Entergy

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Robert Walpole
Manager, Licensing

April 23, 2008

Re: Indian Point Units No 1, 2, 3
Docket Nos. 50-3, 50-247, 50-286
NL-08-068

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop O-P1-17
Washington, DC 20555-0001

Subject: 2007 Annual Radioactive Effluent Release Report

Dear Sir:

Enclosed are the 2007 Annual Effluent and Waste Disposal Report for Indian Point Unit Nos. 1, 2, and 3. Entergy Nuclear Operation, Inc. is submitting this report in accordance with Technical Specification 5.6.3 and Regulatory Guide 1.21.

Entergy Nuclear Operations, Inc. is making no new commitments in this letter.

Should you have any questions regarding this matter, please contact Mr. Robert Walpole, Manager, Licensing, at (914) 734-6710.

Respectfully,

Robert Walpole
Manager, Licensing
Indian Point Energy Center

Enclosure: 2007 Annual Radioactive Effluent Release Report, including Addendum 1, Offsite Dose Calculation Manual Changes and Justification Packages, 2007

cc: next page

IE48
A009
NRR

cc: Mr. Samuel J. Collins, Regional Administrator, NRC Region I
Mr. John P. Boska, Senior Project Manager, NRC NRR DORL
NRC Resident Inspector's Office, Indian Point Energy Center
Chief, Compliance Section, New York State DEC, Division of Water
Regional Water Engineer, New York State DEC
Mr. Paul Eddy, NYS Department of Public Service
Mr. Robert Oliveira, American Nuclear Insurers
Mr. Robert Snyder, NYS Department of Health
Mr. Chuck Nieder, NYS Department of Environmental Conservation

ENCLOSURE TO NL-08-68

Indian Point Energy Center

2007 Annual Radioactive Effluent Release Report

with

Addendum 1, ODCM changes and justification packages, 2007

ENTERGY NUCLEAR OPERATIONS, INC.
INDIAN POINT UNIT 1, 2, AND 3 NUCLEAR POWER PLANTS
DOCKET NOS. 50-03, 50-247, AND 50-286

Radioactive Effluent Release Report: 2007

Facility Indian Point Energy Center (Indian Point Units 1, 2, and 3)

Licensee Entergy Nuclear Operations, Inc (Entergy)

This information is provided in accordance with the requirements of Regulatory Guide 1.21. The numbered sections of this report reference corresponding sections of the subject Guide, pages 10 to 12. This report includes effluent information from Indian Point units 1, 2, and 3. Units 1 and 2 share effluent processing equipment and Technical Specifications. In this site report, releases from Unit 1 are included with Unit 2, while Unit 3 releases are calculated and shown separately.

A. Supplemental Information

1. Regulatory Limits

Indian Point Energy Center is subject to limits on radioactive waste releases that are set forth in the Offsite Dose Calculation Manual (ODCM), Parts I and II, as defined in the Technical Specifications. ODCM Part I, also known as the Radiological Effluent Controls (or RECS) contains the specific requirements and controls, while ODCM Part II (calculational methodologies) contains the details necessary to perform offsite dose calculations from the sampling and monitoring outlined in the RECS.

2. Maximum Permissible Concentration

a) Airborne Releases

Maximum concentrations and compliance with 10CFR20 release rate limits are controlled by the application of Radiation Monitor setpoints, preliminary grab sampling, and conservative procedural guidance for batch and continuous releases. These measures, in conjunction with plant design, preclude approaching release rate limits, per the ODCM.

b) Liquid Effluents

Proximity to release rate and total release limits is controlled through the application of a calculated Allowed Diluted Concentration (ADC) and ALARA guidance with regard to dilution flow and maximum tank concentration. The ADC is used to determine a Radiation Monitor setpoint associated with an estimated amount of Beta activity, as well as the measured gamma activity. ADC is defined in the station ODCM as a means of assuring compliance with the release rate limits of 10CFR20, as defined by the application of ten times the Effluent Concentrations of the new 10CFR20.

Liquid effluents are further controlled by the application of proceduralized ALARA limits such as a MINIMUM dilution flow of 100,000 gpm required for batch discharges, a maximum gamma concentration of 5E-5 uCi/ml (without gas or tritium) for routine effluents, and procedural guidance for optimizing decay and treatment of liquid waste.

3. Average Energy

The average energies ($\bar{E}$) of the radionuclide mixtures in releases of fission and activation gases were as follows:

Units 1 and 2:

1st Quarter	$\bar{E}_\beta$ =	2.48E-01 Mev/dis	$\bar{E}_\gamma$ =	1.49E-01 Mev/dis
2nd Quarter	$\bar{E}_\beta$ =	2.62E-01 Mev/dis	$\bar{E}_\gamma$ =	2.35E-01 Mev/dis
3rd Quarter	$\bar{E}_\beta$ =	2.62E-01 Mev/dis	$\bar{E}_\gamma$ =	3.80E-01 Mev/dis
4th Quarter	$\bar{E}_\beta$ =	2.06E-01 Mev/dis	$\bar{E}_\gamma$ =	2.56E-01 Mev/dis

Unit 3:

1st Quarter	$\bar{E}_\beta$ =	1.37E-01 Mev/dis	$\bar{E}_\gamma$ =	5.11E-02 Mev/dis
2nd Quarter	$\bar{E}_\beta$ =	2.67E-01 Mev/dis	$\bar{E}_\gamma$ =	1.90E-01 Mev/dis
3rd Quarter	$\bar{E}_\beta$ =	4.53E-01 Mev/dis	$\bar{E}_\gamma$ =	1.24E+00 Mev/dis
4th Quarter	$\bar{E}_\beta$ =	4.47E-01 Mev/dis	$\bar{E}_\gamma$ =	1.22E+00 Mev/dis

4. Measurements and Approximations of Total Radioactivity

a) Fission and Activation Gases

Analyses of effluent gases are performed in compliance with the requirements of the RECS (ODCM Part I). In the case of isolated tanks (batch releases), the total activity discharged is based on an isotopic analysis of each batch with the volume of gas in the batch corrected to standard temperature and pressure.

Vapor containment purge and pressure relief (vent) discharges routinely total less than 150 hours/quarter in duration have been treated as batch releases. However, both types of releases from the Vapor Containment are performed randomly with regard to time of day and duration (release periods were not dependant solely on time of day or atmospheric condition). Therefore, determination of doses due to Vapor Containment releases includes the use of annual average dispersion data, as defined in NUREG 0133, Section 3.3.

At least one complete isotopic concentration analysis of containment air is performed monthly and compared to a process monitor's reading. Pressure reliefs are quantified by scaling subsequent releases with the monitor's reading, applying the mixture from the grab sample. In this fashion, the base grab sample defines the mixture and the activity released. The monitor scales the release up or down and provides continuous indication of potential leaks.

Isotopic analyses for each vapor containment purge are taken prior to and during the purge. This information is combined with the volume of air in each discharge to calculate the quantity of activity released from these discharges.

The continuous building discharges are based on weekly samples of ventilation air analyzed for isotopic content. This information is combined with total air volume discharged and the process radiation monitor readings to determine the quantity of activity from continuous discharges.

b/c) Iodines and Particulates

Iodine-131 and particulate releases are quantified by collecting a continuous sample of ventilation air on a Triethylenediamine (TEDA) impregnated, activated charcoal cartridge and a glass-fiber filter paper. These samples are changed weekly as required in the RECS. The concentration of isotopes found by analysis of these samples is combined with the volume of air discharged during the sampling period to calculate the quantity of activity discharged.

If no I-131 is identified in weekly vent samples, "-" is entered in Table 1A. A typical Minimum Detectable Activity (MDA) for weekly I-131 analyses is 1.0E-13 uCi/cc, which is 100 times lower than ODCM requirements.

If I-131 is identified in any routine weekly sample, it is added to the table and other iodine isotopic concentrations are then determined on a 24-hour sample at least once per month. The concentration of each isotope is analytically determined by ratioing the activities with weekly media for I-131. This activity is combined with the volume of air discharged during the sampling period to calculate the quantity of activity discharged.

A compositing method of analyzing for gross alpha is used per the station ODCMs. An absence of any positive Gross Alpha value for the quarter is identified on Table 1A as "-". A typical MDA for gross alpha is 8.0E-14 uCi/cc, which is over 100 times lower than ODCM requirements.

d) Liquid Effluents

A sample of each batch discharge is taken and an isotopic analysis is performed in compliance with requirements specified in the RECS. Proportional composite samples of continuous discharges are taken and analyzed in compliance with the applicable RECS table, as well. Isotopic concentration data are combined with the information on volume discharged to determine the amount of each isotope discharged.

A compositing method of analyzing for gross alpha is used per the station ODCMs. When there has been no positive Gross Alpha identified in a quarter, "-" is entered in Table 2A. A typical MDA value for Gross Alpha in liquids is 5E-8 uCi/ml, which is two times lower than ODCM requirements.

Liquid Effluent volumes of waste released on Table 2A are differentiated between processed fluids (routine liquid waste and Unit 1's North Curtain Drain), and water discharged through monitored pathways identified in the ODCM, but NOT processed (SG Blowdown and Unit 1's Sphere Foundation Drain Sump).

The unprocessed water may still contain trace levels of contamination (generally only tritium) and as such, is identified as liquid waste and included in total curie and dose summaries in the following tables, along with all other liquid effluent, continuous or batch, processed or not.

However, to prevent confusion with regard to measures undertaken to convert liquid to solid waste (resin cleanup), the volumes of processed and unprocessed waste are reported separately.

5. Batch Releases

Airborne:

Unit 1 and 2 Airborne Releases		Qtr 1	Qtr 2	Qtr 3	Qtr 4	2007
Number of Batch Releases		39	40	47	38	164
Total Time Period	(min)	3.45E+3	3.52E+3	3.90E+3	3.65E+3	1.46E+4
Maximum Time Period	(min)	2.23E+2	1.38e+2	1.68E+2	1.68E+2	2.23E+2
Average Time Period	(min)	9.07E+1	8.81E+1	8.29E+1	9.61E+1	8.91E+1
Minimum Time Period	(min)	1.00E+1	3.90E+1	2.00E+0	3.60E+1	2.00E+0

Unit 3 Airborne Releases		Qtr 1	Qtr 2	Qtr 3	Qtr 4	2007
Number of Batch Releases		23	26	19	18	86
Total Time Period	(min)	4.85E+3	2.75E+3	1.94E+3	2.43E+3	1.20E+4
Maximum Time Period	(min)	7.20E+2	2.09E+2	2.23E+2	1.96E+2	7.20E+2
Average Time Period	(min)	2.11E+2	1.06E+2	1.02E+2	1.35E+2	1.39E+2
Minimum Time Period	(min)	2.10E+1	3.00E+0	9.00E+0	8.00E+0	3.00E+0

Liquid:

Unit 1 and 2 Liquid Releases		Qtr 1	Qtr 2	Qtr 3	Qtr 4	2007
Number of Batch Releases		10	7	8	12	37
Total Time Period	(min)	9.85E+2	7.25E+2	7.50E+2	1.06E+2	3.52E+3
Maximum Time Period	(min)	1.12E+2	1.43E+2	1.02E+2	1.15E+2	1.43E+2
Average Time Period	(min)	9.85E+1	1.04E+2	9.38E+1	8.80E+1	9.50E+1
Minimum Time Period	(min)	7.60E+1	8.40E+1	7.40E+1	2.50E+1	2.50E+1

Unit 3 Liquid Releases		Qtr 1	Qtr 2	Qtr 3	Qtr 4	2007
Number of Batch Releases		64	40	15	8	127
Total Time Period	(min)	1.05E+4	4.55E+3	1.64E+3	8.97E+2	1.76E+4
Maximum Time Period	(min)	5.56E+2	1.57E+2	1.16E+2	1.20E+2	5.56E+2
Average Time Period	(min)	1.65E+2	1.14E+2	1.09E+2	1.12E+2	1.39E+2
Minimum Time Period	(min)	1.90E+1	1.00E+2	1.02E+2	1.03E+2	1.90E+1

Average Stream Flow :

Hudson River flow information is obtained from the Department of the Interior, United States Geological Survey (USGS). These data are received after review from the USGS, approximately 18 months after initial data collection. This information is included in the effluents report as the data become available.

Estimated Average Stream Flows of the Hudson River at Indian Point:

Year	Quarter	Flow (cfs)
2005	Fourth	114400
2006	First	97900
2006	Second	95600
2006	Third	52700

6. Abnormal Releases

a) Liquid

Groundwater

The effluent contribution via ground water and storm drain discharges (broken up into six zones across the site) is discussed in Section H. The computation of these effluent contributions is comprised of two parts: 1) computing the groundwater and storm water discharges (flux), and 2) multiplying these fluxes by the measured radionuclide activity in each zone.

Groundwater flux beneath the site is calculated using a calibrated Precipitation Mass Balance model. Storm water discharge rates are generally estimated based on the yearly volume of precipitation falling on storm drain catchment areas.

Groundwater radionuclide activity is based on a yearly rolling average of analytical results from groundwater samples collected from monitoring wells. Storm drain activity is measured via water samples collected directly from the storm drains on site during the calendar year.

The average groundwater activity in each zone is multiplied by the groundwater flux in that portion of the site to obtain the effluent contribution via groundwater. The average activity in each storm water discharge point is multiplied by the estimated storm water flow rate to obtain the effluent contribution via surface water.

The resulting offsite dose from this modeling is identified in the summary of Section H, and is added to the site total summary in the opening discussion of Section E, the Dose To Man report.

Section H provides a summary of the recently completed groundwater investigation on site. Included in this section are 1) the conclusions from effluent dose modeling for 2007, 2) a conservative assessment of groundwater effluent dose from as early as 1994, and 3) per the ODCM and NEI 07-07, a summary table of all groundwater radio-analyses in 2007.

Underground pipe leak

In March 2007, a small secondary fluid leak to environment was identified on an aux steam cross-connect line from unit 2 to unit 3. The part of the line that was found leaking was underground, and wisps of steam through asphalt were the first indicators. The cross connect line was isolated and samples obtained. Regional and federal officials were notified, per the emerging NEI groundwater initiative. This particular event occurred just as the NEI final document was being prepared, and details of *underground* pipe integrity were added to the guidance as a result. An offsite dose evaluation of this steam/water release to environment indicated doses well below 0.1% of routine values, or less than 0.01% of effluent limits, even with a very conservative flow rate assessment determined from secondary system loss rate. This evaluation was performed per IE Bulletin 80-10 and resulted in repair and replacement of the pipe over a 4 month period. The secondary system contamination included no gamma isotopes and only a trace amount of tritium. Nonetheless, per the new guidance in NEI 07-07, secondary fluid at PWRs is considered "contaminated", even if this fluid only contains trace levels of tritium. This evaluation was completed to demonstrate compliance with NEI guidelines and to document no significant impact from this event.

b) Gaseous

There was an assumed trace airborne H-3 effluent as a result of the underground steam piping leak, discussed above. The actual airborne effluent contribution from the steam venting to atmosphere was assessed and determined to be well below 0.1% of routine values, and less than 0.001% of effluent limits.

7. ODCM Reporting Requirements

The ODCM (RECS) requires reporting of prolonged outages of effluent monitoring equipment. Also required in this report is notification of any changes in the land use census, the Radiological Environmental Monitoring Program (REMP), or exceeding the total curie content limitations in outdoor tanks.

ODCM Instrumentation:

During this reporting period, the following ODCM required effluent monitoring equipment was out of service (OOS) for periods greater than 30 consecutive days:

Instrument	Out of Service Period	Details
Unit 1, Waste Distillate Storage Tank Release Flow Rate Transmitter, CT-971	Jul 5, 2007 to Aug 15, 2007 (40 days)	The instrument failed its routine calibration and a replacement was deemed necessary. A new transmitter was ordered and received. Upon receipt and installation, technicians identified that the output signal shifted with no signal input. The vendor then suggested another replacement. The new instrument was tested and successfully placed in service. During this interval, three batch releases were performed, each with compensatory action completed, verifying release flow rate (by level change) at 4-hour intervals.
Unit 1, Waste Distillate Storage Tank #13 Level Transmitter, CT-968	Oct 1, 2007 to Nov 2, 2007 (32 days)	The instrument was originally taken out of service for troubleshooting. A new instrument was deemed necessary, and purchased from the vendor. Upon arrival, the work package was delayed due to administrative challenges involved in training and use of new work control software applied on site. During this interval, no releases were performed from this pathway.

7. ODCM Reporting Requirements (continued)

Other Reporting Criteria:

During this reporting period, no tank curie limits in outdoor tanks were exceeded.

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

The ODCMs were updated several times in 2007.

In January, 2007, independent, but similar ODCMs were effective at each operating unit. ODCM revision at both units (Revision 10 at unit 2, and Revision 18 at unit 3) were processed to include several significant additions and ongoing actions from the Ground Water investigation.

A month later, a revision at unit 2 followed, in February (Rev 11), to officially adopt the new 10CFR20 at unit 2, after Tech Spec approval from the NRC.

In December, the unit-specific versions of the ODCMs at IPEC were combined into Revision 0 of the IPEC ODCM, with the Controls arranged in NUREG 1431 format, identical to the previous revision for unit 2. No new controls or routine dose calculations were added in this merging and reformatting process. The necessary changes performed to complete this upgrade and some minor updates to the ground water offsite dose modeling are discussed in the justification packages.

ODCM update information is discussed in Section G. Full copies of the ODCMs and their justification packages are included as an addendum to this report.

Indian Point Energy Center

(Units 1, 2, and 3)

RADIOACTIVE EFFLUENT RELEASE REPORT

B. GASEOUS EFFLUENTS

2007

TABLE 1A

INDIAN POINT 1 and 2 RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2007)

GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

A. Fission & Activation Gases	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year 2007	Est. Total % Error
1. Total Release	Ci	6.46E-01	2.22E-01	4.38E-01	1.38E-01	1.44E+00	±25
2. Average release rate	uCi/sec	8.31E-02	2.83E-02	5.51E-02	1.73E-02	4.58E-02	

B. Iodines

1. Total Iodine-131	Ci	-	-	-	-	0.00E+00	±25
2. Average release rate	uCi/sec	-	-	-	-	0.00E+00	

C. Particulates

1. Total Release, with half-life > 8 days	Ci	-	-	-	-	0.00E+00	±25
2. Average release rate	uCi/sec	-	-	-	-	0.00E+00	
3. Gross Alpha	Ci	-	-	-	-	0.00E+00	±25

D. Tritium

1. Total release	Ci	3.45E+00	4.75E+00	4.48E+00	1.83E+00	1.45E+01	±25
2. Average release rate	uCi/sec	4.43E-01	6.04E-01	5.63E-01	2.30E-01	4.60E-01	

- Indicates < MDA

TABLE 1C
INDIAN POINT 1 and 2 CONTINUOUS GASEOUS EFFLUENTS
RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2007)

Nuclides Released

1) Fission Gases

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year 2007
Xe-131m	Ci	-	-	-	-	0.00E+00
Xe-133	Ci	-	-	-	-	0.00E+00
Xe-135	Ci	-	-	-	-	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

2) Iodines

I-131	Ci	-		-	-	0.00E+00
I-133	Ci	-	-	-	-	0.00E+00
I-135	Ci	-	-	-	-	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

3) Particulates

Co-58	Ci	-	-	-	-	0.00E+00
Cs-137	Ci	-	-	-	-	0.00E+00
Ni-63	Ci	-	-	-	-	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

- Indicates < MDA

TABLE 1C
INDIAN POINT 1 and 2 - BATCH GASEOUS EFFLUENTS
RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2007)

Nuclides Released

1) Fission Gases

	Units	**Qtr 1**	**Qtr 2**	**Qtr 3**	**Qtr 4**	**Year 2007**
Ar-41	Ci	5.16E-02	3.22E-02	9.15E-02	2.30E-02	1.98E-01
Kr-85	Ci	3.94E-01	1.13E-01	5.71E-02	1.24E-02	5.77E-01
Kr-85m	Ci	2.23E-03	9.81E-04	4.00E-03	1.05E-04	7.32E-03
Kr-87	Ci	1.89E-03	3.52E-04	3.49E-03	2.96E-05	5.75E-03
Kr-88	Ci	4.06E-03	1.45E-03	7.32E-03	9.90E-05	1.29E-02
Xe-131m	Ci	-	-	1.93E-03	3.80E-04	2.31E-03
Xe-133	Ci	1.49E-01	5.32E-02	1.96E-01	9.72E-02	4.95E-01
Xe-133m	Ci	9.43E-04	6.26E-04	1.83E-03	3.76E-04	3.78E-03
Xe-135	Ci	3.61E-02	2.05E-02	6.37E-02	4.00E-03	1.24E-01
Xe-135m	Ci	4.77E-03	7.12E-05	9.34E-03	-	1.42E-02
Xe-138	Ci	1.22E-03	-	2.33E-03	-	3.55E-03
Total for Period	Ci	6.46E-01	2.22E-01	4.38E-01	1.38E-01	1.44E+00

2) Iodines

Not Applicable for Batch Releases

3) Particulates

Not Applicable for Batch Releases

- Indicates < MDA

TABLE 1A

INDIAN POINT 3 RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2007)

GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

A. Fission & Activation Gases	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year 2007	Est. Total % Error
1. Total Release	Ci	7.54E+00	1.21E-01	1.39E-02	2.12E-02	7.70E+00	± 25
2. Average release rate	uCi/sec	9.70E-01	1.54E-02	1.75E-03	2.67E-03	2.44E-01	

B. Iodines

1. Total Iodine-131	Ci	1.42E-04	-	-	-	1.42E-04	± 25
2. Average release rate	uCi/sec	1.82E-05	-	-	-	4.49E-06	

C. Particulates

1. Total Release, with half-life > 8 days	Ci	-	-	-	-	-	± 25
2. Average release rate	uCi/sec	-	-	-	-	-	
3. Gross Alpha	Ci	-	-	-	-	-	± 25

D. Tritium

1. Total release	Ci	2.17E+00	3.94E+00	4.60E+00	2.66E+00	1.34E+01	± 25
2. Average release rate	uCi/sec	2.80E-01	5.01E-01	5.79E-01	3.34E-01	4.24E-01	

\- Indicates < MDA

TABLE 1C
INDIAN POINT 3 - CONTINUOUS GASEOUS EFFLUENTS
RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2007)

Nuclides Released

1) Fission Gases

	Units	**Qtr 1**	**Qtr 2**	**Qtr 3**	**Qtr 4**	**Year 2007**
Xe-133	Ci	5.99E+00	-	-	-	5.99E+00
Total for Period	Ci	5.99E+00	-	-	-	5.99E+00

2) Iodines

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year 2007
I-131	Ci	1.42E-04	-	-	-	1.42E-04
I-133	Ci	1.49E-05	-	-	-	1.49E-05
I-135	Ci	-	-	-	-	-
Total for Period	Ci	1.57E-04	-	-	-	1.57E-04

3) Particulates

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year 2007
Total for Period	Ci	-	-	-	-	-

- indicates < MDA

TABLE 1C
INDIAN POINT 3 - BATCH GASEOUS EFFLUENTS
RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2007)

Nuclides Released

1) Fission Gases

	Units	**Qtr 1**	**Qtr 2**	**Qtr 3**	**Qtr 4**	**Year 2007**
Ar-41	Ci	2.77E-02	1.73E-02	1.35E-02	2.02E-02	7.87E-02
Kr-85	Ci	-	8.96E-02	-	-	8.96E-02
Kr-85m	Ci	-	-	-	-	0.00E+00
Kr-87	Ci	-	-	-	-	0.00E+00
Kr-88	Ci	-	-	-	-	0.00E+00
Xe-131m	Ci	-	2.65E-04	-	-	2.65E-04
Xe-133	Ci	1.50E+00	1.40E-02	4.44E-04	1.07E-03	1.52E+00
Xe-133m	Ci	-	-	-	-	0.00E+00
Xe-135	Ci	2.23E-02	2.70E-06	1.34E-05	-	2.23E-02
Xe-135m	Ci	-	-	-	-	0.00E+00
Total for Period	Ci	1.55E+00	1.21E-01	1.39E-02	2.12E-02	1.71E+00

2) Iodines

Not Applicable for Batch Releases

3) Particulates

Not Applicable for Batch Releases

- Indicates < MDA

Indian Point Energy Center

(Units 1, 2, and 3)

RADIOACTIVE EFFLUENT REPORT

C. LIQUID EFFLUENTS

2007

TABLE 2A

INDIAN POINT 1 and 2 RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2007)

LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

A. Fission & Activation Products	Units	**Qtr 1**	**Qtr 2**	**Qtr 3**	**Qtr 4**	**Year 2007**	Est. Total % Error
1. Total Release (not including Tritium, Gr Alpha, & Gases)	Ci	9.20E-03	1.54E-02	4.56E-03	1.32E-02	4.24E-02	± 25
2. Average Diluted Conc	uCi/ml	1.94E-11	2.20E-11	5.28E-12	1.76E-11	1.52E-11	

B. Tritium

1. Total Release	Ci	3.21E+01	9.01E+01	3.55E+02	2.17E+02	6.94E+02	± 25
2. Average Diluted Conc	uCi/ml	6.76E-08	1.28E-07	4.11E-07	2.89E-07	2.49E-07	

C. Dissolved & Entrained Gases

1. Total Release	Ci	-	-	-	-	0.00E+00	± 25
2. AverageDiluted Conc	uCi/ml	-	-	-	-	0.00E+00	

D. Gross Alpha

1. Total Release	Ci	-	-	-	-	-	± 25

E. Volume of Waste Released

1. Processed (LW, NCD)	liters	2.02E+06	2.30E+06	1.33E+06	2.36E+06	8.02E+06	± 10
2. Unprocessed (SGBD, SFDS)	liters	4.14E+07	4.25E+07	3.72E+07	3.95E+07	1.61E+08	± 10

F. Volume of Dilution Water	liters	4.75E+11	7.03E+11	8.64E+11	7.48E+11	2.79E+12	± 10

\- Indicates < MDA

TABLE 2B

INDIAN POINT 1 and 2 LIQUID RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2007)

CONTINUOUS RADIOACTIVE EFFLUENT

Nuclides Released	Units	**Qtr 1**	**Qtr 2**	**Qtr 3**	**Qtr 4**	**Year 2007**
Cs-137	Ci	9.97E-04	4.03E-03	1.78E-06	9.19E-05	5.12E-03
Ni-63	Ci	-	-	-	-	0.00E+00
Sr-89	Ci	-	-	-	-	0.00E+00
Sr-90	Ci	1.21E-04	1.88E-04	8.45E-05	2.47E-04	6.41E-04
Total for Period	Ci	1.12E-03	4.22E-03	8.63E-05	3.39E-04	5.76E-03

- Indicates < MDA

TABLE 2B

INDIAN POINT 1 and 2 LIQUID RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2007)

BATCH RADIOACTIVE EFFLUENT

Nuclides Released	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year 2007
Ag-110m	Ci	-	-	-	9.42E-05	9.42E-05
Co-57	Ci	7.44E-06	3.16E-05	-	-	3.91E-05
Co-58	Ci	1.48E-03	7.91E-04	1.54E-05	-	2.28E-03
Co-60	Ci	5.71E-04	5.10E-04	7.64E-05	2.89E-04	1.45E-03
Cr-51	Ci	-	-	-	6.36E-05	6.36E-05
Cs-134	Ci	-	2.16E-05	2.06E-04	3.28E-04	5.56E-04
Cs-137	Ci	7.21E-05	2.88E-04	1.84E-03	3.28E-03	5.48E-03
Mn-54	Ci	-	-	-	3.58E-06	3.58E-06
Ni-63	Ci	2.43E-03	8.14E-03	8.06E-04	2.18E-03	1.36E-02
Sb-125	Ci	3.52E-03	1.45E-03	1.53E-03	6.60E-03	1.31E-02
Sr-90	Ci	-	8.66E-07	-	-	8.66E-07
Total for Period	Ci	8.08E-03	1.12E-02	4.47E-03	1.28E-02	3.66E-02

Dissolved & Entrained Gas

Total for Period	Ci	-	-	-	-	0.00E+00

- Indicates < MDA

TABLE 2A

INDIAN POINT 3 RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2007)

LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

A. Fission & Activation Products	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year 2007	Est. Total % Error
1. Total Release (not including Tritium, Gr Alpha, & Gases)	Ci	6.59E-03	1.45E-03	2.76E-03	7.13E-04	1.15E-02	± 25
2. Average Diluted Conc	uCi/ml	1.39E-11	2.06E-12	3.19E-12	9.53E-13	4.13E-12	

B. Tritium

1. Total Release	Ci	6.55E+02	7.72E+01	2.46E+01	1.71E+01	7.74E+02	± 25
2. Average Diluted Conc	uCi/ml	1.38E-06	1.10E-07	2.85E-08	2.28E-08	2.77E-07	

C. Dissolved & Entrained Gases

1. Total Release	Ci	3.87E-02	9.50E-04	-	-	3.96E-02	± 25
2. AverageDiluted Conc	uCi/ml	8.15E-11	1.35E-12	-	-	1.42E-11	

D. Gross Alpha

1. Total Release	Ci	-	-	-	-	-	± 25

E. Volume of Waste Released

1. Processed Fluids (Mon Tanks)	liters	1.18E+06	1.04E+06	3.88E+05	2.06E+05	2.81E+06	± 10
2. Unprocessed Fluids (SGs)	liters	7.43E+06	1.82E+07	1.64E+06	1.64E+06	2.90E+07	± 10

F. Volume of Dilution Water	liters	4.75E+11	7.03E+11	8.64E+11	7.48E+11	2.79E+12	± 10

'- indicates < MDA

TABLE 2B
INDIAN POINT 3 LIQUID RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2007)
BATCH and CONTINUOUS RADIOACTIVE LIQUID EFFLUENT

