.64E-02	1.08	20	AGREEMENT
	Co-60	1.96E-02	1.87E-02	1.05	20	AGREEMENT

A12236-66	Cs-137	6.06E-02	6.12E-02	0.99	17	AGREEMENT
SOLID						
DET. 102764						

A12236-65	Cs-137	6.08E-02	6.12E-02	0.99	17	AGREEMENT
SOLID						
DET. 8428-01130						

ANALYTICS

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30316 · U.S.A.

Phone (404) 352-8677
Fax (404) 352-2837

RESULTS OF RADIOCHEMISTRY

CROSS CHECK PROGRAM

CONSUMERS POWER COMPANY

PALISADES PLANT

Fourth Quarter 1999

 7/13-00
Daniel M. Montgomery, QA Manager

Post-It Fax Note	7671	Date	3/20	# of pages	3
To	Mike Sullivan	From	Doren		
Co./Dept		Co.			
Phone #		Phone #			
Fax #	616-769-2273	Fax #			

SAMPLE	ANALYSIS	PALISADES	ANALYTICS	RATIO		COMPARISON
		VALUE	VALUE	PALISADES:	RESOLUTION	
		microCi/cc	microCi/cc	ANALYTICS		

A12551-66	Ce-141	6.04E-04	7.85E-04	0.77	20	AGREEMENT
SOLID	Cr-51	2.21E-03	2.39E-03	0.92	20	AGREEMENT
DET. 1	Cs-134	5.51E-04	5.35E-04	1.03	20	AGREEMENT
	Cs-137	4.34E-04	4.04E-04	1.08	20	AGREEMENT
	Co-58	6.30E-04	5.98E-04	1.05	20	AGREEMENT
	Mn-54	4.85E-04	4.46E-04	1.09	20	AGREEMENT
	Fe-59	7.46E-04	6.00E-04	1.24	20	AGREEMENT
	Zn-65	8.58E-04	8.41E-04	1.02	20	AGREEMENT
	Co-60	5.10E-04	5.57E-04	0.92	20	AGREEMENT

A12551-66	Ce-141	6.95E-04	7.85E-04	0.89	20	AGREEMENT
SOLID	Cr-51	3.78E-03	2.39E-03	1.58	20	DISAGREEMENT
DET. 2	Cs-134	5.36E-04	5.35E-04	1.00	20	AGREEMENT
	Cs-137	4.08E-04	4.04E-04	1.01	20	AGREEMENT
	Co-58	5.23E-04	5.98E-04	0.87	20	AGREEMENT
	Mn-54	4.74E-04	4.46E-04	1.06	20	AGREEMENT
	Fe-59	7.00E-04	6.00E-04	1.17	20	AGREEMENT
	Zn-65	8.15E-04	8.41E-04	0.97	20	AGREEMENT
	Co-60	5.19E-04	5.57E-04	0.93	20	AGREEMENT

A12551-66	Ce-141	7.79E-04	7.85E-04	0.99	20	AGREEMENT
SOLID	Cr-51	3.23E-03	2.39E-03	1.35	20	DISAGREEMENT
DET. 3	Cs-134	5.48E-04	5.35E-04	1.02	20	AGREEMENT
	Cs-137	4.43E-04	4.04E-04	1.10	20	AGREEMENT
	Co-58	6.97E-04	5.98E-04	1.16	20	AGREEMENT
	Mn-54	4.92E-04	4.46E-04	1.10	20	AGREEMENT
	Fe-59	6.46E-04	6.00E-04	1.08	20	AGREEMENT
	Zn-65	8.65E-04	8.41E-04	1.03	20	AGREEMENT
	Co-60	5.53E-04	5.57E-04	0.99	20	AGREEMENT

SAMPLE ANALYSIS
ANALYSIS
microct/cc
microct/cc
ANALYTICS
VALDE
ANALYTICS
RATIO
PATISADES:
ANALYTICS
RESOLUTION
COMPARISON

A12550-66	CHARCOAL	CA-141	3.02E-02	3.18E-02	0.95	20	AGREEMENT
		CR-51	9.61E-02	9.68E-02	0.99	20	AGREEMENT
	CARRIDGE	CA-134	1.97E-02	2.17E-02	0.91	20	AGREEMENT
		CA-137	1.72E-02	1.63E-02	1.05	20	AGREEMENT
		CO-58	2.49E-02	2.42E-02	1.03	20	AGREEMENT
		Mn-54	1.94E-02	1.81E-02	1.07	20	AGREEMENT
		Fe-59	2.60E-02	2.43E-02	1.07	20	AGREEMENT
		Zn-65	3.63E-02	3.41E-02	1.07	20	AGREEMENT
		CO-60	2.27E-02	2.25E-02	1.01	20	AGREEMENT

A12550-66	CHARCOAL	CA-141	3.02E-02	3.18E-02	0.95	20	AGREEMENT
		CR-51	9.38E-02	9.68E-02	0.97	20	AGREEMENT
	CARRIDGE	CA-134	2.02E-02	2.17E-02	0.93	20	AGREEMENT
		CA-137	1.71E-02	1.63E-02	1.05	20	AGREEMENT
		CO-58	2.47E-02	2.42E-02	1.02	20	AGREEMENT
		Mn-54	1.90E-02	1.81E-02	1.05	20	AGREEMENT
		Fe-59	2.59E-02	2.43E-02	1.07	20	AGREEMENT
		Zn-65	3.50E-02	3.41E-02	1.03	20	AGREEMENT
		CO-60	2.22E-02	2.25E-02	0.98	20	AGREEMENT

A12550-66	CHARCOAL	CA-141	2.78E-02	3.18E-02	0.88	20	AGREEMENT
		CR-51	8.97E-02	9.68E-02	0.93	20	AGREEMENT
	CARRIDGE	CA-134	1.79E-02	2.17E-02	0.83	20	AGREEMENT
		CA-137	1.49E-02	1.63E-02	0.91	20	AGREEMENT
		CO-58	2.18E-02	2.42E-02	0.90	20	AGREEMENT
		Mn-54	1.70E-02	1.81E-02	0.94	20	AGREEMENT
		Fe-59	2.44E-02	2.43E-02	1.00	20	AGREEMENT
		Zn-65	3.29E-02	3.41E-02	0.97	20	AGREEMENT
		CO-60	2.17E-02	2.25E-02	0.96	20	AGREEMENT

ATTACHMENT 7

**CONSUMER ENERGY COMPANY
PALISADES PLANT
DOCKET 50-255**

**RADIOACTIVE EFFLUENT RELEASE REPORT
PROCESS CONTROL PROGRAM (PCP)**

Consumers Energy
Palisades Nuclear Plant

PROCESS CONTROL PROGRAM (PCP)

Approved

Elizabeth A. Byrne
Radiological Services Mgr

4/28/99
Date

A. Bowen
Technical Review

4/28/99
Date

JS Erickson SDR - 99-0138
Plant Review Committee

3-26-99
Date

Periodic Review

Date

Paul R...
Plant General Manager

4/28/99
Date

P PROCESSE D

MAY 03 1999

**PALISADES NUCLEAR PLANT
10CFR50.59 SAFETY REVIEW**

Proc No 3.07
Attachment 1
Revision 9
Page 1 of 1

Log No SDR- 99-013B

Item Identification: No PROGRAM (PCP) Rev 7 Title PROCESS CONTROL

Describe Issue/Change: Added description for RVR-200 system

Reason for Issue/Change: System made permanent

	Yes	No
1. Does the item involve a change to procedures as described in the FSAR? FSAR Sections affected <u>None</u> FSAR Sections reviewed <u>* Section 11</u>		✓
2. Does the item involve a change to the facility as described or implied in the FSAR? FSAR Sections affected <u>Section 11</u> FSAR Sections reviewed <u>* Section 11</u>	X	
3. Does the item involve a test or experiment not described in the FSAR? FSAR Sections affected <u>None</u> FSAR Sections reviewed <u>* Section 11</u>		✓
4. Should the Technical Specifications or any of their Bases be changed in conjunction with this item? TS Sections affected <u>Process control program</u> TS Sections reviewed <u>TS 60, ODCM, PCP</u>	XXXX	✓

If any Safety Review question listed above is answered "YES," perform a written USQ Evaluation. Justify "NO" answers below if logic is not obvious:

* See 98-1480 and 98-00349. Safety evaluation 98-1480 evaluated the installation of the RVR-200 system and provides sufficient justification for the changes made to the Process Control Program.

NOTE: DBD change requests shall be processed in accordance with Administrative Procedure 3.15.

DBD Sections Reviewed See 98-1480, 98-00349 Affected *

NOTE: SDR forwards a copy of all changes potentially affecting proposed Improved Technical Specifications to the Licensing Dept.

Proposed ITS & Bases Reviewed 5.0 Affected None

This attachment shall accompany other review materials for the item to document whether or not a USQ Evaluation was required.

JPM

J-99

Quicker

12/20/99

**PALISADES NUCLEAR PLANT
10CFR50.59 SAFETY REVIEW**

Proc No 3.07
Attachment 2
Revision 8
Page 1 of 1

PS&L Log No 98-00349

Item Identification: No <u>SC 97-024</u> Rev <u>0</u> Title <u>Removal of M-24 Auxiliary Boiler, M-25 Isolated Cooling Water System, P-111 Asphalt Recirculation Pump, T-111 Asphalt Storage Tank</u>		SE REV 0
Describe Issue/Change: <u>Removal of M-24 Auxiliary Boiler, M-25 Isolated Cooling Water, P-111 Asphalt Recirculation Pump, T-111 Asphalt Storage Tank and associated equipment.</u>		
Reason for Issue/Change: <u>Create usable floor space for permanent installation of RVR-200 System and short term facility storage.</u>		
1. Does the item involve a change to procedures as described in the FSAR? FSAR Sections affected <u>NONE</u> FSAR Sections reviewed <u>Sect. 1.2, 1.5, 9.6.3.1, 9.8, 10.2.3, 11.1, 11.2, 11.3, 11.4, 11.5, 11.6.5.1.7.1, 9.8.2.4.27.c, 14.10, 14.21, table 9-1, 5.9.5.1, Tables 5.2-2, Table 5.2-3</u>	Yes -	No X
2. Does the item involve a change to the facility as described or implied in the FSAR? FSAR Sections affected <u>Sect. 11.4.2.5, 1.5, 5.1.7, 11.4.1, 11.4.2.4, 11.4.4, 11.4.5, Table 11-14, Figure 1-5, Figure 1-22, Figure 8-8, Figure 11-4 pages 2.3.4A, 4B, 4C & 5</u> FSAR Sections reviewed <u>Sect. 1.2, 1.5, 9.6.3.1, 9.8, 10.2.3, 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 5.1.7.1, 9.8.2.4.27.c, table 9-1, 5.9.5.1, Table 11-14, Figure 1-5, Figure 1-22, Figure 8-8, Figure 11-4 pages 2.3.4A, 4B, 4C & 5, Tables 5.2-2, Table 5.2-3</u> DBD Sections reviewed <u>DBD 1.02, 1.07, 3.05, 7.02, 7.08</u>	X	-
3. Does the item involve a test or experiment not described in the FSAR? FSAR Sections affected <u>NONE</u> FSAR Sections reviewed <u>Sect. 1.2, 1.5, 9.6.3.1, 9.8, 10.2.3, 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, Chap. 5, 9</u> DBD Sections reviewed <u>DBD 1.02, 1.07, 3.05, 7.02, 7.08</u>	-	X
4. Should the Technical Specifications or any of their Bases be changed in conjunction with this item? T.S. Sections affected <u>None</u> T.S. Sections reviewed <u>6.5.1 and the ODCM</u>	-	X
Justify "NO" answers below if logic is not obvious: A search was performed on the ZYFIND index utilizing keywords: radwaste, solidification, volume reduction system and VRS.		
If any Safety Review question listed above is answered "YES," perform a written USQ Evaluation according to Section 5.3.		
If all Safety Review questions listed above are answered "NO," written USQ Evaluation is not required. However, this attachment shall accompany other review materials for the item to document that a Safety Evaluation was not required.		
Richard Bischoff / Robert L. Ransom (Duke) <i>Richard A. Bischoff</i> 4/15/98 <i>Robert L. Ransom</i> 12/15/98 Prepared By _____ Date _____	_____ 14/24/98 Reviewed By _____ Date _____	

**PALISADES NUCLEAR PLANT
10CFR50.59 SAFETY REVIEW**

Proc No 3.07
Attachment 2
Revision 8
Page 1 of 1

PS&L Log No 98-00349

Item Identification: No SC 97-024 Rev 0 Title Removal of M-24 Auxiliary Boiler, M-25 Isolated Cooling Water System, P-111 Asphalt Recirculation Pump, T-111 Asphalt Storage Tank

SECTION I

1. Will the probability of an accident previously evaluated in the FSAR be increased?
2. Will the consequences of an accident previously evaluated in the FSAR be increased?
3. Will the probability of malfunctions of equipment important to safety previously evaluated in the FSAR be increased?
4. Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?
5. Will the possibility of an accident of a different type than any previously evaluated in the FSAR be created?
6. Will the possibility of a malfunction of a different type than any previously evaluated in the FSAR be created?
7. Will the margin of safety as defined by Plant Licensing Bases be reduced?

Yes	No
	✓
	✓
	✓
	✓
	✓
	✓
	✓

A written Safety Analysis which documents the bases for these answers shall accompany this form. If any of the above questions are answered "YES," an unreviewed safety question is involved and the item shall not be implemented without prior NRC concurrence.

SECTION II

1. Should this be included in an FSAR update?
2. Is an application for amendment to the Palisades Operating License required?
3. Is NRC approval required prior to implementation of this item?

Yes	No
✓	
	✓
	✓

SECTION III

Richard Bischoff / Robert L. Ransom (Duke)
Robert L. Ransom 2/16/98
Richard A. Bischoff 2-16-98
 Prepared By Date

Bischoff 14/24/98
 Reviewed By Date

PS&L Log No _____

Item Identification: No SC97-024 Rev 0 Title Removal of M-24 Auxiliary Boiler, M-25 Isolated Cooling Water System, P-111 Asphalt Recirculation Pump, T-111 Asphalt Storage Tank

Page 1 of 2

General Description of Modification:

The current, permanent radwaste Volume Reduction and Solidification System (VRS) is an asphalt extruder/evaporator system that has not been in use for several years due to reliability. A temporary radwaste processing unit, RVR-200, has been acquired from Molten Metal Technologies (MMT), Inc. as a replacement process, and currently used to process solid waste via TM 96-032, DCR 96-614. Specification Change 97-024 will remove and/or abandon-in-place portions of the current VRS making way for the permanent installation of the RVR 200 (ref. SC 98-003).

1&2. Will the probability or consequences of an accident previously evaluated in the FSAR be increased?

The physical removal of the Asphalt Volume Reduction System (VRS) will not affect any safety related equipment whose malfunction is postulated in the FSAR to initiate an accident. The removal of the VRS from service and the temporary installation / operation of the RVR200 system is addressed in PS&L Log No. 96-1003. FSAR Section 14.20, addresses the Liquid Radwaste Incident of the radwaste system. Removal of the VRS system components, which are out of service, will not change the consequences of the Section 14.20 analysis. Therefore, the probability or consequences of an accident previously evaluated in the FSAR will not be increased.

3&4. Will the probability or consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?

The removal of the non-safety related VRS system components, which are non-operational, will not impact any safety related equipment. Therefore, the probability or consequences of a malfunction of equipment important to safety previously evaluated in the FSAR will not be increased.

PS&L Log No _____

Item Identification: No SC97-024 Rev 0 Title Removal of M-21 Auxiliary Boiler, M-25 Isolated Cooling Water System, P-111 Asphalt Recirculation Pump, T-111 Asphalt Storage Tank

Page 2 of 2

5&6. Will the possibility of an accident or malfunction of a different type than any previously evaluated in the FSAR be created?

The physical removal of the non-safety related VRS system components, will not impact any operating safety related systems. The equipment will be removed utilizing normal work procedures and radiological protection as assigned by the Health Physics Group.

FSAR section 11.4.1 references IE Circular No. 80-18 which references Reg Guide 1.143. The Reg Guide Section C, Par. 3.1.3 states that the foundations and adjacent walls housing the solid radwaste system should be designed to the seismic criteria to a height sufficient to contain the maximum liquid inventory expected to be in the building. Room 759 of the Auxiliary Bldg. Addition houses the Asphalt Tank within a flood barrier for the containment of the tank volume. Since the Asphalt Tank is being removed the surrounding flood barrier is no longer necessary. To facilitate tank removal, a new service door will be installed at grade along with the existing passage way door lowered to grade level.

In addition, FSAR Section 11.4.1 states that the Auxiliary Building Radwaste Addition, is a CPCo Design Class 1 structure. The upper portion of Room 759 is not a seismic structure, but adjacent portions of the building are built to withstand a seismic event. The removal of the asphalt tank, the addition of a service entrance lowered to grade level will not adversely impact the seismic design of the building.

Therefore, the possibility of an accident or malfunction of a different type than any previously evaluated in the FSAR will not be created.

7. Will the margin of safety as defined by Plant Licensing Bases be reduced?

The physical removal of the non-safety related VRS system components, which are not operational, will not impact or degrade the function/operation of any safety related systems and their abilities to mitigate an accident postulated in the FSAR. Therefore, the margin of safety as defined in the plant licensing bases can not be reduced.

**PALISADES NUCLEAR PLANT
10CFR50.59 SAFETY REVIEW**

Proc No 3.07
Attachment 1
Revision 9
Page 1 of 8

Log No SDR- 98-1480

Item Identification: No <u>SC 98-003</u> Rev <u>0</u> Title <u>Installation of Vectra RVR-200 Radwaste Solidification Skid.</u>											
Describe Issue/Change: <u>Make permanent tie-in of the electrical and mechanical services to the Vectra RVR-200 Skid for the continued long term processing of radioactive waste.</u>											
Reason for Issue/Change: <u>The time limit permitted for the temp mod has been exceeded. The Temp Mod was to have been removed during the REFOUT 98. Removal of TM 96-032 via SC 98-003 will make the electrical and mechanical connections permanent for the RVR-200.</u>											
<p>1. Does the item involve a change to procedures as described in the FSAR? FSAR Sections affected <u>NONE</u> FSAR Sections reviewed <u>Sect. 1.2, 1.5, 5.2, 5.7.3.3, 5.9.5.1, 8.3.1.2, 8.3.3.2, 8.4.1.2, 8.5.3.1, 9.1.2.3.2, 9.6.1.2, 9.6.3.1, 9.8.2.4.27, 10.2.3, 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 14.10, 14.20, 14.21</u></p> <p>2. Does the item involve a change to the facility as described or implied in the FSAR? FSAR Sections affected <u>Sect. 1.5, 5.1.7, 11.4.1, 11.4.2.4, 11.4.2.5, 11.4.4, 11.4.5, 5.1.7, Fig.(s) 1-5, 1-22, 8-8, 9-18, 11-4 Sht.(s) 1.2.4B.5, Tables 11-14.9-1</u> FSAR Sections reviewed <u>Sect. 1.2, 5.2, 5.7.3.3, 5.9.5.1, 8.4.1.2, 8.3.1.2, 8.3.2.2, 8.3.3.2, 8.5.3.1, 9.1.2.3.2, 9.6.1.2, 9.6.3.1, 9.8.2.4.27, 10.2.3, 11.1, 11.2, 11.3, 11.4.6, 11.5, 11.6, 14.20, Tables 5.2-2, 5.2-3, 9.17, 9-19, Fig.(s) 11-4, 11-4 Sht.(s) 3.4A, 4C & 5, 1-18, 1-23</u></p> <p>3. Does the item involve a test or experiment not described in the FSAR? FSAR Sections affected <u>NONE</u> FSAR Sections reviewed <u>Sect. 1.2, 1.5, 9.6.3.1, 9.8, 10.2.3, 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, Chap. 5 & 9</u></p> <p>4. Should the Technical Specifications or any of their Bases be changed in conjunction with this item? TS Sections affected <u>NONE</u> TS Sections reviewed <u>ZyFind Search, 3.0, 4.0, 5.0, 6.0</u></p>	<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th style="width:50%;">Yes</th> <th style="width:50%;">No</th> </tr> <tr> <td align="center"><input type="checkbox"/></td> <td align="center"><input checked="" type="checkbox"/></td> </tr> <tr> <td align="center"><input checked="" type="checkbox"/></td> <td align="center"><input type="checkbox"/></td> </tr> <tr> <td align="center"><input type="checkbox"/></td> <td align="center"><input checked="" type="checkbox"/></td> </tr> <tr> <td align="center"><input type="checkbox"/></td> <td align="center"><input checked="" type="checkbox"/></td> </tr> </table>	Yes	No	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Yes	No										
<input type="checkbox"/>	<input checked="" type="checkbox"/>										
<input checked="" type="checkbox"/>	<input type="checkbox"/>										
<input type="checkbox"/>	<input checked="" type="checkbox"/>										
<input type="checkbox"/>	<input checked="" type="checkbox"/>										
If any Safety Review question listed above is answered "YES," perform a written USQ Evaluation. Justify "NO" answers below if logic is not obvious:											
NOTE: DBD change requests shall be processed in accordance with Administrative Procedure 3.15.											
DBD Sections Reviewed <u>DBD 1.02, 1.07, 3.05, 7.02, 7.08</u> Affected <u>DBD 1.02, 1.07</u>											
NOTE: SDR forwards a copy of all changes potentially affecting proposed Improved Technical Specifications to the Licensing Dept.											
Proposed ITS & Bases Reviewed <u>ODCM App. A & B</u> Affected <u>None</u>											
This attachment shall accompany other review materials for the item to document whether or not a USQ Evaluation was required.											
<p><i>Robert L. Larson</i> Prepared by</p> <p align="right"><u>12/25/98</u> Date</p>	<p align="center"><i>Bricker</i> Reviewed by</p> <p align="right"><u>12/21/98</u> Date</p>										

**PALISADES NUCLEAR PLANT
10CFR50.59 SAFETY REVIEW**

Proc No 3.07
Attachment 1
Revision 9
Page 2 of 8

Log No SDR- 98- 1480

Item Identification: No SC 98-003 Rev 0 Title Installation of Vectra RVR-200 Radwaste Solidification Skid

SECTION I

- | | Yes | No |
|---|-----|----|
| 1. Will the probability of an accident previously evaluated in the FSAR be increased? | | ✓ |
| 2. Will the consequences of an accident previously evaluated in the FSAR be increased? | | ✓ |
| 3. Will the probability of malfunctions of equipment important to safety previously evaluated in the FSAR be increased? | | ✓ |
| 4. Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased? | | ✓ |
| 5. Will the possibility of an accident of a different type than any previously evaluated in the FSAR be created? | | ✓ |
| 6. Will the possibility of a malfunction of equipment important to safety of a different type than any previously evaluated in the FSAR be created? | | ✓ |
| 7. Will the margin of safety as defined by Plant Licensing Bases be reduced? | | ✓ |

A written Safety Analysis which documents the bases for these answers shall accompany this form. If any of the above questions are answered "YES," an unreviewed safety question is involved and the item shall not be implemented without prior NRC concurrence.

SECTION II

- | | Yes | No |
|---|-----|----|
| 1. Should this be included in an FSAR update? | ✓ | |
| 2. Is an application for amendment to the Palisades Operating License required? | | ✓ |
| 3. Is NRC approval required prior to implementation of this item? | | ✓ |

SECTION III

Robert L. Ransom

Prepared by

12/25/98

Date

Keicher

Reviewed by

12/21/98

Date

PALISADES NUCLEAR PLANT
SAFETY ANALYSIS

Proc No 3.07
Attachment 3
Revision 9
Page 4 of 9

1. **Will the probability of an accident previously evaluated in the FSAR be increased?**

The activity required for the installation of the RVR-200 (VRS) does not affect any safety related equipment whose malfunction is postulated in the FSAR to initiate an accident.

2. **Will the consequences of an accident previously evaluated in the FSAR be increased?**

Permanent installation of the RVR-200 (VRS) will not affect the dose consequence analysis of any accidents evaluated in the FSAR. This change will not change, degrade, or prevent actions described or assumed in response to any accidents described in the FSAR. Moreover, this change will not affect assumptions made in any FSAR accidents or the methodology used in evaluating the consequences of any FSAR accidents. The accidents analyzed in the FSAR, such as the Volume Control Tank Rupture (FSAR Ch. 14.21.2) and the failure of small lines outside containment (FSAR Ch. 14.23) bound any consequences that could result from operation of the RVR-200.

3. **Will the probability of malfunctions of equipment important to safety previously evaluated in the FSAR be increased?**

The Primary Make-up Water Supply to the RVR-200 (VRS) will be taken from the T-81 Primary Make-up Water Storage Tank. T-81 is referred to in Technical Specification Section 3.5.1.E, Condensate Make-up Inventory. The tank's minimum indicated level for make-up water supply to the Steam Generator is 83%. The RVR-200 (VRS) will require an instantaneous demand of approximately 25 G.P.M. of make-up water from the T-81. Tank T-81 automatically refills at a rate sufficiently greater than the RVR-200 " supply piping flow rate such that the instantaneous water usage will not adversely affect Tank T-81's ability to maintain its required water level. Based on engineering evaluations EA-EPAL-94-019 and EA-SDW-94-001 and the fact that there will be periodic surveillance of tank water level, the minimal amount of suction on the Make-up Water System from the RVR-200 (VRS) along with the duration of operation assures that the minimum tank level required will at no time be in jeopardy.

Portions of the VRS unit operate at high pressures. However, since the liquid system does not operate at a high temperature, a piping failure will not result in a significant blowdown and break flow would be limited by the trip and isolation valves. A number of procedural and engineering features have been incorporated to minimize the probability of system failure.

Therefore, the modification will not create the possibility of breaching the subject systems' integrity nor increase the probability of a malfunction of equipment important to safety.

4. **Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?**

As discussed in question 3, Tank T-81 and its potential role in providing steam generator make-up water for decay heat removal following a reactor trip will not be invalidated.

The RVR-200 installation utilizes lead blankets and other suitable shielding for radiation protection. The RVR-200 (VRS) system will contain liquid waste which contains mostly particulate, a small amount of iodine and virtually no noble gases. Radiological consequence analyses are mainly concerned with iodides and noble gases since these substances are quite mobile. Particulate radio nuclide species are generally immobile and can be retained quite easily via a HEPA filter. The RVR-200 (VRS) has its own HEPA filter system which keeps the HIC at a slight negative pressure to control the release of airborne contaminants. All pathways to the outside will be monitored for closure during the processing of radwaste within the area

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4. Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?(cont'd)

to maintain negative pressure integrity. Failure of the RVR system could result in the maximum release of approximately 120 gallons of contaminated liquid to the Auxiliary Building Addition floor. The consequences of this accident are bounded by the Volume Control Tank Rupture (FSAR Ch. 14.21.2), and the failure of small lines outside containment (FSAR Ch. 14.23) which both result in doses within the limits of 10CFR100 and GDC-19.

Any local leakage or spillage will be contained by the room floor drain(s). The floor drain located in the Room 760, VRS Miscellaneous Storage Area has sufficient capacity to handle the maximum volume, if spilled. Personnel operating the RVR will have available temporary dikes, which will act as retaining curbs, to catch and contain such local leakage or spillage. The Room 754, VRS Corridor/Mezzanine and Miscellaneous Equipment has no floor drain, but due to length, containment of any local spillage from the Cleanout Valve MV-DRW876 will be contained by its size of area. The Room 756, Spent Resin Transfer/Recirculation Pump Room has a floor drain with sufficient capacity to handle any local leakage or spillage. The volume reduction process will be continuously manned and monitored, which allows for immediate operator action should they be required. Thus, leakage or spillage will only contaminate the local area where spilled.

The RVR system has a maximum capacity of 120 gallons of concentrate per waste batch. The waste supply line integrity is assured by the VECTRA RVR-200 operational procedure prior to any movement of liquid concentrated by the high pressure hydrostatic testing of the waste supply. The unit has two protective mechanisms to prevent overfilling the drum/dryer with liquid concentrates which are:

- 1) Unit high concentrate level trip which automatically shuts the waste supply valve
- 2) The drum/dryer visual camera which is governed by the RVR-200 VECTRA operation procedure.

The VRS Miscellaneous Storage Area contains a radwaste drain, which ties in directly with the radwaste drain system, with adequate capacity to remove the entire volume of concentrates contained in the RVR-200. In addition, the entire perimeter of the area where the processing equipment is housed is curbed sufficiently to contain the maximum liquid inventory expected. This curbing is integral with the floor which is part of the seismic portion of the building. These conditions meet the requirements of Regulatory Guide 1.143 (Design Guidance for Radioactive Waste Management Systems, Structures and Components).

The FSAR currently states that the Volume Reduction System processing equipment is located in a CPCo Design Class I building. This statement will be revised to read:

"the isolation point of the radwaste system, (CV-2752) is located in a CPCo Design Class I structure. The RVR-200 processing equipment is located in a CPCo Design Class I structure that meets the design criteria provided in Regulatory Guide 1.143. All components, structures and systems of the RVR system meet the requirements of Regulatory Guideline 1.143".

Therefore, there will not be any increase in the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR.

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5. Will the possibility of an accident of a different type than any previously evaluated in the FSAR be created?

The activity required for the installation of the RVR-200 (VRS) does not change the operation, function, or design bases of any structure, system, and component important to safety as described in the FSAR. No new hazards are created that can be postulated to cause an accident different from those previously analyzed in the FSAR. Therefore, there is no possibility that an accident may be caused that is different from any previously evaluated in the FSAR.

6. Will the possibility of a malfunction of a different type than any previously evaluated in the FSAR be created?

SC 97-024 removed the load, as shown in Figure 8-8 of the FSAR, of the M-24 Auxiliary Boiler from the 480V Bus 17, Breaker 52-1722. This change (SC 98-003) will also add the new load of the RVR-200 (VRS) to the figure. This change to a non-safety load is considered a change to the facility as described in the FSAR. However, this activity does not affect any safety related equipment whose malfunction is postulated in the FSAR or initiate an accident or create any special interactions with any structure, system, or component important to safety.

The RVR-200 system was vendor supplied with flexible, portable cabling, which is not normally utilized in cable tray and not readily available with the IEEE-383-1974 flame test rating as required by the FSAR. The cables utilized are portable cables with insulation types of G/GC, SOW-A, SDN and CL2. The RVR-200 system also utilizes RG59 coaxial cable and type J thermocouple wire which also is not readily available with the IEEE-383 flame test rating.

<u>Type</u>	<u>Comment</u>
SDN	Passed UL-1277-1991 flame test. UL-1277-1991 Vertical Flame Test is identical to UL-1581 Sect. 1160 per EA-SC-98-094-008. UL-1581 Sect. 1160 is equivalent to IEEE 383 Flame Test per EA-RKT-94-01.
CL2	UL-1581 Sect. 1160 Flame Test requirements are specified, which are equivalent to the IEEE 383 Flame Test requirements per EA-RKT-94-01.
SOW-A	Do not meet IEEE 383 or equivalent flame test requirements. However, type SOW-A passed MSHA (Mining Safety and Health Association) flame test (P-136-MSHA) and is UL Listed to Underwriters Laboratory Standard UL62 (Standard for Flexible Cord and Fixture Wire). UL Standard 62 requires a horizontal specimen flame test per section 1100 of U.L. 1581. The flame tests listed by these standards indicates that the cables were tested horizontally, at a minimum, and shown not to propagate a flame. However they do not reconcile with the flame test requirements of IEEE 383-1974..
G/GC	Do not meet IEEE 383 or equivalent flame test requirements but have passed the MSHA flame test (P-136-MSHA). These flame test requirements indicate the cables do not propagate a flame, however they do not reconcile with the requirements of IEEE 383 Flame Test.
RG59	In accordance with manufacturer's data (attachment 3), type RG59 coaxial cable has passed the UL 70,000 BTU Flame Test, which is defined in UL-1581 Sect. 1164. This test requires a 70,000 BTU/h flame, a 20 minute burn and vertical cable tray. These flame test requirements indicate the cables do not propagate a flame, however they do not reconcile with the requirements of IEEE 383 Flame Test.
J	Type J thermocouple wire does not meet IEEE 383 flame test requirements. However, the thermocouple wire is low voltage, small diameter wire and the amount of insulation involved is considered to be insignificant in its potential contribution to the propagation of fire.

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6. Will the possibility of a malfunction of a different type than any previously evaluated in the FSAR be created? (cont'd)

EA-SC-93-084-008 provides justification for the use of non-IEEE-383-1974 rated cables on the Spent Fuel Crane. This EA concluded that the cables do possess flame retardant characteristics, but not to the level of IEEE-383-1974 rated cables. A similar exception was documented by Plant Safety Review (PS&L Log No. 94-0433) relative to the Consumers Energy response to the NRC's Branch Technical Position APCS 9.5-1 which states that new cables will meet IEEE No. 383 or equivalent flame test requirements.

The SOW-A, G/GC, RG59 coaxial, and thermocouple cables for the RVR-200 system are not routed in raceway with other plant cables and therefore do not adversely affect any safety related cables or cables for other systems. There are fire suppression devices within this area and there is no safety related equipment in this area. The introduction of these cables into Fire Area 27 does not increase the combustible loading in the area due to the large reduction from the removal of the Asphalt Tank in SC 97-024.

Based on these facts and that flame retardance has been demonstrated by other flame tests for the cable types used in the RVR-200 system, it is reasonable to conclude that the use of these cables will not create the possibility of a malfunction of a different type than any previously evaluated in the FSAR or adversely affect the ability to achieve and maintain safe shutdown of the plant in the event of a fire in Fire Area 27.

As discussed in question 3, there is a functional interaction of the Make-up Water System's Primary Water Storage Tank, T-81. But as stated in the response to question 4, the interface connections with the RVR-200 (VRS) will not affect the operation and function of the interacting systems and will not create the possibility of a malfunction of a different type than those already evaluated in the FSAR.

7. Will the margin of safety as defined by Plant Licensing Bases be reduced?

This activity does not change the design bases, functions, or operations of any equipment important to safety, and does not adversely affect any other systems, structures, or components important to safety. The Technical Specification requirements and bases applicable to Make-up Water Tank T-81 are not affected. Margins of safety for offsite radiation doses will not be affected because any potential accident resulting from this modification is encompassed by existing analyzed accidents, e.g., the Liquid Waste Incident as described in FSAR Section 14.20. The new VRS will be located in seismically qualified structure and any radioactive release from the RVR will be contained within the area. This modification does not reduce the margin of safety as defined in the plant licensing bases including the bases for the Technical Specifications. Therefore, this activity does not reduce the margin of safety as defined in the bases for the Technical Specifications.

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ZyFind Search

A search of the ZyFind data base was performed for several key words relating to this modification. Documents included in the search were the FSAR, DBD'S, Tech. Specs., NRC Generic Letters, Bulletins, and Inspection Notices, and NPAD Audits, Surveillance, and Field Monitoring.

Search by:	Documents found	Sections
asphalt	DBD 7.08 Plant Protection Against Flooding	Table 9-1 (Item 759)
	DBD 1.07 Aux Bldg. HVAC System	1.2.1 3.2.1.1.b 3.2.1.1.c 7.0.65
	FSAR Section 11.4 Solid Waste Management System	11.4.1 11.4.2.2 11.4.2.4 11.4.2.5 11.4.6 Table 11-14
	FSAR Chapter 5 Design of Structures, Systems, ...	5.1.7.1
	Tech Spec	ODCM Appendix B
		ODCM Appendix A
auxiliary boiler	FSAR Section 11-4	11.4.2.4 11.4.4
		Table 11-14
bitumen	FSAR Chapter 5, Design of Structures, Systems, ...	5.1.7.1
	FSAR Section 1.5 Major Plant Modifications	1.5
isolated cooling water	DBD 1.02	Sect. 5.1 Table 5.1-2 Table E.2
	FSAR Section 9.0	Table 9-1
M-24	DBD 1.02 Service Water System	5.1

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Search by:	Documents found	Sections
radwaste*	DBD 3.05 480V AC System	3.2.5 3.2.5.2 3.2.9.1 3.2.13 Table 3.4-1 7.0.6, 50, 52, 53, 105
	DBD 7.08 Plant Protection Against Flooding	Table 9-1 (Rm 121, 730, 730d) Table 9-2
	DBD 7.02 EQ Master Equipment List	List for RWS system
	DBD 1.07 Aux Bldg... HVAC System	1.1 1.1.1 3.2.1.1.c
	DBD 1.02 Service Water System	5.1 Table 5.1-1 Table 5.1-2 7.0.43
	FSAR Section 11.4	11.4.2.4
	FSAR Chapter 9	Table 9-1
	FSAR Section 1.5	1.5
	ODCM Appendix A	
VRS	DBD 3.05	3.2.9.1
	DBD 7.08	7.0.730-731 7.0.754, 758-762
	DBD 1.07	1.1.1 1.2.1 Table 3.1.1 3.2.1.1.c Table 3.3.7.1
	DBD 1.02	5.1
	OPEN FSAR APR	9.8.2.4.27.c
	FSAR Section 9.8	9.8.2.3.2.7.a-c
	FSAR Section 11.4	various
	FSAR Chapter 9	9.1.2.3 (2)
volume reduction system	DBD 1.02	3.3.3 5.1 Table 5.1-1 Table 5.1-2 Table E-2
	FSAR Chapter 11 Table of Content.	Table 11-4, Sht. 5

* Items listed are those that relate to the subject modification the Solid Radwaste or VRS Systems.

Although the search (by "radwaste") yielded other hits, a review of those documents shows that they are not applicable to this modification.

Consumers Energy
Palisades Nuclear Plant
PROCESS CONTROL PROGRAM (PCP)

Approved

_____	_____
Radiological Services Mgr	Date
_____	_____
Technical Review	Date
_____	_____
Plant Review Committee	Date
_____	_____
Periodic Review	Date
_____	_____
Plant General Manager	Date

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Appendix A - System Diagrams

Appendix B - Relocated Technical Specifications

PALISADES PROCESS CONTROL PROGRAM (PCP)

INTRODUCTION

The Process Control Program contains methodology used to meet the requirements of 10CFR61 for land disposal of radioactive waste. Palisades only available burial ground is located near Barnwell, SC. South Carolina has Agreement State status from the Nuclear Regulatory Commission (NRC) and radioactive waste has to meet SC license conditions as well as the NRC requirements.

1.0 RVR-200 THEORY OF OPERATION

Palisades uses the VECTRA Radwaste Volume Reduction System (RVR-200) to reduce the volume of radioactive liquid concentrates to the minimum amount practicable for storage and burial purposes. The end product will meet South Carolina burial requirements.

The Blender/Dryer (B/D) steam jacket is heated by a steam boiler. The plant evaporator concentrates are introduced to the B/D via a waste slurry supply line through the waste supply valves. When the liquid level in the B/D reaches a predetermined level (approximately 3" from the top of the B/D) the waste supply valve is closed by the operator or will automatically close when a high level is achieved. The agitator/scrapper then mixes the heated waste liquids under a vacuum of approximately 24-30" Hg. Steam vapors are produced by the heating of the steam jacket surrounding the Blender/Dryer. These steam vapors are then drawn through a demister filter to a condensing heat exchanger (HX-1). This condenser is cooled by the chilled water system and its 50 ton chiller skid.

After the level in the Blender/Dryer boils down to a low level or the boil off rate significantly decreases as determined by the system operator, the waste supply valve is opened to refill the B/D. The process of boiling off the liquid in the form of steam vapor is repeated. This sequence of operations continues until the appropriate amount of concentrates have been transferred to the B/D for a batch cycle.

Once the last transfer has been achieved, the dry out phase begins. The dry out phase is the time it takes from the last transfer to the time when all of the free standing liquid has been removed. The dryness of the material is verified by monitoring several system parameters, as well as a visual observation of the product. Upon verification of the removal of free standing liquid, the material is ready for binder addition.

Between 50 and 70 pounds of binder (20-30% of the dried material by weight) will be used to bind the waste solids. This binding agent, which is added at the beginning of the process in solid form, is melted using steam heat from the steam generator in the binder addition tank. The binder takes approximately 2-4 hours to melt completely.

The binding agent is introduced to the B/D through a chemical addition valve (CA-1) and allowed to thoroughly blend with the dry waste product for approximately 20 minutes. This changes the waste product to a near liquid form to allow for free passage through the discharge valve (DV-1). Using the binder will result in a free standing billet with a compressive strength of up to 250 psi. The material is now ready for discharge into a container.

1.1 **PACKAGING**

The binder and waste product mixture is discharged from the unit through a six inch pneumatically operated ball valve (DV-1) into a burial container. The burial container is kept at a slight negative pressure and vented through a HEPA system. A sonic level indicator, as well as a remote visual display, allows for the operator to monitor the filling of the container. The sonic level indicator can be programmed for automatic closure of the dump valve at a predetermined level to prevent overfilling.

1.2 **ALARA CONSIDERATIONS**

Construction of the RVR-200 employs several concepts to permit operation without significant exposure to operating personnel. Some of these will greatly reduce the accumulated dose received by those personnel working on or around the area in which the RVR-200 is located.

- A remotely operated control panel allows for the control of major pumps and valves associated with the operation of the RVR without being near the unit during the process.
- Lead blankets can be used to shield the operator from the processing Blender/Dryer.
- All filling and dumping operations are viewed remotely at the control panel, using a CCTV monitor, which permits the operator to be shielded from direct exposure.

- A 1" steel process shield or shipping cask can be used to contain the HIC while it is being filled. A cart is used to move it out from under the RVR.
- A HEPA system is installed to filter out potential of airborne contaminants.

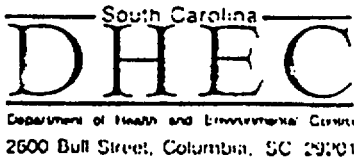
The major portion of radiation exposure is received by personnel during maintenance and radwaste handling. This exposure may be reduced by performing preventive maintenance on the unit after processing and removing of the waste from the system. The units are also skid mounted, permitting them to be removed from the area for maintenance or work away from the unit and reduce exposure to the personnel.

1.3 **SYSTEM PARAMETERS**

There are no critical chemistry parameters for the system to work as designed for acceptable waste form. However other requirements need to be addressed. Waste below 2 pH and above 12 pH is characteristically classified hazardous waste which would make the package mixed waste which must be avoided as no burial site is presently available. Palisades also wants to operate in a pH range to keep iodine in solution and in the waste matrix rather than offgassed which would be counter to good ALARA practices. The required parameters are contained in Chemistry Operating Procedure COP-17, "Radwaste System Chemistry."

Waste form Absence of Liquid will be controlled by System Operating Procedure SOP-18D, "Operating the VECTRA RVR-200 System," and visual observation of material. The visual inspection and quality control requirements will be documented on form HP 6.18-3 as required by procedure Health Physics Procedure HP 6.18,"

The system produces a dry powder which meets the "free liquid" determination of Barnwell License 097. This does not meet the Barnwell License 097, condition 45 unless using wax as a binder to make the waste undispersable. The binder addition is documented in the VECTRA procedure process sheets. A letter from the South Carolina DHEC is attached to document their approval of the wax as a binder.



Interim Commissioner, Thomas E. Brown, Jr.

Board: John M. Burriss, Chairman
Richard E. Jabbour, DDS, Vice Chairman
Robert J. Stripling, Secretary

Preserving Health, Protecting the Environment

William E. Applegate, III,
Tony Graham, Jr., MD
Sandra J. Molander
John U. Pate, MD

July 30, 1992

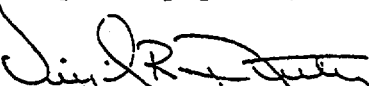
William B. House
Corporate Director of Licensing
Chem-Nuclear Systems, Inc.
140 Stoneridge Drive
Columbia, SC 29210

Dear Mr. House:

Enclosed is information on the Pacific Nuclear Systems, Inc. RVR waste forms. The system produces a dry powder which is processed using wax as a binding matrix. The waste forms meet the intent of License 097, Condition 45 to render the powder non-dispersible. The system has been approved by the Department for processing Class A unstable waste only. Waste processed using this system may be disposed of in Type A unstable waste trenches.

If you have any additional questions concerning these waste forms, please contact our office.

Very truly yours,


Virgil R. Autry, Director
Division of Radioactive Materials
Licensing and Compliance
Bureau of Radiological Health

HJP/em
wbh72992/0792

cc: R. L. Williams, Pacific Nuclear Systems, Inc.

Meeting the above referenced procedure requirements will demonstrate that the system product is acceptable for burial at the Barnwell SC Burial Facility.

2.0 **RVR-200 EQUIPMENT DESCRIPTION**

2.1 **ELECTRIC STEAM GENERATOR**

The RVR-200 is provided with a Chromalox Electric Steam Boiler to supply the steam necessary to pressurize the Blender/Dryer, Binder addition tank and dump valve steam jackets to approximately 10-15 psig. The Blender/Dryer steam jacket is equipped with two steam reliefs to insure that the steam system meets ASME requirements for safety devices on automatically fired boilers. The Steam Boiler, referred by VECTRA as a Steam Generator (S/G), is a model CES-180A with an internal volume of 30.5 gallons. Several heating elements inside the boiler work together in a ramping arrangement. As the requirement for heat increases the heating elements pick up to supply the demand. As the requirement for heat decreases the heating elements drop out. A pressure switch manually set by the operator, is used to control the heat load. As the water level in the Steam Generator decreases due to evaporation a mercury level switch sends a signal to start the S/G makeup pump and increase level. When the level is high the mercury switch shuts the pump down. Normally the pump will cycle during operation between the high and low level. A makeup tank is provided to supply NPSH to the pump. Periodically the Steam Generator should be blown down to remove sediment and suspended solids.

2.2 **BLENDER/DRYER**

The Blender/Dryer (B/D) is constructed of type 304 S/S with an internal volume of approximately 15 cu ft. The B/D will hold approximately 112 gallons of liquid waste. The B/D is equipped with four (4) two inch flanged ports to allow for the addition of optional choppers. The mixing blades are also constructed of type 304 S/S and are arranged in a double helix opposing pitch design. This design limits the axial thrust exerted on the unit because of the inherent push/pull design of the blades. Blades are supported by 1" connecting rods to a solid 4" diameter shaft that penetrates both ends of the B/D. The mixing blades are arranged in a ribbon configuration with a clearance of approximately 3/16" between the blades and the inner wall of the vessel. The shaft is driven by a 15 hp motor through a parallel gear reducer. The reducer drives the agitator/scrapper assembly at a rate of 20 rpm.

A pressure switch, sensing pressure inside the Blender/Dryer , is connected to the bottom of the demister/filter housing and set at 15 psig. Should pressure inside the B/D exceed the setpoint of the pressure switch, the pressure switch will automatically trip the S/G breakers and shut down the steam being supplied to the B/D steam jacket. A manual reset in the control circuit is incorporated such that the steam generator must be re-started from the control panel if it shuts down due to high pressure. A corresponding fault light will be illuminated to alert the operator of the malfunction.

The B/D steam jacket is insulated with 2" of fiberglass insulation. This allows for a uniform heat transfer surface area and protects personnel from contacting the hot steam jacket.

Underneath the B/D, located in the center, is the discharge or dump valve. It is a 6", pneumatically operated ball valve. The dump valve is operated from the control panel. Several interlocks are used to prevent inadvertently opening the dump valve. All interlocks must be met in order to open the valve. The interlocks are listed in Section 4.0.

A fill plate and hose assembly are connected below the dump valve. The fill plate has a light, camera, and sonic probe. The light and camera are used to monitor the HIC fill evolution. The sonic probe is used to monitor the HIC level. A pneumatic lift is installed to lift the fill plate from the HIC after it is filled to allow changeout.

The B/D top cover jacket houses a viewing port equipped with wiper assemblies to permit the operator to view the level of waste slurry both locally and remotely via a CCTV camera. Also mounted on the top of the B/D is the binder addition valve, demister/filter assembly and inlet waste valves.

The Demister/Filter assembly is used to limit the amount of solid carry-over from the B/D to the condensate skid. The demister filter is a 10 inch diameter 5 micron filter. Top and bottom flush connections are installed to flush the demister screen thus, limiting the building up of solids. Hot water from the steam generator blowdown line may be used to flush binder and solids out of the filter down to the Blender/Dryer from the Demister/filter assembly.

2.3 CONDENSATE SYSTEM

The condensate system provides a heat transfer medium for the exhausted water vapors that are drawn from the Blender/Dryer. This heat transfer occurs across a primary heat exchanger, which is supplied with chilled water from a 50 ton chiller unit. The primary heat exchanger (HX-1) is a single pass, opposing flow style heat exchanger that condenses the water vapors as they are drawn across by vacuum created at the base of HX-1.

This vacuum is accomplished by use of a jet pump. The jet pump is an educator which utilizes a motive pump (P-1) to provide motive water flow. The water to be pumped flows in through the suction. High pressure water is supplied to the driving nozzle, which is shaped like a convergent nozzle. The middle of the pump is the throat, or mixing section, which widens into the diffuser. The overall design is a convergent-divergent nozzle. This nozzle converts pressure into velocity, then converts the velocity back into pressure.

The high-pressure water enters the driving nozzle where its pressure is converted into velocity, so that it exits the nozzle at high velocity and low pressure. This low pressure area pulls the fluid to be pumped toward it where it is entrained by the high velocity driving flow. The two flows mix in the pump throat and the divergent diffuser nozzle converts the fluid velocity back to a pressure head. The pressure changes can be graphed vs position.

The motive pump is a 20 hp centrifugal pump that takes a suction on the condensate tank (T-1) and discharges through a secondary heat exchanger (HX-2), then through the jet pump (P-3) back to the condensate tank. HX-2 provides sub-cooling of the condensate prior to entering the adductor.

The condensate tank has a capacity of 157 gallons. It is approximately 30" in diameter and 54" high. The tank is equipped with four float switches, in which two alarms share a common shaft. Corresponding alarm lights are located on the control panel to alert the operator of high or low levels in the tank.

The condensate return valve, a 3/4" pneumatically operated ball valve, is located on the discharge side of the motive pump and can be operated from the control panel or automatically by the high level switch. This valve is used to pump down the Condensate Tank and return condensate to the plant. The valve is air operated to open and is spring loaded to shut.

The RVR-200 Ventilation System takes a suction on the condensate tank to remove air and non-condensable gases through a HEPA filter and moisture separator. The moisture separator has a sight glass and drain for level control.

2.4 CHILLED WATER SYSTEM

The Chilled Water system utilizes a 50 ton TRANE™ CHILLER, with its associated chilled water pump, to remove heat from the condensate system. A 7-1/2 hp pump circulates the chilled water at a rate of 120 GPM @ 50 psig to the two heat exchangers (HX-1 & HX-2).

Control for the chiller utilizes a microcomputer (UCM) that governs unit operation in response to chilled water temperature leaving the evaporator. The UCM controls the starting and stopping of the compressors to achieve the chilled water setpoint, which is programmed in the UCM. The UCM provides a diagnostic and operating code display that can be read on the front panel of the unit. A remote fault light is located on the RVR-200 control panel to indicate a problem with the chiller. Should a fault occur with the chiller, the unit will shut down and must be manually reset at the UCM. The operational display will "flash" the current diagnostic code of the problem and hold the code in memory for future reference.

A flow switch is installed on the chilled water supply line to indicate a loss of chilled water flow, which is interfaced with the TRANE™ units UCM and provides a fault indication to the unit.

2.5 CONTROL PANEL

The RVR-200 control panel is arranged to facilitate easy operation and control. The front panel doors have the necessary control knobs and push buttons to start and stop all pumps/motors and associated valves. The use of the TV monitor permits the operator to view the process remotely and monitor container filling operations by use of CCTV cameras. The logic controls provide alarm indications and protective functions to alert the operator of any potential problems.

2.6 **MCC PANEL**

Inside the Motor Control Center panel doors and mounted in the enclosure are the power supply breakers and logic control circuits. Relays and contactors for the pumps and motors are also housed in this panel and are arranged for easy access for troubleshooting or repair.

3.0 **DEWATERING SOLIDS IN HIGH INTEGRITY CONTAINERS (HIC)**

3.1 Solids such as bead resin, filter cartridges, and powdered resin (Powdex) may be dewatered and shipped in HICs per approved procedures and the HIC certificate of compliance.

3.2 High integrity containers are approved by the individual burial ground agreement states as meeting 10CFR61 waste form stability requirements.

3.3 Free water determination shall be verified by the successful completion and documentation of an approved dewatering procedure.

4.0 **10 CFR 61 REQUIREMENTS**

4.1 10 CFR 61 classification requirements will be met using the shipping computer software program using the scaling factor methodology of AIF/NESP-027, "Methodologies for Classification of Low-Level Radioactive Waste From Nuclear Power Plants," 1983.

