Entergy

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PNP 2012-032

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10 CFR 50.36a

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

Subject: 2011 Annual Radioactive Effluent Release and Waste Disposal Report

Palisades Nuclear Plant	Big Rock Point
Docket 50-255	Dockets 50-155 and 72-043
License No. DPR-20	License No. DPR-6

Dear Sir or Madam:

Attached are the Entergy Nuclear Operations, Inc. 2011 Annual Radioactive Effluent Release and Waste Disposal Reports for Palisades Nuclear Plant (PNP) and Big Rock Point (BRP) Independent Spent Fuel Storage Installation (ISFSI). These reports are submitted in accordance with 10 CFR 50.36a(a)(2).

Attachment 1 contains the report for PNP. Attachment 2 contains the report for the BRP ISFSI.

These reports provide a summary of the quantities of radioactive liquid and gaseous effluent releases and solid radioactive waste processed during the period of January 1, 2011, through December 31, 2011.

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

Sincerely,

OWG/bed

Attachment 1: Palisades Nuclear Plant 2011 Radioactive Effluent Release Report
Attachment 2: Big Rock Point Independent Spent Fuel Storage Installation 2011 Radioactive Effluent Release Report

CC Administrator, Region III, USNRC
Project Manager, Palisades, USNRC
Resident Inspector, Palisades, USNRC
NRC NMSS Project Manager
American Nuclear Insurers (ANI)

ATTACHMENT 1
PALISADES NUCLEAR PLANT
2011 RADIOACTIVE EFFLUENT RELEASE REPORT

2011 Plant Operating History

Palisades Nuclear Plant (PNP) entered the reporting period on line on January 1, 2011, at nominal full power (NFP). PNP reduced power to approximately 54% on January 8, 2011, due to failure of breaker 252-302, that resulted in loss of cooling tower pump P-39A. On January 16, 2011, the plant returned to NFP. PNP tripped on January 22, 2011, due to a ground fault from one of the main generator cables. The unit returned to NFP on January 25, 2011. PNP reduced power to 52% on March 16, 2011, to perform electrical cable testing for startup transformers. The unit returned to NFP on March 18, 2011. PNP began reducing power and subsequently manually tripped the unit on September 16, 2011, due to exceeding 10 gallons per minute unidentified leakage from the primary coolant system. The unit returned to NFP on September 21, 2011. An automatic reactor trip occurred on September 25, 2011, due to a loss of two of the four preferred AC buses. The unit returned to NFP on October 3, 2011. The unit was manually tripped on December 14, 2011, due to main feed pumps tripping on low suction pressure. The unit returned to NFP on December 17, 2011. PNP was on line for the remainder of 2011. The unit generated 6,641,013 MWHrs of net electrical energy during 2011.

A. Gaseous Effluents

Tables A-1, "Gaseous Effluents – Summation of All Discharges," A-1A, "Gaseous Effluents – Ground-Level Release – Batch Mode," and A-1B, "Gaseous Effluents – Ground-Level Release – Continuous Mode," list and summarize gaseous effluents released during this reporting period.

B. Liquid Effluents

Tables A-2, "Liquid Effluents – Summation of All Discharges," A-2A, "Liquid Effluents – Batch Mode," and A-2B, "Liquid Effluents – Continuous Mode," list and summarize liquid effluents released during this reporting period.

C. Solid Waste Storage and Shipments

Table A-3, "Low-Level Waste for Waste Classification A, B and C, summarizes solid radioactive waste shipped for processing or burial in 2011 for the following waste streams: resins, filters and evaporator bottoms, dry active waste, irradiated components, other waste, and sum of all waste.

D. Dose Assessments

Tables A-4, "Dose Assessments, 10 CFR Part 50, Appendix I," and A-5, "EPA 40 CFR Part 190, Individual in the Unrestricted Area," lists annual dose to the members of the public.

E. Supplemental Information

1. Abnormal Discharges

In December 2007, tritium was detected in a groundwater monitoring well at a level of 22,000 pCi/L. The source of the activity is leakage associated with T-91, the utility water storage tank, and associated piping. T-91 is used to store processed liquid waste prior to discharge. No radionuclides other than tritium have been detected in the groundwater.

Additional repair of underground piping was performed during the spring of 2011. The overflow line to T-91 was sleeved to ensure piping integrity. This line was assumed to be dry, based on all indication, but contained highly tritiated water of which a small amount was expelled during the sleeving operation. This resulted in an additional release of tritiated water to the groundwater which caused spiking in monitoring well 3. This event is further discussed under section 9 of this report.

Monitoring of the groundwater tritium plume continues in order to determine repair effectiveness and to ensure the accuracy of the site hydrology.

Depth to Local Water Table – The depth is approximately eight to nine feet.

Classification of Subsurface Aquifers – Not used for drinking water.

Expected Movement/Mobility of Groundwater Plume – Westerly direction down-gradient toward Lake Michigan at approximately two feet per day.

Land Use Characteristics – PNP site property, water not used for drinking or irrigation.

NRC Notification, Date and Contact Organization – The NRC was notified on December 10, 2007, by PNP.

2. Non-Routine Planned Discharges

None.

3. Radioactive Waste Treatment System Changes

None.

4. Annual Land Use Census Changes

The garden critical receptor is now located in the southeast sector at 1.47 miles. The residence critical receptor is unchanged. Also unchanged is that there are no beef cattle, dairy cows or goats located within five miles of the plant.

5. Effluent Monitoring System Inoperability

There were no effluent monitors that were out of service for greater than 30 days.

6. Offsite Dose Calculation Manual (ODCM) Changes

The Offsite Dose Calculation Manual was revised during the report period. The Offsite Dose Calculation Manual, Appendix A, was revised twice during the report period. The General Manager Plant Operations approval is documented on the procedure cover page.

These revisions did not reduce the accuracy or reliability of dose calculations or setpoint determinations. Enclosure 1 contains a copy of the ODCM revision, as well as copies of ODCM, Appendix A revisions 16 and 17, with changes indicated by marginal markings.

7. Process Control Program Changes

None.

8. Errata/Corrections to Previous Reports

Attachment 1, Table A-1B, Gaseous Effluents - Ground Level Release, Continuous Mode Revised for 2010 data is supplied here in its entirety and is associated with CR-PLP-2011-05094. The 2010 data for Table A-1, Gaseous Effluents - Sum of all releases remains correct.

Section E. Supplemental Information, 1. Abnormal Discharges to the 2010 report was updated per the guidance of CR-PLP-2011-5094 and is provided here as follows:

In December 2007, tritium was detected in a groundwater monitoring well at a level of 22,000 pCi/L. The source of the activity is leakage associated with T-91, the utility water storage tank, and associated piping. T-91 is used to store processed liquid waste prior to discharge. No radionuclides other than tritium have been detected in the groundwater. ~~Tritium is still being released to the environment (Lake Michigan) via an unmonitored pathway, as demonstrated by the continued detection of monitoring well sample activity~~Piping leaks associated with T-91 have been repaired and monitoring of the groundwater tritium plume continues in order to determine repair effectiveness and to ensure site hydrology accuracy. ~~However, repairs have been made and t~~Tritium concentrations have dropped to approximately 90% of values detected in previous years. A definitive release rate or total activity released cannot be determined.

Section D. Dose Assessments, of the 2010 report was updated per the guidance of CR-PLP-2011-5094 and is provided here as follows:

Tables A-4, "Dose Assessments, 10 CFR Part 50, Appendix I," and A-5, "EPA 40 CFR Part 190, Individual in the Unrestricted Area," lists annual dose to the members of the public. A methodology change was made in determining the radionuclides released through the Main Stack. The Stack radionuclides were linked directly to Primary Coolant System gas sample results instead of being considered all Xe-133. This change led to approximately seven additional radionuclides being considered as released. These additional radionuclides have different dose conversion factors which had a direct impact on the calculated beta and gamma doses. ~~Conservatively, 0.5% of the total tritium activity released via batch releases, or half of the percentage that was used in 2007, 2008, and 2009, was used for 2010 effluent calculations.~~

9. Other

Groundwater Monitoring

PNP installed five groundwater monitoring wells in 2007, and added an additional nine wells in 2008. These wells were strategically placed within the owner controlled area, both inside and outside the protected area to allow detection of radioactive contamination of ground water due to leaks or spills from plant systems. Monitoring well (MW) 3 is most indicative of the leak described in the Abnormal Discharges section. Tritium levels for 2011 in MW3 ranged from less than minimum detectable activity (MDA) to 19,854 pCi/L. Monitoring wells MW2 and MW11 tritium levels ranged from < MDA to 1,888 and 3,850 pCi/L respectively. The remaining wells showed no activity throughout the year. The spike in MW3 was associated with additional work done on T-91 piping during 2011. Well locations are depicted in Figure 1.

Carbon-14

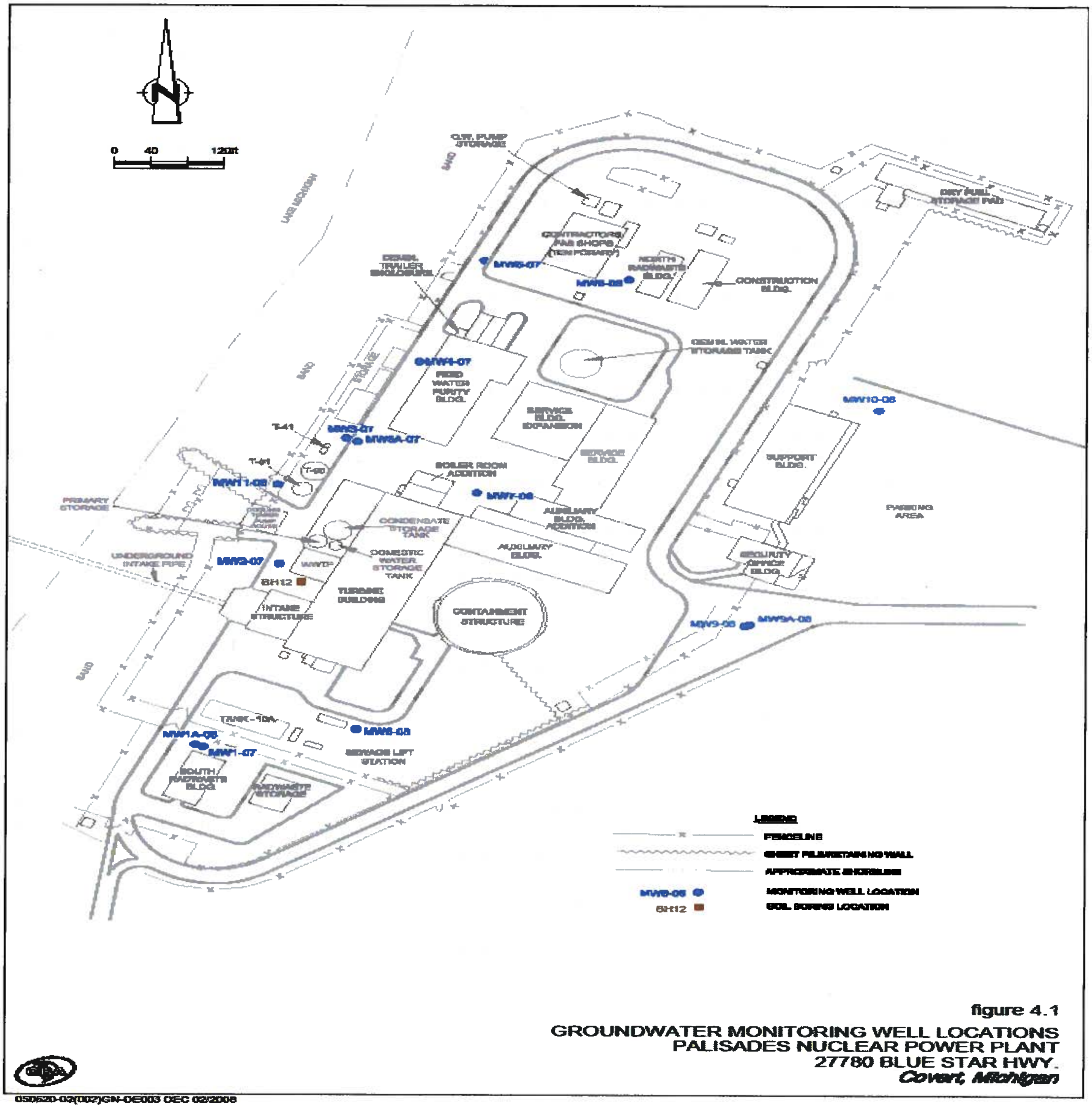
In 2010, PNP and other facilities participated in an EPRI task force to build a model to accurately estimate gaseous C-14 releases, given some key site-specific plant parameters (mass of the primary coolant, average thermal neutron cross section, rated MW, etc). This work was completed in November 2010. The estimates for C-14 were constructed using the aforementioned EPRI methodology contained with EPRI 1021106, Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents. Using the C-14 curie estimates, the annual dose to man was derived from guidance contained within Regulatory Guide 1.109. Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste is not required. (Reg Guide 1.21, Rev 2)

Annual C-14 release PNP and subsequent doses for 2011:

Total Gaseous C-14 Released Curies =	8.13
Gaseous C-14 as CO2 Curies =	2.44
Effective Child TB Dose, C-14 mrem =	0.0219
Effective Child Bone Dose, C-14 mrem =	0.110

The quarterly curies released are provided in Tables A-1A and A-1B. Airborne doses due to C-14 are grouped under the category of Particulate, Iodine, and Tritium, which are contained in Table A-4.

FIGURE 1
GROUNDWATER MONITORING WELL LOCATIONS



ATTACHMENT 1
Palisades - Table A-1
2011 Gaseous Effluents – Sum of All Releases

Summation of All Releases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total	Uncertainty (%)
Fission and Activation Gases	Ci	4.97E-01	9.47E-01	5.30E+00	3.65E+00	1.04E+01	5.17
Average Release Rate	μCi/s	6.40E-02	1.20E-01	6.66E-01	4.60E-01	3.30E-01	
% of Limit	%	7.46E-04	8.57E-04	1.60E-03	6.81E-03	2.52E-03	
Total I-131	Ci	7.47E-05	2.66E-05	6.27E-05	8.29E-05	2.47E-04	5.90
Average Release Rate	μCi/s	9.61E-06	3.38E-06	7.88E-06	1.04E-05	7.83E-06	
% of Limit	%	1.16E-05	4.08E-06	9.50E-06	1.26E-05	9.43E-06	
Particulates	Ci	8.11E-07	1.01E-07	4.91E-05	0.00E+00	5.00E-05	22.7
Average Release Rate	μCi/s	1.04E-07	1.28E-08	6.17E-06	0.00E+00	1.58E-06	
% of Limit	%	1.24E-07	3.80E-08	5.93E-05	0.00E+00	1.50E-05	
Tritium	Ci	5.37E+00	4.84E+00	4.48E+00	3.96E+00	1.87E+01	4.08
Average Release Rate	μCi/s	6.91E-01	6.16E-01	5.64E-01	4.98E-01	5.91E-01	
% of Limit	%	1.66E-03	1.48E-03	1.36E-03	1.20E-03	1.43E-03	
Gross Alpha	Ci	ND	1.89E-06	1.19E-07	1.70E-07	2.18E-06	16.3
C-14	Ci	1.96E+00	2.15E+00	1.92E+00	2.10E+00	8.13E+00	
Average Release Rate	μCi/s	2.52E-01	2.73E-01	2.42E-01	2.64E-01	2.58E-01	
% of Limit	%	2.02E-06	2.20E-06	1.94E-06	2.12E-06	2.07E-06	

ATTACHMENT 1
Palisades - Table A-1A
2011 Gaseous Effluents – Ground Level Release, Batch Mode

Fission and Activation Gases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Ar-41	Ci	ND	ND	ND	ND
Kr-85	Ci	ND	ND	ND	ND
Kr-85m	Ci	ND	ND	ND	ND
Kr-87	Ci	ND	ND	ND	ND
Kr-88	Ci	ND	ND	ND	ND
Xe-131m	Ci	4.29E-04	1.23E-02	3.08E-02	2.79E-03
Xe-133	Ci	1.96E-02	3.11E-01	3.70E+00	2.39E-01
Xe-133m	Ci	ND	ND	3.13E-02	2.95E-03
Xe-135	Ci	ND	ND	1.39E-01	ND
Xe-135m	Ci	ND	ND	ND	ND
Xe-138	Ci	ND	ND	ND	ND
Total	Ci	2.01E-02	3.23E-01	6.85E+00	2.45E-01

Iodines/Halogens	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
I-131	Ci	ND	ND	9.54E-07	1.68E-06
I-132	Ci	ND	ND	ND	ND
I-133	Ci	ND	ND	9.21E-07	ND
I-134	Ci	ND	ND	ND	ND
I-135	Ci	ND	ND	ND	ND
Total	Ci	0.00E+00	0.00E+00	1.88E-06	1.68E-06

Particulates	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Co-58	Ci	ND	ND	2.19E-05	ND
Co-60	Ci	ND	ND	3.39E-06	ND
Cr-51	Ci	ND	ND	1.08E-05	ND
Nb-95	Ci	ND	ND	5.64E-06	ND
Zr-95	Ci	ND	ND	9.34E-06	ND
Cs-137	Ci	ND	ND	ND	ND
Total	Ci	0.00E+00	0.00E+00	4.91E-05	0.000E+00

Tritium	Ci	NA	NA	2.21E-01	NA

Gross Alpha	Ci	NA	NA	NA	NA

C-14	Ci	NA	NA	NA	NA

ND = Measurements performed but no activity detected.
NA = Analysis not required and not performed.