Batch Fission/Activation Products	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	2007
Ag-110m	Ci	7.33E-05			1.29E-05	8.62E-05
Co-58	Ci	1.35E-03	3.58E-04	3.78E-04	1.26E-04	2.21E-03
Co-60	Ci	2.00E-03	8.12E-05	2.68E-04	1.44E-04	2.49E-03
Cr-51	Ci	1.14E-04				1.14E-04
Cs-134	Ci	5.22E-05				5.22E-05
Cs-137	Ci	1.17E-04	1.54E-05	2.09E-06	2.52E-06	1.37E-04
Fe-55	Ci	1.17E-03	-	-	-	1.17E-03
I-131	Ci	-	4.72E-05	-	-	4.72E-05
I-132	Ci	7.91E-05	-	-	-	7.91E-05
Mn-54	Ci	1.58E-05	8.45E-07	4.05E-06	1.25E-06	2.19E-05
Nb-95	Ci	-	3.27E-06	-	1.12E-05	1.45E-05
Ni-63	Ci	8.35E-04	-	3.48E-05	2.83E-04	1.15E-03
Sb-124	Ci	-	4.41E-05	2.80E-04	-	3.24E-04
Sb-125	Ci	5.71E-04	6.44E-05	1.78E-03	1.29E-04	2.54E-03
Sn-113	Ci	-	-	-	3.10E-06	3.10E-06
Te-123m	Ci	1.39E-04	8.33E-04	1.18E-05	-	9.84E-04
Te-132	Ci	7.65E-05	-	-	-	7.65E-05
Total for Period	Ci	6.59E-03	1.45E-03	2.76E-03	7.13E-04	1.15E-02

Dissolved and Entrained Gas (Batch)

Kr-85	Ci	1.66E-03	5.35E-04	-	-	2.19E-03
Xe-133	Ci	3.70E-02	4.15E-04	-	-	3.74E-02
Xe-133m	Ci	2.41E-05		-	-	2.41E-05
Total for Period	Ci	3.87E-02	9.50E-04	0.00E+00	0.00E+00	3.96E-02

Continuous Releases (SG Blowdown)

H-3 (only)	Ci	7.59E-03	-	1.68E-03	2.62E-03	1.19E-02

'- indicates < mda

Indian Point Energy Center

(Units 1, 2, and 3)

RADIOACTIVE EFFLUENT REPORT

D. SOLID WASTE

2007

Units 1 and 2 Solid Waste Shipped Offsite for Disposal and Estimates of Major Nuclides by Waste Class and Stream 01/01/2007 to 12/31/2007

Percent Cutoff: 0 (all identified isotopes are included)

Waste Stream : Resins, Filters, and Evap Bottoms
LWS Resin — Plant Resin 8-120

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	2.00E+02	5.66E+00	1.12E-01	+/- 25%
B	1.31E+02	3.71E+00	1.23E+01	+/- 25%
C	9.50E+01	2.69E+00	2.74E+02	+/- 25%
All	4.26E+02	1.21E+01	2.86E+02	+/- 25%

Waste Stream : Dry Active Waste — DAW / Equip
DAW/Dirt;B-25 Box — DAW 20' Sea Land — Soil/Debris - Intermodal

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	2.29E+04	6.47E+02	2.09E-01	+/-25%
B	0.00E+00	0.00E+00	0.00E+00	+/-25%
C	0.00E+00	0.00E+00	0.00E+00	+/-25%
All	2.29E+04	6.47E+02	2.09E-01	+/-25%

Waste Stream : Irradiated Components

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	0.00E+00	0.00E+00	0.00E+00	+/-25%
B	0.00E+00	0.00E+00	0.00E+00	+/-25%
C	0.00E+00	0.00E+00	0.00E+00	+/-25%
All	0.00E+00	0.00E+00	0.00E+00	+/-25%

Waste Stream : Other Waste — Combined Packages

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	0.00E+00	0.00E+00	0.00E+00	+/-25%
B	0.00E+00	0.00E+00	0.00E+00	+/-25%
C	2.03E+01	5.75E-01	1.44E+01	+/-25%
All	2.03E+01	5.75E-01	1.44E+01	+/-25%

Waste Stream : Sum of All 4 Categories — Combined Packages:
DAW/Dirt; B-25 Box — DAW 20' Sea Land — LWS Resin
Soil/Debris - Intermodal — DAW-/ Equip — Plant Resin 8-120

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	2.31E+04	5.66E+00	3.21E-01	+/-25%
B	1.31E+02	3.71E+00	1.23E+01	+/-25%
C	1.15E+02	3.27E+00	2.88E+02	+/-25%
All	2.33E+04	1.26E+01	3.01E+02	+/-25%

Combined Waste Type Shipment, Major Volume Waste Type Shown

Units 1 and 2 Solid Waste Shipped Offsite for Disposal and Estimates of Major Nuclides by Waste Class and Stream 01/01/2007 to 12/31/2007

Percent Cutoff: 0

Number of Shipments	Mode of Transportation	Destination
5	Hittman Transport	Duratek, Inc. – GIC
2	Hittman Transport	Energy Solution - Bear Creek
5	Hittman Transport	Studsvik Processing Facility
35	Studsvik Logistics	Studsvik RACE

Resins, Filters, and Evap Bottoms
Waste Class A

Nuclide Name	Percent Abundance	Curies
Co-60	0.215%	2.42E-04
Cs-137	99.785%	1.12E-01

Resins, Filters, and Evap Bottoms
Waste Class B

Nuclide Name	Percent Abundance	Curies
H-3	4.440%	5.45E-01
Mn-54	0.177%	2.18E-02
Fe-55	20.133%	2.47E+00
Co-57	0.055%	6.69E-03
Co-58	1.202%	1.47E-01
Co-60	8.028%	9.85E-01
Ni-63	50.354%	6.18E+00
Sr-90	0.081%	9.97E-03
Ag-110m	0.126%	1.55E-02
Sb-125	0.112%	1.38E-02
Cs-134	1.172%	1.44E-01
Cs-137	14.120%	1.73E+00

Resins, Filters, and Evap Bottoms
Waste Class C

Nuclide Name	Percent Abundance	Curies
Mn-54	0.353%	9.67E-01
Fe-55	3.981%	1.09E+01
Co-57	0.069%	1.88E-01
Co-58	0.302%	8.28E-01
Co-60	6.136%	1.68E+01
Ni-63	36.343%	9.95E+01
Sr-90	0.089%	2.44E-01
Cs-134	18.336%	5.02E+01
Cs-137	33.969%	9.30E+01
Ce-144	0.394%	1.08E+00
Pu-238	0.001%	2.58E-03
Pu-239	0.000%	7.53E-04
Pu-241	0.024%	6.66E-02
Am-241	0.000%	5.28E-04
Cm-242	0.000%	1.29E-04
Cm-243	0.001%	1.54E-03

Resins, Filters, and Evap Bottoms
Waste Class All

Nuclide Name	Percent Abundance	Curies
H-3	0.190%	5.45E-01
Mn-54	0.345%	9.88E-01
Fe-55	4.678%	1.34E+01
Co-57	0.068%	1.95E-01
Co-58	0.340%	9.75E-01
Co-60	6.214%	1.78E+01
Ni-63	37.006%	1.06E+02
Sr-90	0.089%	2.54E-01
Ag-110m	0.005%	1.55E-02
Sb-125	0.005%	1.38E-02
Cs-134	17.560%	5.03E+01
Cs-137	33.096%	9.48E+01
Ce-144	0.377%	1.08E+00
Pu-238	0.001%	2.58E-03
Pu-239	0.000%	7.53E-04
Pu-241	0.023%	6.66E-02
Am-241	0.000%	5.28E-04
Cm-242	0.000%	1.29E-04
Cm-243	0.001%	1.54E-03

Dry Active Waste
Waste Class A

Nuclide Name	Percent Abundance	Curies
C-14	0.012%	2.60E-05
Mn-54	3.035%	6.34E-03
Fe-55	33.935%	7.09E-02
Co-58	15.603%	3.26E-02
Co-60	25.702%	5.37E-02
Ni-63	10.530%	2.20E-02
Sr-90	0.114%	2.39E-04
Cs-137	10.673%	2.23E-02
Ce-144	0.171%	3.58E-04
Pu-238	0.005%	1.03E-05
Pu-239	0.001%	2.64E-06
Pu-241	0.198%	4.13E-04
Am-241	0.001%	2.33E-06
Cm-242	0.011%	2.40E-05
Cm-243	0.007%	1.48E-05

Dry Active Waste
Waste Class All

Nuclide Name	Percent Abundance	Curies
C-14	0.012%	2.60E-05
Mn-54	3.035%	6.34E-03
Fe-55	33.935%	7.09E-02
Co-58	15.603%	3.26E-02
Co-60	25.702%	5.37E-02
Ni-63	10.530%	2.20E-02
Sr-90	0.114%	2.39E-04
Cs-137	10.673%	2.23E-02
Ce-144	0.171%	3.58E-04

Pu-238	0.005%	1.03E-05
Pu-239	0.001%	2.64E-06
Pu-241	0.198%	4.13E-04
Am-241	0.001%	2.33E-06
Cm-242	0.011%	2.40E-05
Cm-243	0.007%	1.48E-05

Other Waste
Waste Class C

Nuclide Name	**Percent Abundance**	**Curies**
H-3	1.177%	1.69E-01
Mn-54	0.669%	9.63E-02
Fe-55	5.308%	7.64E-01
Co-57	0.068%	9.75E-03
Co-58	0.568%	8.18E-02
Co-60	4.789%	6.89E-01
Ni-63	25.421%	3.66E+00
Sr-90	0.070%	1.00E-02
Ag-110m	0.009%	1.35E-03
Sb-125	1.825%	2.63E-01
Cs-134	24.743%	3.56E+00
Cs-137	34.880%	5.02E+00
Ce-144	0.445%	6.41E-02
Pu-238	0.001%	1.43E-04
Pu-239	0.000%	3.02E-05
Pu-241	0.027%	3.92E-03
Am-241	0.000%	2.30E-05
Cm-242	0.000%	8.33E-06
Cm-243	0.000%	4.88E-05

Other Waste
Waste Class All

Nuclide Name	**Percent Abundance**	**Curies**
H-3	1.177%	1.69E-01
Mn-54	0.669%	9.63E-02
Fe-55	5.308%	7.64E-01
Co-57	0.068%	9.75E-03
Co-58	0.568%	8.18E-02
Co-60	4.789%	6.89E-01
Ni-63	25.421%	3.66E+00
Sr-90	0.070%	1.00E-02
Ag-110m	0.009%	1.35E-03
Sb-125	1.825%	2.63E-01
Cs-134	24.743%	3.56E+00
Cs-137	34.880%	5.02E+00
Ce-144	0.445%	6.41E-02
Pu-238	0.001%	1.43E-04
Pu-239	0.000%	3.02E-05
Pu-241	0.027%	3.92E-03
Am-241	0.000%	2.30E-05
Cm-242	0.000%	8.33E-06
Cm-243	0.000%	4.88E-05

Sum of All 4 Categories
Waste Class A

Nuclide Name	Percent Abundance	Curies
C-14	0.008%	2.60E-05
Mn-54	1.970%	6.34E-03
Fe-55	22.030%	7.09E-02
Co-58	10.130%	3.26E-02
Co-60	16.748%	5.39E-02
Ni-63	6.836%	2.20E-02
Sr-90	0.074%	2.39E-04
Cs-137	41.948%	1.35E-01
Ce-144	0.111%	3.58E-04
Pu-238	0.003%	1.03E-05
Pu-239	0.001%	2.64E-06
Pu-241	0.128%	4.13E-04
Am-241	0.001%	2.33E-06
Cm-242	0.007%	2.40E-05
Cm-243	0.005%	1.48E-05

Sum of All 4 Categories
Waste Class B

Nuclide Name	Percent Abundance	Curies
H-3	4.440%	5.45E-01
Mn-54	0.177%	2.18E-02
Fe-55	20.133%	2.47E+00
Co-57	0.055%	6.69E-03
Co-58	1.202%	1.47E-01
Co-60	8.028%	9.85E-01
Ni-63	50.354%	6.18E+00
Sr-90	0.081%	9.97E-03
Ag-110m	0.126%	1.55E-02
Sb-125	0.112%	1.38E-02
Cs-134	1.172%	1.44E-01
Cs-137	14.120%	1.73E+00

Sum of All 4 Categories
Waste Class C

Nuclide Name	Percent Abundance	Curies
H-3	0.059%	1.69E-01
Mn-54	0.368%	1.06E+00
Fe-55	4.063%	1.17E+01
Co-57	0.069%	1.98E-01
Co-58	0.316%	9.10E-01
Co-60	6.077%	1.75E+01
Ni-63	35.766%	1.03E+02
Sr-90	0.088%	2.54E-01
Ag-110m	0.000%	1.35E-03
Sb-125	0.091%	2.63E-01
Cs-134	18.647%	5.37E+01
Cs-137	34.030%	9.80E+01
Ce-144	0.399%	1.15E+00
Pu-238	0.001%	2.73E-03

Pu-239	0.000%	7.83E-04
Pu-241	0.024%	7.05E-02
Am-241	0.000%	5.51E-04
Cm-242	0.000%	1.37E-04
Cm-243	0.001%	1.59E-03

Sum of All 4 Categories
Waste Class All

Nuclide Name	**Percent Abundance**	**Curies**
H-3	0.238%	7.14E-01
C-14	0.000%	2.60E-05
Mn-54	0.363%	1.09E+00
Fe-55	4.726%	1.42E+01
Co-57	0.068%	2.05E-01
Co-58	0.363%	1.09E+00
Co-60	6.190%	1.86E+01
Ni-63	36.275%	1.09E+02
Sr-90	0.088%	2.65E-01
Ag-110m	0.006%	1.68E-02
Sb-125	0.092%	2.77E-01
Cs-134	17.938%	5.39E+01
Cs-137	33.246%	9.99E+01
Ce-144	0.383%	1.15E+00
Pu-238	0.001%	2.74E-03
Pu-239	0.000%	7.86E-04
Pu-241	0.024%	7.10E-02
Am-241	0.000%	5.53E-04
Cm-242	0.000%	1.61E-04
Cm-243	0.001%	1.61E-03

Unit 3 Solid Waste Shipped Offsite for Disposal and Estimates of Major Nuclides by Waste Class and Stream 01/01/2007 to 12/31/2007

Percent Cutoff: 0 (all identified isotopes are included)

Waste Stream : Resins, Filters, and Evap Bottoms
LWS Resin 14-170

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	1.10E+02	3.12E+00	1.66E+00	+/- 25%
B	0.00E+00	0.00E+00	0.00E+00	+/- 25%
C	0.00E+00	0.00E+00	0.00E+00	+/- 25%
All	1.10E+02	3.12E+00	1.66E+00	+/- 25%

Waste Stream : Dry Active Waste DAW 40' Sea Land
Unit 3 DAW-20' Sealand Unit 3 DAW B-25 Soil/Debris B-25

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	3.85E+04	1.09E+03	2.14E+00	+/-25%
B	0.00E+00	0.00E+00	0.00E+00	+/-25%
C	0.00E+00	0.00E+00	0.00E+00	+/-25%
All	3.85E+04	1.09E+03	2.14E+00	+/-25%

Waste Stream : Irradiated Components

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	0.00E+00	0.00E+00	0.00E+00	+/-25%
B	0.00E+00	0.00E+00	0.00E+00	+/-25%
C	0.00E+00	0.00E+00	0.00E+00	+/-25%
All	0.00E+00	0.00E+00	0.00E+00	+/-25%

Waste Stream : Other Waste Combined Packages

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	1.08E+03	3.06E+01	5.78E-01	+/-25%
B	0.00E+00	0.00E+00	0.00E+00	+/-25%
C	0.00E+00	0.00E+00	0.00E+00	+/-25%
All	1.08E+03	3.06E+01	5.78E-01	+/-25%

Waste Stream : Sum of All 4 Categories LWS Resin 14-170
Unit 3 DAW-20' Sealand Unit 3 DAW-B25 Soil/Debris B-25
Combined Packages DAW 40' Sea Land

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	3.96E+04	1.12E+03	4.38E+00	+/-25%
B	0.00E+00	0.00E+00	0.00E+00	+/-25%
C	0.00E+00	0.00E+00	0.00E+00	+/-25%
All	3.96E+04	1.12E+03	4.38E+00	+/-25%

Combined Waste Type Shipment, Major Volume Waste Type Shown

Unit 3 Solid Waste Shipped Offsite for Disposal and Estimates of Major Nuclides by Waste Class and Stream 01/01/2007 to 12/31/2007

Percent Cutoff: 0

Number of Shipments	Mode of Transportation	Destination
2	Hittman Transport	Duratek Services Inc.
1	Hittman Transport	Energy Solutions Gallaher Road
23	Hittman Transport	Energy Solutions Bear Creek
1	Hittman Transport	Studsvik Processing Facility

Resins, Filters, and Evap Bottoms
Waste Class A

Nuclide Name	Percent Abundance	Curies
H-3	6.203%	1.03E-01
Mn-54	0.551%	9.15E-03
Fe-55	11.442%	1.90E-01
Co-57	0.759%	1.26E-02
Co-58	10.839%	1.80E-01
Co-60	11.140%	1.85E-01
Ni-63	31.795%	5.28E-01
Sr-89	0.218%	3.62E-03
Sr-90	0.067%	1.12E-03
Ag-110m	0.129%	2.15E-03
Sb-124	4.047%	6.72E-02
Sb-125	3.908%	6.49E-02
Cs-134	5.588%	9.28E-02
Cs-137	9.996%	1.66E-01
Ce-144	3.312%	5.50E-02
Pu-238	0.001%	2.06E-05
Pu-239	0.000%	6.31E-06
Am-241	0.001%	1.07E-05
Cm-242	0.000%	7.01E-06
Cm-243	0.002%	3.42E-05

Resins, Filters, and Evap Bottoms
Waste Class All

Nuclide Name	Percent Abundance	Curies
H-3	6.203%	1.03E-01
Mn-54	0.551%	9.15E-03
Fe-55	11.442%	1.90E-01
Co-57	0.759%	1.26E-02
Co-58	10.839%	1.80E-01
Co-60	11.140%	1.85E-01
Ni-63	31.795%	5.28E-01
Sr-89	0.218%	3.62E-03
Sr-90	0.067%	1.12E-03
Ag-110m	0.129%	2.15E-03

Sb-124	4.047%	6.72E-02
Sb-125	3.908%	6.49E-02
Cs-134	5.588%	9.28E-02
Cs-137	9.996%	1.66E-01
Ce-144	3.312%	5.50E-02
Pu-238	0.001%	2.06E-05
Pu-239	0.000%	6.31E-06
Am-241	0.001%	1.07E-05
Cm-242	0.000%	7.01E-06
Cm-243	0.002%	3.42E-05

Dry Active Waste
Waste Class A

Nuclide Name	**Percent Abundance**	**Curies**
H-3	0.005%	9.82E-05
C-14	0.005%	1.05E-04
Cr-51	4.913%	1.05E-01
Mn-54	0.195%	4.16E-03
Fe-55	9.218%	1.97E-01
Co-57	0.100%	2.13E-03
Co-58	35.797%	7.65E-01
Co-60	11.745%	2.51E-01
Ni-63	29.340%	6.27E-01
Sr-90	0.001%	1.13E-05
Zr-95	0.000%	3.89E-09
Nb-95	0.096%	2.06E-03
Ag-110m	0.003%	5.97E-05
Sb-124	2.232%	4.77E-02
Sb-125	2.611%	5.58E-02
Cs-134	0.505%	1.08E-02
Cs-137	3.233%	6.91E-02

Dry Active Waste
Waste Class All

Nuclide Name	**Percent Abundance**	**Curies**
H-3	0.005%	9.82E-05
C-14	0.005%	1.05E-04
Cr-51	4.913%	1.05E-01
Mn-54	0.195%	4.16E-03
Fe-55	9.218%	1.97E-01
Co-57	0.100%	2.13E-03
Co-58	35.797%	7.65E-01
Co-60	11.745%	2.51E-01
Ni-63	29.340%	6.27E-01
Sr-90	0.001%	1.13E-05
Zr-95	0.000%	3.89E-09
Nb-95	0.096%	2.06E-03
Ag-110m	0.003%	5.97E-05
Sb-124	2.232%	4.77E-02
Sb-125	2.611%	5.58E-02
Cs-134	0.505%	1.08E-02
Cs-137	3.233%	6.91E-02

Other Waste
Waste Class A

Nuclide Name	Percent Abundance	Curies
Cr-51	10.608%	6.13E-02
Mn-54	0.385%	2.22E-03
Fe-55	2.665%	1.54E-02
Co-57	0.190%	1.09E-03
Co-58	68.953%	3.98E-01
Co-60	1.841%	1.06E-02
Ni-63	3.794%	2.19E-02
Nb-95	0.218%	1.26E-03
Sb-124	5.014%	2.90E-02
Sb-125	4.984%	2.88E-02
Cs-134	0.736%	4.25E-03
Cs-137	0.612%	3.54E-03

Other Waste
Waste Class All

Nuclide Name	Percent Abundance	Curies
Cr-51	10.608%	6.13E-02
Mn-54	0.385%	2.22E-03
Fe-55	2.665%	1.54E-02
Co-57	0.190%	1.09E-03
Co-58	68.953%	3.98E-01
Co-60	1.841%	1.06E-02
Ni-63	3.794%	2.19E-02
Nb-95	0.218%	1.26E-03
Sb-124	5.014%	2.90E-02
Sb-125	4.984%	2.88E-02
Cs-134	0.736%	4.25E-03
Cs-137	0.612%	3.54E-03

Sum of All 4 Categories
Waste Class A

Nuclide Name	Percent Abundance	Curies
H-3	2.366%	1.04E-01
C-14	0.002%	1.05E-04
Cr-51	3.805%	1.67E-01
Mn-54	0.355%	1.55E-02
Fe-55	9.188%	4.02E-01
Co-57	0.361%	1.58E-02
Co-58	30.695%	1.34E+00
Co-60	10.213%	4.47E-01
Ni-63	26.892%	1.18E+00
Sr-89	0.083%	3.62E-03
Sr-90	0.026%	1.13E-03
Zr-95	0.000%	3.89E-09
Nb-95	0.076%	3.32E-03
Ag-110m	0.051%	2.21E-03
Sb-124	3.286%	1.44E-01

Sb-125	3.417%	1.50E-01
Cs-134	2.464%	1.08E-01
Cs-137	5.463%	2.39E-01
Ce-144	1.256%	5.50E-02
Pu-238	0.000%	2.06E-05
Pu-239	0.000%	6.31E-06
Am-241	0.000%	1.07E-05
Cm-242	0.000%	7.01E-06
Cm-243	0.001%	3.42E-05

Sum of All 4 Categories
Waste Class All

Nuclide Name	Percent Abundance	Curies
H-3	2.366%	1.04E-01
C-14	0.002%	1.05E-04
Cr-51	3.805%	1.67E-01
Mn-54	0.355%	1.55E-02
Fe-55	9.188%	4.02E-01
Co-57	0.361%	1.58E-02
Co-58	30.695%	1.34E+00
Co-60	10.213%	4.47E-01
Ni-63	26.892%	1.18E+00
Sr-89	0.083%	3.62E-03
Sr-90	0.026%	1.13E-03
Zr-95	0.000%	3.89E-09
Nb-95	0.076%	3.32E-03
Ag-110m	0.051%	2.21E-03
Sb-124	3.286%	1.44E-01
Sb-125	3.417%	1.50E-01
Cs-134	2.464%	1.08E-01
Cs-137	5.463%	2.39E-01
Ce-144	1.256%	5.50E-02
Pu-238	0.000%	2.06E-05
Pu-239	0.000%	6.31E-06
Am-241	0.000%	1.07E-05
Cm-242	0.000%	7.01E-06
Cm-243	0.001%	3.42E-05

Indian Point Energy Center
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RADIOACTIVE EFFLUENT REPORT

E. RADIOLOGICAL IMPACT ON MAN

Jan 1, 2007 - Dec 31, 2007

RADIOLOGICAL IMPACT ON MAN

Routine Effluent Dose Calculations:

The Radiological Impact on Man due to radioactive effluent from the site is determined from NRC approved modeling, per Reg Guide 1.109 and NUREG 0133. Calculations are divided into 3 categories: Noble Gases, Particulates and Iodine, and Liquid Releases (fish and invertebrate consumption). This modeling involves conservative dose calculations to Adult, Teen, Child, and Infant age groups. Furthermore, dose modeling is performed for six separate organs as well as the total body dose. This well-established industry model provides doses (as a result of plant effluent) to a hypothetical maximally exposed individual offsite. While ALL age groups and organs are considered, it is this ***maximum value*** that is provided in the tables that follow.

An approved computer code is used to perform liquid and gaseous dose calculations according to the models and parameters presented in the Indian Point Offsite Dose Calculation Manual (ODCM). This information is stored in a database on site to enhance dose tracking information and management.

Site airborne effluent dose calculations include annual average dispersion and deposition factors, averaged from data collected over approximate ten year periods. When new data is averaged (approximately every ten years) the modeling is updated and used in subsequent airborne effluent calculations.

Liquid offsite dose calculations involve fish and invertebrate consumption pathways only, as determined in the ODCM. While the ODCM identified some site-specific dose factors, the bulk of this information is obtained directly from Regulatory Guide 1.109 and NUREG 0133. Details of the calculations, site-specific data, and their bases are presented in the ODCM.

Carbon-14 (C-14):

Concentrations and offsite dose from C-14 have been estimated using data generated at IP3 from August 1980 to June 1982 after a study conducted by the NY State Department of Health. These estimates are consistent with NUREG 0017, Rev. 1. The maximum expected annual dose from C-14 releases at IP2 and IP3 have been calculated using the maximum dependable gross electrical capacity, which is approximately 1000 MW(e) maintained for the entire year. The resultant bounding doses are based upon site specific assumptions of source term released for an entire year at 1000 MW(e) output, as outlined in the ODCM.

The resulting annual dose to the maximally exposed individual (child) from gaseous releases of C-14 is 0.254 mRem to the critical organ (bone) and 0.0508 mRem to the total body. The annual dose to the maximally exposed individual (child) from liquid releases of C-14 is 0.00583 mRem to the critical organ (bone) and 0.00117 mRem to the total body. These curies and doses are reported in this section (and not in the earlier tables), specifically to avoid confusion. The data is listed separately from other isotopes (in the familiar table format) to preserve consistency with the format of Reg Guide 1.21 and the listed isotopes of concern, which do NOT include C-14.

Groundwater:

Curies and dose contribution from activity discovered in onsite ground water and storm drain pathways during the year are discussed in detail in Section H. The offsite dose calculation involves multiple source term measurements, as well as determinations for release and dilution flow. A summary of the quantification methodology, and the resulting calculated doses, is provided at the end of Section H. The Total Dose table below provides a means to compare ground water doses with those of other components making up the site's total dose.

Members of the Public:

Members of the public visiting the site receive minimal dose as a result of airborne and liquid releases because of the relatively insignificant total amount of time they are on site, as well as the immeasurably low levels of dose at the critical receptors. Their doses can be calculated from standard ODCM methodology, with typical occupancy factors employed. These factors are determined by comparing a conservative assumption for their expected hours on site, to 8760 hours (the number of hours in a year, used in calculations in the ODCM).

example 1: Several students visit the site for an 8-hour guided tour.
Their occupancy factor is: 8 / 8760 or **.0009**.

example 2: A man drives his wife to work and drops her off at the security gate each morning, with a total stay-time on site for 2 minutes per day. His occupancy factor is calculated as follows:
2 min/60 min per hour =.0333 hr; 0.0333 / 8760 = **3.8E-6**

These factors, when multiplied by doses calculated per the ODCM, demonstrate that dose to MEMBERS OF THE PUBLIC within the site boundary is negligible, despite a potential reduction in the atmospheric dispersion.

Total Dose:
In compliance with 40CFR190, the following table indicates the Total Dose, including any measured direct shine component from the site property for 2007:

		Whole Body (mrem)	Max Organ (mrem)
40 CFR 190 limit ===➔	**IPEC**	**25**	**75**
Routine Airborne Effluents	Units 1 and 2	2.43E-03	2.43E-03
Routine Liquid Effluents	Units 1 and 2	5.35E-04	1.30E-03
Routine Airborne Effluents	Unit 3	3.88E-03	3.88E-03
Routine Liquid Effluents	Unit 3	3.20E-04	2.14E-04
Carbon-14 Liquid & Airborne Totals	IPEC	5.20E-02	2.60E-01
Ground Water & Storm Drain Totals	IPEC[1]	2.66E-04	9.94E-04
Radwaste Storage, Direct Shine	IPEC[2]	< 7	< 7
Indian Point Energy Center Total Dose, per 40 CFR 190	**IPEC**	**< 7.06**	**< 7.27**

Note 1: Groundwater curie and dose calculations are provided in Section H.

Note 2: The direct shine component is indistinguishable from background. Seven mrem is conservatively used from the siting criteria and assumptions established for each area.