The scaling factors will be updated by an ongoing analysis program of actual waste streams. The program will initiate with semiannual samples of available waste streams and may be modified to longer intervals if the data base warrants. Waste streams should include, if available; bead resin, concentrates, reactor coolant, clean waste, filter crud, and compacted trash.

4.2 10 CFR 61 waste form stability requirements will be met by generic testing of the waste stream product or the use of High Integrity Containers (HIC) approved by the State of South Carolina. The generic waste streams will be boric acid, bead resin, and chemical regenerative wastes.

4.3 Documentation of the waste stream analysis, waste form stability, and computer software scaling factor security shall be maintained by the Radiological Services Department.

5.0 **RADWASTE SYSTEM**

| 5.1 A radwaste system flow diagram is included in Appendix A, A-2.

6.0 **TECHNICAL SPECIFICATION REQUIREMENTS**

| The PCP is implemented per the requirements of the Administrative Controls section of the Plant Technical Specification 6.5.15. Procedural requirements included in Appendix B have been relocated from the Technical Specifications in accordance with NRC Generic Letter 89-01, dated January 31, 1989.

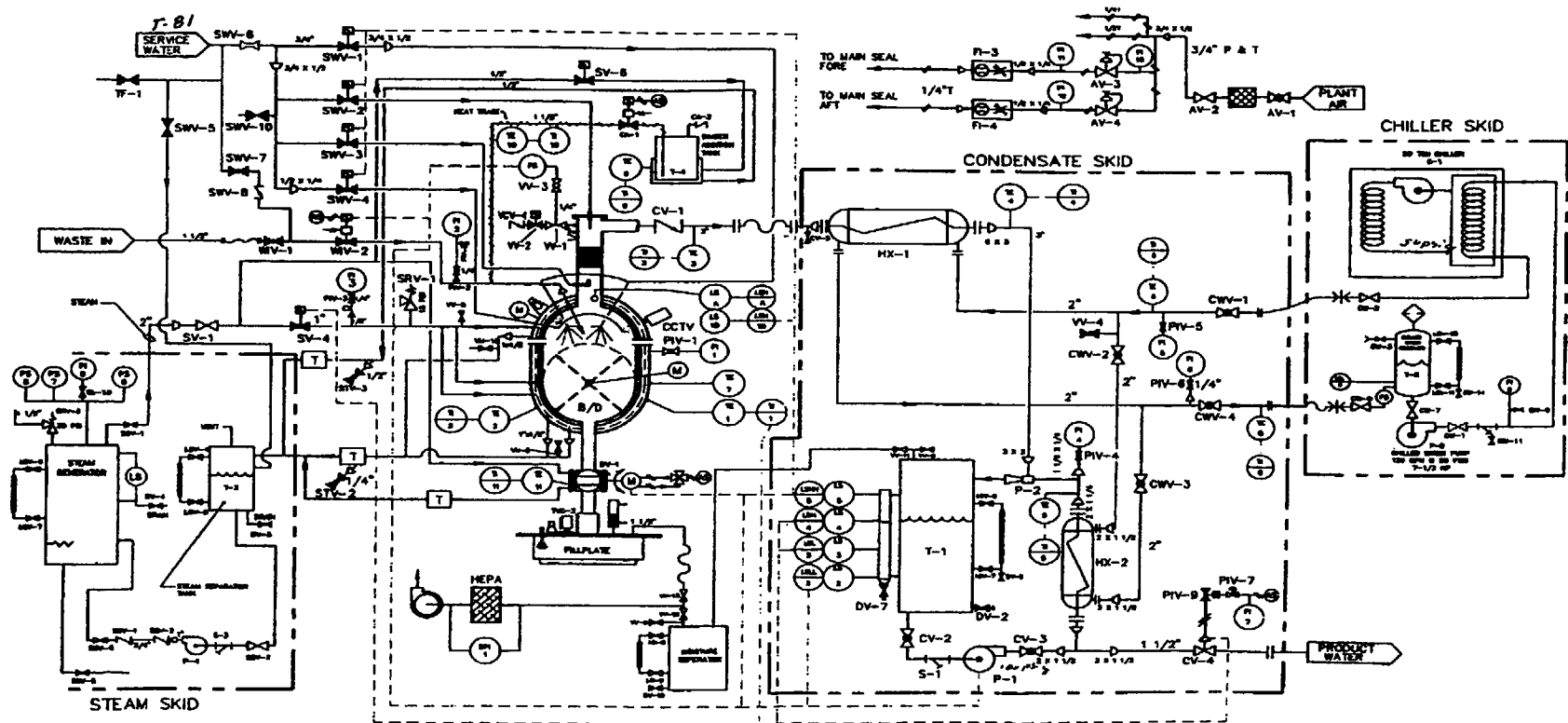
APPENDIX A

Consumers Energy
Palisades Nuclear Plant

PROCESS CONTROL PROGRAM (PCP)

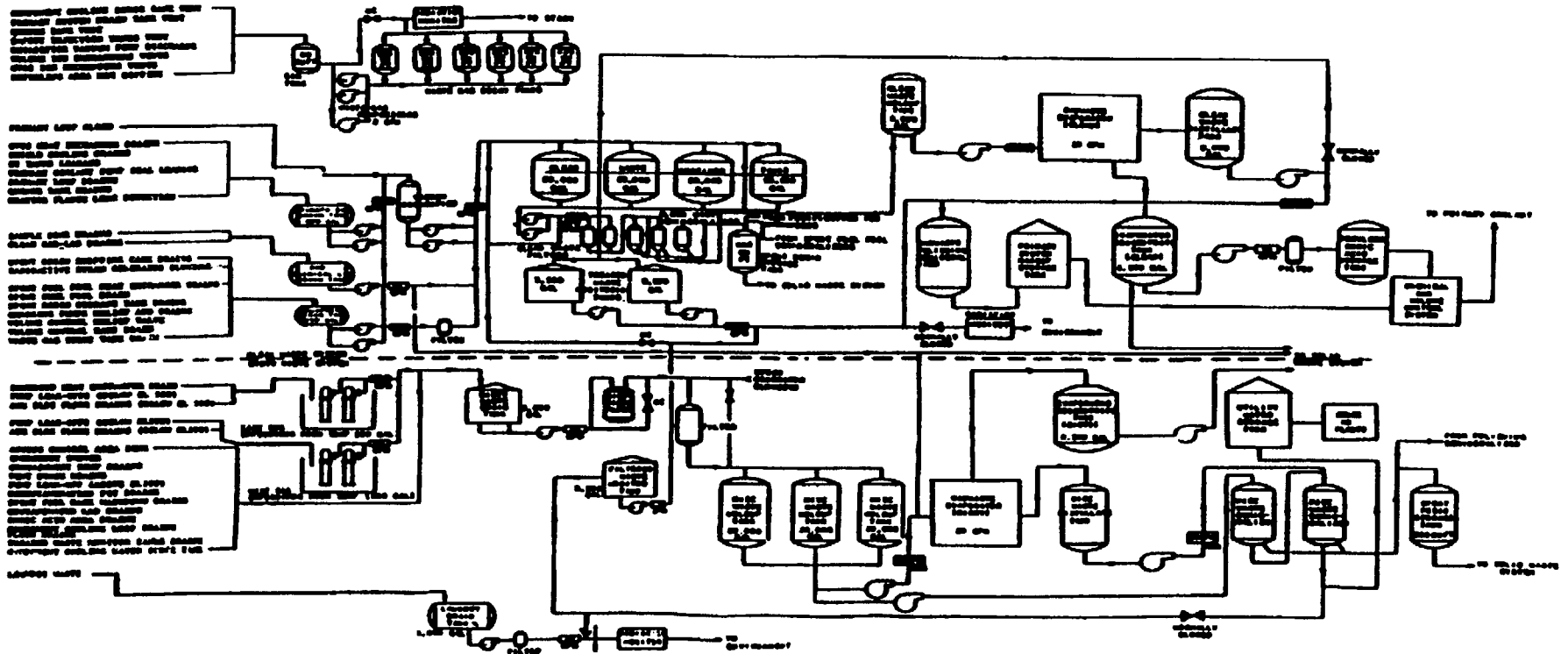
System Diagrams

APPENDIX A



APPENDIX A

A-2 RADWASTE SYSTEM FLOW DIAGRAM



APPENDIX B

Consumers Energy
Palisades Nuclear Plant

PROCESS CONTROL PROGRAM (PCP)

Relocated Technical Specifications
(per NRC Generic Letter 89-01)
(dated January 31, 1989)

Relocated Technical Specifications

Introduction

The NRC, through 10CFR 50.36a, requires implementation of Technical Specifications on effluents from nuclear power plants. NRC Generic Letter 89-01, dated January 31, 1989, allowed the relocation of the existing procedural requirements from the Technical Specifications (implemented in Amendment 85, November 9, 1984). The relocated procedural requirements pertaining to solid radwaste follow below. Programmatic controls are retained in the Administrative Controls section of the Technical Specifications to satisfy the regulatory requirements of 10CFR 50.36a. The Technical Specifications programmatic controls include requirements for the establishment, implementation, maintenance, and changes to the Process Control Program (PCP), as well as record retention and reporting requirements.

Definitions

The Technical Specification's definition of the PCP is:

The Process Control Program (PCP) shall contain the current formulas, sampling, analyses, test, 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 10CFR Parts 20, 61, and 71, state regulations, burial ground requirements, and other requirements governing the disposal of solid radioactive waste.

Solidification shall be the conversion of radioactive wastes from liquid systems to a homogeneous (uniformly distributed), monolithic, immobilized solid with definite volume and shape, bounded by a stable surface of distinct outline on all sides (free-standing).

Requirements

The solid radwaste system shall be used in accordance with the PCP to process wet radioactive wastes to meet shipping and burial ground requirements.

Action

With the provisions of the PCP not satisfied, suspend shipments of defectively processed or defectively packaged solid radioactive wastes from the site.

Surveillance Requirements

The Process Control Program shall be used to verify the solidification of at least one representative test specimen from at least every tenth batch of each type of wet radioactive waste (eg, filter sludges, spent resins, evaporator bottoms, and boric acid solutions).

- a. If any test specimen fails to verify solidification, the solidification of the batch under test shall be suspended until such time as additional test specimens can be obtained, alternative solidification parameters can be determined in accordance with the Process Control Program and a subsequent test verifies solidification. Solidification of the batch may then be resumed using the alternative solidification parameters determined by the Process Control Program.
- b. If the initial test specimen from a batch of waste fails to verify solidification, the Process Control Program shall provide for the collection and testing of representative test specimens from each consecutive batch of the same type of wet waste until at least 3 consecutive initial test specimens demonstrate solidification. The Process Control Program shall be modified as required, as provided in the Technical Specification 6.5.15, to assure solidification of subsequent batches of waste.

BASES

Solid Radioactive Waste

The Process Control Program implements the requirements of 10CFR Part 50.36a and General Design Criterion 60 of Appendix A to 10CFR Part 50. The process parameters included in establishing the Process Control Program may include, but are not limited to, waste type, waste pH, waste/liquid/solidification agent/catalyst ratios, waste oil content, waste principal chemical constituents, and mixing and curing times.

Reporting Requirements

The Radiological Effluent Release Report, pursuant to the Plant Technical Specifications, shall include the following information for each class of solid waste (as defined by 10CFR Part 61) shipped offsite during the report period. (Additional details of the report are contained in the Offsite Dose Calculation Manual.)

- a. Container burial volume.
- b. Total curie quantity (specify whether determined by measurement or estimate).
- c. Principal radionuclides (specify whether determined by measurement or estimate).
- d. Source of waste and processing employed (eg, dewatered spent resin, compacted dry waste, evaporator bottoms).
- e. Type of container (eg, LSA, Type A, Type B, Large Quantity).
- f. Solidification agent or absorbent (eg, cement, asphalt).
- g. Any changes made during the reporting period to the PCP pursuant to the Plant Technical Specifications.

Major Modifications to Radioactive Solid Waste Treatment System

Licensee initiated major modifications to the radioactive solid waste systems:

1. Shall be reported to the NRC pursuant to 10CFR 50.59. The discussion of each modification shall contain:
 - a. A summary of the evaluation that led to the determination that the modification could be made in accordance with 10CFR Part 50.59.
 - b. A description of the equipment, components, and processes involved and the interface with other Plant systems.
 - c. Documentation of the fact that the modification was reviewed and found acceptable by the PRC.
2. Shall become effective upon review and acceptance by the Plant Manager.

ATTACHMENT 8

**CONSUMER ENERGY COMPANY
PALISADES PLANT
DOCKET 50-255**

**RADIOACTIVE EFFLUENT RELEASE REPORT
OFFSITE DOSE CALCULATION MANUAL**

175 Pages

PALISADES NUCLEAR PLANT
10CFR50.59 SAFETY REVIEW

Proc No 3.07
 Attachment 1
 Revision 9
 Page 1 of 1

Log No SDR- 99-1398

Item Identification: No ODCM, Appendix A Rev 9A Title _____
OFFSITE DOSE CALCULATION MANUAL, APPENDIX A

Describe Issue/Change: REMOVE SURVIELLANCE REQUIREMENTS FOR FI-0632

Reason for Issue/Change: FLOW INDICATOR FI-0632 WAS CHANGED OUT IN 1997 (EAR-0350, PS&L LOG 97-1441) FROM A SAIC MODEL WHICH REQUIRED CALIBRATION TO A BROOKS INST ROTOMETER WHICH IS MANUFACTURED EQUIVALENT TO A PRIMARY STANDARD AND NEVER REQUIRES CALIBRATION.

	Yes	No
1. Does the item involve a change to procedures as described in the FSAR? FSAR Sections affected <u>NONE</u> FSAR Sections reviewed <u>10, 11</u>		X
2. Does the item involve a change to the facility as described or implied in the FSAR? FSAR Sections affected <u>NONE</u> FSAR Sections reviewed <u>10, 11</u>		X
3. Does the item involve a test or experiment not described in the FSAR? FSAR Sections affected <u>NONE</u> FSAR Sections reviewed <u>10, 11</u>		X
4. Should the Technical Specifications or any of their Bases be changed in conjunction with this item? TS Sections affected <u>ODCM, APP A</u> TS Sections reviewed <u>4.6 AND ODCM</u>	X	

If any Safety Review question listed above is answered "YES," perform a written USQ Evaluation. Justify "NO" answers below if logic is not obvious:

PS&L LOG 97-1441 DIDN'T IDENTIFY THAT FI-0632 HAD A ODCM, APP A SURVILLANCE REQUIREMENT AND AS A RESULT THE ODCM , APP A WAS NOT REVISED. THIS DISCREPANCY WAS DOCUMENTED ON C-PAL-99-1120


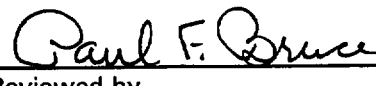
NOTE: DBD change requests shall be processed in accordance with Administrative Procedure 3.15.

DBD Sections Reviewed NA Affected NONE

NOTE: SDR forwards a copy of all changes potentially affecting proposed Improved Technical Specifications to the Licensing Dept.

Proposed ITS & Bases Reviewed ALL Affected NONE

This attachment shall accompany other review materials for the item to document whether or not a USQ Evaluation was required.

	<u>9-14-99</u>		<u>11/1-99</u>
Prepared by	Date	Reviewed by	Date

PALISADES NUCLEAR PLANT
10CFR50.59 UNREVIEWED SAFETY QUESTION EVALUATION

Proc No 3.07
Attachment 2
Revision 9
Page 1 of 1

Log No SDR- 99-1398

Item Identification: No ODCM, APP A Rev 9A Title _____
OFFSITE DOSE CALCULATION MANUAL (ODCM), APPENDIX A

SECTION I

1. Will the probability of an accident previously evaluated in the FSAR be increased?
2. Will the consequences of an accident previously evaluated in the FSAR be increased?
3. Will the probability of malfunctions of equipment important to safety previously evaluated in the FSAR be increased?
4. Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?
5. Will the possibility of an accident of a different type than any previously evaluated in the FSAR be created?
6. Will the possibility of a malfunction of equipment important to safety of a different type than any previously evaluated in the FSAR be created?
7. Will the margin of safety as defined by Plant Licensing Bases be reduced?

Yes	No
	X
	X
	X
	X
	X
	X
	X

A written Safety Analysis which documents the bases for these answers shall accompany this form. If any of the above questions are answered "YES," an unreviewed safety question is involved and the item shall not be implemented without prior NRC concurrence.

SECTION II

1. Should this be included in an FSAR update?
2. Is an application for amendment to the Palisades Operating License required?
3. Is NRC approval required prior to implementation of this item?

Yes	No
	X
	X
	X

SECTION III

J.P. Neal 19-14-99
Prepared by Date

Paul F. Bruce 11/1-99
Reviewed by Date

PALISADES NUCLEAR PLANT
SAFETY ANALYSIS

Proc No 3.07
Attachment 3
Revision 9
Page 1 of 1

Item Identification: No ODCM, APP A Rev 9A Log No SDR-99-1398

DESCRIPTION OF ITEM

Page 1 of 1

SAIC MODEL C-812 WAS REPLACED BY A BROOKS METERING TUBE TYPE FLOW METER WHICH IS A BETTER APPLICATION FOR MEASURING OFFGAS FLOW. THIS FLOW METER IS IN THE CONDENSER OFFGAS LINE WHICH IS NOT IMPORTANT TO NUCLEAR SAFETY OR CONNECTED TO EQUIPMENT THAT IS.

JUSTIFICATION

THE ANSWERS TO QUESTIONS 1 THROUGH 7 ARE ALL NO. CHANGE OF A FLOW METER IN THE CONDENSER OFF GAS LINE WILL NOT AFFECT THE PROBABILITY OF ANY ACCIDENT OR ANY CONSEQUENCE OF AN ACCIDENT. IT ALSO CANNOT INCREASE THE PROBABILITY OR CONSEQUENCE OF A MALFUNCTION IMPORTANT TO SAFETY. IT CANNOT CREATE THE POSSIBILITY OF AN ACCIDENT OR A MALFUNCTION TO EQUIPMENT IMPORTANT TO SAFETY. IT HAS NO EFFECT ON ANY MARGIN OF SAFETY.

**PALISADES NUCLEAR PLANT
10CFR50.59 SAFETY REVIEW**

Proc No 3.07
Attachment 1
Revision 9
Page 1 of 1

Log No SDR- 99-0531

Item Identification: No ODCM, APP A Rev 8 Title OFFSITE DOSE CALCULATION MANUAL
APP A

Describe Issue/Change: ADDED "applicability column" to Table C-1 and note to Action 2 statement.

Reason for Issue/Change: Clarify that the monitors are required for effluent release operations only.

1. Does the item involve a change to procedures as described in the FSAR?
FSAR Sections affected NONE
FSAR Sections reviewed 11
2. Does the item involve a change to the facility as described or implied in the FSAR?
FSAR Sections affected NONE
FSAR Sections reviewed 11
3. Does the item involve a test or experiment not described in the FSAR?
FSAR Sections affected NONE
FSAR Sections reviewed 11
4. Should the Technical Specifications or any of their Bases be changed in conjunction with this item?
TS Sections affected None FOR TECH SPECS-ODCM, APP A
TS Sections reviewed 6 - ODCM

Yes	No
	X
	X
	X
X	

If any Safety Review question listed above is answered "YES," perform a written USQ Evaluation. Justify "NO" answers below if logic is not obvious:
THE TABLE IS BEING REVISED TO CLARIFY WHEN THESE MONITORS ARE ACTUALLY REQUIRED.

NOTE: DBD change requests shall be processed in accordance with Administrative Procedure 3.15.

DBD Sections Reviewed N/A Affected NONE

NOTE: SDR forwards a copy of all changes potentially affecting proposed Improved Technical Specifications to the Licensing Dept.

Proposed ITS & Bases Reviewed 5 Affected NONE

This attachment shall accompany other review materials for the item to document whether or not a USQ Evaluation was required.

J.P. Neal
Prepared by

15-2-99
Date

Paul F. Bruce
Reviewed by

5-16-99
Date

PALISADES NUCLEAR PLANT
10CFR50.59 UNREVIEWED SAFETY QUESTION EVALUATION

Proc No 3.07
 Attachment 2
 Revision 9
 Page 1 of 1

Log No SDR- 99-0531

Item Identification: No ODCM, APP A Rev 8 Title OFFSITE DOSE
CALCULATION MANUAL

SECTION I

	Yes	No
1. Will the probability of an accident previously evaluated in the FSAR be increased?		X
2. Will the consequences of an accident previously evaluated in the FSAR be increased?		X
3. Will the probability of malfunctions of equipment important to safety previously evaluated in the FSAR be increased?		X
4. Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?		X
5. Will the possibility of an accident of a different type than any previously evaluated in the FSAR be created?		X
6. Will the possibility of a malfunction of equipment important to safety of a different type than any previously evaluated in the FSAR be created?		X
7. Will the margin of safety as defined by Plant Licensing Bases be reduced?		X

A written Safety Analysis which documents the bases for these answers shall accompany this form. If any of the above questions are answered "YES," an unreviewed safety question is involved and the item shall not be implemented without prior NRC concurrence.

SECTION II

	Yes	No
1. Should this be included in an FSAR update?		X
2. Is an application for amendment to the Palisades Operating License required?		X
3. Is NRC approval required prior to implementation of this item?		X

SECTION III

JPM Neal
 Prepared by _____ Date 15-6-99

Paul F. Bruce
 Reviewed by _____ Date 5/6-99

**PALISADES NUCLEAR PLANT
SAFETY ANALYSIS**

**Proc No 3.07
Attachment 3
Revision 9
Page 1 of 1**

Item Identification: No QDCM. APP A Rev 8 Log No SDR-

DESCRIPTION OF ITEM

ADDITION OF APPLICABILITY COLUMN TO TABLE C-2 AND CLARIFYING NOTE TO

Page ATT 2

ACTION 2. The Steam Generator Blowdown Monitor is now used in a clean up loop instead of an effluent direct to Lake Michigan. Certain offline functions require flow be rerouted from the monitor and should not require an Action statement to be entered.

JUSTIFICATION

1. No-The monitors will be operational when in an effluent mode.
2. No-Same as 1.
3. No-Operability of monitors is not applicable to equipment malfunctions.
4. No-Same as 3.
5. No-Operation of monitors cannot create and accident.
6. NO-Operation of monitors can not cause other malfunctions.
7. NO margin of safety is applicable to effluent monitors.

PALISADES NUCLEAR PLANT
OFFSITE DOSE CALCULATION MANUAL

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

Thomas P. Neal, 11-3-99
Procedure Sponsor Date

Richard J. Wagner, 11/3/99
Technical Reviewer Date

- N/A -
User Reviewer Date

[Signature], 11/4/99
Plant Manager - Operations Date

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

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**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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E-3	Detection Capabilities for Environmental Sample Analysis
F-1	Environmental Radiological Monitoring Program Summary

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

I. **INTRODUCTION**

The NRC, through 10CFR50.36a, requires implementation of Technical Specifications on effluents from nuclear power plants. NRC Generic Letter 89-01, dated January 31, 1989, allowed relocation of the existing procedural requirements from the Technical Specifications (implemented in Amendment 85, November 9, 1984). The relocated procedural requirements related to gaseous and liquid effluents, total dose, environmental monitoring program, and associated procedural reporting requirements follow below. Programmatic controls are retained in the Administrative Controls section of the Technical Specification to satisfy the regulatory requirements of 10CFR50.36a. The Technical Specifications programmatic controls include requirements for the establishment, implementation, maintenance, and changes to the Offsite Dose Calculation Manual (ODCM) as well as record retention and reporting requirements.

II. **DEFINITIONS**

- A. **Channel Calibration** - a Channel Calibration shall be the adjustment, as necessary, of the channel output such that it responds with the necessary range and accuracy to known values of the parameter which the channel monitors. The Channel Calibration shall encompass the entire channel including the sensor and alarm and/or trip functions, and shall include the Channel Function Test. The Channel Calibration may be performed by any series of sequential, overlapping or total channel steps such that the entire channel is calibrated.
- B. **Channel Check** - a Channel Check shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrumentation channels measuring the same parameter.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

- C. Channel Functional Test - a Channel Functional Test shall be:
1. Analog channels - the injection of a simulated signal into the channel as close to the sensor as practicable to verify operability including alarm and/or trip functions.
 2. Bistable channels - the injection of a simulated signal into the sensor to verify operability including alarm and/or trip functions.
- D. Source Check - a source check shall be the qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.
- E. Offsite Dose Calculation Manual - (per Plant Technical Specification) - the Offsite Dose Calculation Manual (ODCM) shall contain the methodology and parameters used in the calculation of offsite doses resulting from radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring alarm/trip setpoints, and in the conduct of the Radiological Environmental Monitoring Program. The ODCM shall also contain; 1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs required by the Technical Specifications and, 2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Radioactive Effluent Release Reports required by the Technical Specifications.
- F. Gaseous Radwaste Treatment System - any system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system off gases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.
- G. Members of the Public - all persons who are not occupationally associated with the Plant. This category does not include employees of the utility, its contractors or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries.

PALISADES NUCLEAR PLANT
OFFSITE DOSE CALCULATION MANUAL

ODCM
Appendix A
Revision 9
Page 3 of 61

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

- H. Process Control Program (PCP) - shall contain the current formula, sampling, analyses, tests and determinations to be made to ensure that the 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 10CFR Part 20, 10CFR Part 71 and Federal and State regulations and other requirements governing the disposal of the radioactive waste.
- I. Site Boundary - that line beyond which the land is neither owned nor otherwise controlled by the licensee.
- J. Unrestricted Area - any area at or beyond the Site Boundary access which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials or, any area within the Site Boundary used for residential quarters or for industrial, commercial, institutional, and/or recreational purposes.
- K. Ventilation Exhaust Treatment System - any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal absorbers and/or HEPA filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment. Such a system is not considered to have any effect on noble gas effluents. Engineered Safety Feature (ESF) atmospheric cleanup systems are not considered to be ventilation exhaust treatment system components.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

III. PROCEDURAL AND SURVEILLANCE REQUIREMENTS AND BASES

A. Radioactive Gaseous Effluent Monitoring Instrumentation

1. Requirement:

The radioactive gaseous effluent monitoring instrumentation channels shown in Table A-1 shall be operable with their alarm/trip setpoints set to ensure that the limits of requirement III.B.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

2. Action:

- a. With a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above requirement, without delay, suspend the release of radioactive gaseous effluents monitored by the affected channel or declare the channel inoperable or change the setpoint so it is acceptably conservative.
- b. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels operable, take the action shown in Table A-1. Exert best efforts to return the instruments to operable status within 30 days and, if unsuccessful, explain in the next Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.

3. Surveillance Requirements:

Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated operable by performance of the Channel Check, Source Check, Channel Calibration and Channel Functional Test operations at the frequencies shown in Table A-2.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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4. Bases:

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The alarm/trip setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10CFR Part 20.

The operability and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10CFR Part 50.

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**Table A-1
Radioactive Gaseous Effluent Monitoring Instrumentation**

Instrument	Minimum Operable Channels	Applicability	Action
1. WASTE GAS HOLDUP SYSTEM			
a. Noble Gas Activity Monitor (RIA 1113) Providing Alarm and Automatic Termination of Release	(1)	At All Times	1
2. CONDENSER EVACUATION SYSTEM (RIA 0631)			
a. Noble Gas Activity Monitor	(1)	Above 210°F	3
b. Evacuation Flow Indicator (FI-0631 or FI-0632)	(1)***	Above 210°F	
3. STACK GAS EFFLUENT SYSTEM			
a. Noble Gas Activity Monitor (RIA 2326)	(1)	At All Times	3
b. Iodine/Particulate/Sampler/Monitor (RIA 2325)	(1)	At All Times	3
c. Sampler Flow Rate Monitor	(1)	At All Times	2
d. Hi Range Noble Gas (RIA 2327)*	(1)	Above 210°F	4
4. STEAM GENERATOR BLOWDOWN VENT SYSTEM			
a. Noble Gas Activity Monitor (RIA 2320)	(1)	Above 210°F	3
5. MAIN STEAM SAFETY AND DUMP VALVE DISCHARGE LINE			
a. Gross Gamma Activity Monitor* (RIA 2323 and 2324)	1 per Main Steam Line	Above 325°F	4
6. ENGINEERED SAFEGUARDS PUMP ROOM VENTILATION HIGH RADIATION SYSTEM			
a. Noble Gas Activity Monitor ** (RIA 1810 and 1811)	1 per Room	Above 210°F	5

* Setpoints for these instruments are exempted from III.B.1 limits, but are governed by Emergency Implementing Procedures or Operating procedures.

** Setpoints for these instruments are exempted from III.B.1 limits, but are governed by Technical Specification Section 3.16 and Table 3.16 {ITS - Improved Technical Specification SR 3.3.10.3}.

*** Documentation of operability not required.

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Table A-1 (Cont'd)

TABLE NOTATION - ACTION STATEMENTS

- ACTION 1 -** With the number of channels operable less than required by the Minimum Operable Channels requirements, the contents of the tank(s) may be released to the environment provided that prior to initiating the release:
- a. At least two independent samples of the tank's contents are analyzed, and
 - b. At least two technically qualified members of the Facility staff independently verify the release rate calculations and discharge valve line up;
- Otherwise, suspend release of radioactive effluents via this pathway.
- ACTION 2 -** With the number of channels operable less than required by the Minimum Operable Channels requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 24 hours.
- ACTION 3 -** With the number of channels operable less than required by the Minimum Operable Channels requirement, effluent releases via this pathway may continue provided grab samples are taken at least once per 12 hours and these samples are analyzed for gross activity within 24 hours.
- ACTION 4 -** With the number of operable channels less than required by the Minimum Operable Channels requirements, initiate the preplanned alternate method of monitoring the appropriate parameter(s), within 72 hours, and:
- a. Either restore the inoperable channel(s) to operable status within 7 days of the event, or
 - b. Prepare and submit a Special Report to the NRC within 30 days following the event outlining the actions taken, the cause of the inoperability, and the plans and schedule for restoring the system to operable status.
- ACTION 5 -** If either channel fails low or is otherwise inoperable, the ventilation dampers associated with that channel shall be closed immediately and action shall be taken to have the affected channel repaired. The dampers associated with the channel shall not be opened until the affected channel has been declared operable. (Reference Technical Specification 3.17.3.4.)

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**Table A-2
Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements**

Instrument	Channel Check	Source Check	Channel Calibration	Channel Functional Test	Modes in Which Surveillance Required
1. WASTE GAS HOLDUP SYSTEM					
a. Noble Gas Activity Monitor-Providing Alarm and Automatic Termination of Release	D(4)	P	R(3)	Q(1)(2)	*
2. CONDENSER EVACUATION SYSTEM					
a. Noble Gas Activity Monitor	D	M	R(3)	Q(2)	Above 210°F
b. Evacuation Flow Indicator (FI-0632) or	***	***	***	***	
c. Evacuation Flow Indicator (FI-0631)	***	***	***	***	
3. STACK GAS EFFLUENT SYSTEM					
a. Noble Gas Activity Monitor	D	M	R(3)	Q(2)	*
b. Iodine Particulate Sampler/Monitor	W	M**	R(3)**	NA	*
c. Sampler Flow Rate Monitor	D	NA	R	NA	*
d. Hi Range Noble Gas	D	M	R(3)	Q(2)	Above 210°F
4. STEAM GENERATOR BLOWDOWN VENT SYSTEM					
a. Noble Gas Activity Monitor	D	M	R(3)	Q(2)	Above 210°F
5. MAIN STEAM SAFETY AND DUMP VALVE DISCHARGE LINE					
a. Gross Gamma Activity Monitor	D	M	R(3)	Q(2)	Above 325°F
6. ENGINEERED SAFEGUARDS PUMP ROOM VENTILATION HIGH RADIATION SYSTEM					
a. Noble Gas Activity Monitor (Technical Specification Table 4.17.3 Item 4)	S	M	R(3)	M(1)(2)	Above 210°F

* At all times other than when the line is valved out and locked.

** Sampler not applicable

*** This type of Flowmeter doesn't have any surveillance requirements.

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Table A-2 (Cont'd)
TABLE NOTATION

- (1) The Channel Functional Test shall also demonstrate that automatic isolation of this pathway occurs if instrument indicates measured levels above the alarm/trip setpoint.
- (2) The Channel Functional Test shall also demonstrate that control room alarm annunciation occurs if either of the following conditions exists.
 - a. Instrument indicates measured levels above the alarm setpoint (not applicable for Item 3.d, Hi Range Noble Gas).
 - b. Circuit failure.
- (3)
 - a. The Channel Calibration shall be performed using one or more of the reference standards traceable to the National Institute of Standards and Technology or using standards that have been obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range.
 - b. For subsequent Channel Calibration, sources that have been related to the (1) calibration may be used.
- (4) Channel Check shall be made at least once per 24 hours on days on which continuous or batch releases are made.

TABLE FREQUENCY NOTATION

S	At least once per 12 hours
D	At least once per 24 hours
M	At least once per 31 days
P	Prior to radioactive batch release
Q	At least once per 92 days
R	At least once per 18 months
W	At least once per week

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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B. Gaseous Effluents Dose Rate

1. Requirement:

The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the Site Boundary (see Figure 2-1) shall be limited to the following:

- a. For noble gases: Less than or equal to 500mrems/yr to the total body and less than or equal to 3000 mrems/yr to the skin, and
- b. For Iodine-131, for Iodine-133, for tritium, and for all radionuclides in particulate form with half-lives greater than 8 days: Less than or equal to 1500 mrems/yr to any organ.

2. Action:

With the dose rate(s) averaged over a period of one hour exceeding the above limits, without delay, restore the release rate to within the above limit(s).

3. Surveillance Requirements:

- a. The dose rate due to noble gases in gaseous effluents shall be determined to be within the limits of B.1.a in accordance with the methodology and parameters in the ODCM.
- b. The dose rate due to Iodine-131, Iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents shall be determined to be within the limits of B.1.b in accordance with the methodology and parameters in the ODCM by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table B-1.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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4. Bases:

This is provided to ensure that the dose at any time at and beyond the Site Boundary from gaseous effluents from all units on the site will be within 10 times the annual dose limits of 10CFR Part 20 to Unrestricted Areas. The annual dose limits are the doses associated with the concentrations of 10 times 10CFR Part 20, Appendix B, Table 2, Column 1. These restrictions provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a Member of the Public in an Unrestricted Area, either within or outside the Site Boundary, to annual exposure greater than design objectives of 10CFR 50, Appendix I, Section II.B.1. For Members of the Public who may at times be within the Site Boundary, the occupancy of the Member of the Public will usually be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the Site Boundary. Examples of calculations for such Members of the Public, with the appropriate occupancy factors, shall be given in the ODCM. The specified release rate limits restrict, at all times, the corresponding dose rate above background to a Member of the Public at or beyond the Site Boundary to less than or equal to 500 mrem/yr to the total body.

The required detection capabilities for radioactive materials in gaseous waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD and other detection limits can be found in HASL Procedures Manual, HASL-300, Currie, L A, "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal Chem **40**, 586-93 (1968), and Hartwell, JK, "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

C. Noble Gases Dose

1. Requirement:

The air dose due to noble gases released in gaseous effluents to areas at and beyond the Site Boundary (see Figure 2-1) shall be limited to the following:

- a. During any calendar quarter: Less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation, and
- b. During any calendar year: Less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

2. Action:

With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the NRC within 30 days a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

3. Surveillance Requirements:

Cumulative dose contributions for the current calendar quarter and current calendar year for noble gases shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

4. Bases:

This requirement is provided to implement the requirements of Sections II.B, III.A, and IV.A of Appendix I, 10CFR Part 50. The limiting Condition for Operation implements the guides set forth in Section II.B of Appendix I. The Action statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to Unrestricted Areas will be kept "as low as is reasonably achievable." The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a Member of the Public through appropriate pathways is unlikely to be substantially underestimated. The dose calculation methodology and parameters established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR 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 ODCM equations provided for determining the air doses at and beyond the Site Boundary are based upon the historical average atmospheric conditions.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

D. I-131, I-133, Tritium, and Particulates

1. Requirement:

The dose to a Member of the Public from Iodine-131, Iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, from each reactor unit, to areas at and beyond the Site Boundary (see Figure 2-1) shall be limited to the following:

- a. During any calendar quarter: Less than or equal to 7.5 mrems to any organ, and
- b. During any calendar year: Less than or equal to 15 mrems to any organ.

2. Action:

With the calculated dose from the release of Iodine-131, Iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the NRC within 30 days a Special Report that identifies the cause(s) for exceeding the limit and define(s) the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

3. Surveillance Requirements:

Cumulative dose contributions for the current calendar quarter and current calendar year for Iodine-131, Iodine-133, tritium and radionuclides in particulate form with half-lives greater than 8 days shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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4. Bases:

This requirement is provided to implement the requirements of Sections II.C, III.A, and IV.A of Appendix I, 10CFR Part 50. The requirements are the guides set forth in Section II.C of Appendix I. The Action statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents to Unrestricted Areas will be kept "as low as is reasonably achievable." The ODCM calculational methods specified in the Surveillance Requirements implement the requirements in Section II.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a Member of the Public through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methodology and parameters for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases From Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate requirements for Iodine-131, Iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man, in areas at and beyond the Site Boundary. The pathways that were examined in the development of these calculations were: 1) individual inhalation of airborne radionuclides, 2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, 3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and 4) deposition on the ground with subsequent exposure of man.

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**Table B-1
Radioactive Gaseous Waste Sampling and Analysis Program**

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit Detection (LLD)^a (μCi/ml)
A. Waste Gas Storage Tank	P Each Tank Grab Sample	P Each Tank	Principal Gamma Emitters ^b	1×10^{-4}
B. Containment PURGE	P Each PURGE Grab Sample	P Each PURGE	Principal Gamma Emitters ^b	1×10^{-4}
C. Stack Gas Effluent	Continuous ^c	W ^{d,e} Charcoal Sample	I-131, I-133	1×10^{-12}
	Continuous ^c	W ^{d,e} Particulate Sample	Principal Gamma Emitters ^b (I-131, Others)	1×10^{-11}
	Continuous ^c	Q Composite Particulate Sample	Sr-89, Sr-90 and Gross Alpha	1×10^{-11}
	Continuous ^c	Noble Gas Monitor	Noble Gases Gross Beta or Gamma	1E-06

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Table B-1 (Cont'd)

TABLE NOTATION

- a The LLD is defined, in Table E-3, note C.
- b The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emissions and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99*, Cs-134, Cs-137, Ce-141, and Ce-144* for particulate emissions. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report.
- *Ten times the LLD because of low gamma yields.
- c The ratio of the sample flow rate to the sample stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with requirements III.B.1, III.C.1, and III.D.1.
- d Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing or after removal from sampler.
- e With channels operable on iodine monitor RIA 2325 less than required per III.A.1, sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, start-up or Thermal Power change exceeding 15 percent of Rated Thermal Power in one hour and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement does not apply if, 1) analysis shows that the Dose Equivalent I-131 concentration in the primary coolant has not increased more than a factor of 3, and 2) the noble gas monitor shows that effluent activity has not increased more than a factor of 3.

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E. Gaseous Waste Treatment System

1. Requirement:

When gaseous waste exceeds a Xe-133 concentration of $1E-05 \mu\text{Ci/cc}$, the Waste Gas Decay Tank System shall be used to reduce radioactive gaseous effluents by holding gaseous waste collected by the system for a minimum of 15 days up to 60 days.

2. Action:

- a. If a waste gas decay tank is required to be released with less than 60 days holdup time, the system waste gas tank contents shall be evaluated and the waste gas decay tank with the lowest Xe-133 content shall be released.
- b. Gaseous waste may be discharged directly from the waste gas surge tank through a high-efficiency filter or from a waste gas decay tank with less than 15 days of holdup directly to the stack for a period not to exceed 7 days if the holdup system equipment is not available and the release rates meet requirements III.B, C, and D.

3. Surveillance Requirements:

Not Applicable.

4. Bases:

The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable" by meeting the design objectives given in Section II.D of Appendix I to 10CFR50.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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It is expected that releases of radioactive materials in effluents shall be kept at small fractions of the limits specified in 20.1302 of 10CFR20. At the same time the licensee is permitted the flexibility of operation, compatible with considerations of health and safety, to assure that the public is provided a dependable source of power even under unusual operating conditions which may temporarily result in releases higher than such small fractions, but still within the limits specified in III.B, C, and D.

F. Radioactive Liquid Effluent Monitoring Instrumentation

1. Requirement:

The radioactive liquid effluent monitoring instrumentation channels shown in Table C-1 shall be operable with their alarm/trip setpoints set to ensure that the limits of III.G are not exceeded. The alarm/trip setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the Offsite Dose Calculation Manual (ODCM).

2. Action:

a. With a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above specification, without delay suspend the release of radioactive liquid effluents monitored by the affected channel or declare the channel inoperable, or change the setpoint so it is acceptably conservative.

b. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels Operable, take the Action shown in Table C-1. Exert best efforts to return the instruments to Operable status within 30 days and, if unsuccessful, explain in the next Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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3. Surveillance Requirements:

Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated Operable by performance of the Channel Check, Source Check, Channel Calibration and Channel Functional Test operations at the frequencies shown in Table C-2.

4. Bases:

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The alarm/trip setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10CFR Part 20. The Operability and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10CFR Part 50.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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Table C-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Instrument	Minimum Operable Channels	Applicability	Action
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE			
a. Liquid Radwaste Effluent Line (RIA 1049)	(1)	For Effluent Releases	1
b. Steam Generator Blowdown Effluent Line (RIA 0707)	(1)	For Effluent Releases	2
2. GROSS BETA OR GAMMA RADIOACTIVE MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE			
a. Service Water System Effluent Line (RIA 0833)	(1)	For Effluent Releases	3
b. Turbine Building (Floor Drains) Sumps Effluent Line (RIA 5211)	(1)	For Effluent Releases	3
3. FLOW RATE MEASUREMENT DEVICES			
a. Liquid Radwaste Effluent Line (FIC 1051 or 1050)	(1)	For Effluent Releases	4
4. CONTINUOUS COMPOSITE SAMPLERS (Alarm/Trip Setpoints are not applicable)			
a. Turbine Building Sumps Effluent Line	(1)	For Effluent Releases	3
b. Service Water System Effluent	(1)	For Effluent Releases	3
c. Steam Generator Blowdown Effluent	(1)	For Effluent Releases	3

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Table C-1 (Cont'd)

TABLE NOTATION

ACTION 1 - With the number of channels operable less than required by the Minimum Operable Channels requirement, effluent releases may continue provided that prior to initiating a release:

- a. At least two independent samples are analyzed in accordance with requirements and
- b. At least two technically qualified members of the Facility Staff independently verify the release rate calculations and discharge line valving;

Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 2 - With the number of channels operable less than required by the Minimum Operable Channels requirement, effluent releases via this pathway may continue provided grab samples are analyzed for radioactivity at a lower limit of detection as specified in Table D-1 for principle gamma emitters and I-131 at least once per 12 hours.

NOTE: The Steam Generator blowdown monitor is normally used in a clean up closed loop system instead of as an effluent monitor. The action statement only applies when the monitor is used as an effluent monitor.

ACTION 3 - With the number of channels operable less than required by the Minimum Operable Channels requirement, effluent releases via this pathway may continue provided that, at least once per 24 hours, grab samples are collected and analyzed for radioactivity at a lower limit of detection as specified in Table D-1 for principle gamma emitters and I-131.

ACTION 4 - With the number of channels operable less than required by the Minimum Operable Channels requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves or tank levels may be used to estimate flow.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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Table C-2

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Instrument	Channel Check	Source Check	Channel Calibration	Channel Functional Test
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE				
a. Liquid Radwaste Effluent Line (RIA 1049)	P	P	R(3)	Q(1)(2)
b. Steam Generator Blowdown Effluent Line (RIA 0707)	D	M	R(3)	Q(1)(2)
2. GROSS GAMMA OR GAMMA RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE				
a. Service Water System Effluent Line (RIA 0833)	D	M	R(3)	Q(2)
b. Turbine Building (Floor Drains) Sumps Effluent Line (RIA 5211)	D	M	R(3)	Q(2)
3. FLOW RATE MEASUREMENT DEVICES (5)				
a. Liquid Radwaste Effluent Line (FIC 1051 or 1050)	D(4)	NA	R	NA
4. TURBINE SUMP EFFLUENT COMPOSITER	D(4)	NA	NA	NA
5. SERVICE WATER SYSTEM EFFLUENT COMPOSITE SAMPLER	D(4)	NA	NA	NA
6. STEAM GENERATOR BLOWDOWN EFFLUENT COMPOSITER	D(4)	NA	NA	NA

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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Table C-2 (Cont'd)

TABLE NOTATION

- (1) The Channel Functional Test shall also demonstrate that automatic isolation of this pathway occurs if instrument indicates measured levels above the alarm/trip setpoint.
- (2) The Channel Functional Test shall also demonstrate that Control Room alarm annunciation occurs if either of the following conditions exists:
 - a. Instrument indicates measured levels above the alarm setpoint.
 - b. Circuit failure.
- (3)
 - a. The Channel Calibration shall be performed using one or more of the reference standards traceable to the National Institute of Standards and Technology or using standards that have been obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range.
 - b. For subsequent Channel Calibration, sources that have been related to the (a) calibration may be used.
- (4) Channel Check shall consist of verifying indication of flow during periods of releases. Channel Check shall be made at least once per 24 hours on days on which continuous or batch releases are made.
- (5) Turbine Sump Discharge Flow Meter FQI-5210 was calibrated at factory and doesn't require recalibration.

TABLE FREQUENCY NOTATION

D	At least once per 24 hours	Q	At least once per 92 days
M	At least once per 31 days	R	At least once per 18 months
P	Prior to radioactive batch release	W	At least once per week

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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G. Liquid Effluents Concentration

1. Requirement:

The concentration of radioactive material released in liquid effluents to Unrestricted Areas shall be limited to 10 times the concentrations specified in 10CFR Part 20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} microcuries/ml total activity.

2. Action:

With the concentration of radioactive material released in liquid effluents to Unrestricted Areas exceeding the above limits, without delay, restore the concentration to within the above limits.

3. Surveillance Requirements:

- a. Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program of Table D-1.
- b. The results of the radioactivity analysis shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits of G.1 above.

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4. Bases:

This requirement is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to Unrestricted Areas will be less than 10 times the concentration levels specified in 10CFR Part 20, Appendix B, Table 2, Column 2. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in Unrestricted Areas will result in exposures within the Section II.A design objectives of Appendix I, 10CFR Part 50, to a Member of the Public. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and 10 times the effluent concentration in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD and other detection limits can be found in HASL Procedures Manual, HASL-300, Currie, LA, "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal Chem 40, 586-93 (1968), and Hartwell, JK, "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

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**Table D-1
Radioactive Liquid Waste Sampling and Analysis Program**

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit Detection (LLD) ^a ($\mu\text{Ci/ml}$)
A. Batch Waste Release Tanks ^b	P Each Batch	P Each Batch	Principal Gamma Emitters ^c I-131	5×10^{-7} 1×10^{-6}
	P One Batch/M	M	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
	P Each Batch	M Composite ^d	H-3 Gross Alpha	1×10^{-5} 1×10^{-7}
	P Each Batch	Q Composite ^d	Sr-89, Sr-90	5×10^{-8}
B. Continuous Releases ^a (Turbine Sump, Steam Generator Blowdown, and Service Water)	Continuous ^f	W ^f Composite	Principal Gamma Emitters ^c I-131	5×10^{-7} 1×10^{-6}
	M Grab Sample	M	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
	Continuous ^f	M Composite ^f	H-3 Gross Alpha	1×10^{-5} 1×10^{-7}
	Continuous ^f	Q Composite ^f	Sr-89, Sr-90	5×10^{-8}

Frequency Notation

- P** Prior to batch release
- M** Calendar month
- Q** Calendar quarter
- W** Calendar week

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Table D-1 (Cont'd)

TABLE NOTATION

- a The LLD is defined, in Table E-3, Note C.
- b A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated and then thoroughly mixed to assure representative sampling.
- c The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99*, Cs-134, Cs-137, Ce-141, and Ce-144*. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report.
- *LLD - 5E-06 because of low gamma yields.
- d A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen that is representative of the liquids released.
- e A continuous release is the discharge of liquid wastes of a nondiscrete volume; eg, from a volume of a system that has an input flow during the continuous release.
- f To be representative of the quantities and concentrations of radioactive materials in liquid effluents, samples shall be collected in a series of aliquots of constant volume collected at regular time intervals and combined to form a single sample. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent release.

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H. Liquid Effluent Dose

1. Requirement:

The dose or dose commitment to a Member of the Public from radioactive materials in liquid effluents released from each reactor unit to Unrestricted Areas shall be limited:

- a. During any calendar quarter to less than or equal to 1.5 mrem to the total body and to less than or equal to 5 mrem to any organ, and
- b. During any calendar year to less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

2. Action:

With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the NRC within 30 days a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits. This Special Report shall also include the results of radiological analyses of the drinking water source.

3. Surveillance Requirements:

Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined in accordance with the methodology and parameters in the ODCM at least once every 31 days.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

4. Bases:

This requirement is provided to implement the requirements of Sections II.A, III.A, and IV.A of Appendix I, 10CFR Part 50. The Limiting Condition for Operation implements the guides set forth in Section II.A of Appendix I. The Action statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents to Unrestricted Areas will be kept "as low as is reasonably achievable." Also, for freshwater sites with drinking water supplies that can be potentially affected by Plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40CFR Part 141. The dose calculation methodology and parameters in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a Member of the Public through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM 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 10CFR 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.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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I. Total Dose

1. Requirement:

The annual (calendar year) dose or dose commitment to any Member of the Public due to releases of radioactivity and to 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.

2. Action:

With the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of III.C.1.a, III.C.1.b, III.D.1.a, III.D.1.b, III.H.1.a, or III.H.1.b, calculations should be made including direct radiation contributions from the reactor units and from outside storage tanks to determine whether the above limits of III.I.1 have been exceeded. If such is the case, prepare and submit to the NRC within 30 days a Special Report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report, as defined in 10CFR 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 40CFR Part 190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40CFR Part 190. Submittal of the report is considered a timely request and a variance is granted until staff action on the request is complete.

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3. Surveillance Requirements:
 - a. Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with III.C.1, III.D.1 and III.H.1 and in accordance with the methodology and parameters in the ODCM.
 - b. Cumulative dose contributions from direct radiation from the reactor units and from radwaste storage tanks shall be determined in accordance with the methodology and parameters in the ODCM. This requirement is applicable only under conditions set forth in Action 1.2 above.

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4. Bases:

This requirement is provided to meet the dose limitations of 40CFR Part 190 that have been incorporated into 10CFR Part 20 by 46 FR 18525. It also requires the preparation and submittal of a Special Report whenever the calculated doses from Plant generated radioactive effluents and direct radiation exceed 25 mrems to the total body or any organ, except for thyroid, which shall be limited to less than or equal to 75 mrems. For sites containing up to 4 reactors, it is highly unlikely that the resultant dose to a Member of the Public will exceed the dose limits of 40CFR Part 190 if the individual reactors remain within twice the dose design objectives of Appendix I and if direct radiation doses from the reactor units and outside storage tanks are kept small. 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 40CFR 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 40CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40CFR Part 190 have not already been corrected), in accordance with the provisions of 40CFR Part 190.11 and 10CFR Part 20.2203, is considered to be a timely request and fulfills the requirements of 40CFR Part 190 until NRC staff action is completed. The variance only relates to the limits of 40CFR Part 190 and does not apply in any way to the other requirements for dose limitation of 10CFR 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.

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J. Radiological Environmental Monitoring

1. Requirement:

The radiological environmental monitoring program shall be conducted as specified in Table E-1.

2. Action:

- a. With the radiological environmental monitoring program not being conducted as specified in Table E-1, prepare and submit to the NRC, in the Annual Radiological Environmental Operating Report a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.
- b. With the level of radioactivity as the result of Plant effluents in an environmental sampling medium at a specified location exceeding the reporting levels of Table E-2 when averaged over any calendar quarter, prepare and submit to the NRC within 30 days a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce radioactive effluents. When more than one of the radionuclides in Table E-2 are detected in the sampling medium, this report shall be submitted if:

$$\frac{\text{Concentration (1)}}{\text{Reporting Level (1)}} + \frac{\text{Concentration (2)}}{\text{Reporting Level (2)}} + \dots \geq 1.0$$

When radionuclides other than those in Table E-2 are detected and are the result of Plant effluents, this report shall be submitted if the potential annual dose to a Member of the Public is equal to or greater than the calendar year limits of III.C.1, III.D.1, and III.H.1. 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 Operating Report.