ATTACHMENT 1
Palisades - Table A-1B
2011 Gaseous Effluents – Ground Level Release, Continuous Mode

Fission and Activation Gases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Ar-41	Ci	8.03E-02	3.27E-02	4.66E-02	1.38E+00
Kr-85	Ci	ND	ND	ND	ND
Kr-85m	Ci	3.86E-03	1.03E-02	4.73E-03	2.27E-02
Kr-87	Ci	1.61E-02	3.50E-02	2.18E-02	3.92E-02
Kr-88	Ci	4.59E-02	6.76E-02	1.03E-01	2.81E-01
Xe-131m	Ci	ND	ND	ND	ND
Xe-133	Ci	7.45E-03	1.35E-02	ND	6.28E-02
Xe-133m	Ci	ND	ND	ND	ND
Xe-135	Ci	1.29E-01	1.80E-01	8.08E-01	6.33E-01
Xe-135m	Ci	6.13E-02	8.58E-02	2.35E-01	2.44E-01
Xe-138	Ci	1.33E-01	1.99E-01	1.75E-01	7.42E-01
Total	Ci	4.77E-01	6.24E-01	1.39E+00	3.41E+00

Iodines/Halogens	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
I-131	Ci	7.47E-05	2.66E-05	6.17E-05	8.12E-05
I-132	Ci	ND	ND	ND	ND
I-133	Ci	9.23E-05	5.23E-05	1.76E-04	1.98E-04
I-134	Ci	ND	ND	ND	ND
I-135	Ci	ND	ND	ND	ND
Total	Ci	7.47E-05	7.89E-05	2.38E-04	2.80E-04

Particulates	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Co-58	Ci	1.51E-08	ND	ND	ND
Co-60	Ci	ND	4.90E-08	ND	ND
Sr-89	Ci	ND	ND	ND	ND
Ag-110m	Ci	ND	5.20E-08	ND	ND
Cs-134	Ci	ND	ND	ND	ND
Cs-137	Ci	7.96E-07	ND	ND	ND
Total	Ci	8.11E-07	1.01E-07	0.00E+00	0.00E+00

Tritium	Ci	5.37E+00	4.84E+00	4.26E+00	3.96E+00

Gross Alpha	Ci	ND	1.89E-06	1.19E-07	1.70E-07

C-14	Ci	1.96E+00	2.15E+00	1.92E+00	2.10E+00

ND = Measurements performed but no activity detected.

ATTACHMENT 1

Palisades - Table A-1B

~~2011~~ 2010 Revised Gaseous Effluents – Ground Level Release, Continuous Mode

Fission and Activation Gases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Ar-41	Ci	1.560E-01	2.785E-01	5.591E+00	1.800E+00
Kr-85	Ci	ND	ND	ND	ND
Kr-85m	Ci	6.227E-02	5.112E-02	2.851E-01	1.149E-03
Kr-87	Ci	1.638E-01	1.397E-01	9.585E-01	3.328E-03
Kr-88	Ci	2.030E-01	1.343E-01	1.126E+00	5.918E-01
Xe-131m	Ci	ND	ND	ND	ND
Xe-133	Ci	9.162E-01	5.231E+00	1.497E+00	1.031E+01
Xe-133m	Ci	ND	ND	ND	ND
Xe-135	Ci	7.048E-01	1.816E+00	3.813E+00	3.728E+00
Xe-135m	Ci	2.594E-01	9.343E-01	1.529E+00	2.423E-02
Xe-138	Ci	6.697E-01	4.755E-01	4.066E+00	7.499E-02
Total	Ci	3.135E+00	9.061E+00	1.887E+01	1.653E+01

Iodines/Halogens	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
I-131	Ci	7.439E-05	6.465E-04	6.027E-04	3.872E-03
I-132	Ci	ND	ND	ND	3.975E-03
I-133	Ci	2.007E-04	2.990E-04	2.389E-04	2.300E-04
I-134	Ci	ND	ND	ND	ND
I-135	Ci	ND	ND	ND	ND
Total	Ci	2.751E-04	9.455E-04	8.416E-04	8.077E-03

Particulates	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Co-58	Ci	ND	ND	ND	1.510E-06
Co-60	Ci	ND	ND	8.610E-08	ND
Sr-89	Ci	ND	ND	ND	ND
Sr-90	Ci	ND	ND	ND	ND
Cs-134	Ci	ND	ND	ND	ND
Cs-137	Ci	1.094E-08	ND	ND	ND
Total	Ci	1.094E-08	0.000E+00	8.610E-08	1.510E-06

Tritium	Ci	5.144E+00	4.693E+00	4.873E+00	7.726E+00

Gross Alpha	Ci	5.125E-07	ND	ND	5.511E-07

C-14	Ci	2.117E+00	1.980E+00	2.099E+00	1.495E+00

ND = Measurements performed but no activity detected.

ATTACHMENT 1
Palisades - Table A-2
2011 Liquid Effluents – Sum of All Releases

Summation of All Liquid Releases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total	Uncertainty (%)
Fission and Activation Products (excluding tritium, gases, and gross alpha)	Ci	4.55E-03	1.65E-03	1.56E-03	1.29E-02	2.06E-02	5.93
Average Concentration	μCi/ml	1.17E-10	4.28E-11	4.10E-11	5.73E-10	1.50E-10	
% of Limit	%	1.26E-03	7.09E-04	6.34E-04	4.04E-03	1.39E-03	
Tritium	Ci	6.98E+01	5.47E+01	1.63E+02	3.12E+02	6.00E+02	4.00
Average Concentration	μCi/ml	1.79E-06	1.42E-06	4.30E-06	1.39E-05	4.34E-06	
% of Limit	%	1.79E-01	1.42E-01	4.30E-01	1.39E+00	4.34E-01	
Dissolved and Entrained Gases	Ci	0.00E+00	0.00E+00	0.00E+00	6.08E-04	6.08E-04	11.5
Average Concentration	μCi/ml	0.00E+00	0.00E+00	0.00E+00	2.71E-11	4.41E-12	
% Of Limit	%	0.00E+00	0.00E+00	0.00E+00	1.35E-05	2.20E-06	
Gross Alpha	Ci	7.85E-06	0.00E+00	2.00E-05	1.69E-05	4.48E-05	25.0
Average Concentration	μCi/ml	2.01E-13	0.00E+00	5.27E-13	7.54E-13	3.24E-13	
Volume of Primary System Liquid Effluent (Before Dilution)	Liters	3.49E+05	2.34E+05	8.22E+05	1.07E+06	2.48E+06	
Dilution Water Used for Above	Liters	3.90E+10	3.86E+10	3.79E+10	2.25E+10	1.38E+11	
Volume of Secondary or Balance-of-Plant Liquid Effluent (e.g., low-activity or unprocessed) (Before Dilution)	Liters	7.84E+09	7.93E+09	1.01E+10	8.01E+09	3.39E+10	
Average Stream Flow	m^3/s	5.02E+00	4.91E+00	4.77E+00	2.83E+00	4.38E+00	

Dilution flow rate (gal/qtr) = # of Dilution pumps running x days running/qtr x 4000 gpm/pump x min/day

ATTACHMENT 1
Palisades - Table A-2A
2011 Liquid Effluents – Batch Mode

Fission and Activation Products	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Cr-51	Ci	ND	ND	ND	ND
Mn-54	Ci	ND	ND	ND	2.35E-04
Fe-55	Ci	7.82E-04	1.80E-04	2.86E-04	4.80E-04
Fe-59	Ci	ND	ND	ND	ND
Co-57	Ci	ND	ND	ND	ND
Co-58	Ci	1.67E-03	1.56E-04	9.77E-05	4.19E-03
Co-60	Ci	9.68E-04	5.29E-04	4.11E-04	1.40E-03
Sr-89	Ci	ND	1.24E-05	4.08E-06	2.50E-05
Sr-90	Ci	ND	ND	ND	4.90E-05
Nb-95	Ci	1.31E-04	ND	ND	ND
Ag-110m	Ci	2.45E-04	4.99E-04	3.30E-04	2.09E-04
Sn-113	Ci	ND	ND	ND	ND
Sb-124	Ci	ND	ND	ND	ND
Sb-125	Ci	ND	ND	ND	ND
I-131	Ci	ND	ND	ND	ND
I-133	Ci	ND	ND	ND	ND
I-135	Ci	ND	ND	ND	ND
Cs-134	Ci	ND	ND	ND	ND
Cs-137	Ci	ND	ND	2.43E-05	1.89E-05
Ni-63	Ci	6.25E-04	1.12E-04	3.90E-04	6.27E-03
Zn-65	Ci	ND	ND	ND	ND
Zr-95	Ci	2.49E-04	ND	ND	ND
La-140	Ci	ND	ND	ND	ND
Totals	Ci	4.53E-03	1.49E-03	1.54E-03	1.29E-02

Dissolved and Entrained Gases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Kr-85	Ci	ND	ND	ND	ND
Xe-131m	Ci	ND	ND	ND	ND
Xe-133	Ci	ND	ND	ND	6.08E-04
Xe-133m	Ci	ND	ND	ND	ND
Xe-135	Ci	ND	ND	ND	ND
Totals		0.00E+00	0.00E+00	0.00E+00	6.08E-04

Tritium	Ci	6.98E+01	5.47E+01	1.63E+02	3.12E+02

Gross Alpha	Ci	7.85E-06	ND	2.00E-05	1.69E-05

ND = None Detected

ATTACHMENT 1
Palisades - Table A-2B
2011 Liquid Effluents – Continuous Mode

Fission and Activation Products	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Cr-51	Ci	ND	ND	ND	ND
Mn-54	Ci	ND	ND	ND	ND
Fe-55	Ci	ND	ND	ND	ND
Co-58	Ci	ND	ND	ND	ND
Co-60	Ci	8.78E-07	ND	ND	ND
Sr-89	Ci	ND	ND	ND	ND
Sr-90	Ci	ND	ND	ND	ND
Nb-95	Ci	ND	ND	ND	ND
Ag-110m	Ci	ND	ND	ND	ND
Sn-113	Ci	ND	ND	ND	ND
Sb-124	Ci	ND	ND	ND	ND
Sb-125	Ci	ND	ND	ND	ND
I-131	Ci	ND	ND	ND	ND
I-133	Ci	ND	ND	ND	ND
I-135	Ci	ND	ND	ND	ND
Cs-134	Ci	ND	ND	ND	ND
Cs-137	Ci	2.10E-05	ND	1.20E-05	ND
Ni-63	Ci	ND	1.63E-4	ND	ND
Totals	Ci	2.19E-05	1.63E-4	1.20E-05	0.00E+00

Dissolved and Entrained Gases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Kr-85	Ci	ND	ND	ND	ND
Xe-133	Ci	ND	ND	ND	ND
Xe-133m	Ci	ND	ND	ND	ND
Xe-135	Ci	ND	ND	ND	ND
Xe-135m	Ci	ND	ND	ND	ND
Totals		0.000E+00	0.000E+00	0.000E+00	0.000E+00

Tritium	Ci	2.59E-02	4.07E-02	4.41E-02	8.12E-03

Gross Alpha	Ci	ND	ND	ND	ND

ND = None Detected

ATTACHMENT 1
Palisades - Table A-3
2011 Low Level Waste

Resins, Filters, and Evaporator Bottoms	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	3.41E+02	9.66E+00	8.80E-04
B	1.60E+02	4.53E+00	2.74E+02
C	0.00E+00	0.00E+00	0.00E+00
ALL	5.01E+02	1.42E+01	2.74E+02

Major Nuclides for the Above Table: Mn-54 (2%), Fe-55 (2%), Co-58 (16%), Co-60 (45%), Ni-63 (14%), Ag-110m (2%), Sb-125 (3%), Cs-134 (9%), & Cs-137 (7%)

Dry Active Waste	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	8.95E+03	2.54E+02	7.43E-01
B	1.47E+01	4.16E-01	1.03E+00
C	9.32E+00	2.64E-01	3.20E+00
ALL	8.97E+03	2.55E+02	4.97E+00

Major Nuclides for the Above Table: H-3 (13%), C-14 (2%), Fe-55 (14%), Co-58 (1%), Co-60 (7%), Ni-63 (59%), Sr-90 (1%), Ag-110m (1%), & Cs-137 (2%)

Irradiated Components	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	0.00E+00	0.00E+00	0.00E+00
B	0.00E+00	0.00E+00	0.00E+00
C	0.00E+00	0.00E+00	0.00E+00
ALL	0.00E+00	0.00E+00	0.00E+00

Major Nuclides for the Above Table:

Other Waste: Used oil & soil	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	1.73E+03	4.90E+01	3.23E+00
B	0.00E+00	0.00E+00	0.00E+00
C	0.00E+00	0.00E+00	0.00E+00
ALL	1.73E+03	4.90E+01	3.23E+00

Major Nuclides for the Above Table: H-3 (47%), Fe-55 (7%), Co-58 (11%), Co-60 (7%), Ni-63 (11%), Sr-90 (2%), Nb-95 (1%), Sb-125 (5%), Cs-137 (7%) & Ce-144 (2%)

ATTACHMENT 1
Palisades - Table A-3
2011 Low Level Waste

Sum of All Low-Level Waste Shipped from Site	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	1.10E+04	3.13E+02	3.97E+00
B	1.75E+02	4.95E+00	2.75E+02
C	9.32E+00	2.64E-01	3.20E+00
ALL	1.12E+04	3.18E+02	2.82E+02

Major Nuclides for the Above Table: H-3 (1%), Mn-54 (3%), Fe-55 (2%), Co-58 (16%), Co-60 (44%), Ni-63 (14%), Ag-110m (2%), Sb-125 (3%), Cs-134 (9%), & Cs-137 (6%)

ATTACHMENT 1
Palisades - Table A-4
2011 Dose Assessments, 10 CFR Part 50, Appendix I

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Yearly
Liquid Effluent Dose Limit, Total Body	1.5 mrem	1.5 mrem	1.5 mrem	1.5 mrem	3 mrem
Total Body Dose	4.66E-04	2.74E-04	3.05E-04	1.45E-03	2.50E-03
% Of Limit	0.03%	0.02%	0.02%	0.10%	0.08%
Liquid Effluent Dose Limit, Any Organ	5 mrem	5 mrem	5 mrem	5 mrem	10 mrem
Organ Dose	9.74E-04	2.80E-04	3.53E-04	2.62E-03	4.23E-03
% of Limit	0.02%	0.01%	0.01%	0.05%	0.04%
Gaseous Effluent Dose Limit, Gamma Air	5 mrad	5 mrad	5 mrad	5 mrad	10 mrad
Gamma Air Dose	2.48E-04	3.17E-04	5.87E-04	2.01E-03	3.16E-03
% of Limit	0.00%	0.01%	0.01%	0.04%	0.03%
Gaseous Effluent Dose Limit, Beta Air	10 mrad	10 mrad	10 mrad	10 mrad	20 mrad
Beta Air Dose	1.22E-04	1.90E-04	6.10E-04	8.70E-04	1.79E-03
% of Limit	0.001%	0.002%	0.006%	0.009%	0.009%
Gaseous Effluent Dose Limit, Any Organ (Iodine, Tritium, Particulates with >8 day half-life)	7.5 mrem	7.5 mrem	7.5 mrem	7.5 mrem	15 mrem
Gaseous Effluent Organ Dose (Iodine, Tritium, Particulates with >8-Day half-life)	2.64E-02	2.89E-02	2.60E-02	2.84E-02	1.10E-01
% of Limit	0.35%	0.39%	0.35%	0.38%	0.73%

Palisades - Table A-5
2011 EPA 40 CFR Part 190, Individual in the Unrestricted Area

	Whole Body	Thyroid	Any Other Organ
Dose Limit	25 mrem	75 mrem	25 mrem
Dose	6.29E-02	6.82E-03	4.23E-03
% of Limit	0.25%	0.01%	0.02%

ENCLOSURE 1

PALISADES NUCLEAR PLANT

OFFSITE DOSE CALCULATION MANUAL, REVISION 25
OFFSITE DOSE CALCULATION MANUAL, APPENDIX A, REVISION 16
OFFSITE DOSE CALCULATION MANUAL, APPENDIX A, REVISION 17

202 Pages Follow

ODCM
Revision 25
Issued Date 12/29/11

PALISADES NUCLEAR PLANT
OFFSITE DOSE CALCULATION MANUAL

TITLE: OFFSITE DOSE CALCULATION MANUAL

Process Applicability Exclusion	☐

DWFoster	/	12/28/11
Procedure Sponsor		Date
JJMiller	/	12/15/11
Technical Reviewer		Date
JHager	/	12/15/11
User Reviewer		Date
DHamilton	/	12/19/11
General Manager Plant Operations		Date

Table of Contents

Table of Contents

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 mrems/yr to the total body and less than or equal to 3000 mrems/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 mrems/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

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.

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:

$$R_k = X/Q \times F \times \Sigma_i\ C_i/EC_i \leq 10.0 \qquad (1.1)$$

where:

C_i = Actual or measured concentration, at ambient temperature and pressure of nuclide i (μCi/cc)

EC_i = The EC of nuclide i from 10 CFR 20, Appendix B, Table 2

$R_{(k)}$ = The total EC-fraction for release point k

X/Q = Most conservative sector site boundary dispersion (sec/m^3) (listed in site procedure CH 6.41, Land Use Census)

F = Release flow rate (83,000 cfm = 39.2 m^3/sec) for stack monitor considerations; variable for other monitors

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 (μCi/cc) at the monitor is calculated. The detector response to isotopic activities (cpm/μCi/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):

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

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 μCi/cc (or R/hr and μCi/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. NRCDose is the Effluent Dose Calculation software that supports LADTAP, GASPAR, and XOQDOQ which perform the actual dose calculations using the equations supplied here.

   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.

         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 Attachment 2, plus additional nuclides.

         d) Basic radionuclide data are given in Attachment 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 site procedure CH 6.41, Land Use Census.

         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 site procedure CH 6.41, Land Use Census.

j) A semi-infinite cloud model is used.

k) Radioactive decay is considered for the plume.

l) Building wake effects on effluent dispersion are considered.

m) A sector-average dispersion equation is used.

n) The wind speed classes that are used are as follows:

Wind Speed Class Number	Range (m/s)	Midpoint (m/s)
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	--

o) 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.

p) 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:

$$X_i = \sum_{j=1}^{9} \sum_{k=1}^{7} \left(\frac{2}{\pi}\right)^{1/2} \frac{f_{jk}\ Q_i\ p}{\Sigma_{zk}\, U_j\ (2\pi\, x/n)} \left[\exp^{-}\left(\lambda i \frac{x}{U_j}\right)\right] \tag{1.3}$$

where:

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

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.

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

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:

$$D_{TB} = \sum_i X_i \ DFB_i \qquad (1.4)$$

where:

D_{TB} = Total body dose rate, mrem/y.

X_i = Air concentration of radionuclide I, $\mu Ci/m^3$.

DFB_i = Total body dose factor due to gamma radiation, mrem/y per $\mu Ci/m^3$ (Attachment 3).

For determining the skin dose rate:

$$D_s = \sum_i X_i \left(DFS_i + 1.11\, DFY_i\right) \qquad (1.5)$$

where:

D_s = Skin dose rate, mrem/y.

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

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

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 $\mu Ci/m^3$ (Attachment 3).

For determining dose rate to a point in air:

$$D_a = \sum_i X_i \left(DFY_i \text{ or } DFB_i\right) \qquad (1.6)$$

where:

D_a = Air dose rate, mrad/yr.