INDIAN POINT UNITS 1 and 2 NUCLEAR POWER PLANTS
RADIOLOGICAL IMPACT ON MAN
JANUARY - DECEMBER 2007

Maximum exposed individual doses in mrem or mrad

A. LIQUID DOSES

		Qtr 1	Qtr 2	Qtr 3	Qtr 4	ANNUAL
Organ Dose	(mrem)	2.74E-04	5.94E-04	1.31E-04	3.11E-04	1.30E-03
Applicable Limit	(mrem)	5	5	5	5	10
Percent of Limit	(%)	5.48E-03	1.19E-02	2.62E-03	6.22E-03	1.30E-02
Age Group		Child	Child	Adult	Child	Child
Critical Organ		Bone	Bone	Liver	Bone	Bone

Adult Total Body	(mrem)	7.86E-05	1.72E-04	1.12E-04	1.72E-04	5.35E-04
Applicable Limit	(mrem)	1.5	1.5	1.5	1.5	3
Percent of Limit	(%)	5.24E-03	1.15E-02	7.47E-03	1.15E-02	1.78E-02

B. AIRBORNE NOBLE GAS DOSES

		Qtr 1	Qtr 2	Qtr 3	Qtr 4	ANNUAL
Gamma Air	(mrad)	3.14E-05	1.68E-05	5.39E-05	1.15E-05	1.14E-04
Applicable Limit	(mrad)	5	5	5	5	10
Percent of Limit	(%)	6.28E-04	3.36E-04	1.08E-03	2.30E-04	1.14E-03

Beta Air	(mrad)	8.65E-05	3.11E-05	6.06E-05	1.50E-05	1.93E-04
Applicable Limit	(mrad)	10	10	10	10	20
Percent of Limit	(%)	8.65E-04	3.11E-04	6.06E-04	1.50E-04	9.66E-04

C. AIRBORNE IODINE and PARTICULATE DOSES

		Qtr 1	Qtr 2	Qtr 3	Qtr 4	ANNUAL
Iodine/Part	(mrem)	5.77E-04	7.95E-04	7.50E-04	3.06E-04	2.43E-03
Applicable Limit	(mrem)	7.5	7.5	7.5	7.5	15
Percent of Limit	(%)	7.69E-03	1.06E-02	1.00E-02	4.08E-03	1.62E-02

Age Group		Child	Child	Child	Child	Child
Critical Organ		Total Body	Total Body	Total Body	Total Body	Total Body

INDIAN POINT 3 NUCLEAR POWER PLANT
RADIOLOGICAL IMPACT ON MAN
JANUARY - DECEMBER 2007

Maximum exposed individual doses in mrem or mrad

A. LIQUID DOSES

		Qtr 1	Qtr 2	Qtr 3	Qtr 4	ANNUAL
Organ Dose	(mrem)	2.68E-04	2.97E-05	1.46E-05	1.16E-05	3.20E-04
Applicable Limit	(mrem)	5	5	5	5	10
Percent of Limit	(%)	5.36E-03	5.94E-04	2.92E-04	2.32E-04	3.20E-03
Age Group		Adult	Adult	Adult	Child	Adult
Critical Organ		GILLI	GILLI	GILLI	Bone	GILLI

Adult Total Body	(mrem)	1.91E-04	1.49E-05	4.40E-06	3.57E-06	2.14E-04
Applicable Limit	(mrem)	1.5	1.5	1.5	1.5	3
Percent of Limit	(%)	1.27E-02	9.93E-04	2.93E-04	2.38E-04	7.13E-03

B. AIRBORNE NOBLE GAS DOSES

		Qtr 1	Qtr 2	Qtr 3	Qtr 4	ANNUAL
Gamma Air	(mrad)	2.27E-04	5.39E-06	3.81E-06	5.72E-06	2.42E-04
Applicable Limit	(mrad)	5	5	5	5	10
Percent of Limit	(%)	4.54E-03	1.08E-04	7.62E-05	1.14E-04	2.42E-03

Beta Air	(mrad)	1.14E-03	3.50E-05	6.33E-06	9.54E-06	1.19E-03
Applicable Limit	(mrad)	10	10	10	10	20
Percent of Limit	(%)	1.14E-02	3.50E-04	6.33E-05	9.54E-05	5.95E-03

C. AIRBORNE IODINE and PARTICULATE DOSES

		Qtr 1	Qtr 2	Qtr 3	Qtr 4	ANNUAL
Iodine/Part	(mrem)	2.03E-03	6.51E-04	7.60E-04	4.39E-04	3.88E-03
Applicable Limit	(mrem)	7.5	7.5	7.5	7.5	15
Percent of Limit	(%)	2.71E-02	8.68E-03	1.01E-02	5.85E-03	2.59E-02

Age Group		Child	Child	Child	Child	Child
Critical Organ		Thyroid	Total Body	Total Body	Total Body	Thyroid

Indian Point Energy Center
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RADIOLOGICAL EFFLUENT REPORT

F. METEOROLOGICAL DATA

Jan 1, 2007 - Dec 31, 2007

This data is stored onsite and is available in printed or electronic form.

Indian Point Energy Center
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RADIOACTIVE EFFLUENT REPORT

G. OFFSITE DOSE CALCULATION MANUAL,
PROCESS CONTROL PROGRAM, OR LAND USE CENSUS LOCATION CHANGES

2007

There was a minor change in REMP sampling locations in 2007.

(Monitoring Wells were added to the REMP in the South-West boundary locations, as discussed in the ODCM changes below.)

There were no changes to the Land Use Census in year 2007.

There were no changes to the Process Control Programs in year 2007.

There were four ODCM updates 2007.

1) Unit 2's ODCM (Rev 10, included Unit 1), for groundwater program updates, Jan 2007.

2) Unit 3's ODCM (Rev 18), for the same groundwater program updates, Jan 2007.

3) A month later, a revision at Unit 2 followed, in February (Rev 11), to officially adopt the new 10CFR20 at Unit 2 (this version of 10CFR20 had been adopted at Unit 3 in 2000). The update to Unit 2's ODCM was required for consistency with the updated Technical Specifications, Amendment 250 (TSTF-258).

4) In December 2007, the earlier unit-specific versions of the ODCMs at IPEC were combined into Rev 0 of the IPEC ODCM, with the Controls arranged in NUREG 1431 format, identical to the previous revision for unit 2. No new controls or routine dose calculations were added in this merging and reformatting process. However, some minor updates to the ground water offsite dose modeling were added to this new site ODCM (rev 0).

Details of these ODCM updates (justification packages) are provided in an Addendum to this report. In addition, complete copies of the ODCM (for items 1,2, and 4 above) are included in this addendum. The February revision to Unit 2's ODCM (Rev 11) is essentially identical to Rev 10, and included only 2 administrative wording changes to ensure compliance with the Technical Specification update for new 10CFR20, as identified in the justification package. Therefore, for Unit 2's ODCM Rev 11, the addendum includes the justification package, but does NOT include a full copy of the ODCM. All historical revisions to either unit's ODCM remain available on site.

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RADIOACTIVE EFFLUENT REPORT

H. GROUNDWATER and STORM WATER ACTIVITY ON SITE

AND

OFFSITE DOSE CALCULATION

FOR THE PERIOD:

Jan 1, 2007 - Dec 31, 2007

Summary of IPEC Groundwater and Storm Water Activity and Offsite Dose Calculation, 2007

The precipitation mass balance model applied in 2005 through 2006 was enhanced and further validated for 2007. The original 3 groundwater flow zones established in 2005/2006 were split into 6 zones to better partition the distribution of flow across the site. Each zone was also further subdivided into a shallow flow regime and a deeper flow regime based on the depth-specific differences in formation hydraulic conductivity. In addition, the groundwater flow values before and after the Discharge Canal were computed and compared to estimate the amount of groundwater flowing into the canal as well as that discharging directly to the river. The overall precipitation mass balance model was also validated through calibration against a Darcy's Law model relative to groundwater flow through each zone. This calibration was also used to provide the basis for the depth specific and pre-canal/post-canal differentiation of flow values in each zone.

Additional data was also gathered in 2007 from the increased number of wells on site (as compared to the 2006 data). The concentrations at groundwater to surface water discharge points were updated using wells specifically drilled at these points for a more accurate assessment of the plume boundaries, limits and release concentrations. The average concentrations used were based on multiple samples, generally at least one per quarter per elevation per well. The additional wells, and the instrumentation installed therein, also provided further definition of groundwater elevations to enhance the Darcy's Law calibration of the precipitation mass balance model. The specific processes for release and dilution flow evaluation are defined in the following text. The hydrology portion of this assessment and the associated 2007 enhancements were performed by IPEC's consultant, GZA GeoEnvironmental, Inc. IPEC concurs with this methodology.

The precipitation mass balance model partitions the precipitation falling on the watershed catchment area (i.e., that portion of the Facility area where the surface topography is sloped towards the river) into water that infiltrates the ground to become groundwater (GW), water which infiltrates but then moves back into the atmosphere via evaporation / transpiration and other processes, and water that flows off the surface as storm water (SW).

There are five parameters required by the precipitation mass balance method of computing radionuclide release rate to the Hudson River via the groundwater pathway. Enhancements or adjustments made in 2007 based on the Darcy's Law Model are noted.

1. <u>Overall direction of groundwater flow</u> - The surface topography shows that the IPEC facility is located in a significant depression in the eastern bank of the Hudson River. Given that groundwater elevations generally mirror ground surface topography and groundwater flow is from high elevations to lower elevations, the groundwater flows from the north, east and south towards the facility, with ultimate discharge to the Hudson River to the west.

2. <u>Facility-specific groundwater flow paths</u> - To establish facility-specific groundwater flow paths relative to on-site release areas, facility ground surface topography mapping was used. These flow paths were refined based on groundwater contours developed from the groundwater elevations measured with transducers installed in groundwater monitoring installations. The groundwater flow in each zone was then proportioned into shallow flow and deeper flow regimes based on relative hydraulic conductivities measured for the geologic deposits in each zone.

3.

Rate of groundwater flow - The groundwater flow rates through the individual zones were computed using mass-balance relationships that begin with the overall average yearly precipitation for the watershed area and then subtract out precipitation volumes reflecting removal mechanisms such as:

- Direct evaporation;
- Vegetative transpiration;
- Paved and roof surfaces - transport precipitation directly to the river via storm drains;
- Footing drains.

The net precipitation infiltration rates resulting in groundwater flow were adopted from a USGS study performed specifically for the Westchester County area, the location in which the facility is sited. The total groundwater flow rate was initially proportioned relative to the catchment areas associated with individual groundwater flow zones. These groundwater flow values were subsequently refined using the relative flow values computed using the Darcy's Law model. The gradient was computed from the groundwater elevation contours. For this computation, each flow zone was segregated into two depth regimes; a higher hydraulic conductivity shallow regime and a lower conductivity deeper regime. Finally, the zone-specific flow rates before the Discharge Canal were compared to those after the canal to evaluate the groundwater flux to the river via the Discharge Canal as compared to that discharging directly to the river.

4. Groundwater radionuclide concentration - A number of multi-level groundwater monitoring installations are in place up-gradient of the Discharge Canal and along the waterfront, thus allowing the radionuclide concentrations to be measured for groundwater flowing into the canal as well as that near the groundwater/river interface.

5. Radionuclide release rate to river - Once the groundwater flow rates were established, the zone-specific radionuclide release rates to the Hudson River were computed by multiplying the area/depth-specific groundwater flow rates times the associated radionuclide concentrations; these individual zone-specific values were then summed to arrive at the total radionuclide release rate to the river.

Over the entire watershed catchment area of 3.2 million ft^2, the GW and SW has been segmented relative to areas of the facility through which it flows (primarily established based on the relative concentrations and types of contaminants in the various facility areas). The bulk of the GW activity is identified down gradient of the Unit 2 transformer yard. While tritium is suspected to have originated at both Unit 2 and Unit 1 leaks, most of the offsite dose has been demonstrated to originate from Unit 1 contamination from Sr-90 and other radionuclides (tritium has little dose effect). Stream tubes have been drawn through the boundaries of these areas to define six individual groundwater flow zones. The six zones are shown in the figure at the end of this section, and are defined as:

ZONES:

- **Northern Clean Zone**, the area north of Unit 2;
- **Unit 2 North Zone**, the northern areas of Unit 2, including some low levels of tritium;
- **Unit 1 and 2 Zone**, the area encompassing most of the known plume, between units 1 and 2;
- **Unit 3 North Zone**, the area between Unit 1 and Unit 3;
- **Unit 3 South Zone**, the area that primarily includes operating areas of Unit 3;
- **Southern Clean Zone**, south of Unit 3 to the edge of the property line.

Overall, the partitioning is established for groundwater and storm water, including recharge rates where storm drains and ground water communicate. In each zone, the groundwater flow is further subdivided into a shallow flow regime and a deeper flow regime based on the depth-specific differences in formation hydraulic conductivity. In addition, the groundwater flow values before and after the Discharge Canal were computed and compared to estimate the amount of groundwater flowing into the canal as well as that discharging directly to the river.

Concentrations of identified radionuclides have been established for all Zones using the available 2007 quarterly groundwater sampling data from Monitoring Wells and the accumulated Storm Drain sample data. Analyses were conducted by gamma spectroscopy (all wells and drains) and liquid scintillation (for tritium), as well as specific analyses for beta emitters, such as Ni-63 and Sr-90.

The quarterly results from effected wells in the effluent locations were evaluated to compute an average source term for each area or zone. If a result was *below MDC* (whether positive or negative) it was *not* included in the computed average, so as *not* to drive the computed average value down. Therefore more conservative average values, based on only those results above MDC, were used to avoid averaging in zero and negative values (below MDC) for any location that had at least one identified value above MDC, for any quarterly sampling round within 2007. However, if all the sampling locations assigned to a given stream tube provided results below the MDC, then an average concentration value of zero was assigned to the effected portion of the stream tube. This mathematically allows the calculation to proceed in the absence of positive detections.

Using source term and flow data specific to each zone resulted in several improvements over earlier assessments of groundwater's offsite dose contribution:

- More source term data points were available,
- Flow distribution was validated and enhanced, and
- These more precise inputs allowed for a more detailed integration of total measured effluent.

As a result of these improvements, there is greater confidence in the accuracy of the calculated dose.

The following table summarizes the source terms applied for the 2007 assessment, in uCi/ml:

	Northern Clean Zone	Unit 2 North	Units 1 and 2	Unit 3 North	Unit 3 South	Southern Clean Zone
Storm Drains To Canal	None	H-3) 1.26E-6	None	None	None	None
Storm Drains To River	None	H-3) 7.96E-7	H-3) 4.96E-7	H-3) 1.97E-6	None	None
GW to Canal	None	None	H-3) 3.34E-6 Ni-63) 2.49E-9 Sr-90) 1.58E-8	H-3) 5.28E-7 Sr-90) 1.03E-9	H-3) 8.99E-7	H-3) 1.40E-7 Cs-137) 9.56E-10
Upper GW to River	H-3) 1.50E-7	H-3) 4.73E-7 Sr-90) 1.22E-10	H-3) 4.41E-6 Co-60) 2.35E-11 Sr-90) 1.62E-8 Cs-137) 1.02E-8	H-3) 3.11E-7 Co-60) 1.77E-11 Sr-90) 1.31E-9	H-3) 8.99E-7 Co-60) 5.13E-11	H-3) 1.39E-7
Lower GW to River	H-3) 1.50E-7	H-3) 5.76E-7 Co-60) 1.19E-11	H-3) 1.08E-6 Co-60) 1.17E-11 Sr-90) 1.11E-9 Cs-137) 6.08E-11	H-3) 4.63E-7 Co-60) 8.1E-12 Sr-90) 8.19E-10	H-3) 4.07E-7 Co-60) 2.64E-11 Sr-90) 5.32E-9	H-3) 1.83E-7 Co-60) 3.38E-11 Sr-90) 1.53E-10

Source terms, sample results, and documents relating to Monitoring Wells and Storm Drains sampled on site are available in plant records. No source term was applied to storm water from the Northern and Southern Clean Zones, as records indicate no contamination in these areas for 2007 and they include no known sources. Additionally, hydrological studies show that flow through these areas/zones is from up gradient, perimeter areas farther north and south which are unrelated to potential contamination from within the site boundary.

The infiltration rate in non-paved/building areas was computed at 0.87 feet/year which is within the range provided in the USGS report: *Water Use, Groundwater Recharge and Availability, and Quality in the Greenwich Area, Fairfield County, CT and Westchester County, NY, 2000 - 2002.* The precipitation rate for the area was set at 3.02 feet/year based on long-term onsite meteorological data averaging. All precipitation falling on paved/building areas was assumed to result in SW flow. Although some of this water actually evaporates directly to atmosphere from pavement and buildings, no credit for this evaporation is taken to ensure conservativism in the model.

The ODCMs were combined in 2007 (as one IPEC document), and updated to included details of the Ground Water Monitoring Program. These updates are discussed in Section G of this report. The ODCM updates reflect both the requirements of the Ground Water Monitoring Program, and specifics on calculating offsite dose.

Results of 2007 Groundwater and Storm water offsite dose evaluation:

The results of the assessment are shown on the following table. These dose values were added to the Total Dose table in the opening summary of the Dose to Man section of this report (Section E).

Based on the above analysis, it is estimated that approximately 0.052 Curies of Tritium migrated directly to the river via the GW flow path in 2007, resulting in an approximate total body dose of less than 0.1 mrem (2.6E-7 mrem). It is evident that tritium alone, whether from ground water or routine effluents, does not significantly add to offsite dose.

Strontium-90, Nickel-63, and Cesium-137, and Co-60 collectively contributed approximately 0.00008 curies from the groundwater pathway.

Combined groundwater releases from IPEC in 2007 (all radionuclides) resulted in a calculated annual dose of less than 0.1 mrem to the whole body and critical organ (0.000266 mrem - total body, and 0.000994 mrem to the critical organ, adult bone primarily from Strontium-90).

The annual dose from combined groundwater and storm water pathways at IPEC, remains well below the applicable limits. When combined with routine liquid effluents, the total dose remains significantly below the ALARA limits of 3 mrem total body and 10 mrem to the critical organ. This comparison is provided in the opening discussion of Section E, Radiological Impact on Man.

See the following groundwater/storm water annual offsite dose summary table.

IPEC Summary for Storm & Ground Water releases (H-3, Co-60, Ni-63, Sr-90, and Cs-137) 2007
year

Northern Clean Zone Adult Doses,in mrem

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI	uCi
H-3	0.00E+00	4.64E-09	4.64E-09	4.64E-09	4.64E-09	4.64E-09	4.64E-09	*4.15E+02*
Co-60	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	*0.00E+00*
Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	*0.00E+00*
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	*0.00E+00*
Cs-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	*0.00E+00*
totals	0.00E+00	4.64E-09	4.64E-09	4.64E-09	4.64E-09	4.64E-09	4.64E-09	***4.15E+02***

Unit 2 North

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI	uCi
H-3	0.00E+00	1.59E-08	1.59E-08	1.59E-08	1.59E-08	1.59E-08	1.59E-08	*3.22E+04*
Co-60	0.00E+00	4.56E-10	1.01E-09	0.00E+00	0.00E+00	0.00E+00	8.57E-09	*7.77E-03*
Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	*0.00E+00*
Sr-90	5.55E-07	0.00E+00	1.36E-07	0.00E+00	0.00E+00	0.00E+00	1.60E-08	*2.21E-02*
Cs-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	*0.00E+00*
totals	5.55E-07	1.64E-08	1.53E-07	1.59E-08	1.59E-08	1.59E-08	4.05E-08	***3.22E+04***

Unit 1/2

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI	uCi
H-3	0.00E+00	1.27E-07	1.27E-07	1.27E-07	1.27E-07	1.27E-07	1.27E-07	*1.54E+04*
Co-60	0.00E+00	4.00E-09	8.81E-09	0.00E+00	0.00E+00	0.00E+00	7.51E-08	*6.81E-02*
Ni-63	9.68E-08	6.72E-09	3.25E-09	0.00E+00	0.00E+00	0.00E+00	1.40E-09	*3.10E+00*
Sr-90	7.07E-04	0.00E+00	1.73E-04	0.00E+00	0.00E+00	0.00E+00	2.04E-05	*4.76E+01*
Cs-137	3.32E-05	4.54E-05	2.98E-05	0.00E+00	1.54E-05	5.12E-06	8.77E-07	*1.58E+01*
totals	7.41E-04	4.56E-05	2.03E-04	1.27E-07	1.55E-05	5.25E-06	2.14E-05	***1.55E+04***

Unit 3 North

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI	uCi
H-3	0.00E+00	7.16E-08	7.16E-08	7.16E-08	7.16E-08	7.16E-08	7.16E-08	*8.24E+03*
Co-60	0.00E+00	1.75E-09	3.86E-09	0.00E+00	0.00E+00	0.00E+00	3.30E-08	*2.99E-02*
Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	*0.00E+00*
Sr-90	6.77E-05	0.00E+00	1.66E-05	0.00E+00	0.00E+00	0.00E+00	1.95E-06	*6.30E+00*
Cs-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	*0.00E+00*
totals	6.77E-05	7.33E-08	1.67E-05	7.16E-08	7.16E-08	7.16E-08	2.05E-06	***8.25E+03***

Unit 3 South

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI	uCi
H-3	0.00E+00	1.25E-08	1.25E-08	1.25E-08	1.25E-08	1.25E-08	1.25E-08	*5.64E+03*
Co-60	0.00E+00	3.71E-09	8.17E-09	0.00E+00	0.00E+00	0.00E+00	6.97E-08	*6.32E-02*
Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	*0.00E+00*
Sr-90	1.58E-04	0.00E+00	3.87E-05	0.00E+00	0.00E+00	0.00E+00	4.55E-06	*6.30E+00*
Cs-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	*0.00E+00*
totals	1.58E-04	1.62E-08	3.88E-05	1.25E-08	1.25E-08	1.25E-08	4.63E-06	***5.65E+03***

Southern Clean Zone

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI	uCi
H-3	0.00E+00	2.63E-08	2.63E-08	2.63E-08	2.63E-08	2.63E-08	2.63E-08	*2.35E+03*
Co-60	0.00E+00	1.40E-08	3.09E-08	0.00E+00	0.00E+00	0.00E+00	2.63E-07	*2.39E-01*
Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	*0.00E+00*
Sr-90	2.71E-05	0.00E+00	6.66E-06	0.00E+00	0.00E+00	0.00E+00	7.81E-07	*1.08E+00*
Cs-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	*0.00E+00*
totals	2.71E-05	4.03E-08	6.71E-06	2.63E-08	2.63E-08	2.63E-08	1.07E-06	***2.36E+03***

Totals: Adult Doses, in mrem

H-3 only	0.00E+00	2.58E-07	2.58E-07	2.58E-07	2.58E-07	2.58E-07	2.58E-07	*Total uCis*	
	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI	*6.43E+04*	H3
all isotopes	**9.94E-04**	4.57E-05	**2.66E-04**	2.58E-07	1.57E-05	5.38E-06	2.92E-05	*4.08E-01*	Co
								3.10E+00	Ni
Adult Doses								*6.13E+01*	Sr
% Annual Limit	*0.0099*	*0.000*	*0.0089*	*0.000*	*0.000*	*0.000*	*0.000*	*1.58E+01*	Cs

INDIAN POINT RADIOLOGICAL GROUNDWATER MONITORING PROGRAM

2007

Summary of Results

The following pages represent a summary of isotopic radio-analytical data for all onsite groundwater testing performed at Indian Point in 2007, as required per the ODCM and NEI 07-07.

2007 RG 1.21 H-3 Summary Report

Well Name	# Samples in 2007	# Positive Samples in 2007	Ave Pos Act	Min Pos Act	Max Pos Act
B-1	3	3	9.98E+02	7.93E+02	1.10E+03
B-6	3	1	4.03E+02	4.03E+02	4.03E+02
MH-5	3	3	1.40E+03	1.17E+03	1.62E+03
MW-111	2	2	1.09E+05	9.88E+04	1.19E+05
MW-30-69	13	13	1.59E+05	8.17E+04	2.97E+05
MW-30-84	5	5	5.84E+03	4.27E+03	7.79E+03
MW-31-49	5	5	6.07E+03	1.20E+03	1.19E+04
MW-31-63	5	5	2.66E+04	5.00E+03	4.06E+04
MW-31-85	5	5	3.10E+03	3.17E+02	5.51E+03
MW-32-131	4	3	3.99E+03	3.02E+02	1.13E+04
MW-32-149	4	4	3.62E+03	4.93E+02	1.05E+04
MW-32-173	1	1	5.89E+03	5.89E+03	5.89E+03
MW-32-190	4	4	6.30E+03	1.72E+03	1.13E+04
MW-32-48	3	3	1.53E+04	7.67E+03	2.40E+04
MW-32-59	1	1	1.11E+04	1.11E+04	1.11E+04
MW-32-85	4	4	8.73E+03	5.42E+03	1.26E+04
MW-33	2	2	5.68E+04	2.30E+04	9.06E+04
MW-34	1	1	2.22E+04	2.22E+04	2.22E+04
MW-35	2	2	3.99E+03	2.03E+03	5.95E+03
MW-36-24	3	1	2.86E+02	2.86E+02	2.86E+02
MW-36-41	1	1	6.11E+03	6.11E+03	6.11E+03
MW-36-52	2	2	1.13E+04	1.01E+04	1.25E+04
MW-37-22	3	3	3.03E+03	2.26E+03	4.05E+03
MW-37-32	3	3	3.14E+03	2.49E+03	3.81E+03
MW-37-40	3	3	5.96E+03	5.69E+03	6.35E+03
MW-37-57	3	3	5.82E+03	4.88E+03	6.68E+03
MW-38	2	2	1.42E+03	6.04E+02	2.24E+03
MW-39-102	2	2	5.63E+02	3.21E+02	8.05E+02
MW-39-124	2	2	2.27E+02	1.92E+02	2.61E+02
MW-39-183	2	1	2.47E+02	2.47E+02	2.47E+02
MW-39-195	2	2	2.28E+02	2.00E+02	2.55E+02
MW-39-67	2	2	3.99E+02	3.25E+02	4.73E+02
MW-39-84	2	2	4.22E+02	2.52E+02	5.91E+02
MW-40-100	3	1	1.76E+02	1.76E+02	1.76E+02
MW-40-127	3	1	1.87E+02	1.87E+02	1.87E+02
MW-41-40	2	2	2.15E+03	3.80E+02	3.91E+03
MW-41-63	2	2	5.50E+02	5.47E+02	5.52E+02
MW-42-49	4	4	1.73E+03	1.34E+03	2.46E+03
MW-42-78	4	4	3.98E+02	3.19E+02	4.61E+02
MW-43-28	2	1	2.78E+02	2.78E+02	2.78E+02
MW-44-102	3	3	3.12E+02	2.84E+02	3.54E+02
MW-44-67	3	3	3.99E+02	2.68E+02	5.13E+02
MW-45-42	3	3	1.90E+03	1.16E+03	2.32E+03
MW-45-61	3	3	1.71E+03	1.47E+03	2.15E+03

2007 RG 1.21 H-3 Summary Report

Well Name	# Samples in 2007	# Positive Samples in 2007	Ave Pos Act	Min Pos Act	Max Pos Act
MW-46	3	3	1.92E+03	6.62E+02	3.43E+03
MW-47-56	2	2	4.00E+02	2.70E+02	5.29E+02
MW-47-80	2	2	2.94E+03	2.36E+03	3.51E+03
MW-48-23	2	2	3.33E+02	2.72E+02	3.93E+02
MW-49-26	2	2	7.24E+03	6.72E+03	7.76E+03
MW-49-42	2	2	4.37E+03	4.30E+03	4.44E+03
MW-49-65	2	2	2.52E+03	2.41E+03	2.62E+03
MW-50-42	3	1	2.15E+02	2.15E+02	2.15E+02
MW-50-66	3	3	4.19E+03	3.85E+03	4.50E+03
MW-51-189	4	1	1.87E+02	1.87E+02	1.87E+02
MW-51-40	4	2	2.11E+02	1.98E+02	2.23E+02
MW-52-162	2	2	2.47E+02	2.11E+02	2.82E+02
MW-52-181	2	1	2.48E+02	2.48E+02	2.48E+02
MW-53-120	3	3	8.35E+03	7.40E+03	9.61E+03
MW-53-82	3	3	3.52E+03	7.76E+02	8.68E+03
MW-54-123	3	3	9.25E+02	7.01E+02	1.11E+03
MW-54-144	3	3	1.59E+03	1.34E+03	1.89E+03
MW-54-173	3	3	1.96E+03	1.90E+03	2.08E+03
MW-54-190	3	3	2.08E+03	1.87E+03	2.25E+03
MW-54-37	3	3	9.10E+02	8.01E+02	1.04E+03
MW-54-58	3	3	6.71E+02	5.61E+02	7.60E+02
MW-55-24	3	3	2.66E+03	2.20E+03	3.08E+03
MW-55-35	3	3	3.95E+03	3.09E+03	5.09E+03
MW-55-54	3	3	1.02E+04	9.91E+03	1.04E+04
MW-56-53	3	3	4.28E+02	2.16E+02	7.80E+02
MW-56-83	3	3	1.54E+03	1.28E+03	1.85E+03
MW-57-11	2	2	4.35E+03	4.09E+03	4.61E+03
MW-57-20	2	2	1.31E+03	9.66E+02	1.65E+03
MW-57-45	2	2	8.48E+02	7.40E+02	9.55E+02
MW-58-26	3	3	5.71E+02	2.60E+02	8.56E+02
MW-58-65	3	3	4.02E+02	3.15E+02	5.50E+02
MW-59-32	3	2	3.18E+02	1.69E+02	4.67E+02
MW-59-45	3	2	5.02E+02	2.49E+02	7.54E+02
MW-59-68	3	2	7.05E+02	5.90E+02	8.19E+02
MW-60-135	3	2	4.56E+02	3.92E+02	5.20E+02
MW-60-154	3	2	5.21E+02	4.62E+02	5.80E+02
MW-60-176	3	3	6.94E+02	5.30E+02	8.49E+02
MW-60-35	3	2	4.73E+02	1.84E+02	7.61E+02
MW-62-138	3	3	5.90E+02	4.55E+02	7.78E+02
MW-62-18	3	3	4.45E+02	3.76E+02	5.08E+02
MW-62-182	3	3	4.84E+02	4.17E+02	5.41E+02
MW-62-200	1	1	6.40E+02	6.40E+02	6.40E+02
MW-62-37	3	3	2.83E+02	2.50E+02	3.02E+02
MW-62-53	2	2	3.69E+02	3.45E+02	3.93E+02

2007 RG 1.21 H-3 Summary Report

Well Name	# Samples in 2007	# Positive Samples in 2007	Ave Pos Act	Min Pos Act	Max Pos Act
MW-62-71	3	2	3.86E+02	2.69E+02	5.02E+02
MW-62-92	3	3	5.22E+02	4.28E+02	7.00E+02
MW-63-112	3	3	3.24E+02	2.69E+02	4.24E+02
MW-63-121	3	3	3.56E+02	2.96E+02	4.62E+02
MW-63-163	3	3	4.69E+02	3.49E+02	5.78E+02
MW-63-174	3	3	4.97E+02	3.70E+02	5.93E+02
MW-63-18	3	2	2.15E+02	2.00E+02	2.30E+02
MW-63-191	1	1	3.44E+02	3.44E+02	3.44E+02
MW-63-34	3	3	2.46E+02	2.28E+02	2.80E+02
MW-63-50	3	3	2.80E+02	2.25E+02	3.26E+02
MW-63-93	3	2	2.59E+02	2.37E+02	2.81E+02
MW-65-48	1	1	2.08E+02	2.08E+02	2.08E+02
MW-65-80	1	1	1.83E+02	1.83E+02	1.83E+02
MW-66-21	2	2	2.31E+03	1.04E+03	3.57E+03
MW-66-36	2	2	9.03E+03	8.95E+03	9.10E+03
MW-67-105	2	2	2.25E+03	1.86E+03	2.64E+03
MW-67-173	2	2	1.03E+03	1.01E+03	1.05E+03
MW-67-219	2	2	1.10E+03	9.46E+02	1.25E+03
MW-67-276	2	2	8.95E+02	6.79E+02	1.11E+03
MW-67-323	2	2	8.02E+02	3.13E+02	1.29E+03
MW-67-340	2	2	3.80E+02	3.69E+02	3.90E+02
MW-67-39	2	2	4.97E+03	4.86E+03	5.07E+03
U1-CSS	4	4	2.60E+03	1.53E+03	4.32E+03
U3-T1	3	3	5.09E+02	4.90E+02	5.30E+02
U3-T2	3	3	1.29E+03	1.17E+03	1.45E+03

Note 1: All results are in pCi/L

Note 2: A total of 377 samples were analyzed for H-3 in 2007 with 287 positive results. This total includes samples from REMP wells MW-40 and MW-51. See the AREOR for additional data.