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- c. With milk or fresh leafy vegetable samples unavailable from one or more of the sample locations required by Table E-1, identify locations for obtaining replacement samples and add them to the radiological environmental monitoring program within 30 days. The specific locations from which samples were unavailable may then be deleted from the monitoring program. Identify the cause of the unavailability of samples and identify the new location(s) for obtaining replacement samples in the next Annual Radiological Environmental Report.
3. Surveillance Requirements:
- a. The radiological environmental monitoring samples shall be collected pursuant to Table E-1 and shall be analyzed pursuant to the requirements of Table E-1 and the detection capabilities required by Table E-3.
 - b. A land use census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 9 overland meteorological sectors of the nearest milk animal, the nearest residence and the nearest garden of greater than 50 m² (500 ft²) producing broad leaf vegetation.
 - c. The land use census shall be conducted during the growing season at least once per 12 months using that information that will provide the best results, such as by a door-to-door survey, aerial survey, or by consulting local agriculture authorities. The results of the land use census shall be included in the Annual Radiological Environmental Operating Report and shall be included in a revision of the ODCM for use in the following calendar year.
 - d. Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program that has been approved by the NRC.

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- e. A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report.
 - f. The environmental air samplers shall be operationally checked monthly and airflow verified annually.
4. Bases:

a. Monitoring Program

The radiological environmental monitoring program provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of Members of the Public resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10CFR Part 50 and thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. The initially specified monitoring program will be effective for at least the first three years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table E-3 are considered optimum for routine environmental measurements in industrial laboratories.

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Detailed discussion of the LLD, and other detection limits, can be found in HASL Procedures Manual, HASL-300, Currie, LA, "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal Chem 40, 586-92 (1968), and Hartwell, JK, "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-15 (June 1975).

b. Land Use Census:

This requirement is provided to ensure that changes in the use of areas at and beyond the site boundary are identified and that modifications to the radiological environmental monitoring program are made if required by results of this census. The best information from the door-to-door survey, from aerial survey or from consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10CFR Part 50. Restricting the census to gardens of greater than 50 m² provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (16 kg/yr) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child.

To determine this minimum garden size, the following assumptions were made: (1) 20% of the garden was used for growing broad leaf vegetation (ie, similar to lettuce and cabbage), and (2) a vegetation yield of 2 kg/m².

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c. Interlaboratory Comparison Program:

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

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Table E-1

Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations^a	Sampling and Collection Frequency	Type of Frequency of Analysis
1. DIRECT RADIATION^b	<p>21 routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows:</p> <p>An inner ring of stations, one in each overland meteorological sector (9) in the general area of the Site Boundary.</p> <p>An outer ring of stations, one in each overland meteorological sector (9) within the 12 km range from the site.</p> <p>The balance of the stations (3) to be placed to serve as control stations.</p>	Quarterly	Gamma dose quarterly

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Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations ^a	Sampling and Collection Frequency	Type of Frequency of Analysis
<p>2. AIRBORNE</p> <p>Radioiodine and Particulates</p>	<p>Samples from 5 locations.</p> <p>3 samples from within 6 km of the Site Boundary in different sectors (2.4 km-SSW, 5.6 km-ESE, and 1.6 km-N).</p> <p>1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q (Covert-5.6 km-SE).</p> <p>1 sample from a control location in the least prevalent wind direction^c (Grand Rapids 89 km-NNE).</p>	<p>Continuous sample operation with sample collection weekly or more frequently if required by dust loading.</p>	<p><u>Radioiodine Canister:</u> I-131 analysis weekly for each filter change.</p> <p><u>Particulate Sampler:</u> Gross beta radioactivity analysis following filter change^d. Gamma isotopic analysis^e if gross beta > 1.0 pCi/m³.</p>
<p>3. WATERBORNE</p> <p>a. Lake (surface)</p> <p>b. Well (drinking)</p> <p>c. Lake (drinking)</p> <p>d. Sediment from shoreline</p>	<p>Plant lake water inlet.</p> <p>Samples from Plant, State Park, and Covert Township Park wells.</p> <p>1 sample of South Haven drinking water supply.</p> <p>1 sample from between north boundary and Van Buren State Park beach, approximately 1/2 mile north of the Plant discharge.</p>	<p>Composite sample over 1-month period.</p> <p>Monthly - grab sample.</p> <p>Composite sample over 1-month period.</p> <p>Semiannually</p>	<p>Gross beta (> 10 pCi/l requires gamma) and tritium monthly.</p> <p>Gross beta (> 10 pCi/l requires gamma) and tritium monthly.</p> <p>Gross beta (> 10 pCi/l requires gamma) and tritium monthly.</p> <p>Gamma isotopic analysis^e semiannually.</p>

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Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations ^a	Sampling and Collection Frequency	Type of Frequency of Analysis
<p>4. INGESTION</p> <p>a. Milk</p>	<p>Samples from milking animals in 3 locations between 5-13 km distance.</p> <p>1 sample from milking animals at a control location, 15-30 km distance.</p> <p>NOTE: Samples of 3 different kinds of broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average ground level D/Q if milk sample is not performed. (SE or SSE sectors near site).</p> <p>1 sample of each of the similar broad leaf vegetation grown 15-30 km distance in the least prevalent wind direction if milk sampling is not performed. (SSW or S sectors).</p>	<p>Monthly</p> <p>Sample in season or semiannually if they are not seasonal.</p> <p>At time of harvest^g.</p>	<p>Gamma isotopic^g and I-131 analysis monthly.</p> <p>Gamma isotopic analysis^g on edible portions.</p> <p>Gamma isotopic^g and I-131 analysis.</p>
<p>b. Fish and Invertebrates</p>	<p>Sample 2 species of commercially and/or recreationally important species in vicinity of Plant discharge area. 1 sample of same species in areas not influence by Plant discharge.</p>	<p>Monthly when available.</p>	<p>Gamma isotopic^g and I-131 analysis.</p>
<p>c. Crops</p>	<p>1 sample each of two principal fruit crops (blueberries and apples).</p>	<p>Monthly when available.</p>	<p>Gamma Isotopic^g and I-131 analysis.</p>

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Table E-1 (Cont'd)
Table Notation

- a Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, every effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances, suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the radiological environmental monitoring program.
- b One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place, or in addition to, integrating dosimeters. For the purposes of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors or phosphor readout zones in a packet are considered as two or more dosimeters.
- c The purpose of this sample is to obtain background information. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites that provide valid background data may be substituted.
- d Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than ten times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.
- e Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.
- f A composite sample is one in which the quantity (aliquot) of liquid samples is proportional to the quantity of liquid discharged and in which the method of sampling employed results in a specimen that is representative of the liquid released (continuous composites or daily grab composites which meet this criteria are acceptable).
- g If harvest occurs more than once a year, sampling shall be performed during each discrete harvest.

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**Table E-2
Reporting Levels for Radioactivity Concentrations in Environmental Samples**

Reporting Levels

Analysis	Water (pCi/l)	Airborne Particulates or Gases (pCi/m³)	Fish (pCi/kg, Wet)	Milk (pCi/l)	Food Products (pCi/kg, Wet)
H-3	20,000*				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	2	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200			300	

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* For drinking water samples. This is 40CFR Part 141 value. If no drinking water pathway exists, a value of 30,000 pCi/l may be used.

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Table E-3

Detection Capabilities for Environmental Sample Analysis^a

Lower Limit of Detection (LLD)^{bc}

Analysis	Water (pCi/l)	Airborne Particulates or Gases (pCi/m³)	Fish (pCi/kg, Wet)	Milk (pCi/l)	Food Products (pCi/kg, Wet)	Sediment (pCi/kg, Dry)
Gross Beta	4	0.01				
H-3	2,000*					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131	1 ^d	0.07		1	60	
Cs-134	15	0.05	130	15	80	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15			15		

* If no drinking water pathway exists, a value of 3,000 pCi/l may be used.

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Table E-3 (Cont'd)
TABLE NOTATION

- a** This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report.
- b** Required detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.
- c** 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% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{4.66_s}{E \cdot V \cdot 2.22 \cdot Y \cdot \text{Exp}(-\lambda\Delta t)}$$

Where:

LLD is the "a priori" lower limit of detection as defined above, as picocuries per unit mass or volume.

s^b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate, as counts per minute.

E is the counting efficiency, as counts per disintegration.

V is the sample size in units of mass or volume.

2.22 is the number of disintegrations per minute per picocurie.

Y is the fractional radiochemical yield, when applicable.

λ is the radioactive decay constant for the particular radionuclide.

Δt for environmental samples is the elapsed time between sample collection, or end of the sample collection period, and time of counting.

Typical values of E, V, Y, and Δt should be used in the calculation.

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Table E-3 (Cont'd)
Table Notation

It should be recognized that the LLD is defined as an "a priori" (before the fact) limit representing the capability of a measurement system and not as an "a posteriori" (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report.

- ^d LLD for drinking water samples. If no drinking water pathway exists, the LLD of gamma isotopic analysis may be used.

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K. SIRW or Temporary Liquid Storage Tank

1. Requirement:

The concentration of radioactive material contained in the SIRW tank or any unprotected outside temporary tank* shall be limited such that the mixture radionuclides do not exceed 1,000 times the effluent concentration (EC) as listed in 10CFR Part 20, Appendix B, Table 2, Column 2.

$$\frac{C_a}{EC_a} + \frac{C_b}{EC_b} \dots + \frac{C_i}{EC_i} = < 1000$$

2. Action:

With the quantity of radioactive material in any of the above listed tanks exceeding the above concentration, immediately suspend all additions of radioactive material to the tank, within 48 hours reduce the tank contents to within the limit, and describe the events leading to this condition in the next Radiological Effluent Release Report.

3. Surveillance Requirement:

The concentration of radioactive material contained in each of the above listed tanks shall be determined to be within the above limit by analyzing a representative sample of the tank's contents at least once per 7 days when radioactive materials are being added to the tank.

or

A calculational methodology performed prior to the material being transferred may be used to show compliance with the requirement of this section if a representative sample cannot be obtained at least once per seven days. A representative sample of the radioactive material to be added to the SIRW or Temporary Liquid Storage Tank shall be analyzed and a calculation performed to show compliance with the 1000 EC limit.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

4. Bases:

This requirement will provide reasonable assurance that in the event of an uncontrolled release of the tanks' contents, the resulting concentrations would be less than the limits of 10CFR Part 20, Appendix B, Table 2, Column 2, at the nearest potable water supply and the nearest surface water supply in an Unrestricted Area. (The dilution between Palisades and the South Haven drinking water supply has been established as 1000).

*Tanks included in this specification are those outdoor tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system.

NOTE: The limit for the SIRW Tank may be exceeded for operational flexibility if the conditions of this section are met.

L. Surveillance Requirement Time Intervals

1. Requirement:

Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25 percent of the specified surveillance interval.

2. Action:

Failure to perform a Surveillance Requirement within the allowed surveillance interval shall constitute noncompliance with the operability requirements. The time limits of the action requirements are applicable at the time it is identified that a Surveillance Requirement has not been performed. The action requirements may be delayed for up to 24 hours to permit the completion of the surveillance when the allowed outage time limits of the action requirements are less than 24 hours. Surveillance Requirements do not have to be performed on inoperable equipment.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

3. Surveillance Requirements:

The applicable surveillance interval frequencies are specified in Tables A-2 and C-2. The applicable sampling and/or analysis frequencies are specified in Tables A-1, B-1, C-1, D-1, and E-1. Extendable surveillance requirements are limited to channel checks, source checks, channel calibrations, channel functional checks, sampling frequencies and/or analysis frequencies.

4. Bases:

The maximum allowable extension for a surveillance interval is consistent with the surveillance requirements specified in the Technical Specifications, Section 4.0. Until relocated in the ODCM, all of the effluent surveillances were subject to these same requirements.

M. Sealed Source Contamination

1. Requirement:

Each sealed source containing radioactive material either in excess of 100 microcuries of beta and/or gamma emitting material or 5 microcuries of alpha emitting material shall be free of greater than or equal to 0.005 microcuries of removable contamination.

2. Action:

a. With a sealed source having removable contamination in excess of 0.005 microcuries, immediately withdraw the sealed source from use and either:

- (1) Decontaminate and repair the sealed source, or
- (2) Dispose of the sealed source in accordance with applicable regulations.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

- b. A report shall be prepared and submitted to the Commission on an annual basis if sealed source leakage tests reveal the presence of greater than or equal to 0.005 microcuries of removable contamination.

3. Surveillance Requirements:

- a. Each category of sealed sources as described in the requirement with a half-life greater than 30 days (excluding Hydrogen-3), and in any other form than gas, shall be tested for leakage and/or contamination at intervals not to exceed 6 months.
- b. The test shall be performed by the licensee or by other persons specifically authorized by the Commission or an Agreement State. The test method shall have a detection sensitivity of at least 0.005 microcuries per test sample.
- c. The test sample shall be taken from the sealed source or, in the case of permanently mounted sources, from the surfaces of the mounting device on which contamination would be expected to accumulate.
- d. The periodic leak test does not apply to sealed sources that are stored and not being used. These sources shall be tested prior to use or transfer to another licensee, unless tested within the previous 6 months. Sealed sources which are continuously enclosed within a shielded mechanism (ie, sealed sources within radiation monitoring or boron measuring devices) are considered to be stored and need not be tested unless they are removed from the shielded mechanism.
- e. Sealed sources transferred without a certificate indicating the last test date shall be tested prior to being placed in use.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

4. Bases:

The requirement, actions, and surveillance requirements are the same as contained in the Technical Specification 6.21 prior to relocation to the ODCM and will provide assurance that sealed sources are tested to demonstrate that source integrity is being maintained.

IV. **REPORTING REQUIREMENTS**

A. Radiological Effluent Release Report

The Radioactive Effluent Release Report shall be submitted in accordance with 10CFR 50.36a by March 31 of each year. The report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit. The material provided shall be (1) consistent with the objectives outlined in the ODCM and Process Control Program and (2) in conformance with 10CFR 50.36a and Section IV.B.1 of Appendix I to 10CFR 50.

The report shall include an estimate of the uncertainty associated with the measurement of radioactive effluents. This error term is included to provide an estimate of the uncertainty and is not to be considered the absolute error associated with the measurements or to be used in determining compliance with these requirements.

These estimates will be based on a statistical analysis of a series of sample results (weighed appropriately for counting statistics) taken once a year from a minimum of one typical gaseous waste tank and from a minimum of one typical liquid waste tank. For noble gases released to the atmosphere from other than the waste gas system the error term will be estimated (and weight-averaged with the waste gas tank error) based on a statistical analysis of a series of sample results taken once a year (or the stack gas monitor counting statistics taken over one release per year) from each source contributing more than 10% of the total annual release.

The error term for iodine and particulates released to the atmosphere will be based on the counting statistics for one stack gas sample taken during the year.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

The report shall include an estimate of the lower level of detection (in $\mu\text{Ci/ml}$) if the unidentified portion of the release exceeds 10% of the total annual releases. This estimate of the lower level of detection will be made for those gamma emitting isotopes listed in Appendix B of Regulatory Guide 1.21 (June 1974) and will be provided based on a typical background gamma spectrum.

The report shall provide the following specific terms:

1. Supplemental Information

a. Batch Releases:

The report should provide information relating to batch releases of liquid and gaseous effluents which are discharged to the environment. This information should include the number of releases, total time period for batch releases, and the maximum, mean, and minimum time period of release.

b. Abnormal Releases

The number of abnormal releases of radioactive material to the environment should be reported. The total curies of radioactive materials released as a result of abnormal releases should be included.

2. Gaseous Effluents

a. Gases

(1) Total curies of fission and activation gases releases.

(2) Average release rates ($\mu\text{Ci/s}$) of fission and activation gases for the quarterly periods covered by the report.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

- (3) Percent of limit for releases of fission and activation gases.
- (4) Quarterly sums of total curies for each of the radionuclides determined to be released, based on analyses of fission and activation gases.

b. Iodines

- (1) Total curies of each of the isotopes, Iodine-131, Iodine-133 and Iodine-135 determined to be released.
- (2) Average release rate ($\mu\text{Ci/s}$) of Iodine-131/133.
- (3) Percent of limit for Iodine-131/133.

c. Particulates

- (1) Total curies of radioactive material in particulate form with half-lives greater than 8 days determined to be released.
- (2) Average release rate ($\mu\text{Ci/s}$) of radioactive material in particulate form with half-lives greater than 8 days.
- (3) Percent of limit for radioactive material in particulate form with half-lives greater than 8 days.
- (4) Total curies for each of the radionuclides in particulate form determined to be released based on analyses performed.
- (5) Total curies of gross alpha radioactivity determined to be released.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

d. Tritium

- (1) Total curies of tritium determined to be released in gaseous effluents.
- (2) Average release rate ($\mu\text{Ci/s}$) of tritium.
- (3) Percent of applicable limits for tritium.

3. Liquid Effluents

a. Mixed Fission and Activation Products

- (1) Total curies of radioactive material determined to be released in liquid effluents (not including tritium, dissolved and/or entrained gases, and alpha-emitting material).
- (2) Average concentrations ($\mu\text{Ci/ml}$) of mixed fission and activation products released to unrestricted areas, averaged over the quarterly periods covered by the report.
- (3) Percent of applicable limit of average concentrations released to unrestricted areas.
- (4) Quarterly sums of total curies for each of the radionuclides determined to be released in liquid effluents based on analyses performed.

b. Tritium

- (1) Total curies of tritium determined to be released in liquid effluents.
- (2) Average concentrations ($\mu\text{Ci/ml}$) of tritium released in liquid effluents to unrestricted areas, averaged over the quarterly periods covered by the report.
- (3) Percent of applicable limit of average concentrations released to unrestricted areas.

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NRC GENERIC LETTER 89-01 (TAC NO 75060)**

c. Dissolved and/or Entrained Gases

- (1) Total curies of gaseous radioactive material determined to be released in liquid effluents.**
- (2) Average concentrations ($\mu\text{Ci/ml}$) of dissolved and/or entrained gaseous radioactive material released to unrestricted areas, averaged over the quarterly periods covered by the report.**
- (3) Percent of applicable limit of average concentrations released to unrestricted areas.**
- (4) Total curies for each of the radionuclides determined to be released as dissolved and/or entrained gases in liquid effluents.**

d. Alpha Radioactivity

Total curies of gross alpha-emitting material determined to be released in liquid effluents.

e. Volumes

- (1) Total measured volume (liters), prior to dilution, of liquid effluent released.**
- (2) Total determined volume, in liters, of dilution water used during the period of the report.**

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

4. Radiological Impact on Man:

The Radioactive Effluent Release Report shall include potential doses to individuals and populations calculated using measured effluent and averaged meteorological data in accordance with the methodologies in the ODCM.

- a. Total body and significant organ doses (greater than 1 millirem to individuals in unrestricted areas from receiving water-related exposure pathways.
- b. The maximum offsite air doses (greater than 1 millirad) due to beta and gamma radiation at locations near ground level from gaseous effluents.
- c. Organ doses (greater than 1 millirem) to individuals in unrestricted areas from radioactive iodine and radioactive material in particulate form from the major pathways of exposure.
- d. Total body doses (greater than 1 manrem) to the population and average doses (greater than 1 millirem) to individuals in the population from receiving water-related pathways to a distance of 50 miles from the site.
- e. Total body doses (greater than 1 manrem) to the population and average doses (greater than 1 millirem) to individuals in the population from gaseous effluents to a distance of 50 miles from the site.

5. ODCM Changes:

The Radiological Effluent Release Report shall include any changes made during the reporting period to the Offsite Dose Calculation Manual (ODCM), as well as a listing of new locations for dose calculations and/or environmental monitoring identified by the land use census pursuant to III.J.3.c.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
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B. Radiological Environmental Operating Report

The Radiological Environmental Operating Report covering the operation of the unit during the previous calendar year shall be submitted before May 1 of each year. The report shall include summaries, interpretations, and analysis of trends of the results of the Radiological Environmental Monitoring Program for the reporting period. The material provided shall be consistent with the objectives outlined in; (1) the ODCM, and (2) Sections IV.B.2, IV.B.3, and IV.C of Appendix 1 to 10CFR50.

The Annual Radiological Environmental Operating Reports shall include summaries, interpretation and statistical evaluation of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies, operational controls (as appropriate), and previous environmental surveillance reports and an assessment of the observed impacts of the Plant operation on the environment. The reports shall also include the results of land use census pursuant to III.J.3.c.

The Annual Radiological Environmental Operating Reports shall include summarized and tabulated results in the format of Table F-1 of all radiological environmental samples taken during the report period. In the event that some results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following; a summary description of the radiological environmental monitoring program, including sampling methods for each sample type, a map of all sampling locations keyed to a table giving distances and directions from the reactor and the results of land use census required by III.J.3.c and results of the Interlaboratory Comparison Program required by III.J.3.e.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

C. Nonroutine Reports

A report shall be submitted to the NRC in the event that; 1) the Radiological Environmental Monitoring Programs are not substantially conducted as described in Section III.J, or 2) an unusual or important event occurs from Plant operation that causes a significant environmental impact or affects a potential environmental impact. Reports shall be submitted within 30 days.

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**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

**Table F-1
Environmental Radiological Monitoring Program Summary**

Name of Facility _____ Docket No _____
Location of Facility _____ Reporting Period _____
(County, State)

Medium or Pathway Sampled (Unit of Measure)	Type/Total Number of Analyses Performed	Lower Limit of Detection ^a (LLD)	All Indicator Locations Mean (f) ^b Range ^b	Name Distance & Direction	Mean (f) ^b Range	Control Locations Mean(f) ^b Range	Number of REPORTABLE OCCURRENCES
Air Particulates (pCi/m ³)	Gross β 416	0.003	0.08 (200/312) (0.05-2.0)	Middletown 5 miles 340°	0.10 (5/52) (0.08-2.0)	0.08 (8/104)- (0.05-1.40)	1
	γ-Spec 32						
	Cs-137	0.003	0.05 (4/24) (0.03-0.13)	Smithville 2.5 miles 160°	0.08 (2/4) (0.03-0.13)	<LLD	4
	Ba-140	0.003	0.03 (2/24) (0.01-0.08)	Podunk 4 miles 270°	0.05 (2/4) (0.01-0.08)	0.02 (1/8)	1
	Sr-89 40	0.002	<LLD	--	--	<LLD	0
Sr-90 40	0.0003	<LLD	--	--	<LLD	0	
Fish pCi/kg (dry weight)	γ-Spec 8						
	Cs-137	80	<LLD	--	<LLD	90 (1/4)	0
	Cs-134	80	<LLD	--	<LLD	<LLD	0
	Co-60	80	120 (3/4) (90-200)	River Mile 35 Podunk River	See Column 4	<LLD	0

^a Nominal Lower Limit of Detection (LLD) as defined in table notation c of Table E-3.

^b Mean and range based upon detectable measurements only. Fraction of detectable measurements at specific locations is indicated in parentheses (f).

^d **NOTE:** The example data are provided for illustrative purposes only.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

**V. MAJOR MODIFICATIONS TO RADIOACTIVE LIQUID AND GASEOUS
WASTE TREATMENT SYSTEMS**

A. Licensee Modifications

Licensee initiated major modifications to the radioactive liquid and gaseous waste systems.

1. Shall be reported to the NRC pursuant to 10CFR 50.59. The discussion of each modification shall contain:
 - a. A summary of the evaluation that led to the determination that the modification could be made in accordance with 10CFR Part 50.59.
 - b. A description of the equipment, components and processes involved, and the interfaces with other Plant systems.
 - c. Documentation of the fact that the modification was reviewed and found acceptable by the PRC.
2. Shall become effective upon review and acceptance by the Plant General Manager.

B. Definition of Major Radwaste System Modification

1. Purpose:

The purpose of this definition is to assure that this requirement will be satisfied under clearly identifiable circumstances, and with the objective that current radwaste system capabilities are not jeopardized.

**TITLE: RELOCATED TECHNICAL SPECIFICATIONS PER
NRC GENERIC LETTER 89-01 (TAC NO 75060)**

2. Definition:

A major radwaste system modification is a modification which would remove (either by bypassing for greater than 7 days or physical removal) or replace with less efficient equipment, any components of the radwaste system:

- a. Letdown filters or demineralizers.
- b. Vacuum degassifier (not applicable when the reactor is in cold shutdown and depressurized).
- c. Miscellaneous or clean waste evaporators.
- d. The present waste gas compressor/decay tank system.
- e. Fuel Pool filters/demineralizers.
- f. Radwaste polishing demineralizers.
- g. Radwaste Solidification system.

Improvements or additions to improve efficiency will not be considered major modifications unless a complete substitution of equipment or systems is made with equipment of unrelated design. Examples would be; 1) replacement of mechanical degassifier with steam, jet degassifier, 2) replacement of waste gas system with cryogenic system, 3) replacement of asphalt solidification with cement system, and 4) change from deep bead resins to Powdex, etc.

**PALISADES NUCLEAR PLANT
10CFR50.59 SAFETY REVIEW**

Proc No 3.07
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Page 1 of 1

Log No SDR- 98 2403

Item Identification: No ODCM Rev 13 Title Offsite Dose Calculation Manual

Describe Issue/Change: Updated Tables 1.4, 1.4a, and 1.9

Reason for Issue/Change: Tables 1.4, 1.4a, and 1.9 are updated annually based on the Palisades Land Use Survey.

	Yes	No
1. Does the item involve a change to procedures as described in the FSAR? FSAR Sections affected <u>None</u> FSAR Sections reviewed <u>Chapters 2.5, 11</u>		✓
2. Does the item involve a change to the facility as described or implied in the FSAR? FSAR Sections affected <u>None</u> FSAR Sections reviewed <u>Chapters 2.5, 11</u>		✓
3. Does the item involve a test or experiment not described in the FSAR? FSAR Sections affected <u>None</u> FSAR Sections reviewed <u>Chapters 2.5, 11, 14</u>		✓
4. Should the Technical Specifications or any of their Bases be changed in conjunction with this item? TS Sections affected <u>None</u> TS Sections reviewed <u>6, ODCM, ODCM Appendix A</u>		✓

If any Safety Review question listed above is answered "YES," perform a written USQ Evaluation. Justify "NO" answers below if logic is not obvious: ODCM requires a Land Use Survey be performed to identify "real" offsite dose parameters. This data can be used to predict doses to actual parameters (nearest resident) instead of making conservative default values, ie 24 hour occupancy at site boundary.

NOTE: DBD change requests shall be processed in accordance with Administrative Procedure 3.15.

Searched Land Use Census
DBD Sections Reviewed None Affected N/A

NOTE: SDR forwards a copy of all changes potentially affecting proposed Improved Technical Specifications to the Licensing Dept.

Searched Land Use Census
Proposed ITS & Bases Reviewed NO ITS Affected N/A

This attachment shall accompany other review materials for the item to document whether or not a USQ Evaluation was required.

Prepared by <i>[Signature]</i>	Date <u>1/27/99</u>	Reviewed by <i>[Signature]</i>	Date <u>1/4 1999</u>
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PALISADES NUCLEAR PLANT
OFFSITE DOSE CALCULATION MANUAL

TITLE: OFFSITE DOSE CALCULATION MANUAL

J. P. Neal

1-19-99

Procedure Sponsor

Date

MLGrogan

1/12/8/98

Technical Reviewer

Date

User Reviewer

Date

David W. Roy 1/25/99

Plant Manager - Operations

Date

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Appendix A, "Relocated Technical Specification"

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I. **GASEOUS EFFLUENTS**

A. **ALARM/TRIP SETPOINT METHOD**

Appendix A, Section III.B.1 requires that the dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY shall be limited to the following:

- For noble gases: Less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin, and
- For iodine-131, for iodine-133, for tritium, and for all radionuclides in particulate form with half lives greater than 8 days: Less than or equal to 1500 mrem/yr to any organ.

Appendix A, Section III.A.1 requires gaseous effluent monitors to have alarm/trip setpoints to ensure that offsite concentrations, when averaged over 1 hour, will not be greater than Appendix A, Section III.B.1. This section of the ODCM describes the methodology that will be used to determine these setpoints.

The methodology for determining alarm/trip setpoints is divided into two major parts. The first consists of calculating an allowable concentration for the nuclide mixture to be released. The second consists of determining monitor response to this mixture in order to establish the physical settings on the monitors.

1. **Allowable Concentration**

The total EC-fraction (R_k) for each release point will be calculated by the relationship defined by Note 4 of Appendix B, 10 CFR 20:

$$R_{(k)} = \left(\frac{X}{Q} \right) (F) \sum_i \frac{C_i}{EC_i} \leq 10.0 \quad (1.1)$$

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where:

- C_i = Actual or measured concentration, at ambient temperature and pressure of nuclide i ($\mu\text{Ci/cc}$)
- EC_i = The EC of nuclide i from 10 CFR 20, Appendix B, Table 2 = 50 mrem/yr - total body
- $R_{(k)}$ = The total EC-fraction for release point k
- X/Q = Most conservative sector site boundary dispersion (sec/m^3) - Table 1.3
- F = Release flow rate (83,000 cfm = 39.2 m^3/sec) for stack monitor considerations; variable for other monitors

NOTE: If a batch release is made while a continuous release or another batch release is in progress, the sum of all values of R_k must be less than 10.0.

2. **Monitor Response**

Normal radioactivity releases consist mainly of well-decayed fission gases. Therefore, monitor response calibrations are performed to fission gas typical of normal releases (mainly Xe-133). Response of monitors used to define fission product release rates under accident conditions may vary from that of Xe-133, however. Monitor response for the two categories of monitor is determined as follows:

a. Normal Release (aged fission gasses)

Total gas concentration ($\mu\text{Ci/cc}$) at the monitor is calculated. The calibration curve or constant for $\text{cpm}/\mu\text{Ci/cc}$ is applied to determine cpm expected. The setting for monitor alarms is established at some factor (b) greater than 1 but less than $1/R_k$ (Equation 1.1) times the measured concentration (c):

$$s = b \times c \quad (1.2)$$

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b. Accident Releases

Monitors are preset to alarm at or before precalculated offsite dose rates would be achieved under hypothetical accident conditions. These setpoints are established in accordance with Emergency Plan requirements for defining Emergency Action Levels and associated actions. Emergency Implementing Procedures contain monitor-specific curves or calibration constants for conversion between cpm and $\mu\text{Ci/cc}$ (or R/hr and $\mu\text{Ci/cc}$), depending on monitor type, for fission product mixtures as a function of mixture decay time.

When these monitors are utilized for other than accident conditions, either an appropriately decayed "accident" conversion curve may be used, or a decayed fission gas calibration factor may be applied. In these cases, setpoints are established as in 1.A above.

Setpoints of accident monitors (if set to monitor normal releases) are reset to the accident alarm settings at the end of normal release. Setpoints of other release monitors are maintained at the level used at the latest release (well below the level which would allow 10 times EC to be exceeded at the site boundary), or are reset to approximately three times background in order to detect leakage or inadvertent releases of low level gases.

B. DOSE RATE CALCULATION

1. Dose rates are calculated for (1) noble gases and (2) iodines and particulates. Dose rates as defined in this section are based on 10 CFR 50 Appendix I limits of mrem per quarter and millirem per year. All dose pathways of major importance in the Palisades environs are considered.
 - a. Equations and assumptions for calculating doses from noble gases are as follows:
 - 1) Assumptions
 - a) Doses to be calculated are the maximum offsite point in air, total body and skin.

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- b) Exposure pathway is submersion within a cloud of noble gases.
- c) Noble gas radionuclide mix is based on the historically observed source term given in Table 1.1, plus additional nuclides.
- d) Basic radionuclide data are given in Table 1.2.
- e) All releases are treated as ground-level.
- f) Meteorological data expressed as joint-frequency distribution of wind speed, wind direction, and atmospheric stability for the period resulting in X/Q's and D/Q's shown in Table 1.3.
- g) Raw meteorological data consists of wind speed and direction measurements at 10m and temperature measurements at 10m and 60m.
- h) Dose is to be evaluated at the offsite exposure points where maximum concentrations are expected to exist (overland sector site boundaries), and nearest residents.
- i) Potential maximum population (resident) exposure points are identified in Table 1.4.
- j) A semi-infinite cloud model is used.
- k) For person exposures, credit is taken for shielding by residence (factor of 0.7).
- l) Radioactive decay is considered for the plume.
- m) Building wake effects on effluent dispersion are considered.
- n) A sector-average dispersion equation is used.

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- o) The wind speed classes that are used are as follows:

<u>Wind Speed Class Number</u>	<u>Range (m/s)</u>	<u>Midpoint (m/s)</u>
1	0.0-0.4	0.2
2	0.4-1.5	0.95
3	1.5-3.0	2.25
4	3.0-5.0	4.0
5	5.0-7.5	6.25
6	7.5-10.0	8.75
7	> 10.0	--

- p) The stability classes that will be used are the standard A through G classifications. The stability classes 1-7 will correspond to A = 1, B = 2, ..., G = 7.
- q) Terrain effects are not considered.

2) Equations

To calculate the dose for any one of the exposure points, the following equations are used.

For determining the air concentration of any radionuclide:

$$X_i = \sum_{j=1}^9 \sum_{k=1}^7 \left(\frac{2}{\pi} \right)^{1/2} \frac{f_{jk} Q_i p}{\sum z k U^j (2\pi x/n)} \left[\exp^{- \left(\lambda_i \frac{x}{u_j} \right)} \right] \quad (1.3)$$

where:

- X_i = Air concentration of radionuclide i , $\mu\text{Ci}/\text{m}^3$.
- f_{jk} = Joint relative frequency of occurrence of winds in wind speed class j , stability class k , blowing toward this exposure point, expressed as a fraction.

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- Q_i = Average release rate of radionuclide i , $\mu\text{Ci/s}$.
- p = Fraction of radionuclide remaining in plume.
- Σ_{zk} = Vertical dispersion coefficient for stability class k (m).
- u_j = Midpoint value of wind speed class interval j , m/s.
- x = Downwind distance, m.
- n = Number of sectors, 16.
- λ_i = Radioactive decay coefficient of radionuclide i , s^{-1} .
- $2\pi x/n$ = Sector width at point of interest, m.

For determining the total body dose rate:

$$D_{\text{TB}} = \sum_i X_i \text{DFB}_i \quad (1.4)$$

where:

- D_{TB} = Total body dose rate, mrem/y.
- X_i = Air concentration of radionuclide i , $\mu\text{Ci/m}^3$.
- DFB_i = Total body dose factor due to gamma radiation, mrem/y per $\mu\text{Ci/m}^3$ (Table 1.5).

For determining the skin dose rate:

$$D_s = \sum_i X_i (\text{DFS}_i + 1.11 \text{DFY}_i) \quad (1.5)$$

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where:

D_s = Skin dose rate, mrem/y.

X_i = Air concentration of radionuclide i , $\mu\text{Ci}/\text{m}^3$

DFS_i = Skin dose factor due to beta radiation, mrem/y per $\mu\text{Ci}/\text{m}^3$ (Table 1.5).

1.11 = The average ratio of tissue to air energy absorption coefficients, mrem/mrad.

DFY_i = Gamma-to-air dose factor for radionuclide i , mrad/y per $\mu\text{Ci}/\text{m}^3$ (Table 1.5).

For determining dose rate to a point in air:

$$D_a = \sum_i X_i (\text{DFY}_i \text{ or } \text{DFB}_i) \quad (1.6)$$

where:

D_a = Air dose rate, mrad/yr.

DFB_i = Air dose factor for beta radiation (Table 1.5).

- b. Equations and assumptions for calculating doses from radioiodines and particulates are as follows:

1) Assumptions

- a) Dose is to be calculated for the critical organ, thyroid, and the critical age groups (adult, teen, child, infant), infant (milk) and child (green, leafy vegetables).
- b) Exposure pathways from iodines and particulates are milk ingestion, ground contamination, green leafy vegetables from home gardens, and inhalation.

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- c) The radioiodine and particulate mix is based on the historically observed source term given in Table 1.1.
- d) Basic radionuclide data are given in Table 1.2.
- e) All releases are treated as ground-level.
- f) Mean annual average X/Q's are given in Table 1.3.
- g) Raw meteorological data for ground-level releases consist of wind speed and direction measurements at 10m and temperature measurements at 10m and 60m.
- h) Dose is to be evaluated at the potential offsite exposure points where maximum doses to man are expected to exist.
- i) Real cow, goat and garden locations are considered.
- j) Potential maximum exposure points (Table 1.4) considered are the nearest cow, goat, and home garden locations in each sector.
- k) Terrain effects and open terrain recirculation factors are not considered.
- l) Building wake effects on effluent dispersion are considered.
- m) Plume depletion and radioactive decay are considered for air-concentration calculations.
- n) Radioactive decay is considered for ground-concentration calculations.
- o) Deposition is calculated based on the curves given in Figure 1.2.

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- p) Milk cows and goats obtain 100% of their food from pasture grass May through October of each year. Use default values of 0.58 for cows and 0.67 for goats for fraction of year on pasture.
- q) Credit is taken for shielding by residence (factor of 0.7).

2) **Equations**

To calculate the dose for any one of the potential maximum-exposure points, the following equations in Section 1.2.2 are used.

a) **Inhalation**

Equation for calculating air concentration, X_i is the same as in the Noble Gas Section (Equation 1.3).

For determining the organ dose rate:

$$D_i = 1 \times 10^6 \sum_i X_i DFI_i BR \quad (1.7)$$

where:

D_i = Organ dose rate due to inhalation, mrem/y.

X_i = Air concentration of radionuclide i , $\mu\text{Ci}/\text{m}^3$.

DFI_i = Inhalation dose factor, mrem/pCi (Table 1.7).

BR = Breathing rate 1400 m^3/y infant; 3700 m^3/y child; or 8000 m^3/y teen and adult.

1×10^6 = pCi/ μCi conversion factor.

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b) Ground Contamination

For determining the ground concentration of any nuclide;

$$G_i = 3.15 \times 10^7 \sum_{k=1}^7 \frac{f_k Q_i DR}{(2\pi x/n)\lambda_i} [1 - \exp(-\lambda_i t_b)] \quad (1.8)$$

where:

G_i = Ground concentration of radionuclide i , $\mu\text{Ci}/\text{m}^2$.

k = Stability class.

f_k = Joint relative frequency of occurrence of winds in stability class k blowing toward this exposure point, expressed as a fraction.

Q_i = Average release rate of radionuclide i , $\mu\text{Ci}/\text{s}$.

DR = Relative deposition rate, m^{-1} (Fig 1.2).

x = Downwind distance, m .

n = Number of sectors, 16.

$2\pi x/n$ = Sector width at point of interest, m .

λ_i = Radioactive decay coefficient of radionuclide i , y^{-1} .

t_b = Time for buildup of radionuclides on the ground, 15 y .

3.15×10^7 = s/y conversion factor.

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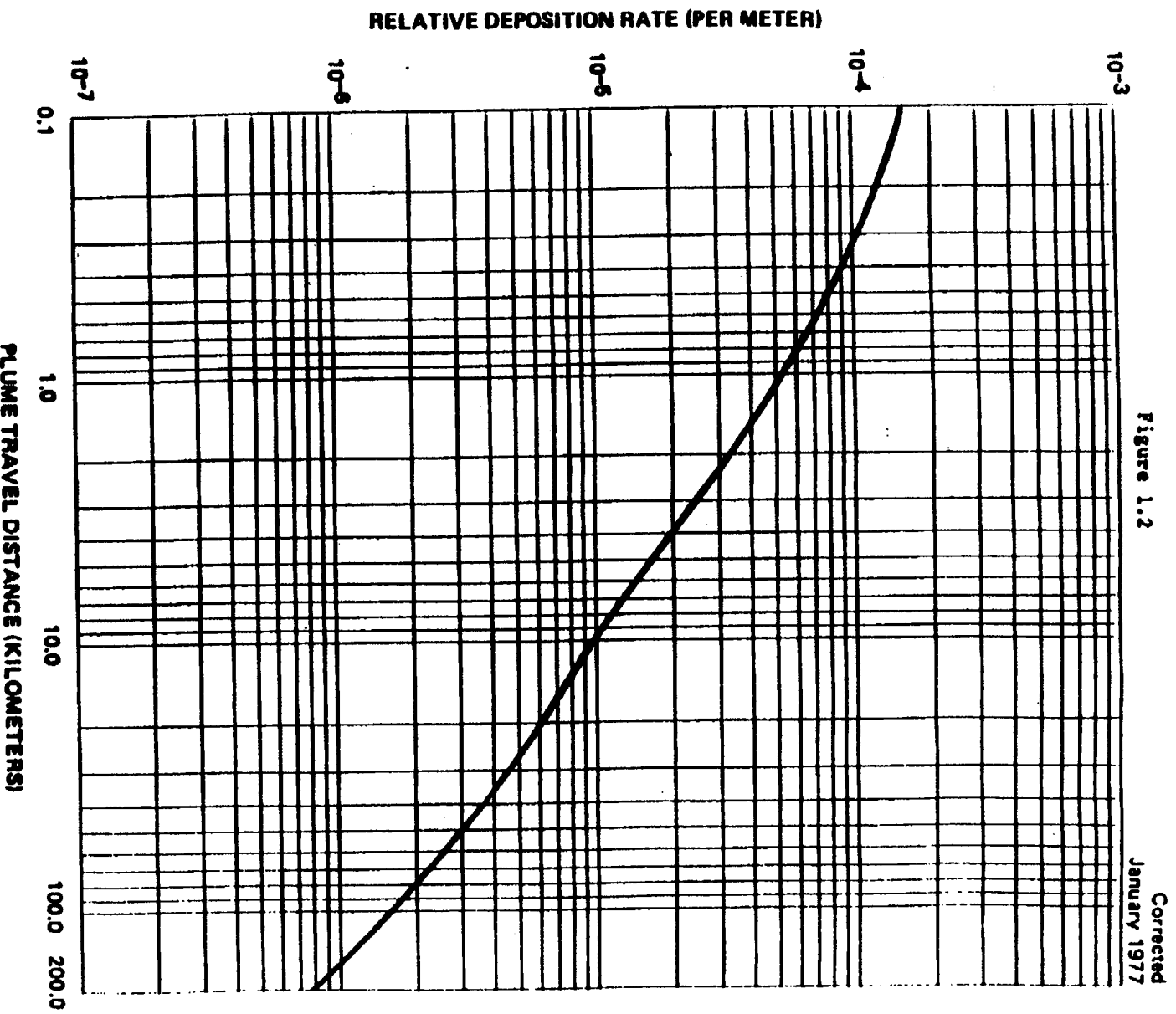


Figure 7. Relative Deposition for Ground Level Releases (All Atmospheric Stability Classes)

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For determining the total body or organ dose rate from ground contamination:

$$D_G = (8,760)(1 \times 10^6)(0.7) \sum_i G_i DFG_i \quad (1.9)$$

where:

- D_G = Dose rate due to ground contamination, mrem/y.
- G_i = Ground concentration of radionuclide i , $\mu\text{Ci}/\text{m}^2$.
- DFG_i = Dose factor for standing on contaminated ground, mrem/h per pCi/m^2 (Table 1.8).
- 8,760 = Occupation time, h/y.
- 1×10^6 = $\text{pCi}/\mu\text{Ci}$ conversion factor.
- 0.7 = Shielding factor accounting for a distance of 1.0 meter above ordinary ground, dimensionless.

c) Milk and Vegetation Ingestion

For determining the concentration of any nuclide (except C-14 and H-3) in and on vegetation:

$$CV_i = 3,600 \sum_{k=1}^7 \frac{f_k Q_i DR}{(2\pi x/n)} \left(\frac{r[1 - \exp(-\lambda_{Ei} t_e)]}{Y_v \lambda_{Ei}} + B_{iv} \left[\frac{1 - \exp(-\lambda_i t_b)}{P \lambda_i} \right] \right) [\exp(-\lambda_i t_h)] \quad (1.10)$$

where:

- CV_i = Concentration of radionuclide i in and on vegetation, $\mu\text{Ci}/\text{kg}$.
- k = Stability class.

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- f_k = Frequency of this stability class and wind direction combination, expressed as a fraction.
- Q_i = Average release rate of radionuclide i , $\mu\text{Ci/s}$.
- DR = Relative deposition rate, m^{-1} (Figure 1.2).
- x = Downwind distance, m.
- n = Number of sectors, 16.
- $2\pi x/n$ = Sector width at point of interest, m.
- r = Fraction of deposited activity retained on vegetation (1.0 for iodines, 0.2 for particulates).
- λ_{Ei} = Effective removal rate constant, $\lambda_{Ei} = \lambda_i + \lambda_w$, where λ_i is the radioactive decay coefficient, h^{-1} , and λ_w is a measure of physical loss by weathering ($\lambda_w = 0.0021 \text{ h}^{-1}$).
- t_e = Period over which deposition occurs, 720 h.
- Y_v = Agricultural yield, 0.7 kg/m^2 .
- B_{iv} = Transfer factor from soil to vegetation of radionuclide i (Table 1.6).
- λ_i = Radioactive decay coefficient of radionuclide i , h^{-1} .
- t_b = Time for buildup of radionuclides on the ground, $1.31 \times 10^5 \text{ h}$ (15Y).

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- p = Effective surface density of soil, 240 kg/m².
- 3,600 = s/h conversion factor.
- t_h = Holdup time between harvest and consumption of food (2,160 hours for stored food).

For determining the concentration of C-14 in vegetation:

$$CV_{14} = 1 \times 10^3 X_{14} (0.11/0.16) \quad (1.11)$$

where:

- CV_{14} = Concentration of C-14 in vegetation, $\mu\text{Ci}/\text{kg}$.
- X_{14} = Air concentration of C-14, $\mu\text{Ci}/\text{m}^3$.
- 0.11 = Fraction of total Plant mass that is natural carbon.
- 0.16 = Concentration of natural carbon in the atmosphere, g/m³.
- 1×10^3 = g/kg conversion factor.

For determining the concentration of H-3 in vegetation:

$$CV_T = 1 \times 10^3 X_T (0.75)(0.5/H) \quad (1.12)$$

where:

- CV_T = Concentration of H-3 in vegetation, $\mu\text{Ci}/\text{m}^3$.
- X_T = Air concentration of H-3, $\mu\text{Ci}/\text{m}^3$.
- 0.75 = Fraction of total Plant mass that is water.

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0.5 = Ratio of tritium concentration in Plant water to tritium concentration in atmospheric water.

H = Absolute humidity of the atmosphere, g/m³.

1x10³ = g/kg conversion factor.

For determining the concentration of any nuclide in cow's or goat's milk:

$$CM_i = CV_i FM_i Q_f \exp(-\lambda_i t_f) \quad (1.13)$$

where:

CM_i = Concentration of radionuclide i (including C-14 and H-3) in milk, $\mu\text{Ci}/\ell$.

CV_i = Concentration of radionuclide i in and on vegetation, $\mu\text{Ci}/\text{kg}$.

FM_i = Transfer factor from feed to milk for radionuclide i, d/ ℓ (Table 1.6).

Q_f = Amount of feed consumed by the milk animal per day, kg/d (cow, 50 kg/d or goat 6 kg/d).

λ_i = Radioactive decay coefficient of radionuclide i, d⁻¹.

t_f = Transport time of activity from feed to milk to receptor, 2 days.

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For determining the organ dose rate from ingestion of green leafy vegetables and milk:

$$D = 1 \times 10^6 \sum_i CM_i DF_i UM \quad (1.14)$$

where:

D = Organ dose rate due to ingestion, mrem/y.

CM_i = Concentration of radionuclide i in vegetables or milk, μCi/kg (or liters).

DF_i = Ingestion dose factor, mrem/pCi (Table 2.1).

UM = Ingestion rate for milk, 330 l/y; for vegetables 26 kg/yr (child), no ingestion by infant.

1x10⁶ = pCi/μCi conversion factor.

d) **Meat Ingestion (Beef)**

To calculate the concentration of a nuclide in animal flesh:

$$C_{fi} = F_{fi} CV_i Q_{fi} \exp(-\lambda_i t) \quad (1.15)$$

where:

C_{fi} = Concentration of nuclide i in the animal flesh, pCi/kg.

F_{fi} = Fraction of animal's daily intake which appears in each kg of flesh, days/kg (Table 1.6).

CV_i = Concentration of radionuclide i in the animal's feed (Equation 1.10).

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Q_f = Amount of feed consumed by the cow per day, 50 kg/d.

t_s = Average time from slaughter to consumption, 20 days.

To determine the organ dose from ingestion of beef:

$$D^f = \sum_i C_{fi} D_{fi} U_f \quad (1.16)$$

where:

D_{fi} = Ingestion dose factor for age group, mrem/pCi (Table 2.1) for nuclide i.

U_f = Ingestion rate of meat for age group, kg/y (child-41, teen-65, adult-110).

e) Organ Dose Rates

For determining the total body and organ dose rate from iodines and particulates:

$$D = D_I + D_G + D_M + D_V + D_F \quad (1.17)$$

where:

D = Total organ dose rate, mrem/y.

D_I = Dose rate due to inhalation, mrem/y.

D_G = Dose rate due to ground contamination, mrem/y.

D_M = Dose rate due to milk ingestion, mrem/y.

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D_v = Dose rate due to vegetable ingestion, mrem/y.

D_f = Dose rate due to beef ingestion, mrem/y.

- 3) The maximum organ dose rate, maximum total body dose rate, and maximum skin dose rate calculated in the previous section (Sec I.B) are used to calculate design basis quantities as described in Section I.B.1.3.

c. Design Basis Quantities

The design basis quantity of a radionuclide emitted to the atmosphere is the amount of that nuclide, when released in one year, which would result in a dose not exceeding any of the following:

- 1) 15 millirem to any organ of an individual from iodines and particulates with half-life greater than 8 days (Appendix A, Section III.D.1).
- 2) 15 millirem to skin of an individual from noble gas (Appendix A, Section III.C.1.b).
- 3) 5 millirem to the total body of an individual from noble gas (Appendix A, Section III.C.1.a).

Design basis quantity (C_i) is the smallest value for each nuclide, calculated by dividing the dose limits (a through c above) by the appropriate dose calculated from the amount of radionuclide (C_i) used to conservatively estimate the doses of Section D, as listed in Table 1.1 (or a hypothetical 1 Ci/year); the result is then multiplied by the amount of radionuclide used.

$$DBQ = \frac{D_{AI}}{D_c} (C_c) \tag{1.18}$$

where:

D_{AI} = Appendix I dose limit (mrem or mrad).

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- D_c = Calculated dose (mrem or mrad).
 C_c = Quantity of nuclide resulting in dose D_c (Ci).
DBQ = Design Basis Quantity (Ci).

The limiting values for Design Basis Quantities for radionuclides released to the atmosphere are given in Table 1.9.

The inverse of the ratio C_c/D_c in the above equation (ie, D_c/C_c) is a useful value, since it represents the most limiting dose per unit quantity of each nuclide released. Use of the D_c/C_c ratio in quarterly evaluation of offsite dose is discussed in Section D. Values of D_c/C_c are given in Table 1.9.

d. Land Use Census and DBQ Changes

Appendix A, Sections J.3.b and J.3.c describe the requirements for an annual land use census and revision of the ODCM for use in the following calendar year. Areas of the ODCM which will be reviewed, and changed if appropriate, are Table 1.4 (Land Use Census Data by Sector), Table 1.4a (Critical Receptors), and Table 1.9 (Gaseous Design Basis Objective Annual Quantities). Changes will be effective on January 1 of the year following the year of the survey.

e. Gaseous Releases From the Steam Generator Blowdown Vent and Atmosphere Release Valves

Releases from the steam generator blowdown vent and atmospheric relief valves are difficult to quantify as there are no sampling capabilities on these steam release systems. However, neither system is a normal release path. The steam generator blowdown vent is normally routed to the main condenser and recirculated. Radioactive releases will be calculated by analyzing steam generator blowdown liquid and assuming that 100 percent of Noble Gases, 10 percent of the Iodines and 1 percent of the Particulates will be released to the environment in the steam phase. Volumes will be released to the environment in the steam phase. Volumes will be calculated using water balances or alternate means as available.

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C. DESIGN OBJECTIVE QUANTITY (DBQ) LIMITS ON BATCH AND CONTINUOUS RELEASES

1. Batch Releases

Prior to each batch release (waste decay tank release or Containment purge), the quantity of each nuclide identified is summed with the quantity of that nuclide released since the first of the current calendar year. The cumulative total for each nuclide then is divided by the design objective quantity for each nuclide (from Table 1.9), and the resultant fractions are summed in order to assure that the sum fraction of all nuclides does not exceed 1.0:

$$\sum_i \frac{A_i}{(DBQ)_i} < 1.0 \tag{1.19}$$

The amount in any calendar quarter should not exceed 0.5. This is checked by subtracting the value obtained at the end of the previous quarter from the value obtained from the cumulative total to date, including the batch to be released.