DFB_i = Air dose factor for beta radiation (Attachment 3).

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.

c) The radioiodine and particulate mix is based on the historically observed source term given in Attachment 2.

d) Basic radionuclide data are given in Attachment 3.

e) All releases are treated as ground-level.

f) Mean annual average X/Q's are given in site procedure CH 6.41, Land Use Census.

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 (site procedure CH 6.41, Land Use Census) 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.

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.

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:

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

where:

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

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

DFI_i = Inhalation dose factor, mrem/pCi (Attachment 5).

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.

b) Ground Contamination

For determining the ground concentration of any nuclide;

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

where:

G_i	=	Ground concentration of radionuclide i, µCi/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, µCi/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.

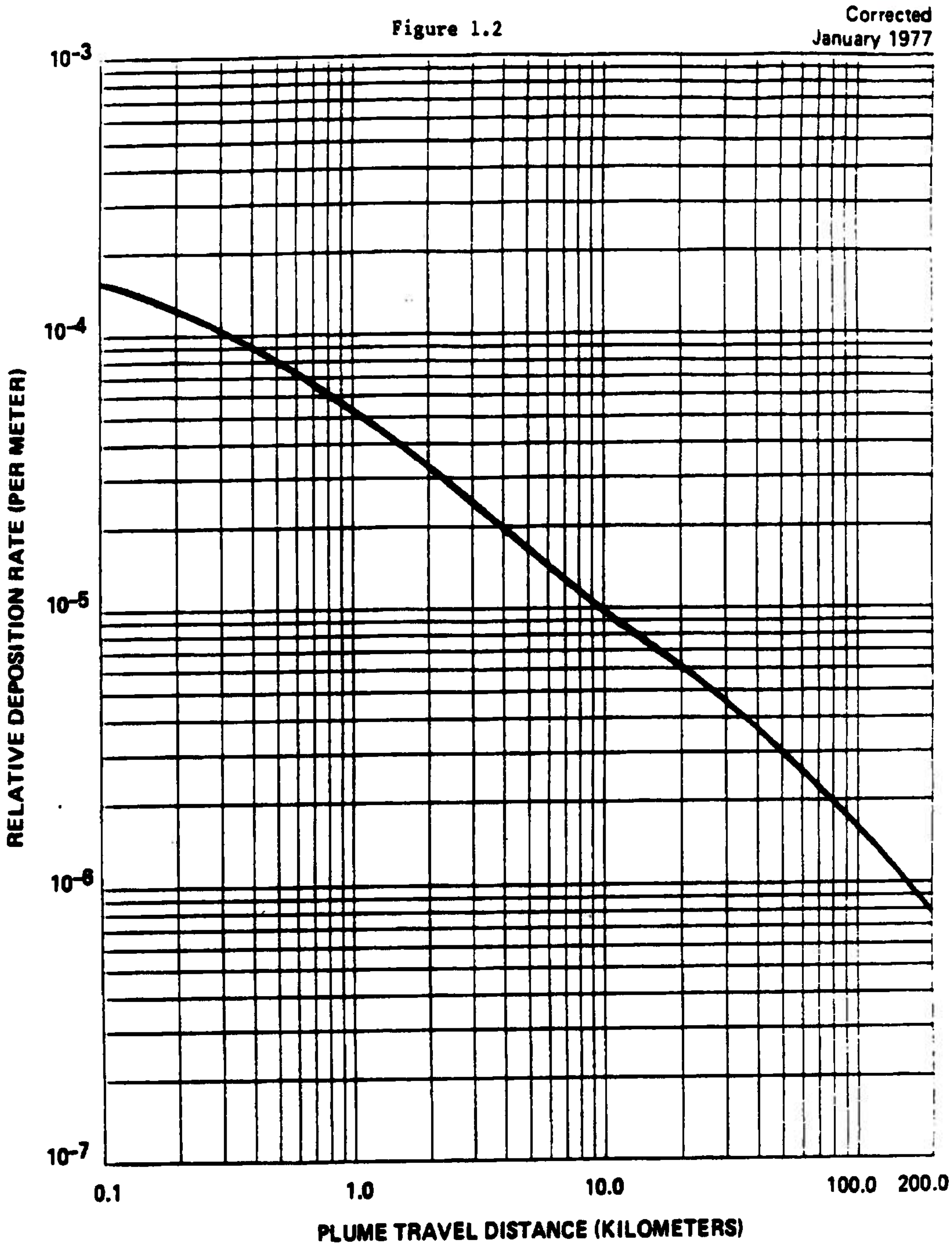


Figure 7. Relative Deposition for Ground Level Releases (All Atmospheric Stability Classes)

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

$$D_G = (8{,}760)(1 X 10^6)(0.7) \sum_i G_i\, DFG_i \qquad (1.9)$$

where:

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

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

DFG_i = Dose factor for standing on contaminated ground, mrem/h per pCi/m^2 (Attachment 6).

8,760 = Occupation time, h/y.

$1x10^6$ = $pCi/\mu Ci$ 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:

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

where:

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

k = Stability class.

f_k = Frequency of this stability class and wind direction combination, expressed as a fraction.

Q_i	=	Average release rate of radionuclide i, μCi/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).
λEi	=	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 ($\lambda_w = 0.0021\ h^{-}$).
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 (Attachment 4).
λ_i	=	Radioactive decay coefficient of radionuclide i, h^{-1}.
t_b	=	Time for buildup of radionuclides on the ground, 1.31×10^5 h (15Y).
p	=	Effective surface density of soil, 240 kg/m^2.
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, µCi/kg.

X_{14} = Air concentration of C-14, µCi/m^3.

0.11 = Fraction of total Plant mass that is natural carbon.

0.16 = Concentration of natural carbon in the atmosphere, g/m^3.

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, µCi/m^3.

X_T = Air concentration of H-3, µCi/m^3.

0.75 = Fraction of total Plant mass that is water.

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

H = Absolute humidity of the atmosphere, g/m^3.

1×10^3 = 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, μCi/l.
CV_i	=	Concentration of radionuclide i in and on vegetation, μCi/kg.
FM_i	=	Transfer factor from feed to milk for radionuclide i, d/l (Attachment 4).
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.

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

$$D = 1 \times 10^{6} \sum_{i} CM_i \, DF_i \, UM \qquad (1.14)$$

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 (Attachment 8).

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

1×10^{6} = pCi/µCi conversion factor.

d) Meat Ingestion (Beef)

To calculate the concentration of a nuclide in animal flesh:

$$C_{fi} = F_{fi} \; CV_i \; Q_{fi} \; \exp(-\lambda_i t_s) \qquad (1.15)$$

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 (Attachment 4).

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

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:

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

where:

D_{fi} = Ingestion dose factor for age group, mrem/pCi (Attachment 8) 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:

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

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.

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. Land Use Census

Appendix A, Sections J.3.b and J.3.c describe the requirements for an annual land use census. Changes will be effective on January 1 of the year following the year of the survey.

d. 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.

C. 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 and displacing of cover gases caused by liquid accumulation in the tanks connected to the vent header.

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.

2. Determination of Satisfactory Operation

Doses will be calculated for batch and continuous releases as described in Section I.B. 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 operating history of the Plant has demonstrated the system's consistent performance well below Appendix I limits, no additional operability requirements are specified.

D. RELEASE RATE FOR OFFSITE EC

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 inhaled or ingested continuously for one year will result in a dose of 50 mrem whole body except for submersion dose isotopes (gaseous tritium and noble gasses) which will results in a dose of 100 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.

The GASPAR code has been run to determine the dose due to external radiation and inhalation. The source term used is listed in Attachment 2. The meteorology data is given in site procedure CH 6.41, Land Use Census. 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 Attachment 2 multiplied by 50/2.15E-02 or 0.11 Ci/sec.

E. 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 dose calculations. 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. Sampling and analysis will be performed per Appendix A, Table B-1 requirements.

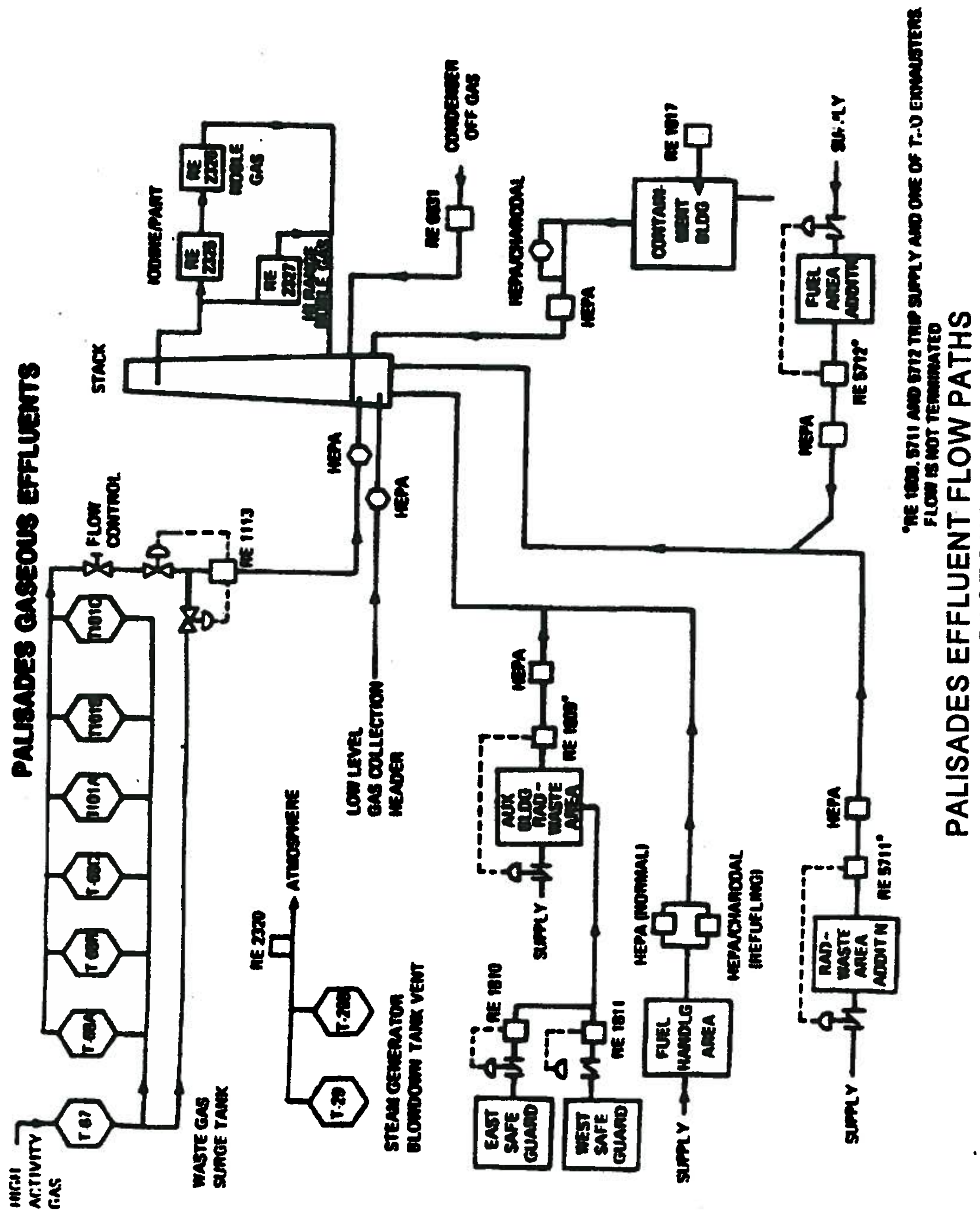
F. NOBLE GAS SAMPLING

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. Non-routine releases will be quantified from the stack noble gas monitor (RE 2326) which has a LLD of 1E-06 μCi/cc. Sampling and analysis will be performed per Appendix A, Table B-1 requirements.

G. TRITIUM SAMPLING

Tritium has a low dose consequence to the public because of low energy decay. 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.

H. FIGURE – GASEOUS EFFLUENTS FLOW PATHS



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 μCi/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.

$$C = \sum_{i=1}^{n} C_i \qquad (2.1)$$

where:

C = Total concentration in the liquid effluent at the release point, μCi/ml.

C_i = Concentration of a single radionuclide i, μCi/ml.

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

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

$$R_j = \sum_i \frac{C_i}{EC_i} \leq 10.0 \qquad (2.2)$$

where:

C_i = Effluent concentration of radionuclide i, µCi/ml.

EC_i = The EC of radionuclide i, 10 CFR 20, Appendix B, Table 2, Column 2 - µCi/ml.

R_j = 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:

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

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.

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:

$$S = b \times C \qquad (2.4)$$

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, and quarterly 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.

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 by 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

Dose calculations shall be performed for each batch release, and weekly for continuous releases unless documentation exists to demonstrate an activity below which dose limits of Section II.C.1 will not be exceeded.

a. Water Ingestion

The dose to an individual from ingestion of radioactivity from any source as described by the following equation:

$$D_j \sum_{i=l}^{i} (DCF)_{ij} \times I_i \qquad (2.5)$$

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 jth organ from the i^{th} radionuclide mrem/pCi, see Attachment 8.

I_i = Activity ingested of the i^{th} radionuclide, pCi.

I_i is described by:

$$I_i = \frac{(A_i)(V)(365)}{(1000)(d)}(1E06) \qquad (2.6)$$

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:

$$D_j = \frac{(3.65E05)(V)}{d} \sum_{i=1}^{i} (DCF)_{ij} \times A_i \text{ mrem} \qquad (2.7)$$

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:

$$I_i = \frac{A_i B_i F(1E09)}{15d} = pCi \qquad (2.8)$$

where:

A_i = Annual released of i^{th} radionuclide, µCi.

B_i = Fish concentration factor of i^{th} radionuclide $\frac{\mu Ci/gm}{\mu Ci/ml}$ (see Attachment 7).

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, gm, and Kg to pCi.

Substitution of Equation 2.8 into Equation 2.5 gives:

$$D_j = \frac{(6.7E07)F}{d} \sum_{i=1}^{i} A_i \times B_i \times DCF_i \text{ mrem} \qquad (2.9)$$

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, Dj, is described by:

$$D_j = \sum_{i=1}^{m} D_{ij} \text{ mrem} \qquad (2.10)$$

$$= \sum_{i=1}^{m} (DCF)_{ij} \times I_j \text{ mrem} \qquad (2.11)$$

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).

$(DCF)_{ij}$ = Adult ingestion dose commitment factor for the j^{th} organ from the i^{th} radionuclide, mrem/pCi (see Attachment 8).

I_i = Activity ingested of the i^{th} radionuclide, μCi.

I_i for water ingestion is described by:

$$I_i = \frac{A_i V_\Gamma}{vd} \ \mu Ci \qquad (2.12)$$

and for fish ingestion I_i is described by:

$$I_i = \frac{A_i B_i F_\Gamma}{v\,d} \ \mu Ci \qquad (2.13)$$

where:

A_i = Activity release of jth 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 ith radionuclide,

Attachment 7, $\frac{\mu\text{Ci/gm}}{\mu\text{Ci/ml}}$

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 (through deep bed filtration and ion exchange) 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.

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 Attachment 2. 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.