Note 3: A sample is positive if the result is both greater than 3 standard deviations and greater than the MDC. The target MDC is 200 pCi/L.

2007 RG 1.21 Sr-90 Summary Report

Well Name	# Samples in 2007	# Positive Samples in 2007	Ave Pos Act	Min Pos Act	Max Pos Act
LAF-001	3	1	1.08E+00	1.08E+00	1.08E+00
MW-111	2	2	9.74E-01	9.74E-01	9.74E-01
MW-30-84	4	1	5.95E-01	5.95E-01	5.95E-01
MW-36-41	1	1	2.18E+00	2.18E+00	2.18E+00
MW-36-52	2	2	2.44E+00	2.26E+00	2.62E+00
MW-37-22	3	3	1.87E+01	1.49E+01	2.29E+01
MW-37-32	3	3	1.96E+01	1.85E+01	2.13E+01
MW-37-40	3	3	6.81E+00	4.69E+00	9.76E+00
MW-37-57	3	3	2.51E+01	2.33E+01	2.78E+01
MW-39-102	2	1	1.32E+00	1.32E+00	1.32E+00
MW-39-195	2	1	1.30E+00	1.30E+00	1.30E+00
MW-39-67	2	2	3.77E+00	2.76E+00	4.78E+00
MW-39-84	2	2	1.26E+00	7.97E-01	1.72E+00
MW-41-40	2	2	5.98E+00	5.96E+00	5.99E+00
MW-41-63	2	2	5.32E+00	3.55E+00	7.08E+00
MW-42-49	4	4	4.85E+01	2.01E+01	7.73E+01
MW-43-28	2	1	1.07E+00	1.07E+00	1.07E+00
MW-43-62	2	1	8.55E-01	8.55E-01	8.55E-01
MW-47-56	2	1	5.93E-01	5.93E-01	5.93E-01
MW-47-80	2	2	3.41E+00	3.27E+00	3.55E+00
MW-49-26	2	2	1.35E+01	1.27E+01	1.43E+01
MW-49-42	2	2	2.32E+01	2.08E+01	2.56E+01
MW-49-65	2	2	1.83E+01	1.58E+01	2.08E+01
MW-50-42	3	3	1.85E+01	1.16E+01	2.45E+01
MW-50-66	3	3	3.59E+01	2.93E+01	4.74E+01
MW-53-120	3	3	3.36E+01	2.81E+01	3.70E+01
MW-53-82	3	1	3.98E+00	3.98E+00	3.98E+00
MW-54-123	3	3	1.57E+01	1.16E+01	2.19E+01
MW-54-144	3	3	1.70E+01	1.58E+01	1.92E+01
MW-54-173	3	3	1.68E+01	1.45E+01	2.09E+01
MW-54-190	3	3	1.93E+01	1.79E+01	2.04E+01
MW-54-37	3	3	8.00E+00	5.30E+00	1.25E+01
MW-54-58	3	2	1.99E+00	1.76E+00	2.22E+00
MW-55-24	3	3	2.62E+01	2.29E+01	3.25E+01
MW-55-35	3	3	3.27E+01	3.16E+01	3.40E+01
MW-55-54	3	3	2.31E+01	2.22E+01	2.47E+01
MW-56-83	3	3	2.20E+00	1.87E+00	2.43E+00
MW-57-11	2	2	4.17E+01	3.79E+01	4.55E+01
MW-57-20	2	2	1.60E+00	1.23E+00	1.96E+00
MW-57-45	2	2	2.23E+00	1.90E+00	2.55E+00
MW-58-26	3	2	1.03E+00	1.02E+00	1.04E+00
MW-62-138	3	1	8.19E-01	8.19E-01	8.19E-01
MW-62-18	3	1	1.80E+00	1.80E+00	1.80E+00
MW-66-21	2	2	2.11E+00	1.79E+00	2.42E+00

2007 RG 1.21 Sr-90 Summary Report

Well Name	# Samples in 2007	# Positive Samples in 2007	Ave Pos Act	Min Pos Act	Max Pos Act
MW-66-36	2	2	8.70E+00	6.20E+00	1.12E+01
MW-67-105	2	1	1.11E+00	1.11E+00	1.11E+00
MW-67-39	2	2	2.29E+01	1.86E+01	2.71E+01
U1-CSS	4	4	1.87E+01	1.38E+01	2.68E+01

Note 1: All results are in pCi/L

Note 2: A total of 364 samples were analyzed for Sr-90 in 2007 with 104 positive results. This total includes samples from REMP wells MW-40 and MW-51. See the AREOR for additional data.

Note 3: A sample is positive if the result is both greater than 3 standard deviations and greater than the MDC. The target MDC is 1 pCi/L.

2007 RG 1.21 Co-60 Summary Report

Well Name	# Samples in 2007	# Positive Samples in 2007	Ave Pos Act	Min Pos Act	Max Pos Act
MW-42-49	4	1	1.59E+01	1.59E+01	1.59E+01

Note 1: All results are in pCi/L

Note 2: A total of 367 samples were analyzed for Co-60 in 2007 with only 1 positive result. This total includes samples from REMP wells MW-40 and MW-51. See the AREOR for additional data.

Note 3: A sample is positive if the result is both greater than 3 standard deviations and greater than the MDC. The target MDC is 15 pCi/L.

2007 RG 1.21 Ni-63 Summary Report

Well Name	# Samples in 2007	# Positive Samples in 2007	Ave Pos Act	Min Pos Act	Max Pos Act
MW-42-49	4	4	8.83E+02	5.26E+02	1.17E+03
MW-53-120	3	1	1.73E+01	1.73E+01	1.73E+01
MW-57-11	2	1	2.24E+01	2.24E+01	2.24E+01

Note 1: All results are in pCi/L

Note 2: A total of 140 samples were analyzed for Ni-63 in 2007 with only 6 positive results.

Note 3: A sample is positive if the result is both greater than 3 standard deviations and greater than the MDC. The target MDC is 30 pCi/L.

2007 RG 1.21 Cs-137 Summary Report

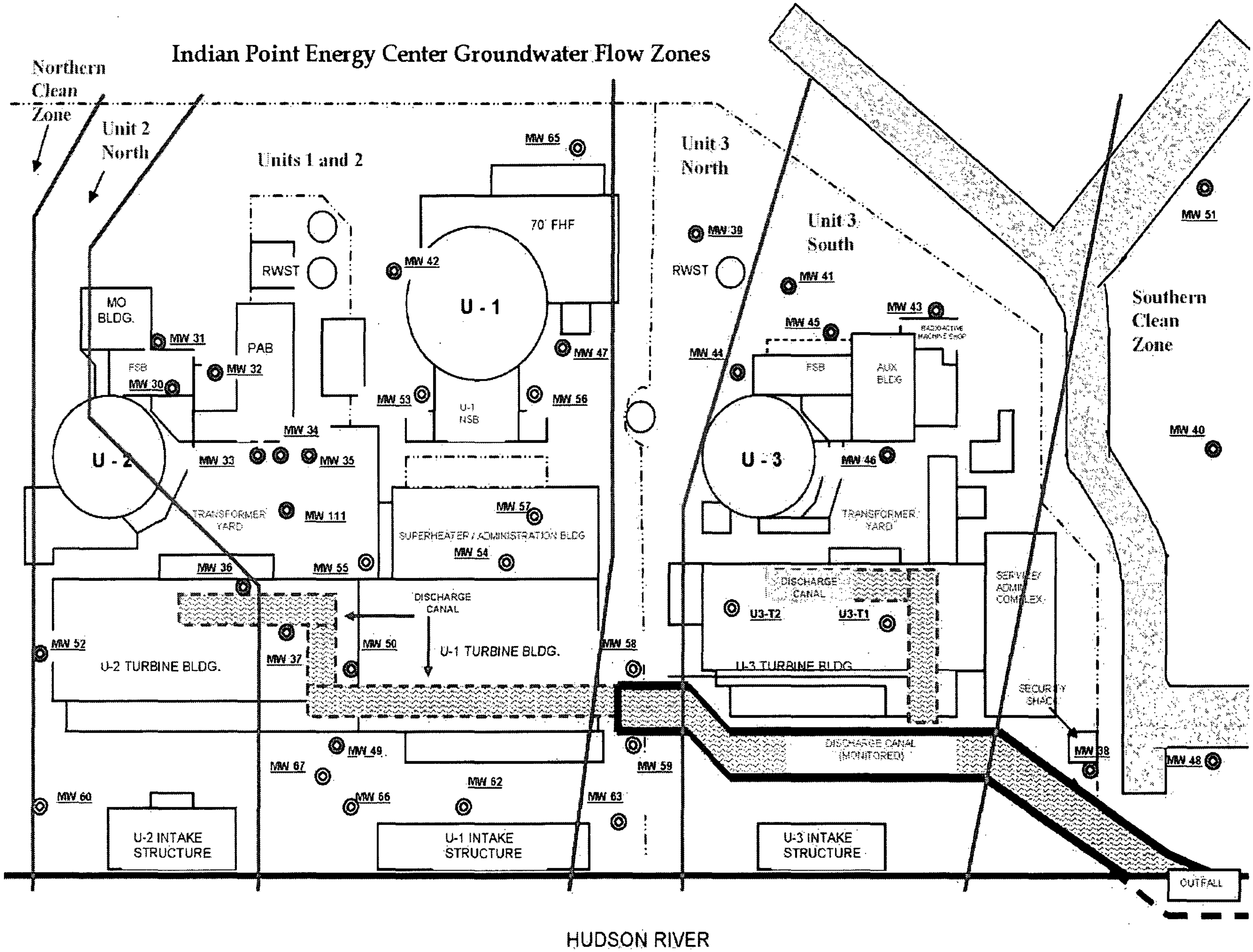
Well Name	# Samples in 2007	# Positive Samples in 2007	Ave Pos Act	Min Pos Act	Max Pos Act
B-1	3	1	1.68E+01	1.68E+01	1.68E+01
MW-31-49	5	1	8.83E+01	8.83E+01	8.83E+01
MW-35	2	1	4.66E+01	4.66E+01	4.66E+01
MW-38	2	1	2.73E+00	2.73E+00	2.73E+00
MW-42-49	4	4	2.51E+04	1.90E+04	3.69E+04
MW-42-78	4	3	1.37E+02	4.51E+01	3.04E+02
MW-51-135	4	1	2.16E+01	2.16E+01	2.16E+01
MW-51-163	4	1	1.16E+01	1.16E+01	1.16E+01
MW-51-189	4	1	1.38E+01	1.38E+01	1.38E+01
MW-51-40	4	1	5.15E+00	5.15E+00	5.15E+00
MW-51-79	4	1	5.37E+00	5.37E+00	5.37E+00
MW-53-120	3	1	7.93E+00	7.93E+00	7.93E+00
MW-54-123	3	1	4.21E+00	4.21E+00	4.21E+00
MW-56-53	3	1	1.36E+01	1.36E+01	1.36E+01
MW-56-83	3	1	1.18E+01	1.18E+01	1.18E+01
MW-59-45	3	1	1.49E+02	1.49E+02	1.49E+02
MW-59-68	3	1	6.76E+01	6.76E+01	6.76E+01
MW-62-200	1	1	1.56E+00	1.56E+00	1.56E+00
MW-63-191	1	1	2.45E+01	2.45E+01	2.45E+01
MW-67-39	2	1	1.02E+01	1.02E+01	1.02E+01

Note 1: All results are in pCi/L

Note 2: A total of 367 samples were analyzed for Cs-137 in 2007 with 25 positive results. This total includes samples from REMP wells MW-40 and MW-51. See the AREOR for additional data.

Note 3: A sample is positive if the result is both greater than 3 standard deviations and greater than the MDC. The target MDC is 18 pCi/L.

Indian Point Energy Center Groundwater Flow Zones



An Assessment of Potential Historical Offsite Dose from Ground Water at Indian Point

1994 - 2007

An assessment of groundwater dose was included in 2005-2007's report, along with the dose assessment for routine effluents typically provided. Since the groundwater dose was not considered a pathway previous to 2005, there were no groundwater dose assessments in 2004 and earlier. In retrospect, the first identification of groundwater contamination was in the Unit 1 North Curtain Drain in mid 1994.

The following data provides an assessment of potential additional offsite dose, over that which was reported in earlier annual effluent reports, for the period 1994 to 2004. This evaluation provides a reasonable yet conservatively high annual calculation for determining an additional potential contribution from groundwater. Groundwater dose assessments for 2005 and later were included in their respective annual effluent reports.

Groundwater Dose Assessment 1994-2004

In order to conservatively determine the ground water effluent dose impact from 1994 to current, a ratio was established between Unit 1 North Curtain Drain (NCD) Sr-90 annual microcuries released and effluent dose, for the periods in which detailed assessment had already been completed (2005-2007). This ratio was then used for the previous time periods (1994 – 2004) for which no groundwater dose assessments were performed. This ratio appears to be a justifiable method to determine offsite dose, as the Sr-90 in this pathway since 2005 was responsible for greater than 95% of the total groundwater dose.

The ratios for 2005 – 2007 are developed in the table below:

Year	NCD annual Sr-90 uCi	GW Critical Organ (CO) Dose (mrem)	Ratio - CO Dose per uCi Sr-90 (mrem/uCi)		GW Whole Body Dose (mrem)	Ratio - Whole Body Dose per uCi Sr-90 (mrem/uCi)
2005	511	9.72E-03	1.90E-05		2.12E-03	4.15E-06
2006	664	7.21E-03	1.09E-05		1.78E-03	2.68E-06
2007	481	9.94E-04	2.07E-06		2.66E-04	5.53E-07
Avg	552	5.97E-03	**1.07E-05**		1.39E-03	**2.46E-06**

Records of NCD Sr-90 and integrated curies were compiled from earliest records with identified contamination in the system, which was July 1994. From 1994 to the end of 1996, the NCD was directed to routine liquid waste (and specific curies from this system were unavailable). From 1997 to 2007, the NCD was directed, in one fashion or another, to the discharge canal as its own effluent pathway. The following table was generated by applying this ratio back to 1997, and using 1997's ratio back to 1994 (when contamination in the NCD was first discovered). These ratios are used to estimate the dose for the years 1994 – 2004, as follows:

Year	NCD annual Sr-90 uCi	GW Critical Organ (CO) Dose (mrem)	GW Whole Body Dose (mrem)
1994-1997 (each)	1373	1.5E-02	3.4E-03
1998	1790	1.9E-02	4.4E-03
1999	1774	1.9E-02	4.4E-03
2000	1646	1.8E-02	4.1E-03
2001	1952	2.1E-02	4.8E-03
2002	1639	1.7E-02	4.0E-03
2003	952	1.0E-02	2.3E-03
2004	475	5.1E-03	1.2E-03

The table above represents conservative additional liquid effluent dose, potentially attributable to ground water from IPEC (principally Unit 1) since 1994. These values represent a conservative assessment of potential additional offsite dose, beyond that which was reported in routine effluent reports from 1994 to 2004, due to the potential for undetected groundwater contamination during these years. The basis (from NCD activity) does not suggest a verified groundwater component, but an assessment to provide a conservative estimate of what may have been released.

Unit 3 ODCM Revision 18 Justification Package

Prepared by: Steven Sandike | **Brief Summary of Changes** | January, 2007

ODCM Part I

1 *Corrected typo for Action 11 on Table 2.2-1 regarding "a" radwaste tank.*

2 *Clarified Table 3.3.1-1 to more clearly comply with NUREG 1301 requirements (31 days used in lieu of monthly, etc).*

3 *Added clarification to Note " f " following Table 3.3.1-1 for analyses on SG Feedwater and Turbine Hall drains.*

4 *Clarified VCPR sampling requirements in Note "i" following Table 3.4.1-1, when no rad monitor is available.*

5 *Added Sr-90 requirements to the REMP in Table 2.7-1, Sections 3c (sediment) and 4b (Fish / Inv) per **NL-06-033, #7 & #8.***

6 *Added Site Boundary Mon Well sample requirements to Table 2.7-1 (as Sec 5) per the GWMP per **NL-06-033, #2 & #3.***

7 *Added Sr-90 to Tables 2.7-2 and 3.7-1, with note identifying the GWMP interface with the REMP per **NL-06-033, #6.***

8 *Reworded SR 3.10 to reference ODCM (as the gas tank section does) for methodologies of verifying $\leq$ 10 curies per tank.*

9 *Added Section 5.8 to identify the Ground Water Monitoring Program and its key components per **NL-06-033, #4 & #5.***

ODCM Part II

10 *Expanded and updated Figure 1-1 into two figures (adding 1-2), to show greater detail with release points and site boundary.*

11 *Clarified the requirement for having a permit for batch liquid releases in Section 2.1.2.*

12 *Added clarification to Section 2.1.10 regarding the use of variable speed circulating pumps.*

13 *Expanded Section 2.1.11 to add the option to verifying tank curie levels by tracking curies added to idle tanks.*

14 *Added Section 2.1.21 to identify potentially necessary additional release quantification from the GWMP per **NL-06-033, #1.***

15 *Added ground and storm water representation to Figure 2-1.*

16 *Modified Section 4.0 to identify Figure 4-3 as "additional" sample points, rather than "non-RECS".*

17 *Identified in Section 4.0 that distances in Table 4-1 were measured from the unit 1 stack.*

18 *Added a paragraph in Section 4.0 describing the interface between the REMP and the GWMP.*

19 *Removed "RECS" from the title of Figures 4-1, 4-2, 4-3, and Table 4-1.*

20 *Identified Roseton as a control sample location without use of a footnote on Table 4-1, page 1.*

21 *Denoted samples that are NOT required by RECS on Table 4-1 (pages 3 and 4).*

22 *Added Boundary Wells (MW-40/51) in Table 4-1, page 4 & explained note 13, supporting GWMP, per **NL-06-033, #2 & #3.***

Each change is discussed in detail on the following pages. This information is to be included in the OSRC presentation, the 50.59 package, and the next Annual Effluent Release Report sent to the Commission per Reg Guide 1.21

Unit 3 ODCM Revision 18 Justification Package

item # 1 of 22 Jan, 2007

OBJECTIVE:

Correct typo for Action 11 on Table 2.2-1 regarding "a" radwaste tank.

DESCRIPTION OF CHANGES:

Changed "...contents of the radwaste gas decay tanks ..."
to
"... contents of a radwaste gas decay tank ..."

IMPACT:

None

JUSTIFICATION:

Typographical improvement

Unit 3 ODCM Revision 18 Justification Package

item # 2 of 22 Jan, 2007

OBJECTIVE:

Clarify Table 3.3.1-1 to more readily apply to NUREG 1431 format, while maintaining compliance with NUREG 1301 requirements (31 days used in lieu of monthly, etc).

DESCRIPTION OF CHANGES:

Sample frequencies were identified as "composite" and the ANALYSIS FREQUENCY was clarified as is specified in NUREG 1301, but using NUREG 1431 format of # of days in lieu of words like "monthly" or quarterly.

IMPACT:

None

JUSTIFICATION:

In an effort to standardize the ODCMs for both operating units at IPEC, the format of the RECS is targeted to be that of NUREG 1431, like the Technical Specifications. This improvement drives the unit 3 ODCM one step closer to that goal, prior to actually merging the ODCMs into one document for the site in a future revision. The use of # of days in lieu of "monthly" or "quarterly" is standard practice for experienced readers of licensing basis documents after ITS. This methodology, aside from the improvements of standardization, also allows for a less complicated and more universally understood determination of the 25% grace period for required analyses or surveillances.

Although the format of the verbiage has been upgraded to NUREG 1431 format (ITS), the periodicities of samples, analyses, and surveillances have not changed from the requirements of NUREG 1301.

Unit 3 ODCM Revision 18 Justification Package

item # 3 of 22 Jan, 2007

OBJECTIVE:

Add clarification to Note " f " following Table 3.3.1-1 for analyses on Steam Generator Feedwater and Turbine Hall drains.

DESCRIPTION OF CHANGES:

Identify that these pathways are adequately monitored from SG Blowdown, clarifying that increased monitoring is only required when the conditions of a "Primary to Secondary Leak" have been met, per RECS definition of this term.

IMPACT:

None.

JUSTIFICATION:

Station procedures have assumed this understanding and the ODCM was clarified to ensure compliance. These sample descriptions are in excess of NUREG 1301 and are listed in the station ODCMs for clarify and completeness for "continuous" pathways that do NOT involve SG Blowdown.

Unit 3 ODCM Revision 18 Justification Package

item # 4 of 22 Jan, 2007

OBJECTIVE:

Clarify VCPR sampling requirements in Note "i" following Table 3.4.1-1, when neither the VC Noble Gas, nor the particulate radiation monitor is available.

DESCRIPTION OF CHANGES:

Identified a required noble gas grab sample prior to a pressure relief if the noble gas rad monitor is out of service. Also identified the condition and necessary compensatory actions for periods when both the VC Noble Gas and Particulate monitors are out of service.

IMPACT:

None.

JUSTIFICATION:

Station procedures have been used to clarify these requirements because VCPR requirements are generally incomplete in NUREG 1301, and its predecessor, NUREG 0472. To ensure licensing basis documents cover the necessary requirements for conditions involving out of service rad monitors, as well as the effluent concern of properly quantifying the impact of VC Pressure Reliefs, this verbiage is added to the ODCM for clarity and completeness. These criteria are in excess of NUREG 1301.

Unit 3 ODCM Revision 18 Justification Package

item # 5 of 22 Jan, 2007

OBJECTIVE:

Add Sr-90 requirements to the REMP in Table 2.7-1, Sections 3c (sediment) and 4b (Fish / Inv).

DESCRIPTION OF CHANGES:

Added Sr-90 analysis for sediment and "edible portions" of fish/invertebrates in REMP as a result of ground water investigation and commitments, per NL-06-033 , # 7 and #8.

IMPACT:

Increased annual operating cost and new procedural requirements for the REMP.

JUSTIFICATION:

The presence of trace levels of Sr-90 in some Monitoring Wells (defining the U1 ground water plume) suggests a specific effort to detect Sr-90 in REMP samples, in addition to the existing Gross Beta requirements. This effort will determine the significance of any movement of Sr-90 into the Hudson or the human food chain through fish or invertebrate consumption.

Identified specific effluent concerns and an association, such as this effort between the EFFLUENTS program and the REMP, are required per NUREG 1301 and other effluent and environmental regulations.

Unit 3 ODCM Revision 18 Justification Package

item # 6 of 22 Jan, 2007

OBJECTIVE:

Add Site Boundary Monitoring Well sample requirements to Table 2.7-1 (as Section 5) per the GW Monitoring Program.

DESCRIPTION OF CHANGES:

Added the Site Boundary Monitoring Wells and sample requirements to Table 2.7-1, per the Ground Water Monitoring Program. Included in these requirements are analyses for gamma spectroscopy, Tritium, and Strontium-90, per NRC commitments NL-06-033 , # 2 and # 3.

IMPACT:

Increased annual operating cost and new procedural requirements for the REMP.

JUSTIFICATION:

Analyzing for these isotopes at or on the way to the site boundary will help define the extent of any potential plume. It will give an early warning of possible movement toward the actual site boundary in these directions. This effort is required per the NEI initiative on ground water.

Unit 3 ODCM Revision 18 Justification Package

item # 7 of 22 Jan, 2007

OBJECTIVE:

Add Sr-90 to Tables 2.7-2 and 3.7-1, with note identifying the GWMP interface with the REMP.

DESCRIPTION OF CHANGES:

Reporting Levels and LLDs for Sr-90 were reinstated into these tables, as a result of adding the requirement to analyze for this isotope. Added a note to ensure there is a clear understanding of the interface between the GWMP and the REMP (such that LLDs and Reporting Levels are understood to be potentially different between the two).

IMPACT:

None. Vendor labs have verified ability to meet LLDs.

JUSTIFICATION:

Sr-90 was added to these tables as a commitment from the Ground Water investigation. While the old values of ETSR in 1977 were evaluated for application, a new dose basis for the values selected was performed per IPEC-CHM-06-026. This memo establishes LLDs and Reporting Levels by comparisons to ratios of other isotopes and EPA drinking water standards, as well as a determination of ensuring the LLD represents 10% or less of the annual critical organ dose contribution for Sr-90 in both water and fish. The resulting LLDs dropped slightly from those in practice when Sr-90 was last required in the REMP.

Reporting levels were then extrapolated from comparisons to other nuclides and to the drinking water guidelines.

The memo also made clear the distinction between these values (applying solely to the REMP) and values determined for use in the Ground Water Monitoring Program (GWMP), which may involve other criteria. Reporting levels and LLDs for ground water are included in the GWMP and station procedures.

Unit 3 ODCM Revision 18 Justification Package

item # 8 of 22 Jan, 2007

OBJECTIVE:

Reword SR 3.10 to reference the ODCM (as the gas tank section does) for methodologies of verifying that curies in the tank remain less than 10 curies.

DESCRIPTION OF CHANGES:

Reworded this section to place the conditional phrase first, add added a phrase at the end that this determination will be performed in accordance with the methodology and parameters of the ODCM.

IMPACT:

None.

JUSTIFICATION:

Placing the conditional phrase first is in keeping with station procedural policy and improves clarity for understanding this condition and required surveillances. The methods of determining compliance with the ten curie limit are defined in the applicable section of ODCM Part II, Calculational Methodologies.

Unit 3 ODCM Revision 18 Justification Package

item # 9 of 22 Jan, 2007

OBJECTIVE:

Add Section 5.8 to identify the Ground Water Monitoring Program and its key components..

DESCRIPTION OF CHANGES:

Add a section to the Admin portion of the RECS to ensure licensing basis inclusion of the GWMP and comply with commitments NL-06-033, #4 and #5.

IMPACT:

Lower tier procedures as well as an SMM are drafted for implementing the GWMP.

JUSTIFICATION:

This new section is added to the RECS Admin Requirements to ensure the GWMP maintains a tie to the licensing basis requirements and NRC commitments, as well as the NEI initiative. Placing the overview and general requirements of the program (defined in the SMM for GWMP) here in the RECS ensures continued connection with the licensing basis, in a similar fashion as the effluents and environmental monitoring programs.

Unit 3 ODCM Revision 18 Justification Package

item # 10 of 22 Jan, 2007

OBJECTIVE:

Expand / update Figure 1-1 into two figures (adding 1-2), to show greater detail with regard to the release points and site boundary.

DESCRIPTION OF CHANGES:

Indicated the GWMP Boundary Wells (MW-40 and MW-51 on the site boundary map, and removed the confusing complexity of identifying release points on this map. Included a second, more detailed map of the power block area, specifically for identifying release points. Section 1.3 description of the maps included in the ODCM was updated to identify their purpose.

IMPACT:

None.

JUSTIFICATION:

A map showing the unrestricted area and effluent release points is required by NUREG 1301.

Using 2 maps more clearly complies with these requirements. The maps include all the desired functionality, and allow for the addition of locating the GWMP boundary wells. The location of these wells cannot be shown on other REMP maps, due to their location WITHIN the site boundary.

Unit 3 ODCM Revision 18 Justification Package

 Jan, 2007

OBJECTIVE:

Clarify the requirement for having a permit for batch liquid releases in Section 2.1.2.

DESCRIPTION OF CHANGES:

All batch liquid releases require a permit prior to release. Reworded this section to more accurately state the requirements by replacing the word "should" with more appropriate verbiage.

IMPACT:

None.

JUSTIFICATION:

The requirements of NUREG 1301 were being met in station procedures, but this verbiage in the ODCM was not as clear as it should have been to reflect the absolute requirement for permitting batch liquid releases. The improved wording more precisely ensures compliance verbiage for NUREG 1301 is captured in the ODCM, not just station procedures.

Unit 3 ODCM Revision 18 Justification Package

item # 12 of 22 Jan, 2007

OBJECTIVE:

Add clarification to Section 2.1.10 regarding the use of variable speed circulating pumps.

DESCRIPTION OF CHANGES:

Changed "reduced speed" to verbiage clarifying the application of variable speed pumps at unit 3. Circulators can operate at any speed between typical low and high end values.

IMPACT:

None.

JUSTIFICATION:

This update more accurately describes operation of unit 3's circulating pumps and provides reasoning for using actual Circ Pump flow rate for quantification, rather than a default low or high speed value. (Unit 3 circulators operate at variable speeds between 64,000 gpm and 140,000 gpm).

Unit 3 ODCM Revision 18 Justification Package

item # 13 of 22 Jan, 2007

OBJECTIVE:

Expand Section 2.1.11 to identify the means of curie tracking in idle liquid tanks.

DESCRIPTION OF CHANGES:

Added the explanation at end of this section for the option of determining that curies remain below the ten curie limit in outdoor unprotected tanks.

IMPACT:

None.