2. Continuous Releases

Low level continuous releases from the vent gas collection header and other low level sources are totaled on a weekly basis and summed with any batch releases for the week in order to establish the cumulative DBQ fraction from batch plus continuous released for the year-to-date. Calculations are performed in the same manner as for batch releases described in C.1.

3. Exceeding DBQ Limits

As discussed under B.1.3, the DBQ is a very conservative estimate of activity which could give doses at Appendix I limits. Because different organs are summed together and doses to different people are summed, the DBQ typically overestimates dose by about a factor of five. Thus, if calculations of DBQ fraction exceed 1.0 for year-to-date or 0.5 for the quarter, technical specifications probably still would not be exceeded. However, further discretionary releases should be deferred until an accurate assessment of dose is made by use of GASPARG computer code or by analysis of appropriate release data via the segment gaussian dose model used in emergency planning (inhalation dose, total body external dose, and boundary dose in air). See also Section D.1.2.

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It should be noted that Palisades Plant to date (based on review of semiannual effluent data) has never exceeded the annual or quarterly DBQ fraction, despite its conservatism. Thus, it is not expected that an alternate to the DBQ method will be required unless the Plant is in a significantly off-normal condition.

4. **Releasing Radionuclides Not Listed in Table 1.9**

Table 1.9 contains all nuclides identified to date as routine constituents of gaseous releases at Palisades Plant, plus those common to PWRs in general, even if not previously detected at Palisades. From time to time, however, other nuclides may be detected.

If the unlisted nuclide constitutes less than 10% of the EC-fraction for the release, and all unlisted nuclides total less than 25% of the EC-fraction, the nuclide may be considered not present.

If the unlisted nuclide constitutes greater than 10% of the EC-fraction, or all unlisted nuclides together constitute greater than 25%, then each nuclide should be assigned a DBQ equal to the most conservative value listed for the physical form of the nuclide involved (noble gas, halogen, or particulate).

Should a nuclide not listed in Table 1.9 begin to appear in significant quantities on a routine basis, revision to this ODCM should be made in order to include a design basis quantity specific to that nuclide.

D. **OPTIONAL QUARTERLY DOSE CALCULATIONS**

1. **Methodology for Optional Quarterly Dose Calculations**

This option may be used in place of, or in addition to, the Design Basis Quantity (DBQ) fraction calculation described by Equation 1.19. This optional conservative calculation relates the DBQ fraction to the doses from which it was originally derived. Use of this method may assist in identification of the critical dose pathway or characteristics of the assumed critical individual (infant, child, teen, and adult), since Table 1.9 indicates these parameters.

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a. Simplified Conservative Approach

This method utilizes a limiting dose concept such that the limiting dose for each nuclide is summed with the limiting dose for each other nuclide, regardless if such sum is physically possible. It also assumes critical pathways, such as milk and vegetables, are in effect even in winter when the pathway is absent.

As such, the method is highly conservative and significantly over-estimates dose. If limits appear to be exceeded by this method, Section D.1.2 (a concise method, but requiring computer support) will be utilized.

1) Assumptions

- a) All assumptions of Section 1.1 are utilized.
- b) Limiting doses for each gaseous nuclide are summed, regardless of limiting decay mode (gamma or beta).
- c) Limiting doses for each particulate and iodine nuclide are summed, regardless of dose point location, exposure pathway, or organ affected.
- d) Doses are summed for detected nuclides such that all nuclides which contribute greater than 10% individually or 25% in aggregate, to the EC of released radioactivity, are included in the dose calculation.

2) Equations

For determining gaseous effluent dose:

$$D_G = \sum_0^i A_{iG}(D_c/C_{iG}) < 5 \text{ millirad/quarter, } 10 \text{ mrad/yr}$$

(1.20)

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where:

DG = Dose from gaseous effluents (mrad).

A_{iG} = Quantity of gaseous nuclide i released (Ci).

(D_c/C_c)_{iG} = Dose per Ci factor for gaseous nuclide i (mrad/Ci).

The limit for this mixture is conservatively taken as that for gamma exposure (5 mrem/quarter, 10 mrem/year) although as indicated in Table 1.9, a majority of the gaseous effluents are beta-limiting and on an individual basis have the higher limit of 10 millirem/quarter and 20 millirem/year.

For determining tritium, particulate and iodine dose to organs:

$$D_{TPI} = \sum^i A_{TPIi} (D_c/C_c)_{TPIi} < 7.5 \text{ mrem/q, } 15 \text{ mrem/y}$$

(1.21)

where:

D_{TPI} = Dose from particulates and iodines (mrem).

A_{TPIi} = Quantity of particulate or iodine nuclide i released (Ci).

(D_c/C_c)_{TPIi} = Dose per Ci factor for particulate or iodine nuclide i (mrad/Ci).

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b. Realistic Calculation

This methodology is to be used if the highly conservative calculations described in C.1 or D.1 yield values that appear to exceed applicable limits.

Doses for released particulates, iodines and noble gases will be determined by use of the NRC GASPAR computer code. The computer run will utilize the annual average joint frequency meteorological data based on not less than 3 years of meteorological measurement, and will reflect demographic and land use information from the land use survey generated in the most recent prior year. Where appropriate, seasonal adjustments will be applied to obtain realistic dose estimates since both recreational and agricultural activities can vary greatly in relation to season of the year.

An alternative to GASPAR for offsite dose calculation is the use of the Palisades Segmented Gaussian Plume Emergency offsite dose calculation program. This dose model allows evaluation of dose under the actual meteorological conditions present at the time of release. It is anticipated that the system may be used in major short-term releases such as Containment purges are to be made under conditions which depart significantly from mean annual conditions.

E. GASEOUS RADWASTE TREATMENT SYSTEM OPERATION

The gaseous radwaste treatment system (GRTS) described below shall be maintained and operated to keep releases ALARA.

1. System Description

A flow diagram for the GRTS is given in Figure 1-1. The system consists of three waste-gas compressor packages, six gas decay tanks, and the associated piping, valves, and instrumentation. Gaseous wastes are received from the following: degassing of the reactor coolant and purging of the volume control tank prior to a cold shutdown, displacing of cover gases caused by liquid accumulation in the tanks connected to the vent header, and boron recycle process operation.

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Design of the system precludes hydrogen explosion by means of ignition source elimination (diaphragm valves, low flow diaphragm compressors and system electrical grounding), and minimization of leakage outside the system. Explosive mixtures of hydrogen and oxygen have been demonstrated compatible with the system by operational experience over the past 13 years.

2. Determination of Satisfactory Operation

Design basis quantity fraction will be calculated for batch and continuous releases as described in Section I.C. These calculations will be used to ensure that the GRTS is operating as designed. Because the Plant was designed to collect and hold for decay a vast majority of the high level gases generated within the primary system, and because the 13-year operating history (to date of writing the initial ODCM) of the Plant has demonstrated the system's consistent performance well below Appendix I limits, no additional operability requirements are specified.

F. RELEASE RATE FOR OFFSITE EC (50 mrem/yr)

10 CFR 20.1302 requires radioactive effluent releases to unrestricted areas be in concentrations less than the limits specified in Appendix B, Table 2 when averaged over a period not to exceed one year.

(Note: there are no unrestricted areas anywhere within the site boundary as defined by Figure 1-1.) Concentrations at this level if present for one year will result in a dose of 50 mrem whole body. 10 CFR 50.36a requires that the release of radioactive materials be kept as low as reasonably achievable. However, the section further states that the licensee is permitted the flexibility of operation, to assure a dependable source of power even under unusual operating conditions, to release quantities of material higher than a small percentage of 10 CFR 20.1302 limits but still within those limits. Appendix I to 10 CFR 50 provides the numerical guidelines on limiting conditions for operations to meet the as low as reasonably achievable requirement.

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The GASPAR code has been run to determine the dose due to external radiation and inhalation. The source term used is listed in Table 1.1. The meteorology data is given in Table 1.3. Dose using annual average meteorology, to the most limiting organ of the person assume to be residing at the site boundary with highest X/Q, is 2.15E-02 mrem (for one year). The release rate which would result in a dose rate equivalent to 50 mrem/year (using the more conservative total body limit) is the curies/year given in Table 1.1 multiplied by 50/2.15E-02 or 0.11 Ci/sec.

G. PARTICULATE AND IODINE SAMPLING

Particulate and iodine samples are obtained from the continuous sample stream pulled from the Plant stack. Samples typically are obtained to represent an integrated release from a gas batch (waste gas decay tank or Containment purge, for example), or a series of samples are obtained to follow the course of a release. In any event, sample intervals are weekly, at a minimum.

Because HEPA filters are present between most source inputs to the stack and the sample point, releases of particulates normally are significantly less than pre-release calculations indicate. This provides for conservatism in establishing setpoints and in estimation of pre-release design basis quantity fraction. However, for the sake of maintaining accurate release totals, monitor results (for gases) and sample results (for particulates and iodines) utilized rather than the pre-release estimates, for cumulative records.

Gamma analytical results for particulate and halogen filters are combined for determination of total activity of particulates and halogens released. Beta and alpha counting also is performed on the particulate filters. Beta yields of the gamma isotopes detected on particulate filters are applied to determine "identified" beta, and the "identified" count rate is subtracted from the observed count rate to give "unidentified" beta. The "unidentified" beta is assumed to be Sr-90 until results on actual Sr-90 (chemically separated from a quarterly composite of filters) are obtained. Sampling and analysis will be performed per Appendix A, Table B-1 requirements.

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H. **NOBLE GAS SAMPLING**

Noble gases will be sampled from Waste Gas Decay Tanks prior to release and the Containment prior to purging. Analysis of these samples will be used for accountability of noble gases. Off gas will be sampled at least weekly and used to calculate monthly noble gas releases. Nonroutine releases will be quantified from the stack noble gas monitor (RE 2326) which has a LLD of $1\text{E-}06 \mu\text{Ci/cc}$. Sampling and analysis will be performed per Appendix A, Table B-1 requirements.

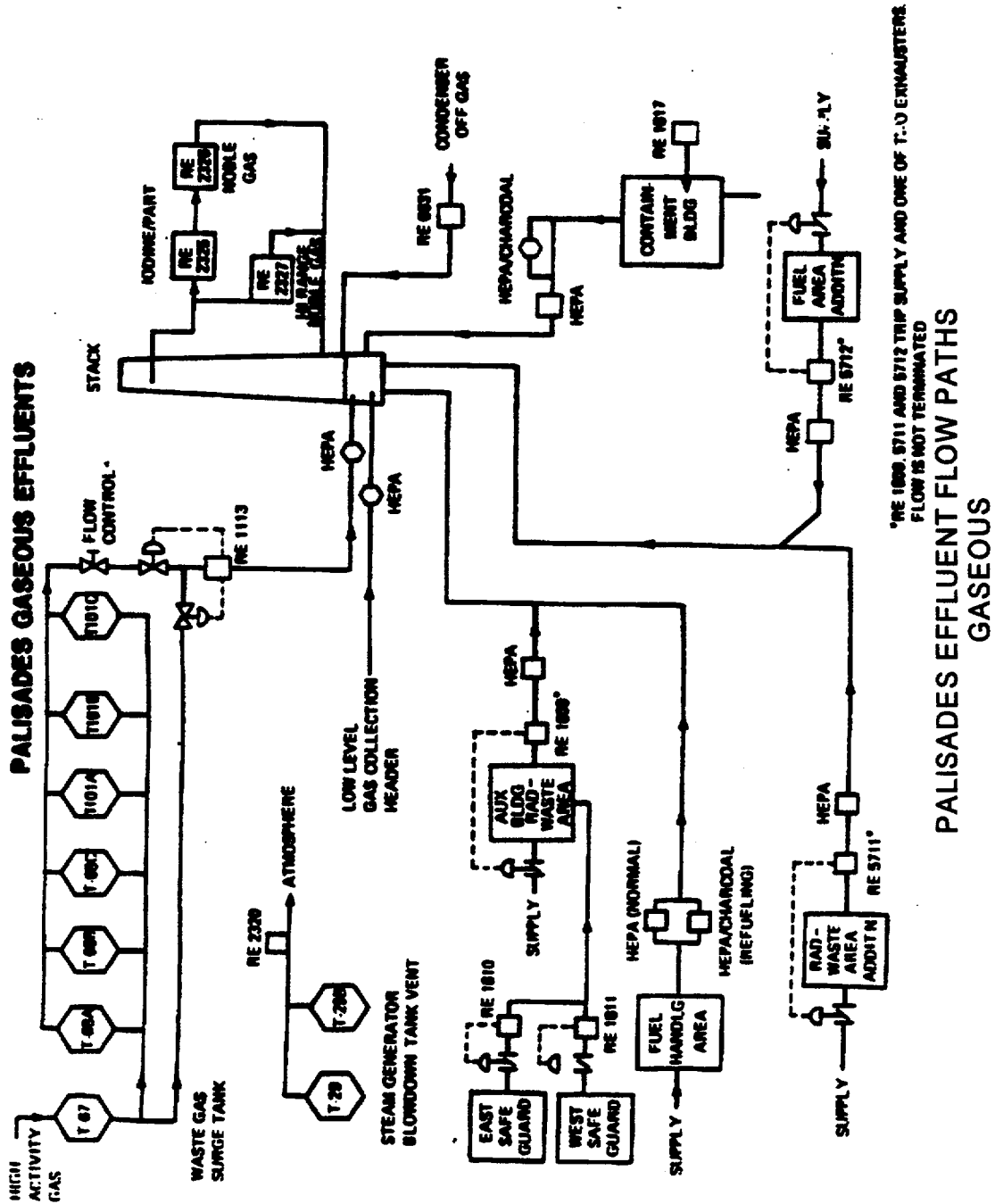
I. **TRITIUM SAMPLING**

Tritium has a low dose consequence to the public because of low production rates. The major contributors to tritium effluents are evaporation from the fuel pool and reactor cavity (when flooded). Because of the low dose impact, gaseous tritium sampling will not be required. Tritium effluents will be estimated using conservative evaporation rate calculations from the fuel pool and reactor cavity.

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J. FIGURES AND TABLES



**PALISADES NUCLEAR PLANT
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TABLE 1.1
PALISADES GASEOUS AND LIQUID SOURCE TERMS, CURIES/YEAR (1)

<u>Nuclide</u>	<u>Gaseous(2)</u>	<u>Liquid(2)</u>
H-3	5.5	159
Kr-85	4.1	NA
Kr-85m	0.12	NA
Kr-87	8.4E-02	NA
Kr-88	2.1E-01	NA
Ar-41	3.1E-02	NA
Xe-131m	2.2	NA
Xe-133	1493	NA
Xe-133m	0.43	NA
Xe-135	1.11	NA
Xe-135m	0.3	NA
I-131	0.025	3.21E-03
I-132	2.91E-03	NA
I-133	6.5E-03	4.7E-05
I-134	4.8E-04	NA
I-135	1.84E-02	NA
Na-24	1.5E-06	NA
Cr-51	2.5E-04	3.9E-03
Mn-54	4.1E-04	7.8E-03
Co-57	2.1E-06	3.2E-05
Co-58	8.6E-04	2.9E-02
Fe-59	6.6E-06	4.1E-04
Co-60	1.1E-03	1.24E-02
Se-75	3.7E-06	NA
Nb-95	2.4E-05	4.53E-04
Zr-95	4.7E-06	1.79E-04
Mo-99	1.5E-07	NA
Ru-103	.3E-07	.1E-05
Sb-127	NA	3.5E-05
Cs-134	4.5E-05	0.7
Cs-136	NA	1.8E-06
Cs-137	2.6E-04	1.36E-02
Ba-140	2.8E-07	NA
La-140	7.5E-07	1.1E-04
Unidentified beta	3.9E-04	3.3E-03

- (1) Data derived from taking the effluents released during July-December 1978 through January-June 1982 and dividing by 4.
- (2) Nuclide values listed as NA have not been observed at detectable levels in these waste streams.

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TABLE 1.2
BASIC RADIONUCLIDE DATA

	<u>NUCLIDE</u>	<u>HALF-LIFE</u> <u>(days)</u>	<u>LAMBDA</u> <u>(1/s)</u>	<u>BETA¹</u> <u>(MEV/DIS)</u>	<u>GAMMA¹</u> <u>(MEV/DIS)</u>
1	Tritium	4.49E 03	1.79E-09	5.68E-03	0.0
2	C-14	2.09E 06	3.84E-12	4.95E-02	0.0
3	N-13	6.94E-03	1.16E-03	4.91E-01	1.02E 00
4	O-19	3.36E-04	2.39E-02	1.02E 00	1.05E 00
5	F-18	7.62E-02	1.05E-04	2.50E-01	1.02E 00
6	NA-24	6.33E-01	1.27E-05	5.55E-01	4.12E 00
7	P-32	1.43E 01	5.61E-07	6.95E-01	0.0
8	AR-41	7.63E-02	1.05E-04	4.64E-01	1.28E 00
9	CR-51	2.78E 01	2.89E-07	3.86E-03	3.28E-02
10	MN-54	3.03E 02	2.65E-08	3.80E-03	8.36E-01
11	MN-56	1.07E-01	7.50E-05	8.29E-01	1.69E 00
12	FE-59	4.50E 01	1.78E-07	1.18E-01	1.19E 00
13	CO-58	7.13E 01	1.12E-07	3.41E-02	9.78E-01
14	CO-60	1.92E 03	4.18E-09	9.68E-02	2.50E 00
15	ZN-69m	5.75E-01	1.39E-05	2.21E-02	4.16E-01
16	ZN-69	3.96E-02	2.03E-04	3.19E-01	0.0
17	BR-84	2.21E-02	3.63E-04	1.28E 00	1.77E 00
18	BR-85	2.08E-03	3.86E-03	1.04E 00	6.60E-02
19	KR-85m	1.83E-01	4.38E-05	2.53E-01	1.59E-01
20	KR-85	3.93E 03	2.04E-09	2.51E-01	2.21E-03
21	KR-87	5.28E-02	1.52E-04	1.32E 00	7.93E-01
22	KR-88	1.17E-01	6.86E-05	3.61E-01	1.96E 00
23	KR-89	2.21E-03	3.63E-03	1.36E 00	1.83E 00
24	RB-88	1.24E-02	6.47E-04	2.06E 00	6.26E-01
25	RB-89	1.07E-02	7.50E-04	1.01E 00	2.05E-00
26	SR-89	5.20E 01	1.54E-07	5.83E-01	8.45E-05
27	SR-90	1.03E 04	7.79E-10	1.96E-01	0.0
28	SR-91	4.03E-01	1.99E-05	6.50E-01	6.95E-01
29	SR-92	1.13E-01	7.10E-05	1.95E-01	1.34E 00
30	SR-93	5.56E-03	1.44E-03	9.20E-01	2.24E 00
31	Y-90	2.67E 00	3.00E-06	9.36E-01	0.0
32	Y-91m	3.47E-02	2.31E-04	2.73E-02	5.30E-01
33	Y-91	5.88E 01	1.36E-07	6.06E-01	3.61E-03
34	Y-92	1.47E-01	5.46E-05	1.44E 00	2.50E-01
35	Y-93	4.29E-01	1.87E-05	1.17E 00	8.94E-02
36	ZR-95	6.50E 01	1.23E-07	1.16E-01	7.35E-01
37	NB-95m	3.75E 00	2.14E-06	1.81E-01	6.06E-02
38	NB-95	3.50E 01	2.29E-07	4.44E-02	7.64E-01
39	MO-99	2.79E 00	2.87E-06	3.96E-01	1.50E-01
40	TC-99m	2.50E-01	3.21E-05	1.56E-02	1.26E-01

**PALISADES NUCLEAR PLANT
OFFSITE DOSE CALCULATION MANUAL**

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**TABLE 1.2 (continued)
BASIC RADIONUCLIDE DATA**

	<u>NUCLIDE</u>	<u>HALF-LIFE</u> <u>(days)</u>	<u>LAMBDA</u> <u>(1/s)</u>	<u>BETA¹</u> <u>(MEV/DIS)</u>	<u>GAMMA¹</u> <u>(MEV/DIS)</u>
41	TC-99	7.74E 07	1.04E-13	8.46E-02	0.0
42	TC-104	1.25E-02	6.42E-04	1.60E 00	1 .95E 00
43	RU-106	3.67E 02	2.19E-08	1.01E-02	0.0
44	TE-132	3.24E 00	2.48E-06	1.00E-01	2.33E-01
45	I-129	6.21E 09	1.29E-15	5.43E-02	2.46E-02
46	I-131	8.05E 00	9.96E-07	1.94E-01	3.81E-01
47	I-132	9.58E-02	8.37E-05	4.89E-01	2.24E 00
48	I-133	8.75E-01	9.17E-06	4.08E-01	6.02E-01
49	I-134	3.61E-02	2.22E-04	6.16E-01	2.59E 00
50	I-135	2.79E-01	2.87E-05	3.68E-01	1.55E 00
51	XE-131m	1.18E 01	6.80E-07	1.43E-01	2.01E-02
52	XE-133m	2.26E 00	3.55E-06	1.90E-01	4.15E-02
53	XE-133	5.27E 00	1.52E-06	1.35E-01	4.60E-02
54	XE-135m	1.08E-02	7.43E-04	9.58E-02	4.32E-01
55	XE-135	3.83E-01	2.09E-05	3.17E-01	2.47E-01
56	XE-137	2.71E 03	2.96E-03	1.77E 00	1.88E-01
57	XE-138	9.84E-03	8.15E-04	6.65E-01	1.10E 00
58	CS-134	7.48E 02	1.07E-08	1.63E-01	1.55E 00
59	CS-135	1.10E 09	7.29E-15	5.63E-02	0.0
60	CS-136	1.30E 01	6.17E-07	1.37E-01	2.15E 00
61	CS-137	1.10E 04	7.29E-10	1.71E-01	5.97E-01
62	CS-138	2.24E-02	3.58E-04	1.20E 00	2.30E 00
63	BA-139	5.76E-02	1.39E-04	8.96E-01	3.53E-02
64	BA-140	1.28E 01	6.27E-07	3.15E-01	1.71E-01
65	LA-140	1.68E 00	4.77E-06	5.33E-01	2.31E 00
66	CE-144	2.84E 02	2.82E-08	9.13E-02	1.93E-02
67	PR-143	1.36E 01	5.90E-07	3.14E-01	0.0
68	PR-144	1.20E-02	6.68E-04	1.21E 00	3.18E 00

¹ Average energy per disintegration values were obtained from ICRP Publication No 38, Radionuclide Transformations: Energy and Intensity of Emissions 1983 and NUREG/CR-1413 (ORNL/NUREG-70), a Radionuclide Decay Data Base - Index and Summary Table, DC Kocher, May 1980.

***** PALISADES XOQDOQ82 ***** USING 01/01/92 - 12/31/96 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
NO DECAY, UNDEPLETED

SECTOR	ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)				DISTANCE IN MILES FROM THE SITE						
	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	4.208E-06	1.381E-06	7.556E-07	4.993E-07	2.782E-07	1.842E-07	1.340E-07	1.033E-07	8.298E-08	6.867E-08	5.813E-08
SSW	3.330E-06	1.086E-06	5.856E-07	3.870E-07	2.160E-07	1.437E-07	1.048E-07	8.108E-08	6.528E-08	5.413E-08	4.590E-08
SW	3.890E-06	1.242E-06	6.590E-07	4.333E-07	2.413E-07	1.614E-07	1.184E-07	9.203E-08	7.440E-08	6.191E-08	5.267E-08
WSW	4.060E-06	1.279E-06	6.715E-07	4.401E-07	2.450E-07	1.648E-07	1.215E-07	9.484E-08	7.694E-08	6.422E-08	5.477E-08
W	5.554E-06	1.759E-06	9.224E-07	6.035E-07	3.349E-07	2.249E-07	1.657E-07	1.292E-07	1.047E-07	8.735E-08	7.447E-08
WNW	7.378E-06	2.346E-06	1.235E-06	8.084E-07	4.487E-07	3.010E-07	2.216E-07	1.726E-07	1.399E-07	1.166E-07	9.937E-08
NW	9.531E-06	2.974E-06	1.551E-06	1.012E-06	5.610E-07	3.784E-07	2.800E-07	2.191E-07	1.781E-07	1.490E-07	1.273E-07
NNW	1.286E-05	3.959E-06	2.052E-06	1.339E-06	7.443E-07	5.039E-07	3.741E-07	2.935E-07	2.391E-07	2.003E-07	1.715E-07
N	1.087E-05	3.347E-06	1.739E-06	1.138E-06	6.348E-07	4.300E-07	3.192E-07	2.504E-07	2.040E-07	1.709E-07	1.462E-07
NNE	5.487E-06	1.717E-06	9.119E-07	6.000E-07	3.353E-07	2.256E-07	1.664E-07	1.299E-07	1.054E-07	8.793E-08	7.501E-08
NE	5.450E-06	1.803E-06	9.856E-07	6.476E-07	3.578E-07	2.355E-07	1.705E-07	1.310E-07	1.049E-07	8.657E-08	7.312E-08
ENE	4.258E-06	1.379E-06	7.464E-07	4.886E-07	2.697E-07	1.773E-07	1.282E-07	9.850E-08	7.885E-08	6.507E-08	5.496E-08
E	4.618E-06	1.531E-06	8.321E-07	5.438E-07	2.990E-07	1.959E-07	1.413E-07	1.082E-07	8.645E-08	7.120E-08	6.002E-08
ESE	4.436E-06	1.479E-06	8.008E-07	5.210E-07	2.848E-07	1.860E-07	1.338E-07	1.023E-07	8.153E-08	6.704E-08	5.644E-08
SE	5.091E-06	1.678E-06	9.044E-07	5.872E-07	3.207E-07	2.096E-07	1.509E-07	1.155E-07	9.217E-08	7.586E-08	6.391E-08
SSE	6.044E-06	2.000E-06	1.088E-06	7.106E-07	3.901E-07	2.557E-07	1.845E-07	1.415E-07	1.131E-07	9.317E-08	7.858E-08

SECTOR	ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)				DISTANCE IN MILES FROM THE SITE						
	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	5.010E-08	2.837E-08	1.901E-08	1.086E-08	7.328E-09	5.410E-09	4.227E-09	3.433E-09	2.869E-09	2.450E-09	2.127E-09
SSW	3.963E-08	2.257E-08	1.519E-08	8.728E-09	5.913E-09	4.379E-09	3.431E-09	2.793E-09	2.338E-09	2.000E-09	1.740E-09
SW	4.560E-08	2.627E-08	1.782E-08	1.037E-08	7.086E-09	5.284E-09	4.163E-09	3.405E-09	2.863E-09	2.458E-09	2.145E-09
WSW	4.753E-08	2.763E-08	1.886E-08	1.106E-08	7.602E-09	5.693E-09	4.501E-09	3.693E-09	3.113E-09	2.678E-09	2.342E-09
W	6.459E-08	3.749E-08	2.557E-08	1.498E-08	1.029E-08	7.706E-09	6.091E-09	4.996E-09	4.211E-09	3.623E-09	3.168E-09
WNW	8.615E-08	4.992E-08	3.400E-08	1.989E-08	1.364E-08	1.021E-08	8.059E-09	6.606E-09	5.565E-09	4.785E-09	4.183E-09
NW	1.106E-07	6.471E-08	4.436E-08	2.618E-08	1.808E-08	1.359E-08	1.077E-08	8.857E-09	7.481E-09	6.449E-09	5.649E-09
NNW	1.492E-07	8.772E-08	6.035E-08	3.579E-08	2.479E-08	1.867E-08	1.483E-08	1.221E-08	1.033E-08	8.915E-09	7.817E-09
N	1.273E-07	7.475E-08	5.139E-08	3.045E-08	2.107E-08	1.586E-08	1.259E-08	1.036E-08	8.762E-09	7.559E-09	6.625E-09
NNE	6.508E-08	3.782E-08	2.581E-08	1.513E-08	1.039E-08	7.781E-09	6.148E-09	5.042E-09	4.248E-09	3.654E-09	3.194E-09
NE	6.291E-08	3.539E-08	2.361E-08	1.342E-08	9.033E-09	6.656E-09	5.193E-09	4.213E-09	3.517E-09	3.000E-09	2.604E-09
ENE	4.729E-08	2.665E-08	1.781E-08	1.015E-08	6.847E-09	5.056E-09	3.951E-09	3.211E-09	2.684E-09	2.293E-09	1.993E-09
E	5.155E-08	2.883E-08	1.915E-08	1.083E-08	7.262E-09	5.337E-09	4.155E-09	3.366E-09	2.806E-09	2.392E-09	2.074E-09
ESE	4.843E-08	2.698E-08	1.788E-08	1.007E-08	6.742E-09	4.948E-09	3.848E-09	3.114E-09	2.594E-09	2.210E-09	1.915E-09
SE	5.488E-08	3.069E-08	2.039E-08	1.154E-08	7.748E-09	5.702E-09	4.445E-09	3.604E-09	3.008E-09	2.566E-09	2.227E-09
SSE	6.753E-08	3.785E-08	2.519E-08	1.428E-08	9.595E-09	7.064E-09	5.507E-09	4.466E-09	3.727E-09	3.179E-09	2.758E-09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT (METERS) 58.10
DIAMETER (METERS) 0.00
EXIT VELOCITY (METERS) 0.00

REP. WIND HEIGHT (METERS) 10.0
BUILDING HEIGHT (METERS) 58.1
BLDG. MIN. CRS. SEC. AREA (SQ. METERS) 2000.0
HEAT EMISSION RATE (CAL/SEC) 0.0

ALL GROUND LEVEL RELEASES.

TABLE 1.3

Revision 13

***** PALISADES XQDDQ82 ***** USING 01/01/92 - 12/31/96 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
NO DECAY, UNDEPLETED

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

DIRECTION FROM SITE	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	7.808E-07	2.856E-07	1.351E-07	8.334E-08	5.828E-08	2.904E-08	1.110E-08	5.448E-09	3.445E-09	2.454E-09
SSW	6.085E-07	2.219E-07	1.057E-07	6.555E-08	4.602E-08	2.308E-08	8.912E-09	4.409E-09	2.802E-09	2.004E-09
SW	6.883E-07	2.484E-07	1.193E-07	7.468E-08	5.279E-08	2.681E-08	1.057E-08	5.316E-09	3.415E-09	2.462E-09
WSW	7.038E-07	2.527E-07	1.224E-07	7.721E-08	5.489E-08	2.815E-08	1.126E-08	5.725E-09	3.703E-09	2.683E-09
W	9.666E-07	3.457E-07	1.669E-07	1.051E-07	7.463E-08	3.821E-08	1.525E-08	7.749E-09	5.010E-09	3.629E-09
WNW	1.292E-06	4.630E-07	2.232E-07	1.404E-07	9.958E-08	5.089E-08	2.025E-08	1.026E-08	6.625E-09	4.793E-09
NW	1.627E-06	5.800E-07	2.819E-07	1.787E-07	1.276E-07	6.587E-08	2.662E-08	1.366E-08	8.879E-09	6.458E-09
NNW	2.159E-06	7.695E-07	3.765E-07	2.399E-07	1.718E-07	8.923E-08	3.636E-08	1.877E-08	1.224E-08	8.928E-09
N	1.829E-06	6.557E-07	3.212E-07	2.046E-07	1.465E-07	7.604E-08	3.093E-08	1.594E-08	1.039E-08	7.569E-09
NNE	9.521E-07	3.454E-07	1.676E-07	1.057E-07	7.516E-08	3.854E-08	1.540E-08	7.825E-09	5.056E-09	3.660E-09
NE	1.017E-06	3.678E-07	1.720E-07	1.054E-07	7.332E-08	3.627E-08	1.374E-08	6.704E-09	4.227E-09	3.006E-09
ENE	7.724E-07	2.773E-07	1.294E-07	7.922E-08	5.511E-08	2.731E-08	1.038E-08	5.092E-09	3.222E-09	2.298E-09
E	8.592E-07	3.076E-07	1.426E-07	8.686E-08	6.020E-08	2.958E-08	1.109E-08	5.378E-09	3.378E-09	2.397E-09
ESE	8.271E-07	2.934E-07	1.351E-07	8.193E-08	5.661E-08	2.770E-08	1.033E-08	4.986E-09	3.126E-09	2.214E-09
SE	9.353E-07	3.305E-07	1.524E-07	9.262E-08	6.411E-08	3.149E-08	1.182E-08	5.745E-09	3.617E-09	2.571E-09
SSE	1.123E-06	4.016E-07	1.863E-07	1.136E-07	7.881E-08	3.882E-08	1.462E-08	7.116E-09	4.482E-09	3.186E-09

TABLE 1.3

Revision 13

***** PALISADES XQOQOQ82 ***** USING 01/01/92 - 12/31/96 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
2.260 DAY DECAY, UNDEPLETED

SECTOR	ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)										
	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	4.205E-06	1.379E-06	7.540E-07	4.979E-07	2.769E-07	1.831E-07	1.330E-07	1.024E-07	8.212E-08	6.785E-08	5.735E-08
SSW	3.327E-06	1.084E-06	5.842E-07	3.858E-07	2.150E-07	1.428E-07	1.040E-07	8.032E-08	6.457E-08	5.346E-08	4.526E-08
SW	3.887E-06	1.240E-06	6.575E-07	4.319E-07	2.402E-07	1.604E-07	1.175E-07	9.117E-08	7.359E-08	6.114E-08	5.193E-08
WSW	4.057E-06	1.277E-06	6.699E-07	4.388E-07	2.439E-07	1.637E-07	1.206E-07	9.394E-08	7.609E-08	6.341E-08	5.400E-08
W	5.550E-06	1.757E-06	9.203E-07	6.016E-07	3.334E-07	2.235E-07	1.644E-07	1.280E-07	1.036E-07	8.628E-08	7.344E-08
WNW	7.373E-06	2.343E-06	1.232E-06	8.062E-07	4.468E-07	2.993E-07	2.200E-07	1.712E-07	1.385E-07	1.153E-07	9.810E-08
NW	9.524E-06	2.969E-06	1.547E-06	1.009E-06	5.585E-07	3.761E-07	2.779E-07	2.171E-07	1.762E-07	1.472E-07	1.256E-07
NNW	1.285E-05	3.953E-06	2.047E-06	1.335E-06	7.408E-07	5.008E-07	3.712E-07	2.907E-07	2.365E-07	1.979E-07	1.691E-07
N	1.087E-05	3.341E-06	1.735E-06	1.134E-06	6.316E-07	4.271E-07	3.165E-07	2.478E-07	2.016E-07	1.686E-07	1.440E-07
NNE	5.483E-06	1.714E-06	9.099E-07	5.982E-07	3.338E-07	2.242E-07	1.652E-07	1.287E-07	1.042E-07	8.687E-08	7.398E-08
NE	5.447E-06	1.800E-06	9.837E-07	6.458E-07	3.563E-07	2.343E-07	1.693E-07	1.299E-07	1.039E-07	8.564E-08	7.223E-08
ENE	4.255E-06	1.377E-06	7.448E-07	4.872E-07	2.685E-07	1.763E-07	1.273E-07	9.763E-08	7.804E-08	6.431E-08	5.423E-08
E	4.615E-06	1.528E-06	8.303E-07	5.423E-07	2.977E-07	1.948E-07	1.403E-07	1.073E-07	8.559E-08	7.039E-08	5.925E-08
ESE	4.433E-06	1.477E-06	7.992E-07	5.196E-07	2.837E-07	1.850E-07	1.328E-07	1.014E-07	8.075E-08	6.631E-08	5.575E-08
SE	5.088E-06	1.676E-06	9.026E-07	5.856E-07	3.194E-07	2.085E-07	1.499E-07	1.145E-07	9.128E-08	7.502E-08	6.312E-08
SSE	6.040E-06	1.997E-06	1.086E-06	7.087E-07	3.885E-07	2.543E-07	1.833E-07	1.403E-07	1.120E-07	9.213E-08	7.760E-08

SECTOR	ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)										
	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	4.936E-08	2.774E-08	1.845E-08	1.039E-08	6.911E-09	5.029E-09	3.874E-09	3.103E-09	2.557E-09	2.153E-09	1.844E-09
SSW	3.901E-08	2.204E-08	1.472E-08	8.327E-09	5.555E-09	4.051E-09	3.126E-09	2.506E-09	2.067E-09	1.742E-09	1.492E-09
SW	4.489E-08	2.566E-08	1.727E-08	9.893E-09	6.657E-09	4.889E-09	3.793E-09	3.056E-09	2.531E-09	2.140E-09	1.840E-09
WSW	4.678E-08	2.698E-08	1.827E-08	1.055E-08	7.141E-09	5.267E-09	4.101E-09	3.314E-09	2.751E-09	2.332E-09	2.009E-09
W	6.361E-08	3.664E-08	2.480E-08	1.431E-08	9.688E-09	7.147E-09	5.566E-09	4.500E-09	3.738E-09	3.170E-09	2.732E-09
WNW	8.494E-08	4.886E-08	3.304E-08	1.906E-08	1.289E-08	9.508E-09	7.405E-09	5.987E-09	4.975E-09	4.220E-09	3.639E-09
NW	1.090E-07	6.323E-08	4.301E-08	2.500E-08	1.700E-08	1.259E-08	9.836E-09	7.972E-09	6.638E-09	5.641E-09	4.872E-09
NNW	1.469E-07	8.570E-08	5.851E-08	3.417E-08	2.331E-08	1.730E-08	1.354E-08	1.099E-08	9.164E-09	7.796E-09	6.739E-09
N	1.251E-07	7.285E-08	4.966E-08	2.893E-08	1.969E-08	1.458E-08	1.139E-08	9.223E-09	7.674E-09	6.516E-09	5.622E-09
NNE	6.410E-08	3.697E-08	2.504E-08	1.446E-08	9.786E-09	7.218E-09	5.620E-09	4.541E-09	3.771E-09	3.196E-09	2.754E-09
NE	6.206E-08	3.468E-08	2.298E-08	1.289E-08	8.558E-09	6.223E-09	4.791E-09	3.836E-09	3.160E-09	2.662E-09	2.280E-09
ENE	4.659E-08	2.607E-08	1.729E-08	9.711E-09	6.459E-09	4.702E-09	3.624E-09	2.904E-09	2.395E-09	2.018E-09	1.730E-09
E	5.082E-08	2.822E-08	1.861E-08	1.037E-08	6.861E-09	4.973E-09	3.819E-09	3.051E-09	2.509E-09	2.110E-09	1.805E-09
ESE	4.776E-08	2.643E-08	1.739E-08	9.664E-09	6.380E-09	4.619E-09	3.544E-09	2.830E-09	2.327E-09	1.956E-09	1.673E-09
SE	5.413E-08	3.005E-08	1.983E-08	1.106E-08	7.329E-09	5.320E-09	4.091E-09	3.273E-09	2.695E-09	2.268E-09	1.943E-09
SSE	6.659E-08	3.706E-08	2.449E-08	1.369E-08	9.073E-09	6.588E-09	5.066E-09	4.053E-09	3.337E-09	2.808E-09	2.404E-09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT (METERS) 58.10
DIAMETER (METERS) 0.00
EXIT VELOCITY (METERS) 0.00

REP. WIND HEIGHT (METERS) 10.0
BUILDING HEIGHT (METERS) 58.1
BLDG. MIN. CRS. SEC. AREA (SQ. METERS) 2000.0
HEAT EMISSION RATE (CAL/SEC) 0.0

ALL GROUND LEVEL RELEASES.

***** PALISADES XOQDOQ82 ***** USING 01/01/92 - 12/31/96 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
2.260 DAY DECAY, UNDEPLETED

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

DIRECTION FROM SITE	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
	5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	7.791E-07	2.843E-07	1.341E-07	8.248E-08	5.750E-08	2.842E-08	1.064E-08	5.069E-09	3.115E-09	2.158E-09
SSW	6.072E-07	2.209E-07	1.049E-07	6.484E-08	4.537E-08	2.256E-08	8.515E-09	4.082E-09	2.516E-09	1.746E-09
SW	6.867E-07	2.473E-07	1.184E-07	7.387E-08	5.205E-08	2.621E-08	1.010E-08	4.922E-09	3.066E-09	2.145E-09
WSW	7.022E-07	2.516E-07	1.214E-07	7.636E-08	5.412E-08	2.751E-08	1.075E-08	5.300E-09	3.324E-09	2.337E-09
W	9.645E-07	3.441E-07	1.656E-07	1.040E-07	7.360E-08	3.737E-08	1.459E-08	7.192E-09	4.514E-09	3.176E-09
WNW	1.290E-06	4.611E-07	2.216E-07	1.390E-07	9.832E-08	4.985E-08	1.942E-08	9.569E-09	6.007E-09	4.229E-09
NW	1.624E-06	5.775E-07	2.798E-07	1.768E-07	1.258E-07	6.441E-08	2.545E-08	1.267E-08	7.996E-09	5.651E-09
NNW	2.154E-06	7.661E-07	3.736E-07	2.373E-07	1.694E-07	8.722E-08	3.475E-08	1.740E-08	1.102E-08	7.810E-09
N	1.825E-06	6.524E-07	3.185E-07	2.022E-07	1.443E-07	7.415E-08	2.943E-08	1.466E-08	9.251E-09	6.528E-09
NNE	9.500E-07	3.438E-07	1.663E-07	1.046E-07	7.414E-08	3.770E-08	1.473E-08	7.263E-09	4.556E-09	3.203E-09
NE	1.015E-06	3.664E-07	1.709E-07	1.044E-07	7.244E-08	3.557E-08	1.321E-08	6.272E-09	3.851E-09	2.668E-09
ENE	7.708E-07	2.761E-07	1.285E-07	7.840E-08	5.439E-08	2.673E-08	9.950E-09	4.739E-09	2.916E-09	2.023E-09
E	8.574E-07	3.063E-07	1.416E-07	8.600E-08	5.943E-08	2.897E-08	1.064E-08	5.015E-09	3.064E-09	2.115E-09
ESE	8.255E-07	2.922E-07	1.342E-07	8.115E-08	5.592E-08	2.715E-08	9.921E-09	4.659E-09	2.842E-09	1.961E-09
SE	9.335E-07	3.292E-07	1.514E-07	9.173E-08	6.332E-08	3.086E-08	1.135E-08	5.364E-09	3.286E-09	2.274E-09
SSE	1.121E-06	4.000E-07	1.850E-07	1.125E-07	7.783E-08	3.804E-08	1.404E-08	6.642E-09	4.070E-09	2.815E-09

***** PALISADES XQOQOQ82 ***** USING 01/01/92 - 12/31/96 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
8.000 DAY DECAY, DEPLETED

SECTOR	ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)										
	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	3.982E-06	1.261E-06	6.730E-07	4.367E-07	2.359E-07	1.523E-07	1.083E-07	8.186E-08	6.456E-08	5.254E-08	4.378E-08
SSW	3.150E-06	9.913E-07	5.215E-07	3.384E-07	1.832E-07	1.187E-07	8.473E-08	6.423E-08	5.078E-08	4.141E-08	3.457E-08
SW	3.681E-06	1.134E-06	5.869E-07	3.789E-07	2.047E-07	1.334E-07	9.572E-08	7.291E-08	5.787E-08	4.736E-08	3.966E-08
WSW	3.842E-06	1.168E-06	5.980E-07	3.849E-07	2.078E-07	1.362E-07	9.823E-08	7.513E-08	5.985E-08	4.912E-08	4.125E-08
W	5.256E-06	1.606E-06	8.215E-07	5.278E-07	2.841E-07	1.859E-07	1.339E-07	1.023E-07	8.146E-08	6.682E-08	5.608E-08
WNW	6.982E-06	2.141E-06	1.100E-06	7.071E-07	3.806E-07	2.488E-07	1.791E-07	1.368E-07	1.088E-07	8.923E-08	7.486E-08
NW	9.018E-06	2.715E-06	1.381E-06	8.848E-07	4.758E-07	3.128E-07	2.263E-07	1.736E-07	1.386E-07	1.140E-07	9.588E-08
NNW	1.217E-05	3.613E-06	1.827E-06	1.171E-06	6.312E-07	4.165E-07	3.024E-07	2.325E-07	1.860E-07	1.532E-07	1.291E-07
N	1.029E-05	3.055E-06	1.549E-06	9.954E-07	5.384E-07	3.554E-07	2.579E-07	1.983E-07	1.586E-07	1.307E-07	1.101E-07
NNE	5.192E-06	1.567E-06	8.121E-07	5.248E-07	2.844E-07	1.865E-07	1.345E-07	1.029E-07	8.196E-08	6.727E-08	5.649E-08
NE	5.157E-06	1.646E-06	8.778E-07	5.664E-07	3.035E-07	1.947E-07	1.378E-07	1.038E-07	8.162E-08	6.625E-08	5.509E-08
ENE	4.029E-06	1.259E-06	6.648E-07	4.273E-07	2.287E-07	1.466E-07	1.037E-07	7.804E-08	6.135E-08	4.978E-08	4.139E-08
E	4.370E-06	1.397E-06	7.410E-07	4.756E-07	2.536E-07	1.620E-07	1.142E-07	8.576E-08	6.727E-08	5.448E-08	4.522E-08
ESE	4.198E-06	1.350E-06	7.132E-07	4.557E-07	2.416E-07	1.538E-07	1.081E-07	8.103E-08	6.344E-08	5.130E-08	4.252E-08
SE	4.817E-06	1.532E-06	8.055E-07	5.136E-07	2.720E-07	1.733E-07	1.220E-07	9.152E-08	7.172E-08	5.805E-08	4.815E-08
SSE	5.719E-06	1.826E-06	9.691E-07	6.216E-07	3.309E-07	2.114E-07	1.492E-07	1.121E-07	8.798E-08	7.129E-08	5.920E-08

SECTOR	ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)										
	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	3.719E-08	1.987E-08	1.266E-08	6.668E-09	4.208E-09	2.931E-09	2.174E-09	1.683E-09	1.345E-09	1.102E-09	9.195E-10
SSW	2.941E-08	1.580E-08	1.011E-08	5.355E-09	3.392E-09	2.370E-09	1.762E-09	1.367E-09	1.094E-09	8.973E-10	7.499E-10
SW	3.384E-08	1.840E-08	1.187E-08	6.362E-09	4.065E-09	2.860E-09	2.138E-09	1.667E-09	1.340E-09	1.103E-09	9.248E-10
WSW	3.527E-08	1.935E-08	1.256E-08	6.786E-09	4.361E-09	3.081E-09	2.311E-09	1.807E-09	1.457E-09	1.202E-09	1.010E-09
W	4.794E-08	2.626E-08	1.703E-08	9.195E-09	5.907E-09	4.173E-09	3.130E-09	2.448E-09	1.973E-09	1.628E-09	1.368E-09
WNW	6.396E-08	3.498E-08	2.266E-08	1.222E-08	7.839E-09	5.533E-09	4.148E-09	3.241E-09	2.612E-09	2.154E-09	1.810E-09
NW	8.212E-08	4.532E-08	2.954E-08	1.607E-08	1.037E-08	7.352E-09	5.531E-09	4.335E-09	3.502E-09	2.894E-09	2.436E-09
NNW	1.107E-07	6.143E-08	4.019E-08	2.196E-08	1.422E-08	1.011E-08	7.617E-09	5.980E-09	4.836E-09	4.002E-09	3.371E-09
N	9.439E-08	5.231E-08	3.419E-08	1.866E-08	1.207E-08	8.564E-09	6.449E-09	5.058E-09	4.087E-09	3.379E-09	2.844E-09
NNE	4.831E-08	2.649E-08	1.719E-08	9.289E-09	5.967E-09	4.214E-09	3.160E-09	2.470E-09	1.991E-09	1.642E-09	1.379E-09
NE	4.671E-08	2.481E-08	1.574E-08	8.249E-09	5.194E-09	3.612E-09	2.676E-09	2.070E-09	1.653E-09	1.353E-09	1.129E-09
ENE	3.510E-08	1.867E-08	1.186E-08	6.231E-09	3.932E-09	2.740E-09	2.032E-09	1.574E-09	1.259E-09	1.031E-09	8.614E-10
E	3.827E-08	2.020E-08	1.276E-08	6.651E-09	4.172E-09	2.894E-09	2.139E-09	1.652E-09	1.317E-09	1.077E-09	8.971E-10
ESE	3.596E-08	1.891E-08	1.192E-08	6.190E-09	3.875E-09	2.684E-09	1.981E-09	1.529E-09	1.219E-09	9.955E-10	8.292E-10
SE	4.075E-08	2.150E-08	1.359E-08	7.089E-09	4.453E-09	3.093E-09	2.288E-09	1.769E-09	1.413E-09	1.156E-09	9.641E-10
SSE	5.014E-08	2.653E-08	1.679E-08	8.772E-09	5.515E-09	3.831E-09	2.836E-09	2.192E-09	1.750E-09	1.432E-09	1.194E-09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT (METERS)	58.10	REP. WIND HEIGHT (METERS)	10.0
DIAMETER (METERS)	0.00	BUILDING HEIGHT (METERS)	58.1
EXIT VELOCITY (METERS)	0.00	BLDG. MIN. CRS. SEC. AREA (SQ. METERS)	2000.0
		HEAT EMISSION RATE (CAL/SEC)	0.0

ALL GROUND LEVEL RELEASES.