F. FIGURES

Figure 2-1

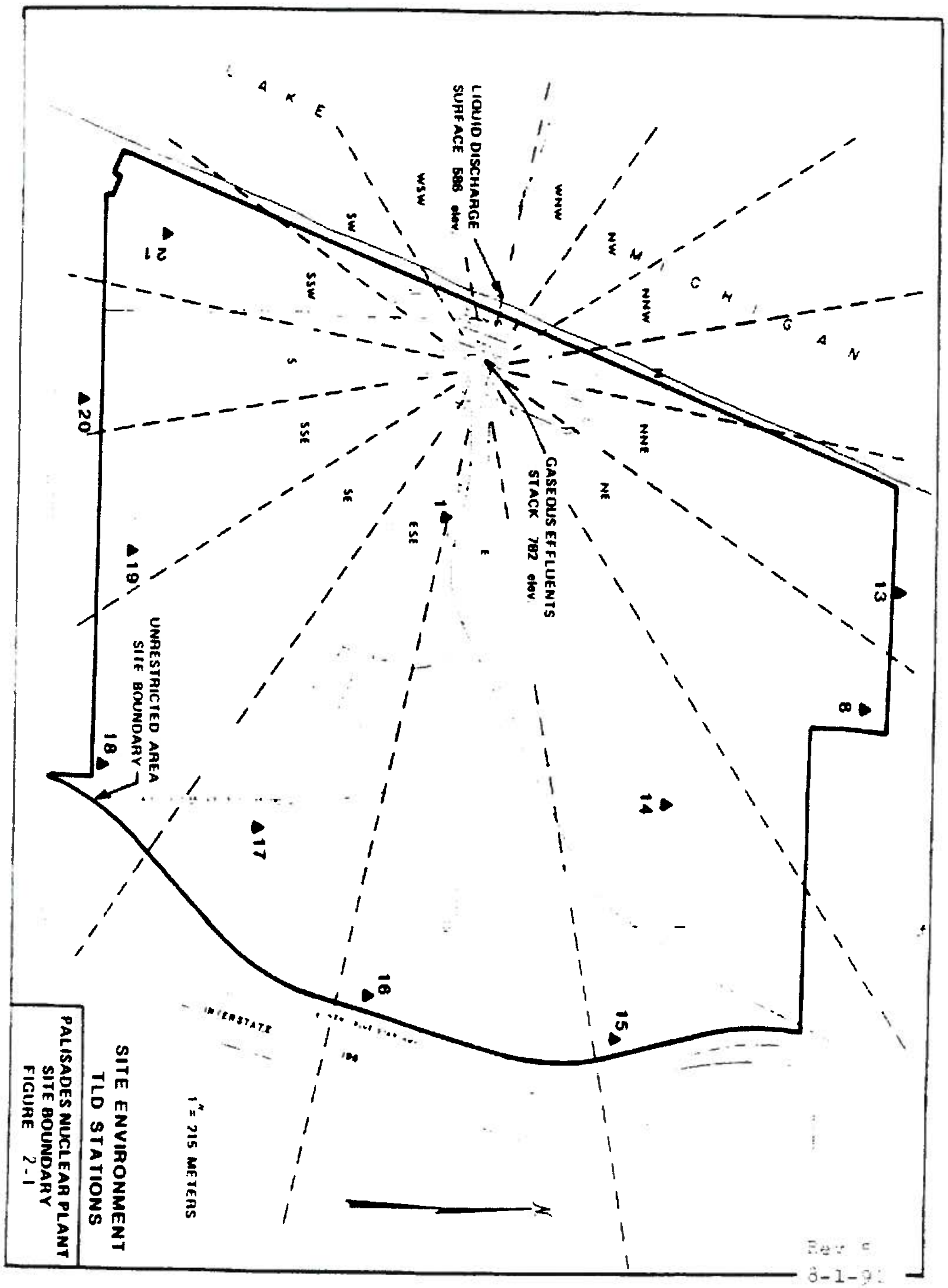
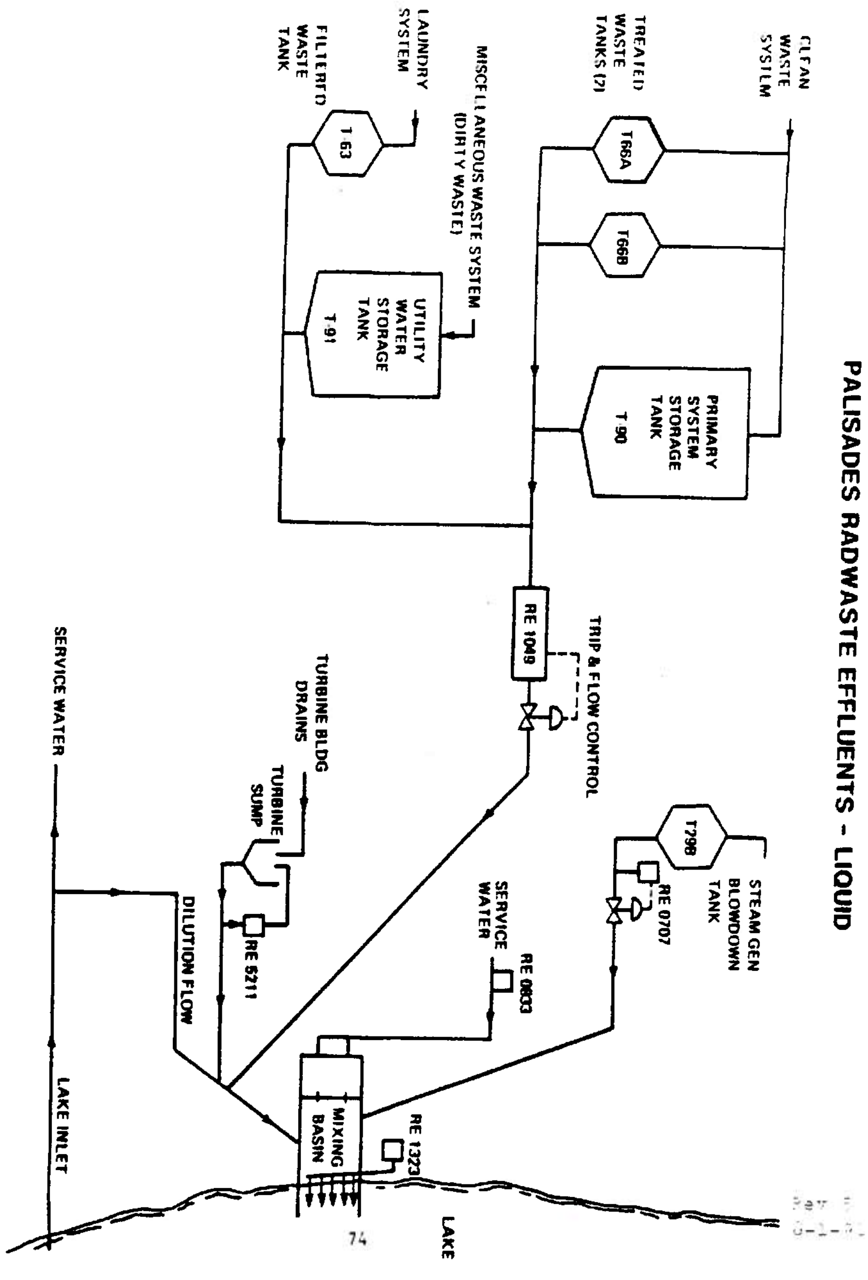


Figure 2-2


PALISADES RADWASTE EFFLUENTS - LIQUID
CLEAN WASTE SYSTEM
TREATED WASTE TANKS (2)
T66A
T66B
PRIMARY SYSTEM STORAGE TANK
T-90
MISCELLANEOUS WASTE SYSTEM (DIRTY WASTE)
LAUNDRY SYSTEM
FILTERED WASTE TANK
T-63
UTILITY WATER STORAGE TANK
T-91
RE 1049
TRIP & FLOW CONTROL
STEAM GEN BLOWDOWN TANK
RE 0707
SERVICE WATER
RE 0833
TURBINE BLDG DRAINS
TURBINE SUMP
RE 5211
DILUTION FLOW
SERVICE WATER
LAKE INLET
MIXING BASIN
RE 1323
LAKE
74

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.

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 curing 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 questions (hours).

IV. SOURCE REFERENCE DOCUMENTS

1. Regulatory Guide 1.21, Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioacitve Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants, R1.

2. Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, R1.

3. NUREG-1301, Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors, April 91.

4. NUREG-0472, Standard Radiological Effluent Technical Specifications for Pressurized Water Reactors, R3.

5. NUREG/CR-4013, LADTAP II - Technical Reference and User Guide, April 86.

6. NUREG/CR-4653, GASPAR II - Technical Reference and User Guide, March 87.

7. CH 6.61, Revising the ODCM and ODCM Appendix A.

PALISADES GASEOUS AND LIQUID SOURCE TERMS, CURIES/YEAR (1)

Nuclide	Gaseous(2)	Liquid(2)
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	0.3E-07	0.1E-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.

BASIC RADIONUCLIDE DATA

	NUCLIDE	HALF-LIFE (days)	LAMBDA (1/s)	BETA[1] (MEV/DIS)	GAMMA[1] (MEV/DIS)
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

BASIC RADIONUCLIDE DATA

	NUCLIDE	HALF-LIFE (days)	LAMBDA (1/s)	BETA[1] (MEV/DIS)	GAMMA[1] (MEV/DIS)
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	2.3OE 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.

DOSE FACTORS FOR SUBMERSION IN NOBLE GASES*

	Gamma body dose[1]	Gamma air dose[2]	Beta skin dose[1]	Beta air dose[2]
Kr-85m	1.17E3	1.23E3	1.46E3	1.97E3
Kr-85	1.61E1	1.72E1	1.34E3	1.95E3
Kr-87	5.92E3	6.17E3	9.73E3	1.03E4
Kr-88	1.47E4	1.52E4	2.37E3	2.93E3
Kr-89	1.66E4	1.73E4	1.01E4	1.06E4
Xe-131m	9.15E1	1.56E2	4.76E2	1.11E3
Xe-133m	2.51E2	3.27E2	9.94E2	1.48E3
Xe-133	2.94E2	3.53E2	3.06E2	1.05E3
Xe-135m	3.12E3	3.36E3	7.11E2	7.39E3
Xe-135	1.81E3	1.92E3	1.86E3	2.46E3
Xe-137	1.42E3	1.51E3	1.22E4	1.27E4
Xe-138	8.83E3	9.21E3	4.13E3	4.75E3
Ar-41	8.84E3	9.30E3	2.69E3	3.28E3

1. mrem/y per $\mu Ci/m^3$
2. mrad/y per $\mu Ci/m^3$

*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).

STABLE ELEMENT TRANSFER DATA

ELEMENT	F_m - MILK (COW) (DAYS/L)	F_m - MILK (GOAT) (DAYS/L)	F_f - MEAT (DAYS/KG)	B_{iv} (VEG/SOIL)
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

INHALATION DOSE COMMITMENT FACTORS

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	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	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	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	0.	2.29E-07	1.47E-07	0.	0.	0.	4.87E-08
SR89	2.84E-04	0.	8.15E-06	0.	0.	1.45E-03	4.57E-05
SR90	2.92E-02	0.	1.85E-03	0.	0.	8.03E-03	9.36E-05
SR91	6.83E-08	0.	2.47E-09	0.	0.	3.76E-05	5.24E-05
SR92	7.50E-09	0.	2.79E-10	0.	0.	1.70E-05	1.00E-04

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

INHALATION DOSE COMMITMENT FACTORS

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	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	2.24E-04	9.51E-05	6.18E-05	0.	3.19E-04	1.37E-03	1.48E-05
ZR95	8.24E-05	1.99E-05	1.45E-05	0.	2.22E-05	1.25E-03	1.55E-05
ZR97	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	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	1.44E-06	0.	4.85E-07	0.	3.03E-06	3.94E-04	1.15E-05
RU105	8.74E-10	0.	2.93E-10	0.	6.42E-10	1.12E-05	3.46E-05
RU106	6.20E-05	0.	7.77E-06	0.	7.61E-05	8.26E-03	1.17E-04
RH105	8.26E-09	5.41E-09	3.63E-09	0.	1.50E-08	2.08E-05	1.37E-05
PD107	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	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	1.01E-05	2.51E-07	6.00E-07	2.47E-07	0.	6.43E-04	7.26E-05
SN126	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	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	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	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	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
TE131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
TE132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
TE133M	6.13E-11	3.59E-11	2.74E-11	5.52E-11	1.72E-10	3.92E-06	1.59E-05
TE134	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	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	0.	7.56E-07

INHALATION DOSE COMMITMENT FACTORS

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	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	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	0.	0.	0.	0.	0.	9.78E-08	0.
CS134M	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	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	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	4.00E-05	4.00E-08	2.07E-06	0.	9.59E-09	1.14E-03	2.74E-05
BA141	1.12E-10	7.70E-14	3.55E-12	0.	4.64E-14	2.12E-06	3.39E-06
BA142	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	2.09E-07	1.38E-07	1.58E-08	0.	4.03E-08	8.30E-05	3.55E-05
CE144	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	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	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

INHALATION DOSE COMMITMENT FACTORS

INFANT INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210	8.62E-02	2.02E-02	3.43E-03	0.	6.85E-02	1.76E-01	3.79E-05
BI210	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	0.	0.	0.	0.	0.	9.88E-06	0.
RA223	1.56E-03	2.26E-06	3.12E-04	0.	4.16E-05	2.25E-01	3.04E-04
RA224	1.77E-04	4.00E-07	3.54E-05	0.	7.30E-06	7.91E-02	3.42E-04
RA225	2.57E-03	2.88E-06	5.13E-04	0.	5.31E-05	2.57E-01	2.87E-04
RA226	2.48E-01	1.46E-05	2.05E-01	0.	2.94E-04	7.83E-01	3.05E-04
RA228	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	5.29E+00	8.76E-01	3.28E-01	0.	1.86E-01	1.62E+00	5.27E-05
TH227	1.82E-03	3.03E-05	5.24E-05	0.	1.13E-04	3.27E-01	3.53E-04
TH228	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	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	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	2.57E-01	0.	2.13E-02	0.	2.40E-02	1.49E+00	4.36E-05
U233	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	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	4.79E-02	0.	3.29E-03	0.	9.40E-03	3.06E-01	3.54E-05
NP237	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	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	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

INHALATION DOSE COMMITMENT FACTORS

CHILD INHALATION DOSE COMMITMENT FACTORS (MREM/50Y 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	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	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	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	0.	9.33E-08	7.83E-08	0.	0.	0.	5.11E-10
SR89	1.62E-04	0.	4.66E-06	0.	0.	5.83E-04	4.52E-05
SR90	2.73E-02	0.	1.74E-03	0.	0.	3.99E-03	9.28E-05
SR91	3.28E-08	0.	1.24E-09	0.	0.	1.44E-05	4.70E-05
SR92	3.54E-09	0.	1.42E-10	0.	0.	6.49E-06	6.55E-05

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

INHALATION DOSE COMMITMENT FACTORS

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	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	2.07E-04	7.80E-05	5.55E-05	0.	3.00E-04	7.10E-04	1.47E-05
ZR95	5.13E-05	1.13E-05	1.00E-05	0.	1.61E-05	6.03E-04	1.65E-05
ZR97	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	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	7.55E-07	0.	2.90E-07	0.	1.90E-06	1.79E-04	1.21E-05
RU105	4.13E-10	0.	1.50E-10	0.	3.63E-10	4.30E-06	2.69E-05
RU106	3.68E-05	0.	4.57E-06	0.	4.97E-05	3.87E-03	1.16E-04
RH105	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	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	4.95E-06	9.94E-08	2.95E-07	1.03E-07	0.	2.43E-04	7.17E-05
SN126	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	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	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	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	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
TE131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
TE132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
TE133M	2.93E-11	1.51E-11	1.50E-11	2.32E-11	1.01E-10	1.60E-06	4.77E-06
TE134	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	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	0.	7.68E-07

INHALATION DOSE COMMITMENT FACTORS

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	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	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	0.	0.	0.	0.	0.	5.17E-08	0.
CS134M	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	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	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	2.00E-05	1.75E-08	1.17E-06	0.	5.71E-09	4.71E-04	2.75E-05
BA141	5.29E-11	2.95E-14	1.72E-12	0.	2.56E-14	7.89E-07	7.44E-08
BA142	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	9.89E-08	5.37E-08	7.77E-09	0.	2.26E-08	3.12E-05	3.44E-05
CE144	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	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	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

INHALATION DOSE COMMITMENT FACTORS

CHILD INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210	8.03E-02	1.85E-02	3.18E-03	0.	6.31E-02	8.74E-02	3.75E-05
BI210	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	0.	0.	0.	0.	0.	4.82E-06	0.
RA223	7.69E-04	8.89E-07	1.54E-04	0.	2.36E-05	8.48E-02	3.00E-04
RA224	8.44E-05	1.53E-07	1.69E-05	0.	4.06E-06	2.92E-02	3.34E-04
RA225	1.28E-03	1.14E-06	2.56E-04	0.	3.02E-05	9.74E-02	2.84E-04
RA226	2.34E-01	7.66E-06	1.92E-01	0.	2.03E-04	3.90E-01	3.02E-04
RA228	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	4.96E+00	8.05E-01	3.07E-01	0.	1.77E-01	8.04E-01	5.22E-05
TH227	9.24E-04	1.26E-05	2.67E-05	0.	6.67E-05	1.26E-01	3.49E-04
TH228	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	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	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
U232	2.19E-01	0.	1.56E-02	0.	1.67E-02	7.42E-01	4.33E-05
U233	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	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	4.09E-02	0.	2.42E-03	0.	6.55E-03	1.53E-01	3.51E-05
NP237	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	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	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

INHALATION DOSE COMMITMENT FACTORS

TEEN INHALATION DOSE COMMITMENT FACTORS (MREM/50Y 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.	2.24F-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	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	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	0.	0.	0.	0.	0.	5.81E-08	0.
KR89	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	0.	4.40E-08	2.91E-08	0.	0.	0.	4.22E-17
SR89	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	1.10E-08	0.	4.39E-10	0.	0.	7.59E-06	3.24E-05
SR92	1.19E-09	0.	5.08E-11	0.	0.	3.43E-06	1.49E-05

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

INHALATION DOSE COMMITMENT FACTORS

TEEN INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)

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	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	6.83E-05	3.38E-05	1.84E-05	0.	1.16E-04	3.67E-04	1.60E-05
ZR95	1.82E-05	5.73E-06	3.94E-06	0.	8.42E-06	3.36E-04	1.86E-05
ZR97	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	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	2.63E-07	0.	1.12E-07	0.	9.29E-07	9.79E-05	1.36E-05
RU105	1.40E-10	0.	5.42E-11	0.	1.76E-10	2.27E-06	1.13E-05
RU106	1.23E-05	0.	1.55E-06	0.	2.38E-05	2.01E-03	1.20E-04
RH105	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	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	1.66E-06	4.42E-08	9.99E-08	3.45E-08	0.	1.26E-04	7.29E-05
SN126	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	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	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	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	1.23E-08	7.51E-09	5.03E-09	9.06E-09	5.49E-08	2.97E-05	7.76E-05
TE131	1.97E-12	1.04E-12	6.30E-13	1.55E-12	7.72E-12	2.92E-07	1.89E-09
TE132	4.50E-08	3.63E-08	2.74E-08	3.07E-08	2.44E-07	5.61E-05	5.79E-05
TE133M	1.01E-11	7.33E-12	5.71E-12	8.18E-12	5.07E-11	8.71E-07	1.23E-07
TE134	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	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	0.	8.11E-07

INHALATION DOSE COMMITMENT FACTORS

TEEN INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)

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	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	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	0.	0.	0.	0.	0.	4.38E-08	0.
CS134M	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	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	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	6.84E-06	8.38E-09	4.40E-07	0.	2.85E-09	2.54E-04	2.86E-05
BA141	1.78E-11	1.32E-14	5.93E-13	0.	1.23E-14	4.11E-07	9.33E-14
BA142	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	3.32E-08	2.42E-08	2.70E-09	0.	1.08E-08	1.63E-05	3.19E-05
CE144	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	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	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

INHALATION DOSE COMMITMENT FACTORS

TEEN INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210	3.09E-02	8.28E-03	1.07E-03	0.	2.95E-02	4.52E-02	3.87E-05
BI210	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	0.	0.	0.	0.	0.	3.94E-06	0.
RA223	2.57E-04	3.93E-07	5.14E-05	0.	1.12E-05	4.39E-02	3.04E-04
RA224	2.83E-05	6.77E-08	5.65E-06	0.	1.93E-06	1.51E-02	3.29E-04
RA225	4.28E-04	5.04E-07	8.56E-05	0.	1.44E-05	5.04E-02	2.89E-04
RA226	1.33E-01	3.38E-06	9.87E-02	0.	9.67E-05	2.02E-01	3.11E-04
RA228	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	2.49E+00	3.69E-01	1.48E-01	0.	1.07E-01	4.16E-01	5.38E-05
TH227	3.09E-04	5.56E-06	8.93E-06	0.	3.18E-05	6.50E-02	3.57E-04
TH228	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	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	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
U232	7.31E-02	0.	5.23E-03	0.	7.94E-03	3.84E-01	4.46E-05
U233	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	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	1.36E-02	0.	8.10E-04	0.	3.12E-03	7.89E-02	3.62E-05
NP237	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	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	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

INHALATION DOSE COMMITMENT FACTORS

ADULT INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)