JUSTIFICATION:

Adding this explanation ensures that a grab sample of an idle tank is not automatically required to demonstrate compliance with this surveillance. While isolating, recirculating, and sampling are always an option, "determining" that the curie level of an outdoor tank can also be accomplished by tracking the curie contents from inlet concentrations and volume added, which in many case, is zero.

Station procedures, as well as this section of the ODCM, limit the concentration in these tanks such that ten curies cannot be approached at any time. This improvement will ensure there is a means of determining the curie content, while precluding mandated significant resource expenditure for idle tanks which can otherwise be proven well below the ten curie limit.

Unit 3 ODCM Revision 18 Justification Package

item # 14 of 22 Jan, 2007

OBJECTIVE:

Add Section 2.1.21 to identify potentially necessary additional release quantification from the GWMP.

DESCRIPTION OF CHANGES:

Summarize the inputs to the process of quantifying groundwater's contribution to offsite dose, in a similar fashion to the discussion of inputs to other quantification methodologies, per NL-06-033, #1. These inputs include source term, release rate, and the dilution factor, per new References 32 and 33.

IMPACT:

None.

JUSTIFICATION:

Quantification methodologies for all effluent calculations are discussed in this section of the ODCM (Calculational Methodologies). Hence, an overview of the Ground Water calculational inputs is added to this section of the ODCM. Release rate and dilution flow quantification bases are provided in References 32 and 33 for this purpose. Once these inputs are gathered, this step refers to Reg Guide 1.109 processes like other liquid effluent, for determining the offsite dose. Beyond the basic tenants of quantifying ground water effluent, the details of this quantification process, like other liquid and airborne pathways, are provided in station procedures.

Unit 3 ODCM Revision 18 Justification Package

item # 15 of 22 Jan, 2007

OBJECTIVE:

Add ground and storm water representation to Figure 2-1.

DESCRIPTION OF CHANGES:

Add the representation of ground and storm water pathways to the figure of liquid effluent pathways.

IMPACT:

None.

JUSTIFICATION:

This effort results in a more complete representation of all liquid effluent.

Unit 3 ODCM Revision 18 Justification Package

item # 16 of 22 Jan, 2007

OBJECTIVE:

Modify Section 4.0 to identify Figure 4-3 as "additional" sample points, rather than "non-RECS".

DESCRIPTION OF CHANGES:

Discontinue the differentiation of RECS and NON-RECS atop the pages of sample locations. Instead, samples that are in excess of RECS requirements are denoted in the list of locations.

IMPACT:

None.

JUSTIFICATION:

Data from extra sample locations will continue to be collected for historical purposes. The attempt to differentiate RECS and NON-RECS locations generated confusion with regard to the fact that all locations listed in the ODCM are required by the "ODCM", if not the "RECS". This effort was a hold-over from pre-89-01 implementation and has no purpose in our more modern ODCMs, all of which is governed by the 50.59 process.

Simplifying, all samples listed are required due to their presence in the ODCM, and those in excess of the RECS are so designated.

Unit 3 ODCM Revision 18 Justification Package

item # 17 of 22 Jan, 2007

OBJECTIVE:

Identify in Section 4.0 that distances in Table 4-1 were measured from the unit 1 stack.

DESCRIPTION OF CHANGES:

Added to Section 4.0 the already completed work to standardize the measured distances in the REMP from a central starting point at IPEC.

IMPACT:

None.

JUSTIFICATION:

The distances are quoted as one value for both operating units at IPEC per NUREG 1301. Therefore, a common central starting point is inferred. This addition to the ODCM clarifies that point, as it was not included in the earlier revisions where common distances were determined. This common application of the REMP for a multi-unit site is conducted per guidance in NUREG 1301.

Unit 3 ODCM Revision 18 Justification Package

item # 18 of 22 Jan, 2007

OBJECTIVE:

Add a paragraph in Section 4.0 describing the interface between the REMP and the GWMP.

DESCRIPTION OF CHANGES:

A paragraph was added at the end of this section to ensure clarity regarding the boundary and interface between the REMP and the Ground Water Monitoring Program. This added verbiage identifies that the GWMP is defined on site with station procedures and program documents (SMM), in a similar fashion to NEM procedures that implement the REMP.

IMPACT:

None.

JUSTIFICATION:

This paragraph is added to ensure clarity and avoid what was considered to be a possible opportunity for confusion regarding the interface of these two similar programs. The REMP improvements and the GWPM are added to the ODCM and defined per NUREG 1301 and the NEI initiative for ground water investigation.

Unit 3 ODCM Revision 18 Justification Package

item # 19 of 22 Jan, 2007

OBJECTIVE:

Remove "RECS" from the title of Figures 4-1, 4-2, 4-3, and Table 4-1.

DESCRIPTION OF CHANGES:

Removed the word "RECS" from the title of these tables, leaving simply "sampling locations".

IMPACT:

None.

JUSTIFICATION:

This simplification was performed in light of the fact that all listed locations are required due to their inclusion in the ODCM. Sample locations in excess of the RECS are so designated within the tables.

Unit 3 ODCM Revision 18 Justification Package

item # 20 of 22 Jan, 2007

OBJECTIVE:

Identify Roseton as a control sample location without use of a footnote on Table 4-1, page 1.

DESCRIPTION OF CHANGES:

Removed the previous footnote and simply included this information on the effected line of the table.

IMPACT:

None

JUSTIFICATION:

Typographical improvement.

Unit 3 ODCM Revision 18 Justification Package

item # 21 of 22 Jan, 2007

OBJECTIVE:

Denote samples that are NOT required by RECS on Table 4-1 (pages 3 and 4).

DESCRIPTION OF CHANGES:

In place of identifying sample locations as RECS or NON-RECS, this verbiage was replaced by a notation for each effected sample location as being in excess of RECS requirements.

IMPACT:

None

JUSTIFICATION:

This improvement clarifies that although all samples are required by the ODCM, some are in excess of RECS requirements. Samples listed are continued for historical purposes. This update reduces confusion with regard to RECS and NON-RECS sampling by eliminating those terms in favor of notation identifying effected sample location as being "in excess of RECS requirements".

Unit 3 ODCM Revision 18 Justification Package

item # 22 of 22 Jan, 2007

OBJECTIVE:

Add Boundary Wells (MW-40 and MW-51) at end of Table 4-1, page 4, and explain note 13 as supporting the GWMP.

DESCRIPTION OF CHANGES:

Added boundary well sample requirements to the REMP per NL-06-033, #2, and #3.

IMPACT:

Increased annual operating cost and new procedural requirements for the REMP.
NEM procedures are updated for this inclusion.
References of this interface are drafted in the GWMP implementing procedures.

JUSTIFICATION:

The commitment to add these boundary wells to the REMP was driven from the NEI ground water initiative. The interface between the REMP and the GWMP is identified as these boundary wells in the REMP, and are added to the ODCM in excess of the requirements of NUREG 1301.

Entergy Nuclear Northeast

Indian Point 3

TITLE: OFFSITE DOSE CALCULATION MANUAL (ODCM)

Rev. 18

WRITTEN BY:	Steve Sandike 12-5-06
REVIEWED BY:	[illegible] 1/10/07
OSRC REVIEW:	Donna Lynes 1/10/07 Mtg #07-001
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EFFECTIVE DATE:	1-19-7

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1/07

INDIAN POINT 3

OFFSITE DOSE CALCULATION MANUAL

PART I

RADIOLOGICAL EFFLUENT CONTROLS

(RECS)

Revision 18

1.0 DEFINITIONS

****

NOTE:
Common definitions are found in Technical Specifications Section 1.1.
In addition, the following specific terms are defined below.

****

1.1 GASEOUS RADWASTE TREATMENT SYSTEM

A GASEOUS RADWASTE TREATMENT SYSTEM is any system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system offgases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

1.2 MAXIMUM PERMISSIBLE CONCENTRATION WATER (MPCW)

MPCW is that concentration of a radionuclide equal to 10 times the liquid EFFLUENT CONCENTRATION(s) specified in column 2, Table 2 of Appendix B to 10CFR20.

1.3 MEMBER(S) OF THE PUBLIC

MEMBER(S) OF THE PUBLIC means any individual who is not occupationally associated with the plant. Excluded from this category are utility employees, its contractors or vendors, and delivery or service personnel. Included in this category are persons using the site for recreation or occupation not associated with the plant.

1.4 OFFSITE DOSE CALCULATION MANUAL (ODCM)

The OFFSITE DOSE CALCULATION MANUAL shall contain the current 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 (RECS) and Radiological Environmental Monitoring Programs (REMP) required by Technical Specification 5.5.1 and 5.5.4 and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Radioactive Effluent Release Reports required by Technical Specifications 5.6.2 and 5.6.3.

1.6 PRIMARY TO SECONDARY LEAK

A PRIMARY TO SECONDARY LEAK is defined by a quantifiable leak rate equal to or greater than 0.5 gpd, AND

a) The presence of fission or activation products in the secondary fluid, verified as Steam Generator U-tube leaks (and not from other known contamination, such as IVSWS leaks), OR

b) Tritium activity in the secondary fluid indicating an increase above historical baseline (normal diffusion) of 5.00E-6 uCi/ml or greater.

1.6 PROCESS CONTROL PROGRAM (PCP)

The PROCESS CONTROL PROGRAM shall contain the current formulas, 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 10 CFR Parts 20, 61 and 71 and Federal and State regulations and other requirements governing the disposal of solid radioactive waste. The PCP is further described in RECS 5.5.

1.7 PURGE - PURGING

PURGE or PURGING is the controlled process of discharging air or gas from a confinement in such a manner that replacement air or gas is required to purify the confinement.

1.8 SITE BOUNDARY

The SITE BOUNDARY (ODCM Part II, Figure 1-1) means that line beyond which the land or property is not owned, leased, or otherwise controlled by either site licensee.

1.9 SOURCE CHECK

A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.

1.10 UNRESTRICTED AREA

An UNRESTRICTED AREA (ODCM Part II, Figure 1-1) means an area at or beyond the SITE BOUNDARY, access to which is neither limited nor controlled by the licensee for purposes of radiation protection, or a similarly uncontrolled area within the SITE BOUNDARY that is used for residential quarters or for industrial, commercial, institutional, and/or recreational purposes.

1.11 VENTILATION EXHAUST TREATMENT SYSTEM

A VENTILATION EXHAUST TREATMENT SYSTEM is 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.

2/3.0 RADIOLOGICAL EFFLUENT CONTROLS AND SURVEILLANCE REQUIREMENTS

2.1 Radioactive Liquid Effluent Monitoring Instrumentation

CONTROL:

In accordance with Technical Specification 5.5.4, the radioactive liquid effluent monitoring instrumentation channels shown in Table 2.1-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Control 2.3.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: As shown in Table 2.1-1.

ACTION:

A. With a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above Control, immediately 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 2.1-1. Exert best efforts to return the instruments to OPERABLE status within 30 days and if unsuccessful, explain in the next Annual Radioactive Effluent Release Report, pursuant to RECS 5.2, why the inoperability was not corrected within this time frame.

C. Report all deviations in the Annual Radioactive Effluent Release Report.

3.1 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 OPERATIONAL TEST operations at the frequencies shown in Table 3.1-1.

TABLE 2.1-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION		
INSTRUMENT	**MINIMUM CHANNELS OPERABLE [a]**	**ACTION**
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE [c]		
a. Liquid Radwaste Processing Effluent Line (R-18)	(1)	1
b. Condensate Polisher Facility (CPF) Waste Line (R-61) [b]	(1)	1
c. Steam Generator Blowdown (R-19) [e]	(1)	2
2. GROSS BETA OR GAMMA RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE		
a. Service Water System Effluent Line (R-16A, R-16B)	(1)	3
b. Service Water System Effluent Line (R-23)	(1)	3
3. FLOW RATE MEASUREMENT DEVICES		
a. Liquid Radwaste Effluent Line	(1)	4
b. CPF Effluent Line [b]	(1)	4
c. Steam Generator Blowdown Effluent Line	(1)	4
4. TANK LEVEL INDICATING DEVICES [d]		
a. Refueling Water Storage Tank	(1)	5
b. Primary Water Storage Tank	(1)	5
c. Monitor Tank #31	(1)	5
d. Monitor Tank #32	(1)	5
e. CPF High Total Dissolved Solids Tank [b]	(1)	5
f. CPF Low Total Dissolved Solids Tank [b]	(1)	5

TABLE 2.1-1 *(Continued)*

TABLE NOTATION

a) During releases via this pathway, channels shall be OPERABLE and in service during such release on a continuous, uninterrupted basis, except that outages are permitted, within the time frame and limitations of the specified action, for the purpose of maintenance and performance of required CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION or CHANNEL OPERATIONAL TEST.

b) The Condensate Polisher Facility (CPF) instrumentation requirements apply only when a primary to secondary leak is present (R-61, the effluent flow rate meter, and the TDS level instruments). Primary to Secondary Leak is defined in RECS Section 1.

c) Recorders are only required if alarm/trip setpoints are based on recorder-controller.

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

e) Applicable for Continuous Steam Generator Blowdown to the environment only. Not applicable for Steam Generator Draindowns in Mode 5 or 6.

<u>TABLE 2.1-1 *(Continued)*</u>

TABLE NOTATION

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

a. At least two independent samples are analyzed in accordance with Radiological Effluent Control Surveillance Requirement 3.3.1.A,

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 Channels OPERABLE requirement, effluent releases via this pathway may continue provided grab samples are analyzed either for principal gamma emitters or for gross radioactivity (beta or gamma) at a lower limit of detection of at least 5E-7 microcurie/ml (as Cs-137):

a. At least once per 12 hours when the specific activity of the secondary coolant is greater than 0.01 microcurie/gram Dose Equivalent I-131.

b. At least once per 24 hours when the specific activity of the secondary coolant is less than or equal to 0.01 microcurie/gram Dose Equivalent I-131.

ACTION 3 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that, at least once per 12 hours, grab samples are collected and analyzed for gross radioactivity (beta or gamma) at a lower limit of detection of at least 5E-7 microcurie/ml (as Cs-137).

ACTION 4 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE 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 may be used to estimate flow.

ACTION 5 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, liquid additions to this tank may continue provided the tank liquid level is estimated during all liquid additions to the tank.

TABLE 3.1-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS				
INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL OPERATIONAL TEST
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE [d]				
a. Liquid Radwaste Effluent Line (R-18)	Daily [a]	Daily [a]	24M [i]	Quarterly [a,g]
b. CPF Effluent Line (R-61)	Daily [a,e]	Monthly[a,e]	24M [i]	Quarterly [a,g]
c. Steam Generator Blowdown (R-19) [f]	Daily [a]	Monthly[a]	24M [i]	Quarterly [a,g]
2. GROSS BETA OR GAMMA RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE				
a. Service Water System Effluent Line (R-16A and R-16B)	Daily [a]	Monthly[a]	24M [i]	Quarterly [a,h]
b. Service Water System Effluent Line (R-23)	Daily [a]	Monthly[a]	24M [i]	Quarterly [a,h]
3. FLOW RATE MEASUREMENT DEVICES				
a. Liquid Radwaste Effluent Line	Daily [j]	N.A.	24M	Quarterly
b. CPF Effluent Line	Daily [j,e]	N.A.	24M	Quarterly
c. Steam Generator Blowdown Effluent Line	Daily [j]	N.A.	24M	Quarterly
4. TANK LEVEL INDICATING DEVICES [c]				
a. Refueling Water Storage Tank	Daily [b]	N.A.	24M	24M
b. Primary Water Storage Tank	Daily [b]	N.A	24M	24M
c. Monitor Tank #31	Daily [b]	N.A.	24M	24M
d. Monitor Tank #32	Daily [b]	N.A.	24M	24M
e. CPF High Total Dissolved Solids Tank [e]	Daily [b]	N.A.	24M	24M
f. CPF Low Total Dissolved Solids Tank [e]	Daily [b]	N.A.	24M	24M

TABLE 3.1-1*(Continued)*

TABLE NOTATION

a) When this pathway is utilized for releases, with frequency no more than indicated.

b) During liquid additions to the tank.

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

d) Recorders are only required if alarm/trip setpoints are based on recorder-controller.

e) CHANNEL and SOURCE CHECKS on the CPF instrumentation are required only when a primary to secondary leak exists, per RECS Section 1. The tank level indicator calibrations are also required by the SPDES permit.

f) Applicable for Steam Generator Blowdown to the river only. Not applicable for Steam Generator Draindowns in Mode 5 or 6.

g) The CHANNEL OPERATIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if the following condition exists:

    1. Instrument indicates measured levels above the alarm/trip setpoint.

h) The CHANNEL OPERATIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists:

    1. Instrument indicates measured levels above the alarm setpoint.

    2. Instrument controls not set in operate mode.

i) Radioactive calibration standards used for CHANNEL CALIBRATIONS shall be traceable to the National Institute of Standards and Technology (NIST) or an aliquot of calibration solution shall be analyzed with instrumentation which is calibrated with NIST traceable standards. (Standards from suppliers who participate in measurement assurance activities with NIST are acceptable).

j) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days on which continuous, periodic, or batch releases are made.

Periodicity Abbreviations

N.A. Not Applicable

24M At least once per 24 months

2.2 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

CONTROL:

In accordance with Technical Specification 5.5.4, the radioactive gaseous effluent monitoring instrumentation channels shown in Table 2.2-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Control 2.4.1 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.

APPLICABILITY: As shown in Table 2.2-1.

ACTION:

A. With a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above Control, immediately suspend the release of radioactive gaseous effluents monitored by the affected channel or declare the channel inoperable, or change the setpoint so it is acceptably conservative.

B. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 2.2-1. Exert best efforts to return the instruments to OPERABLE status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report, pursuant to RECS 5.2, why the inoperability was not corrected within this time frame.

C. Report all deviations in the Annual Radioactive Effluent Release Report.

3.2 SURVEILLANCE REQUIREMENTS:

Radioactive gaseous effluent monitoring instrumentation channels shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and CHANNEL OPERATIONAL TEST operations at the frequencies shown in Table 3.2-1.

TABLE 2.2-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION			
INSTRUMENT	**MINIMUM CHANNELS OPERABLE**	**APPLICABILITY**	**ACTION**
1. WASTE GAS HOLDUP SYSTEM			
a. Noble Gas Activity Monitor Providing Alarm (R-20)	(1)	(b)	6
2. CONDENSER AIR EJECTOR			
a. Noble Gas Activity Monitor (R-15)	(1)	(a)	8
3. ENVIRONMENTAL RELEASE POINTS: (PLANT VENT [c], ADMIN BUILDING CONTROLLED AREA, RAD MACHINE SHOP)			
a. Noble Gas Activity Monitors:			
• PV (R-14 or R-27)	(1)	(a)	8, 11
• Admin Bldg (R-46)	(1)	(a)	8
• Rams Bldg (R-59)	(1)	(a)	8
b. Iodine Sampler	(1)	(a)	10
c. Particulate Sampler	(1)	(a)	10
d. Flow Rate Monitor	(1) [d]	(a)	7
e. Sampler Flow Rate Monitor	(1)	(a)	7
4. CONTAINMENT PURGE SYSTEM			
a. Containment Noble Gas Activity Monitor (R-12), Providing Alarm and Automatic Termination of Release	(1)	(a)	9

TABLE NOTATION

(a) Channels shall be OPERABLE and in service on a continuous basis during release via this pathway, except that outages are permitted, within the time frame of the specified action for the purpose of maintenance and performance of required tests, checks and calibrations.

(b) During waste gas holdup system operation (treatment for primary system offgases).

(c) The Plant Vent will also monitor releases from the Vent Header, Auxiliary Building Vents, Fuel Storage Building Vents, and the Rad Waste Area Vent.

(d) The Admin Bldg Controlled Area ventilation system uses default fan flow rate in lieu of a Process Flow Rate Monitor, per ODCM Part II, Section 3.1.13.

TABLE 2.2-1 *(Continued)*

ACTION 6 - With the number of channels OPERABLE less than that required by the Minimum Channels OPERABLE requirement, the radioactive content of the receiving gas decay tank shall be determined daily to ensure compliance with RECS 2.11.

ACTION 7 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours.

ACTION 8 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE 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 9 - With the number of channels OPERABLE less than the Minimum Channels OPERABLE requirement, immediately suspend PURGING of radioactive effluents via this pathway.

During containment building ventilation in Modes 5 or 6, continuous monitoring and automatic termination of release is not required. One continuous monitor at the final release point (Plant Vent) is sufficient.

ACTION 10 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via the effected pathway may continue provided samples are continuously collected with auxiliary sampling equipment as required in Table 3.4-1.

ACTION 11 - With the number of channels OPERABLE less than that required by the Minimum Channels OPERABLE requirement for the plant vent, the contents of a radwaste gas decay tank may be released to the environment provided that prior to initiating the release: | 1/0

a. At least two independent samples of the tank contents are analyzed, AND,

b. At least two technically qualified members of the facilities staff independently verify the release rate calculations and discharge valve lineup.

TABLE 3.2-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS				
INSTRUMENT [a]	**CHANNEL CHECK**	**SOURCE CHECK**	**CHANNEL CALIBRATION**	**CHANNEL OPERATIONAL TEST**
1. WASTE GAS HOLDUP SYSTEM				
a. Noble Gas Activity Monitor Providing Alarm (R-20)	Daily	Monthly	24M [e]	Quarterly [b,d]
2. CONDENSER AIR EJECTOR				
a. Noble Gas Activity Monitor (R-15)	Daily	Monthly	24M [e]	Quarterly [b,d]
3. ENVIRONMENTAL RELEASE POINTS: (PLANT VENT, ADMIN BUILDING CONTROLLED AREA, RAD MACHINE SHOP VENT)				
a. Noble Gas Activity Monitors:				
• PV (R-14 or R-27)	Daily	Monthly	24M [e]	Quarterly [b,d]
• Admin Bldg (R-46)	Daily	Monthly	24M [e]	Quarterly [b,d]
• Rams Bldg (R-59)	Daily	Monthly	24M [e]	Quarterly [b,d]
b. Iodine Sampler	Weekly	N.A.	N.A.	N.A.
c. Particulate Sampler	Weekly	N.A.	N.A.	N.A.
d. Flow Rate Monitor	Daily	N.A.	24M	Quarterly [c]
e. Sampler Flow Rate Monitor	Daily	N.A.	24M	N.A.
4. CONTAINMENT PURGE SYSTEM				
a. Containment Noble Gas Activity Monitor (R12) providing Alarm and Automatic Termination of Release	Daily	Monthly	24M [e]	Quarterly [b,d]

TABLE 3.2-1 *(Continued)*

TABLE NOTATION

a) Surveillances are required at all times except when monitor has been removed from service in accordance with Table 2.2-1.

b) Will not include operation of automatic control functions.

c) Environmental Release Point flow rate meters are normally associated with the corresponding noble gas radiation monitor. The Administration Building Controlled Area Vent system does NOT have an installed process flow meter and uses default fan flow rate instead, per ODCM Part II, Section 3.1.13.

d) The CHANNEL OPERATIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exists:

- Instrument indicates measured levels above the alarm setpoint.
- Instrument controls not set in operate mode.

e) Radioactive Calibration Standards used for CHANNEL CALIBRATIONS shall be traceable to the National Institute of Standards and Technology (NIST) or an aliquot of calibration gas shall be analyzed with instrumentation which is calibrated with NIST traceable standards (standards from suppliers which participate in measurement assurance activities with NIST are acceptable).

Periodicity Abbreviations

N.A.	Not Applicable
24M	At least once per 24 months.

2.3 RADIOACTIVE LIQUID EFFLUENTS

2.3.1 LIQUID EFFLUENT CONCENTRATION

CONTROL:

In accordance with Technical Specifications 5.5.4, the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS shall be limited to 10 times the EFFLUENT CONCENTRATION values specified in Appendix B, Table 2, Column 2 of 10CFR20 in accordance with 10CFR20.1302(2)(i) for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2E-4 uCi/ml.

APPLICABILITY: At all times.

ACTION:

With the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeding the above limits, immediately restore the concentration to within these limits.

3.3.1 SURVEILLANCE REQUIREMENTS:

A. Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program of Table 3.3.1-1.

B. The results of the radioactivity analyses 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 Control 2.3.1.

TABLE 3.3.1-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM				
Liquid Release Type	**Sampling Frequency**	**Minimum Analysis Frequency**	**Type of Activity Analysis**	**Lower Limit of Detection (LLD)[a] (uCi/ml)**
A. Batch Releases[b] (Waste Tanks, Steam Generator Draindowns to the River, etc)	Each Batch (completed prior to release)	Each Batch (completed prior to release)	Principal Gamma Emitters[c]	5E-7
			Mo-99, Ce-144	5E-6
			I-131	1E-6
	One Batch per 31 days (completed prior to release)	31 days (completed prior to release)	Dissolved & Entrained Gases (Gamma Emitters)	1E-5
	Each Batch	31 days (Composite[d])	H-3	1E-5
			Gross Alpha	1E-7
	Each Batch	92 days (Composite[d])	Sr-89, Sr-90	5E-8
			Fe-55	1E-6
B. Continuous Releases[e] (Steam Generator Blowdown to River, etc)	Composite[d]	7 days (Composite[d])	Principal Gamma Emitters	5E-7
			Mo-99, Ce-144	5E-6
			I-131	1E-6
	31 days (grab sample)	31 days	Dissolved & Entrained Gases (Gamma Emitters)	1E-5
	Composite[d]	31 days (Composite[d])	H-3	1E-5
			Gross Alpha	1E-7
		92 days (Composite[d])	Sr-89, Sr-90	5E-8
			Fe-55	1E-6
C. Service Water (in Radiologically Controlled Areas)	31 days	31 days	Gamma and Beta emitters[g]	per Section A, Liquid Batch Releases
D. Turbine Hall Drains, SG Feedwater[f]	Composite[d]	7 days (Composite[d])	Gamma and Beta emitters[g]	per Section A, Liquid Batch Releases

TABLE 3.3.1-1 *(Continued)*

TABLE NOTATION

a) The LLD is defined, for purposes of these Controls, 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. Equations used in the calculation of the LLD for a particular measurement system are presented in the ODCM.

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.

b) A batch release is the discharge of liquid wastes of a discrete volume. Prior to samplings for analyses, each batch shall be isolated, and then thoroughly mixed to assure representative sampling.

c) The principal gamma emitters for which the LLD Control applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Cs-134, Cs-137; and Ce-141. This list does not mean that only these nuclides are to be monitored. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report pursuant to Reporting Requirement 5.2.

d) A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged for each pathway. 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, e.g., from a volume of a system that has an input flow during the continuous release.

f) Steam Generator Feedwater and Turbine Hall Drains are adequately monitored from Steam Generator Blowdown composites. Increased monitoring need only be performed when a Primary to Secondary leak exists, as defined in RECS Section 1.

g) Beta emitters need only be analyzed if gamma emitters have been positively identified.

2.3.2 DOSE FROM LIQUID EFFLUENTS

CONTROLS:

In accordance with Technical Specifications 5.5.4, 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:

1. 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

2. 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.

APPLICABILITY: At all times.

ACTION:

With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days, pursuant to RECS 5.7, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective action(s) that have been taken to reduce the release(s) and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

If drinking water supply is taken from the receiving water body within 3 miles of the plant discharge (3 miles downstream for river sited plants), this Special Report shall also include:

1) the results of radiological analyses of the drinking water source; and

2) the radiological impact on finished drinking water supplies with regard to the requirements of 40 CFR Part 141.

3.3.2 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 per month.

2.3.3 LIQUID RADWASTE TREATMENT SYSTEM

CONTROL:

In accordance with Technical Specification 5.5.4, the liquid radwaste treatment system shall be used when the projected doses due to the liquid effluent, from each reactor unit, to UNRESTRICTED AREAS would exceed 0.06 mrem to the total body or 0.2 mrem to any organ in a 31 day period.

APPLICABILITY: At all times.

ACTION:

With radioactive liquid waste being discharged without treatment and in excess of the above limits, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days, pursuant to RECS 5.7, a Special Report that includes the following information:

A. Explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability,

B. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

C. Summary description of action(s) taken to prevent a recurrence.

3.3.3 SURVEILLANCE REQUIREMENTS:

Doses due to liquid releases from each reactor unit to UNRESTRICTED AREAS shall be projected at least once per month in accordance with the methodology and parameters in the ODCM when the liquid radwaste treatment systems are not being fully utilized.

2.4 RADIOACTIVE GASEOUS EFFLUENTS

2.4.1 GASEOUS EFFLUENT DOSE RATES

CONTROL:

In accordance with Technical Specification 5.5.4, 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:

A. For noble gases: Less than or equal to a dose rate of 500 mrems/yr to the total body and less than or equal to a dose rate of 3000 mrems/yr to the skin,

and

B. For iodine-131, for tritium, and for all radionuclides in particulate form with half lives greater than 8 days: Less than or equal to a dose rate of 1500 mrem/yr to any organ.

APPLICABILITY: At all times.

ACTION:

With the dose rate(s) exceeding the above limits, immediately restore the release rate to within the above limit(s).

3.4.1 SURVEILLANCE REQUIREMENTS:

A. The dose rate due to noble gases in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM.

B. The dose rate due to iodine-131, tritium, and all radionuclides in particulate form with half lives greater than 8 days in gaseous effluents shall be determined to be within the above limits 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 3.4.1-1.

TABLE 3.4.1-1

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM					
Gaseous Release Type		**Sampling Frequency**	**Minimum Analysis Frequency**	**Type of Activity Analysis**	**Lower Limit of Detection (LLD)[a] , uCi/cc**
A. Waste Gas Storage		Batch Grab Sample Prior to Each Release	Batch Grab Sample Prior to Each Release	Principal Noble Gas (NG)Gamma Emitters [b]	1E-4
B. Vapor Containment	Purge	Batch Grab Sample Prior to Each Purge	Batch Grab Sample Prior to Each Purge	Principal NG Gamma Emitters [b]	1E-4
	Press Relief	Monthly [i]	Monthly [i]		
C. Condenser Air Ejector		Grab Sample	Monthly	Principal NG Gamma Emitters [b,h]	1E-4
D. Environmental Release Points		Monthly Grab Sample [c]	Monthly [c]	Principal NG Gamma Emitters [b]	1E-4
(Plant Vent,		Monthly Grab Sample [d,e]	Monthly [d,e]	H-3	1E-6
Admin Bldg Controlled Area Vent,		Continuous [f]	Weekly [g] Charcoal Sample	I-131	1E-12
Radioactive Machine Shop Vent)		Continuous [f]	Weekly [g] Particulate Sample	Principal [b] Gamma Emitters	1E-11
		Continuous [f]	Monthly Composite Particulate Sample	Gross Alpha	1E-11
		Continuous [f]	Quarterly Composite Particulate Sample	Sr-89, Sr-90	1E-11
		Continuous [f]	Noble Gas Monitor	Noble Gases Gross Beta or Gamma	1E-6

TABLE 3.4.1-1 *(Continued)*

TABLE NOTATION

a) The LLD is defined, for purposes of these Controls, 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. Equations used in the calculation of the LLD for a particular measurement system are presented in the ODCM.