***** PALISADES XQDOQ82 ***** USING 01/01/92 - 12/31/96 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
8.000 DAY DECAY, DEPLETED

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

DIRECTION FROM SITE	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
	5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	6.986E-07	2.434E-07	1.094E-07	6.492E-08	4.393E-08	2.052E-08	6.907E-09	2.969E-09	1.695E-09	1.106E-09
SSW	5.445E-07	1.891E-07	8.560E-08	5.105E-08	3.468E-08	1.630E-08	5.540E-09	2.399E-09	1.376E-09	9.011E-10
SW	6.160E-07	2.117E-07	9.664E-08	5.816E-08	3.979E-08	1.893E-08	6.565E-09	2.892E-09	1.677E-09	1.107E-09
WSW	6.299E-07	2.153E-07	9.911E-08	6.013E-08	4.137E-08	1.987E-08	6.991E-09	3.114E-09	1.818E-09	1.206E-09
W	8.653E-07	2.946E-07	1.351E-07	8.184E-08	5.625E-08	2.697E-08	9.475E-09	4.218E-09	2.462E-09	1.634E-09
WNW	1.157E-06	3.946E-07	1.808E-07	1.094E-07	7.508E-08	3.594E-08	1.259E-08	5.594E-09	3.261E-09	2.162E-09
NW	1.457E-06	4.943E-07	2.283E-07	1.392E-07	9.614E-08	4.648E-08	1.653E-08	7.429E-09	4.359E-09	2.904E-09
NNW	1.932E-06	6.557E-07	3.049E-07	1.868E-07	1.295E-07	6.295E-08	2.257E-08	1.021E-08	6.012E-09	4.016E-09
N	1.637E-06	5.586E-07	2.601E-07	1.593E-07	1.104E-07	5.361E-08	1.918E-08	8.652E-09	5.085E-09	3.391E-09
NNE	8.521E-07	2.943E-07	1.357E-07	8.234E-08	5.665E-08	2.721E-08	9.569E-09	4.260E-09	2.485E-09	1.648E-09
NE	9.101E-07	3.136E-07	1.394E-07	8.210E-08	5.529E-08	2.565E-08	8.556E-09	3.659E-09	2.084E-09	1.359E-09
ENE	6.913E-07	2.364E-07	1.049E-07	6.171E-08	4.155E-08	1.930E-08	6.461E-09	2.775E-09	1.585E-09	1.036E-09
E	7.689E-07	2.622E-07	1.156E-07	6.768E-08	4.539E-08	2.091E-08	6.908E-09	2.932E-09	1.663E-09	1.081E-09
ESE	7.403E-07	2.502E-07	1.095E-07	6.384E-08	4.269E-08	1.959E-08	6.434E-09	2.721E-09	1.540E-09	1.000E-09
SE	8.371E-07	2.818E-07	1.235E-07	7.217E-08	4.834E-08	2.226E-08	7.362E-09	3.134E-09	1.782E-09	1.161E-09
SSE	1.005E-06	3.424E-07	1.510E-07	8.852E-08	5.943E-08	2.745E-08	9.106E-09	3.882E-09	2.208E-09	1.438E-09

TABLE 1.3

Revision 13

***** PALISADES XQDQD82 ***** USING 01/01/92 - 12/31/96 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING

***** RELATIVE DEPOSITION PER UNIT AREA (M⁻²) AT FIXED POINTS BY DOWNWIND SECTORS *****

DIRECTION FROM SITE	DISTANCES IN MILES										
	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
S	2.600E-08	8.794E-09	4.515E-09	2.772E-09	1.382E-09	8.383E-10	5.668E-10	4.107E-10	3.123E-10	2.460E-10	1.992E-10
SSW	1.731E-08	5.852E-09	3.005E-09	1.845E-09	9.198E-10	5.579E-10	3.772E-10	2.733E-10	2.078E-10	1.637E-10	1.325E-10
SW	1.866E-08	6.309E-09	3.239E-09	1.989E-09	9.916E-10	6.014E-10	4.066E-10	2.946E-10	2.240E-10	1.765E-10	1.429E-10
WSW	1.829E-08	6.183E-09	3.175E-09	1.949E-09	9.719E-10	5.894E-10	3.985E-10	2.888E-10	2.196E-10	1.730E-10	1.401E-10
W	2.673E-08	9.040E-09	4.641E-09	2.850E-09	1.421E-09	8.618E-10	5.826E-10	4.222E-10	3.210E-10	2.529E-10	2.048E-10
WNW	4.142E-08	1.401E-08	7.191E-09	4.416E-09	2.201E-09	1.335E-09	9.027E-10	6.541E-10	4.974E-10	3.919E-10	3.172E-10
NW	4.847E-08	1.639E-08	8.416E-09	5.168E-09	2.576E-09	1.563E-09	1.056E-09	7.656E-10	5.821E-10	4.586E-10	3.713E-10
NNW	5.897E-08	1.994E-08	1.024E-08	6.287E-09	3.135E-09	1.901E-09	1.285E-09	9.314E-10	7.082E-10	5.580E-10	4.517E-10
N	4.172E-08	1.411E-08	7.244E-09	4.448E-09	2.218E-09	1.345E-09	9.093E-10	6.589E-10	5.010E-10	3.947E-10	3.196E-10
NNE	2.423E-08	8.194E-09	4.207E-09	2.583E-09	1.288E-09	7.811E-10	5.281E-10	3.827E-10	2.910E-10	2.292E-10	1.856E-10
NE	4.208E-08	1.423E-08	7.306E-09	4.486E-09	2.237E-09	1.356E-09	9.171E-10	6.646E-10	5.053E-10	3.981E-10	3.223E-10
ENE	3.387E-08	1.145E-08	5.881E-09	3.611E-09	1.800E-09	1.092E-09	7.382E-10	5.349E-10	4.067E-10	3.204E-10	2.594E-10
E	3.926E-08	1.328E-08	6.816E-09	4.185E-09	2.087E-09	1.266E-09	8.556E-10	6.200E-10	4.715E-10	3.714E-10	3.007E-10
ESE	4.148E-08	1.403E-08	7.202E-09	4.423E-09	2.205E-09	1.337E-09	9.041E-10	6.552E-10	4.982E-10	3.925E-10	3.177E-10
SE	4.919E-08	1.663E-08	8.540E-09	5.244E-09	2.614E-09	1.586E-09	1.072E-09	7.769E-10	5.907E-10	4.654E-10	3.768E-10
SSE	5.133E-08	1.736E-08	8.913E-09	5.473E-09	2.728E-09	1.655E-09	1.119E-09	8.107E-10	6.165E-10	4.857E-10	3.932E-10

DIRECTION FROM SITE	DISTANCES IN MILES										
	5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
S	1.648E-10	8.074E-11	5.066E-11	2.561E-11	1.550E-11	1.039E-11	7.446E-12	5.591E-12	4.347E-12	3.473E-12	2.834E-12
SSW	1.096E-10	5.373E-11	3.371E-11	1.704E-11	1.031E-11	6.915E-12	4.955E-12	3.721E-12	2.893E-12	2.311E-12	1.886E-12
SW	1.182E-10	5.792E-11	3.634E-11	1.837E-11	1.112E-11	7.455E-12	5.342E-12	4.011E-12	3.119E-12	2.491E-12	2.033E-12
WSW	1.159E-10	5.677E-11	3.562E-11	1.801E-11	1.090E-11	7.307E-12	5.236E-12	3.931E-12	3.057E-12	2.442E-12	1.993E-12
W	1.694E-10	8.300E-11	5.208E-11	2.632E-11	1.593E-11	1.068E-11	7.654E-12	5.748E-12	4.469E-12	3.570E-12	2.914E-12
WNW	2.624E-10	1.286E-10	8.069E-11	4.078E-11	2.468E-11	1.655E-11	1.186E-11	8.905E-12	6.924E-12	5.531E-12	4.514E-12
NW	3.071E-10	1.505E-10	9.443E-11	4.773E-11	2.889E-11	1.937E-11	1.388E-11	1.042E-11	8.103E-12	6.473E-12	5.283E-12
NNW	3.736E-10	1.831E-10	1.149E-10	5.807E-11	3.515E-11	2.357E-11	1.689E-11	1.268E-11	9.859E-12	7.875E-12	6.428E-12
N	2.643E-10	1.295E-10	8.128E-11	4.108E-11	2.487E-11	1.667E-11	1.195E-11	8.970E-12	6.975E-12	5.571E-12	4.547E-12
NNE	1.535E-10	7.523E-11	4.720E-11	2.386E-11	1.444E-11	9.682E-12	6.938E-12	5.210E-12	4.051E-12	3.236E-12	2.641E-12
NE	2.666E-10	1.306E-10	8.198E-11	4.143E-11	2.508E-11	1.681E-11	1.205E-11	9.047E-12	7.034E-12	5.619E-12	4.586E-12
ENE	2.146E-10	1.052E-10	6.598E-11	3.335E-11	2.019E-11	1.353E-11	9.698E-12	7.282E-12	5.662E-12	4.523E-12	3.692E-12
E	2.487E-10	1.219E-10	7.648E-11	3.866E-11	2.340E-11	1.569E-11	1.124E-11	8.441E-12	6.563E-12	5.242E-12	4.279E-12
ESE	2.628E-10	1.288E-10	8.081E-11	4.085E-11	2.472E-11	1.658E-11	1.188E-11	8.919E-12	6.935E-12	5.539E-12	4.521E-12
SE	3.117E-10	1.527E-10	9.583E-11	4.844E-11	2.932E-11	1.966E-11	1.408E-11	1.058E-11	8.223E-12	6.569E-12	5.361E-12
SSE	3.252E-10	1.594E-10	1.000E-10	5.055E-11	3.059E-11	2.051E-11	1.470E-11	1.104E-11	8.581E-12	6.855E-12	5.595E-12

TABLE 1.3

Revision 13

***** PALISADES XQDDQ82 ***** USING 01/01/92 - 12/31/96 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING

DIRECTION FROM SITE	RELATIVE DEPOSITION PER UNIT AREA (M ⁻²) BY DOWNWIND SECTORS									
	SEGMENT BOUNDARIES IN MILES									
	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	4.691E-09	1.449E-09	5.768E-10	3.152E-10	2.003E-10	8.604E-11	2.668E-11	1.057E-11	5.647E-12	3.495E-12
SSW	3.122E-09	9.645E-10	3.838E-10	2.097E-10	1.333E-10	5.726E-11	1.776E-11	7.037E-12	3.758E-12	2.326E-12
SW	3.366E-09	1.040E-09	4.138E-10	2.261E-10	1.437E-10	6.173E-11	1.914E-11	7.587E-12	4.051E-12	2.508E-12
WSW	3.299E-09	1.019E-09	4.055E-10	2.216E-10	1.409E-10	6.050E-11	1.876E-11	7.436E-12	3.971E-12	2.458E-12
W	4.823E-09	1.490E-09	5.929E-10	3.240E-10	2.059E-10	8.845E-11	2.743E-11	1.087E-11	5.805E-12	3.593E-12
WNW	7.472E-09	2.308E-09	9.186E-10	5.020E-10	3.190E-10	1.370E-10	4.249E-11	1.684E-11	8.994E-12	5.567E-12
NW	8.745E-09	2.702E-09	1.075E-09	5.875E-10	3.734E-10	1.604E-10	4.974E-11	1.971E-11	1.053E-11	6.516E-12
NNW	1.064E-08	3.287E-09	1.308E-09	7.147E-10	4.543E-10	1.951E-10	6.051E-11	2.398E-11	1.281E-11	7.927E-12
N	7.527E-09	2.325E-09	9.253E-10	5.057E-10	3.214E-10	1.380E-10	4.281E-11	1.697E-11	9.060E-12	5.608E-12
NNE	4.371E-09	1.351E-09	5.374E-10	2.937E-10	1.866E-10	8.017E-11	2.486E-11	9.853E-12	5.262E-12	3.257E-12
NE	7.591E-09	2.345E-09	9.333E-10	5.100E-10	3.241E-10	1.392E-10	4.317E-11	1.711E-11	9.138E-12	5.656E-12
ENE	6.110E-09	1.888E-09	7.512E-10	4.105E-10	2.609E-10	1.121E-10	3.475E-11	1.377E-11	7.355E-12	4.552E-12
E	7.082E-09	2.188E-09	8.707E-10	4.758E-10	3.024E-10	1.299E-10	4.028E-11	1.596E-11	8.525E-12	5.277E-12
ESE	7.484E-09	2.312E-09	9.200E-10	5.028E-10	3.195E-10	1.373E-10	4.256E-11	1.687E-11	9.008E-12	5.576E-12
SE	8.874E-09	2.742E-09	1.091E-09	5.962E-10	3.789E-10	1.628E-10	5.047E-11	2.000E-11	1.068E-11	6.612E-12
SSE	9.261E-09	2.861E-09	1.139E-09	6.222E-10	3.954E-10	1.699E-10	5.267E-11	2.088E-11	1.115E-11	6.900E-12

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT (METERS)	58.10
DIAMETER (METERS)	0.00
EXIT VELOCITY (METERS)	0.00

REP. WIND HEIGHT (METERS)	10.0
BUILDING HEIGHT (METERS)	58.1
BLDG. MIN. CRS. SEC. AREA (SQ. METERS)	2000.0
HEAT EMISSION RATE (CAL./SEC)	0.0

ALL GROUND LEVEL RELEASES.

***** PALISADES XQOQOQ82 ***** USING 01/01/92 - 12/31/96 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
SPECIFIC POINTS OF INTEREST

RELEASE ID	TYPE OF LOCATION	DIRECTION FROM SITE	DISTANCE (MILES)	DISTANCE (METERS)	X/Q			D/Q (PER SQ.METER)
					NO DECAY			
					(SEC/CUB.METER) UNDEPLETED	(SEC/CUB.METER) UNDEPLETED	(SEC/CUB.METER) DEPLETED	
A	SITE BOUNDARY	NNE	0.50	805.	1.72E-06	1.71E-06	1.57E-06	8.19E-09
A	SITE BOUNDARY	NE	0.65	1046.	1.22E-06	1.22E-06	1.10E-06	9.30E-09
A	SITE BOUNDARY	ENE	0.87	1400.	5.99E-07	5.98E-07	5.29E-07	4.58E-09
A	SITE BOUNDARY	E	0.82	1320.	7.28E-07	7.27E-07	6.45E-07	5.86E-09
A	SITE BOUNDARY	ESE	0.76	1223.	7.85E-07	7.83E-07	6.98E-07	7.04E-09
A	SITE BOUNDARY	SE	0.63	1014.	1.18E-06	1.18E-06	1.06E-06	1.14E-08
A	SITE BOUNDARY	SSE	0.48	772.	2.13E-06	2.12E-06	1.95E-06	1.86E-08
A	SITE BOUNDARY	S	0.42	676.	1.78E-06	1.78E-06	1.64E-06	1.16E-08
A	SITE BOUNDARY	SSW	0.48	772.	1.16E-06	1.15E-06	1.06E-06	6.26E-09
A	GARDEN	NNE	1.60	2575.	3.06E-07	3.04E-07	2.58E-07	1.15E-09
A	GARDEN	NE	1.20	1931.	4.96E-07	4.95E-07	4.28E-07	3.29E-09
A	GARDEN	ENE	2.70	4345.	1.15E-07	1.14E-07	9.20E-08	6.45E-10
A	GARDEN	E	2.20	3541.	1.70E-07	1.69E-07	1.40E-07	1.07E-09
A	GARDEN	ESE	2.30	3701.	1.51E-07	1.50E-07	1.23E-07	1.05E-09
A	GARDEN	SE	1.80	2897.	2.45E-07	2.44E-07	2.04E-07	1.91E-09
A	GARDEN	SSE	1.60	2575.	3.55E-07	3.53E-07	2.99E-07	2.44E-09
A	GARDEN	S	1.50	2414.	2.78E-07	2.77E-07	2.36E-07	1.38E-09
A	BEEF COW	NE	2.90	4667.	1.38E-07	1.36E-07	1.09E-07	7.06E-10
A	BEEF COW	ENE	4.00	6437.	6.51E-08	6.43E-08	4.98E-08	3.20E-10
A	BEEF COW	E	3.50	5633.	8.64E-08	8.56E-08	6.73E-08	4.71E-10
A	BEEF COW	ESE	4.00	6437.	6.70E-08	6.63E-08	5.13E-08	3.93E-10
A	BEEF COW	SSE	3.00	4828.	1.41E-07	1.40E-07	1.12E-07	8.11E-10
A	DAIRY COW	SE	4.30	6920.	6.83E-08	6.75E-08	5.18E-08	4.09E-10
A	GOAT	NE	3.20	5150.	1.19E-07	1.18E-07	9.39E-08	5.93E-10
A	GOAT	ESE	3.00	4828.	1.02E-07	1.01E-07	8.10E-08	6.55E-10

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT (METERS) 58.10
DIAMETER (METERS) 0.00
EXIT VELOCITY (METERS) 0.00

REP. WIND HEIGHT (METERS) 10.0
BUILDING HEIGHT (METERS) 58.1
BLDG. MIN. CRS. SEC. AREA (SQ.METERS) 2000.0
HEAT EMISSION RATE (CAL/SEC) 0.0

ALL GROUND LEVEL RELEASES.

***** PALISADES XQDOQ82 ***** USING 01/01/92 - 12/31/96 MET DATA *****

GROUND LEVEL RELEASE - TOP OF CONTAINMENT BUILDING
SPECIFIC POINTS OF INTEREST

RELEASE ID	TYPE OF LOCATION	DIRECTION FROM SITE	DISTANCE (MILES) (METERS)		X/Q			D/Q	
					NO DECAY		2.260 DAY DECAY		8.000 DAY DECAY
					(SEC/CUB.METER) UNDEPLETED	(SEC/CUB.METER) UNDEPLETED	(SEC/CUB.METER) DEPLETED	(PER SQ.METER)	
A	SITE BOUNDARY	NNE	0.50	805.	1.72E-06	1.71E-06	1.57E-06	8.19E-09	
A	SITE BOUNDARY	NE	0.65	1046.	1.22E-06	1.22E-06	1.10E-06	9.30E-09	
A	SITE BOUNDARY	ENE	0.87	1400.	5.99E-07	5.98E-07	5.29E-07	4.58E-09	
A	SITE BOUNDARY	E	0.82	1320.	7.28E-07	7.27E-07	6.45E-07	5.86E-09	
A	SITE BOUNDARY	ESE	0.76	1223.	7.85E-07	7.83E-07	6.98E-07	7.04E-09	
A	SITE BOUNDARY	SE	0.63	1014.	1.18E-06	1.18E-06	1.06E-06	1.14E-08	
A	SITE BOUNDARY	SSE	0.48	772.	2.13E-06	2.12E-06	1.95E-06	1.86E-08	
A	SITE BOUNDARY	S	0.42	676.	1.78E-06	1.78E-06	1.64E-06	1.16E-08	
A	SITE BOUNDARY	SSW	0.48	772.	1.16E-06	1.15E-06	1.06E-06	6.26E-09	
A	RESIDENCE	NNE	1.10	1770.	5.23E-07	5.21E-07	4.55E-07	2.20E-09	
A	RESIDENCE	NE	1.20	1931.	4.96E-07	4.95E-07	4.28E-07	3.29E-09	
A	RESIDENCE	ENE	1.30	2092.	3.33E-07	3.31E-07	2.85E-07	2.30E-09	
A	RESIDENCE	E	1.00	1609.	5.44E-07	5.42E-07	4.76E-07	4.19E-09	
A	RESIDENCE	ESE	1.00	1609.	5.21E-07	5.20E-07	4.56E-07	4.42E-09	
A	RESIDENCE	SE	1.00	1609.	5.87E-07	5.86E-07	5.14E-07	5.25E-09	
A	RESIDENCE	SSE	0.70	1127.	1.21E-06	1.20E-06	1.08E-06	1.00E-08	
A	RESIDENCE	S	0.50	805.	1.38E-06	1.38E-06	1.26E-06	8.79E-09	
A	RESIDENCE	SSW	0.70	1127.	6.50E-07	6.49E-07	5.81E-07	3.37E-09	
A	BEEF COW	NE	2.90	4667.	1.38E-07	1.36E-07	1.09E-07	7.06E-10	
A	BEEF COW	ENE	4.00	6437.	6.51E-08	6.43E-08	4.98E-08	3.20E-10	
A	BEEF COW	E	3.50	5633.	8.64E-08	8.56E-08	6.73E-08	4.71E-10	
A	BEEF COW	ESE	4.00	6437.	6.70E-08	6.63E-08	5.13E-08	3.93E-10	
A	BEEF COW	SSE	3.00	4828.	1.41E-07	1.40E-07	1.12E-07	8.11E-10	
A	DAIRY COW	SE	4.30	6920.	6.83E-08	6.75E-08	5.18E-08	4.09E-10	
A	GOAT	NE	3.20	5150.	1.19E-07	1.18E-07	9.39E-08	5.93E-10	
A	GOAT	ESE	3.00	4828.	1.02E-07	1.01E-07	8.10E-08	6.55E-10	

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT (METERS) 58.10
DIAMETER (METERS) 0.00
EXIT VELOCITY (METERS) 0.00

REP. WIND HEIGHT (METERS) 10.0
BUILDING HEIGHT (METERS) 58.1
BLDG. MIN. CRS. SEC. AREA (SQ. METERS) 2000.0
HEAT EMISSION RATE (CAL/SEC) 0.0

ALL GROUND LEVEL RELEASES.

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TABLE 1.4

1998 PALISADES LAND USE CENSUS

Distance to the nearest residence, garden, dairy/beef cattle, and goat in each sector.

<u>SECTOR</u>	<u>RESIDENCE</u>	<u>GARDEN</u>	<u>BEEF CATTLE</u>	<u>DAIRY COW</u>	<u>GOAT</u>
N	>5 mi	>5 mi	>5 mi	>5 mi	>5 mi
NNE	1.1 mi	1.6 mi	>5 mi	>5 mi	>5 mi
NE	1.2 mi	1.2 mi	2.9 mi	>5 mi	3.2 mi
ENE	1.3 mi	3.3 mi	1.8 mi	>5 mi	4.0 mi
E	1.0 mi	2.1 mi	3.5 mi	>5 mi	>5 mi
ESE	1.0 mi	1.9 mi	*4.0 mi	>5 mi	3.0 mi
SE	1.0 mi	1.0 mi	*4.0 mi	4.3 mi	4.3 mi
SSE	0.7 mi	1.6 mi	5.0 mi	>5 mi	>5 mi
S	0.5 mi	>5 mi	>5 mi	>5 mi	4.7 mi
SSW	0.7 mi	>5 mi	>5 mi	>5 mi	>5 mi

*Note: Farm bisected by ESE/SE boundary line.

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TABLE 1.4a

1998 PALISADES LAND USE CENSUS

Critical Receptor Items

<u>Sector</u>	<u>Distance Miles</u>	<u>Location/Description</u>	<u>Item</u>	<u>*X/Q (sec/m³)</u>
SSE	0.48	Site Boundary	N/A	2.13E-06
S	0.50	Residence, Palisades Park; 1/2 mile west of 29th Avenue and Blue Star intersection	Residence	1.38E-06
SE	1.0	77550 28th Avenue	Garden	5.87E-07
ENE	1.8	22595 76th Ave .3 miles N of 24th, East side of road	Beef Cattle	2.14E-07
SE	4.3	72401 36th Ave	Dairy Cow	6.83E-08
NE	3.2	C Bernt 18019 M-140	Goat	1.19E-07

*Based on Palisades 5-year composite meteorological data, 1992 - 1996.

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**PALISADES NUCLEAR PLANT
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TABLE 1.5

DOSE FACTORS FOR SUBMERSION IN NOBLE GASES*

	<u>DFR¹</u>	<u>DFY²</u>	<u>DFS¹</u>	<u>DFB²</u>
Kr-85m	1.17(+3) ³	1.23(+3)	1.46(+3)	1.97(+3)
Kr-85	1.61(+1)	1.72(+1)	1.34(+3)	1.95(+3)
Kr-87	5.92(+3)	6.17(+3)	9.73(+3)	1.03(+4)
Kr-88	1.47(+4)	1.52(+4)	2.37(+3)	2.93(+3)
Kr-89	1.66(+4)	1.73(+4)	1.01(+4)	1.06(+4)
Xe-131m	9.15(+1)	1.56(+2)	4.76(+2)	1.11(+3)
Xe-133m	2.51(+2)	3.27(+2)	9.94(+2)	1.48(+3)
Xe-133	2.94(+2)	3.53(+2)	3.06(+2)	1.05(+3)
Xe-135m	3.12(+3)	3.36(+3)	7.11(+2)	7.39(+3)
Xe-135	1.81(+3)	1.92(+3)	1.86(+3)	2.46(+3)
Xe-137	1.42(+3)	1.51(+3)	1.22(+4)	1.27(+4)
Xe-138	8.83(+3)	9.21(+3)	4.13(+3)	4.75(+3)
Ar-41	8.84(+3)	9.30(+3)	2.69(+3)	3.28(+3)

1. mrem/y per $\mu\text{Ci}/\text{m}^3$
2. mrad/y per $\mu\text{Ci}/\text{m}^3$
3. $1.17(+3) = 1.17 \times 10^3$

*Dose factors for exposure to a semi-infinite cloud of noble gases. Values were obtained from USNRC Regulatory Guide 1.109, Revision 1 (October 1977).

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TABLE 1.6

STABLE ELEMENT TRANSFER DATA

<u>ELEMENT</u>	<u>F_m - MILK (COW)</u> <u>(DAYS/L)</u>	<u>F_m - MILK (GOAT)</u> <u>(DAYS/L)</u>	<u>F_f - MEAT</u> <u>(DAYS/KG)</u>	<u>B_{iv}</u> <u>(VEG/SOIL)</u>
H	1.0E-02	1.7E-01	1.2E-02	4.8E-00
C	1.2E-02	1.0E-01	3.1E-02	5.5E-00
Na	4.0E-02	4.0E-02	3.0E-02	5.2E-02
P	2.5E-02	2.5E-01	4.6E-02	1.1E-00
Cr	2.2E-03	2.2E-03	2.4E-03	2.5E-04
Mn	2.5E-04	2.5E-04	8.0E-04	2.9E-02
Fe	1.2E-03	1.3E-04	4.0E-02	6.6E-04
Co	1.0E-03	1.0E-03	1.3E-02	9.4E-03
Ni	6.7E-03	6.7E-03	5.3E-02	1.9E-02
Cu	1.4E-02	1.3E-02	8.0E-03	1.2E-01
Zn	3.9E-02	3.9E-02	3.0E-02	4.0E-01
Rb	3.0E-02	3.0E-02	3.1E-02	1.3E-01
Sr	8.0E-04	1.4E-02	6.0E-04	1.7E-02
Y	1.0E-05	1.0E-05	4.6E-03	2.6E-03
Zr	5.0E-06	5.0E-06	3.4E-02	1.7E-04
Nb	2.5E-03	2.5E-03	2.8E-01	9.4E-03
Mo	7.5E-03	7.5E-03	8.0E-03	1.2E-01
Tc	2.5E-02	2.5E-02	4.0E-01	2.5E-01
Ru	1.0E-06	1.0E-06	4.0E-01	5.0E-02
Rh	1.0E-02	1.0E-02	1.5E-03	1.3E+01
Ag	5.0E-02	5.0E-02	1.7E-02	1.5E-01
Te	1.0E-03	1.0E-03	7.7E-02	1.3E-00
I	6.0E-03	6.0E-02	2.9E-03	2.0E-02
Cs	1.2E-02	3.0E-01	4.0E-03	1.0E-02
Ba	4.0E-04	4.0E-04	3.2E-03	5.0E-03
La	5.0E-06	5.0E-06	2.0E-04	2.5E-03
Ce	1.0E-04	1.0E-04	1.2E-03	2.5E-03
Pr	5.0E-06	5.0E-06	4.7E-03	2.5E-03
Nd	5.0E-06	5.0E-06	3.3E-03	2.4E-03
W	5.0E-04	5.0E-04	1.3E-03	1.8E-02
Np	5.0E-06	5.0E-06	2.0E-04	2.5E-03

**PALISADES NUCLEAR PLANT
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TABLE 1.7

INFANT INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)							
ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3*	0.	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07
BE10	9.49E-04	1.25E-04	2.65E-05	0.	0.	1.49E-03	1.73E-05
C14	1.89E-05	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06
N13	4.39E-08	4.39E-08	4.39E-08	4.39E-08	4.39E-08	4.39E-08	4.39E-08
F18	3.92E-06	0.	3.33E-07	0.	0.	0.	6.10E-07
NA22	7.37E-05	7.37E-05	7.37E-05	7.37E-05	7.37E-05	7.37E-05	7.37E-05
NA24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P32	1.45E-03	8.03E-05	5.53E-05	0.	0.	0.	1.15E-05
AR39	0.	0.	0.	0.	0.	1.00E-08	0.
AR41	0.	0.	0.	0.	0.	3.14E-08	0.
CA41	7.48E-05	0.	8.16E-06	0.	0.	6.94E-02	2.96E-07
SC46	3.75E-04	5.41E-04	1.69E-04	0.	3.56E-04	0.	2.19E-05
CR51	0.	0.	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
MN54	0.	1.81E-05	3.56E-06	0.	3.56E-06	7.14E-04	5.04E-06
MN56	0.	1.10E-09	1.58E-10	0.	7.86E-10	8.95E-06	5.12E-05
FE55	1.41E-05	8.39E-06	2.38E-06	0.	0.	6.21E-05	7.82E-07
FE59	9.69E-06	1.68E-05	6.77E-06	0.	0.	7.25E-04	1.77E-05
CO57	0.	4.65E-07	4.58E-07	0.	0.	2.71E-04	3.47E-06
CO58	0.	8.71E-07	1.30E-06	0.	0.	5.55E-04	7.95E-06
CO60	0.	5.73E-06	8.41E-06	0.	0.	3.22E-03	2.28E-05
NI59	1.81E-05	5.44E-06	3.10E-06	0.	0.	5.48E-05	6.34E-07
NI63	2.42E-04	1.46E-05	8.29E-06	0.	0.	1.49E-04	1.73E-06
NI65	1.71E-09	2.03E-10	8.79E-11	0.	0.	5.80E-06	3.58E-05
CU64	0.	1.34E-09	5.53E-10	0.	2.84E-09	6.64E-06	1.07E-05
ZN65	1.38E-05	4.47E-05	2.22E-05	0.	2.32E-05	4.62E-04	3.67E-05
ZN69M + D	8.98E-09	1.84E-08	1.67E-09	0.	7.45E-09	1.91E-05	2.92E-05
ZN69	3.85E-11	6.91E-11	5.13E-12	0.	2.87E-11	1.05E-06	9.44E-06
SE79	0.	2.25E-06	4.20E-07	0.	2.47E-06	2.99E-04	3.46E-06
BR82	0.	0.	9.49E-06	0.	0.	0.	0.
BR83 + D	0.	0.	2.72E-07	0.	0.	0.	0.
BR84	0.	0.	2.86E-07	0.	0.	0.	0.
BR85	0.	0.	1.46E-08	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	2.50E-09	0.
KR85M	0.	0.	0.	0.	0.	1.31E-08	0.
KR85	0.	0.	0.	0.	0.	1.16E-08	0.
KR87	0.	0.	0.	0.	0.	6.59E-08	0.
KR88 + D	0.	0.	0.	0.	0.	1.38E-07	0.
KR89	0.	0.	0.	0.	0.	8.67E-08	0.
RB86	0.	1.36E-04	6.30E-05	0.	0.	0.	2.17E-06
RB87	0.	7.11E-05	2.64E-05	0.	0.	0.	2.99E-07
RB88	0.	3.98E-07	2.05E-07	0.	0.	0.	2.42E-07
RB89 + D	0.	2.29E-07	1.47E-07	0.	0.	0.	4.87E-08
SR89 + D	2.84E-04	0.	8.15E-06	0.	0.	1.45E-03	4.57E-05
SR90 + D	2.92E-02	0.	1.85E-03	0.	0.	8.03E-03	9.36E-05
SR91 + D	6.83E-08	0.	2.47E-09	0.	0.	3.76E-05	5.24E-05
SR92 + D	7.50E-09	0.	2.79E-10	0.	0.	1.70E-05	1.00E-04

Includes a 50% increase to account for percutaneous transpiration.

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TABLE 1.7 (continued)

INFANT INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)							
ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	2.35E-06	0.	6.30E-08	0.	0.	1.92E-04	7.43E-05
Y91M+D	2.91E-10	0.	9.90E-12	0.	0.	1.99E-06	1.68E-06
Y91	4.20E-04	0.	1.12E-05	0.	0.	1.75E-03	5.02E-05
Y92	1.17E-08	0.	3.29E-10	0.	0.	1.75E-05	9.04E-05
Y93	1.07E-07	0.	2.91E-09	0.	0.	5.46E-05	1.19E-04
ZR93+D	2.24E-04	9.51E-05	6.18E-05	0.	3.19E-04	1.37E-03	1.48E-05
ZR95+D	8.24E-05	1.99E-05	1.45E-05	0.	2.22E-05	1.25E-03	1.55E-05
ZR97+D	1.07E-07	1.83E-08	8.36E-09	0.	1.85E-08	7.88E-05	1.00E-04
NB93M	1.38E-04	3.59E-05	1.15E-05	0.	3.68E-05	2.09E-04	2.47E-06
NB95	1.12E-05	4.59E-06	2.70E-06	0.	3.37E-06	3.42E-04	9.05E-06
NB97	2.44E-10	5.21E-11	1.88E-11	0.	4.07E-11	2.37E-06	1.92E-05
MO93	0.	6.46E-06	2.22E-07	0.	1.54E-06	3.40E-04	3.76E-06
MO99+D	0.	1.18E-07	2.31E-08	0.	1.89E-07	9.63E-05	3.48E-05
TC99M	9.98E-13	2.06E-12	2.66E-11	0.	2.22E-11	5.79E-07	1.45E-06
TC99	2.09E-07	2.68E-07	8.85E-08	0.	2.49E-06	6.77E-04	7.82E-06
TC101	4.65E-14	5.88E-14	5.80E-13	0.	6.99E-13	4.17E-07	6.03E-07
RU103+D	1.44E-06	0.	4.85E-07	0.	3.03E-06	3.94E-04	1.15E-05
RU105+D	8.74E-10	0.	2.93E-10	0.	6.42E-10	1.12E-05	3.46E-05
RU106+D	6.20E-05	0.	7.77E-06	0.	7.61E-05	8.26E-03	1.17E-04
RU105	8.26E-09	5.41E-09	3.63E-09	0.	1.50E-08	2.08E-05	1.37E-05
RU107	0.	4.92E-07	4.11E-08	0.	2.75E-06	6.34E-05	7.33E-07
PD109	0.	3.92E-09	1.05E-09	0.	1.28E-08	1.68E-05	2.85E-05
AG110M+D	7.13E-06	5.16E-06	3.57E-06	0.	7.80E-06	2.62E-03	2.36E-05
AG111	3.75E-07	1.45E-07	7.75E-08	0.	3.05E-07	2.06E-04	3.02E-05
CD113M	0.	6.67E-04	2.64E-05	0.	5.80E-04	1.40E-03	1.65E-05
CD115M	0.	1.73E-04	6.19E-06	0.	9.41E-05	1.47E-03	5.02E-05
SN123	2.09E-04	4.21E-06	7.28E-06	4.27E-06	0.	2.22E-03	4.08E-05
SN125+D	1.01E-05	2.51E-07	6.00E-07	2.47E-07	0.	6.43E-04	7.26E-05
SN126+D	8.30E-04	1.44E-05	3.52E-05	3.84E-06	0.	4.93E-03	1.65E-05
SB124	2.71E-05	3.97E-07	8.56E-06	7.18E-08	0.	1.89E-03	4.22E-05
SB125+D	3.69E-05	3.41E-07	7.78E-06	4.45E-08	0.	1.17E-03	1.05E-05
SB126	3.08E-06	6.01E-08	1.11E-06	2.35E-08	0.	6.88E-04	5.33E-05
SB127	2.82E-07	5.04E-09	8.76E-08	3.60E-09	0.	1.54E-04	3.78E-05
TE125M	3.40E-06	1.42E-06	4.70E-07	1.16E-06	0.	3.19E-04	9.22E-06
TE127M+D	1.19E-05	4.93E-06	1.48E-06	3.48E-06	2.68E-05	9.37E-04	1.95E-05
TE127	1.59E-09	6.81E-10	3.49E-10	1.32E-09	3.47E-09	7.39E-06	1.74E-05
TE129M+D	1.01E-05	4.35E-06	1.59E-06	3.91E-06	2.27E-05	1.20E-03	4.93E-05
TE129	5.63E-11	2.48E-11	1.34E-11	4.82E-11	1.25E-10	2.14E-06	1.88E-05
TE131M+D	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
TE131+D	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
TE132+D	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
TE133M+D	6.13E-11	3.59E-11	2.74E-11	5.52E-11	1.72E-10	3.92E-06	1.59E-05
TE134+D	3.18E-11	2.04E-11	1.68E-11	2.91E-11	9.59E-11	2.93E-06	2.53E-06
I129	2.16E-05	1.59E-05	1.16E-05	1.04E-02	1.88E-05	0.	2.12E-07
I130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	0.	1.42E-06
I131+D	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	0.	7.56E-07

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TABLE 1.7 (continued)

INFANT INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)							
ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	0.	1.36E-06
I133+D	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	0.	1.54E-06
I134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	0.	9.21E-07
I135+D	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	0.	1.31E-06
XE131M	0.	0.	0.	0.	0.	6.77E-09	0.
XE133M	0.	0.	0.	0.	0.	8.89E-09	0.
XE133	0.	0.	0.	0.	0.	7.41E-09	0.
XE135M	0.	0.	0.	0.	0.	8.05E-09	0.
XE135	0.	0.	0.	0.	0.	1.80E-08	0.
XE137	0.	0.	0.	0.	0.	8.30E-08	0.
XE138+D	0.	0.	0.	0.	0.	9.78E-08	0.
CS134M+D	1.32E-07	2.10E-07	1.11E-07	0.	8.50E-08	2.00E-08	1.16E-07
CS134	2.83E-04	5.02E-04	5.32E-05	0.	1.36E-04	5.69E-05	9.53E-07
CS135	1.00E-04	8.66E-05	4.73E-06	0.	2.58E-05	1.01E-05	2.18E-07
CS136	3.45E-05	9.61E-05	3.78E-05	0.	4.03E-05	8.40E-06	1.02E-06
CS137+D	3.92E-04	4.37E-04	3.25E-05	0.	1.23E-04	5.09E-05	9.53E-07
CS138	3.61E-07	5.58E-07	2.84E-07	0.	2.93E-07	4.67E-08	6.26E-07
CS139+D	2.32E-07	3.03E-07	1.22E-07	0.	1.65E-07	2.53E-08	1.33E-08
BA139	1.06E-09	7.03E-13	3.07E-11	0.	4.23E-13	4.25E-06	3.64E-05
BA140+D	4.00E-05	4.00E-08	2.07E-06	0.	9.59E-09	1.14E-03	2.74E-05
BA141+D	1.12E-10	7.70E-14	3.55E-12	0.	4.64E-14	2.12E-06	3.39E-06
BA142+D	2.84E-11	2.36E-14	1.40E-12	0.	1.36E-14	1.11E-06	4.95E-07
LA140	3.61E-07	1.43E-07	3.68E-08	0.	0.	1.20E-04	6.06E-05
LA141	4.85E-09	1.40E-09	2.45E-10	0.	0.	1.22E-05	5.96E-05
LA142	7.36E-10	2.69E-10	6.46E-11	0.	0.	5.87E-06	4.25E-05
CE141	1.98E-05	1.19E-05	1.42E-06	0.	3.75E-06	3.69E-04	1.54E-05
CE143+D	2.09E-07	1.38E-07	1.58E-08	0.	4.03E-08	8.30E-05	3.55E-05
CE144+D	2.28E-03	8.65E-04	1.26E-04	0.	3.84E-04	7.03E-03	1.06E-04
PR143	1.00E-05	3.74E-06	4.99E-07	0.	1.41E-06	3.09E-04	2.66E-05
PR144	3.42E-11	1.32E-11	1.72E-12	0.	4.80E-12	1.15E-06	3.06E-06
ND147+D	5.67E-06	5.81E-06	3.57E-07	0.	2.25E-06	2.30E-04	2.23E-05
PM147	3.91E-04	3.07E-05	1.56E-05	0.	4.93E-05	4.55E-04	5.75E-06
PM148M+D	5.00E-05	1.24E-05	9.94E-06	0.	1.45E-05	1.22E-03	3.37E-05
PM148	3.34E-06	4.82E-07	2.44E-07	0.	5.76E-07	3.20E-04	6.04E-05
PM149	3.10E-07	4.08E-08	1.78E-08	0.	4.96E-08	6.50E-05	3.01E-05
PM151	7.52E-08	1.10E-08	5.55E-09	0.	1.30E-08	3.25E-05	2.58E-05
SM151	3.38E-04	6.45E-05	1.63E-05	0.	5.24E-05	2.98E-04	3.46E-06
SM153	1.53E-07	1.18E-07	9.06E-09	0.	2.47E-08	3.70E-05	1.93E-05
EU152	7.83E-04	1.77E-04	1.72E-04	0.	5.94E-04	1.48E-03	9.88E-06
EU154	2.96E-03	3.46E-04	2.45E-04	0.	1.14E-03	3.05E-03	2.84E-05
EU155	5.97E-04	5.72E-05	3.46E-05	0.	1.58E-04	5.20E-04	5.19E-05
EU156	1.56E-05	9.59E-06	1.54E-06	0.	4.48E-06	6.12E-04	4.14E-05
TB160	1.12E-04	0.	1.40E-05	0.	3.20E-05	1.11E-03	2.14E-05
HO166M	1.45E-03	3.07E-04	2.51E-04	0.	4.22E-04	2.05E-03	1.65E-05
W181	4.86E-08	1.46E-08	1.67E-09	0.	0.	1.33E-05	2.63E-07
W185	1.57E-06	4.83E-07	5.58E-08	0.	0.	4.48E-04	1.12E-05
W187	9.26E-09	6.44E-09	2.23E-09	0.	0.	2.83E-05	2.54E-05

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TABLE 1.7 (continued)

INFANT INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)							
ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210 + D	8.62E-02	2.02E-02	3.43E-03	0.	6.85E-02	1.76E-01	3.79E-05
BI210 + D	0.	1.33E-05	1.18E-06	0.	1.03E-04	9.96E-03	3.27E-05
PO210	2.98E-03	5.63E-03	7.12E-04	0.	1.30E-02	2.40E-01	4.36E-05
RN222 + D	0.	0.	0.	0.	0.	9.88E-06	0.
RA223 + D	1.56E-03	2.26E-06	3.12E-04	0.	4.16E-05	2.25E-01	3.04E-04
RA224 + D	1.77E-04	4.00E-07	3.54E-05	0.	7.30E-06	7.91E-02	3.42E-04
RA225 + D	2.57E-03	2.88E-06	5.13E-04	0.	5.31E-05	2.57E-01	2.87E-04
RA226 + D	2.48E-01	1.46E-05	2.05E-01	0.	2.94E-04	7.83E-01	3.05E-04
RA228 + D	1.60E-01	7.61E-06	1.80E-01	0.	1.53E-04	1.09E-00	5.19E-05
AC225	3.69E-03	4.72E-03	2.48E-04	0.	3.49E-04	1.96E-01	2.71E-04
AC227 + D	5.29E+00	8.76E-01	3.28E-01	0.	1.86E-01	1.62E+00	5.27E-05
TH227 + D	1.82E-03	3.03E-05	5.24E-05	0.	1.13E-04	3.27E-01	3.53E-04
TH228 + D	8.46E-01	1.10E-02	2.86E-02	0.	5.61E-02	4.65E+00	3.62E-04
TH229	1.34E+01	1.82E-01	6.62E-01	0.	8.99E-01	1.22E+01	3.29E-04
TH230	3.46E+00	1.79E-01	9.65E-02	0.	8.82E-01	2.18E+00	3.87E-05
TH232 + D	3.86E+00	1.53E-01	2.29E-01	0.	7.54E-01	2.09E+00	3.29E-05
TH234	1.33E-05	7.17E-07	3.84E-07	0.	2.70E-06	1.62E-03	7.40E-05
PA231 + D	9.10E+00	3.00E-01	3.62E-01	0.	1.62E+00	3.85E-01	4.61E-05
PA233	6.84E-06	1.32E-06	1.19E-06	0.	3.68E-06	2.19E-04	9.04E-06
U232 + D	2.57E-01	0.	2.13E-02	0.	2.40E-02	1.49E+00	4.36E-05
J233 + D	5.44E-02	0.	3.83E-03	0.	1.09E-02	3.56E-01	4.03E-05
U234	5.22E-02	0.	3.75E-03	0.	1.07E-02	3.49E-01	3.95E-05
U235 + D	5.01E-02	0.	3.52E-03	0.	1.01E-02	3.28E-01	5.02E-05
U236	5.01E-02	0.	3.60E-03	0.	1.03E-02	3.35E-01	3.71E-05
U237	3.25E-07	0.	8.65E-08	0.	8.08E-07	9.13E-05	1.31E-05
U238 + D	4.79E-02	0.	3.29E-03	0.	9.40E-03	3.06E-01	3.54E-05
NP237 + D	3.03E+00	2.32E-01	1.26E-01	0.	7.69E-01	3.49E-01	5.10E-05
NP238	2.67E-06	6.73E-08	4.16E-08	0.	1.47E-07	9.19E-05	2.58E-05
NP239	2.65E-07	2.37E-08	1.34E-08	0.	4.73E-08	4.25E-05	1.78E-05
PU238	5.02E+00	6.33E-01	1.27E-01	0.	4.64E-01	9.03E-01	4.69E-05
PU239	5.50E+00	6.72E-01	1.34E-01	0.	4.95E-01	8.47E-01	4.28E-05
PU240	6.49E+00	6.71E-01	1.34E-01	0.	4.94E-01	8.47E-01	4.36E-05
PU241 + D	1.55E-01	6.69E-03	3.11E-03	0.	1.15E-02	7.62E-04	8.97E-07
PU242	5.09E+00	6.47E-01	1.29E-01	0.	4.77E-01	8.15E-01	4.20E-05
PU244	5.95E+00	7.40E-01	1.48E-01	0.	5.46E-01	9.33E-01	6.26E-05
AM241	1.84E+00	8.44E-01	1.31E-01	0.	7.94E-01	4.06E-01	4.78E-05
AM242M	1.90E+00	8.24E-01	1.35E-01	0.	8.03E-01	1.64E-01	6.01E-05
AM243	1.82E+00	8.10E-01	1.27E-01	0.	7.72E-01	3.85E-01	5.60E-05
CM242	8.58E-02	7.44E-02	5.70E-03	0.	1.69E-02	2.97E-01	5.10E-05
CM243	1.73E+00	7.94E-01	1.06E-01	0.	3.91E-01	4.24E-01	5.02E-05
CM244	1.43E+00	7.04E-01	8.89E-02	0.	3.21E-01	4.08E-01	4.86E-05
CM245	2.26E+00	8.80E-01	1.36E-01	0.	5.23E-01	3.92E-01	4.53E-05
CM246	2.24E+00	8.79E-01	1.36E-01	0.	5.23E-01	3.99E-01	4.45E-05
CM247 + D	2.18E+00	8.64E-01	1.33E-01	0.	5.15E-01	3.92E-01	5.85E-05
CM248	1.82E+01	7.12E+00	1.10E+00	0.	4.24E+00	3.23E+00	9.43E-04
CF252	4.26E+00	0.	1.01E-01	0.	0.	1.37E+00	1.85E-04

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CHILD INHALATION DOSE COMMITMENT FACTORS (MREM/50YR PER PCI INHALED IN FIRST YR)							
ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3*	0.	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
BE10	8.43E-04	9.83E-05	2.12E-05	0.	0.	7.41E-04	1.72E-05
C14	9.70E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06
N13	2.33E-08	2.33E-08	2.33E-08	2.33E-08	2.33E-08	2.33E-08	2.33E-08
F18	1.88E-06	0.	1.85E-07	0.	0.	0.	3.37E-07
NA22	4.41E-05	4.41E-05	4.41E-05	4.41E-05	4.41E-05	4.41E-05	4.41E-05
NA24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P32	7.04E-04	3.09E-05	2.67E-05	0.	0.	0.	1.14E-05
AR39	0.	0.	0.	0.	0.	4.89E-09	0.
AR41	0.	0.	0.	0.	0.	1.68E-08	0.
CA41	7.06E-05	0.	7.70E-06	0.	0.	7.21E-02	2.94E-07
SC46	1.97E-04	2.70E-04	1.04E-04	0.	2.39E-04	0.	2.45E-05
CR51	0.	0.	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
MN54	0.	1.16E-05	2.57E-06	0.	2.71E-06	4.26E-04	6.19E-06
MN56	0.	4.48E-10	8.43E-11	0.	4.52E-10	3.55E-06	3.33E-05
FE55	1.28E-05	6.80E-06	2.10E-06	0.	0.	3.00E-05	7.75E-07
FE59	5.59E-06	9.04E-06	4.51E-06	0.	0.	3.43E-04	1.91E-05
CO57	0.	2.44E-07	2.88E-07	0.	0.	1.37E-04	3.58E-06
CO58	0.	4.79E-07	8.55E-07	0.	0.	2.99E-04	9.29E-06
CO60	0.	3.55E-06	6.12E-06	0.	0.	1.91E-03	2.60E-05
NI59	1.66E-05	4.67E-06	2.83E-06	0.	0.	2.73E-05	6.29E-07
NI63	2.22E-04	1.25E-05	7.56E-06	0.	0.	7.43E-05	1.71E-06
NI65	8.08E-10	7.99E-11	4.44E-11	0.	0.	2.21E-06	2.27E-05
CU64	0.	5.39E-10	2.90E-10	0.	1.63E-09	2.59E-06	9.92E-06
ZN65	1.15E-05	3.06E-05	1.90E-05	0.	1.93E-05	2.69E-04	4.41E-06
ZN69M + D	4.26E-09	7.28E-09	8.59E-10	0.	4.22E-09	7.36E-06	2.71E-05
ZN69	1.81E-11	2.61E-11	2.41E-12	0.	1.58E-11	3.84E-07	2.75E-06
SE79	0.	1.23E-06	2.60E-07	0.	1.71E-06	1.49E-04	3.43E-06
BR82	0.	0.	5.66E-06	0.	0.	0.	0.
BR83 + D	0.	0.	1.28E-07	0.	0.	0.	0.
BR84	0.	0.	1.48E-07	0.	0.	0.	0.
BR85	0.	0.	6.84E-09	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	1.22E-09	0.
KR85M	0.	0.	0.	0.	0.	6.58E-09	0.
KR85	0.	0.	0.	0.	0.	5.66E-09	0.
KR87	0.	0.	0.	0.	0.	3.38E-08	0.
KR88 + D	0.	0.	0.	0.	0.	6.99E-08	0.
KR89	0.	0.	0.	0.	0.	4.55E-08	0.
RB86	0.	5.36E-05	3.09E-05	0.	0.	0.	2.16E-06
RB87	0.	3.16E-05	1.37E-05	0.	0.	0.	2.96E-07
RB88	0.	1.52E-07	9.90E-08	0.	0.	0.	4.66E-09
RB89 + D	0.	9.33E-08	7.83E-08	0.	0.	0.	5.11E-10
SR89 + D	1.62E-04	0.	4.66E-06	0.	0.	5.83E-04	4.52E-05
SR90 + D	2.73E-02	0.	1.74E-03	0.	0.	3.99E-03	9.28E-05
SR91 + D	3.28E-08	0.	1.24E-09	0.	0.	1.44E-05	4.70E-05
SR92 + D	3.54E-09	0.	1.42E-10	0.	0.	6.49E-06	6.55E-05

*Includes a 50% increase to account for percutaneous transpiration.