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	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	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	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	0.	3.20E-08	2.12E-08	0.	0.	0.	1.16E-21
SR89	3.80E-05	0.	1.09E-06	0.	0.	1.75E-04	4.37E-05
SR90	1.24E-02	0.	7.62E-04	0.	0.	1.20E-03	9.02E-05
SR91	7.74E-09	0.	3.13E-10	0.	0.	4.56E-06	2.39E-05
SR92	8.43E-10	0.	3.64E-11	0.	0.	2.06E-06	5.38E-06

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

INHALATION DOSE COMMITMENT FACTORS

ADULT INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)

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	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	5.22E-05	2.92E-06	1.37E-06	0.	1.11E-05	2.13E-05	1.51E-06
ZR95	1.34E-05	4.30E-06	2.91E-06	0.	6.77E-06	2.21E-04	1.88E-05
ZR97	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	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	1.91E-07	0.	8.23E-08	0.	7.29E-07	6.31E-05	1.38E-05
RU105	9.88E-11	0.	3.89E-11	0.	1.27E-10	1.37E-06	6.02E-06
RU106	8.64E-06	0.	1.09E-06	0.	1.67E-05	1.17E-03	1.14E-04
RH105	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	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	1.16E-06	3.12E-08	7.03E-08	2.59E-08	0.	7.37E-05	6.81E-05
SN126	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	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	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	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	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05
TE131	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09
TE132	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05
TE133M	7.24E-12	5.40E-12	4.17E-12	6.27E-12	3.74E-11	5.51E-07	5.49E-08
TE134	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	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	0.	7.85E-07

INHALATION DOSE COMMITMENT FACTORS

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	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	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	0.	0.	0.	0.	0.	2.44E-08	0.
CS134M	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	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	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	4.88E-06	6.13E-09	3.21E-07	0.	2.09E-09	1.59E-04	2.73E-05
BA141	1.25E-11	9.41E-15	4.20E-13	0.	8.75E-15	2.42E-07	1.45E-17
BA142	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	2.33E-08	1.72E-08	1.91E-09	0.	7.60E-09	9.97E-06	2.83E-05
CE144	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	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	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

INHALATION DOSE COMMITMENT FACTORS

ADULT INHALATION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INHALED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210	2.64E-02	6.73E-03	8.37E-04	0.	2.12E-02	2.62E-02	3.65E-05
BI210	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	0.	0.	0.	0.	0.	2.05E-06	0.
RA223	1.80E-04	2.77E-07	3.60E-05	0.	7.85E-06	2.55E-02	2.84E-04
RA224	1.98E-05	4.78E-08	3.96E-06	0.	1.35E-06	8.77E-03	3.01E-04
RA225	3.00E-04	3.56E-07	5.99E-05	0.	1.01E-05	2.92E-02	2.71E-04
RA226	1.25E-01	2.39E-06	9.14E-02	0.	6.77E-05	1.17E-01	2.94E-04
RA228	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	2.30E+00	3.05E-01	1.36E-01	0.	9.82E-02	2.41E-01	5.08E-05
TH227	2.17E-04	3.92E-06	6.25E-06	0.	2.22E-05	3.77E-02	3.34E-04
TH226	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	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	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
U232	5.14E-02	0.	3.66E-03	0.	5.56E-03	2.22E-01	4.21E-05
U233	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	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	9.58E-03	0.	5.67E-04	0.	2.18E-03	4.58E-02	3.41E-05
NP237	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	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	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

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND (DFG_i) (mrem/hr per pCi/m^2)

ELEMENT	TOTAL BODY	SKIN
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

EXTERNAL DOSE FACTORS FOR STANDING ON CONTAMINATED GROUND (DFG_i) (mrem/hr per pCi/m²)

ELEMENT	TOTAL BODY	SKIN
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

BIOACCUMULATION FACTORS
μCi/gm per μCi/ml

ELEMENT	FRESHWATER FISH
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.OE 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

INGESTION DOSE COMMITMENT FACTORS

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	3.083-07
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	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	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	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	0.	2.86E-07	1.97E-07	0.	0.	0.	9.74E-08
SR89	2.51E-03	0.	7.20E-05	0.	0.	0.	5.16E-05
SR90	1.85E-02	0.	4.71E-03	0.	0.	0.	2.31E-04
SR91	5.00E-05	0.	1.81E-06	0.	0.	0.	5.92E-05
SR92	1.92E-05	0.	7.13E-07	0.	0.	0.	2.07E-04

INGESTION DOSE COMMITMENT FACTORS

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	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	1.93E-07	9.18E-08	5.54E-08	0.	2.71E-07	0.	2.39E-05
ZR95	2.06E-07	5.02E-08	3.56E-08	0.	5.41E-08	0.	2.50E-05
ZR97	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	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	1.48E-06	0.	4.95E-07	0.	3.08E-06	0.	1.80E-05
RU105	1.36E-07	0.	4.58E-08	0.	1.00E-06	0.	5.41E-05
RU106	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	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	7.41E-05	1.38E-06	3.29E-06	1.36E-06	0.	0.	1.11E-04
SN126	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	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	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	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	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	0.	1.03E-04
TE131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	0.	7.11E-06
TE132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	0.	3.81E-05
TE133M	3.91E-07	1.79E-07	1.71E-07	3.45E-07	1.22E-06	0.	1.93E-05
TE134	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	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	0.	1.51E-06

INGESTION DOSE COMMITMENT FACTORS

INFANT INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

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	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	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	0.	0.	0.	0.	0.	0.	0.
CS134M	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	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	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	1.71E-04	1.71E-07	8.81E-06	0.	4.06E-08	1.05E-07	4.20E-05
BA141	4.25E-07	2.91E-10	1.34E-08	0.	1.75E-10	1.77E-10	5.19E-06
BA142	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	1.48E-08	9.82E-06	1.12E-09	0.	2.86E-09	0.	5.73E-05
CE144	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	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	1.65E-07	4.18E-08	3.28E-08	0.	4.80E-08	0.	5.443-05
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

INGESTION DOSE COMMITMENT FACTORS

INFANT INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210	5.28E-02	1.42E-02	2.38E-03	0.	4.33E-02	0.	5.62E-05
BI210	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	0.	0.	0.	0.	0.	0.	0.
RA223	4.41E-02	6.42E-05	8.82E-03	0.	1.17E-03	0.	3.43E-04
RA224	1.46E-02	3.29E-05	2.91E-03	0.	6.00E-04	0.	3.86E-04
RA225	5.78E-02	6.42E-05	1.15E-02	0.	1.19E-03	0.	3.24E-04
RA226	6.20E-01	4.76E-05	5.14E-01	0.	8.71E-04	0.	3.44E-04
RA228	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	4.49E-03	7.67E-04	2.79E-04	0.	1.56E-04	0.	8.50E-05
TH227	1.20E-04	2.01E-06	3.45E-06	0.	7.41E-06	0.	5.70E-04
TH228	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	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	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	2.42E-02	0.	2.16E-03	0.	2.37E-03	0.	7.04E-05
U233	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	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	4.47E-03	0.	3.33E-04	0.	9.28E-04	0.	5.71E-05
NP237	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	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	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

INGESTION DOSE COMMITMENT FACTORS

CHILD INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

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	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	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	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	0.	1.17E-07	1.04E-07	0.	0.	0.	1.02E-09
SR89	1.32E-03	0.	3.77E-05	0.	0.	0.	5.11E-05
SR90	1.70E-02	0.	4.31E-03	0.	0.	0.	2.29E-04
SR91	2.40E-05	0.	9.06E-07	0.	0.	0.	5.30E-05
SR92	9.03E-06	0.	3.62E-07	0.	0.	0.	1.71E-04

INGESTION DOSE COMMITMENT FACTORS

CHILD INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

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	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	1.67E-07	6.25E-08	4.45E-08	0.	2.42E-07	0.	2.37E-05
ZR95	1.16E-07	2.55E-08	2.27E-08	0.	3.65E-08	0.	2.66E-05
ZR97	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	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	7.31E-07	0.	2.81E-07	0.	1.84E-06	0.	1.89E-05
RU105	6.45E-08	0.	2.34E-08	0.	5.67E-07	0.	4.21E-05
RU106	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	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	3.55E-05	5.35E-07	1.59E-06	5.55E-07	0.	0.	1.10E-04
SN126	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	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	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	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	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	0.	1.01E-04
TE131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	0.	4.36E-07
TE132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	0.	4.50E-05
TE133M	1.87E-07	7.56E-08	9.37E-08	1.45E-07	7.18E-07	0.	5.77E-06
TE134	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	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	0.	1.54E-06

INGESTION DOSE COMMITMENT FACTORS

CHILD INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

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	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	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	0.	0.	0.	0.	0.	0.	0.
CS134M	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	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	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	8.31E-05	7.28E-08	4.85E-06	0.	2.37E-08	4.34E-08	4.21E-05
BA141	2.00E-07	1.12E-10	6.51E-09	0.	9.69E-11	6.58E-10	1.14E-07
BA142	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	6.99E-09	3.79E-06	5.49E-10	0.	1.59E-09	0.	5.55E-05
CE144	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	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	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

INGESTION DOSE COMMITMENT FACTORS

CHILD INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210	4.75E-02	1.22E-02	2.09E-03	0.	3.67E-02	0.	5.57E-05
BI210	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	0.	0.	0.	0.	0.	0.	0.
RA223	2.12E-02	2.45E-05	4.24E-03	0.	6.50E-04	0.	3.38E-04
RA224	6.89E-03	1.25E-05	1.38E-03	0.	3.31E-04	0.	3.78E-04
RA225	2.80E-02	2.50E-05	5.59E-03	0.	6.62E-04	0.	3.21E-04
RA226	5.75E-01	1.84E-05	4.72E-01	0.	4.88E-04	0.	3.41E-04
RA228	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	4.12E-03	6.63E-04	2.55E-04	0.	1.46E-04	0.	8.43E-05
TH227	5.85E-05	7.96E-07	1.69E-06	0.	4.22E-06	0.	5.63E-04
TH228	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	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	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	1.76E-02	0.	1.26E-03	0.	1.34E-03	0.	6.98E-05
U233	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	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	3.27E-03	0.	1.94E-04	0.	5.24E-04	0.	5.66E-05
NP237	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	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	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

INGESTION DOSE COMMITMENT FACTORS

TEEN INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

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.	5.193-06
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	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	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	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	0.	5.50E-08	3.89E-08	0.	0.	0.	8.43E-17
SR89	4.40E-04	0.	1.26E-05	0.	0.	0.	5.24E-05
SR90	8.30E-03	0.	2.05E-03	0.	0.	0.	2.33E-04
SR91	8.07E-06	0.	3.21E-07	0.	0.	0.	3.66E-05
SR92	3.05E-06	0.	1.30E-07	0.	0.	0.	7.77E-05

INGESTION DOSE COMMITMENT FACTORS

TEEN INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

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	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	5.53E-08	2.73E-08	1.49E-08	0.	9.65E-08	0.	2.58E-05
ZR95	4.12E-08	1.30E-08	8.94E-09	0.	1.91E-08	0.	3.00E-05
ZR97	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	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	2.55E-07	0.	1.09E-07	0.	8.99E-07	0.	2.13E-05
RU105	2.18E-08	0.	8.46E-09	0.	2.75E-07	0.	1.76E-05
RU106	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	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	1.19E-05	2.37E-07	5.37E-07	1.86E-07	0.	0.	1.12E-04
SN126	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	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	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	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	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	0.	9.39E-05
TE131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	0.	2.29E-09
TE132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	0.	7.00E-05
TE133M	6.44E-08	3.66E-08	3.56E-08	5.11E-08	3.62E-07	0.	1.48E-07
TE134	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	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	0.	1.62E-06

INGESTION DOSE COMMITMENT FACTORS

TEEN INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

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	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	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	0.	0.	0.	0.	0.	0.	0.
CS134M	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	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	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	2.84E-05	3.48E-08	1.83E-06	0.	1.18E-08	2.34E-08	4.38E-05
BA141	6.71E-08	5.01E-11	2.24E-09	0.	4.65E-11	3.43E-11	1.43E-13
BA142	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	2.35E-09	1.71E-06	1.91E-10	0.	7.67E-10	0.	5.14E-05
CE144	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	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	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

INGESTION DOSE COMMITMENT FACTORS

TEEN INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210	1.81E-02	5.44E-03	7.01E-04	0.	1.72E-02	0.	5.74E-05
BI210	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	0.	0.	0.	0.	0.	0.	0.
RA223	7.11E-03	1.08E-05	1.42E-03	0.	3.10E-04	0.	3.43E-04
RA224	2.31E-03	5.52E-06	4.61E-04	0.	1.58E-04	0.	3.71E-04
RA225	9.37E-03	1.10E-05	1.87E-03	0.	3.15E-04	0.	3.27E-04
RA226	3.22E-01	8.13E-06	2.39E-01	0.	2.32E-04	0.	3.51E-04
RA228	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	2.05E-03	3.03E-04	1.22E-04	0.	8.81E-05	0.	8.68E-05
TH227	1.96E-05	3.52E-07	5.65E-07	0.	2.01E-06	0.	5.75E-04
TH228	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	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	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	5.89E-03	0.	4.21E-04	0.	6.38E-04	0.	7.19E-05
U233	1.24E-03	0.	7.543-05	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	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	1.09E-03	0.	6.49E-05	0.	2.50E-04	0.	5.83E-05
NP237	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	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	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

INGESTION DOSE COMMITMENT FACTORS

ADULT INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

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.	1.51E-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	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	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	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	0.	4.01E-08	2.82E-08	0.	0.	0.	2.33E-21
SR89	3.08E-04	0.	8.84E-06	0.	0.	0.	4.94E-05
SR90	7.58E-03	0.	1.86E-03	0.	0.	0.	2.19E-04
SR91	5.67E-06	0.	2.29E-07	0.	0.	0.	2.70E-05
SR92	2.15E-06	0.	9.30E-08	0.	0.	0.	4.26E-05

INGESTION DOSE COMMITMENT FACTORS

ADULT INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

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	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	4.18E-08	2.34E-09	1.09E-09	0.	8.87E-09	0.	2.43E-06
ZR95	3.04E-08	9.75E-09	6.60E-09	0.	1.53E-08	0.	3.09E-05
ZR97	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	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	1.85E-07	0.	7.97E-08	0.	7.06E-07	0.	2.16E-05
RU105	1.54E-08	0.	6.08E-09	0.	1.99E-07	0.	9.42E-06
RU106	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	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	8.33E-06	1.68E-07	3.78E-07	1.39E-07	0.	0.	1.04E-04
SN126	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	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	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	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	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	0.	8.40E-05
TE131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	0.	2.79E-09
TE132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	0.	7.71E-05
TE133M	4.62E-08	2.70E-08	2.60E-08	3.91E-08	2.67E-07	0.	6.64E-08
TE134	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	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	0.	1.57E-06

INGESTION DOSE COMMITMENT FACTORS

ADULT INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

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	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	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	0.	0.	0.	0.	0.	0.	0.
CS134M	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	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	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	2.03E-05	2.55E-08	1.33E-06	0.	8.67E-09	1.46E-08	4.18E-05
BA141	4.71E-08	3.56E-11	1.59E-09	0.	3.31E-11	2.02E-11	2.22E-17
BA142	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	1.65E-09	1.22E-06	1.35E-10	0.	5.37E-10	0.	4.56E-05
CE144	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	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	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

INGESTION DOSE COMMITMENT FACTORS

ADULT INGESTION DOSE COMMITMENT FACTORS (MREM/50Y PER PCI INGESTED IN FIRST YR)

ISOTOPE	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
PB210	1.53E-02	4.37E-03	5.44E-04	0.	1.23E-02	0.	5.42E-05
BI210	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	0.	0.	0.	0.	0.	0.	0.
RA223	4.97E-03	7.65E-06	9.94E-04	0.	2.17E-04	0.	3.21E-04
RA224	1.61E-03	3.90E-06	3.23E-04	0.	1.10E-04	0.	3.40E-04
RA225	6.56E-03	7.78E-06	1.31E-03	0.	2.21E-04	0.	3.06E-04
RA226	3.02E-01	5.74E-06	2.20E-01	0.	1.63E-04	0.	3.32E-04
RA228	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	1.87E-03	2.48E-04	1.11E-04	0.	8.00E-05	0.	8.19E-05
TH227	1.37E-05	2.48E-07	3.95E-07	0.	1.41E-06	0.	5.40E-04
TH228	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	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	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	4.13E-03	0.	2.95E-04	0.	4.47E-04	0.	6.78E-05
U233	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	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	7.67E-04	0.	4.54E-05	0.	1.75E-04	0.	5.50E-05
NP237	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	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	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

PALISADES NUCLEAR PLANT
OFFSITE DOSE CALCULATION MANUAL

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

Process Applicability Exclusion	☐

Joe Hager / 5/17/11
Procedure Sponsor — Date

JJMiller / 5/13/11
Technical Reviewer — Date

JBBurnett / 6/3/10
User Reviewer — Date

DHamilton / 5/13/11
General Manager Plant Operations — Date

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

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TABLES

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.

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 Specifications) - 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.

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.

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.

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.

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 Modes 1, 2, 3, 4	3
b. Evacuation Flow Indicator (FI-0631 or FI-0632)	(1)***	Above 210°F Modes 1, 2, 3, 4	
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 (FE-2346)	(1)	At All Times	2
d. Hi Range Noble Gas (RIA 2327)*	(1)	Above 210°F Modes 1, 2, 3, 4	4
4. **STEAM GENERATOR BLOWDOWN VENT SYSTEM**			
a. Noble Gas Activity Monitor (RIA 2320)	(1)	Above 210°F Modes 1, 2, 3, 4	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 Modes 1, 2, 3	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 Modes 1, 2, 3, 4	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 Specifications SR 3.3.10.3.

*** Documentation of operability not required.

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 Specifications LCO 3.3.10.)

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 Modes 1, 2, 3, 4
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 Modes 1, 2, 3, 4
4. STEAM GENERATOR BLOWDOWN VENT SYSTEM					
a. Noble Gas Activity Monitor	D	M	R(3)	Q(2)	Above 210°F Modes 1, 2, 3, 4
5. MAIN STEAM SAFETY AND DUMP VALVE DISCHARGE LINE					
a. Gross Gamma Activity Monitor	D	M	R(3)	Q(2)	Above 325°F Modes 1, 2, 3
6. ENGINEERED SAFEGUARDS PUMP ROOM VENTILATION HIGH RADIATION SYSTEM					
a. Noble Gas Activity Monitor (Technical Specifications SR 3.3.10 and SR 3.7.13.1)	12 hours	31 days	18 months (3)	31 days(1)(2)	Above 210°F Modes 1, 2, 3, 4

* 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.