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.

b) The principal gamma emitters for which the LLD Control 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 monitored. Other identifiable gamma peaks (I-131 in particulate form, for example), together with those of the above nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report pursuant to RECS 5.2.

c) IF following a shutdown, startup, or thermal power change (within one hour) exceeding 15% of RATED THERMAL POWER, analyses indicate that the DOSE EQUIVALENT IODINE-131 concentration in the primary coolant AND the plant vent noble gas activity (as indicated on a radiation monitor) have increased by a factor of 3 or more THEN:

1) Sample the Plant Vent for noble gases within 24 hours, AND

2) Sample the Plant Vent for Iodine and Particulate once per 24 hours for at least 7 days with analyses completed within 48 hours of sample changeout. The LLDs of these samples may be increased by a factor of 10.

d) Plant vent Tritium grab samples shall be taken at least once per 24 hours when the refueling canal is flooded unless continuous sampling equipment is in use.

e) Plant vent tritium grab samples shall be taken at least once per 7 days from the ventilation exhaust from the spent fuel pool area, whenever spent fuel is in the spent fuel pool unless continuous sampling equipment is in use.

TABLE 3.4.1-1 *(Continued)*

TABLE NOTATION

f) The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Controls 2.4.1, 2.4.2 and 2.4.3.

g) Continuous 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.

Additionally, IF routine Iodine sampling indicates I-131 in a continuous ventilation pathway, THEN, collect a 24 hour sample (within 48 hours) for short-lived Iodine isotope quantification, on a periodicity not to exceed once per 31 days. The LLDs of these samples may be increased by a factor of 10.

h) The air ejector shall be sampled for Iodine and Tritium when a Primary to Secondary Leak exists. This leak is defined in RECS Section 1.

i) Vapor Containment (VC) noble gas shall be sampled at least monthly to ensure Pressure Reliefs are quantified with an accurate isotopic mixture. Containment noble gas radiation monitor readings can be used for quantification of Pressure Reliefs, provided the monitor readings are consistent with those observed during recent (at least monthly) grab samples. Sample data is routinely adjusted by the noble gas radiation monitor reading for purposes of quantification of each release.

- Should the VC Noble Gas Radiation Monitor be inoperable, a containment noble gas grab sample is required within 24 hours prior to the Pressure Relief. 1/07
- Should BOTH the VC and Plant Vent (PV) noble gas radiation monitors be inoperable (no auto-termination), two independent samples of the VC are required prior to the Pressure Relief.

2.4.2 DOSE FROM NOBLE GASES

CONTROLS:

In accordance with Technical Specification 5.5.4, the air dose due to noble gases released in gaseous effluents, from each reactor unit, to areas at and beyond the SITE BOUNDARY shall be limited to the following:

1. 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,

2. 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.

APPLICABILITY: At all times.

ACTION:

With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days, pursuant to RECS 5.7, 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.

3.4.2 SURVEILLANCE REQUIREMENTS:

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

2.4.3 DOSE FROM IODINE-131, TRITIUM, AND RADIONUCLIDES IN PARTICULATE FORM

CONTROLS:

In accordance with Technical Specification 5.5.4, the dose to a MEMBER OF THE PUBLIC from Iodine-131, 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 shall be limited to the following:

1. During any calendar quarter: Less than or equal to 7.5 mrems to any organ

   and,

2. During any calendar year: Less than or equal to 15 mrems to any organ.

APPLICABILITY: At all times.

ACTION:

With the calculated dose from the release of iodine-131, tritium, and radionuclides in particulate form with half lives greater than 8 days, in gaseous effluents exceeding any of the above limits, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days, pursuant to RECS 5.7, a Special Report that identifies the cause(s) for exceeding the limit 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.

3.4.3 SURVEILLANCE REQUIREMENTS:

Cumulative dose contributions for the current calendar quarter and current calendar year for iodine-131, 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 month.

2.4.4 GASEOUS RADWASTE TREATMENT SYSTEM

CONTROL:

In accordance with Technical Specification 5.5.4, the appropriate GASEOUS RADWASTE TREATMENT SYSTEM and the appropriate VENTILATION EXHAUST TREATMENT SYSTEM shall be used to reduce radioactive materials in gaseous waste prior to their discharge when the projected gaseous effluent air doses due to gaseous effluent releases, from each reactor unit, to areas at and beyond the SITE BOUNDARY would exceed 0.2 mrad for gamma radiation and 0.4 mrad for beta radiation in a 31 day period. The VENTILATION EXHAUST TREATMENT SYSTEM shall be used to reduce radioactive materials in gaseous waste prior to their discharge when the projected doses due to gaseous effluent releases, from each reactor unit, to areas at and beyond the SITE BOUNDARY would exceed 0.3 mrem to any organ of a MEMBER OF THE PUBLIC in a 31 day period.

APPLICABILITY: At all times.

ACTION:

With gaseous waste being discharged without treatment and in excess of the above limits, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days, pursuant to RECS 5.7, a Special Report that includes the following information:

A. Explanation of why gaseous radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability,

B. Action(s) taken to restore the inoperable equipment to OPERABLE status,

and

C. Summary description of action(s) taken to prevent a recurrence.

3.4.4 SURVEILLANCE REQUIREMENTS:

Doses due to gaseous releases from each reactor unit to areas at and beyond the SITE BOUNDARY shall be projected at least once per month in accordance with the methodology and parameters in the ODCM when the GASEOUS RADWASTE TREATMENT SYSTEMS are not being fully utilized.

2.5/3.5 SOLID RADIOACTIVE WASTE
CONTROLS AND SURVEILLANCE REQUIREMENTS:

These sections are contained in the PCP.

2.6 TOTAL DOSE

CONTROL:

In accordance with Technical Specification 5.5.4, limit the annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and to direct radiation from uranium fuel cycle sources 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.

APPLICABILITY: At all times.

ACTION:

A. With calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Control 2.3.2.1, 2.4.2.1 or 2.4.3.1, calculations should be made, including direct radiation contributions from the reactor units and from outside storage tanks, etc., to determine whether the above limits have been exceeded.

B. If such is the case, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days, pursuant to RECS 5.7, a Special Report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report, as defined in 10 CFR Part 20.2203(a)(4), shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits and if the release condition resulting in violation of 40 CFR Part 190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR Part 190. Submittal of the report within 30 days is considered a timely request, and a variance is granted until staff action on the request is complete.

3.6 SURVEILLANCE REQUIREMENTS:

A. Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with Surveillance Requirements 3.3.2, 3.4.2, 3.4.3 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, etc., shall be determined in accordance with the methodology and parameters in the ODCM. This requirement is applicable only under conditions set forth in Control 2.6.

2.7 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

CONTROL:

Pursuant to Technical Specifications 5.5.1.b, a program shall be provided to monitor the radiation and radionuclides in the environs of the plant. The program shall provide (1) representative measurements of radioactivity in the highest potential exposure pathways, and (2) verification of the accuracy of the effluent monitoring program and modeling of the environmental exposure pathways. The program shall (1) be contained in the ODCM, (2) conform to the guidance of 10CFR50, Appendix I, and (3) include the following:

A. Monitoring, sampling, analysis, and reporting of radiation and radionuclides in the environment in accordance with the methodology and parameters in the ODCM.

B. A Land Use Census to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the monitoring program are made if required by the results of this census.

C. Participation in an Interlaboratory Comparison Program to ensure that independent checks on the precision and accuracy of the measurements of radioactive materials in the environmental sample matrices are performed as part of the quality assurance program for environmental monitoring.

The Radiological Environmental Monitoring Program (REMP) shall be conducted as specified in Table 2.7-1.

APPLICABILITY: At all times.

ACTION:

A. With the Radiological Environmental Monitoring Program not being conducted as specified in Table 2.7-1, in lieu of a Licensee Event Report, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report required by RECS 5.3, 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 2.7-2 when averaged over any calendar quarter, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days, pursuant to RECS 5.7, 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 so that the potential annual dose to A MEMBER OF THE PUBLIC is less than the calendar year limits of Controls 2.3.2, 2.4.2, and 2.4.3.

When more than one of the radionuclides in Table 2.7-2 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 2.7-2 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 Controls 2.3.2, 2.4.2, and 2.4.3. 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 2.7-1, 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. In lieu of a Licensee Event Report and pursuant to RECS 5.2, identify the cause of the unavailability of samples and identify the new location(s) for obtaining replacement samples in the next Annual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

3.7 SURVEILLANCE REQUIREMENTS:

The radiological environmental monitoring samples shall be collected pursuant to Table 2.7-1 from the specific locations given in the table and figure(s) in the ODCM and the detection capabilities required by Table 3.7-1.

TABLE 2.7-1

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]	41 routine monitoring stations (DR1-DR41) with two or more dosimeters for measuring and recording integrated dose continuously placed as follows: an inner ring of stations, one in each meteorological sector in the general area of the site boundary (DR1-DR16) an outer ring of stations, one in each meteorological sector in the 6 to 8 km range from the site (DR17- DR32) the balance of the stations (DR33-DR41) to be placed in special interest areas and in one area to serve as a control station.	Quarterly	Gamma dose quarterly

TABLE 2.7-1 *(Continued)*

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**
2. Airborne Radioiodine and Particulates	Samples from 5 locations (A1-A5): 3 samples (A1-A3) from close to the 3 site boundary locations in different sectors, of the highest calculated annual average ground level D/Q. 1 sample (A4) from the vicinity of a community having the highest calculated annual average ground level D/Q. 1 sample (A5) from a control location approximately 15-30 km distant and in the least prevalent wind direction. [c]	Continuous sampler operation with collection weekly, or more frequently if required by dust loading	Radioiodine <u>Canister:</u> I-131 analysis weekly. Particulate <u>Sampler:</u> Gross beta radioactivity analysis following filter change [d] Gamma isotopic analysis [e] of composite (by location) quarterly
3. Waterborne a. Surface [f]	1 sample upstream (Wa1) 1 sample downstream (Wa2)	Composite sample over 1 month period [g]	Gamma isotopic analysis [e] monthly. Composite for tritium analysis quarterly.
b. Drinking	1 sample (Wb1) of the nearest surface drinking supply	Grab monthly	Gross beta and gamma isotopic analysis monthly. Composite for tritium analysis quarterly. [e]

TABLE 2.7-1 *(Continued)*

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**
3. Waterborne (cont)			
c. Sediment from Shoreline	2 samples (Wc1-Wc2) 1 sample (Wc1) from downstream area with existing or potential recreational value. 1 control sample (Wc2) from an upstream area.	2 annually at least 90 days apart	Gamma isotopic analysis [e], and Sr-90
d. Ground Water	Site Boundary samples (2 Monitoring Wells, drilled near the south-western site boundary.)	Quarterly	Gamma isotopic analysis [e], H-3, and Sr-90
4. Ingestion a. Milk [i]	Samples from milking animals in 3 locations (Ia1-Ia3) within 5 km distance (for human consumption) having the highest dose potential. If there are none, then 1 sample from milking animals in each of 3 areas (Ia1-Ia3) between 5 to 8 km distant if available where doses are calculated to be greater than 1 mrem per yr[h].	Semimonthly when animals are on pasture; monthly at other times.	Gamma isotopic [e] and I-131 analysis semimonthly when animals are on pasture; monthly at other times.
	1 sample from milking animals at a control location (Ia4), 15-30 km distant and in the least prevalent wind direction.	Concurrently with indicator locations.	

TABLE 2.7-1 *(Continued)*

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**
4. Ingestion			
b. Fish and Invertebrates	2 samples (Ib1, Ib2) 1 sample (Ib1) from edible portions of 2 commercially and/or recreationally important species of fish or invertebrate, in the vicinity of the discharge, when available. 1 sample (Ib2) from edible portions of each of 2 commercially and/ or recreationally important species (the same species as in Ib1 if available) from an area not influenced by plant discharge.	Sample in season, or semi-annually if they are not seasonal	Gamma isotopic analysis [e] and Sr-90
c. Food Products	Samples of 3 different kinds of broad leaf vegetation (edible or inedible) grown nearest each of two different offsite locations of highest predicted annual average ground level D/Q if milk sampling is not performed (Ic1-Ic2). [j]	Monthly when available	Gamma isotopic [e] and I-131 analysis
	1 sample of each of the similar broad leaf vegetation grown 15-30 km distant in the least prevalent wind direction if milk sampling is not performed (Ic3).	Monthly when available	Gamma isotopic [e] and I-131 analysis

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TABLE 2.7-1 *(Continued)*

TABLE NOTATION

[a] The code letters in parenthesis (e.g., DR1, A1, etc.) refer to sample locations as specified in the ODCM. Specific parameters of distance and direction sector from the centerline of one reactor, and additional description where pertinent, shall be provided for each and every sample location in Table 2.7-1 in a table and figure(s) in the ODCM. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plant," October 1978, and to Radiological Assessment Branch Technical Position, Revision 1, November 1979. 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 pursuant to RECS 5.3. 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. In lieu of a Licensee Event Report and pursuant to RECS 5.2, identify the cause of the unavailability of samples for that pathway and identify the new location(s) for obtaining replacement samples in the next Annual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

[b] One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a thermo luminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation.

[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 the previous calendar year, of control samples, gamma isotopic analysis shall be performed on the individual samples.

TABLE 2.7-1 *(Continued)*

TABLE NOTATION

[e] Gamma isotopic analysis means the identification and quantification of gamma emitting radionuclides that may be attributable to the effluents from the facility.

[f] The "upstream" sample shall be taken near the intake structures as described in the ODCM. The "downstream" sample shall be taken from the mixing zone at the diffuser to the discharge canal.

[g] A composite sample is one in which the quantity (aliquot) of liquid sampled shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.

[h] The dose shall be calculated for the maximum organ and age group using the methodology and parameters in the ODCM.

[i] The requirement to obtain and analyze samples from milch animals within 8 km of the site is intended to ensure monitoring of the "cow-milk" and vegetation pathways. Thus, only milch animals whose milk is used for human consumption are considered in the pathway and sample evaluation.

[j] Broad lead vegetation sampling of at least three different kinds of vegetation may be performed at the SITE BOUNDARY in each of two different sectors with the highest predicted D/Q in lieu of the garden census.

TABLE 2.7-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES **					
Analysis	Water (pCi/L)	Airborne Particulate 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		
Sr-90 ***	8*		40		
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	

TABLE NOTATION

* Values provided are for drinking water samples. If no drinking water pathway exists, higher values are allowed, as follows:

H-3 30,000 pCi/L (This is a 40 CFR Part 141 value)
Sr-90 12 pCi/L
I-131 20 pCi/L

** These reporting levels are associated only with the REMP requirements. The Ground Water Monitoring Program may involve unique reporting level criteria, independent of the REMP, and defined in station procedures.

*** Sr-90 is added to this table due to its potential pathway via ground water.

TABLE 3.7-1

** DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS [a]						
LOWER LIMIT OF DETECTION (LLD) [b,c]						
Analysis	Water (pCi/l)	Airborne Particulate 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			
Sr-90 ***	1		5			5000
Zr-Nb-95	15					
I-131	1*	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		

TABLE NOTATION

* If no drinking water pathway exists, higher detection capability values may be used, as follows:

H-3 3,000 pCi/l

I-131 15 pCi/l 1/07

** These required lower limits of detection are associated only with the REMP. The Ground Water Monitoring Program may involve unique requirements, independent of the REMP, and defined in station procedures.

*** Sr-90 is added to this table due to its potential pathway via ground water.

TABLE 3.7-1 (Continued)

[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 pursuant to RECS 5.3.

[b] Required detection capabilities for thermo luminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.

[c] The LLD is defined, for purposes of these Controls 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. Equations used in the calculation of the LLD for a particular measurement system are presented in the ODCM, Part II, Appendix B.

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 pursuant to RECS 5.3.

2.8 LAND USE CENSUS

CONTROL:

In accordance with Technical Specification 5.5.1.b and RECS 2.7, conduct a land use census which identifies within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors of the nearest milk animal, the nearest residence and the nearest garden of greater than $50m^2$ ($500 ft^2$) producing broad leaf vegetation. Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the SITE BOUNDARY in each of two different direction sectors with the highest predicted D/Qs in lieu of the garden census. The Controls for broad leaf vegetation sampling in Table 2.7-1.4c shall be followed, including analysis of control samples.

APPLICABILITY: At all times.

ACTION:

A. With a land use census identifying a location(s) that yields a calculated dose or dose commitment greater than the values currently being calculated in Control 3.4.3, in lieu of a Licensee Event Report, identify the new location(s) in the next Annual Radioactive Effluent Release Report, pursuant to RECS 5.2.

B. With a land use census identifying a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) two times greater than at a location from which samples are currently being obtained in accordance with Control 2.7, add the new location(s) to the Radiological Environmental Monitoring Program within 30 days. The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from this monitoring program after (October 31) of the year in which this land use census was conducted. In lieu of a Licensee Event Report and pursuant to RECS 5.2, identify the new location(s) in the next Annual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

3.8 SURVEILLANCE REQUIREMENTS:

The land use census shall be conducted during the growing season at least once per calendar year 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 pursuant to RECS 5.3.

2.9 INTERLABORATORY COMPARISON PROGRAM

CONTROL:

In accordance with Technical Specification 5.5.1.b and RECS 2.7, perform analyses on radioactive materials supplied as part of an Interlaboratory Comparison Program.

APPLICABILITY: At all times.

ACTION:

With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report pursuant to RECS 5.3.

3.9 SURVEILLANCE REQUIREMENTS:

A summary of the results obtained as part of the required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operation Report pursuant to RECS 5.3.

2.10 RADIOACTIVE LIQUID EFFLUENT HOLDUP TANKS

CONTROL:

The quantity of radioactive material contained in each of the following unprotected outdoor tanks [a] shall be limited to less than or equal to 10 curies, excluding tritium and dissolved or entrained noble gases.

1. Refueling Water Storage Tank [b]
2. Primary Water Storage Tank
3. 31 Monitor Tank
4. 32 Monitor Tank
5. CPF High Total Dissolved Solids Tank [c]
6. CPF Low Total Dissolved Solids Tank [c]
7. Outside Temporary Tank [d]

APPLICABILITY: At all times [c]

ACTION:

With the quantity of radioactive material in any of the above listed tanks exceeding the above limit, 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 Annual Radioactive Effluent Release Report, per RECS 5.2.

3.10 SURVEILLANCE REQUIREMENTS:

When radioactive materials are being added to any of the listed tanks[c], the quantity of radioactive material in the tanks shall be determined to be less than or equal to 10 curies, excluding tritium and noble gas, once per 31 days, in accordance with the methodology and parameters in the ODCM. 1/07

NOTES:

a) Tanks included in the 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.

b) After refueling operations, liquid from the reactor cavity will be sampled for radioactive material content prior to pumping into the tank.

c) The Condensate Polisher Facility (CPF) Total Dissolved Solids Tanks require controls and surveillances **only** when a primary to secondary leak exists.

d) Liquid will be sampled for radioactive content prior to being pumped into the tank.

2.11 GAS STORAGE TANKS

CONTROL:

The quantity of radioactivity contained in each gas storage tank shall be limited to less than or equal to 50,000 curies of noble gas (considered as Xe-133 equivalent).

APPLICABILITY: At all times.

ACTION:

With the quantity of radioactive material in any gas storage tank exceeding the above limit, 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 Annual Radioactive Effluent Release Report, per RECS 5.2.

3.11 SURVEILLANCE REQUIREMENTS:

The quantity of radioactive material contained in each gas storage tank shall be determined to be within the limits at least once per 24 hours when radioactive materials are being added to the tank in accordance with the methodology and parameters in the ODCM.

4.0 BASES

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION (2/3.1)

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 EFFLUENT CONCENTRATION values specified in Appendix B, Table 2, Column 2 to 10 CFR 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 10 CFR Part 50. The purpose of tank level indicating devices is to assure the detection and control of leaks that if not controlled could potentially result in the transport of radioactive materials to UNRESTRICTED AREAS.

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION (2/3.2)

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 10 CFR 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 10 CFR Part 50.

LIQUID EFFLUENTS CONCENTRATION (2/3.3.1)

This Control 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 EFFLUENT CONCENTRATION values specified in Appendix B, Table 2, Column 2 to 10 CFR 20. The Control provides operational flexibility for releasing liquid effluents in concentrations to follow the Section II.A and II.C design objectives of Appendix I to 10 CFR Part 50. This limitation provides reasonable assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, to a MEMBER OF THE PUBLIC and (2) the restrictions authorized by 10 CFR Part 20.1301(e). The concentration limit for the dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radionuclide and its EFFLUENT CONCENTRATION in air (submersion) was converted to an equivalent concentration in water. This control does not affect the requirement to comply with the annual limitations of 10 CFR Part 20.1301(a).

This Control applies to the release of radioactive materials in liquid effluents from all units at the site.

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 Currie, L.A., "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," NUREG/CR-4007 (September 1984), and in the HASL Procedures Manual, HASL-300 (revised annually).

DOSE FROM LIQUID EFFLUENTS (2/3.3.2)

This Control is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The Control statement 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 will be kept "as low as is reasonably achievable." Also, for fresh water 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 40 CFR 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 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

This Control applies to the release of liquid effluents from each reactor at the site. For units with shared radwaste treatment systems, the liquid effluents from the shared system are proportioned among the units sharing that system.

LIQUID RADWASTE TREATMENT SYSTEM (2/3.3.3)

The requirement that the appropriate portions of this system be used, when specified, provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable". This Control implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR part 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

This Control applies to the release of liquid effluents from each reactor at the site. For units with shared radwaste treatment systems, the liquid effluents from the shared system are proportioned among the units sharing that system.

GASEOUS EFFLUENTS DOSE RATE (2/3.4.1)

This Control provides 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 at or beyond the SITE BOUNDARY in excess of the design objectives of Appendix I to 10 CFR Part 50. This Control is provided to ensure that gaseous effluents from all units on the site will be appropriately controlled. It provides operational flexibility for releasing gaseous effluents to satisfy the Section II.A and II.C design objectives of Appendix I to 10 CFR Part 50. For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of that MEMBER OF THE PUBLIC will usually be sufficiently low to compensate for the reduced atmospheric dispersion of gaseous effluents relative to 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 rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrem/year to the total body or to less than or equal to 3000 mrem/year to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a child via the inhalation pathway to less than or equal to 1500 mrem/year. This Control does not affect the requirement to comply with the annual limitations of 10 CFR 20.1301(a).

This Control applies to the release of gaseous effluents from all units at the site.

DOSE FROM NOBLE GASES (2/3.4.2)

This Control is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The Control statements implement the guides set forth in Section II.B of Appendix I. The Action statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low as is reasonably achievable." The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of 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 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," Revision 1, July 1977. The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

This Control applies to the release of gaseous effluents from each reactor at the site. For units with shared radwaste treatment systems, the gaseous effluents from the shared system are proportioned among the units sharing that system.

DOSE FROM IODINE-131, TRITIUM, AND RADIONUCLIDES IN PARTICULATE FORM (2/3.4.3)

This Control is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Controls 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 will be kept "as low as is reasonably achievable." The ODCM calculational methods specified in 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 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 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate controls for Iodine-131, Tritium, and radionuclides in particulate form with half lives greater than 8 days are dependent upon the existing radionuclide pathways to man, in the 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 (determined to be not applicable at Indian Point), and 4) deposition on the ground with subsequent exposure of man.

This Control applies to the release of gaseous effluents from each reactor at the site. For units with shared radwaste treatment systems, the gaseous effluents from the shared systems are proportioned among the units sharing that system.

GASEOUS RADWASTE TREATMENT SYSTEM (2/3.4.4)

The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the release of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." This Control implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50.

The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

This Control applies to the release of gaseous effluents from each reactor at the site. For units with shared radwaste treatment systems, the gaseous effluents from the shared systems are proportioned among the units sharing that system.

TOTAL DOSE (2/3.6)

This Control is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20.1301(d). The Control requires the preparation and submittal of a Special Report whenever the calculated doses due to releases of radioactivity and to radiation from uranium fuel cycle sources exceed 25 mrems to the total body or any organ, except the 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 40 CFR 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, etc., 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 40 CFR Part 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, submittal of the Special Report within 30 days with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR Part 190.11 and 10 CFR Part 20.2203(a)(4), is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Parts 20, as addressed in Controls 2.3.1 and 2.4.1. 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.

Demonstration of compliance with the limits of 40 CFR Part 190 or with the design objectives of Appendix I to 10 CFR Part 50 will be considered to demonstrate compliance with the 0.1 rem limit of 10 CFR Part 20.1301.

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (2/3.7)

The Radiological Environmental Monitoring Program required by this Control 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 10 CFR 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. Isotopes identified in REMP are compared to those identified in the applicable Annual Effluent Report. Program changes may be initiated based on these operational experiences.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 3.7-1 are considered optimum for routine environmental measurements in industrial laboratories. 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.

LAND USE CENSUS (2/3.8)

This Control 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 the 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 10 CFR 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 (26 kg/year) 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 (i.e., similar to lettuce and cabbage), and 2) a vegetation yield of 2 kg/m^2.

INTERLABORATORY COMPARISON PROGRAM (2/3.9)

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 reasonably valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

LIQUID HOLDUP TANKS (2/3.10)

Pursuant to Technical Specification 5.5.11.c, the tanks listed in this specification include all 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.

Restricting the quantity of radioactive material contained in the specified tanks provides assurance that in the event of an uncontrolled release of the tanks' contents, the resulting concentrations would be less than the limits identified in Appendix B, Table 2, Column 2 of 10CFR20, at the nearest potable water supply and the nearest surface water supply in an UNRESTRICED AREA.

GAS STORAGE TANKS (2/3.11)

Pursuant to Technical Specification 5.5.11.b, the tanks included in this specification are those tanks for which the quantity of radioactivity contained is not limited directly or indirectly by another specification to a quantity that is less than the quantity that provides assurance that in the event of an uncontrolled release of the tanks' contents, the resulting total body exposure to a MEMBER OF THE PUBLIC at the nearest SITE BOUNDARY will not exceed 0.5 rem in an event of 2 hours duration.

Restricting the quantity of radioactivity contained in each gas storage tank provides assurance that in the event of an uncontrolled release of the tanks' contents, the resulting total body exposure to a MEMBER OF THE PUBLIC at the nearest SITE BOUNDARY will not exceed 0.5 rem. This is consistent with NUREG-0133.

5.0 ADMINISTRATIVE REQUIREMENTS

5.1 RECORDS RETENTION

In addition to the applicable record retention requirements of Title 10, Code of Federal Regulations, records shall be retained in accordance with the retention schedule of TRM 5.5.

The following specific Effluent and Environmental records shall be retained for the duration of the unit operating license:

- Records of any drawing changes reflecting facility design modifications made to systems and equipment described in the Final Safety Analysis Report.
- Records of gaseous or liquid radioactive material released to the environs.
- Records of reviews performed for changes made to procedures or equipment or reviews of tests and experiments pursuant to 10 CFR 50.59.
- Records of analyses required by the radiological environmental monitoring program that would permit evaluation of the accuracy of the analysis at a later date. This should include procedures effective at specified times and records showing that these procedures were followed.
- Records of reviews performed for changes made to the Offsite Dose Calculation Manual and the Process Control Program.

5.2 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

A Radioactive Effluent Release Report covering the operation of the unit during the previous year shall be submitted prior to May 1 of each year. A single submittal may be made for a multiple unit station. The submittal should combine those sections that are common to all units at the station. However, for units with separate radwaste systems, the submittal shall specify the releases of radioactive material from each unit.

The Annual Radioactive Effluent Release Report shall include the following information:

- A summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof or as modified in the RECS.

- For solid wastes, the following information for each class of solid waste (as defined by 10 CFR Part 61) shipped offsite during the report period will be presented in tabular form similar to that of Table 3 of Regulatory Guide 1.21:

  a. Container volume,

  b. Total curie quantity (specify whether determined by measurement or estimate),

  c. Principal radionuclides (specify whether determined by measurement or estimate,

  d. Source of waste and processing employed (e.g., dewatered spent resin, compacted dry waste, evaporator bottoms),

  e. Type of container (e.g., LSA, Type A, Type B, Large Quantity), and

  f. Solidification agent or absorbent (e.g., cement, urea formaldehyde).

- An annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by-hour listing on electronic media of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability. In lieu of submission with the Radioactive Effluent Release Report, the licensee has the option of retaining this summary of required meteorological data on site in a file that shall be provided to the NRC upon request.

- An assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit or station during the previous calendar year.

- An assessment of the radiation doses from radioactive liquid and gaseous effluents to MEMBERS OF THE PUBLIC due to their activities inside the SITE BOUNDARY during the report period. All assumptions used in making these assessments, i.e., specific activity, exposure time and location, shall be included in the report. Approximate and conservative approximate methods for determining the meteorological conditions shall be used for determining gaseous pathway doses. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

- An assessment of radiation doses to the likely most exposed MEMBER OF THE PUBLIC from reactor releases and other nearby uranium fuel cycle sources, when required by Sections 2.6 and 3.6, including doses from primary effluent pathways and direct radiation, for the previous calendar year to show conformance with 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation." Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in Regulatory Guide 1.109 Rev. 1, October, 1977.

- A list and description of unplanned releases from the site to UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

- Pursuant to Controls 2.1 and 2.2, an explanation as to why the inoperability of liquid or gaseous effluent monitoring instrumentation was not corrected within the time specified.