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TABLE 1.7 (contd)

CHILD INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)							
ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	1.11E-06	0.	2.99E-08	0.	0.	7.07E-05	7.24E-05
Y91M+D	1.37E-10	0.	4.98E-12	0.	0.	7.60E-07	4.64E-07
Y91	2.47E-04	0.	6.59E-06	0.	0.	7.10E-04	4.97E-05
Y92	5.50E-09	0.	1.57E-10	0.	0.	6.46E-06	6.46E-05
Y93	5.04E-08	0.	1.38E-09	0.	0.	2.01E-05	1.05E-04
ZR93+D	2.07E-04	7.80E-05	5.55E-05	0.	3.00E-04	7.10E-04	1.47E-05
ZR95+D	5.13E-05	1.13E-05	1.00E-05	0.	1.61E-05	6.03E-04	1.65E-05
ZR97+D	5.07E-08	7.34E-09	4.32E-09	0.	1.05E-08	3.06E-05	9.49E-05
NB93M	1.27E-04	3.17E-05	1.04E-05	0.	3.44E-05	1.04E-04	2.45E-06
NB95	6.35E-06	2.48E-06	1.77E-06	0.	2.33E-06	1.66E-04	1.00E-05
NB97	1.16E-10	2.08E-11	9.74E-12	0.	2.31E-11	9.23E-07	7.52E-06
MO93	0.	3.76E-06	1.35E-07	0.	1.06E-06	1.70E-04	3.78E-06
MO99+D	0.	4.66E-08	1.15E-08	0.	1.06E-07	3.66E-05	3.42E-05
TC99M	4.81E-13	9.41E-13	1.56E-11	0.	1.37E-11	2.57E-07	1.30E-06
TC99	1.34E-07	1.49E-07	5.35E-08	0.	1.75E-06	3.37E-04	7.75E-06
TC101	2.19E-14	2.30E-14	2.91E-13	0.	3.92E-13	1.58E-07	4.41E-09
RU103+D	7.55E-07	0.	2.90E-07	0.	1.90E-06	1.79E-04	1.21E-05
RU105+D	4.13E-10	0.	1.50E-10	0.	3.63E-10	4.30E-06	2.69E-05
RU106+D	3.68E-05	0.	4.57E-06	0.	4.97E-05	3.87E-03	1.16E-04
H105	3.91E-09	2.10E-09	1.79E-09	0.	8.39E-09	7.82E-06	1.33E-05
PD107	0.	2.65E-07	2.51E-08	0.	1.97E-06	3.16E-05	7.26E-07
PD109	0.	1.48E-09	4.95E-10	0.	7.06E-09	6.16E-06	2.59E-05
AG110M+D	4.56E-06	3.08E-06	2.47E-06	0.	5.74E-06	1.48E-03	2.71E-05
AG111	1.81E-07	5.68E-08	3.75E-08	0.	1.71E-07	7.73E-05	2.98E-05
CD113M	0.	4.93E-04	2.12E-05	0.	5.13E-04	6.94E-04	1.63E-05
CD115M	0.	7.88E-05	3.39E-06	0.	5.93E-05	5.86E-04	4.97E-05
SN123	1.29E-04	2.14E-06	4.19E-06	2.27E-06	0.	9.59E-04	4.05E-05
SN125+D	4.95E-06	9.94E-08	2.95E-07	1.03E-07	0.	2.43E-04	7.17E-05
SN126+D	6.23E-04	1.04E-05	2.36E-05	2.84E-06	0.	3.02E-03	1.63E-05
SB124	1.55E-05	2.00E-07	5.41E-06	3.41E-08	0.	8.76E-04	4.43E-05
SB125+D	2.66E-05	2.05E-07	5.59E-06	2.46E-08	0.	6.27E-04	1.09E-05
SB126	1.72E-06	2.62E-08	6.16E-07	1.00E-08	0.	2.86E-04	5.67E-05
SB127	1.36E-07	2.09E-09	4.70E-08	1.51E-09	0.	6.17E-05	3.82E-05
TE125M	1.82E-06	6.29E-07	2.47E-07	5.20E-07	0.	1.29E-04	9.13E-06
TE127M+D	6.72E-06	2.31E-06	8.16E-07	1.64E-06	1.72E-05	4.00E-04	1.93E-05
TE127	7.49E-10	2.57E-10	1.65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
TE129M+D	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
TE129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
TE131M+D	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
TE131+D	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
TE132+D	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
TE133M+D	2.93E-11	1.51E-11	1.50E-11	2.32E-11	1.01E-10	1.60E-06	4.77E-06
TE134+D	1.53E-11	8.81E-12	9.40E-12	1.24E-11	5.71E-11	1.23E-06	4.87E-07
I129	1.05E-05	6.40E-06	5.71E-06	4.28E-03	1.08E-05	0.	2.15E-07
I130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	0.	1.38E-06
I131+D	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	0.	7.68E-07

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CHILD INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)							
ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	0.	8.65E-07
I133 + D	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	0.	1.48E-06
I134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	0.	2.58E-07
I135 + D	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	0.	1.20E-06
XE131M	0.	0.	0.	0.	0.	3.30E-09	0.
XE133M	0.	0.	0.	0.	0.	4.36E-09	0.
XE133	0.	0.	0.	0.	0.	3.66E-09	0.
XE135M	0.	0.	0.	0.	0.	4.48E-09	0.
XE135	0.	0.	0.	0.	0.	9.09E-09	0.
XE137	0.	0.	0.	0.	0.	4.07E-08	0.
XE138 + D	0.	0.	0.	0.	0.	5.17E-08	0.
CS134M + D	6.33E-08	8.92E-08	6.12E-08	0.	4.94E-08	8.35E-09	7.92E-08
CS134	1.76E-04	2.74E-04	6.07E-05	0.	8.93E-05	3.27E-05	1.04E-06
CS135	6.23E-05	4.13E-05	4.45E-06	0.	1.53E-05	5.22E-06	2.17E-07
CS136	1.76E-05	4.62E-05	3.14E-05	0.	2.58E-05	3.93E-06	1.13E-06
CS137 + D	2.45E-04	2.23E-04	3.47E-05	0.	7.63E-05	2.81E-05	9.78E-07
CS138	1.71E-07	2.27E-07	1.50E-07	0.	1.68E-07	1.84E-08	7.29E-08
CS139 + D	1.09E-07	1.15E-07	5.80E-08	0.	9.08E-08	9.36E-09	7.23E-12
BA139	4.98E-10	2.66E-13	1.45E-11	0.	2.33E-13	1.56E-06	1.56E-05
BA140 + D	2.00E-05	1.75E-08	1.17E-06	0.	5.71E-09	4.71E-04	2.75E-05
BA141 + D	5.29E-11	2.95E-14	1.72E-12	0.	2.56E-14	7.89E-07	7.44E-08
BA142 + D	1.35E-11	9.73E-15	7.54E-13	0.	7.87E-15	4.44E-07	7.41E-10
LA140	1.74E-07	6.08E-08	2.04E-08	0.	0.	4.94E-05	6.10E-05
LA141	2.28E-09	5.31E-10	1.15E-10	0.	0.	4.48E-06	4.37E-05
LA142	3.50E-10	1.11E-10	3.49E-11	0.	0.	2.35E-06	2.05E-05
CE141	1.06E-05	5.28E-06	7.83E-07	0.	2.31E-06	1.47E-04	1.53E-05
CE143 + D	9.89E-08	5.37E-08	7.77E-09	0.	2.26E-08	3.12E-05	3.44E-05
CE144 + D	1.83E-03	5.72E-04	9.77E-05	0.	3.17E-04	3.23E-03	1.05E-04
PR143	4.99E-06	1.50E-06	2.47E-07	0.	8.11E-07	1.17E-04	2.63E-05
PR144	1.61E-11	4.99E-12	8.10E-13	0.	2.64E-12	4.23E-07	5.32E-08
ND147 + D	2.92E-06	2.36E-06	1.84E-07	0.	1.30E-06	8.87E-05	2.22E-05
PM147	3.52E-04	2.52E-05	1.36E-05	0.	4.45E-05	2.20E-04	5.70E-06
PM148M + D	3.31E-05	6.55E-06	6.55E-06	0.	9.74E-06	5.72E-04	3.58E-05
PM148	1.61E-06	1.94E-07	1.25E-07	0.	3.30E-07	1.24E-04	6.01E-05
PM149	1.47E-07	1.56E-08	8.45E-09	0.	2.75E-08	2.40E-05	2.92E-05
PM151	3.57E-08	4.33E-09	2.82E-09	0.	7.35E-09	1.24E-05	2.50E-05
SM151	3.14E-04	4.75E-05	1.49E-05	0.	4.89E-05	1.48E-04	3.43E-06
SM153	7.24E-08	4.51E-08	4.35E-09	0.	1.37E-08	1.37E-05	1.87E-05
EU152	7.42E-04	1.37E-04	1.61E-04	0.	5.73E-04	9.00E-04	1.14E-05
EU154	2.74E-03	2.49E-04	2.27E-04	0.	1.09E-03	1.66E-03	2.98E-05
EU155	5.60E-04	4.05E-05	3.18E-05	0.	1.51E-04	2.79E-04	5.39E-05
EU156	7.89E-06	4.23E-06	8.75E-07	0.	2.72E-06	2.54E-04	4.24E-05
TB160	7.79E-05	0.	9.67E-06	0.	2.32E-05	5.34E-04	2.28E-05
HO166M	1.34E-03	2.81E-04	2.37E-04	0.	4.01E-04	1.13E-03	1.63E-05
W181	2.66E-08	6.52E-09	8.99E-10	0.	0.	5.71E-06	2.61E-07
W185	8.31E-07	2.08E-07	2.91E-08	0.	0.	1.86E-04	1.11E-05
W187	4.41E-09	2.61E-09	1.17E-09	0.	0.	1.11E-05	2.46E-05

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CHILD INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)							
ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210 + D	8.03E-02	1.85E-02	3.18E-03	0.	6.31E-02	8.74E-02	3.75E-05
BI210 + D	0.	5.11E-06	5.65E-07	0.	5.76E-05	3.70E-03	3.21E-05
PO210	1.70E-03	2.76E-03	4.09E-04	0.	8.85E-03	1.05E-01	4.32E-05
RN222 + D	0.	0.	0.	0.	0.	4.82E-06	0.
RA223 + D	7.69E-04	8.89E-07	1.54E-04	0.	2.36E-05	8.48E-02	3.00E-04
RA224 + D	8.44E-05	1.53E-07	1.69E-05	0.	4.06E-06	2.92E-02	3.34E-04
RA225 + D	1.28E-03	1.14E-06	2.56E-04	0.	3.02E-05	9.74E-02	2.84E-04
RA226 + D	2.34E-01	7.66E-06	1.92E-01	0.	2.03E-04	3.90E-01	3.02E-04
RA228 + D	1.49E-01	3.94E-06	1.68E-01	0.	1.04E-04	5.37E-01	5.14E-05
AC225	1.81E-03	1.87E-03	1.21E-04	0.	1.99E-04	7.37E-02	2.67E-04
AC227 + D	4.96E+00	8.05E-01	3.07E-01	0.	1.77E-01	8.04E-01	5.22E-05
TH227 + D	9.24E-04	1.26E-05	2.67E-05	0.	6.67E-05	1.26E-01	3.49E-04
TH228 + D	8.06E-01	1.04E-02	2.72E-02	0.	5.41E-02	3.34E+00	3.59E-04
TH229	1.28E+01	1.76E-01	6.31E-01	0.	8.68E-01	1.04E+01	3.27E-04
TH230	3.30E+00	1.73E-01	9.20E-02	0.	8.52E-01	1.85E+00	3.84E-05
TH232 + D	3.68E+00	1.47E-01	1.28E-01	0.	7.28E-01	1.77E+00	3.27E-05
TH234	6.94E-06	3.07E-07	2.00E-07	0.	1.62E-06	6.31E-04	7.32E-05
PA231 + D	8.62E+00	2.86E-01	3.43E-01	0.	1.56E+00	1.92E-01	4.57E-05
PA233	4.14E-06	6.48E-07	7.25E-07	0.	2.38E-06	9.77E-05	8.95E-06
232 + D	2.19E-01	0.	1.56E-02	0.	1.67E-02	7.42E-01	4.33E-05
J233 + D	4.64E-02	0.	2.82E-03	0.	7.62E-03	1.77E-01	4.00E-05
U234	4.46E-02	0.	2.76E-03	0.	7.47E-03	1.74E-01	3.92E-05
U235 + D	4.27E-02	0.	2.59E-03	0.	7.01E-03	1.63E-01	4.98E-05
U236	4.27E-02	0.	2.65E-03	0.	7.16E-03	1.67E-01	3.67E-05
U237	1.57E-07	0.	4.17E-08	0.	4.53E-07	3.40E-05	1.29E-05
U238 + D	4.09E-02	0.	2.42E-03	0.	6.55E-03	1.53E-01	3.51E-05
NP237 + D	2.88E+00	2.21E-01	1.19E-01	0.	7.41E-01	1.74E-01	5.06E-05
NP238	1.26E-06	2.56E-08	1.97E-08	0.	8.16E-08	3.39E-05	2.50E-05
NP239	1.26E-07	9.04E-09	6.35E-09	0.	2.63E-08	1.57E-05	1.73E-05
PU238	4.77E+00	6.05E-01	1.21E-01	0.	4.47E-01	6.08E-01	4.65E-05
PU239	5.24E+00	6.44E-01	1.28E-01	0.	4.78E-01	5.72E-01	4.24E-05
PU240	5.23E+00	6.43E-01	1.27E-01	0.	4.77E-01	5.71E-01	4.33E-05
PU241 + D	1.46E-01	6.33E-03	2.93E-03	0.	1.10E-02	5.06E-04	8.90E-07
PU242	4.85E+00	6.20E-01	1.23E-01	0.	4.60E-01	5.50E-01	4.16E-05
PU244	5.67E+00	7.10E-01	1.41E-01	0.	5.27E-01	6.30E-01	6.20E-05
AM241	1.74E+00	7.85E-01	1.24E-01	0.	7.63E-01	2.02E-01	4.73E-05
AM242M	1.79E+00	7.65E-01	1.27E-01	0.	7.71E-01	8.14E-02	5.96E-05
AM243	1.72E+00	7.53E-01	1.20E-01	0.	7.42E-01	1.92E-01	5.55E-05
CM242	6.33E-02	4.84E-02	4.20E-03	0.	1.34E-02	1.31E-01	5.06E-05
CM243	1.61E+00	7.33E-01	9.95E-02	0.	3.74E-01	2.10E-01	4.98E-05
CM244	1.33E+00	6.48E-01	8.31E-02	0.	3.06E-01	2.02E-01	4.82E-05
CM245	2.14E+00	8.16E-01	1.28E-01	0.	5.03E-01	1.95E-01	4.49E-05
CM246	2.13E+00	8.15E-01	1.28E-01	0.	5.03E-01	1.99E-01	4.41E-05
CM247 + D	2.07E+00	8.02E-01	1.26E-01	0.	4.95E-01	1.95E-01	5.80E-05
CM248	1.72E+01	6.61E+00	1.04E+00	0.	4.08E+00	1.61E+00	9.35E-04
CF252	3.92E+00	0.	9.33E-02	0.	0.	6.62E-01	1.84E-04

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TEEN INHALATION DOSE COMMITMENT FACTORS (MREM/50YR PER PCI INHALED IN FIRST YR)							
ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3*	0.	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07
BE10	2.78E-04	4.33E-05	7.09E-06	0.	0.	3.84E-04	1.77E-05
C14	3.25E-06	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07
N13	8.65E-09	8.65E-09	8.65E-09	8.65E-09	8.65E-09	8.65E-09	8.65E-09
F18	6.52E-07	0.	7.10E-08	0.	0.	0.	3.89E-08
NA22	1.76E-05	1.76E-05	1.76E-05	1.76E-05	1.76E-05	1.76E-05	1.76E-05
NA24	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
P32	2.36E-04	1.37E-05	8.95E-06	0.	0.	0.	1.16E-05
AR39	0.	0.	0.	0.	0.	4.00E-09	0.
AR41	0.	0.	0.	0.	0.	1.44E-08	0.
CA41	4.05E-05	0.	4.38E-06	0.	0.	1.01E-01	3.03E-07
SC46	7.24E-05	1.41E-04	4.18E-05	0.	1.35E-04	0.	2.98E-05
CR51	0.	0.	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
MN54	0.	6.39E-06	1.05E-06	0.	1.59E-06	2.48E-04	8.35E-06
MN56	0.	2.12E-10	3.15E-11	0.	2.24E-10	1.90E-06	7.18E-06
FE55	4.18E-06	2.98E-06	6.93E-07	0.	0.	1.55E-05	7.99E-07
FE59	1.99E-06	4.62E-06	1.79E-06	0.	0.	1.91E-04	2.23E-05
CO57	0.	1.18E-07	1.15E-07	0.	0.	7.33E-05	3.93E-06
CO58	0.	2.59E-07	3.47E-07	0.	0.	1.68E-04	1.19E-05
CO60	0.	1.89E-06	2.48E-06	0.	0.	1.09E-03	3.24E-05
NI59	5.44E-06	2.02E-06	9.24E-07	0.	0.	1.41E-05	6.48E-07
NI63	7.25E-05	5.43E-06	2.47E-06	0.	0.	3.84E-05	1.77E-06
NI65	2.73E-10	3.66E-11	1.59E-11	0.	0.	1.17E-06	4.59E-06
CU64	0.	2.54E-10	1.06E-10	0.	8.01E-10	1.39E-06	7.68E-06
ZN65	4.82E-06	1.67E-05	7.80E-06	0.	1.08E-05	1.55E-04	5.83E-06
ZN69M + D	1.44E-09	3.39E-09	3.11E-10	0.	2.06E-09	3.92E-06	2.14E-05
ZN69	6.04E-12	1.15E-11	8.07E-13	0.	7.53E-12	1.98E-07	3.56E-08
SE79	0.	5.43E-07	8.71E-08	0.	8.13E-07	7.71E-05	3.53E-06
BR82	0.	0.	2.28E-06	0.	0.	0.	0.
BR83 + D	0.	0.	4.30E-08	0.	0.	0.	0.
BR84	0.	0.	5.41E-08	0.	0.	0.	0.
BR85	0.	0.	2.29E-09	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	9.97E-10	0.
KR85M	0.	0.	0.	0.	0.	5.46E-09	0.
KR85	0.	0.	0.	0.	0.	4.63E-09	0.
KR87	0.	0.	0.	0.	0.	2.82E-08	0.
KR88 + D	0.	0.	0.	0.	0.	5.81E-08	0.
KR88	0.	0.	0.	0.	0.	3.85E-08	0.
RB86	0.	2.38E-05	1.05E-05	0.	0.	0.	2.21E-06
RB87	0.	1.40E-05	4.58E-06	0.	0.	0.	3.05E-07
RB88	0.	6.82E-08	3.40E-08	0.	0.	0.	3.65E-15
RB89 + D	0.	4.40E-08	2.91E-08	0.	0.	0.	4.22E-17
SR90 + D	5.43E-05	0.	1.56E-06	0.	0.	3.02E-04	4.64E-05
SR90	1.35E-02	0.	8.35E-04	0.	0.	2.06E-03	9.56E-05
SR91 + D	1.10E-08	0.	4.39E-10	0.	0.	7.59E-06	3.24E-05
SR92 + D	1.19E-09	0.	5.08E-11	0.	0.	3.43E-06	1.49E-05

*Includes a 50% increase to account for percutaneous transpiration.

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	3.73E-07	0.	1.00E-08	0.	0.	3.66E-05	6.99E-05
Y91M + D	4.63E-11	0.	1.77E-12	0.	0.	4.00E-07	3.77E-09
Y91	8.26E-05	0.	2.21E-06	0.	0.	3.67E-04	5.11E-05
Y92	1.84E-09	0.	5.36E-11	0.	0.	3.35E-06	2.06E-05
Y93	1.69E-08	0.	4.65E-10	0.	0.	1.04E-05	7.24E-05
ZR93 + D	6.83E-05	3.38E-05	1.84E-05	0.	1.16E-04	3.67E-04	1.60E-05
ZR95 + D	1.82E-05	5.73E-06	3.94E-06	0.	8.42E-06	3.36E-04	1.86E-05
ZR97 + D	1.72E-08	3.40E-09	1.57E-09	0.	5.15E-09	1.62E-05	7.88E-05
NB93M	4.14E-05	1.36E-05	3.41E-06	0.	1.59E-05	5.36E-05	2.52E-06
NB95	2.32E-06	1.29E-06	7.08E-07	0.	1.25E-06	9.39E-05	1.21E-05
NB97	3.92E-11	9.72E-12	3.55E-12	0.	1.14E-11	4.91E-07	2.71E-07
MO93	0.	1.66E-06	4.52E-08	0.	5.06E-07	8.81E-05	3.99E-06
MO99 + D	0.	2.11E-08	4.03E-09	0.	5.14E-08	1.92E-05	3.36E-05
TC99M	1.73E-13	4.83E-13	6.24E-12	0.	7.20E-12	1.44E-07	7.66E-07
TC99	4.48E-08	6.58E-08	1.79E-08	0.	8.35E-07	1.74E-04	7.99E-06
TC101	7.40E-15	1.05E-14	1.03E-13	0.	1.90E-13	8.34E-08	1.09E-16
RU103 + D	2.63E-07	0.	1.12E-07	0.	9.29E-07	9.79E-05	1.36E-05
RU105 + D	1.40E-10	0.	5.42E-11	0.	1.76E-10	2.27E-06	1.13E-05
RU106 + D	1.23E-05	0.	1.55E-06	0.	2.38E-05	2.01E-03	1.20E-04
H105	1.32E-09	9.48E-10	6.24E-10	0.	4.04E-09	4.09E-06	1.23E-05
PD107	0.	1.17E-07	8.39E-09	0.	9.39E-07	1.63E-05	7.49E-07
PD109	0.	6.56E-10	1.66E-10	0.	3.36E-09	3.19E-06	1.96E-05
AG110M + D	1.73E-06	1.64E-06	9.99E-07	0.	3.13E-06	8.44E-04	3.41E-05
AG111	6.07E-08	2.52E-08	1.26E-08	0.	8.17E-08	4.00E-05	3.00E-05
CD113M	0.	2.17E-04	7.10E-06	0.	2.43E-04	3.59E-04	1.68E-05
CD115M	0.	3.48E-05	1.14E-06	0.	2.82E-05	3.03E-04	5.10E-05
SN123	4.31E-05	9.44E-07	1.40E-06	7.55E-07	0.	4.96E-04	4.16E-05
SN125 + D	1.66E-06	4.42E-08	9.99E-08	3.45E-08	0.	1.26E-04	7.29E-05
SN126 + D	2.18E-04	5.39E-06	8.24E-06	1.42E-06	0.	1.72E-03	1.68E-05
SB124	5.38E-06	9.92E-08	2.10E-06	1.22E-08	0.	4.81E-04	4.98E-05
SB125 + D	9.23E-06	1.01E-07	2.15E-06	8.80E-09	0.	3.42E-04	1.24E-05
SB126	6.19E-07	1.27E-08	2.23E-07	3.50E-09	0.	1.55E-04	6.01E-05
SB127	4.64E-08	9.92E-10	1.75E-08	5.21E-10	0.	3.31E-05	3.94E-05
TE125M	6.10E-07	2.80E-07	8.34E-08	1.75E-07	0.	6.70E-05	9.38E-06
TE127M + D	2.25E-06	1.02E-06	2.73E-07	5.48E-07	8.17E-06	2.07E-04	1.99E-05
TE127	2.51E-10	1.14E-10	5.52E-11	1.77E-10	9.10E-10	1.40E-06	1.01E-05
TE129M + D	1.74E-06	8.23E-07	2.81E-07	5.72E-07	6.49E-06	2.47E-04	5.06E-05
TE129	8.87E-12	4.22E-12	2.20E-12	6.48E-12	3.32E-11	4.12E-07	2.02E-07
TE131M + D	1.23E-08	7.51E-09	5.03E-09	9.06E-09	5.49E-08	2.97E-05	7.76E-05
TE131 + D	1.97E-12	1.04E-12	6.30E-13	1.55E-12	7.72E-12	2.92E-07	1.89E-09
TE132 + D	4.50E-08	3.63E-08	2.74E-08	3.07E-08	2.44E-07	5.61E-05	5.79E-05
TE133M + D	1.01E-11	7.33E-12	5.71E-12	8.18E-12	5.07E-11	8.71E-07	1.23E-07
TE134 + D	5.31E-12	4.35E-12	3.64E-12	4.46E-12	2.91E-11	6.75E-07	1.37E-09
I129	3.53E-06	2.94E-06	4.90E-06	3.66E-03	5.26E-06	0.	2.29E-07
I130	7.80E-07	2.24E-06	8.96E-07	1.86E-04	3.44E-06	0.	1.14E-06
I131 + D	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	0.	8.11E-07

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	1.99E-07	5.47E-07	1.97E-07	1.89E-05	8.65E-07	0.	1.59E-07
I133 + D	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	0.	1.29E-06
I134	1.11E-07	2.90E-07	1.05E-07	4.94E-06	4.58E-07	0.	2.55E-09
I135 + D	4.62E-07	1.18E-06	4.36E-07	7.76E-05	1.86E-06	0.	8.69E-07
XE131M	0.	0.	0.	0.	0.	2.70E-09	0.
XE133M	0.	0.	0.	0.	0.	3.59E-09	0.
XE133	0.	0.	0.	0.	0.	2.99E-09	0.
XE135M	0.	0.	0.	0.	0.	3.88E-09	0.
XE135	0.	0.	0.	0.	0.	7.55E-09	0.
XE137	0.	0.	0.	0.	0.	3.33E-08	0.
XE138 + D	0.	0.	0.	0.	0.	4.38E-08	0.
CS134M + D	2.20E-08	4.35E-08	2.35E-08	0.	2.54E-08	4.56E-09	2.02E-08
CS134	6.28E-05	1.41E-04	6.86E-05	0.	4.69E-05	1.83E-05	1.22E-06
CS135	2.08E-05	1.82E-05	4.47E-06	0.	7.30E-06	2.70E-06	2.23E-07
CS136	6.44E-06	2.42E-05	1.71E-05	0.	1.38E-05	2.22E-06	1.36E-06
CS137 + D	8.38E-05	1.06E-04	3.89E-05	0.	3.80E-05	1.51E-05	1.06E-06
CS138	5.82E-08	1.07E-07	5.58E-08	0.	8.28E-08	9.84E-09	3.38E-11
CS139 + D	3.65E-08	5.12E-08	1.97E-08	0.	4.34E-08	4.86E-09	1.66E-23
BA139	1.67E-10	1.18E-13	4.87E-12	0.	1.11E-13	8.08E-07	8.06E-07
BA140 + D	6.84E-06	8.38E-09	4.40E-07	0.	2.85E-09	2.54E-04	2.86E-05
BA141 + D	1.78E-11	1.32E-14	5.93E-13	0.	1.23E-14	4.11E-07	9.33E-14
BA142 + D	4.62E-12	4.63E-15	2.84E-13	0.	3.92E-15	2.39E-07	5.99E-20
LA140	5.99E-08	2.95E-08	7.82E-09	0.	0.	2.68E-05	6.09E-05
LA141	7.63E-10	2.35E-10	3.87E-11	0.	0.	2.31E-06	1.54E-05
LA142	1.20E-10	5.31E-11	1.32E-11	0.	0.	1.27E-06	1.50E-06
CE141	3.55E-06	2.37E-06	2.71E-07	0.	1.11E-06	7.67E-05	1.58E-05
CE143 + D	3.32E-08	2.42E-08	2.70E-09	0.	1.08E-08	1.63E-05	3.19E-05
CE144 + D	6.11E-04	2.53E-04	3.28E-05	0.	1.51E-04	1.67E-03	1.08E-04
PR143	1.67E-06	6.64E-07	8.28E-08	0.	3.86E-07	6.04E-05	2.67E-05
PR144	5.37E-12	2.20E-12	2.72E-13	0.	1.26E-12	2.19E-07	2.94E-14
ND147 + D	9.83E-07	1.07E-06	6.41E-08	0.	6.28E-07	4.65E-05	2.28E-05
PM147	1.15E-04	1.10E-05	4.50E-06	0.	2.10E-05	1.14E-04	5.87E-06
PM148M + D	1.32E-05	3.35E-06	2.62E-06	0.	5.07E-06	3.20E-04	4.10E-05
PM148	5.44E-07	8.88E-08	4.48E-08	0.	1.60E-07	6.52E-05	6.14E-05
PM149	4.91E-08	6.89E-09	2.84E-09	0.	1.31E-08	1.24E-05	2.79E-05
PM151	1.20E-08	1.99E-09	1.01E-09	0.	3.57E-09	6.56E-06	2.27E-05
SM151	1.07E-04	2.10E-05	4.86E-06	0.	2.27E-05	7.68E-05	3.53E-06
SM153	2.43E-08	2.01E-08	1.47E-09	0.	6.56E-09	7.11E-06	1.77E-05
EU152	2.96E-04	7.19E-05	6.30E-05	0.	3.34E-04	5.01E-04	1.35E-05
EU154	9.43E-04	1.23E-04	8.60E-05	0.	5.44E-04	9.12E-04	3.34E-05
EU155	2.00E-04	1.96E-05	1.21E-05	0.	7.65E-05	1.51E-03	5.97E-05
EU156	2.70E-06	2.03E-06	3.30E-07	0.	1.36E-06	1.37E-04	4.56E-05
TB160	3.04E-05	0.	3.79E-06	0.	1.20E-05	2.97E-04	2.60E-05
HO166M	4.40E-04	1.36E-04	9.87E-05	0.	2.00E-04	6.24E-04	1.68E-05
W181	8.90E-09	2.88E-09	3.01E-10	0.	0.	2.95E-06	2.69E-07
W185	2.78E-07	9.17E-08	9.73E-09	0.	0.	9.60E-05	1.14E-05
W187	1.50E-09	1.22E-09	4.29E-10	0.	0.	5.92E-06	2.21E-05

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210 + D	3.09E-02	8.28E-03	1.07E-03	0.	2.95E-02	4.52E-02	3.87E-05
BI210 + D	0.	2.26E-06	1.89E-07	0.	2.74E-05	1.91E-03	3.19E-05
PO210	5.68E-04	1.22E-03	1.37E-04	0.	4.21E-03	5.41E-02	4.45E-05
RN222 + D	0.	0.	0.	0.	0.	3.94E-06	0.
RA223 + D	2.57E-04	3.93E-07	5.14E-05	0.	1.12E-05	4.39E-02	3.04E-04
RA224 + D	2.83E-05	6.77E-08	5.65E-06	0.	1.93E-06	1.51E-02	3.29E-04
RA225 + D	4.28E-04	5.04E-07	8.56E-05	0.	1.44E-05	5.04E-02	2.89E-04
RA226 + D	1.33E-01	3.38E-06	9.87E-02	0.	9.67E-05	2.02E-01	3.11E-04
RA228 + D	5.34E-02	1.74E-06	5.88E-02	0.	4.97E-05	2.78E-01	5.30E-05
AC225	6.04E-04	8.25E-04	4.06E-05	0.	9.47E-05	3.81E-02	2.70E-04
AC227 + D	2.49E+00	3.69E-01	1.48E-01	0.	1.07E-01	4.16E-01	5.38E-05
TH227 + D	3.09E-04	5.56E-06	8.93E-06	0.	3.18E-05	6.50E-02	3.57E-04
TH228 + D	2.60E-01	4.37E-03	8.78E-03	0.	2.45E-02	1.69E+00	3.70E-04
TH229	9.06E+00	1.36E-01	4.45E-01	0.	6.67E-01	5.05E+00	3.36E-04
TH230	2.34E+00	1.34E-01	6.49E-02	0.	6.55E-01	8.98E-01	3.95E-05
TH232 + D	2.61E+00	1.14E-01	9.21E-02	0.	5.60E-01	8.60E-01	3.36E-05
TH234	2.32E-06	1.35E-07	6.71E-08	0.	7.73E-07	3.26E-04	7.49E-05
PA231 + D	5.32E+00	2.00E-01	2.07E-01	0.	1.12E+00	9.91E-02	4.71E-05
PA233	1.68E-06	3.24E-07	2.89E-07	0.	1.22E-06	5.39E-05	1.00E-05
232 + D	7.31E-02	0.	5.23E-03	0.	7.94E-03	3.84E-01	4.46E-05
U233 + D	1.55E-02	0.	9.42E-04	0.	3.63E-03	9.18E-02	4.12E-05
U234	1.48E-02	0.	9.23E-04	0.	3.55E-03	8.99E-02	4.04E-05
U235 + D	1.42E-02	0.	8.67E-04	0.	3.34E-03	8.44E-02	5.13E-05
U236	1.42E-02	0.	8.86E-04	0.	3.41E-03	8.62E-02	3.79E-05
U237	5.25E-08	0.	1.40E-08	0.	2.16E-07	1.76E-05	1.29E-05
U238 + D	1.36E-02	0.	8.10E-04	0.	3.12E-03	7.89E-02	3.62E-05
NP237 + D	1.77E+00	1.54E-01	7.21E-02	0.	5.35E-01	8.99E-02	5.22E-05
NP238	4.23E-07	1.13E-08	6.59E-09	0.	3.88E-08	1.75E-05	2.38E-05
NP239	4.23E-08	3.99E-09	2.21E-09	0.	1.25E-08	8.11E-06	1.65E-05
PU238	2.86E+00	4.06E-01	7.22E-02	0.	3.10E-01	3.12E-01	4.79E-05
PU239	3.31E+00	4.50E-01	8.05E-02	0.	3.44E-01	2.93E-01	4.37E-05
PU240	3.31E+00	4.49E-01	8.04E-02	0.	3.43E-01	2.93E-01	4.46E-05
PU241 + D	6.97E-02	3.57E-03	1.40E-03	0.	6.47E-03	2.60E-04	9.17E-07
PU242	3.07E+00	4.33E-01	7.75E-02	0.	3.31E-01	2.82E-01	4.29E-05
PU244	3.59E+00	4.96E-01	8.88E-02	0.	3.79E-01	3.23E-01	6.39E-05
AM241	1.06E+00	4.07E-01	7.10E-02	0.	5.32E-01	1.05E-01	4.88E-05
AM242M	1.07E+00	3.93E-01	7.15E-02	0.	5.30E-01	4.21E-02	6.14E-05
AM243	1.06E+00	3.92E-01	6.95E-02	0.	5.21E-01	9.91E-02	5.72E-05
CM242	2.12E-02	2.14E-02	1.41E-03	0.	6.40E-03	6.76E-02	5.21E-05
CM243	8.45E-01	3.50E-01	5.00E-02	0.	2.34E-01	1.09E-01	5.13E-05
CM244	6.46E-01	3.03E-01	3.88E-02	0.	1.81E-01	1.05E-01	4.96E-05
CM245	1.32E+00	4.11E-01	7.53E-02	0.	3.52E-01	1.01E-01	4.63E-05
CM246	1.31E+00	4.11E-01	7.52E-02	0.	3.51E-01	1.03E-01	4.54E-05
CM247 + D	1.28E+00	4.04E-01	7.41E-02	0.	3.46E-01	1.01E-01	5.97E-05
CM248	1.06E+01	3.33E+00	6.11E-01	0.	2.85E+00	8.32E-01	9.63E-04
CF252	1.29E+00	0.	3.07E-02	0.	0.	3.43E-01	1.89E-04

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3*	0.	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07
BE10	1.98E-04	3.06E-05	4.96E-06	0.	0.	2.22E-04	1.67E-05
C14	2.27E-06	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07
N13	6.27E-09	6.27E-09	6.27E-09	6.27E-09	6.27E-09	6.27E-09	6.27E-09
F18	4.71E-07	0.	5.19E-08	0.	0.	0.	9.24E-09
NA22	1.30E-05	1.30E-05	1.30E-05	1.30E-05	1.30E-05	1.30E-05	1.30E-05
NA24	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06
P32	1.65E-04	9.64E-06	6.26E-06	0.	0.	0.	1.08E-05
AR39	0.	0.	0.	0.	0.	2.08E-09	0.
AR41	0.	0.	0.	0.	0.	8.06E-09	0.
CA41	3.83E-05	0.	4.13E-06	0.	0.	3.83E-06	2.86E-07
SC46	5.51E-05	1.07E-04	3.11E-05	0.	9.99E-05	0.	3.23E-05
CR51	0.	0.	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
MN54	0.	4.95E-06	7.87E-07	0.	1.23E-06	1.75E-04	9.67E-06
MN56	0.	1.55E-10	2.29E-11	0.	1.63E-10	1.18E-06	2.53E-06
FE55	3.07E-06	2.12E-06	4.93E-07	0.	0.	9.01E-06	7.54E-07
FE59	1.47E-06	3.47E-06	1.32E-06	0.	0.	1.27E-04	2.35E-05
CO57	0.	8.65E-08	8.39E-08	0.	0.	4.62E-05	3.93E-06
CO58	0.	1.98E-07	2.59E-07	0.	0.	1.16E-04	1.33E-05
CO60	0.	1.44E-06	1.85E-06	0.	0.	7.46E-04	3.56E-05
NI59	4.06E-06	1.46E-06	6.77E-07	0.	0.	8.20E-06	6.11E-07
NI63	5.40E-05	3.93E-06	1.81E-06	0.	0.	2.23E-05	1.67E-06
NI65	1.92E-10	2.62E-11	1.14E-11	0.	0.	7.00E-07	1.54E-06
CU64	0.	1.83E-10	7.69E-11	0.	5.78E-10	8.48E-07	6.12E-06
ZN65	4.05E-06	1.29E-05	5.82E-06	0.	8.62E-06	1.08E-04	6.68E-06
ZN69M + D	1.02E-09	2.45E-09	2.24E-10	0.	1.48E-09	2.38E-06	1.71E-05
ZN69	4.23E-12	8.14E-12	5.65E-13	0.	5.27E-12	1.15E-07	2.04E-09
SE79	0.	3.83E-07	6.09E-08	0.	5.69E-07	4.47E-05	3.33E-06
BR82	0.	0.	1.69E-06	0.	0.	0.	1.30E-06
BR83 + D	0.	0.	3.01E-08	0.	0.	0.	2.90E-08
BR84	0.	0.	3.91E-08	0.	0.	0.	2.05E-13
BR85	0.	0.	1.60E-09	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	5.19E-10	0.
KR85M	0.	0.	0.	0.	0.	2.91E-09	0.
KR85	0.	0.	0.	0.	0.	2.41E-09	0.
KR87	0.	0.	0.	0.	0.	1.53E-08	0.
KR88 + D	0.	0.	0.	0.	0.	3.13E-08	0.
KR89	0.	0.	0.	0.	0.	2.13E-08	0.
RB86	0.	1.69E-05	7.37E-06	0.	0.	0.	2.08E-06
RB87	0.	9.86E-06	3.21E-06	0.	0.	0.	2.88E-07
RB88	0.	4.84E-08	2.41E-08	0.	0.	0.	4.18E-19
RB89 + D	0.	3.20E-08	2.12E-08	0.	0.	0.	1.16E-21
SR89 + D	3.80E-05	0.	1.09E-06	0.	0.	1.75E-04	4.37E-05
SR90 + D	1.24E-02	0.	7.62E-04	0.	0.	1.20E-03	9.02E-05
SR91 + D	7.74E-09	0.	3.13E-10	0.	0.	4.56E-06	2.39E-05
SR92 + D	8.43E-10	0.	3.64E-11	0.	0.	2.06E-06	5.38E-06

*Includes a 50% increase to account for percutaneous transpiration.

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	2.61E-07	0.	7.01E-09	0.	0.	2.12E-05	6.32E-05
Y91M+D	3.26E-11	0.	1.27E-12	0.	0.	2.40E-07	1.66E-10
Y91	5.78E-05	0.	1.55E-06	0.	0.	2.13E-04	4.81E-05
Y92	1.29E-09	0.	3.77E-11	0.	0.	1.96E-06	9.19E-06
Y93	1.18E-08	0.	3.26E-10	0.	0.	6.06E-06	5.27E-05
ZR93+D	5.22E-05	2.92E-06	1.37E-06	0.	1.11E-05	2.13E-05	1.51E-06
ZR95+D	1.34E-05	4.30E-06	2.91E-06	0.	6.77E-06	2.21E-04	1.88E-05
ZR97+D	1.21E-08	2.45E-09	1.13E-09	0.	3.71E-09	9.84E-06	6.54E-05
NB93M	3.10E-05	1.01E-05	2.49E-06	0.	1.16E-05	3.11E-05	2.38E-06
NB95	1.76E-06	9.77E-07	5.26E-07	0.	9.67E-07	6.31E-05	1.30E-05
NB97	2.78E-11	7.03E-12	2.56E-12	0.	8.18E-12	3.00E-07	3.02E-08
MO93	0.	1.17E-06	3.17E-08	0.	3.55E-07	5.11E-05	3.79E-06
MO99+D	0.	1.51E-08	2.87E-09	0.	3.64E-08	1.14E-05	3.10E-05
TC99M	1.29E-13	3.64E-13	4.63E-12	0.	5.52E-12	9.55E-08	5.20E-07
TC99	3.13E-08	4.64E-08	1.25E-08	0.	5.85E-07	1.01E-04	7.54E-06
TC101	5.22E-15	7.52E-15	7.38E-14	0.	1.35E-13	4.99E-08	1.36E-21
RU103+D	1.91E-07	0.	8.23E-08	0.	7.29E-07	6.31E-05	1.38E-05
RU105+D	9.88E-11	0.	3.89E-11	0.	1.27E-10	1.37E-06	6.02E-06
RU106+D	8.64E-06	0.	1.09E-06	0.	1.67E-05	1.17E-03	1.14E-04
H105	9.24E-10	6.73E-10	4.43E-10	0.	2.86E-09	2.41E-06	1.09E-05
PD107	0.	8.27E-08	5.87E-09	0.	6.57E-07	9.47E-06	7.06E-07
PD109	0.	4.63E-10	1.16E-10	0.	2.35E-09	1.85E-06	1.52E-05
AG110M+D	1.35E-06	1.25E-06	7.43E-07	0.	2.46E-06	5.79E-04	3.78E-05
AG111	4.25E-08	1.78E-08	8.87E-09	0.	5.74E-08	2.33E-05	2.79E-05
CD113M	0.	1.54E-04	4.97E-06	0.	1.71E-04	2.08E-04	1.59E-05
CD115M	0.	2.46E-05	7.95E-07	0.	1.98E-05	1.76E-04	4.80E-05
SN123	3.02E-05	6.67E-07	9.82E-07	5.67E-07	0.	2.88E-04	3.92E-05
SN125+D	1.16E-06	3.12E-08	7.03E-08	2.59E-08	0.	7.37E-05	6.81E-05
SN126+D	1.58E-04	4.18E-06	6.00E-06	1.23E-06	0.	1.17E-03	1.59E-05
SB124	3.90E-06	7.36E-08	1.55E-06	9.44E-09	0.	3.10E-04	5.08E-05
SB125+D	6.67E-06	7.44E-08	1.58E-06	6.75E-09	0.	2.18E-04	1.26E-05
SB126	4.50E-07	9.13E-09	1.62E-07	2.75E-09	0.	9.57E-05	6.01E-05
SB127	3.30E-08	7.22E-10	1.27E-08	3.97E-10	0.	2.05E-05	3.77E-05
TE125M	4.27E-07	1.98E-07	5.84E-08	1.31E-07	1.55E-06	3.92E-05	8.83E-06
TE127M+D	1.58E-06	7.21E-07	1.96E-07	4.11E-07	5.72E-06	1.20E-04	1.87E-05
TE127	1.75E-10	8.03E-11	3.87E-11	1.32E-10	6.37E-10	8.14E-07	7.17E-06
TE129M+D	1.22E-06	5.84E-07	1.98E-07	4.30E-07	4.57E-06	1.45E-04	4.79E-05
TE129	6.22E-12	2.99E-12	1.55E-12	4.87E-12	2.34E-11	2.42E-07	1.96E-08
TE131M+D	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05
TE131+D	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09
TE132+D	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05
TE133M+D	7.24E-12	5.40E-12	4.17E-12	6.27E-12	3.74E-11	5.51E-07	5.49E-08
TE134+D	3.84E-12	3.22E-12	1.57E-12	3.44E-12	2.18E-11	4.343-07	2.97E-11
I129	2.48E-06	2.11E-06	6.91E-06	5.54E-03	4.53E-06	0.	2.22E-07
I130	5.72E-07	1.68E-06	6.60E-07	1.42E-04	2.61E-06	0.	9.61E-07
I131+D	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	0.	7.85E-07

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TABLE 1.7 (contd)

ADULT INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)							
ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	0.	5.08E-08
I133 + D	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	0.	1.11E-06
I134	8.05E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	0.	1.26E-10
I135 + D	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	0.	6.56E-07
XE131M	0.	0.	0.	0.	0.	1.40E-09	0.
XE133M	0.	0.	0.	0.	0.	1.89E-09	0.
XE133	0.	0.	0.	0.	0.	1.57E-09	0.
XE135M	0.	0.	0.	0.	0.	2.22E-09	0.
XE135	0.	0.	0.	0.	0.	4.05E-09	0.
XE137	0.	0.	0.	0.	0.	1.74E-08	0.
XE138 + D	0.	0.	0.	0.	0.	2.44E-08	0.
CS134M + D	1.59E-08	3.20E-08	1.72E-08	0.	1.83E-08	2.93E-09	7.92E-09
CS134	4.66E-05	1.06E-04	9.10E-05	0.	3.59E-05	1.22E-05	1.30E-06
CS135	1.46E-05	1.29E-05	5.99E-06	0.	5.11E-06	1.57E-06	2.11E-07
CS136	4.88E-06	1.83E-05	1.38E-05	0.	1.07E-05	1.50E-06	1.46E-06
CS137 + D	5.98E-05	7.76E-05	5.35E-05	0.	2.78E-05	9.40E-06	1.05E-06
CS138	4.14E-08	7.76E-08	4.05E-08	0.	6.00E-08	6.07E-09	2.33E-13
CS139 + D	2.56E-08	3.63E-08	1.39E-08	0.	3.05E-08	2.84E-09	5.49E-31
BA139	1.17E-10	8.32E-14	3.42E-12	0.	7.78E-14	4.70E-07	1.12E-07
BA140 + D	4.88E-06	6.13E-09	3.21E-07	0.	2.09E-09	1.59E-04	2.73E-05
BA141 + D	1.25E-11	9.41E-15	4.20E-13	0.	8.75E-15	2.42E-07	1.45E-17
BA142 + D	3.29E-12	3.38E-15	2.07E-13	0.	2.86E-15	1.49E-07	1.96E-26
LA140	4.30E-08	2.17E-08	5.73E-09	0.	0.	1.70E-05	5.73E-05
LA141	5.34E-10	1.66E-10	2.71E-11	0.	0.	1.35E-06	7.31E-06
LA142	8.54E-11	3.88E-11	9.65E-12	0.	0.	7.91E-07	2.64E-07
CE141	2.49E-06	1.69E-06	1.91E-07	0.	7.83E-07	4.52E-05	1.50E-05
CE143 + D	2.33E-08	1.72E-08	1.91E-09	0.	7.60E-09	9.97E-06	2.83E-05
CE144 + D	4.29E-04	1.79E-04	2.30E-05	0.	1.06E-04	9.72E-04	1.02E-04
PR143	1.17E-06	4.69E-07	5.80E-08	0.	2.70E-07	3.51E-05	2.50E-05
PR144	3.76E-12	1.56E-12	1.91E-13	0.	8.81E-13	1.27E-07	2.69E-18
ND147 + D	6.59E-07	7.62E-07	4.56E-08	0.	4.45E-07	2.76E-05	2.16E-05
PM147	8.37E-05	7.87E-06	3.19E-06	0.	1.49E-05	6.60E-05	5.54E-06
PM148M + D	9.82E-06	2.54E-06	1.94E-06	0.	3.85E-06	2.14E-04	4.18E-05
PM148	3.84E-07	6.37E-08	3.20E-08	0.	1.20E-07	3.91E-05	5.80E-05
PM149	3.44E-08	4.87E-09	1.99E-09	0.	9.19E-09	7.21E-06	2.50E-05
PM151	8.50E-09	1.42E-09	7.21E-10	0.	2.55E-09	3.94E-06	2.00E-05
SM151	8.59E-05	1.48E-05	3.55E-06	0.	1.66E-05	4.45E-05	3.25E-06
SM153	1.70E-08	1.42E-08	1.04E-09	0.	4.59E-09	4.14E-06	1.58E-05
EU152	2.38E-04	5.41E-05	4.76E-05	0.	3.35E-04	3.43E-04	1.59E-05
EU154	7.40E-04	9.10E-05	6.48E-05	0.	4.36E-04	5.84E-04	3.40E-05
EU155	1.01E-04	1.43E-05	9.21E-06	0.	6.59E-05	9.46E-05	5.95E-06
EU156	1.93E-06	1.48E-06	2.40E-07	0.	9.95E-07	8.56E-05	4.50E-05
TB160	2.21E-05	0.	2.75E-06	0.	9.10E-06	1.92E-04	2.68E-05
HO166M	3.37E-04	1.05E-04	8.00E-05	0.	1.57E-04	3.94E-04	1.59E-05
W181	6.23E-09	2.03E-09	2.17E-10	0.	0.	1.71E-06	2.53E-07
W185	1.95E-07	6.47E-08	6.81E-09	0.	0.	5.57E-05	1.07E-05
W187	1.06E-09	8.85E-10	3.10E-10	0.	0.	3.63E-06	1.94E-05

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ADULT INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)							
ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210+D	2.64E-02	6.73E-03	8.37E-04	0.	2.12E-02	2.62E-02	3.65E-05
BI210+D	0.	1.59E-06	1.32E-07	0.	1.92E-05	1.11E-03	2.95E-05
PO210	3.97E-04	8.60E-04	9.58E-05	0.	2.95E-03	3.14E-02	4.19E-05
RN222+D	0.	0.	0.	0.	0.	2.05E-06	0.
RA223+D	1.80E-04	2.77E-07	3.60E-05	0.	7.85E-06	2.55E-02	2.84E-04
RA224+D	1.98E-05	4.78E-08	3.96E-06	0.	1.35E-06	8.77E-03	3.01E-04
RA225+D	3.00E-04	3.56E-07	5.99E-05	0.	1.01E-05	2.92E-02	2.71E-04
RA226+D	1.25E-01	2.39E-06	9.14E-02	0.	6.77E-05	1.17E-01	2.94E-04
RA228+D	4.41E-02	1.23E-06	4.78E-02	0.	3.48E-05	1.61E-01	5.00E-05
AC225	4.23E-04	5.82E-04	2.84E-05	0.	6.63E-05	2.21E-02	2.52E-04
AC227+D	2.30E+00	3.05E-01	1.36E-01	0.	9.82E-02	2.41E-01	5.08E-05
TH227+D	2.17E-04	3.92E-06	6.25E-06	0.	2.22E-05	3.77E-02	3.34E-04
TH226+D	2.00E-01	3.39E-03	6.77E-03	0.	1.89E-02	1.01E+00	3.49E-04
TH229	8.88E+00	1.33E-01	4.36E-01	0.	6.52E-01	3.49E+00	3.17E-04
TH230	2.29E+00	1.31E-01	6.36E-02	0.	6.40E-01	6.21E-01	3.73E-05
TH232+D	2.56E+00	1.12E-01	9.04E-02	0.	5.47E-01	5.96E-01	3.17E-05
TH234	1.63E-06	9.56E-08	4.70E-08	0.	5.41E-07	1.89E-04	7.03E-05
PA231+D	5.08E+00	1.91E-01	1.98E-01	0.	1.07E+00	5.75E-02	4.44E-05
PA233	1.21E-06	2.42E-07	2.09E-07	0.	9.15E-07	3.52E-05	1.02E-05
232+D	5.14E-02	0.	3.66E-03	0.	5.56E-03	2.22E-01	4.21E-05
U233+D	1.09E-02	0.	6.60E-04	0.	2.54E-03	5.32E-02	3.89E-05
U234	1.04E-02	0.	6.46E-04	0.	2.49E-03	5.22E-02	3.81E-05
U235+D	1.00E-02	0.	6.07E-04	0.	2.34E-03	4.90E-02	4.84E-05
U236	1.00E-02	0.	6.20E-04	0.	2.39E-03	5.00E-02	3.57E-05
U237	3.67E-08	0.	9.77E-09	0.	1.51E-07	1.02E-05	1.20E-05
U238+D	9.58E-03	0.	5.67E-04	0.	2.18E-03	4.58E-02	3.41E-05
NP237+D	1.69E+00	1.47E-01	6.87E-02	0.	5.10E-01	5.22E-02	4.92E-05
NP238	2.96E-07	8.00E-09	4.61E-09	0.	2.72E-08	1.02E-05	2.13E-05
NP239	2.87E-08	2.82E-09	1.55E-09	0.	8.75E-09	4.70E-06	1.49E-05
PU238	2.74E+00	3.87E-01	6.90E-02	0.	2.96E-01	1.82E-01	4.52E-05
PU239	3.19E+00	4.31E-01	7.75E-02	0.	3.30E-01	1.72E-01	4.13E-05
PU240	3.18E+00	4.30E-01	7.73E-02	0.	3.29E-01	1.72E-01	4.21E-05
PU241+D	6.41E-02	3.28E-03	1.29E-03	0.	5.93E-03	1.52E-04	8.65E-07
PU242	2.95E+00	4.15E-01	7.46E-02	0.	3.17E-01	1.65E-01	4.05E-05
PU244	3.45E+00	4.76E-01	8.54E-02	0.	3.64E-01	1.89E-01	6.03E-05
AM241	1.01E+00	3.59E-01	6.71E-02	0.	5.04E-01	6.06E-02	4.60E-05
AM242M	1.02E+00	3.46E-01	6.73E-02	0.	5.01E-01	2.44E-02	5.79E-05
AM243	1.01E+00	3.47E-01	6.57E-02	0.	4.95E-01	5.75E-02	5.40E-05
CM242	1.48E-02	1.51E-02	9.84E-04	0.	4.48E-03	3.92E-02	4.91E-05
CM243	7.86E-01	2.97E-01	4.61E-02	0.	2.15E-01	6.31E-02	4.84E-05
CM244	5.90E-01	2.54E-01	3.51E-02	0.	1.64E-01	6.06E-02	4.68E-05
CM245	1.26E+00	3.59E-01	7.14E-02	0.	3.33E-01	5.85E-02	4.36E-05
CM246	1.25E+00	3.59E-01	7.13E-02	0.	3.33E-01	5.96E-02	4.29E-05
CM247+D	1.22E+00	3.53E-01	7.03E-02	0.	3.28E-01	5.85E-02	5.63E-05
CM248	1.01E+01	2.91E+00	5.79E-01	0.	2.70E+00	4.82E-01	9.09E-04
CF252	9.78E-01	0.	2.33E-02	0.	0.	1.99E-01	1.78E-04

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TABLE 1.8
EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATION GROUND (DFG)
(MREM/HR PER PCI/M²)

<u>ELEMENT</u>	<u>TOTAL BODY</u>	<u>SKIN</u>
H-3	0.0	0.0
C-14	0.0	0.0
Na-24	2.50E-08	2.90E-08
P-32	0.0	0.0
Cr-51	2.20E-10	2.60E-10
Mn-54	5.80E-09	6.80E-09
Mn-56	1.10E-08	1.30E-08
Fe-55	0.0	0.0
Fe-59	8.00E-09	9.40E-09
Co-58	7.00E-09	8.20E-09
Co-60	1.70E-08	2.00E-08
Ni-63	0.0	0.0
Ni-65	3.70E-09	4.30E-09
Cu-64	1.50E-09	1.70E-09
Zn-65	4.00E-09	4.60E-09
Zn-69	0.0	0.0
Br-83	6.40E-11	9.30E-11
Br-84	1.20E-08	1.40E-08
Br-85	0.0	0.0
Rb-86	6.30E-10	7.20E-10
Rb-88	3.50E-09	4.00E-09
Rb-89	1.50E-08	1.80E-08
Sr-89	5.60E-13	6.50E-13
Sr-91	7.10E-09	8.30E-09
Sr-92	9.00E-09	1.00E-08
Y-90	2.20E-12	2.60E-12
Y-91m	3.80E-09	4.40E-09
Y-91	2.40E-11	2.70E-11
Y-92	1.60E-09	1.90E-09
Y-93	5.70E-10	7.80E-10
Zr-95	5.00E-09	5.80E-09
Zr-97	5.50E-09	6.40E-09
Nb-95	5.10E-09	6.00E-09
Mo-99	1.90E-09	2.20E-09
Tc-99m	9.60E-10	1.10E-09
Tc-101	2.70E-09	3.00E-09

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**TABLE 1.8 (continued)
EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATION GROUND (DFG)
(MREM/HR PER PCI/M²)**