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

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 500 mrems/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.

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 mrems/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).

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 mrads for gamma radiation and less than or equal to 10 mrads for beta radiation, and

b. During any calendar year: Less than or equal to 10 mrads for gamma radiation and less than or equal to 20 mrads 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.

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.

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.

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.

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

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.

E. GASEOUS WASTE TREATMENT SYSTEM

1. Requirement

When gaseous waste exceeds a Xe-133 concentration of 1E-05 μCi/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.

2. Action

a. If a waste gas decay tank is required to be released with less than 15 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.

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.

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 10 times 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.

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

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.

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

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

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.

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).

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] (μCi/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[e] (Turbine Sump, Steam Generator Blowdown, and Service Water)	Continuous[f]	W Composite[f]	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

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.

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 mrems to the total body and to less than or equal to 5 mrems to any organ, and

b. During any calendar year to less than or equal to 3 mrems to the total body and to less than or equal to 10 mrems 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.

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.

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 mrems to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems.

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.

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 I.2 above.

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.

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:

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

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.

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 m^2 (500 ft^2) 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.

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.

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 m^2 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/m^2.

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.

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 and Frequency of Analysis
1. **DIRECT RADIATION**[b]	21 routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: An inner ring of stations, one in each overland meteorological sector (9) in the general area of the Site Boundary. An outer ring of stations, one in each overland meteorological sector (9) within the 12 km range from the site. The balance of the stations (3) to be placed to serve as control stations.	Quarterly	Gamma dose quarterly

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
2. **AIRBORNE**			
Radioiodine and Particulates	Samples from 5 locations. 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). 1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q (Covert-5.6 km-SE). 1 sample from a control location in the least prevalent wind direction[c] (Grand Rapids 89 km-NNE).	Continuous sample operation with sample collection weekly or more frequently if required by dust loading.	Radioiodine Canister: I-131 analysis weekly for each filter change. Particulate Sampler: Gross beta radioactivity analysis following filter change[d]. Gamma isotopic analysis[e] if gross beta >1.0 pCi/m^3.
3. **WATERBORNE**			
a. Lake (surface)	Plant lake water inlet.	Composite sample over 1-month period[f].	Gross beta (>10 pCi/l requires gamma) and tritium monthly.
b. Lake (drinking)	1 sample of South Haven drinking water supply.	Composite sample over 1-month period[f].	Gross beta (>10 pCi/l requires gamma) and tritium monthly.
	1 sample from a control location (Ludington Pumped Storage 201 km N)	Composite sample over 1-month period[f]	Gross beta (>10 pCi/l requires gamma) and tritium monthly.
c. Well (drinking)	1 grab sample per month when Palisades Park community drinking water well is in operation (Park is seasonal in operations and is only open for the summer months)	1 grab sample per month when operational	Gross beta (>10 pCi/l requires gamma) and tritium per month when Park is operational

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

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
d. Sediment from shoreline	1 sample from between north boundary and Van Buren State Park beach, approximately ½ mile north of the Plant discharge.	Semiannually	Gamma isotopic analysis[e] semiannually.
4. **INGESTION**			
a. Milk	Samples from milking animals in 3 locations between 5-8 km distance.	Monthly	Gamma isotopic[e] and I-131 analysis monthly.
	1 sample from milking animals at a control location, 15-30 km distance.	Monthly	Gamma isotopic[e] and I-131 analysis monthly.
b. Broad leaf vegetation	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.)	Monthly during growing season	Gamma isotopic[e] and I-131 analysis
	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. (NNE or NE sectors.)	Monthly during growing season	Gamma isotopic[e] and I-131 analysis
c. Fish	Sample 2 species of commercially and/or recreationally important species in vicinity of Plant discharge area. 1 sample of same species in areas not influenced by Plant discharge.	Sample in season or semiannually if they are not seasonal.	Gamma isotopic[e] and I-131 analysis.
d. Food Products	1 sample each of two principal fruit crops (blueberries and apples).	At time of harvest[g]	Gamma Isotopic[e] and I-131 analysis.

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.

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

Reporting Levels

Analysis	Water (pCi/l)	Airborne Particulates or Gases (pCi/m^3)	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	

* 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.

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/m^3)	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	60	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.

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:

$$LLD = \frac{4.66 s_b}{E \cdot V \cdot 2.22 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

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.

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.

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.

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

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.

<u>or</u>

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.

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.

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.

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.

4. Bases

The requirement, actions, and surveillance requirements are the same as contained in the Technical Specifications 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 prior to May 1 of each year. The report shall follow the guidance contained in Regulatory Guide 1.21 Revision 2, Section 8, Format and Content of the Annual Radioactive Effluent release Report.

B. RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

The Radiological Environmental Operating Report covering the operation of the unit during the previous calendar year shall be submitted prior to May 15 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.

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.

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[b]	Control Locations Mean(f)[b] Range[b]	Number of REPORTABLE OCCURRENCES
Air Particulates (pCi/m^3)	Gross ß 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).

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

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 General Manager Plant Operations.

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.

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.

VI. ONSITE GROUND WATER MONITORING

Palisades installed 5 ground water monitoring wells in 2007 and added an additional 9 wells in 2008. These wells were installed in response to NEI 07-07, Industry Ground Water Protection Initiative – Final Guidance Document. These wells are strategically placed within the Owner Controlled Area, both inside and outside the Protected Area to allow detection of radioactive contamination of ground water due to leaks or spills from plant systems.

PALISADES NUCLEAR PLANT
OFFSITE DOSE CALCULATION MANUAL

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

Process Applicability Exclusion	☐

DWFoster for JHager	/	12/28/11
Procedure Sponsor		Date
JJMiller	/	12/15/11
Technical Reviewer		Date
JHager	/	12/15/11
User Reviewer		Date
DHamilton	/	12/19/11
General Manager Plant Operations		Date

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

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TABLES

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.

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 Specifications) - 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.

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.

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.

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.

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

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 Modes 1, 2, 3, 4	3
b. Evacuation Flow Indicator (FI-0631 or FI-0632)	(1)***	Above 210°F Modes 1, 2, 3, 4	
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	6
c. Sampler Flow Rate Monitor (FE-2346)	(1)	At All Times	2
d. Hi Range Noble Gas (RIA 2327)*	(1)	Above 210°F Modes 1, 2, 3, 4	4
4. **STEAM GENERATOR BLOWDOWN VENT SYSTEM**			
a. Noble Gas Activity Monitor (RIA 2320)	(1)	Above 210°F Modes 1, 2, 3, 4	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 Modes 1, 2, 3	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 Modes 1, 2, 3, 4	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 Specifications SR 3.3.10.3.

*** Documentation of operability not required.

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 Specifications LCO 3.3.10.)

ACTION 6 - With the number of channels operable less than required by the Minimum Operable Channels requirement, effluent releases via the affected pathway may continue provided samples are continuously collected with auxiliary sampling equipment as required in Table B-1.

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**					Above 210°F Modes 1, 2, 3, 4
a. Noble Gas Activity Monitor	D	M	R(3)	Q(2)	
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 Modes 1, 2, 3, 4
4. **STEAM GENERATOR BLOWDOWN VENT SYSTEM**					
a. Noble Gas Activity Monitor	D	M	R(3)	Q(2)	Above 210°F Modes 1, 2, 3, 4
5. **MAIN STEAM SAFETY AND DUMP VALVE DISCHARGE LINE**					
a. Gross Gamma Activity Monitor	D	M	R(3)	Q(2)	Above 325°F Modes 1, 2, 3
6. **ENGINEERED SAFEGUARDS PUMP ROOM VENTILATION HIGH RADIATION SYSTEM**					
a. Noble Gas Activity Monitor (Technical Specifications SR 3.3.10 and SR 3.7.13.1)	12 hours	31 days	18 months (3)	31 days(1)(2)	Above 210°F Modes 1, 2, 3, 4

* 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.

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

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 500 mrems/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.

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 mrems/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).

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 mrads for gamma radiation and less than or equal to 10 mrads for beta radiation, and

b. During any calendar year: Less than or equal to 10 mrads for gamma radiation and less than or equal to 20 mrads 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.

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.

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.

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.

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]	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

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

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit Detection (LLD)[a] (μCi/ml)
D. Condenser Evacuation System	Continuous	Noble Gas Monitor	Noble Gases	1×10^{-6}
	W[f] Grab	W	Principal Gamma Emitters[b]	1×10^{-4}

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.

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.

f Obtain and analyze a gas sample weekly for noble gas quantification.

E. GASEOUS WASTE TREATMENT SYSTEM

1. Requirement

When gaseous waste exceeds a Xe-133 concentration of 1E-05 µCi/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.

2. Action

a. If a waste gas decay tank is required to be released with less than 15 days holdup time, the system waste gas tank contents shall be evaluated and the waste gas decay tank with the lowest dose consequence 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.

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.

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 10 times 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 NRC GENERIC LETTER 89-01 (TAC NO 75060)

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

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.

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

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

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.

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).

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] (μCi/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 Fe-55, Ni-63	5×10^{-8} 1×10^{-6}
B. Continuous Releases[e] (Turbine Sump, Steam Generator Blowdown, and Service Water)	Continuous[f]	W Composite[f]	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

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.

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 mrems to the total body and to less than or equal to 5 mrems to any organ, and

b. During any calendar year to less than or equal to 3 mrems to the total body and to less than or equal to 10 mrems 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.

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 NRC GENERIC LETTER 89-01 (TAC NO 75060)

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 mrems to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems.

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.

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 I.2 above.

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.

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:

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

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.

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 m^2 (500 ft^2) 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.

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.

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 m^2 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/m^2.

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.

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 and Frequency of Analysis
1. **DIRECT RADIATION**[b]	21 routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: An inner ring of stations, one in each overland meteorological sector (9) in the general area of the Site Boundary. An outer ring of stations, one in each overland meteorological sector (9) within the 12 km range from the site. The balance of the stations (3) to be placed to serve as control stations.	Quarterly	Gamma dose quarterly

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

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
2. **AIRBORNE**			
Radioiodine and Particulates	Samples from 5 locations. 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). 1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q (Covert-5.6 km-SE). 1 sample from a control location in the least prevalent wind direction[c] (Grand Rapids 89 km-NNE)[h].	Continuous sample operation with sample collection weekly or more frequently if required by dust loading.	Radioiodine Canister: I-131 analysis weekly for each filter change. Particulate Sampler: Gross beta radioactivity analysis following filter change[d]. Gamma isotopic[e] analysis on quarterly composite
3. **WATERBORNE**			
a. Lake (surface)	Plant lake water inlet.	Composite sample over 1-month period[f].	Gamma isotopic[e] and tritium analyses monthly.
b. Lake (drinking)	1 sample of South Haven drinking water supply.	Composite sample over 1-month period[f].	Gamma isotopic[e], gross beta, and tritium analyses monthly.
	1 sample from a control location (Ludington Pumped Storage 201 km N)	Composite sample over 1-month period[f].	Gamma isotopic[e], gross beta, and tritium analyses monthly.
c. Well (drinking)	1 grab sample per month when Palisades Park community drinking water well is in operation (Park is seasonal in operations and is only open for the summer months)	1 grab sample per month when operational	Gamma isotopic[e] and tritium analyses monthly when Park is operational.

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

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
d. Sediment from shoreline	1 sample from between north boundary and Van Buren State Park beach, approximately ½ mile north of the Plant discharge.	Semiannually	Gamma isotopic[e] analysis semiannually.
4. **INGESTION**			
a. Milk	Samples from milking animals in 3 locations between 5-8 km distance.	Monthly	Gamma isotopic[e] and I-131 analyses monthly.
	1 sample from milking animals at a control location, 15-30 km distance.	Monthly	Gamma isotopic[e] and I-131 analyses monthly.
b. Broad leaf vegetation	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.)	Monthly during growing season	Gamma isotopic[e] and I-131 analyses
	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. (NNE or NE sectors.)	Monthly during growing season	Gamma isotopic[e] and I-131 analyses
c. Fish	Sample 2 species of commercially and/or recreationally important species in vicinity of Plant discharge area. 1 sample of same species in areas not influenced by Plant discharge.	Sample in season or semiannually if they are not seasonal.	Gamma isotopic[e] analysis
d. Food Products	1 sample each of two principal fruit crops (blueberries and apples).	At time of harvest[g]	Gamma isotopic[e] and I-131 analyses.

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.

h The Control Air sample results from Cook Nuclear Plant, except Coloma, may be used as a backup of the Grand Rapids control.

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

Reporting Levels

Analysis	Water (pCi/l)	Airborne Particulates or Gases (pCi/m^3)	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	

* 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.

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/m^3)	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	15		130			
Co-60	15		130			
Zn-65	30		260			
Zr-95	30					
Nb-95	15					
I-131	1[d]	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140	60			60		
La-140	15			15		

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

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:

$$LLD = \frac{4.66 \times s_b}{E \times V \times 2.22 \times Y \times Exp(-\lambda \Delta t)}$$

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.

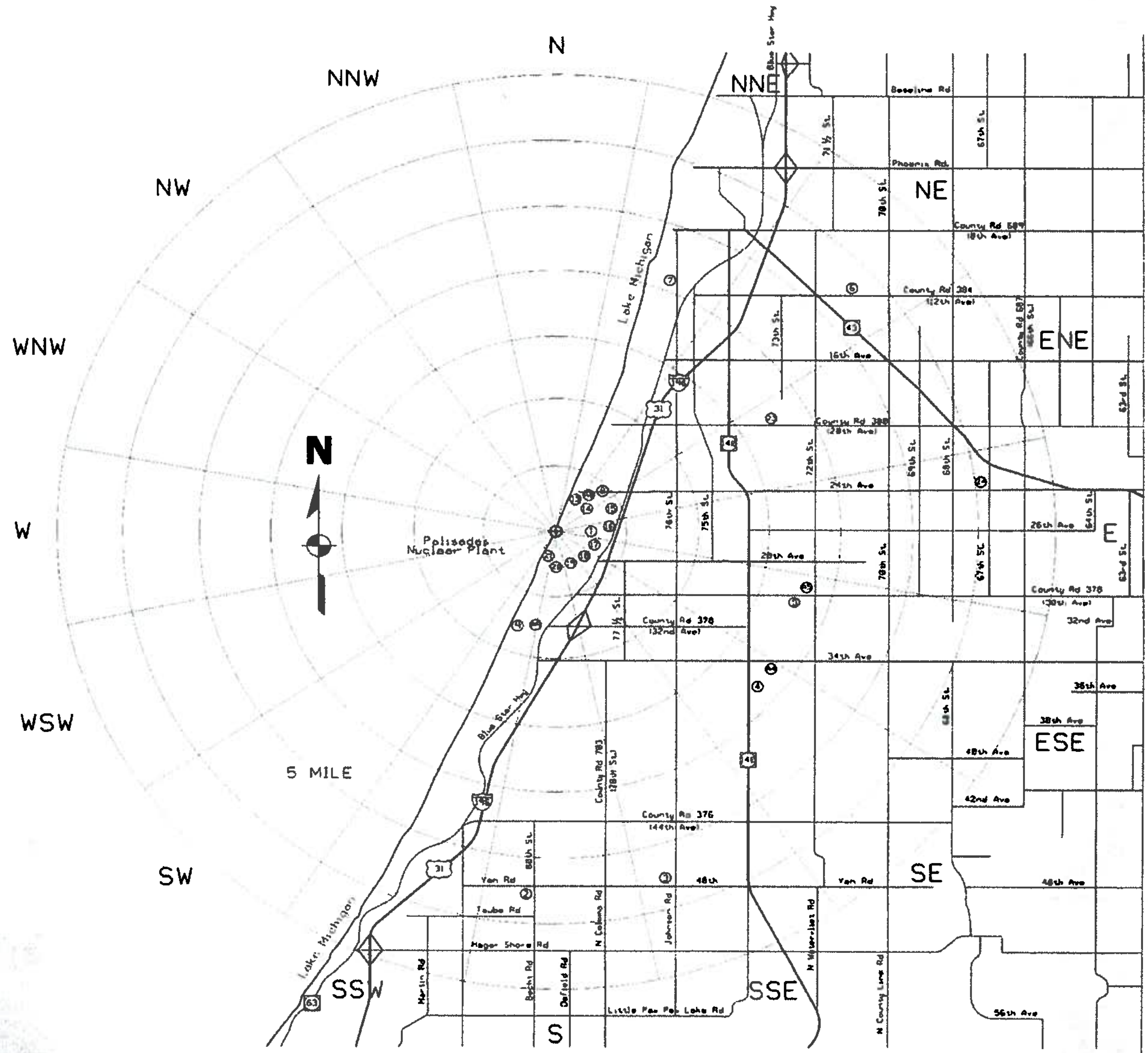
Typical values of E, V, Y, and Δt should be used in the calculation.

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.