- Pursuant to Controls 2.1 and 2.2, a discussion of all deviations from the provisions of these Controls.

- Pursuant to Control 2.7 and Table 2.7-1, Notation (a), identify the causes of the unavailability of samples for pathway analysis and identify the new locations for obtaining replacement samples. Include revised figure(s) and table for the ODCM reflecting the new locations.

- Pursuant to Table 3.3.1-1, Notation (c) and Table 3.4.1-1, Notation (b), a discussion of identifiable gamma peaks, including those of nuclides specified in Tables 3.3.1-1 and 3.4.1-1.

- Pursuant to Control 2.8, a listing of new location(s) for dose calculations and/or environmental monitoring identified by the land use census. Include revised figure(s) and table for the ODCM reflecting the new location(s).

- Pursuant to Controls 2.10 and 2.11, a description of the events leading to liquid holdup tanks or gas storage tanks exceeding the Control limits.

- Pursuant to RECS 5.4, a discussion of the major changes to radioactive liquid, gaseous, and solid waste treatment systems.

- Pursuant to RECS 5.5 and 5.6, any changes made during the reporting period to the PROCESS CONTROL PROGRAM (PCP) and to the OFFSITE DOSE CALCULATION MANUAL (ODCM), respectively.

5.3 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

An annual Radiological Environmental Operating Report covering the operation of the unit during the previous calendar year shall be submitted prior to May 15th of each year, according to Technical Specification 5.6.2. A single submittal may be made for a multiple unit station.

The Annual Radiological Environmental Operating Report shall include:

- Summaries, interpretations, and an analysis of trends of the results of the Radiological Environmental Monitoring Program for the report period, including a comparison, as appropriate, with preoperational studies, with operational controls, and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment.

- At least two legible maps covering all sampling locations keyed to a table giving distances and directions from the centerline of one reactor. One map shall cover stations near the site boundary and the second shall include the more distant stations.

- The results of analysis of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the locations specified in the tables and figures in the ODCM, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual 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.

- A summary description of the Radiological Environmental Monitoring Program.

- A discussion of the reasons for not conducting the Radiological Environmental Monitoring Program as specified by Control 2.7 and the plans for preventing recurrence.

- Pursuant to Control 2.7, a discussion of environmental sample measurements that exceed the reporting levels of Table 2.7-2 but are not the result of plant effluents.

- Pursuant to Table 2.7-1, Notation (a), a discussion of all deviations from the sampling schedule of Table 2.7-1.

- Pursuant to Table 3.7-1, Notation (c), a discussion of the contributing factors for cases in which the LLD required by Table 3.7-1 was not achievable.

- Pursuant to Table 3.7-1, Notation (a), a discussion of identifiable nuclide peaks, including those of nuclides specified in Table 3.7-1.

- Pursuant to Control 3.8, the results of the land use census.

- Pursuant to Control 2.9, the corrective actions taken to prevent a recurrence if the Interlaboratory Comparison Program is not being performed as required.

- Pursuant to Control 3.9, the results of licensee participation in the Interlaboratory Comparison Program.

5.4 MAJOR CHANGES TO RADIOACTIVE LIQUID, GASEOUS AND SOLID WASTE TREATMENT SYSTEMS

Licensee initiated major changes to the radioactive waste systems (liquid, gaseous and solid) shall be reported to the Commission in the Annual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the OSRC. The discussion of each shall contain:

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

- Sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information

- A detailed description of the equipment, components and processes involved and the interfaces with other plant systems

- An evaluation of the change, which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the license application and amendments thereto

- An evaluation of the change, which shows the expected maximum exposures to an individual in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the license application and amendments thereto

- A comparison of the predicted releases of radioactive materials, in liquid and gaseous effluents and in solid waste, to the actual releases for the period prior to when the changes are to be made

- An estimate of the exposure to plant operating personnel as a result of the change

- Documentation of the fact that the change was reviewed and found acceptable by the OSRC.

- A single submittal may be made for a multiple unit station

- The information called for in this Specification will be submitted as part of the annual FSAR update

5.5 PROCESS CONTROL PROGRAM (PCP)

5.5.1 The PCP shall be approved by the Commission prior to implementation.

5.5.2 Licensee initiated changes to the PCP:

5.5.2.1 Shall be documented and records of reviews performed shall be retained as required by RECS 5.1. This documentation shall contain:

- Sufficient information to support the change together with the appropriate analyses or evaluations justifying the change(s); and

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

5.5.2.2 Shall become effective upon review and acceptance by the OSRC and the approval of the Site Executive Officer.

5.5.2.3 Shall be submitted to the Commission as a part of or concurrent with the Annual Radioactive Effluent Release Report for the period of the report in which any change to the PCP was made. Each change shall be identified by marking in the margin of the affected pages, clearly indicating the area of the page that was changed, and shall indicate the date (e.g., month/year) the change was implemented.

5.6 OFFSITE DOSE CALCULATION MANUAL (ODCM)

5.6.1 The ODCM shall be approved by the Commission prior to implementation.

5.6.2 Licensee initiated changes to the ODCM:

5.6.2.1 Shall be documented and records of reviews performed shall be retained as required by RECS 5.1. This documentation shall contain:

- Sufficient information to support the change together with the appropriate analyses or evaluations justifying the changes(s); and
- A determination that the change will maintain the level of radioactive effluent control required pursuant to 10 CFR 20.1302, 40 CFR Part 190, 10 CFR 50.36a, and Appendix I to 10 CFR Part 50 and not adversely impact the accuracy or reliability of effluent dose or setpoint calculations;

5.6.2.2 Shall become effective upon review and acceptance by the OSRC and the approval of the Site Executive Officer.

5.6.2.3 Shall be submitted to the Commission as a part of or concurrent with the Annual Radioactive Effluent Release Report for the period of the report in which any change to the ODCM was made. Each change shall be identified by marking in the margin of the affected pages, clearly indicating the area of the page that was changed, and shall indicate the date (e.g., month/year) the change was implemented.

5.7 SPECIAL REPORTS

In lieu of a Licensee Event Report (LER), the following special reports must be generated within 30 days:

- Pursuant to Control 2.3.2, identify the cause(s) for exceeding the specified limits for dose or dose commitment to a MEMBER OF THE PUBLIC from the release of radioactive materials in liquid effluents to UNRESTRICTED AREAS. Define the corrective action(s) taken to reduce the releases and the proposed corrective action(s) to be taken to assure subsequent releases will be in compliance with limits. Include the results of radiological analyses of the drinking water source and the radiological impact on finished drinking water supplies with regard to the requirements of 40 CFR Part 141.
- Pursuant to Control 2.3.3, explain why liquid radwaste was discharged without treatment and identify any inoperable liquid radwaste treatment system equipment or subsystems and the reason for the inoperability. Include the action(s) taken to restore the inoperable equipment to OPERABLE status and a summary description of the action(s) taken to prevent a recurrence.
- Pursuant to Control 2.4.2, identify the cause(s) for exceeding the specified limit(s) for the air dose due to radioactive noble gases released in gaseous effluents. Define the corrective actions taken to reduce the releases and the proposed corrective actions to be taken to assure subsequent releases will be in compliance with Control limits.

- Pursuant to Control 2.4.3, identify the cause(s) for exceeding the specified limits for the dose to a MEMBER OF THE PUBLIC from the release of iodine-131, tritium, and radionuclides in particulate form with half lives greater than 8 days in gaseous effluents. Define the corrective actions taken to reduce the releases and define the proposed corrective actions to be taken to assure subsequent releases will be in compliance with limits specified in the Control.

- Pursuant to Control 2.4.4, explain why gaseous radwaste was discharged without treatment and identify inoperable gaseous radwaste treatment system equipment or subsystems and the reason for the inoperability. Include the action(s) taken to restore the inoperable equipment to OPERABLE status and a summary description of the action(s) taken to prevent a recurrence.

- Pursuant to Control 2.6 and 10 CFR Part 20.2203(a)(4), define the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the specified total dose limits. Include a schedule for achieving conformance with the limits and describe the course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR Part 190 limits. 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 releases covered by this report. Also describe the levels of radiation and the concentrations of radioactive material involved as well as the cause of the exposure levels or concentrations. Include a request, if required by the provisions of the Control, for a variance in accordance with the provisions of 40 CFR Part 190.

- Pursuant to Control 2.7, identify the cause(s) for exceeding the reporting levels of Table 2.7-2 and define the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of Controls 2.3.2, 2.4.2, and 2.4.3. Report when more than one radionuclide in Table 2.7-2 is detected <u>and</u>

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

- Report when radionuclides other than those in Table 2.7-2 are detected <u>and</u> are the result of plant effluents <u>and</u> the potential annual dose to a MEMBER OF THE PUBLIC is equal to or greater than the calendar year limits of Controls 2.3.2, 2.4.2, and 2.4.3.

5.8 <u>GROUND WATER MONITORING PROGRAM (GWMP)</u>

The GWMP shall be defined in station procedures and shall include detailed information regarding the following:

- Purpose and scope of the program
- Sample locations, types, and species analyzed
- Methods of archiving and retrieving historical records of analytical results
- Reporting instructions, including limits of detection
- Summary information characterizing the condition of site ground water
- An annual summary report for submittal to the NRC and/or general publication

1/07

INDIAN POINT 3

OFFSITE DOSE CALCULATION MANUAL

ODCM PART II - CALCULATIONAL METHODOLOGIES

REVISION 18

1.0 INSTRUMENTATION AND SYSTEMS

1.1 Effluent Monitoring System Description

Effluent monitor information is provided in Table 1-1, including an indication of which monitors use effluent setpoints. Figures 2-1 and 3-1 show a schematic of the possible radioactive release points which monitor locations for liquid and gaseous pathways, respectively.

1.2 Setpoints

This section provides equations and methodology used for each alarm and trip setpoint on each effluent release point according to Sections 2.1 and 2.2 of the RECS.

1.2.1 Setpoints for Gaseous Effluent Monitors

Setpoints for gaseous monitors are based on the permissible discharge rate as calculated in Section 3 of the ODCM. These setpoints are inherently conservative due to the assumed mixture (Table 3-8) and the use of the most restrictive setpoints (annual average dose limit), which are used whenever practical. Higher release rates may be authorized with the proper concurrence, as delineated in Section 3.1.8. The methodology identified in Section 3, along with an isotopic mix described in Table 3-8, are used to generate the following noble gas discharge rates (normally utilized for alarm setpoints):

Indian Point Unit 3 Conservative Permissible Discharge Rates (μCi/sec)

Basis of Limit	Iodine/Particulate*	Noble Gases
Annual Average **	4.05E-2	3.57E+3
Quarterly Average **	8.10E-2	7.14E+3
Instantaneous ***	1.38E+1	7.00E+4

* Half-lives greater than 8 days

** These limits are not part of Section 2.4.1 of the RECS, but are included for information, as these limits are used for operational control of releases.

*** Derived from Section 2.4.1 of the RECS.

1.2.1.1 The Plant Vent Wide Range Gas Monitor (R-27) reads and alarms in μCi/sec, hence, the alarm setpoints are set directly in μCi/sec.

1.2.1.2 If the monitor reads and alarms in μCi/cc, the maximum alarm set point is calculated as follows:

$$S = D / [(F) * (4.72E+2)]$$

where: S = Maximum alarm setpoint in μCi/cc

D = Permissible discharge rate in μCi/sec
F = Vent duct flow in ft^3/min
4.72E+2 = unit conversion factor (28317 cc•min/ft^3•60sec)

1.2.1.3 If the monitor reads and alarms in cpm, then the maximum alarm setpoint is calculated as follows:

S = D / [(F) * (4.72E+2) * (CF)]

where:

S, D, F, and 4.72E+2 are defined in the previous step
CF = Rad Monitor Conversion Factor (μCi/cc per net cpm)

1.2.1.4 Normally, maximum allowable limits are calculated using a standard nuclide mix. However, setpoints may be determined based on the actual mix, on a case by case basis. This method is usually performed when the instantaneous release rate is applied. Should this method be applied, extra care should be applied to setpoint partitioning (for all release points) to ensure site dose rate limits are not approached.

1.2.1.5 During normal operation, the Unit 3 main plant vent is the only significant release point. Hence, monitors on the plant vent are routinely set at the *annual* limit, which is approximately 10% of the conservative *instantaneous* limit.

Monitor setpoints on other pathways are routinely set to 1% of the *instantaneous* limit. If multiple pathways become significant, each pathway's permissible release rate is apportioned with the Plant Vent's to ensure the total discharge rate for all release points remains less than the maximum permissible discharge rate.

1.2.2 Setpoints for Liquid Effluent Monitors

1.2.2.1 Liquid Effluent Monitors have setpoints based on limiting the concentrations in the discharge canal to ten times the concentration values in Appendix B, Table 2, Column 2 to 10CFR20 in accordance with 10CFR20.1302(2)(i). Monitor setpoints are inherently conservative due to the routine use of Circulating Water Pumps for liquid waste releases, and Service Water for continuous releases. In actuality, both Circulating and Service Water systems contribute to site dilution.

1.2.2.2 For monitors that read and alarm in μCi/ml, such as the liquid waste disposal monitor (R-18), the service water monitors (R-16 A and B and R-23), and the steam generator blowdown monitor (R-19) the alarm setpoint is calculated as follows:

S = [(ADC) (F)]/[f] = Maximum alarm setpoint in μCi/ml where:

F = Available discharge canal dilution flow for this release in gal/min

f = calculated allowable release rate in gal/min (Section 2.2.6)

ADC = Allowed diluted concentration is the equivalent MPCW for gamma emitting isotopes weighted for total specific activity (beta and gamma emitters). This parameter is further clarified in Section 2.2.

NOTE: The gamma equivalent MPCW or ADC must be used due to the insensitivity of the radiation monitor to beta emitters and the time necessary to analyze liquid releases for these beta emitters.

1.2.2.3 Alert setpoints should be used on batch liquid release monitors to ensure the contents of the batch tank have not changed since sampling. The alert setpoint is calculated as follows:

$$AS = (C) * (M)$$

where:

AS = Alert setpoint in μCi/ml
C = Average monitor reading at time of sample
M = A conservative factor based upon the mixing ratio of two tank volumes and an expected monitor response error term (typically 1.25, coinciding with 25%).

NOTE: Liquid Monitor alert setpoints do not control any auto functions but simply provide indication to the operators.

1.3 MAPS DEFINING UNRESTRICTED AREAS AND RADIOACTIVE GASEOUS AND LIQUID EFFLUENTS | 1/07

Information regarding radioactive gaseous and liquid effluents, which will allow identification of structures and release points as well as definition of UNRESTRICTED AREAS within the SITE BOUNDARY that are accessible to MEMBERS OF THE PUBLIC, are shown in Figures 1-1 and 1-2. | 1/07

The definition of UNRESTRICED AREA used in implementing the Radiological Effluent Controls (RECS or ODCM Part I) has been expanded over that in 10 CFR 20.1003. For calculations performed pursuant to 10 CFR 50.36a, the concept of UNRESTRICTED AREAS refers to areas at or beyond the SITE BOUNDARY and does not include areas over water bodies. This definition is utilized in the RECS to keep levels of radioactive materials in liquid and gaseous effluents as low as reasonably achievable.

Figure 1-1 MAP DEFINING UNRESTRICTED AREAS FOR RADIOACTIVE GASEOUS AND LIQUID EFFLUENTS
Showing Locations of Site Boundary Wells (MW-40 and MW-51)

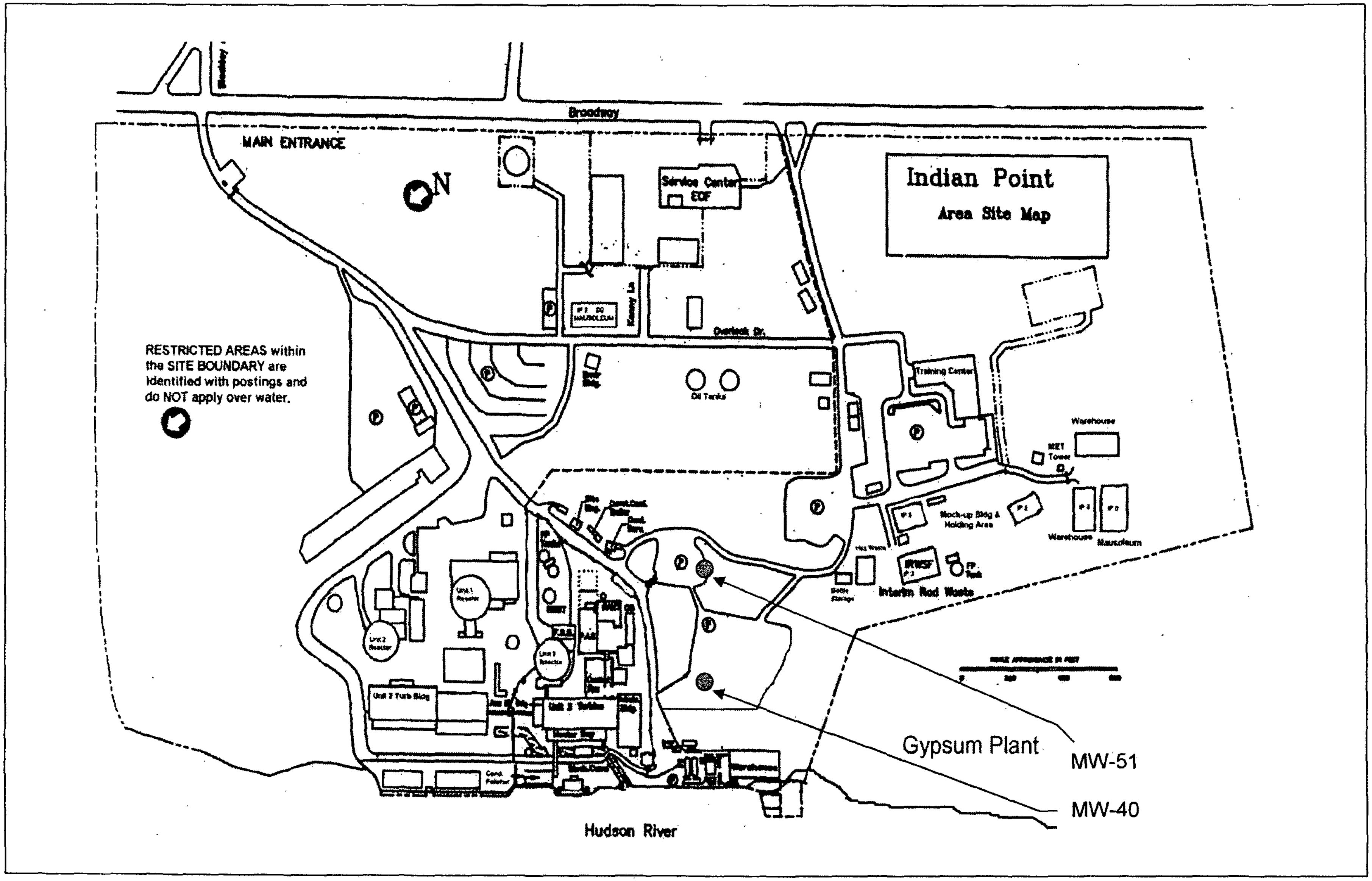


Figure 1-2 MAP DEFINING RELEASE POINTS

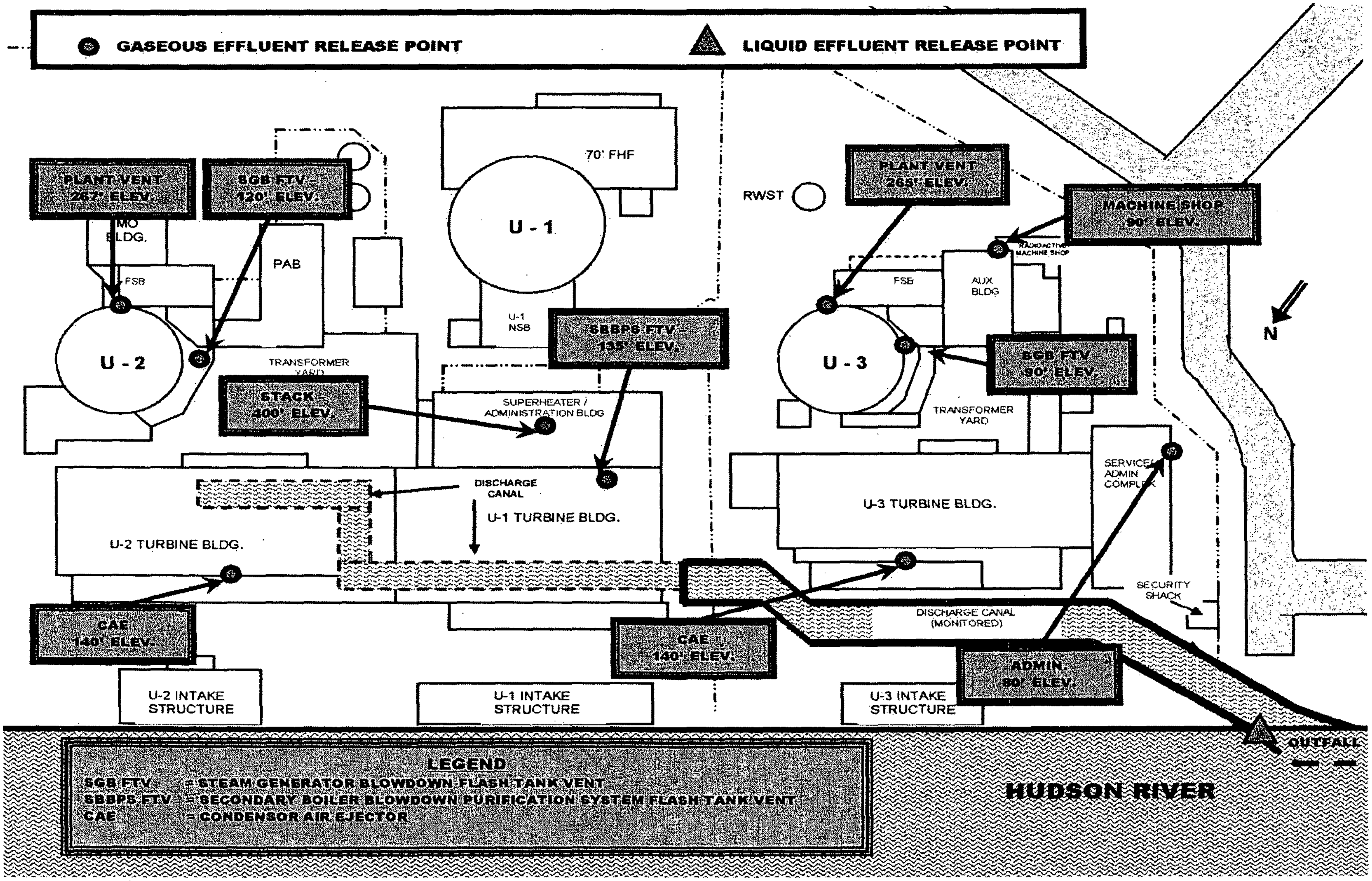


TABLE 1 – 1 (Page 1 of 2)

EFFLUENT MONITORING SYSTEM DATA

CHANNEL	MONITOR DESCRIPTION	SAMPLING LOCATIONS	RANGE	EFFLUENT CONTROL FUNCTIONS	ALARM SETPOINT USED
R-12 G	Containment Gas Monitor	Samples drawn from 32 and 35 Containment Fan Coolers	1E-7 to 1E-1 μCi/cc	Containment Ventilation Isolation	Note 1
R-14 G	Plant Vent Radiogas Monitor	In Plant Vent at approximately 105' elevation	1E-6 to 1E-1 μCi/cc	Secures waste gas tank release and Containment Ventilation Isolation	Note 1
R-15 G	Condenser Air Ejector Monitor	In-line detector on the air ejector exhaust header	1E-6 to 1E+0 μCi/cc	On alarm diverts air ejector flow to VC, steam to condenser priming air ejector stopped and steam to reheater secured	Note 1
R-20 G	Waste Gas Disposal System Monitor	Adjacent to line monitor on suction to waste gas compressors	1E-2 to 1E+3 μCi/cc	None	Note 3
R-27 G	Plant Vent Wide-Range Monitor	Sample drawn from inside Plant Vent	1E-7 to 1E+5 μCi/cc	Secure waste gas tank release and Containment Ventilation Isolation	Note 1
R-46 G	Administration Building Vent Radiogas Monitor	4th Floor Administration Building Monitor Exhaust Plenum for Controlled Areas	1E+1 to 1E+6 cpm (typically 5E-8 to 5E-2μCi/cc)	None	Note 1
R-59 G	RAMS Building Vent Radiogas Monitor	55' RAMS Building Monitor Exhaust Plenum	1E-6 to 1E+2 μCi/cc	None	Note 1

TABLE 1 – 1 (Page 2 of 2)

EFFLUENT MONITORING SYSTEM DATA

CHANNEL	MONITOR DESCRIPTION	SAMPLING LOCATIONS	RANGE	EFFLUENT CONTROL FUNCTIONS	ALARM SETPOINT USED
R-16 A/B L	Fan Cooler and Motor Cooler Service Water Return	Adjacent to service water return line from V.C. fan cooler units and motor coolers	1E-7 to 1E-1 µCi/cc	None	Note 1
R-17 A/B L	Component Cooling System pump outlet	Adjacent to line monitors on each pump outlet	1E-6 to 1E-1 µCi/ml	None	Note 2
R-23 L	Component Cooling Heat Exchanger Service Water Monitor	Adjacent to line monitor mounted on service water return line from Component Cooling Heat Exchanger	1E-7 to 1E-1 µCi/cc	None	Note 1
R-18 L	Waste Disposal Liquid Effluent Monitor	In-line monitor on monitor tank recirc pump discharge	1E-7 to 1E-1 µCi/cc	Terminates monitor tank release on alarm	Note 1
R-19 L	SG Blowdown Monitor	PAB blowdown room monitors steam generator blown	1E-6 to 1E+2 µCi/cc	Closes blowdown isolation valves and SG sample valves	Note 1
R-61 L	CPF Regen Waste Release Monitor	Monitor recirculation of HTDS and LTDS tanks in condensate polisher (used when primary to secondary leakage exists).	1E-7 to 1E-1 µCi/cc	Terminates HTDS or LTDS tank release	Note 4

Note 1 Alarm setpoint used for effluent considerations.

G = Gaseous L = Liquid

Note 2 Alarm setpoint NOT used for effluent considerations, used for information only.

Note 3 Ensures 50000 Ci limit in gas decay tanks is not exceeded.

Note 4 Alarm setpoint based on effluent considerations ONLY if a Primary to Secondary Leak exists, per RECS Section 1.

2.0 LIQUID EFFLUENTS

2.1 Liquid Effluent Releases - General Information

2.1.1 The surveillance and lower limit of detection requirements for liquid radioactive effluents are contained in Section 3.3.1 of the Radiological Effluent Controls (RECS). Lower limit of detection calculations are listed in ODCM Part II, Appendix B.

2.1.2 A completed and properly authorized Liquid Radioactive Waste Permit is required prior to the release of any radioactive waste from an isolated tank to the discharge canal. 1/07

2.1.3 All activity determinations for liquid radioactive effluents are performed in such a manner as to be representative of the activity released to the river.

2.1.4 The radioactivity in liquid waste tanks shall be continuously monitored during release except as allowed by Section 2.1 of the RECS. If the flowmeter is inoperable, the flow shall be estimated every four hours by difference in tank level or by discharge pump curves.

2.1.5 Prior to discharge, the radioactive waste tank contents shall be recirculated for at least two tank volumes. After this recirculation, and prior to discharge, a sample shall be taken and analyzed for activity with a portion of the sample set aside for composite analysis. The measured activity shall be used for calculating allowable discharge rate and the alarm setpoint for the liquid waste discharge monitor.

2.1.6 Radioactive releases of steam generator blowdown during primary to secondary leaks when released to the river should be documented on Liquid Radioactive Waste Release Permits using data supplied by the Chemistry Technician.

2.1.7 Assurance that combined liquid releases from Units 2 and 3 do not exceed the requirement of the RECS, Section 2.3 (10CFR20 requirements) are provided by administrative controls which include routine use of unit-specific dilution flow for each permitted release. In order to facilitate two-unit operation, however, upon agreement between shift managers, one unit can reduce or eliminate radioactive liquid waste discharges for a period of time to allow the other unit to use the full site dilution flow, or a specified portion thereof, for a limited time.

2.1.8 Steam Generator Blowdown activity is determined by samples taken at least three times per week. These "grab" samples of the steam generators are collected in a manner to be proportional to the rate of flow of individual steam generator to total steam generator blowdown. These samples are then analyzed for the various radionuclides at frequencies specified in Table 3.3.1-1 of the RECS. Further flow proportional composites are made where appropriate.

2.1.9 Time average dose calculations (10CFR50) may use total site dilution flow for both units, with the determined dose contributions additive for a site report over any specified period.

2.1.10 The discharge canal flow rate is determined by the use of pump flow characteristics curves. Nominal maximum flow for condenser cooling pumps is 140,000 gpm. During the cold weather months, the condenser cooling pumps are operated at reduced speed, nominally 64,000 gpm or greater, depending on the variable speed selected. | 1/0

2.1.11 Radioactivity content in outdoor tanks is to be limited to less than 10 curies, excluding tritium and noble gas, as per Section 2.10 of the RECS. Compliance with this requirement is demonstrated by limiting the radioactive concentration in these tanks to the value which results in 10 curies when the tank is at full liquid capacity, except as modified below. The radioactive concentration limits for these tanks are:

<u>RWST</u>:

$$\frac{10\,curies \times 10^{6}\,\mu Ci/curie}{358{,}500gal \times 3785ml/gal} = 7.3 \times 10^{-3}\,\mu Ci/ml$$

<u>PWST</u>:

$$\frac{10\,curies \times 10^{6}\,\mu Ci/curie}{165{,}000gals \times 3785ml/gal} = 1.6 \times 10^{-2}\,\mu Ci/ml$$

<u>31 & 32 MT</u>:

$$\frac{10\ curies \times 10^{6}\,\mu Ci/curie}{11{,}750gals \times 3785ml/gal} = 2.2 \times 10^{-1}\,\mu Ci/ml$$

<u>Condensate Polisher High and Low Total Dissolved Solids Tanks:</u>

$$\frac{10\ curies \times 10^{6}\,\mu Ci/curie}{60{,}000gals \times 3785ml/gal} = 4.4 \times 10^{-2}\,\mu Ci/ml$$

<u>Outside Temporary Tanks</u>:

$$\frac{10\ curies \times 10^{-6}\,\mu Ci/curie}{Volume\ (gal) \times 3785ml/\ gal} = \mu Ci/ml$$

Integrated curies in a tank can similarly be determined by calculating the curies added from known inlet concentrations and volumes, which would then be combined with previously determined tank curie levels. | 1/07

The refueling water storage tank has the potential to be filled from the reactor cavity with liquid which exceeds the limits stated. Therefore, prior to filling the RWST from the reactor cavity after refueling operations, the reactor cavity (or residual heat removal system) must be sampled for radioactivity and action taken to ensure that the total activity in the tank does not exceed 10 curies.