<u>ELEMENT</u>	<u>TOTAL BODY</u>	<u>SKIN</u>
Ru-103	3.60E-09	4.20E-09
Ru-105	4.50E-09	5.10E-09
Ru-106	1.50E-09	1.80E-09
Ag-110m	1.80E-08	2.10E-08
Te-125m	3.50E-11	4.80E-11
Te-127m	1.10E-12	1.30E-12
Te-127	1.00E-11	1.10E-11
Te-129m	7.70E-10	9.00E-10
Te-129	7.10E-10	8.40E-10
Te-131m	8.40E-09	9.90E-09
Te-131	2.20E-09	2.60E-06
Te-132	1.70E-09	2.00E-09
I-130	1.40E-08	1.70E-08
I-131	2.80E-09	3.40E-09
I-132	1.70E-08	2.00E-08
I-133	3.70E-09	4.50E-09
I-134	1.60E-08	1.90E-08
I-135	1.20E-08	1.40E-08
Cs-134	1.20E-08	1.40E-08
Cs-136	1.50E-08	1.70E-08
Cs-137	4.20E-09	4.90E-09
Cs-138	2.10E-08	2.40E-08
Ba-139	2.40E-09	2.70E-09
Ba-140	2.10E-09	2.40E-09
Ba-141	4.30E-09	4.90E-09
Ba-142	7.90E-09	9.00E-09
La-140	1.50E-08	1.70E-08
La-142	1.50E-08	1.80E-08
Ce-141	5.50E-10	6.20E-10
Ce-143	2.20E-09	2.50E-09
Ce-144	3.20E-10	3.70E-10
Pr-143	0.0	0.0
Pr-144	2.00E-10	2.30E-10
Nd-147	1.00E-09	1.20E-09
W-187	3.10E-09	3.60E-09
Np-239	9.50E-10	1.10E-09

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TABLE 1.9
1999 PALISADES GASEOUS DESIGN
OBJECTIVE ANNUAL QUANTITIES

<u>Nuclide</u>	<u>Organ</u>	<u>Dose Factor</u> <u>Mrem/Ci</u>	<u>Design Objective</u> <u>Annual Quantity</u> <u>Ci</u>
Na-24	Total Body-C	4.02E - 03	1.24E + 03
Nb-95	GI Tract-A	1.92E - 01	7.81E + 01
Ni-63	Bone-C	1.21E + 01	1.24E + 00
Ni-65	GI Tract-C	4.70E - 03	3.19E + 03
Np-239	GI Tract-T	8.13E - 03	1.84E + 03
Rb-88	Total Body-C	2.38E - 05	2.10E + 05
Ru-103	GI Tract-A	2.93E - 01	5.12E + 01
Ru-105	GI Tract-C	5.82E - 03	2.58E + 03
Sb-124	GI Tract-T	9.47E - 01	1.58E + 01
Sb-125	GI Tract-T	4.35E - 01	3.45E + 01
Sr-89	Bone-C	8.98E + 00	1.67E + 00
Sr-90	Bone-C	3.73E + 02	4.02E - 02
Sr-91	Bone-I	2.46e + 00	6.10E + 00
Sr-92	GI Tract-C	1.37E - 02	1.09E + 03
Tc-99	GI Tract-T	5.85E - 01	2.62E + 01
Tc-99m	GI Tract-T	3.64E - 04	4.12E + 04
Tc-101	GI Tract-I	8.33E - 05	1.80E + 05
Te-127	GI Tract-T	4.87E - 03	3.08E + 03
Xe-131m	Skin	4.03E - 05	3.72E + 05
Xe-133	Total Body	1.39E - 05	3.60E + 05
Xe-133m	Skin	8.39E - 05	1.79E + 05
Xe-135	Total Body	8.32E - 05	6.01E + 04
Xe-135m	Total Body	9.55E - 05	5.24E + 04
Xe-137	Skin	5.85E - 04	2.56E + 04
Xe-138	Total body	2.70E - 04	1.85E + 04

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TABLE 1.9 (Continued)
1999 PALISADES GASEOUS DESIGN
OBJECTIVE ANNUAL QUANTITIES (Continued)

<u>Nuclide</u>	<u>Organ</u>	<u>Dose Factor Mrem/Ci</u>	<u>Design Objective Annual Quantity Ci</u>
Zn-65	Liver-C	9.38E - 01	1.60E + 01
Zr-95	GI Tract-T	3.90E - 01	3.85E + 01
Pu-238	Bone-T	1.42E + 03	1.06E - 02
Pu-239	Bone-T	1.64E + 03	9.15E - 03
Pu-241	Bone-T	3.45E + 01	4.35E - 01
Am-241	Bone-T	5.25E + 02	2.86E - 02
Cm-242	Lung-T	3.35E + 01	4.48E - 01
Cm-244	Bone-T	3.20E + 02	4.69E - 02
Ag-110m	GI-Tract-T	2.13E + 00	7.04E + 00
Ar-41	Total Body	3.64E - 04	1.37E + 04
Ba-139	GI Tract-C	2.97E - 03	5.05E + 03
Ba-140	Lung-T	1.26E - 01	1.19E + 02
Br-82	total Body-C	4.97E - 03	1.01E + 03
C-14	Bone-C	1.48E - 01	1.01E + 02
Ce-141	GI Tract-T	1.34E - 01	1.12E + 02
Ce-144	GI Tract-T	3.37E + 00	4.45E + 00
Co-57	GI Tract-T	8.53E - 02	1.76E + 02
Co-58	GI Tract-T	2.59E - 01	5.79E + 01
Co-60	GI Tract-T	6.86E + 00	2.19E + 00
Cr-51	GI Tract-A	3.75E - 03	1.33E + 03
Cs-134	Liver-C	8.77E + 00	1.71E + 00
Cs-136	Liver-I	1.99E - 01	7.54E + 01
Cs-137	Bone-C	9.58E + 00	1.57E + 00
Cs-138	Total body-C	1.00E - 01	5.00E + 01
Fe-55	Bone-C	2.06E - 01	7.28E + 01
Fe-59	GI Tract-T	3.20E - 01	4.69E + 01

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TABLE 1.9 (Continued)
1999 PALISADES GASEOUS DESIGN
OBJECTIVE ANNUAL QUANTITIES (Continued)

<u>Nuclide</u>	<u>Organ</u>	<u>Dose Factor</u> <u>Mrem/Ci</u>	<u>Design Objective</u> <u>Annual Quantity</u> <u>Ci</u>
H-3	Total Body-C	2.19E - 04	2.28E + 04
I-129	Thyroid-A	3.66E + 02	4.10E - 02
I-131	Thyroid-I	7.35E + 00	2.04E + 00
I-132	Thyroid-C	1.12E - 02	1.34E + 03
I-133	Thyroid-C	2.46E - 01	6.11E + 01
I-134	Thyroid-C	245E - 03	6.12E + 03
I-135	Thyroid-C	4.93E - 02	3.04E + 02
Kr-83m	Skin	8.82E - 07	1.70E + 07
Kr-85	Skin	9.14E - 05	1.64E + 05
Kr-85m	Total Body	5.22E - 05	9.58E + 04
Kr-87	Skin	8.03E - 04	1.87E + 04
Kr-88	Total Body	6.35E - 04	7.87E + 03
Kr-89	Total Body	5.08E - 04	9.84E + 03
La-140	GI Tract-T	3.04E - 02	4.93E + 02
Mn-54	GI Tract-T	6.29E - 01	2.38E + 01
Mn-56	GI Tract-C	6.91E - 03	2.17E + 03
Mo-99	GI Tract-T	1.66E - 02	9.04E + 02
N-13	Total Body-C	3.44E - 06	1.45E + 06

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II. **LIQUID EFFLUENTS**

A. **CONCENTRATION**

1. **Requirements**

Appendix A, Section III.G requires that the concentration of radioactive material released at any time from the site to unrestricted areas shall be limited to ten times the Effluent Concentration (EC) specified in 10 CFR 20, Appendix B, Table 2, Column 2 for nuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2E-04 $\mu\text{Ci/ml}$ total activity. To ensure compliance, the following approach will be used for each release.

2. **Prerelease Analysis**

Most tanks will be recirculated through two volume changes prior to sampling for release to the environment to ensure that a representative sample is obtained. The appropriate recirculation time for those tanks too large to provide two volume changes will be the time that the suspended particulate concentration reaches steady state. Either a one-time test, or prior sampling data, may be used to determine appropriate recirculation time.

Prior to release, a grab sample will be analyzed for each release, and the concentration of each radionuclide determined.

$$C = \sum_{i=1}^n C_i \tag{2.1}$$

where:

C = Total concentration in the liquid effluent at the release point, $\mu\text{Ci/ml}$.

C_i = Concentration of a single radionuclide i, $\mu\text{Ci/ml}$.

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3. **Effluent Concentration (EC) - Sum of the Ratios**

The EC-Fraction (R_i) for each release point will be calculated by the relationship defined by Note 4 of Appendix B, 10 CFR 20:

$$R_i = \sum_j \frac{C_j}{EC_j} \leq 10.0 \quad (2.2)$$

where:

C_i = Effluent concentration of radionuclide i , $\mu\text{Ci/ml}$.

EC_i = The EC of radionuclide i , 10 CFR 20, Appendix B, Table 2, Column 2 - $\mu\text{Ci/ml}$.

R_i = The Total EC-Fraction for the release point.

The sum of the ratios at the discharge to the lake must be ≤ 10 due to the releases from any or all concurrent releases. The following relationship will assure this criterion is met:

$$f_1(R_1-1) + f_2(R_2-1) + f_3(R_3-1) \leq F \quad (2.3)$$

where:

f_1, f_2, f_3 = The effluent flow rate (gallons/minute) for the respective releases, determined by Plant personnel.

R_1, R_2, R_3 = The Total EC-Fractions for the respective releases as determined by Equation 2.2.

F = Minimum required dilution flow rate. Normally, a conservatively high dilution flow rate is used, that is, flow rate used = $(b_i)(F)$ where b_i is a conservative factor greater than 1.0.

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B. INSTRUMENT SETPOINTS

1. Setpoint Determination

Appendix A, Section III.F requires alarm setpoints for each liquid effluent monitor will be established using Plant instructions to ensure the requirements of Appendix A, Section III.G are not exceeded. Concentration, flow rate, dilution, principal gamma emitter, geometry, and detector efficiency are combined to give an equivalent setpoint in counts per minute (cpm). The identification number for each liquid effluent radiation detector is contained in Figure 2-2.

The respective alarm/trip setpoints at each release point will be set such that the sum of the ratios at each point, as calculated by Equation 2.2, will not be exceeded. The value of R is directly related to the total concentration calculated by Equation 2.1. An increase in the concentration would indicate an increase in the value of R. A large increase would cause the limits specified in Section 2.1.1 to be exceeded. The minimum alarm/trip setpoint value is equal to the release concentration, but for ease of operation it may be desired that the setpoint (S) be set above the effluent concentration (C) by the same factor (b) utilized in setting dilution flow. That is:

$$S = b \times C \tag{2.4}$$

Liquid effluent flow paths and release points are indicated in Figure 2.1.

2. Composite Samplers

Effluent pathways, Turbine Sump and Service Water, are equipped with continuous compositors to meet the requirements of Appendix A, Table D-1. These compositors are adjustable and normally set in a time mode and collect three to six samples hourly, 24 hours a day with a total collection of approximately one gallon per day. A representative sample is collected daily from the compositor and saved for the weekly, monthly analysis requirements of Appendix A, Table D-1. In the event that a compositor is not operational, effluent releases via this pathway may continue provided that grab samples are collected and analyzed for gross beta or gamma radioactivity at least once per 24 hours per Appendix A, Table C-1, Action 3.

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3. **Post-Release Analysis**

A post-release analysis will be done using actual release data to ensure that the limits specified in Section 1 were not exceeded.

A composite list on concentrations (C_i), by isotope, will be used with the actual liquid radwaste (f) and dilution (F) flow rates (or volumes) during the release. The data will be substituted into Equation 2.3 to demonstrate compliance with the limits in Section 1. This data and setpoints will be recorded in auditable records by Plant personnel.

C. **DOSE**

1. **RETS Requirement**

Appendix A, Section III.H.1 requires that the quantity of radionuclides released be limited such that the dose or dose commitment to an individual from radioactive materials in liquid effluents release to unrestricted areas from the reactor (see Figure 2-1) will not exceed:

- a. During any calendar quarter, 1.5 mrem to the total body and 5 mrem to any organ, and
- b. During any calendar year, 3 mrem to the total body and 10 mrem to any organ.

To ensure compliance, quantities of activity of each radionuclide released will be summed for each release and accumulated for each quarter as follows in Section 2.

2. **Release Analysis**

Calculations shall be performed for each batch release, and weekly for continuous releases according to the formula:

$$\sum_i A_i/C_i \leq 0.5$$

(2.5)

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where:

A_i = Cumulative quarterly activity of nuclide i identified in liquid release (C_i).

C_i = Design objective annual quantity of radionuclide i from Table 2.2.

The design basis quantities are derived in such a conservative manner that doses may be greatly overestimated by this technique. As a consequence of this conservatism, and in light of historically consistent operations with releases well below annual design basis quantities, the Appendix A, effluent requirements do not require monthly dose projections. Instead, if at any time, calculations by Equation (2.5) results in values greater than 0.5 for a given quarter or 1.0 for year-to-date, the NRC LADTAP code will be run to ensure that Appendix A, Section III.H.1 has been met.

Values for the design basis quantities (C_i), and the dose per Curie (Dc/Cc) $_i$ for each nuclide i shown in Table 2.2, were calculated as follows in Sections 2.1 and 2.2.

a. Water Ingestion

The dose to an individual from ingestion of radioactivity from any source as described by the following equation:

$$D_j = \sum_{i=1}^i (DCF)_{ij} \times I_i \quad (2.6)$$

where:

D_j = Dose for the j th organ from radionuclides releases, mrem.

j = The organ of interest.

$(DCF)_{ij}$ = Ingestion dose commitment factor for the j th organ from the i^{th} radionuclide mrem/pCi, see Table 2.1.

I_i = Activity ingested of the i^{th} radionuclide, pCi.

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I_i is described by:

$$I_i = \frac{(A_i)(V)(365)}{(1000)(d)} (1E06) \quad (2.7)$$

where:

365 = Days per year.

A_i = Annual activity released of i^{th} radionuclide, μCi .

V = Average rate of water consumption
(2000 ml/d - adult, 1400 ml/d - teen and child,
900 ml/d - infant, ICRP 23, p 358).

d = Dilution water flow for year, ml.

1000 = Dispersion factor from discharge to nearest
drinking water supply.

1E06 = Conversion μCi to pCi.

The dose equation then becomes:

$$D_j = \frac{(3.65E05)(V)}{d} \sum_{i=1}^j (\text{DCF})_{ij} \times A_i \text{ mrem} \quad (2.8)$$

b. Fish Ingestion

The dose to an individual from the consumption of fish is described by Equation 2.10. In this case, the activity ingested of the i^{th} radionuclide (I_i) is described by:

$$I_i = \frac{A_i B_i F (1E09)}{15d} = \text{pCi} \quad (2.9)$$

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where:

A_i = Annual released of i^{th} radionuclide, μCi .

B_i = Fish concentration factor of i^{th} radionuclide (see Table 2.0). $\frac{\mu\text{Ci/gm}}{\mu\text{Ci/ml}}$

F = Amount of fish eaten per year (21 kg adult, 16 kg teen, 6.9 kg child, none infant).

15 = Dispersion factor from discharge to fish exposure point.

d = Dilution water flow for year, ml.

1E09 = Conversion of μCi and Kgm to gross.

Substitution of Equation 2.9 into Equation 2.6 gives:

$$D_j = \frac{(6.7\text{E}07)F}{d} \sum_{i=1}^i A_i \times B_i \times \text{DCF}_i \text{ mrem} \quad (2.10)$$

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c. Annual Analysis

A complete analysis utilizing the NRC computer code LADTAP with the total source release will be done annually in conjunction with the annual environmental report. This analysis will provide estimates of dose to the total body and various organs in addition to the dose limiting organs considered in the method of Section 2. The following approach is utilized on LADTAP. The dose to the j^{th} organ from m radionuclides, D_j , is described by:

$$\begin{aligned} D_j &= \sum_{i=1}^m D_{ij} \text{ mrem} \\ &= \sum_{i=1}^m (\text{DCF})_{ij} \times I_i \text{ mrem} \end{aligned} \tag{2.11}$$

where:

- D_j = Dose to the j^{th} organ from the i^{th} radionuclide, mrem.
- j = The organ of interest (bone, GI tract, thyroid, liver, kidney, lung, or total body).
- $(\text{DCF})_{ij}$ = Adult ingestion dose commitment factor for the j^{th} organ from the i^{th} radionuclide, mrem/pCi (see Table 2.1).
- I_i = Activity ingested of the i^{th} radionuclide, μCi .

I_i for water ingestion is described by:

$$I_i = \frac{A_i V_r}{v d} \mu\text{Ci} \tag{2.13}$$

and for fish ingestion I_i is described by:

$$I_i = \frac{A_i B_i F_r}{v d} \mu\text{Ci}$$

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where:

A_j = Activity release of j^{th} radionuclide during the year, μCi .

V = Average rate of water consumption (2000 ml/d).

Γ = Number of days during the year (365 d).

v = Dispersion factor from point of discharge to point of exposure.

d = Dilution water volume (ml).

B_i = Fish concentration factor of the i^{th} radionuclide,

Table 2.0, $\frac{\mu\text{Ci/gm}}{\mu\text{Ci/ml}}$

F = Amount of fish eaten per day (57.5 gm/d).

D. OPERABILITY OF LIQUID RADWASTE EQUIPMENT

The Palisades liquid radwaste system is designed to reduce the radioactive materials in liquid wastes prior to their discharge (by recycle or shipment for disposal) so that radioactivity in liquid effluent releases to unrestricted areas (see Figure 2-1) will not exceed the limits of Appendix A, III.H.1. Maintaining the cumulative fraction if allowable release for each batch release and weekly for continuous releases assures compliance with this requirement. In addition, 13 years of operating experience (to the date this ODCM was first adopted) has shown that design basis quantities never have been exceeded.

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E. RELEASE RATE FOR OFFSITE EC (50 mRem/yr)

10 CFR 20.1302 requires radioactive effluent releases to unrestricted areas be less than the limits specified in Appendix B, Table 2 when averaged over a period not to exceed one year. Concentrations at this Effluent Concentration (EC) level, if ingested for one year, will result in a dose of 50 millirem to the total body. In addition, 10 CFR 50.36a requires that the release of radioactive materials be kept as low as is reasonably achievable. Appendix I to 10 CFR 50 provides the numerical guidelines on limiting conditions for operations to meet the as low as is reasonably achievable requirement.

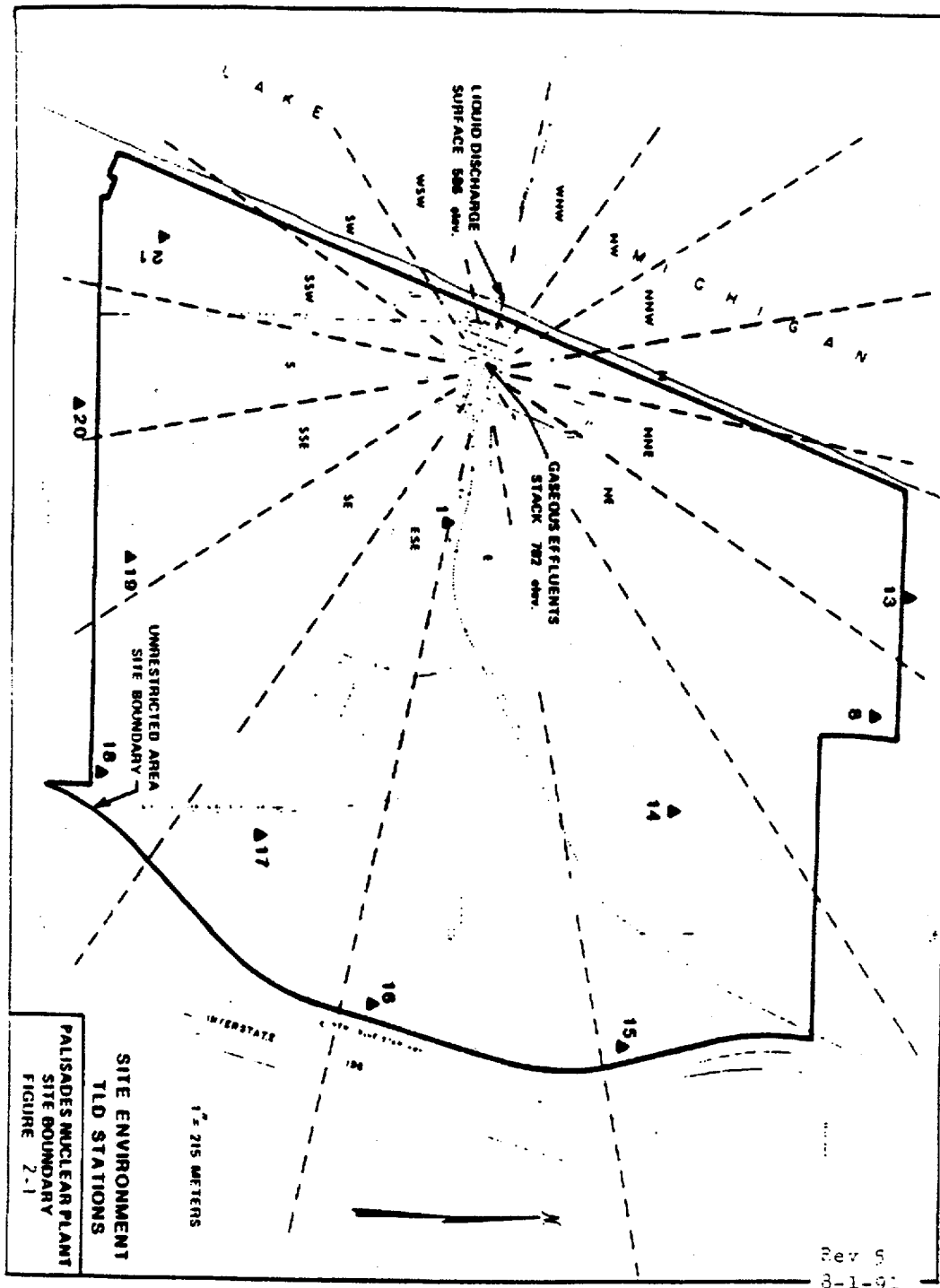
The LADTAP code has been run to determine the dose due to drinking water at Plant discharge concentration (1,000 x nearest drinking water intake concentration). The nominal average source term used is given in Table 1.1. Dose to the most limiting organ of the person hypothetically drinking this water is 3.88E-03 mrem. This is only 0.13% of the more conservative 50 mrem/yr total body value.

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F. FIGURES AND TABLES

Figure 2-1

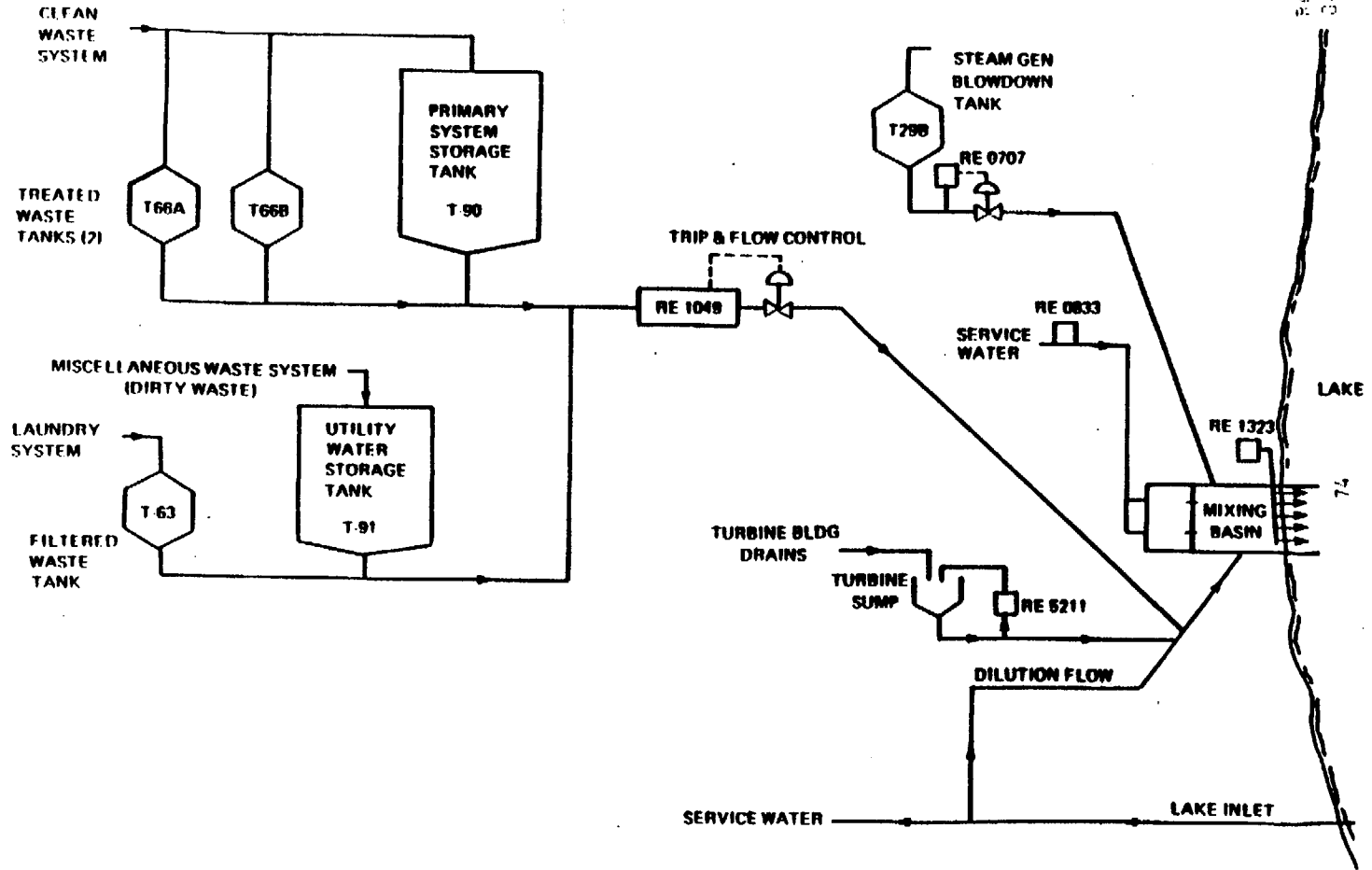


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Figure 2-2

PALISADES RADWASTE EFFLUENTS - LIQUID



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TABLE 2.0

BIOACCUMULATION FACTORS
 $\mu\text{Ci/gm per } \mu\text{Ci/ml}$

<u>ELEMENT</u>	<u>FRESHWATER FISH</u>
H	9.0E-01
C	4.6E 03
NA	1.0E 02
P	1.0E 05
CR	2.0E 02
MN	4.0E 02
FE	1.0E 02
CO	5.0E 01
NI	1.0E 02
CU	5.0E 01
ZN	2.0E 03
BR	4.2E 02
RB	2.0E 03
SR	3.0E 01
Y	2.5E 01
ZR	3.3E 00
NB	3.0E 04
MO	1.0E 01
TC	1.5E 01
RU	1.0E 01
RH	1.0E 01
TE	4.0E 02
I	1.5E 01
CS	2.0E 03
BA	4.0E 00
LA	2.5E 01
CE	1.0E 00
PR	2.5E 01
ND	2.5E 01
W	1.2E 03
NP	1.0E 01

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TABLE 2.1

INFANT INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
BE10	1.71E-05	2.49E-06	5.16E-07	0.	1.64E-06	0.	2.78E-05
C14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
N13	5.85E-08	5.85E-08	5.85E-08	5.835E-08	5.85E-08	5.85E-08	5.85E-08
F18	5.19E-06	0.	4.43E-07	0.	0.	0.	1.22E-06
NA22	9.83E-05	9.83E-05	9.83E-05	9.83E-05	9.83E-05	9.83E-05	9.83E-05
NA24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P32	1.70E-03	1.00E-04	6.59E-05	0.	0.	0.	2.30E-05
AR39	0.	0.	0.	0.	0.	0.	0.
AR41	0.	0.	0.	0.	0.	0.	0.
CA41	3.74E-04	0.	4.08E-05	0.	0.	0.	1.91E-07
SC46	3.75E-08	5.41E-08	1.69E-08	0.	3.56E-08	0.	3.53E-05
CR51	0.	0.	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
MN54	0.	1.99E-05	4.51E-06	0.	4.41E-06	0.	7.31E-06
MN56	0.	8.18E-07	1.41E-07	0.	7.03E-07	0.	7.43E-05
FE55	1.39E-05	8.98E-06	2.40E-06	0.	0.	4.39E-06	1.14E-06
FE59	3.08E-05	5.38E-05	2.12E-05	0.	0.	1.59E-05	2.57E-05
CO57	0.	1.15E-06	1.87E-06	0.	0.	0.	3.92E-06
CO58	0.	3.60E-06	8.98E-06	0.	0.	0.	8.97E-06
CO60	0.	1.08E-05	2.55E-05	0.	0.	0.	2.57E-05
NI59	4.78E-05	1.45E-05	8.17E-06	0.	0.	0.	7.16E-07
NI63	6.34E-04	3.92E-05	2.20E-05	0.	0.	0.	1.95E-06
NI65	4.70E-06	5.32E-07	2.42E-07	0.	0.	0.	4.05E-05
CU64	0.	6.09E-07	2.82E-07	0.	1.03E-06	0.	1.25E-05
ZN65	1.84E-05	6.31E-05	2.91E-05	0.	3.06E-05	0.	5.33E-05
ZN69M + D	1.50E-06	3.06E-06	2.79E-07	0.	1.24E-06	0.	4.24E-05
ZN69	9.33E-08	1.68E-07	1.25E-08	0.	6.98E-08	0.	1.37E-05
SE79	0.	2.10E-05	3.90E-06	0.	2.43E-05	0.	5.58E-07
BR82	0.	0.	1.27E-05	0.	0.	0.	0.
BR83 + D	0.	0.	3.63E-07	0.	0.	0.	0.
BR84	0.	0.	3.82E-07	0.	0.	0.	0.
BR85	0.	0.	1.94E-08	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	0.	0.
KR85M	0.	0.	0.	0.	0.	0.	0.
KR85	0.	0.	0.	0.	0.	0.	0.
KR87	0.	0.	0.	0.	0.	0.	0.
KR88 + D	0.	0.	0.	0.	0.	0.	0.
KR89	0.	0.	0.	0.	0.	0.	0.
RB86	0.	1.70E-04	8.40E-05	0.	0.	0.	4.35E-06
RB87	0.	8.88E-05	3.52E-05	0.	0.	0.	5.98E-07
RB88	0.	4.98E-07	2.73E-07	0.	0.	0.	4.85E-07
RB89 + D	0.	2.86E-07	1.97E-07	0.	0.	0.	9.74E-08
SR89 + D	2.51E-03	0.	7.20E-05	0.	0.	0.	5.16E-05
SR90 + D	1.85E-02	0.	4.71E-03	0.	0.	0.	2.31E-04
SR91 + D	5.00E-05	0.	1.81E-06	0.	0.	0.	5.92E-05
SR92 + D	1.92E-05	0.	7.13E-07	0.	0.	0.	2.07E-04

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TABLE 2.1

INFANT INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	8.69E-08	0.	2.33E-09	0.	0.	0.	1.20E-04
Y91M+D	8.10E-10	0.	2.76E-11	0.	0.	0.	2.70E-06
Y91	1.13E-06	0.	3.01E-08	0.	0.	0.	8.10E-05
Y92	7.65E-09	0.	2.15E-10	0.	0.	0.	1.46E-04
Y93	2.43E-08	0.	6.62E-10	0.	0.	0.	1.92E-04
ZR93+D	1.93E-07	9.18E-08	5.54E-08	0.	2.71E-07	0.	2.39E-05
ZR95+D	2.06E-07	5.02E-08	3.56E-08	0.	5.41E-08	0.	2.50E-05
ZR97+D	1.48E-08	2.54E-09	1.16E-09	0.	2.56E-09	0.	1.62E-04
NB93M	1.23E-07	3.33E-08	1.04E-08	0.	3.25E-08	0.	3.98E-06
NB95	4.20E-08	1.73E-08	1.00E-08	0.	1.24E-08	0.	1.46E-05
NB97	4.59E-10	9.79E-11	3.53E-11	0.	7.65E-11	0.	3.09E-05
MO93	0.	5.65E-05	1.82E-06	0.	1.13E-05	0.	1.21E-06
MO99+D	0.	3.40E-05	6.63E-06	0.	5.08E-05	0.	1.12E-05
TC99M	1.92E-09	3.96E-09	5.10E-08	0.	4.26E-08	2.07E-09	1.15E-06
TC99	1.08E-06	1.46E-06	4.55E-07	0.	1.23E-05	1.42E-07	6.31E-06
TC101	2.27E-09	2.86E-09	2.83E-08	0.	3.40E-08	1.56E-09	4.86E-07
RU103+D	1.48E-06	0.	4.95E-07	0.	3.08E-06	0.	1.80E-05
RU105+D	1.36E-07	0.	4.58E-08	0.	1.00E-06	0.	5.41E-05
RU106+D	2.41E-05	0.	3.01E-06	0.	2.85E-05	0.	1.83E-04
RH105	1.09E-06	7.13E-07	4.79E-07	0.	1.98E-06	0.	1.77E-05
PD107	0.	1.19E-06	8.45E-08	0.	6.79E-06	0.	9.46E-07
PD109	0.	1.50E-06	3.62E-07	0.	5.51E-06	0.	3.68E-05
AG110M+D	9.96E-07	7.27E-07	4.81E-07	0.	1.04E-06	0.	3.77E-05
AG111	5.20E-07	2.02E-07	1.07E-07	0.	4.22E-07	0.	4.82E-05
CD113M	0.	1.77E-05	6.52E-07	0.	1.34E-05	0.	2.66E-05
CD115M	0.	1.42E-05	4.93E-07	0.	7.41E-06	0.	8.09E-05
SN123	2.49E-04	3.89E-06	6.50E-06	3.91E-06	0.	0.	6.58E-05
SN125+D	7.41E-05	1.38E-06	3.29E-06	1.36E-06	0.	0.	1.11E-04
SN126+D	5.53E-04	7.26E-06	1.80E-05	1.91E-06	0.	0.	2.52E-05
SB124	2.14E-05	3.15E-07	6.63E-06	5.68E-08	0.	1.34E-05	6.60E-05
SB125+D	1.23E-05	1.19E-07	2.53E-06	1.54E-08	0.	7.72E-06	1.64E-05
SB126	8.06E-06	1.58E-07	2.91E-06	6.19E-08	0.	5.07E-06	8.35E-05
SB127	2.23E-06	3.98E-08	6.90E-07	2.84E-08	0.	1.15E-06	5.91E-05
TE125M	2.33E-05	7.79E-06	3.15E-06	7.84E-06	0.	0.	1.11E-05
TE127M+D	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	0.	2.36E-05
TE127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	0.	2.10E-05
TE129M+D	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	0.	5.97E-05
TE129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	0.	2.27E-05
TE131M+D	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	0.	1.03E-04
TE131+D	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	0.	7.11E-06
TE132+D	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	0.	3.81E-05
TE133M+D	3.91E-07	1.79E-07	1.71E-07	3.45E-07	1.22E-06	0.	1.93E-05
TE134+D	2.67E-07	1.34E-07	1.38E-07	2.39E-07	9.03E-07	0.	3.06E-06
I129	2.86E-05	2.12E-05	1.55E-05	1.36E-02	2.51E-05	0.	4.24E-07
I130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	0.	2.83E-06
I131+D	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	0.	1.51E-06

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	0.	2.73E-06
I133+D	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	0.	3.08E-06
I134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	0.	1.84E-06
I135+D	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	0.	2.62E-06
XE131M	0.	0.	0.	0.	0.	0.	0.
XE133M	0.	0.	0.	0.	0.	0.	0.
XE133	0.	0.	0.	0.	0.	0.	0.
XE135M	0.	0.	0.	0.	0.	0.	0.
XE135	0.	0.	0.	0.	0.	0.	0.
XE137	0.	0.	0.	0.	0.	0.	0.
XE138+D	0.	0.	0.	0.	0.	0.	0.
CS134M+D	1.76E-07	2.93E-07	1.48E-07	0.	1.13E-07	2.60E-08	2.32E-07
CS134	3.77E-04	7.03E-04	7.10E-05	0.	1.81E-04	7.42E-05	1.91E-06
CS135	1.33E-04	1.21E-04	6.30E-06	0.	3.44E-05	1.31E-05	4.37E-07
CS136	4.59E-05	1.35E-04	5.04E-05	0.	5.38E-05	1.10E-05	2.05E-06
CS137+D	5.22E-04	6.11E-04	4.33E-05	0.	1.64E-04	6.64E-05	1.91E-06
CS138	4.81E-07	7.82E-07	3.79E-07	0.	3.90E-07	6.09E-08	1.25E-06
CS139+D	3.10E-07	4.24E-07	1.62E-07	0.	2.19E-07	3.30E-08	2.66E-08
BA139	8.81E-07	5.84E-10	2.55E-08	0.	3.51E-10	3.54E-10	5.58E-05
BA140+D	1.71E-04	1.71E-07	8.81E-06	0.	4.06E-08	1.05E-07	4.20E-05
BA141+D	4.25E-07	2.91E-10	1.34E-08	0.	1.75E-10	1.77E-10	5.19E-06
BA142+D	1.84E-07	1.53E-10	9.06E-09	0.	8.81E-11	9.26E-11	7.59E-07
LA140	2.11E-08	8.32E-09	2.14E-09	0.	0.	0.	9.77E-05
LA141	2.89E-09	8.38E-10	1.46E-10	0.	0.	0.	9.61E-05
LA142	1.10E-09	4.04E-10	9.67E-11	0.	0.	0.	6.86E-05
CE141	7.87E-08	4.80E-08	5.65E-09	0.	1.48E-08	0.	2.48E-05
CE143+D	1.48E-08	9.82E-06	1.12E-09	0.	2.86E-09	0.	5.73E-05
CE144+D	2.98E-06	1.22E-06	1.67E-07	0.	4.93E-07	0.	1.71E-04
PR143	8.18E-08	3.04E-08	4.03E-09	0.	1.13E-08	0.	4.29E-05
PR144	2.74E-10	1.06E-10	1.38E-11	0.	3.84E-11	0.	4.93E-06
ND147+D	5.53E-08	5.68E-08	3.48E-09	0.	2.19E-08	0.	3.60E-05
PM147	3.88E-07	3.27E-08	1.59E-08	0.	4.88E-08	0.	9.27E-06
PM148M+D	1.65E-07	4.18E-08	3.28E-08	0.	4.80E-08	0.	5.44E-05
PM148	6.32E-08	9.13E-09	4.60E-09	0.	1.09E-08	0.	9.74E-05
PM149	1.38E-08	1.81E-09	7.90E-10	0.	2.20E-09	0.	4.86E-05
PM151	6.18E-09	9.01E-10	4.56E-10	0.	1.07E-09	0.	4.17E-05
SM151	2.90E-07	6.67E-08	1.44E-08	0.	4.53E-08	0.	5.58E-06
SM153	7.72E-09	5.97E-09	4.58E-10	0.	1.25E-09	0.	3.12E-05
EU152	6.74E-07	1.79E-07	1.51E-07	0.	5.02E-07	0.	1.59E-05
EU154	2.64E-06	3.67E-07	2.20E-07	0.	9.95E-07	0.	4.58E-05
EU155	5.42E-07	6.25E-08	3.23E-08	0.	1.40E-07	0.	8.37E-05
EU156	1.14E-07	7.06E-08	1.12E-08	0.	3.26E-08	0.	6.67E-05
TB160	2.59E-07	0.	3.24E-08	0.	7.37E-08	0.	3.45E-05
HO166M	1.25E-06	2.69E-07	2.13E-07	0.	3.57E-07	0.	0.
W181	8.85E-08	2.72E-08	3.04E-09	0.	0.	0.	3.82E-07
W185	3.62E-06	1.13E-06	1.29E-07	0.	0.	0.	1.62E-05
W187	9.03E-07	6.28E-07	2.17E-07	0.	0.	0.	3.69E-05

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210 + D	5.28E-02	1.42E-02	2.38E-03	0.	4.33E-02	0.	5.62E-05
BI210 + D	4.16E-06	2.68E-05	3.58E-07	0.	2.08E-04	0.	5.27E-05
PO210	3.10E-03	5.93E-03	7.41E-04	0.	1.26E-02	0.	6.61E-05
RN222 + D	0.	0.	0.	0.	0.	0.	0.
RA223 + D	4.41E-02	6.42E-05	8.82E-03	0.	1.17E-03	0.	3.43E-04
RA224 + D	1.46E-02	3.29E-05	2.91E-03	0.	6.00E-04	0.	3.86E-04
RA225 + D	5.78E-02	6.42E-05	1.15E-02	0.	1.19E-03	0.	3.24E-04
RA226 + D	6.20E-01	4.76E-05	5.14E-01	0.	8.71E-04	0.	3.44E-04
RA228 + D	4.32E-01	2.58E-05	4.86E-01	0.	4.73E-04	0.	5.86E-05
AC225	3.92E-05	5.03E-05	2.63E-06	0.	3.69E-06	0.	4.36E-04
AC227 + D	4.49E-03	7.67E-04	2.79E-04	0.	1.56E-04	0.	8.50E-05
TH227 + D	1.20E-04	2.01E-06	3.45E-06	0.	7.41E-06	0.	5.70E-04
TH228 + D	2.47E-03	3.38E-05	8.36E-05	0.	1.58E-04	0.	5.84E-04
TH229	1.48E-02	1.94E-04	7.29E-04	0.	9.29E-04	0.	5.31E-04
TH230	3.80E-03	1.90E-04	1.06E-04	0.	9.12E-04	0.	6.24E-05
TH232 + D	4.24E-03	1.63E-04	1.65E-04	0.	7.79E-04	0.	5.31E-05
TH234	6.92E-07	3.77E-08	2.00E-08	0.	1.39E-07	0.	1.19E-04
PA231 + D	7.57E-03	2.50E-04	3.02E-04	0.	1.34E-03	0.	7.44E-05
PA233	3.11E-08	6.09E-09	5.43E-09	0.	1.67E-08	0.	1.46E-05
U232 + D	2.42E-02	0.	2.16E-03	0.	2.37E-03	0.	7.04E-05
U233 + D	5.08E-03	0.	3.87E-04	0.	1.08E-03	0.	6.51E-05
U234	4.88E-03	0.	3.80E-04	0.	1.06E-03	0.	6.37E-05
U235 + D	4.67E-03	0.	3.56E-04	0.	9.93E-04	0.	8.10E-05
U236	4.67E-03	0.	3.64E-04	0.	1.01E-03	0.	5.98E-05
U237	4.95E-07	0.	1.32E-07	0.	1.23E-06	0.	2.11E-05
U238 + D	4.47E-03	0.	3.33E-04	0.	9.28E-04	0.	5.71E-05
NP237 + D	2.53E-03	1.93E-04	1.05E-04	0.	6.34E-04	0.	8.23E-05
NP238	1.24E-07	3.12E-09	1.92E-09	0.	6.81E-09	0.	4.17E-05
NP239	1.11E-08	9.93E-10	5.61E-10	0.	1.98E-09	0.	2.87E-05
PU238	1.34E-03	1.69E-04	3.40E-05	0.	1.21E-04	0.	7.57E-05
PU239	1.45E-03	1.77E-04	3.54E-05	0.	1.28E-04	0.	6.91E-05
PU240	1.45E-03	1.77E-04	3.54E-05	0.	1.28E-04	0.	7.04E-05
PU241 + D	4.38E-05	1.90E-06	8.82E-07	0.	3.17E-06	0.	1.45E-06
PU242	1.35E-03	1.70E-04	3.41E-05	0.	1.23E-04	0.	6.77E-05
PU244	1.57E-03	1.95E-04	3.91E-05	0.	1.41E-04	0.	1.01E-04
AM241	1.53E-03	7.18E-04	1.09E-04	0.	6.55E-04	0.	7.70E-05
AM242M	1.58E-03	7.02E-04	1.13E-04	0.	6.64E-04	0.	9.69E-05
AM243	1.51E-03	6.88E-04	1.06E-04	0.	6.36E-04	0.	9.03E-05
CM242	1.37E-04	1.24E-04	9.10E-06	0.	2.62E-05	0.	8.23E-05
CM243	1.45E-03	6.88E-04	8.98E-05	0.	3.27E-04	0.	8.10E-05
CM244	1.22E-03	6.16E-04	7.59E-05	0.	2.71E-04	0.	7.84E-05
CM245	1.88E-03	7.49E-04	1.13E-04	0.	4.32E-04	0.	7.30E-05
CM246	1.87E-03	7.49E-04	1.13E-04	0.	4.31E-04	0.	7.17E-05
CM247 + D	1.82E-03	7.36E-04	1.11E-04	0.	4.24E-04	0.	9.43E-05
CM248	1.51E-02	6.07E-03	9.16E-04	0.	3.50E-03	0.	1.52E-03
CF252	1.24E-03	0.	2.95E-05	0	0.	0.	2.99E-04

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
BE10	1.35E-05	1.57E-06	3.39E-07	0.	1.11E-06	0.	2.75E-05
C14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
N13	3.10E-08	3.10E-08	3.10E-08	3.10E-08	3.10E-08	3.10E-08	3.10E-08
F18	2.49E-06	0.	2.47E-07	0.	0.	0.	6.74E-07
NA22	5.88E-05	5.88E-05	5.88E-05	5.88E-05	5.88E-05	5.88E-05	5.88E-05
NA24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P32	8.25E-04	3.86E-05	3.18E-05	0.	0.	0.	2.28E-05
AR39	0.	0.	0.	0.	0.	0.	0.
AR41	0.	0.	0.	0.	0.	0.	0.
CA41	3.47E-04	0.	3.79E-05	0.	0.	0.	1.90E-07
SC46	1.97E-08	2.70E-08	1.04E-08	0.	2.30E-08	0.	3.95E-05
CR51	0.	0.	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
MN54	0.	1.07E-05	2.85E-06	0.	3.00E-06	0.	8.98E-06
MN56	0.	3.34E-07	7.54E-08	0.	4.04E-07	0.	4.84E-05
FE55	1.15E-05	6.10E-06	1.89E-06	0.	0.	3.45E-06	1.13E-06
FE59	1.65E-05	2.67E-05	1.33E-05	0.	0.	7.74E-06	2.78E-05
CO57	0.	4.93E-07	9.98E-07	0.	0.	0.	4.04E-06
CO58	0.	1.80E-06	5.51E-06	0.	0.	0.	1.05E-05
CO60	0.	5.29E-06	1.56E-05	0.	0.	0.	2.93E-05
NI59	4.02E-05	1.07E-05	6.82E-06	0.	0.	0.	7.10E-07
NI63	5.38E-04	2.88E-05	1.83E-05	0.	0.	0.	1.94E-06
NI65	2.22E-06	2.09E-07	1.22E-07	0.	0.	0.	2.56E-05
CU64	0.	2.45E-07	1.48E-07	0.	5.92E-07	0.	1.15E-05
ZN65	1.37E-05	3.65E-05	2.27E-05	0.	2.30E-05	0.	6.41E-06
ZN69M + D	7.10E-07	1.21E-06	1.43E-07	0.	7.03E-07	0.	3.94E-05
ZN69	4.38E-08	6.33E-08	5.85E-09	0.	3.84E-08	0.	3.99E-06
SE79	0.	8.43E-06	1.87E-06	0.	1.37E-05	0.	5.53E-07
BR82	0.	0.	7.55E-06	0.	0.	0.	0.
BR83 + D	0.	0.	1.71E-07	0.	0.	0.	0.
BR84	0.	0.	1.98E-07	0.	0.	0.	0.
BR85	0.	0.	9.12E-09	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	0.	0.
KR85M	0.	0.	0.	0.	0.	0.	0.
KR85	0.	0.	0.	0.	0.	0.	0.
KR87	0.	0.	0.	0.	0.	0.	0.
KR88 + D	0.	0.	0.	0.	0.	0.	0.
KR89	0.	0.	0.	0.	0.	0.	0.
RB86	0.	6.70E-05	4.12E-05	0.	0.	0.	4.31E-06
RB87	0.	3.95E-05	1.83E-05	0.	0.	0.	5.92E-07
RB88	0.	1.90E-07	1.32E-07	0.	0.	0.	9.32E-09
RB89 + D	0.	1.17E-07	1.04E-07	0.	0.	0.	1.02E-09
SR89 + D	1.32E-03	0.	3.77E-05	0.	0.	0.	5.11E-05
SR90 + D	1.70E-02	0.	4.31E-03	0.	0.	0.	2.29E-04
SR91 + D	2.40E-05	0.	9.06E-07	0.	0.	0.	5.30E-05
SR92 + D	9.03E-06	0.	3.62E-07	0.	0.	0.	1.71E-04

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	4.11E-08	0.	1.10E-09	0.	0.	0.	1.17E-04
Y91M+D	3.82E-10	0.	1.39E-11	0.	0.	0.	7.48E-07
Y91	6.02E-07	0.	1.61E-08	0.	0.	0.	8.02E-05
Y92	3.60E-09	0.	1.03E-10	0.	0.	0.	1.04E-04
Y93	1.14E-08	0.	3.13E-10	0.	0.	0.	1.70E-04
ZR93+D	1.67E-07	6.25E-08	4.45E-08	0.	2.42E-07	0.	2.37E-05
ZR95+D	1.16E-07	2.55E-08	2.27E-08	0.	3.65E-08	0.	2.66E-05
ZR97+D	6.99E-09	1.01E-09	5.96E-10	0.	1.45E-09	0.	1.53E-04
NB93M	1.05E-07	2.62E-08	8.61E-09	0.	2.83E-08	0.	3.95E-06
NB95	2.25E-08	8.76E-09	6.26E-09	0.	8.23E-09	0.	1.62E-05
NB97	2.17E-10	3.92E-11	1.83E-11	0.	4.35E-11	0.	1.21E-05
MO93	0.	2.41E-05	8.65E-07	0.	6.35E-06	0.	1.22E-06
MO99+D	0.	1.33E-05	3.29E-06	0.	2.84E-05	0.	1.10E-05
TC99M	9.23E-10	1.81E-09	3.00E-08	0.	2.63E-08	9.19E-10	1.03E-06
TC99	5.35E-07	5.96E-07	2.14E-07	0.	7.02E-06	5.27E-08	6.25E-06
TC101	1.07E-09	1.12E-09	1.42E-08	0.	1.91E-08	5.92E-10	3.56E-09
RU103+D	7.31E-07	0.	2.81E-07	0.	1.84E-06	0.	1.89E-05
RU105+D	6.45E-08	0.	2.34E-08	0.	5.67E-07	0.	4.21E-05
RU106+D	1.17E-05	0.	1.46E-06	0.	1.58E-05	0.	1.82E-04
RH105	5.14E-07	2.76E-07	2.36E-07	0.	1.10E-06	0.	1.71E-05
PD107	0.	4.72E-07	4.01E-08	0.	3.95E-06	0.	9.37E-07
PD109	0.	5.67E-07	1.70E-07	0.	3.04E-06	0.	3.35E-05
AG110M+D	5.39E-07	3.64E-07	2.91E-07	0.	6.78E-07	0.	4.33E-05
AG111	2.48E-07	7.76E-08	5.12E-08	0.	2.34E-07	0.	4.75E-05
CD113M	0.	1.02E-05	4.34E-07	0.	1.05E-05	0.	2.63E-05
CD115M	0.	5.89E-06	2.51E-07	0.	4.38E-06	0.	8.01E-05
SN123	1.33E-04	1.65E-06	3.24E-06	1.75E-06	0.	0.	6.52E-05
SN125+D	3.55E-05	5.35E-07	1.59E-06	5.55E-07	0.	0.	1.10E-04
SN126+D	3.33E-04	4.15E-06	9.46E-06	1.14E-06	0.	0.	2.50E-05
SB124	1.11E-05	1.44E-07	3.89E-06	2.45E-08	0.	6.16E-06	6.94E-05
SB125+D	7.16E-06	5.52E-08	1.50E-06	6.63E-09	0.	3.99E-06	1.71E-05
SB126	4.40E-06	6.73E-08	1.58E-06	2.58E-08	0.	2.10E-06	8.87E-05
SB127	1.06E-06	1.64E-08	3.68E-07	1.18E-08	0.	4.60E-07	5.97E-05
TE125M	1.14E-05	3.09E-06	1.52E-06	3.20E-06	0.	0.	1.10E-05
TE127M+D	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	0.	2.34E-05
TE127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	0.	1.84E-05
TE129M+D	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	0.	5.94E-05
TE129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	0.	8.34E-06
TE131M+D	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	0.	1.01E-04
TE131+D	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	0.	4.36E-07
TE132+D	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	0.	4.50E-05
TE133M+D	1.87E-07	7.56E-08	9.37E-08	1.45E-07	7.18E-07	0.	5.77E-06
TE134+D	1.29E-07	5.80E-08	7.74E-08	1.02E-07	5.37E-07	0.	5.89E-07
I129	1.39E-05	8.53E-06	7.62E-06	5.58E-03	1.44E-05	0.	4.29E-07
I130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	0.	2.76E-06
I131+D	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	0.	1.54E-06