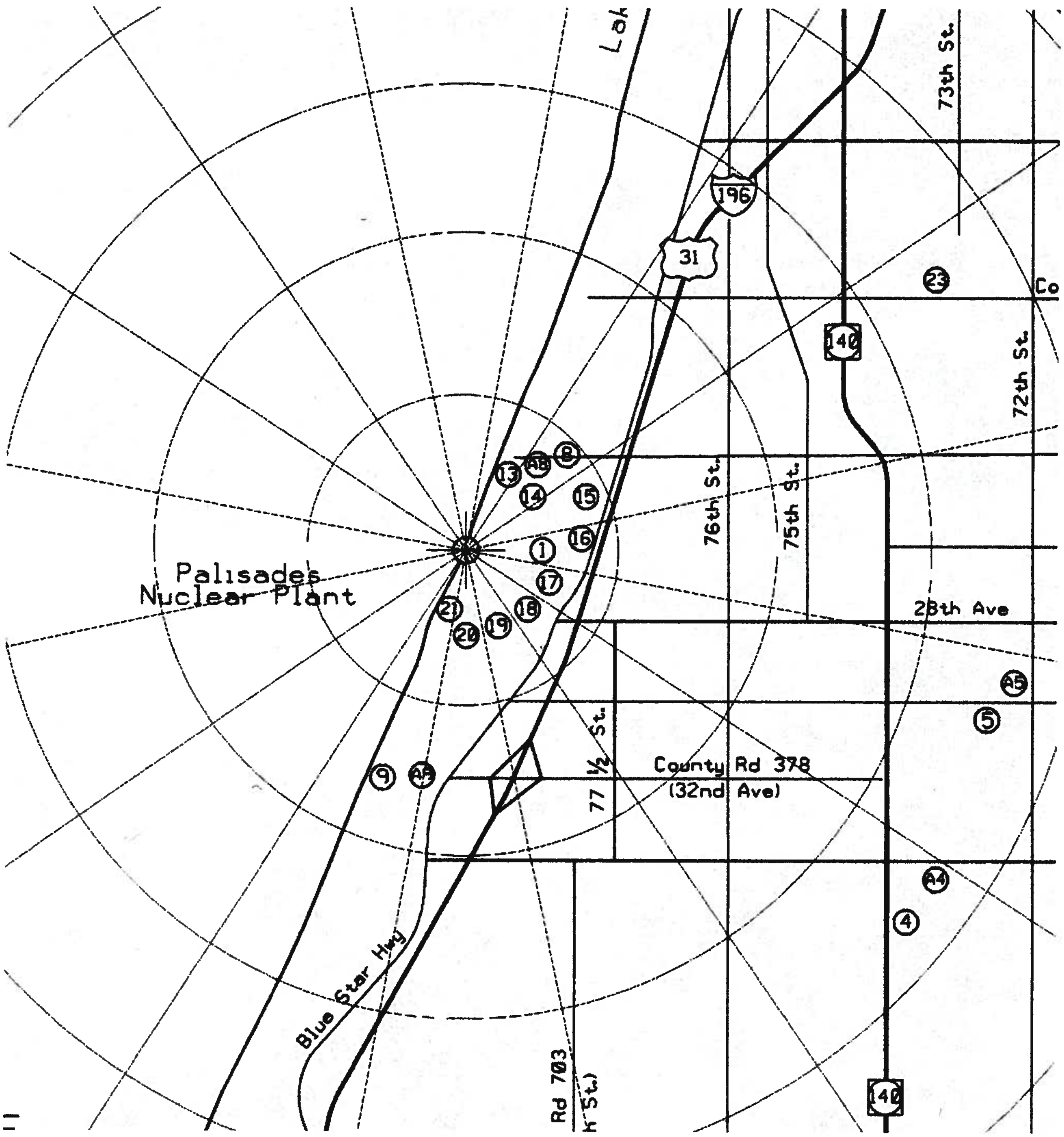
Table E-4
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM LOCATIONS
Seven Mile Map



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

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM LOCATIONS

Four Mile Map



RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM LOCATIONS

TLDs

Location	Coordinates	Distance (miles)	Degrees	Sector
Stack	N 42 19 23.5 W 86 18 51.6			
1	N 42 19 20.7 W 86 18 36.1	0.507	96.09	E
Inner Ring				
13	N 42 19 47.2 W 86 18 34.1	0.518	28.62	NNE
8	N 42 19 46.8 W 86 18 24.0	0.594	41.21	NE
14	N 42 19 41.1 W 86 18 21.2	0.548	51.93	NE
15	N 42 19 42.3 W 86 17 58.1	0.838	64.94	ENE
16	N 42 19 28.0 W 86 17 54.6	0.814	83.9	E
17	N 42 19 10.5 W 86 18 13.9	0.590	114.98	ESE
18	N 42 19 4.2 W 86 18 28.9	0.491	138.96	SE
19	N 42 19 0.9 W 86 18 39.7	0.465	158.69	SSE
20	N 42 19 1.1 W 86 18 48.8	0.432	174.42	S
21	N 42 19 3.4 W 86 18 58.4	0.397	194.02	SSW
Outer Ring - Displayed on 7 mile map				
7	N 42 22 40.8 W 86 17 0.4	4.102	22.6	NNE
6	N 42 22 30.6 W 86 14 15.9	5.309	47.42	NE
23	N 42 20 44.7 W 86 15 35.3	3.191	60.75	ENE
24	N 42 19 59.4 W 86 11 49.4	6.029	83.4	E
5	N 42 18 27.6 W 86 14 57.5	3.491	107.87	ESE
4	N 42 17 10.8 W 86 15 43.5	3.690	133.63	SE
3	N 42 14 38.0 W 86 16 59.7	5.704	163.82	SSE

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM LOCATIONS

TLDs

Location	Coordinates	Distance (miles)	Degrees	Sector
2	N 42 14 33.4 W 86 19 16.4	5.578	183.62	S
9	N 42 18 1.6 W 86 19 34.6	1.686	201.22	SSW
Control TLDs				
10	N 42 53 16.5 W 85 40 36.1	50.727	39.51	NE
11	N 42 15 24.4 W 85 32 49.4	39.749	96.42	E
12	N 41 56 54.3 W 86 6 24.5	27.989	157.61	SSE

TLD 10 is located within the Consumers Energy Grand Rapids service facility attached to a pole located adjacent to the south fence.

TLD 11 is located within Consumers Energy Kalamazoo service facility attached ot a pole in the far NE corner of the facility, past the employee parking lot.

TLD 12 is located approximately 30 yards from the road, NE and next to a private residence located at 58399 Wilbur Road, Dowagiac, Mi.

Air Sample Stations

Location	Coordinates	Distance (miles)	Degrees	Sector
A8 (State Park)	N 42 19 46.8 W 86 18 24.8	0.587	40.38	NE
A9 (Township Park)	N 42 18 4.6 W 86 19 11.2	1.539	190.40	S
A4 (Covert)	N 42 17 12.1 W 86 15 21.7	3.903	130.22	SE
A5 (Rood)	N 42 18 30.5 W 86 14 47.8	5.804	106.36	ESE
A10 (Grand Rapids)	N 42 53 16.5 W 85 40 36.1	50.727	39.51	NE

Air Sample Station 10 is located within Consumers Energy Grand Rapids service facility, south side, next to a small service building and due east of TLD 10.

Control fish and water samples are obtained from the Consumers Energy Pump Storage Facility located in Ludington, Mi

K. SIRW OR TEMPORARY LIQUID STORAGE TANK

1. Requirement

The concentration of radioactive material (excluding tritium and noble gases) 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.

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

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.

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.

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.

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.

4. Bases

The requirement, actions, and surveillance requirements are the same as contained in the Technical Specifications 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 (RERR) shall be submitted in accordance with 10CFR 50.36a prior to May 1 of each year. The report shall include a summary of the quantities of liquid and gaseous effluents and solid waste released as outlined in Regulatory Guide 1.21, R1, Measuring, Evaluating and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Material in Liquid and Gaseous Effluents from Light Water Cooled Nuclear Power Plants, with data summarized on a quarterly basis following the format of Appendix B, thereof.

The following information shall also be included in the RERR:

- Assessment of the radiation doses due to the liquid and gaseous effluents released during the previous year
- Inoperable effluent radiation monitors that exceeded 30 continuous days; explain causes of inoperability and actions taken to prevent reoccurrence
- Evaluation to show conformance with 40 CFR 190, Environmental Radiation Protection Standards for Nuclear Power Operation
- Unplanned releases of radioactive materials in gaseous or liquid effluents to unrestricted areas on a quarterly basis
- Any changes to this procedure made during the reporting period
- Groundwater monitoring results taken in support of the Groundwater Protection Initiative, but are not part of the REMP

Solid radioactive waste data shall be reported as follows:

- Type of waste (example: spent resin, dry waste. Irradiated components)
- Volume in cubic meters, include estimated error
- Curie quantity per type of waste, include estimated error
- Principal radionuclides in each category
- Disposition of waste shipments and irradiated fuel shipments (identify number of shipments mode of transport and destination)

B. RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

The Radiological Environmental Operating Report covering the operation of the unit during the previous calendar year shall be submitted prior to May 15 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.

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.

Table F-1
Environmental Radiological Monitoring Program Summary

Name of Facility ______________________ Docket No ______________

Location of Facility (County, State) ______________________ Reporting Period______________

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[b]	Control Locations Mean(f)[b] Range[b]	Number of REPORTABLE OCCURRENCES
Air Particulates (pCi/m^3)	Gross ß 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).

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

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 General Manager Plant Operations.

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.

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.

VI. ONSITE GROUND WATER MONITORING

Palisades installed 5 ground water monitoring wells in 2007 and added an additional 9 wells in 2008. These wells were installed in response to NEI 07-07, Industry Ground Water Protection Initiative – Final Guidance Document. These wells are strategically placed within the Owner Controlled Area, both inside and outside the Protected Area to allow detection of radioactive contamination of ground water due to leaks or spills from plant systems.

ENCLOSURE 2

PALISADES NUCLEAR PLANT

JOINT FREQUENCY TABLES – MET DATA

32 Pages Follow

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 1/1/11 - 3/31/11
Stability Class: A
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N		2	3	1			6
NNE		2	3				5
NE		6	1				7
ENE		3	1				4
E		2					2
ESE				2	1		3
SE		2	2				4
SSE		5	6				11
S		2	3				5
SSW		3	2	1			6
SW		2	8				10
WSW		6	3				9
W			2				2
WNW		3	5				8
NW		6	15				21
NNW		1	35	9			45
Total		45	89	13	1		148

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 39

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 1/1/11 - 3/31/11
Stability Class: B
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N			2	1			3
NNE	1	2	2				5
NE		1	1				2
ENE		1	1				2
E							0
ESE		1		1			2
SE			4				4
SSE		2	1	2			5
S		1	1				2
SSW							0
SW		2	4				6
WSW		8	2	1			11
W			1				1
WNW		3	2				5
NW			6				6
NNW		1	14	5			20
Total	1	22	41	10			74

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 39

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 1/1/11 - 3/31/11
Stability Class: C
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N		3	8	3			14
NNE			1				1
NE		1	2				3
ENE		1					1
E		1	3	1			5
ESE			1	3	1		5
SE		2	6	1	3		12
SSE		3	6	2			11
S		7					7
SSW		2	3				5
SW		5	3	3			11
WSW		2	4	1			7
W		2	3	1			6
WNW		3	2				5
NW		5	5				10
NNW		5	6				11
Total		42	53	15	4		114

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 39

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 1/1/11 - 3/31/11
Stability Class: D
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	5	38	73	9			125
NNE	3	22	24				49
NE	2	21	17	5	1		46
ENE	4	13	26	10	4		57
E	6	8	20	4			38
ESE	2	8	25	18	6		59
SE	5	18	37	37	4		101
SSE	7	52	28	29			116
S	14	58	16				88
SSW	6	25	6				37
SW		26	38	5			69
WSW		10	35	13			58
W	1	20	67	21			109
WNW	4	22	61	10			97
NW	6	26	66	37			135
NNW	1	24	35	43			103
Total	66	391	574	241	15		1287

Periods of Calm (hours): 2
Variable direction: 0
Hours of Missing Data: 39

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 1/1/11 - 3/31/11
Stability Class: E
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	12	2				15
NNE	1	27					28
NE	1	28					29
ENE	2	28	15				45
E	4	7	4				15
ESE	1	6	9				16
SE	5	5	23	4			37
SSE	5	22	13	1			41
S	3	24	19				46
SSW	2	13	10	1			26
SW		7	10	6			23
WSW		2	7	5			14
W	2	6	6	6	1		21
WNW	3	6	7	1			17
NW	2	2	4				8
NNW	2	10	1				13
Total	34	205	130	24	1		394

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 39

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 1/1/11 - 3/31/11
Stability Class: F
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	1					2
NNE	1	4					5
NE		5					5
ENE		6	1				7
E	1	7					8
ESE	1	4	2				7
SE	2	7	2				11
SSE		20					20
S		7					7
SSW							0
SW							0
WSW				1			1
W		2		1			3
WNW			5				5
NW			2				2
NNW		1					1
Total	6	64	12	2			84

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 39

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 1/1/11 - 3/31/11
Stability Class: G
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N							0
NNE							0
NE		2					2
ENE		2					2
E		2					2
ESE							0
SE							0
SSE		6					6
S		4	1				5
SSW							0
SW							0
WSW							0
W							0
WNW							0
NW							0
NNW		1					1
Total		17	1				18

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 39

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 1/1/11 - 3/31/11
Stability Class: All
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	7	56	88	14			165
NNE	6	57	30				93
NE	3	64	21	5	1		94
ENE	6	54	44	10	4		118
E	11	27	27	5			70
ESE	4	19	37	24	8		92
SE	12	34	74	42	7		169
SSE	12	110	54	34			210
S	17	103	40				160
SSW	8	43	21	2			74
SW		42	63	14			119
WSW		28	51	21			100
W	3	30	79	29	1		142
WNW	7	37	82	11			137
NW	8	39	98	37			182
NNW	3	43	91	57			194
Total	107	786	900	305	21		2119

Periods of Calm (hours): 2
Variable direction: 0
Hours of Missing Data: 39

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 4/1/11 - 6/30/11
Stability Class: A
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Direction	Wind Speed (MPH) 1-3	4-7	8-12	13-18	19-24	>24	Total
N			1				1
NNE	1	1	1				3
NE		3	8	2			13
ENE	1		3				4
E	1	2	3	1			7
ESE	1	2	3				6
SE		5	8	7	2		22
SSE		7	6	1			14
S		6	10	1			17
SSW		1	2				3
SW		10	15	1			26
WSW		7	13				20
W	2	22	2	1			27
WNW	4	29	9				42
NW	4	20	12				36
NNW		20	29	5			54
Total	14	135	125	19	2		295

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 3

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 4/1/11 - 6/30/11
Stability Class: B
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N		1	1				2
NNE			1				1
NE		3	2				5
ENE		2	1				3
E		3	2				5
ESE		3	5	3			11
SE		1	5	5	1		12
SSE		1	5	2			8
S		1	1				2
SSW		1	1				2
SW		5	4	1			10
WSW		2	3				5
W		6	4	1			11
WNW	2	4	6				12
NW		6	1				7
NNW	1	5	9				15
Total	3	44	51	12	1		111

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 3

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 4/1/11 - 6/30/11
Stability Class: C
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N		1	2				3
NNE		2	2				4
NE		2	3				5
ENE		1	2				3
E		1	2				3
ESE		1	10		3		14
SE		2	4	6	1		13
SSE		2	3	1	2		8
S		2	1				3
SSW			2				2
SW		3	8				11
WSW		2	10				12
W	1	4	3	2			10
WNW	4	4	2				10
NW	2	5					7
NNW		6	6				12
Total	7	38	60	9	6		120

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 3

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 4/1/11 - 6/30/11
Stability Class: D
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	5	21	10				36
NNE	1	10	11				22
NE	2	15	20				37
ENE	2	12	15	3			32
E	1	24	26	15	1		67
ESE	3	8	39	45	16		111
SE	2	17	44	51	8		122
SSE	3	21	17	7	1		49
S	3	10	8	1			22
SSW		14	2	2			18
SW	1	24	32	4			61
WSW	6	9	16				31
W	8	47	15	14			84
WNW	10	25	11	1			47
NW	5	18	16	2			41
NNW	3	32	23	2			60
Total	55	307	305	147	26		840

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 3

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 4/1/11 - 6/30/11
Stability Class: E
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	5	22	5	2			34
NNE	3	16					19
NE	1	15	2				18
ENE	3	12	1				16
E	1	10	4				15
ESE	2	11	16	2			31
SE	3	27	28	2			60
SSE	1	25	24	7			57
S	2	27	4				33
SSW	3	20	2	1			26
SW	3	8	20	3			34
WSW	6	11	16				33
W	5	10	9				24
WNW	7	10	5				22
NW	5	7	3				15
NNW	10	22	4	2			38
Total	60	253	143	19			475

Periods of Calm (hours): 5
Variable direction: 0
Hours of Missing Data: 3

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 4/1/11 - 6/30/11
Stability Class: F
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	2	6	1				9
NNE		6					6
NE	3	11					14
ENE	2	6	1				9
E	1	6					7
ESE	6	14	1				21
SE	3	19	1				23
SSE	1	7	3				11
S	2	11		1			14
SSW	4	3					7
SW	3	2	1				6
WSW			2				2
W	2	2	3				7
WNW	7	6					13
NW	4	5	1				10
NNW	6	8					14
Total	46	112	14	1			173

Periods of Calm (hours): 1
Variable direction: 0
Hours of Missing Data: 3

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 4/1/11 - 6/30/11
Stability Class: G
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	6					7
NNE	3	3					6
NE	3	3					6
ENE		5					5
E	5	13					18
ESE	1	15					16
SE	2	19	2				23
SSE	6	15	1				22
S	3	17					20
SSW	2	4	1				7
SW							0
WSW	1						1
W	4	1					5
WNW	5	1					6
NW	9	1					10
NNW	7	1					8
Total	52	104	4				160

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 3

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 4/1/11 - 6/30/11
Stability Class: All
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	13	57	20	2			92
NNE	8	38	15				61
NE	9	52	35	2			98
ENE	8	38	23	3			72
E	9	59	37	16	1		122
ESE	13	54	74	50	19		210
SE	10	90	92	71	12		275
SSE	11	78	59	18	3		169
S	10	74	24	3			111
SSW	9	43	10	3			65
SW	7	52	80	9			148
WSW	13	31	60				104
W	22	92	36	18			168
WNW	39	79	33	1			152
NW	29	62	33	2			126
NNW	27	94	71	9			201
Total	237	993	703	207	35		2175

Periods of Calm (hours): 6
Variable direction: 0
Hours of Missing Data: 3

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 7/1/11 - 9/30/11
Stability Class: A
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	4	5				10
NNE	1	1					2
NE		6					6
ENE		5					5
E	1						1
ESE	2	2	2				6
SE	1	5	4				10
SSE	1	8	4				13
S		3	1				4
SSW	1	1					2
SW		5	2				7
WSW		7	1				8
W	3	9					12
WNW	1	21		1			23
NW	4	40	3		2		49
NNW	1	29	48	1			79
Total	17	146	70	2	2		237

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 0

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 7/1/11 - 9/30/11
Stability Class: B
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Direction	Wind Speed (MPH) 1-3	4-7	8-12	13-18	19-24	>24	Total
N		1	6				7
NNE							0
NE		4					4
ENE		3					3
E	1						1
ESE		1	3	1			5
SE	1		2	2			5
SSE	1	4	2	1			8
S		1					1
SSW		2					2
SW	3	5	2				10
WSW	1	9	1				11
W	2	3	1				6
WNW		6					6
NW		16	1				17
NNW	1	7	14				22
Total	10	62	32	4			108

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 0

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 7/1/11 - 9/30/11
Stability Class: C
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	2	4				7
NNE	4	1	1				6
NE	2	2					4
ENE	2	2					4
E		4					4
ESE	1	2	3	1			7
SE	1	3	6				10
SSE	1	1	4	1			7
S		2	1				3
SSW	2	1					3
SW	1	8	7				16
WSW	2	6	1				9
W	4	6	1				11
WNW	2	8			1		11
NW	5	11	1				17
NNW	2	12	6	1	1		22
Total	30	71	35	3	2		141