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	0.	1.73E-06
I133+D	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	0.	2.95E-06
I134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	0.	5.16E-07
I135+D	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	0.	2.40E-06
XE131M	0.	0.	0.	0.	0.	0.	0.
XE133M	0.	0.	0.	0.	0.	0.	0.
XE133	0.	0.	0.	0.	0.	0.	0.
XE135M	0.	0.	0.	0.	0.	0.	0.
XE135	0.	0.	0.	0.	0.	0.	0.
XE137	0.	0.	0.	0.	0.	0.	0.
XE138+D	0.	0.	0.	0.	0.	0.	0.
CS134M+D	8.44E-08	1.25E-07	8.16E-08	0.	6.59E-08	1.09E-08	1.58E-07
CS134	2.34E-04	3.84E-04	8.10E-05	0.	1.19E-04	4.27E-05	2.07E-06
CS135	8.30E-05	5.78E-05	5.93E-06	0.	2.04E-05	6.81E-06	4.33E-07
CS136	2.35E-05	6.46E-05	4.18E-05	0.	3.44E-05	5.13E-06	2.27E-06
CS137+D	3.27E-04	3.13E-04	4.62E-05	0.	1.02E-04	3.67E-05	1.96E-06
CS138	2.28E-07	3.17E-07	2.01E-07	0.	2.23E-07	2.40E-08	1.46E-07
CS139+D	1.45E-07	1.61E-07	7.74E-08	0.	1.21E-07	1.22E-08	1.45E-11
BA139	4.14E-07	2.21E-10	1.20E-08	0.	1.93E-10	1.30E-10	2.39E-05
BA140+D	8.31E-05	7.28E-08	4.85E-06	0.	2.37E-08	4.34E-08	4.21E-05
BA141+D	2.00E-07	1.12E-10	6.51E-09	0.	9.69E-11	6.58E-10	1.14E-07
BA142+D	8.74E-08	6.29E-11	4.88E-09	0.	5.09E-11	3.70E-11	1.14E-09
LA140	1.01E-08	3.53E-09	1.19E-09	0.	0.	0.	9.84E-05
LA141	1.35E-09	3.17E-10	6.88E-11	0.	0.	0.	7.05E-05
LA142	5.24E-10	1.67E-10	5.23E-11	0.	0.	0.	3.31E-05
CE141	3.97E-08	1.98E-08	2.94E-09	0.	8.68E-09	0.	2.47E-05
CE143+D	6.99E-09	3.79E-06	5.49E-10	0.	1.59E-09	0.	5.55E-05
CE144+D	2.08E-06	6.52E-07	1.11E-07	0.	3.61E-07	0.	1.70E-04
PR143	3.93E-08	1.18E-08	1.95E-09	0.	6.39E-09	0.	4.24E-05
PR144	1.29E-10	3.99E-11	6.49E-12	0.	2.11E-11	0.	8.59E-08
ND147+D	2.79E-08	2.26E-08	1.75E-09	0.	1.24E-08	0.	3.58E-05
PM147	3.18E-07	2.27E-08	1.22E-08	0.	4.01E-08	0.	9.19E-06
PM148M+D	1.03E-07	2.05E-08	2.05E-08	0.	3.04E-08	0.	5.78E-05
PM148	3.02E-08	3.63E-09	2.35E-09	0.	6.17E-09	0.	9.70E-05
PM149	6.49E-09	6.90E-10	3.74E-10	0.	1.22E-09	0.	4.71E-05
PM151	2.92E-09	3.55E-10	2.31E-10	0.	6.02E-10	0.	4.03E-05
SM151	2.56E-07	3.81E-08	1.20E-08	0.	3.94E-08	0.	5.53E-06
SM153	3.65E-09	2.27E-09	2.19E-10	0.	6.91E-10	0.	3.02E-05
EU152	6.15E-07	1.12E-07	1.33E-07	0.	4.73E-07	0.	1.84E-05
EU154	2.30E-06	2.07E-07	1.89E-07	0.	9.09E-07	0.	4.81E-05
EU155	4.82E-07	3.47E-08	2.72E-08	0.	1.30E-07	0.	8.69E-05
EU156	5.62E-08	3.01E-08	6.23E-09	0.	1.94E-08	0.	6.83E-05
TB160	1.66E-07	0.	2.06E-08	0.	4.94E-08	0.	3.68E-05
HO166M	1.08E-06	2.26E-07	1.91E-07	0.	3.22E-07	0.	0.
W181	4.23E-06	1.04E-08	1.43E-09	0.	0.	0.	3.79E-07
W185	1.73E-06	4.32E-07	6.05E-08	0.	0.	0.	1.61E-05
W187	4.29E-07	2.54E-07	1.14E-07	0.	0.	0.	3.57E-05

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210 + D	4.75E-02	1.22E-02	2.09E-03	0.	3.67E-02	0.	5.57E-05
BI210 + D	1.97E-06	1.02E-05	1.69E-07	0.	1.15E-04	0.	5.17E-05
PO210	1.52E-03	2.43E-03	3.67E-04	0.	7.56E-03	0.	6.55E-05
RN222 + D	0.	0.	0.	0.	0.	0.	0.
RA223 + D	2.12E-02	2.45E-05	4.24E-03	0.	6.50E-04	0.	3.38E-04
RA224 + D	6.89E-03	1.25E-05	1.38E-03	0.	3.31E-04	0.	3.78E-04
RA225 + D	2.80E-02	2.50E-05	5.59E-03	0.	6.62E-04	0.	3.21E-04
RA226 + D	5.75E-01	1.84E-05	4.72E-01	0.	4.88E-04	0.	3.41E-04
RA228 + D	3.85E-01	9.99E-06	4.32E-01	0.	2.65E-04	0.	5.81E-05
AC225	1.88E-05	1.94E-05	1.26E-06	0.	2.07E-06	0.	4.31E-04
AC227 + D	4.12E-03	6.63E-04	2.55E-04	0.	1.46E-04	0.	8.43E-05
TH227 + D	5.85E-05	7.96E-07	1.69E-06	0.	4.22E-06	0.	5.63E-04
TH228 + D	2.07E-03	2.65E-05	7.00E-05	0.	1.38E-04	0.	5.79E-04
TH229	1.38E-02	1.81E-04	6.80E-04	0.	8.84E-04	0.	5.27E-04
TH230	3.55E-03	1.78E-04	9.91E-05	0.	8.67E-04	0.	6.19E-05
TH232 + D	3.96E-03	1.52E-04	3.01E-04	0.	7.41E-04	0.	5.27E-05
TH234	3.42E-07	1.51E-08	9.88E-09	0.	8.01E-08	0.	1.18E-04
PA231 + D	7.07E-03	2.34E-04	2.81E-04	0.	1.28E-03	0.	7.37E-05
PA233	1.81E-08	2.82E-09	3.16E-09	0.	1.04E-08	0.	1.44E-05
U232 + D	1.76E-02	0.	1.26E-03	0.	1.34E-03	0.	6.98E-05
U233 + D	3.72E-03	0.	2.25E-04	0.	6.10E-04	0.	6.45E-05
U234	3.57E-03	0.	2.21E-04	0.	5.98E-04	0.	6.32E-05
U235 + D	3.42E-03	0.	2.07E-04	0.	5.61E-04	0.	8.03E-05
U236	3.42E-03	0.	2.12E-04	0.	5.73E-04	0.	5.92E-05
U237	2.36E-07	0.	6.27E-08	0.	6.81E-07	0.	2.08E-05
U238 + D	3.27E-03	0.	1.94E-04	0.	5.24E-04	0.	5.66E-05
NP237 + D	2.36E-03	1.81E-04	9.79E-05	0.	6.05E-04	0.	8.16E-05
NP238	5.83E-08	1.18E-09	9.08E-10	0.	3.76E-09	0.	4.04E-05
NP239	5.25E-09	3.77E-10	2.65E-10	0.	1.09E-09	0.	2.79E-05
PU238	1.25E-03	1.56E-04	3.16E-05	0.	1.15E-04	0.	7.50E-05
PU239	1.36E-03	1.65E-04	3.31E-05	0.	1.22E-04	0.	6.85E-05
PU240	1.36E-03	1.65E-04	3.31E-05	0.	1.22E-04	0.	6.98E-05
PU241 + D	4.00E-05	1.72E-06	8.04E-07	0.	2.96E-06	0.	1.44E-06
PU242	1.26E-03	1.59E-04	3.19E-05	0.	1.17E-04	0.	6.71E-05
PU244	1.47E-03	1.82E-04	3.65E-05	0.	1.35E-04	0.	1.00E-04
AM241	1.43E-03	6.40E-04	1.02E-04	0.	6.23E-04	0.	7.64E-05
AM242M	1.47E-03	6.25E-04	1.04E-04	0.	6.30E-04	0.	9.61E-05
AM243	1.41E-03	6.14E-04	9.83E-05	0.	6.06E-04	0.	8.95E-05
CM242	8.80E-05	6.73E-05	5.84E-06	0.	1.87E-05	0.	8.16E-05
CM243	1.33E-03	6.03E-04	8.24E-05	0.	3.08E-04	0.	8.03E-05
CM244	1.11E-03	5.36E-04	6.93E-05	0.	2.54E-04	0.	7.77E-05
CM245	1.76E-03	6.64E-04	1.05E-04	0.	4.11E-04	0.	7.24E-05
CM246	1.74E-03	6.64E-04	1.05E-04	0.	4.10E-04	0.	7.11E-05
CM247 + D	1.70E-03	6.53E-04	1.03E-04	0.	4.04E-04	0.	9.35E-05
CM248	1.41E-02	5.38E-03	8.52E-04	0.	3.33E-03	0.	1.51E-03
CF252	1.07E-03	0.	2.54E-05	0.	0.	0.	2.96E-04

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07
BE10	4.48E-06	6.94E-07	1.13E-07	0.	5.30E-07	0.	2.84E-05
C14	4.06E-06	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07	8.12E-07
N13	1.15E-08	1.15E-08	1.15E-08	1.15E-08	1.15E-08	1.15E-08	1.15E-08
F18	8.64E-07	0.	9.47E-08	0.	0.	0.	7.78E-08
NA22	2.34E-05	2.34E-05	2.34E-05	2.34E-05	2.34E-05	2.34E-05	2.34E-05
NA24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P32	2.76E-04	1.71E-05	1.07E-05	0.	0.	0.	2.32E-05
AR39	0.	0.	0.	0.	0.	0.	0.
AR41	0.	0.	0.	0.	0.	0.	0.
CA41	1.97E-04	0.	2.13E-05	0.	0.	0.	1.95E-07
SC46	7.24E-09	1.41E-08	4.18E-09	0.	1.35E-08	0.	4.80E-05
CR51	0.	0.	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
MN54	0.	5.90E-06	1.17E-06	0.	1.76E-06	0.	1.21E-05
MN56	0.	1.58E-07	2.81E-08	0.	2.00E-07	0.	1.04E-05
FE55	3.78E-06	2.68E-06	6.25E-07	0.	0.	1.70E-06	1.16E-06
FE59	5.87E-06	1.37E-05	5.29E-06	0.	0.	4.32E-06	3.24E-05
CO57	0.	2.38E-07	3.99E-07	0.	0.	0.	4.44E-06
CO58	0.	9.72E-07	2.24E-06	0.	0.	0.	1.34E-05
CO60	0	2.81E-06	6.33E-06	0.	0.	0.	3.66E-05
NI59	1.32E-05	4.66E-06	2.24E-06	0.	0.	0.	7.31E-07
NI63	1.77E-04	1.25E-05	6.00E-06	0.	0.	0.	1.99E-06
NI65	7.49E-07	9.57E-08	4.36E-08	0.	0.	0.	5.193E-06
CU64	0.	1.15E-07	5.41E-08	0.	2.91E-07	0.	8.92E-06
ZN65	5.76E-06	2.00E-05	9.33E-06	0.	1.28E-05	0.	8.47E-06
ZN69M + D	2.40E-07	5.66E-07	5.19E-08	0.	3.44E-07	0.	3.11E-05
ZN69	1.47E-08	2.80E-08	1.96E-09	0.	1.83E-08	0.	5.16E-08
SE79	0.	3.73E-06	6.27E-07	0.	6.50E-06	0.	5.70E-07
BR82	0.	0.	3.04E-06	0.	0.	0.	0.
BR83 + D	0.	0.	5.74E-08	0.	0.	0.	0.
BR84	0.	0.	7.22E-08	0.	0.	0.	0.
BR85	0.	0.	3.05E-09	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	0.	0.
KR85M	0.	0.	0.	0.	0.	0.	0.
KR85	0.	0.	0.	0.	0.	0.	0.
KR87	0.	0.	0.	0.	0.	0.	0.
KR88 + D	0.	0.	0.	0.	0.	0.	0.
KR89	0.	0.	0.	0.	0.	0.	0.
RB86	0.	2.98E-05	1.40E-05	0.	0.	0.	4.41E-06
RB87	0.	1.75E-05	6.11E-06	0.	0.	0.	6.11E-07
RB88	0.	8.52E-08	4.54E-08	0.	0.	0.	7.30E-15
RB89 + D	0.	5.50E-08	3.89E-08	0.	0.	0.	8.43E-17
SR89 + D	4.40E-04	0.	1.26E-05	0.	0.	0.	5.24E-05
SR90 + D	8.30E-03	0.	2.05E-03	0.	0.	0.	2.33E-04
SR91 + D	8.07E-06	0.	3.21E-07	0.	0.	0.	3.66E-05
SR92 + D	3.05E-06	0.	1.30E-07	0.	0.	0.	7.77E-05

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	1.37E-08	0.	3.69E-10	0.	0.	0.	1.13E-04
Y91M + D	1.29E-10	0.	4.93E-12	0.	0.	0.	6.09E-09
Y91	2.01E-07	0.	5.39E-09	0.	0.	0.	8.24E-05
Y92	1.21E-09	0.	3.50E-11	0.	0.	0.	3.32E-05
Y93	3.83E-09	0.	1.05E-10	0.	0.	0.	1.17E-04
ZR93 + D	5.53E-08	2.73E-08	1.49E-08	0.	9.65E-08	0.	2.58E-05
ZR95 + D	4.12E-08	1.30E-08	8.94E-09	0.	1.91E-08	0.	3.00E-05
ZR97 + D	2.37E-09	4.69E-10	2.16E-10	0.	7.11E-10	0.	1.27E-04
NB93M	3.44E-08	1.13E-08	2.83E-09	0.	1.32E-08	0.	4.07E-06
NB95	8.22E-09	4.56E-09	2.51E-09	0.	4.42E-09	0.	1.95E-05
NB97	7.37E-11	1.83E-11	6.68E-12	0.	2.14E-11	0.	4.37E-07
MO93	0.	1.06E-05	2.90E-07	0.	3.04E-06	0.	1.29E-06
MO99 + D	0.	6.03E-06	1.15E-06	0.	1.38E-05	0.	1.08E-05
TC99M	3.32E-10	9.26E-10	1.20E-08	0.	1.38E-08	5.14E-10	6.08E-07
TC99	1.79E-07	2.63E-07	7.17E-08	0.	3.34E-06	2.72E-08	6.44E-06
TC101	3.60E-10	5.12E-10	5.03E-09	0.	9.26E-09	3.12E-10	8.75E-17
RU103 + D	2.55E-07	0.	1.09E-07	0.	8.99E-07	0.	2.13E-05
RU105 + D	2.18E-08	0.	8.46E-09	0.	2.75E-07	0.	1.76E-05
RU106 + D	3.92E-06	0.	4.94E-07	0.	7.56E-06	0.	1.88E-04
RH105	1.73E-07	1.25E-07	8.20E-08	0.	5.31E-07	0.	1.59E-05
PD107	0.	2.08E-07	1.34E-08	0.	1.88E-06	0.	9.66E-07
PD109	0.	2.51E-07	5.70E-08	0.	1.45E-06	0.	2.53E-05
AG110M + D	2.05E-07	1.94E-07	1.18E-07	0.	3.70E-07	0.	5.45E-05
AG111	8.29E-08	3.44E-08	1.73E-08	0.	1.12E-07	0.	4.80E-05
CD113M	0.	4.51E-06	1.45E-07	0.	4.99E-06	0.	2.71E-05
CD115M	0.	2.60E-06	8.39E-08	0.	2.08E-06	0.	8.23E-05
SN123	4.44E-05	7.29E-07	1.08E-06	5.84E-07	0.	0.	6.71E-05
SN125 + D	1.19E-05	2.37E-07	5.37E-07	1.86E-07	0.	0.	1.12E-04
SN126 + D	1.16E-04	2.16E-06	3.30E-06	5.69E-07	0.	0.	2.58E-05
SB124	3.87E-06	7.13E-08	1.51E-06	8.78E-09	0.	3.38E-06	7.80E-05
SB125 + D	2.48E-06	2.71E-08	5.80E-07	2.37E-09	0.	2.18E-06	1.93E-05
SB126	1.59E-06	3.25E-08	5.71E-07	8.99E-09	0.	1.14E-06	9.41E-05
SB127	3.63E-07	7.76E-09	1.37E-07	4.08E-09	0.	2.47E-07	6.16E-05
TE125M	3.83E-06	1.38E-06	5.12E-07	1.07E-06	0.	0.	1.13E-05
TE127M + D	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	0.	2.41E-05
TE127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	0.	1.22E-05
TE129M + D	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	0.	6.12E-05
TE129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	0.	2.45E-07
TE131M + D	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	0.	9.39E-05
TE131 + D	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	0.	2.29E-09
TE132 + D	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	0.	7.00E-05
TE133M + D	6.44E-08	3.66E-08	3.56E-08	5.11E-08	3.62E-07	0.	1.48E-07
TE134 + D	4.47E-08	2.87E-08	3.00E-08	3.67E-08	2.74E-07	0.	1.66E-09
I129	4.66E-06	3.92E-06	6.54E-06	4.77E-03	7.01E-06	0.	4.57E-07
I130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	0.	2.29E-06
I131 + D	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	0.	1.62E-06

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	0.	3.18E-07
I133+D	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	0.	2.58E-06
I134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	0.	5.10E-09
I135+D	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	0.	1.74E-06
XE131M	0.	0.	0.	0.	0.	0.	0.
XE133M	0.	0.	0.	0.	0.	0.	0.
XE133	0.	0.	0.	0.	0.	0.	0.
XE135M	0.	0.	0.	0.	0.	0.	0.
XE135	0.	0.	0.	0.	0.	0.	0.
XE137	0.	0.	0.	0.	0.	0.	0.
XE138+D	0.	0.	0.	0.	0.	0.	0.
CS134M+D	2.94E-08	6.09E-08	3.13E-08	0.	3.39E-08	5.95E-09	4.05E-08
CS134	8.37E-05	1.97E-04	9.14E-05	0.	6.26E-05	2.39E-05	2.45E-06
CS135	2.78E-05	2.55E-05	5.96E-06	0.	9.73E-06	3.52E-06	4.46E-07
CS136	8.59E-06	3.38E-05	2.27E-05	0.	1.84E-05	2.90E-06	2.72E-06
CS137+D	1.12E-04	1.49E-04	5.19E-05	0.	5.07E-05	1.97E-05	2.12E-06
CS138	7.76E-08	1.49E-07	7.45E-08	0.	1.10E-07	1.28E-08	6.76E-11
CS139+D	4.87E-08	7.17E-08	2.63E-08	0.	5.79E-08	6.34E-09	3.33E-23
BA139	1.39E-07	9.78E-11	4.05E-09	0.	9.22E-11	6.74E-11	1.24E-06
BA140+D	2.84E-05	3.48E-08	1.83E-06	0.	1.18E-08	2.34E-08	4.38E-05
BA141+D	6.71E-08	5.01E-11	2.24E-09	0.	4.65E-11	3.43E-11	1.43E-13
BA142+D	2.99E-08	2.99E-11	1.84E-09	0.	2.53E-11	1.99E-11	9.18E-20
LA140	3.48E-09	1.71E-09	4.55E-10	0.	0.	0.	9.82E-05
LA141	4.55E-10	1.40E-10	2.31E-11	0.	0.	0.	2.48E-05
LA142	1.79E-10	7.95E-11	1.98E-11	0.	0.	0.	2.42E-06
CE141	1.33E-08	8.88E-09	1.02E-09	0.	4.18E-09	0.	2.54E-05
CE143+D	2.35E-09	1.71E-06	1.91E-10	0.	7.67E-10	0.	5.14E-05
CE144+D	6.96E-07	2.88E-07	3.74E-08	0.	1.72E-07	0.	1.75E-04
PR143	1.31E-08	5.23E-09	6.52E-10	0.	3.04E-09	0.	4.31E-05
PR144	4.30E-11	1.76E-11	2.18E-12	0.	1.01E-11	0.	4.74E-14
ND147+D	9.38E-09	1.02E-08	6.11E-10	0.	5.99E-09	0.	3.68E-05
PM147	1.05E-07	9.96E-09	4.06E-09	0.	1.90E-08	0.	9.47E-06
PM148M+D	4.14E-08	1.05E-08	8.21E-09	0.	1.59E-08	0.	6.61E-05
PM148	1.02E-08	1.66E-09	8.36E-10	0.	3.00E-09	0.	9.90E-05
PM149	2.17E-09	3.05E-10	1.25E-10	0.	5.81E-10	0.	4.49E-05
PM151	9.87E-10	1.63E-10	8.25E-11	0.	2.93E-10	0.	3.66E-05
SM151	8.73E-08	1.68E-08	3.94E-09	0.	1.84E-08	0.	5.70E-06
SM153	1.22E-09	1.01E-09	7.43E-11	0.	3.30E-10	0.	2.85E-05
EU152	2.45E-07	5.90E-08	5.20E-08	0.	2.74E-07	0.	2.17E-05
EU154	7.91E-07	1.02E-07	7.19E-08	0.	4.56E-07	0.	5.39E-05
EU155	1.74E-07	1.68E-08	1.04E-08	0.	6.57E-08	0.	9.63E-05
EU156	1.92E-08	1.44E-08	2.35E-09	0.	9.69E-09	0.	7.36E-05
TB160	6.47E-08	0.	8.07E-09	0.	2.56E-08	0.	4.19E-05
HO166M	3.57E-07	1.10E-07	7.96E-08	0.	1.61E-07	0.	0.
W181	1.42E-08	4.58E-09	4.79E-10	0.	0.	0.	3.90E-07
W185	5.79E-07	1.91E-07	2.02E-08	0.	0.	0.	1.65E-05
W187	1.46E-07	1.19E-07	4.17E-08	0.	0.	0.	3.22E-05

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210 +D	1.81E-02	5.44E-03	7.01E-04	0.	1.72E-02	0.	5.74E-05
BI210 +D	6.59E-07	4.51E-06	5.66E-08	0.	5.48E-05	0.	5.15E-05
PO210	6.09E-04	1.07E-03	1.23E-04	0.	3.60E-03	0.	6.75E-05
RN222 +D	0.	0.	0.	0.	0.	0.	0.
RA223 +D	7.11E-03	1.08E-05	1.42E-03	0.	3.10E-04	0.	3.43E-04
RA224 +D	2.31E-03	5.52E-06	4.61E-04	0.	1.58E-04	0.	3.71E-04
RA225 +D	9.37E-03	1.10E-05	1.87E-03	0.	3.15E-04	0.	3.27E-04
RA226 +D	3.22E-01	8.13E-06	2.39E-01	0.	2.32E-04	0.	3.51E-04
RA228 +D	1.37E-01	4.41E-06	1.51E-01	0.	1.26E-04	0.	5.98E-05
AC225	6.29E-06	8.59E-06	4.22E-07	0.	9.85E-07	0.	4.36E-04
AC227 +D	2.05E-03	3.03E-04	1.22E-04	0.	8.81E-05	0.	8.68E-05
TH227 +D	1.96E-05	3.52E-07	5.65E-07	0.	2.01E-06	0.	5.75E-04
TH228 +D	6.80E-04	1.14E-05	2.30E-05	0.	6.41E-05	0.	5.97E-04
TH229	8.39E-03	1.26E-04	4.11E-04	0.	6.10E-04	0.	5.43E-04
TH230	2.16E-03	1.23E-04	6.00E-05	0.	5.99E-04	0.	6.38E-05
TH232 +D	2.42E-03	1.05E-04	1.63E-04	0.	5.11E-04	0.	5.43E-05
TH234	1.14E-07	6.68E-09	3.31E-09	0.	3.81E-08	0.	1.21E-04
PA231 +D	4.31E-03	1.62E-04	1.68E-04	0.	9.10E-04	0.	7.60E-05
PA233	7.33E-09	1.41E-09	1.26E-09	0.	5.32E-09	0.	1.61E-05
U232 +D	5.89E-03	0.	4.21E-04	0.	6.38E-04	0.	7.19E-05
U233 +D	1.24E-03	0.	7.54E-05	0.	2.90E-04	0.	6.65E-05
U234	1.19E-03	0.	7.39E-05	0.	2.85E-04	0.	6.51E-05
U235 +D	1.14E-03	0.	6.94E-05	0.	2.67E-04	0.	8.28E-05
U236	1.14E-03	0.	7.09E-05	0.	2.73E-04	0.	6.11E-05
U237	7.89E-08	0.	2.10E-08	0.	3.24E-07	0.	2.09E-05
U238 +D	1.09E-03	0.	6.49E-05	0.	2.50E-04	0.	5.83E-05
NP237 +D	1.44E-03	1.25E-04	5.85E-05	0.	4.33E-04	0.	8.41E-05
NP238	1.95E-08	5.22E-10	3.04E-10	0.	1.79E-09	0.	3.83E-05
NP239	1.76E-09	1.66E-10	9.22E-11	0.	5.21E-10	0.	2.67E-05
PU238	7.21E-04	1.02E-04	1.82E-05	0.	7.80E-05	0.	7.73E-05
PU239	8.27E-04	1.12E-04	2.01E-05	0.	8.57E-05	0.	7.06E-05
PU240	8.26E-04	1.12E-04	2.01E-05	0.	8.56E-05	0.	7.19E-05
PU241 +D	1.84E-05	9.42E-07	3.69E-07	0.	1.71E-06	0.	1.48E-06
PU242	7.66E-04	1.08E-04	1.94E-05	0.	8.25E-05	0.	6.92E-05
PU244	8.95E-04	1.23E-04	2.22E-05	0.	9.45E-05	0.	1.03E-04
AM241	8.62E-04	3.29E-04	5.75E-05	0.	4.31E-04	0.	7.87E-05
AM242M	8.70E-04	3.19E-04	5.80E-05	0.	4.30E-04	0.	9.90E-05
AM243	8.60E-04	3.17E-04	5.62E-05	0.	4.22E-04	0.	9.23E-05
CM242	2.94E-05	2.97E-05	1.95E-06	0.	8.89E-06	0.	8.40E-05
CM243	6.91E-04	2.86E-04	4.09E-05	0.	1.91E-04	0.	8.28E-05
CM244	5.32E-04	2.49E-04	3.19E-05	0.	1.49E-04	0.	8.00E-05
CM245	1.07E-03	3.33E-04	6.10E-05	0.	2.85E-04	0.	7.46E-05
CM246	1.06E-03	3.32E-04	6.09E-05	0.	2.84E-04	0.	7.33E-05
CM247 +D	1.03E-03	3.27E-04	6.00E-05	0.	2.80E-04	0.	9.63E-05
CM248	8.60E-03	2.69E-03	4.95E-04	0.	2.31E-03	0.	1.55E-03
CR252	3.51E-04	0.	8.37E-06	0.	0.	0.	3.05E-04

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
H3	0.	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07
BE10	3.18E-06	4.91E-07	7.94E-08	0.	3.71E-07	0.	2.68E-05
C14	2.84E-06	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07	5.68E-07
N13	8.36E-09	8.36E-09	8.36E-09	8.36E-09	8.36E-09	8.36E-09	8.36E-09
F18	6.24E-07	0.	6.92E-08	0.	0.	0.	1.85E-08
NA22	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05
NA24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P32	1.93E-04	1.20E-05	7.46E-06	0.	0.	0.	2.17E-05
AR39	0.	0.	0.	0.	0.	0.	0.
AR41	0.	0.	0.	0.	0.	0.	0.
CA41	1.83E-05	0.	2.00E-05	0.	0.	0.	1.84E-07
SC46	5.51E-09	1.07E-08	3.11E-09	0.	9.99E-09	0.	5.21E-05
CR51	0.	0.	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
MN54	0.	4.57E-06	8.72E-07	0.	1.36E-06	0.	1.40E-05
MN56	0.	1.15E-07	2.04E-08	0.	1.46E-07	0.	3.67E-06
FE55	2.75E-06	1.90E-06	4.43E-07	0.	0.	1.06E-06	1.09E-06
FE59	4.34E-06	1.02E-05	3.91E-06	0.	0.	2.85E-06	3.40E-05
CO57	0.	1.75E-07	2.91E-07	0.	0.	0.	4.44E-06
CO58	0.	7.45E-07	1.67E-06	0.	0.	0.	1.81E-05
CO60	0.	2.14E-06	4.72E-06	0.	0.	0.	4.02E-05
NI59	9.76E-06	3.35E-06	1.63E-06	0.	0.	0.	6.90E-07
NI63	1.30E-04	9.01E-06	4.36E-06	0.	0.	0.	1.88E-06
NI65	5.28E-07	6.86E-08	3.13E-08	0.	0.	0.	1.74E-06
CU64	0.	8.33E-08	3.91E-08	0.	2.10E-07	0.	7.10E-06
ZN65	4.84E-06	1.54E-05	6.96E-06	0.	1.03E-05	0.	9.70E-06
ZN69M + D	1.70E-07	4.08E-07	3.73E-08	0.	2.47E-07	0.	2.49E-05
ZN69	1.03E-08	1.97E-08	1.37E-09	0.	1.28E-08	0.	2.96E-09
SE79	0.	2.63E-06	4.39E-07	0.	4.55E-06	0.	5.38E-07
BR82	0.	0.	2.26E-06	0.	0.	0.	2.59E-06
BR83 + D	0.	0.	4.02E-08	0.	0.	0.	5.79E-08
BR84	0.	0.	5.21E-08	0.	0.	0.	4.09E-13
BR85	0.	0.	2.14E-09	0.	0.	0.	0.
KR83M	0.	0.	0.	0.	0.	0.	0.
KR85M	0.	0.	0.	0.	0.	0.	0.
KR85	0.	0.	0.	0.	0.	0.	0.
KR87	0.	0.	0.	0.	0.	0.	0.
KR88 + D	0.	0.	0.	0.	0.	0.	0.
KR89	0.	0.	0.	0.	0.	0.	0.
RB86	0.	2.11E-05	9.83E-06	0.	0.	0.	4.16E-06
RB87	0.	1.23E-05	4.28E-06	0.	0.	0.	5.76E-07
RB88	0.	6.05E-08	3.21E-08	0.	0.	0.	8.36E-19
RB89 + D	0.	4.01E-08	2.82E-08	0.	0.	0.	2.33E-21
SR89 + D	3.08E-04	0.	8.84E-06	0.	0.	0.	4.94E-05
SR90 + D	7.58E-03	0.	1.86E-03	0.	0.	0.	2.19E-04
SR91 + D	5.67E-06	0.	2.29E-07	0.	0.	0.	2.70E-05
SR92 + D	2.15E-06	0.	9.30E-08	0.	0.	0.	4.26E-05

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y90	9.62E-09	0.	2.58E-10	0.	0.	0.	1.02E-04
Y91M+D	9.09E-11	0.	3.52E-12	0.	0.	0.	2.67E-10
Y91	1.41E-07	0.	3.77E-09	0.	0.	0.	7.76E-05
Y92	8.45E-10	0.	2.47E-11	0.	0.	0.	1.48E-05
Y93	2.68E-09	0.	7.40E-11	0.	0.	0.	8.50E-05
ZR93+D	4.18E-08	2.34E-09	1.09E-09	0.	8.87E-09	0.	2.43E-06
ZR95+D	3.04E-08	9.75E-09	6.60E-09	0.	1.53E-08	0.	3.09E-05
ZR97+D	1.68E-09	3.39E-10	1.55E-10	0.	5.12E-10	0.	1.05E-04
NB93M	2.55E-08	8.32E-09	2.05E-09	0.	9.57E-09	0.	3.84E-06
NB95	6.22E-09	3.46E-09	1.86E-09	0.	3.42E-09	0.	2.10E-05
NB97	5.22E-11	1.32E-11	4.82E-12	0.	1.54E-11	0.	4.87E-08
MO93	0.	7.51E-06	2.03E-07	0.	2.13E-06	0.	1.22E-06
MO99+D	0.	4.31E-06	8.20E-07	0.	9.76E-06	0.	9.99E-06
TC99M	2.47E-10	6.98E-10	8.89E-09	0.	1.06E-08	3.42E-10	4.13E-07
TC99	1.25E-07	1.86E-07	5.02E-08	0.	2.34E-06	1.58E-08	6.08E-06
TC101	2.54E-10	3.66E-10	3.59E-09	0.	6.59E-09	1.87E-10	1.10E-21
RU103+D	1.85E-07	0.	7.97E-08	0.	7.06E-07	0.	2.16E-05
RU105+D	1.54E-08	0.	6.08E-09	0.	1.99E-07	0.	9.42E-06
RU106+D	2.75E-06	0.	3.48E-07	0.	5.31E-06	0.	1.78E-04
RH105	1.21E-07	8.85E-08	5.83E-08	0.	3.76E-07	0.	1.41E-05
PD107	0.	1.47E-07	9.40E-09	0.	1.32E-06	0.	9.11E-07
PD109	0.	1.77E-07	3.99E-08	0.	1.01E-06	0.	1.96E-05
AG110M+D	1.60E-07	1.48E-07	8.79E-08	0.	2.91E-07	0.	6.04E-05
AG111	5.81E-08	2.43E-08	1.21E-08	0.	7.84E-08	0.	4.46E-05
CD113M	0.	3.18E-06	1.02E-07	0.	3.50E-06	0.	2.56E-05
CD115M	0.	1.84E-06	5.87E-08	0.	1.46E-06	0.	7.74E-05
SN123	3.11E-05	5.15E-07	7.59E-07	4.38E-07	0.	0.	6.33E-05
SN125+D	8.33E-06	1.68E-07	3.78E-07	1.39E-07	0.	0.	1.04E-04
SN126+D	8.45E-05	1.67E-06	2.40E-06	4.92E-07	0.	0.	2.43E-05
SB124	2.80E-06	5.29E-08	1.11E-06	6.79E-09	0.	2.18E-06	7.95E-05
SB125+D	1.79E-06	2.00E-08	4.26E-07	1.82E-09	0.	1.38E-06	1.97E-05
SB126	1.15E-06	2.34E-08	4.15E-07	7.04E-09	0.	7.05E-07	9.40E-05
SB127	2.58E-07	5.65E-09	9.90E-08	3.10E-09	0.	1.53E-07	5.90E-05
TE125M	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	0.	1.07E-05
TE125M+D	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	0.	2.27E-05
TE127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	0.	8.68E-06
TE129M+D	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	0.	5.79E-05
TE129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	0.	2.37E-08
TE131M+D	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	0.	8.40E-05
TE131+D	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	0.	2.79E-09
TE132+D	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	0.	7.71E-05
TE133M+D	4.62E-08	2.70E-08	2.60E-08	3.91E-08	2.67E-07	0.	6.64E-08
TE134+D	3.24E-08	2.12E-08	1.30E-08	2.83E-08	2.05E-07	0.	3.59E-11
I129	3.27E-06	2.81E-06	9.21E-06	7.23E-03	6.04E-06	0.	4.44E-07
I130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	0.	1.92E-06
I131+D	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	0.	1.57E-06

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
I132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	0.	1.02E-07
I133 + D	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	0.	2.22E-06
I134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	0.	2.51E-10
I135 + D	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	0.	1.31E-06
XE131M	0.	0.	0.	0.	0.	0.	0.
XE133M	0.	0.	0.	0.	0.	0.	0.
XE133	0.	0.	0.	0.	0.	0.	0.
XE135M	0.	0.	0.	0.	0.	0.	0.
XE135	0.	0.	0.	0.	0.	0.	0.
XE137	0.	0.	0.	0.	0.	0.	0.
XE138 + D	0.	0.	0.	0.	0.	0.	0.
CS134M + D	2.13E-08	4.48E-08	2.29E-08	0.	2.43E-08	3.83E-09	1.58E-08
CS134	6.22E-05	1.48E-04	1.21E-04	0.	4.79E-05	1.59E-05	2.59E-06
CS135	1.95E-05	1.80E-05	7.99E-06	0.	6.81E-06	2.04E-06	4.21E-07
CS136	6.51E-06	2.57E-05	1.85E-05	0.	1.43E-05	1.96E-06	2.92E-06
CS137 + D	7.97E-05	1.09E-04	7.14E-05	0.	3.70E-05	1.23E-05	2.11E-06
CS138	6.52E-08	1.09E-07	5.40E-08	0.	8.01E-08	7.91E-09	4.65E-13
CS139 + D	3.41E-08	5.08E-08	1.85E-08	0.	4.07E-08	3.70E-09	1.10E-30
BA139	9.70E-08	6.91E-11	2.84E-09	0.	6.46E-11	3.92E-11	1.72E-07
BA140 + D	2.03E-05	2.55E-08	1.33E-06	0.	8.67E-09	1.46E-08	4.18E-05
BA141 + D	4.71E-08	3.56E-11	1.59E-09	0.	3.31E-11	2.02E-11	2.22E-17
BA142 + D	2.13E-08	2.19E-11	1.34E-09	0.	1.85E-11	1.24E-11	3.00E-26
LA140	2.50E-09	1.26E-09	3.33E-10	0.	0.	0.	9.25E-05
LA141	3.19E-10	9.90E-11	1.62E-11	0.	0.	0.	1.18E-05
LA142	1.28E-10	5.82E-11	1.45E-11	0.	0.	0.	4.25E-07
CE141	9.36E-09	6.33E-09	7.18E-10	0.	2.94E-09	0.	2.42E-05
CE143 + D	1.65E-09	1.22E-06	1.35E-10	0.	5.37E-10	0.	4.56E-05
CE144 + D	4.88E-07	2.04E-07	2.62E-08	0.	1.21E-07	0.	1.65E-04
PR143	9.20E-09	3.69E-09	4.56E-10	0.	2.13E-09	0.	4.03E-05
PR144	3.01E-11	1.25E-11	1.53E-12	0.	7.05E-12	0.	4.33E-18
ND147 + D	6.29E-09	7.27E-09	4.35E-10	0.	4.25E-09	0.	3.49E-05
PM147	7.54E-08	7.09E-09	2.87E-09	0.	1.34E-08	0.	8.93E-06
PM148M + D	3.07E-08	7.95E-09	6.08E-09	0.	1.20E-08	0.	6.74E-05
PM148	7.17E-09	1.19E-09	5.99E-10	0.	2.25E-09	0.	9.35E-05
PM149	1.52E-09	2.15E-10	8.78E-11	0.	4.06E-10	0.	4.03E-05
PM151	6.97E-10	1.17E-10	5.91E-11	0.	2.09E-10	0.	3.22E-05
SM151	6.90E-08	1.19E-08	2.85E-09	0.	1.33E-08	0.	5.25E-06
SM153	8.57E-10	7.15E-10	5.22E-11	0.	2.31E-10	0.	2.55E-05
EU152	1.95E-07	4.44E-08	3.90E-08	0.	2.75E-07	0.	2.56E-05
EU154	6.15E-07	7.56E-08	5.38E-08	0.	3.62E-07	0.	5.48E-05
EU155	8.60E-08	1.22E-08	7.87E-09	0.	5.63E-08	0.	9.60E-06
EU156	1.37E-08	1.06E-08	1.71E-09	0.	7.08E-09	0.	7.26E-05
TB160	4.70E-08	0.	5.86E-09	0.	1.94E-08	0.	4.33E-05
HO166M	2.70E-07	8.43E-08	6.40E-08	0.	1.26E-07	0.	0.
W181	9.91E-09	3.23E-09	3.46E-10	0.	0.	0.	3.68E-07
W185	4.05E-07	1.35E-07	1.42E-08	0.	0.	0.	1.56E-05
W187	1.03E-07	8.61E-08	3.01E-08	0.	0.	0.	2.82E-05

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ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210 +D	1.53E-02	4.37E-03	5.44E-04	0.	1.23E-02	0.	5.42E-05
BI210 +D	4.61E-07	3.18E-06	3.96E-08	0.	3.83E-05	0.	4.75E-05
PO210	3.56E-04	7.56E-04	8.59E-05	0.	2.52E-03	0.	6.36E-05
RN222 +D	0.	0.	0.	0.	0.	0.	0.
RA223 +D	4.97E-03	7.65E-06	9.94E-04	0.	2.17E-04	0.	3.21E-04
RA224 +D	1.61E-03	3.90E-06	3.23E-04	0.	1.10E-04	0.	3.40E-04
RA225 +D	6.56E-03	7.78E-06	1.31E-03	0.	2.21E-04	0.	3.06E-04
RA226 +D	3.02E-01	5.74E-06	2.20E-01	0.	1.63E-04	0.	3.32E-04
RA228 +D	1.12E-01	3.12E-06	1.21E-01	0.	8.83E-05	0.	5.64E-05
AC225	4.40E-06	6.06E-06	2.96E-07	0.	6.90E-07	0.	4.07E-04
AC227 +D	1.87E-03	2.48E-04	1.11E-04	0.	8.00E-05	0.	8.19E-05
TH227 +D	1.37E-05	2.48E-07	3.95E-07	0.	1.41E-06	0.	5.40E-04
TH228 +D	4.96E-04	8.40E-06	1.68E-05	0.	4.67E-05	0.	5.63E-04
TH229	7.98E-03	1.19E-04	3.91E-04	0.	5.75E-04	0.	5.12E-04
TH230	2.06E-03	1.17E-04	5.70E-05	0.	5.65E-04	0.	6.02E-05
TH232 +D	2.30E-03	1.00E-04	1.50E-04	0.	4.82E-04	0.	5.12E-05
TH234	8.01E-08	4.71E-09	2.31E-09	0.	2.67E-08	0.	1.13E-04
PA231 +D	4.10E-03	1.54E-04	1.59E-04	0.	8.64E-04	0.	7.17E-05
PA233	5.26E-09	1.06E-09	9.12E-10	0.	3.99E-09	0.	1.64E-05
U232 +D	4.13E-03	0.	2.95E-04	0.	4.47E-04	0.	6.78E-05
U233 +D	8.71E-04	0.	5.28E-05	0.	2.03E-04	0.	6.27E-05
U234	8.36E-04	0.	5.17E-05	0.	1.99E-04	0.	6.14E-05
U235 +D	8.01E-04	0.	4.86E-05	0.	1.87E-04	0.	7.81E-05
U236	8.01E-04	0.	4.96E-05	0.	1.91E-04	0.	5.76E-05
U237	5.52E-8	0.	1.47E-08	0.	2.27E-07	0.	1.94E-05
U238 +D	7.67E-04	0.	4.54E-05	0.	1.75E-04	0.	5.50E-05
NP237 +D	1.37E-03	1.19E-04	5.54E-05	0.	4.12E-04	0.	7.94E-05
NP238	1.37E-08	3.69E-10	2.13E-10	0.	1.25E-09	0.	3.43E-05
NP239	1.19E-09	1.17E-10	6.45E-11	0.	3.65E-10	0.	2.40E-05
PU238	6.80E-04	9.58E-05	1.71E-05	0.	7.32E-05	0.	7.30E-05
PU239	7.87E-04	1.06E-04	1.91E-05	0.	8.11E-05	0.	6.66E-05
PU240	7.85E-04	1.06E-04	1.91E-05	0.	8.10E-05	0.	6.78E-05
PU241 +D	1.65E-05	8.44E-07	3.32E-07	0.	1.53E-06	0.	1.40E-06
PU242	7.29E-04	1.02E-04	1.84E-05	0.	7.81E-05	0.	6.53E-05
PU244	8.52E-04	1.17E-04	2.11E-05	0.	8.95E-05	0.	9.73E-05
AM241	8.19E-04	2.88E-04	5.41E-05	0.	4.07E-04	0.	7.42E-05
AM242M	8.24E-04	2.78E-04	5.43E-05	0.	4.05E-04	0.	9.34E-05
AM243	8.18E-04	2.78E-04	5.30E-05	0.	3.99E-04	0.	8.70E-05
CM242	2.06E-05	2.10E-05	1.37E-06	0.	6.22E-06	0.	7.92E-05
CM243	6.39E-04	2.41E-04	3.75E-05	0.	1.75E-04	0.	7.81E-05
CM244	4.83E-04	2.07E-04	2.87E-05	0.	1.34E-04	0.	7.55E-05
CM245	1.02E-03	2.87E-04	5.76E-05	0.	2.69E-04	0.	7.04E-05
CM246	1.01E-03	2.87E-04	5.75E-05	0.	2.68E-04	0.	6.91E-05
CM247 +D	9.84E-04	2.83E-04	5.67E-05	0.	2.64E-04	0.	9.09E-05
CM248	8.18E-03	2.33E-03	4.67E-04	0.	2.18E-03	0.	1.47E-03
CF252	2.64E-04	0.	6.29E-06	0.	0.	0.	2.88E-04

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TABLE 2.2

**PALISADES
Liquid Effluent**

Design Objective Annual Quantity

<u>Nuclide</u>	<u>Half-Life</u>	<u>Dose Conversion Factors (mrem/Ci)</u>	<u>Individual/Organ</u>	<u>Design Objective Annual Quantity (Curies)</u>
H-3	12.3 yr	1.75E-06	Adult/TB	1.71E+06
Na-24	15 h	5.44E-03	Teen/TB	551.5
Sc-46	83.9 d	2.02E-02	Teen/TB	148.5
Cr-51	27.8 d	1.56E-03	Adult/GI (LLI)	6,410.0
Mn-54	303 d	3.50E-02	Teen/TB	85.7
Fe-55	2.6 yr	4.48E-03	Child/Bone	2,232.0
Mn-56	2.576 h	1.86E-03	Teen/TB	1,612.0
Co-57	270 d	4.39E-03	Teen/TB	683.4
Co-58	71.3 d	1.03E-02	Teen/TB	291.3
Fe-59	45.6 d	4.08E-02	Adult/GI (LLI)	245.1
Co-60	5.26 yr	4.71E-01	Teen/TB	6.37
Cu-64	12.8 h	1.32E-03	Teen/GI (LLI)	7,575.0
Ni-65	2.56 h	5.82E-04	Teen/TB	5,154.0
Zn-65	245 d	1.83E-01	Teen/TB	16.4
Br-84	31.8 mo	2.02E-03	Teen/TB	1,485.2
Rb-86	1.02 mo	3.06E-01	Child/TB	9.80
Rb-88	17.8 mo	6.92E-04	Teen/TB	4,335.3
Sr-89	52.7 d	1.56E-01	Child/Bone	64.1
Sr-90	27.7 yr	2.71E-00	Adult/Bone	3.69
Sr-91	9.67 h	1.16E-03	Teen/TB	2,586.0
Sr-92	2.71 h	1.51E-03	Teen/TB	1,986.8
Y-92	3.53 h	2.69E-04	Teen/TB	11,150.0
Nb-95	35 d	7.24E+00	Adult/GI (LLI)	1.38
Zr-95	65.5 d	6.17E-03	Teen/TB	486.2
Nb-97	72 mo	6.95E-04	Teen/TB	4,316.6
Zr-97	17 h	9.28E-04	Teen/TB	3,232.8
Mo-99	66.7 h	1.11E-03	Teen/Kidney	9,009.0
Tc-99m	6.05 h	1.42E-04	Teen/TB	21,126.8
Ru-103	39.5 d	2.74E-03	Teen/TB	1,094.9
Ag-110m	255 d	7.75E-02	Teen/TB	38.7

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TABLE 2.2 (continued)

PALISADES
Liquid Effluent

Design Objective Annual Quantity

<u>Nuclide</u>	<u>Half-Life</u>	<u>Dose Conversion Factors (mrem/Ci)</u>	<u>Individual/Organ</u>	<u>Design Objective Annual Quantity (Curies)</u>
Cd-113m	13.6 yr	6.02E-02	Adult/GI (LLI)	166.1
Sb-124	60 d	1.51E-02	Teen/TB	198.7
Sb-125	2.7 yr	5.11E-02	Teen/TB	58.7
Te-127	9.4 h	7.38E-03	Teen/GI (LLI)	1,355.0
Te-127m	109 d	1.39E-01	Teen/Kidney	71.9
Te-129m	34.1 d	2.66E-01	Adult/GI (LLI)	37.6
I-130	12.3 h	1.17E-02	Child/Thyroid	854.7
I-131	8.05 d	3.27E-01	Child/Thyroid	30.6
Te-131m	30 h	2.27E-01	Adult/GI (LLI)	44.0
I-132	2.26 h	3.18E-05	Teen/TB	94,339.0
Te-132	77.7 h	2.93E-01	Adult/GI (LLI)	34.1
I-133	20.3 h	3.94E-02	Child/Thyroid	253.8
Cs-134	2 yr	2.86E+00	Adult/TB	1.04
I-134	52 mo	2.43E-03	Teen/TB	1,234.0
I-135	6.68 h	1.64E-03	Child/Thyroid	6,097.0
Cs-136	13.7 d	4.13E-01	Adult/TB	7.26
Cs-137	30 yr	1.71E+00	Adult/TB	1.75
Cs-138	32.2 mo	2.31E-03	Teen/TB	1,298.0
Ba-139	82.9 mo	4.66E-05	Teen/TB	64,377.0
Ba-140	12.8 d	7.96E-04	Teen/TB	3,768.0
La-140	40.22 h	1.85E-02	Adult/GI (LLI)	540.5
Ce-141	32.5 d	3.70E-04	Teen/TB	8,108.0
Ce-144	284 d	1.56E-03	Teen/TB	1,923.0
Eu-152	12.7 yr	3.24E-01	Teen/TB	9.25
W-187	23.9 h	1.98E-01	Adult/GI (LLI)	50.5
Np-239	2.346 d	2.26E-03	Adult/GI (LLI)	4,424.0

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III. URANIUM FUEL CYCLE DOSE

A. SPECIFICATION

In accordance with Appendix A, Section III.I.1, if either liquid or gaseous quarterly releases exceed the quantity which would cause offsite doses more than twice the limit of Appendix A, Sections III.C.1, III.D.1, or III.H.1, then the cumulative dose contributions from combined release plus direct radiation sources (from the reactor unit and radwaste storage tanks) shall be calculated. The dose is to be determined for the member of the public protected to be the most highly exposed to these combined sources.

B. ASSUMPTIONS

1. The full time resident determined to be maximally exposed individual (excluding infant) is assumed also to be a fisherman. This individual is assumed to drink water and ingest local fish at the rates specified in Sections II.C.2.1 and II.C.2.2.
2. Amount of shore line fishing (at accessible shoreline adjacent to site security fence) is conservatively assumed as 48 hours per quarter (average of approximately 1/2 hour per day each day of the quarter) for the second and third quarters of the year, 36 hours for the fourth quarter and 16 hours for the first quarter.

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C. DOSE CALCULATION

Maximum doses to the total body and internal organs of an individual shall be determined by use of LADTAP and GASPAR computer codes, and doses to like organs and total body summed. Added to this sum will be a mean dose rate, calculated or measured for the shoreline due to Plant present during the quarter in question, times the assumed fishing time.

$$D_{40} = D_G + D_L + (R_T)(T) \quad (2.15)$$

where:

D_{40} = 40 CFR 190 dose (mrem).

D_G = Limiting dose to an individual from gaseous source term (mrem).

D_L = Limiting dose to an individual from liquid source term (mrem).

R_T = Mean dose rate calculated to be applicable to Lake Michigan shoreline adjacent to Plant site (mrem/hr).

T = Assumed shoreline fishing time for the quarter in question (hours).