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 0

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 7/1/11 - 9/30/11
Stability Class: D
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	8	18	10	3			39
NNE	5	10	1				16
NE	3	5					8
ENE	1	8					9
E	1	7	2				10
ESE	5	16	5	3			29
SE	1	8	21	2			32
SSE	3	16	9				28
S	1	4	2				7
SSW	6	13					19
SW	9	38	19				66
WSW	7	20	5				32
W	10	19	3	1			33
WNW	14	13					27
NW	18	35	10		1		64
NNW	11	34	26	4	9	2	86
Total	103	264	113	13	10	2	505

Periods of Calm (hours): 1
Variable direction: 0
Hours of Missing Data: 0

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 7/1/11 - 9/30/11
Stability Class: E
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Direction	Wind Speed (MPH) 1-3	4-7	8-12	13-18	19-24	>24	Total
N	10	43	10	1			64
NNE	2	23	3				28
NE	8	16					24
ENE	7	11	1				19
E	6	8					14
ESE	6	24	13				43
SE	2	26	17	1			46
SSE	8	38	9				55
S	8	21					29
SSW	10	11	1				22
SW	11	33	23				67
WSW	6	21	2				29
W	4	17	3	1			25
WNW	18	16	4				38
NW	17	15	5				37
NNW	17	42	17				76
Total	140	365	108	3			616

Periods of Calm (hours): 2
Variable direction: 0
Hours of Missing Data: 0

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 7/1/11 - 9/30/11
Stability Class: F
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	7	12					19
NNE	6	9					15
NE	8	11					19
ENE	14	14					28
E	5	9					14
ESE	5	15	6				26
SE	8	26	8				42
SSE	10	32	2				44
S	19	21					40
SSW	9	16					25
SW	6	7					13
WSW	2						2
W	9						9
WNW	4	4	1				9
NW	2						2
NNW	10	6					16
Total	124	182	17				323

Periods of Calm (hours): 6
Variable direction: 0
Hours of Missing Data: 0

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 7/1/11 - 9/30/11
Stability Class: G
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N		3					3
NNE	1	2					3
NE	3	6					9
ENE	4	19	1				24
E	8	13					21
ESE	3	5					8
SE	9	10	1				20
SSE	10	60					70
S	6	73					79
SSW	7	13					20
SW	2						2
WSW	3						3
W	1						1
WNW							0
NW							0
NNW		4					4
Total	57	208	2				267

Periods of Calm (hours): 1
Variable direction: 0
Hours of Missing Data: 0

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 7/1/11 - 9/30/11
Stability Class: All
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Direction	Wind Speed (MPH) 1-3	4-7	8-12	13-18	19-24	>24	Total
N	27	83	35	4			149
NNE	19	46	6				71
NE	24	50					74
ENE	28	62	2				92
E	22	41	2				65
ESE	22	65	32	5			124
SE	23	78	59	5			165
SSE	34	159	30	2			225
S	34	125	4				163
SSW	35	57	1				93
SW	32	96	53				181
WSW	21	63	10				94
W	33	54	8	2			97
WNW	39	68	5	1	1		114
NW	46	117	20		3		186
NNW	42	134	111	6	10	2	305
Total	481	1298	378	25	14	2	2198

Periods of Calm (hours): 10
Variable direction: 0
Hours of Missing Data: 0

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 10/1/11 - 12/31/11
Stability Class: A
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N			10	3			13
NNE		3	1	2			6
NE							0
ENE		2					2
E		1					1
ESE							0
SE		3	2				5
SSE	1	10	12				23
S		16	18	1			35
SSW		4	5	1			10
SW	2	7					9
WSW		4					4
W	2	4	9	1			16
WNW	1	8	4	3	3		19
NW	1	12	4	5	1		23
NNW		6	5	3	9		23
Total	7	80	70	19	13		189

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 0

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 10/1/11 - 12/31/11
Stability Class: B
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N			3	5	2		10
NNE		1					1
NE							0
ENE			1				1
E		1					1
ESE		2					2
SE			3				3
SSE		6	4				10
S		4	4	1			9
SSW		3	1				4
SW		9	2				11
WSW		2	1				3
W		1	1	4			6
WNW	1	3	6				10
NW		4	3				7
NNW		1	1		1		3
Total	1	37	30	10	3		81

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 0

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 10/1/11 - 12/31/11
Stability Class: C
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Direction	Wind Speed (MPH) 1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	1	6	4			12
NNE		1					1
NE		1	1				2
ENE		1					1
E		1					1
ESE							0
SE		2	3				5
SSE		1	4	1			6
S		4	6	1			11
SSW		3	5	1			9
SW	1	9	4				14
WSW		3	3				6
W	3	2	5	1			11
WNW	2	4	5	1			12
NW	2	6	2	1			11
NNW		2	2				4
Total	9	41	46	10			106

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 0

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 10/1/11 - 12/31/11
Stability Class: D
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N		23	22	10			55
NNE	2	33	31	5			71
NE	5	56	19				80
ENE	1	10	10	2			23
E	2	6	2	6	1		17
ESE	2	4	5				11
SE	4	9	23	4			40
SSE	4	43	24	20			91
S	5	46	43	5			99
SSW	4	33	41	2			80
SW	4	22	42	3			71
WSW	8	15	17	2			42
W	3	23	59	20	1		106
WNW	4	26	85	39	1		155
NW	1	29	53	22			105
NNW	1	19	16	18	10		64
Total	50	397	492	158	13		1110

Wind Speed (MPH)

Periods of Calm (hours): 3
Variable direction: 0
Hours of Missing Data: 0

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 10/1/11 - 12/31/11
Stability Class: E
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	7	6				14
NNE	1	5					6
NE	2	12					14
ENE	1	4	12				17
E	5	3	4	3			15
ESE	3	12	2	1			18
SE	4	14	15	4			37
SSE	5	33	40	6			84
S	3	98	13				114
SSW	4	16	5				25
SW	5	8	11	2			26
WSW		6	1	2			9
W	2	4	3				9
WNW		6	2				8
NW		4	1	1			6
NNW	3	8	4				15
Total	39	240	119	19			417

Periods of Calm (hours): 2
Variable direction: 0
Hours of Missing Data: 0

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 10/1/11 - 12/31/11
Stability Class: F
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	3	1					4
NNE		7					7
NE	1	2					3
ENE	1	4					5
E							0
ESE		7	3				10
SE	4	25	2				31
SSE	2	31	11				44
S	2	25					27
SSW		1	1				2
SW	1	1					2
WSW							0
W	1						1
WNW	4						4
NW	2	1					3
NNW	2						2
Total	23	105	17				145

Periods of Calm (hours): 1
Variable direction: 0
Hours of Missing Data: 0

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 10/1/11 - 12/31/11
Stability Class: G
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	1	1					2
NNE	2	2					4
NE	2						2
ENE	2	4					6
E	3	4					7
ESE	3	6					9
SE		18					18
SSE	4	62					66
S	1	37					38
SSW		1					1
SW							0
WSW							0
W							0
WNW							0
NW							0
NNW	1						1
Total	19	135					154

Periods of Calm (hours): 0
Variable direction: 0
Hours of Missing Data: 0

Hours are not adjusted for Daylight Savings Time.

SITE: Palisades

Hours at each Wind Speed and Direction

Period of Record: 10/1/11 - 12/31/11
Stability Class: All
Elevation: Speed: SP10M Direction: DIR10M Lapse:DT50M

Wind Speed (MPH)

Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	Total
N	6	33	47	22	2		110
NNE	5	52	32	7			96
NE	10	71	20				101
ENE	5	25	23	2			55
E	10	16	6	9	1		42
ESE	8	31	10	1			50
SE	12	71	48	8			139
SSE	16	186	95	27			324
S	11	230	84	8			333
SSW	8	61	58	4			131
SW	13	56	59	5			133
WSW	8	30	22	4			64
W	11	34	77	26	1		149
WNW	12	47	102	43	4		208
NW	6	56	63	29	1		155
NNW	7	36	28	21	20		112
Total	148	1035	774	216	29		2202

Periods of Calm (hours): 6
Variable direction: 0
Hours of Missing Data: 0

Hours are not adjusted for Daylight Savings Time.

ATTACHMENT 2
BIG ROCK POINT INDEPENDENT SPENT FUEL STORAGE INSTALLATION
2011 RADIOACTIVE EFFLUENT RELEASE REPORT

This report provides information relating to radioactive effluent releases and solid radioactive waste disposal at Big Rock Point (BRP) for the year 2011. The report format is detailed in the BRP Offsite Dose Calculation Manual (ODCM). Effluent releases from BRP are controlled by the Defueled Technical Specifications and the ODCM requirements. The ODCM was not revised in 2011.

<u>2011 Operating History</u>

On January 8, 2007, the Nuclear Regulatory Commission (NRC) approved release of the former BRP Nuclear Plant property for unrestricted use in accordance with the BRP License Termination Plan[1]. On April 11, 2007, the license for BRP, DPR-6, was transferred to Entergy Nuclear Operations, Inc.

During 2011, normal independent spent fuel installation (ISFSI) operations continued. There were no operational activities that generated any solid radioactive waste.

Liquid and gaseous effluent monitoring is no longer conducted as the former BRP nuclear plant property has been released from the license. Short-lived radionuclides, including iodines and noble gas, are neither expected nor reported.

1. <u>Supplemental Information</u>

   A. Batch Releases

      There were no batch releases of gaseous or liquid effluents during 2011. All batch releases of radioactive liquids as described in the ODCM ceased in 2004.

   B. Abnormal Releases

      There were no abnormal releases from BRP during 2011.

   C. Radioactive Effluent Monitoring Instrumentation

      All plant-installed liquid and gaseous radioactive effluent monitoring instrument channels have been permanently removed and dismantled.

2. <u>Gaseous Effluents</u>

   Although there were no gaseous effluents released during 2011, Table 1 provides a summary of all gaseous radioactive effluent monitoring conducted during the reporting period as required by the ODCM.

[1] Letter from the USNRC dated January 8, 2007, "Release of Land from Part 50 License for Unrestricted Use"

3. Liquid Effluents

There were no liquid effluent batch releases during 2011. Table 2 lists and summarizes liquid effluent releases in accordance with the ODCM.

4. Solid Waste

There was no solid radioactive waste generated or shipped during 2011.

5. Summary of Radiological Impact on Man

The ODCM specifies that the annual effluent release report provide potential dose calculations based on measured effluent to liquid and gaseous pathways, if estimates of dose exceed one millirem to an organ or total body of any individual or more than one person-rem to the population within 50 miles. During 2011, there were no releases. Therefore, no calculations were required.

6. Offsite Dose Calculation Manual

The ODCM describes the radiological release requirements for the BRP site. There were no revisions to the ODCM in 2011.

7. Process Control Program (PCP)

The Process Control Program (PCP) describes solid waste processing and disposal methods utilized at the BRP site. The PCP was not revised during 2011.

TABLE 1
Big Rock Point
Gaseous Effluent Releases
January 1, 2011 to December 31, 2011

A. FISSION AND ACTIVATION GASES	Units	1ST QTR	2ND QTR	3RD QTR	4TH QTR	Est Total Error %
1. Total release	Ci	N/A	N/A	N/A	N/A	N/A
2. Average release rate for period	µCi/sec	N/A	N/A	N/A	N/A	
3. Percent of annual avg EC	%	N/A	N/A	N/A	N/A	
B. IODINES						
1. Total iodine	Ci	N/A	N/A	N/A	N/A	N/A
2. Average release rate for period	µCi/sec	N/A	N/A	N/A	N/A	
3. Percent of annual avg EC	%	N/A	N/A	N/A	N/A	
C. PARTICULATES						
1. Particulates with half-life >8 day	Ci	N/A	N/A	N/A	N/A	N/A
2. Average release rate for period	µCi/sec	N/A	N/A	N/A	N/A	
3. Percent of annual avg EC	%	N/A	N/A	N/A	N/A	
4. Gross alpha radioactivity	Ci	N/A	N/A	N/A	N/A	
D. TRITIUM						
1. Total Release	Ci	N/A	N/A	N/A	N/A	
2. Average release rate for period	µCi/sec	N/A	N/A	N/A	N/A	
3. Percent of annual avg EC	%	N/A	N/A	N/A	N/A	
E. WHOLE BODY DOSE						
1. Beta Air dose at Site Boundary due to Noble Gases (ODCM Section 1, 1.3.2 a (1) (2))	mrads	N/A	N/A	N/A	N/A	
2. Percent limit	%	N/A	N/A	N/A	N/A	
3. Gamma Air dose at Site Boundary due to Noble Gas (ODCM Section 1, 1.3.2 a (1) (2))	mrads	N/A	N/A	N/A	N/A	
4. Percent limit	%	N/A	N/A	N/A	N/A	
F. ORGAN DOSE (ODCM Section 1, 1.3.2b (1) (2))						
1. Maximum organ dose to pubic based on Critical Receptors (child bone)	mrem	N/A	N/A	N/A	N/A	
2. Percent of limit (7.5 mrem/quarter)	%	N/A	N/A	N/A	N/A	

TABLE 1
Big Rock Point
Gaseous Effluent Releases
January 1, 2011 to December 31, 2011

1. FISSION GASES	Units	1ST QTR	2ND QTR	3RD QTR	4TH QTR
Krypton-85m	Ci	N/A	N/A	N/A	N/A
Krypton-87	Ci	N/A	N/A	N/A	N/A
Krypton-88	Ci	N/A	N/A	N/A	N/A
Xenon-133	Ci	N/A	N/A	N/A	N/A
Xenon-133m	Ci	N/A	N/A	N/A	N/A
Xenon-135	Ci	N/A	N/A	N/A	N/A
Xenon-135m	Ci	N/A	N/A	N/A	N/A
Xenon-138	Ci	N/A	N/A	N/A	N/A
Total for Period	Ci	N/A	N/A	N/A	N/A

2. IODINES					
Iodine-131	Ci	N/A	N/A	N/A	N/A
Iodine-132	Ci	N/A	N/A	N/A	N/A
Iodine-133	Ci	N/A	N/A	N/A	N/A
Iodine-134	Ci	N/A	N/A	N/A	N/A
Iodine-135	Ci	N/A	N/A	N/A	N/A
Total for Period	Ci	N/A	N/A	N/A	N/A

TABLE 1
Big Rock Point
Gaseous Effluent Releases
January 1, 2011 to December 31, 2011

3. PARTICULATES*	Units	1ST QTR	2ND QTR	3RD QTR	4TH QTR
Chromium-51	Ci	N/A	N/A	N/A	N/A
Manganese-54	Ci	N/A	N/A	N/A	N/A
Cobalt-58	Ci	N/A	N/A	N/A	N/A
Iron-59	Ci	N/A	N/A	N/A	N/A
Cobalt-60	Ci	N/A	N/A	N/A	N/A
Zinc-65	Ci	N/A	N/A	N/A	N/A
Silver-110m	Ci	N/A	N/A	N/A	N/A
Cesium-134	Ci	N/A	N/A	N/A	N/A
Cesium-137	Ci	N/A	N/A	N/A	N/A
Barium-140	Ci	N/A	N/A	N/A	N/A
Europium-152	Ci	N/A	N/A	N/A	N/A
Strontium-89	Ci	N/A	N/A	N/A	N/A
Strontium-90	Ci	N/A	N/A	N/A	N/A
Net unidentified beta	Ci	N/A	N/A	N/A	N/A
Total	Ci	N/A	N/A	N/A	N/A

* Particulates with half-life >8 days

TABLE 2
Big Rock Point
Liquid Effluent Releases
January 1, 2011 to December 31, 2011

A. FISSION AND ACTIVATION PRODUCTS	Units	1ST QTR	2ND QTR	3RD QTR	4TH QTR	Est Total Error %
1. Total release (not including tritium, gases, alpha)	Ci	N/A	N/A	N/A	N/A	N/A
2. Average diluted concentration during period	µCi/ml	N/A	N/A	N/A	N/A	
3. Percent of EC	%	N/A	N/A	N/A	N/A	
B. TRITIUM						
1. Total release	Ci	N/A	N/A	N/A	N/A	N/A
2. Average diluted concentration during period	µCi/ml	N/A	N/A	N/A	N/A	
3. Percent of EC	%	N/A	N/A	N/A	N/A	
C. DISSOLVED AND ENTRAINED GASES						
1. Total release	Ci	N/A	N/A	N/A	N/A	N/A
2. Average diluted concentration during period	µCi/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	Ci	N/A	N/A	N/A	N/A	
E. VOLUME OF WASTE RELEASED (Prior to dilution)	Liters	N/A	N/A	N/A	N/A	
F. VOLUME OF DILUTION WATER USED DURING PERIOD	Liters	N/A	N/A	N/A	N/A	
G. MAXIMUM DOSE COMMITMENT WHOLEBODY	mrem	N/A	N/A	N/A	N/A	
Percent of ODCM Section 1, 2.3.2 a (1.5 mrem)	%	N/A	N/A	N/A	N/A	
H. MAXIMUM DOSE COMMITMENT – ORGAN	Mrem	N/A	N/A	N/A	N/A	
Percent of ODCM Section 1, 2.3.2 b (3.0 mrem)	%	N/A	N/A	N/A	N/A	

TABLE 2
Big Rock Point
Liquid Effluent Releases
January 1, 2011 to December 31, 2011

1. NUCLIDES RELEASED	Units	1ST QTR	2ND QTR	3RD QTR	4TH QTR
Chromium-51	Ci	--	--	--	--
Manganese 54	Ci	--	--	--	--
Cobalt-58	Ci	--	--	--	--
Iron-59	Ci	--	--	--	--
Cobalt-60	Ci	--	--	--	--
Zinc-65	Ci	--	--	--	--
Strontium-89	Ci	--	--	--	--
Strontium-90	Ci	--	--	--	--
Molybdenum-99	Ci	--	--	--	--
Silver-110m	Ci	--	--	--	--
Iodine-131	Ci	--	--	--	--
Cesium-134	Ci	--	--	--	--
Cesium-137	Ci	--	--	--	--
Antimony-125	Ci	--	--	--	--
Tin-113	Ci	--	--	--	--
Net Unidentified Beta	Ci	--	--	--	--
Fission & Activation Product Total	Ci	--	--	--	--
Xenon-133	Ci	--	--	--	--
Tritium	Ci	--	--	--	--
Grand Total	Ci	--	--	--	--