Outside temporary tanks should not be filled with liquid which could exceed the concentration limit calculated. Therefore, prior to transfer to outside temporary tanks, the source of liquid shall be sampled for radioactivity. If it exceeds the concentration limit calculated, action shall be taken to ensure that the total activity in the tank does not exceed 10 curies.

2.1.12 Although R-19 continuously monitors steam generator blowdown to the river, there are no continuous composite samples for steam generator blowdown. The method of determining release concentration is as follows:

Individual blowdown flow rate to river (by flowmeter or curves)	X	Sample Blowdown Concentration	=	Composite activity being released

2.1.13 The service water radioactivity monitors listed in Table 2.1-1 of the RECS are defined as the process radiation monitors which monitor components discharging into or are cooled by the service water system. These and other liquid effluent process radiation monitors are:

<u>Service Water:</u>

R-16 A or B: Fan Cooler and Motor Cooler unit service water return monitors

R-23: Component cooling service water return

<u>Liquid Waste (separate release points):</u>

R-18: Liquid waste release monitor

R-19: Steam generator blowdown radioactivity monitor

R-61: Condensate Polisher waste monitor. Applicable only after a Primary to Secondary Leak, per RECS Section 1.6 and ODCM Part II, Sec 1, Table 1-1, Note 4.

If all monitors on the effected release path are taken out of service and the removal of that monitor from service is not specifically addressed in the RECS, releases may continue via this pathway provided that samples are taken on the effected stream every 12 hours.

2.1.14 Liquid effluent concentrations must be within the limitations of 2.3.1 of the RECS. The total dose per quarter and per year must be within the limitations of 2.3.2 of the RECS.

2.1.15 There are no drinking water intakes within 3 miles downstream of the site on the Hudson River (see Section 2.4.1 for further details).

2.1.16 A turbine hall drain system which would collect leakage of contaminated secondary plant waters during operation does not exist at IP3. The sumps present in the turbine hall (five foot elevation) receive drains from areas containing secondary plant components at sub-atmospheric pressures. These sumps do not meet the intent of a turbine hall drain system as defined in NUREG 0472.

Quantification of effluents is performed on this pathway during a Primary to Secondary leak, as defined by ODCM Part II, Section 1, Table 1-1, Note 4. In these cases, releases from this pathway would be quantified by periodic sampling and determination of the release rate to the river.

At elevated Steam Generator activity levels (approximately 1.0E-4 or above), turbine hall drains may require temporary processing, should effluents via this pathway approach the 31-day dose projection limits per RECS 2.3.2. In this case, water is directed to the Condensate Polishing Facility or otherwise processed prior to release. Activity released via this pathway is determined as follows:

$$\begin{pmatrix}\text{Turbine Hall}\\ \text{Drain}\\ \text{Effluent Activity}\end{pmatrix} = \begin{pmatrix}\text{Feedwater}\\ \text{Specific}\\ \text{Activity}\end{pmatrix} * \begin{pmatrix}\text{Steam Plant} & & \text{SG Blowdown}\\ \text{Makeup} & - & \text{Rate to the}\\ \text{Rate} & & \text{River}\end{pmatrix}$$

2.1.17 Carbon 14 is released at a rate of .07 curies per GW(e)/yr with an average make up rate of 0.5 gal/min based upon studies performed by the New York State Department of Health. The estimate of Carbon 14 releases are included in the Radiological Impact on Man section of the Annual Radioactive Effluent Release Report. These estimates are not included in dose calculations for routine releases.

2.1.18 Several normally non-radioactive systems are periodically analyzed for radioactivity. Examples include the condensate polisher regenerant waste tank, the Spent Fuel Pool Auxiliary Heat Exchanger Secondary Cooling System (when in use), and Site Storm Drains, etc. The monitoring program for these type of release points is consistent with the direction set forth in NRC IE Bulletin 80-10 "Contamination of Non-radioactive Systems and Resulting Potential for Unmonitored, Uncontrolled Release of Radioactivity to Environment". Should a system become contaminated, releases will be evaluated and quantified (as either batch or continuous) in accordance with the requirements listed in the RECS and the IPEC 80-10 program, or as defined in Section 2.1.21.

2.1.19 The liquid waste monitor tanks have an airborne release pathway. The original plant design limited the gases through this pathway by reducing the entrained gases to less than 2E-3 μCi/ml. When the entrained gas concentration in the monitor tank inlet exceeds 2E-3 μCi/ml, the noble gas release will be quantified by calculating the difference (in μCi's) between the gaseous activity added to the tank and the gaseous activity present in the effluent release sample. This difference will be the activity released through the tank vents and is quantified as an airborne release.

2.1.20 Due to the addition of Hafnium control rods in fuel cycle 11, an offsite dose may need to be calculated for Hafnium isotopes in waste pathways. In the absence of site-specific bioaccumulation and dose factors for Hafnium, factors for Zirconium will be used, as suggested in ICRP 30. Should these calculations become necessary, they will be performed per Sections 2.4 and 2.5, and manually added to other totals.

2.1.21 Investigations from the Ground Water Monitoring Program (GWMP) may result in a determination of liquid effluent. A quantification and dose assessment of radioactive groundwater or storm water leaving the site shall be performed at least annually.

This quantification shall include, as a minimum, the source term from samples obtained near the effluent points of each applicable pathway (eg, ground water wells nearest the site boundary), and a determination of release rate and dilution flow. 1/07

Release rates to the river from both the bedrock pathways and collective storm drain pathways are provided from modeling by hydrologists, as determined from annual average rainfall, the condition of the surface area over the effected zones, and other studies of ground water movement, per Reference 32.

Dilution flow is directly measured in the Discharge Canal for the Storm Drain component. For groundwater reaching the Hudson via a direct path under the canal, a dilution factor equivalent to a 6-hour half-tidal surge in the effected area of the Hudson applies, as discussed in Reference 33.

Dose calculations are otherwise then completed per Section 2.4, with results included in the annual effluent report, as defined in the GWMP.

2.2 <u>Liquid Effluent Concentrations</u>

2.2.1 This section provides a description of the means that will be used to demonstrate compliance with the RECS, Section 2.3.1.

2.2.2 Compliance with the instantaneous limits of 10CFR20 is achieved by allocating dilution per Section 2.1.7, on a per unit basis. Compliance with 10CFR50 (quarterly and annual limitations) is assured by completing a monthly report which summarizes the time-average releases from the site.

2.2.3 Each isolated liquid waste tank must be recirculated for at least two tank volumes prior to sampling in order to ensure a representative sample is obtained. A default minimum recirculation time of 4 hours may be used for 31 and 32 monitor tank in lieu of the actual calculation:

$$\frac{11750\ gals * 2\ Tank\ Volumes}{100\ gal/\min} = 3.9\ Hours \approx 4\ Hours$$

Note: Nominal monitor tank pump flow rate is approximately 135 gpm. For conservativism however, 100 gpm is used for the recirculation flow rate, while 150 gpm is used for the discharge flow rate in all release calculations.

2.2.4 For batch releases, the concentration in liquid effluents prior to dilution in the discharge canal is determined by sampling prior to release.

For continuous releases, the concentrations can be determined by either grab sampling (like the batch method), or by direct reading radiation monitor. If the process radiation monitor is utilized, the conversion factor should be verified as appropriate for the mixture being released.

For non-direct reading monitors, the following calculation is used:

$$C = CF * CR$$

C = Concentration of liquid effluent (uCi/ml) prior to dilution

CF = Conversion factor of monitor (uCi/ml per net cpm)

CR = Count rate of monitor (in net cpm)

2.2.5 The final diluted concentration in the canal is determined as follows:

$$CD = (C) * (f) / (F)$$

Where:

CD = Diluted concentration in the discharge canal in uCi/ml

C = Pre-dilution liquid concentration in uCi/ml

F = Dilution flow in the discharge canal in gal/min

f = Release rate of liquid effluent in gal/min

2.2.6 <u>Calculation of Maximum Permissible Concentration in Liquid Effluents</u>

a. This section describes the methodology used to ensure the requirements of section 2.3.1 of the RECS are satisfied. The total discharge canal concentration of radionuclides must be maintained less than those identified by section 2.3.1 of the RECS. The noble gases will be included using the limit 2E-4 uCi/ml as specified in section 2.3.1 of the RECS.

These criteria are normally assured by using an ***Allowed Dilution Concentration*** (ADC) on each discrete release. This differs from the ECs given in 10CFR20 Appendix B in that, for radioisotopes that do not have gammas greater than 60 kev emitted during decay, default values are included to estimate their contribution. The Allowed Diluted Concentration is derived and calculated as follows:

$$ADC = \frac{MPCWt * CG}{Total activity} \quad \text{or} \quad ADC = \frac{MPCWt * CG}{CG + CB} \quad \text{or} \quad ADC = \frac{MPCWt}{1 + {CB}/{CG}}$$

where: ADC = Allowed diluted concentration in uCi/ml

MPCWt = Maximum permissible concentration in water for all isotopes (beta & gamma), in uCi/ml, as defined in RECS, Section 1.2, as follows:

$$MPCWt = \frac{\sum_i Ci}{\sum_i \left({Ci}/{MPCWi} \right)}$$

Ci and MPCWi = Concentration and MPCW for each isotope

CB = The concentration of the non gamma emitters, in uCi/ml

CG = The concentration of the gamma emitters, in uCi/ml

b. A representative sample must be obtained. For batch releases, at least two tank volumes are recirculated after the tank has been isolated to meet these requirements. The minimum recirculation time is determined as follows:

T = 2 (V) / (G) where;

T = Minimum recirculation time in min

V = Volumes in the tank to be discharged, in gal

G = Recirculation rate in gal/min

NOTE: As stated in Section 2.2.3, a default recirculation time for 31 and 32 Monitor tanks of 4 hours may be used to simplify routine calculations.

c. After the tank has been sampled, determine the Allowed Diluted Concentration as per step 2.2.6a.

d. Determine if other liquid radioactive discharges are being made from this unit and obtain the radioactive concentration and discharge rate. If another release is occurring, the available dilution flow must be adjusted. This may be performed by allocation or by calculation.

The required dilution flow is calculated as follows:

$$E = \frac{Dr * CG}{ADC}$$ where;

Dr = Current release discharge rate, gpm

E = Required dilution for current existing release(s), gpm

CG and ADC are defined in Section 2.2.6.a

e. Calculate the permissible discharge rate as follows:

$$D = \frac{ADC * B}{CG}$$ Where:

D = Permissible discharge rate in gal/min

ADC = Calculated and described in Step 2.2.6.a

CG = Gamma emitter concentration in μCi/ml

B = Adjusted dilution flow from the unit, in gpm, from Step 2.2.6.d, above, as follows:

$$B = [\ Available Dilution\ Flow] - [\ Required\ Dilution\ Flow\ for\ other\ releases\ (E)]$$

Note: With no "other" releases, *B* simply becomes the *Available Dilution Flow.*

2.3 Liquid Effluent Dose Calculation Requirements

2.3.1 Section 2.3.2 of the RECS requires that the dose or dose commitment above background to an individual in an unrestricted area from radioactive materials in liquid effluents released from each reactor unit shall be limited:

a) During any calendar quarter: Less than or equal to 1.5 mrem to the total body and to less than or equal to 5 mrem to any organ.

b) During any calendar year: Less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

NOTE: If either of the above limits is exceeded by a factor of two or more, then cumulative dose contributions from direct radiation would be determined by evaluation of existing perimeter and environmental TLDs per Section 2.6.A of the RECS.

2.3.2 Section 2.3.3 of the RECS requires that appropriate portions of the radwaste treatment system be used to reduce the radioactive material in liquid waste prior to their discharge when the projected dose due to liquid effluent from each reactor unit when averaged over 31 days, would exceed 0.06 mrem to the total body or 0.2 mrem to any organ.

Doses due to liquid release shall be projected at least once per 31 days. These doses are projected based on the dose methodology in Section 2.4. or 2.5. The average of previous months' doses is used to project future dose, as follows:

$$\begin{bmatrix} \text{Dose} \\ \text{Projection} \end{bmatrix} = \frac{\text{Current Month Dose} + \text{Previous months' Dose}}{\text{number of months used}} \pm \begin{bmatrix} \textit{major} \\ \textit{planned} \\ \textit{evolutions} \end{bmatrix}$$

The term for planned evolutions is routinely determined from previous similar evolutions, such as releases associated with plant shutdown.

2.3.3 Section 2.3.1 of the RECS requires that the concentration of radioactive material released from the site shall be limited to 10 times the concentration values specified in 10 CFR 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 2E-4 uCi/ml total activity.

2.4 Dose Methodology (Computer Calculation)

2.4.1 NUREG 0133 (Ref. 1, Section 4.3, Pg. 14) states that cumulative dose contributions should consider the dose contribution from the maximum exposed individual's consumption of fish, invertebrates, and potable water as appropriate. The river at IP3NPP is considered to be fresh water when in reality it is a tidal estuary and never completely fresh. Observed average chlorosity at IP3NPP has ranged as high as 2.5 gm/liter or about 13% sea water and 87% fresh water.

Hence, use of the Hudson River for water supply purposes is precluded south of Chelsea (mile point 65) which is the nearest point of potable water supply (approximately 15 miles upstream of IP3NPP). Radionuclide concentrations in the nearest water supply have been calculated (Ref. 2) to be a factor of at least 500 lower than the river water in the Indian Point area.

Due to the absence of a potable water pathway downstream of IP3NPP, RECS 2.3.2 reporting regulations for a 3 mile downstream limit do not apply. Exposures from ingestion of drinking water is therefore negligible.

Based on these factors, potable water consumption is not considered to be a pathway at IP3NPP. Thus, at IP3NPP, the cumulative dose considers only the dose contributions from the maximum exposed individuals consumption of fish and invertebrates. Tables of dose factors for three age groups were developed as per Section 2.4.3 and are included as Tables 2-1, 2-2, and 2-3. (Infant dose factors are 0 and are not included).

2.4.2 The relationships and methods that form the calculational base for dose accounting for the liquid effluent pathway are described in this section. These relationships can be used to meet the calculational requirements of Section 2.3.1. The cumulative dose factors (AiT) are calculated in Section 2.4.3. The following equation is generally applicable and can be used for any number of isotopes released over any time period.

$$D(T) = \sum_{i=1}^{m} [A_{iT} * \sum_{k=1}^{n} (dt_k)(C_{ik})(F_k)]$$

Where:

m = The total number of isotopes released.

D(T) = The liquid effluent cumulative dose commitment from nuclides to the total body or any organ, T, for the time period k, in mrem.

dt_k = The length of the time period, k over which C_{ik} and F_k are averaged for all liquid releases, in hours. (This can be individual release durations summed, or an entire period duration, defined with each application of this equation.)

C_{ik} = The undiluted liquid effluent average concentration of nuclide, i, in uCi/ml, during time period dt_k from any liquid release.

n = The total number of releases considered.

A_{iT} = The site related ingestion dose commitment factor to the total body or any organ for each IP3NPP identified principal gamma and beta emitter listed in Table 2-1, 2-2, and 2-3, in mrem-ml per hr-uCi.

F_k = The total dilution factor for C_{ik} during any liquid effluent releases; defined as the ratio of the maximum undiluted liquid waste flow during release to the average flow from the site discharge structure to unrestricted receiving waters, times an applicable factor.

The term C_{ik} represents the total undiluted concentration of radioactive material in liquid waste at the release point as determined by the radioactive liquid waste sampling and analysis program as contained in the RECS. All dilution factors beyond the sample point are included in the F_k and A_{iT} terms.

The term F_k is a total dilution factor and is determined as follows:

$$F_k = \frac{\text{Liquid Radioactive Waste Flow}}{[\text{Discharge Structure Exit Flow} * \text{Applicable Factor}]}$$

The liquid radioactive waste flow is the flow from all continuous and batch radioactive effluent releases specified in the RECS from all liquid radioactive waste management systems. The discharge structure exit flow is the average flow during disposal from the discharge structure release point into the receiving body of water. Based on studies by New York University Medical Center (ref. 14 page 7), the appropriate "Applicable Factor" (also known as the "near field dilution factor") is 5.

F_k is first determined with dilution flow concurrent with applicable releases, for permitting requirements (see Section 2.2). Doses are later recalculated (for the entire site) on a quarterly basis to determine actual doses from quarterly total site dilution volume. This method allows both an immediate and accurate long-term assessment of radiation dose resulting from liquid effluent releases at Indian Point.

2.4.3 Dose Factor for Liquid Effluent Calculations

The equation for dose from liquid effluents requires the use of a dose factor A_{iT} for each nuclide, i, which embodies the dose factors, pathway transfer factor, pathway usage factors, and dilution factors for the points of pathway origin.

IPEC follows the guidance of NUREG 0133 and has calculated A_{iT} for the total body and critical organ of the maximum exposed individual (e.g. the adult). All the factors needed in the equation were obtained from Regulatory Guide 1.109 with the exception of the fish and invertebrate bioaccumulation factors (BF_i and BI_i) for Cesium, Niobium, Silver, and Antimony, which were determined locally (References 2, 12, 13, and 25).

For Cesium, a site specific factor of 224 was used instead of the 2,000 presented in Table A-1 of the Regulatory Guide for fish. Similarly, a factor of 224 was used for invertebrates instead of the Regulatory Guide value of 1000. For Silver, the fish and invertebrate factors are 2.3 and 3300, respectively. For Niobium, the fish and invertebrate factors are 300 and 100 respectively. For Antimony, the fish and invertebrate factors are 1 and 300 respectively. The justification for these substitutions is discussed in Section 2.6. The summary dose factor is as follows:

$$A_{iT} = K[(UF)BF_i + (UI)BI_i]Df$$

Where:

A_{iT} = Composite dose parameter for the total body or critical organ for nuclide, i, for all appropriate pathways, mrem/hr per µCi/ml.

K = Units conversion factor, $114155 = \frac{(1E6pCi/\mu Ci) * (1E3ml/kg)}{8760\ hr/yr}$

UF = kg/yr fish consumption from Table E-5 of Reg Guide 1.109:

21 Adult	6.9 Child
16 Teen	0 Infant

BFi = Fresh Water Fish Bioaccumulation factor for nuclide, i, in pCi/kg per pCi/l from Table A-1 of Regulatory Guide 1.109.

UI = kg/yr invertebrate consumption from Table E-5 of Regulatory Guide 1.109:

5.0 Adult	1.7 Child
3.8 Teen	0 Infant

BIi = Salt Water Invertebrates Bioaccumulation factor for nuclide, i, in pCi/kg per pCi/l from Table A-1 of Regulatory Guide 1.109.

DF_i = Dose conversion factor for nuclide i, for age groups in pre-selected organs, T, in mrem/pCi, from Tables E-11, 12 & 13 of Regulatory Guide 1.109.

IP3NPP has compiled A_{iT} factors for 3 age groups and various organs for the maximum exposed individual. These are included as Table 2-1, 2-2, and 2-3. For completeness, this table includes all isotopes found in Reg Guide 1.109, however, several isotopes listed are not routinely identified at IP-3. In addition, the values for Antimony, Silver, Cesium, and Niobium are site specific as previously discussed.

2.5 Backup Calculation Methodology

Note: These methods provide backup calculations identical to those in Section 2.4.

2.5.1 An alternate computer method which completely complies with Section 2.4 should be used when the primary computer system is inoperable.

2.5.2 Hand Calculations which completely comply with Section 2.4 can be employed if the primary and secondary computer codes are inoperable. Because they are time consuming and subject to calculational errors, procedural guidance in the actual flow of calculations should be used to maintain a standard format. These procedures are also used for periodic benchmark tests of the computer codes.

2.6 Site Specific Bio-Accumulation & Dose Factors

2.6.1 As stated in Section 2.4.3 the bioaccumulation factor (BF_i) for Cesium in fish is assumed to be 224 instead of the 2000 listed in Regulatory Guide 1.109 (Ref. 3). Similarly, the bioaccumulation factor for invertebrates is 224. This is based on the fact that the Hudson River at IP3NPP is not completely fresh, the Bioaccumulation Factor for salt water is 40 (Ref. 2), and that the behavior of Cesium in the Hudson is a complex phenomenon.

The NYU Study (Ref. 2) shows that Cesium concentrations in fish are regulated at a relatively constant value independent of the concentration of Cesium in water, and the bioaccumulation factors are thus inversely proportional to the water concentration of Cesium. This explains the lower bioaccumulation factor for Cesium reported by numerous investigators for salt water fish as opposed to fresh water fish because of the higher stable Cesium content of sea water. The NYU Report states that water at Indian Point has a dissolved Cesium concentration which is much higher than would be expected from simple mixing between sea water and fresh water and postulates that these higher concentrations result from leaching of Cesium from bottom sediment by saline water.

Use of the bioaccumulation factors of Regulatory Guide 1.109 for a fresh water site will thus substantially overestimate fish ingestion doses because no account is taken of the phenomena just discussed. However, radio-cesium concentrations in fish may still be estimated through the use of a bioaccumulation factor, provided that this factor is determined from the body of water of interest. This factor has been estimated (Ref. 12, page 33) to be about 224 for the flesh of indigenous fish caught in the Indian Point area. In contrast, the Cesium fresh water bioaccumulation factor presented by Regulatory Guide 1.109 for fish is 2000.

Fish ingestion doses would therefore be overestimated by a factor of 13 if the Regulatory Guide values were used.

Similarly for invertebrates, the site specific bioaccumulation factor of 224 is used. This is larger than the value of 25 given in Reg Guide 1.109 for salt water invertebrates.

A second conservatism in the NRC model concerns the location at which the concentrations in the river of the discharged Cesium are evaluated. Use of this model implies that these fish have grown directly in such a location prior to being caught, which is unrealistic and adds about a factor of five in conservation. This conservatism remains in the calculation, thus the use of the NYU (Ref. 12) bioaccumulation factor is justifiable since this remains as a conservative calculation.

2.6.2 No bioaccumulation factor for Silver is listed in Rev. 1 of Regulatory Guide 1.109, Table A-1. The values of 2.3 and 5000 for fish and invertebrates were obtained from ORNL-4992 (sponsored by ERDA 660, Ref. 25) and are included in the ODCM in the interests of increased accuracy since Ag-110m is a potential component of IP3NPP liquid releases.

2.6.3 International Atomic Energy Agency Report No. 57 provides data more recent than that presented in Regulatory Guide 1.109 for niobium bioaccumulation factors. The factor in the Regulatory Guide appears to be substantially over-conservative and, therefore, the more recent IAEA information is incorporated into the dose calculation methodology for liquid releases of radio-niobium. The values from Table XVII of IAEA No. 57 are 300 and 100 for freshwater fish and marine invertebrates respectively and are incorporated into this ODCM.

2.6.4 Antimony isotopes are not listed in Reg. Guide 1.109. As for Niobium above, IAEA Report No. 57 was used to provide bioaccumulation factors for the Antimony isotopes in Table 2-1. Dose factors were calculated for Antimony as per Reference #13.

2.6.5 In summary, with the exception of the bioaccumulation factors discussed above, all remaining factors are as follows: fish factors are for fresh water and invertebrate factors are for salt water.

Table 2 - 1

Site Related Adult Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.82E-01	2.82E-01	2.82E-01	2.82E-01	2.82E-01	2.82E-01
BE-7	3.29E-01	7.45E-01	3.69E-01	0.00E+00	7.83E-01	0.00E+00	1.28E+02
NA-24	4.08E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02
P-32	4.96E+07	3.08E+06	1.92E+06	0.00E+00	0.00E+00	0.00E+00	5.57E+06
CR-51	0.00E+00	0.00E+00	4.31E+00	2.58E+00	9.50E-01	5.72E+00	1.08E+03
MN-54	0.00E+00	5.43E+03	1.04E+03	0.00E+00	1.61E+03	0.00E+00	1.66E+04
MN-56	0.00E+00	1.37E+02	2.42E+01	0.00E+00	1.73E+02	0.00E+00	4.36E+03
FE-55	3.21E+04	2.21E+04	5.16E+03	0.00E+00	0.00E+00	1.24E+04	1.27E+04
FE-59	5.06E+04	1.19E+05	4.56E+04	0.00E+00	0.00E+00	3.32E+04	3.96E+05
CO-58	0.00E+00	5.15E+02	1.15E+03	0.00E+00	0.00E+00	0.00E+00	1.04E+04
CO-60	0.00E+00	1.48E+03	3.26E+03	0.00E+00	0.00E+00	0.00E+00	2.78E+04
NI-63	4.97E+04	3.45E+03	1.67E+03	0.00E+00	0.00E+00	0.00E+00	7.19E+02
NI-65	2.02E+02	2.62E+01	1.20E+01	0.00E+00	0.00E+00	0.00E+00	6.65E+02
CU-64	0.00E+00	9.08E+01	4.26E+01	0.00E+00	2.29E+02	0.00E+00	7.74E+03
ZN-65	1.61E+05	5.13E+05	2.32E+05	0.00E+00	3.43E+05	0.00E+00	3.23E+05
ZN-69	3.43E+02	6.57E+02	4.57E+01	0.00E+00	4.27E+02	0.00E+00	9.87E+01
BR-83	0.00E+00	0.00E+00	4.05E+01	0.00E+00	0.00E+00	0.00E+00	5.84E+01
BR-84	0.00E+00	0.00E+00	5.25E+01	0.00E+00	0.00E+00	0.00E+00	4.13E-04
BR-85	0.00E+00	0.00E+00	2.16E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	1.01E+05	4.72E+04	0.00E+00	0.00E+00	0.00E+00	2.00E+04
RB-88	0.00E+00	2.91E+02	1.54E+02	0.00E+00	0.00E+00	0.00E+00	4.02E-09
RB-89	0.00E+00	1.93E+02	1.35E+02	0.00E+00	0.00E+00	0.00E+00	1.12E-11
SR-89	2.57E+04	0.00E+00	7.37E+02	0.00E+00	0.00E+00	0.00E+00	4.12E+03
SR-90	6.32E+05	0.00E+00	1.55E+05	0.00E+00	0.00E+00	0.00E+00	1.82E+04
SR-91	4.72E+02	0.00E+00	1.91E+01	0.00E+00	0.00E+00	0.00E+00	2.25E+03
SR-92	1.79E+02	0.00E+00	7.75E+00	0.00E+00	0.00E+00	0.00E+00	3.55E+03
Y-90	6.07E+00	0.00E+00	1.63E-01	0.00E+00	0.00E+00	0.00E+00	6.43E+04
Y-91M	5.73E-02	0.00E+00	2.22E-03	0.00E+00	0.00E+00	0.00E+00	1.68E-01
Y-91	8.89E+01	0.00E+00	2.38E+00	0.00E+00	0.00E+00	0.00E+00	4.89E+04
Y-92	5.33E-01	0.00E+00	1.56E-02	0.00E+00	0.00E+00	0.00E+00	9.33E+03
Y-93	1.69E+00	0.00E+00	4.67E-02	0.00E+00	0.00E+00	0.00E+00	5.36E+04
ZR-95	1.63E+00	5.22E-01	3.54E-01	0.00E+00	8.20E-01	0.00E+00	1.66E+03
ZR-97	9.00E-02	1.82E-02	8.30E-03	0.00E+00	2.74E-02	0.00E+00	5.63E+03
NB-95	4.83E+00	2.69E+00	1.44E+00	0.00E+00	2.65E+00	0.00E+00	1.63E+04
MO-99	0.00E+00	1.28E+02	2.43E+01	0.00E+00	2.90E+02	0.00E+00	2.97E+02
TC-99M	1.59E-02	4.50E-02	5.73E-01	0.00E+00	6.84E-01	2.21E-02	2.66E+01
TC-101	1.64E-02	2.36E-02	2.32E-01	0.00E+00	4.25E-01	1.21E-02	7.09E-14
RU-103	1.10E+02	0.00E+00	4.74E+01	0.00E+00	4.20E+02	0.00E+00	1.28E+04
RU-105	9.16E+00	0.00E+00	3.62E+00	0.00E+00	1.18E+02	0.00E+00	5.60E+03
RU-106	1.64E+03	0.00E+00	2.07E+02	0.00E+00	3.16E+03	0.00E+00	1.06E+05
AG-110M	4.58E+02	4.23E+02	2.51E+02	0.00E+00	8.32E+02	0.00E+00	1.73E+05
SB-122	3.47E+01	7.99E-01	1.20E+01	5.38E-01	0.00E+00	2.08E+01	1.32E+04
SB-124	4.86E+02	9.20E+00	1.91E+02	1.18E+00	0.00E+00	3.79E+02	1.38E+04
SB-125	3.11E+02	3.47E+00	7.40E+01	3.16E-01	0.00E+00	2.40E+02	3.42E+03

Table 2 - 1

Site Related Adult Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
TE-125M	2.72E+03	9.87E+02	3.65E+02	8.19E+02	1.11E+04	0.00E+00	1.09E+04
TE-127M	6.88E+03	2.46E+03	8.38E+02	1.76E+03	2.79E+04	0.00E+00	2.31E+04
TE-127	1.12E+02	4.01E+01	2.42E+01	8.28E+01	4.55E+02	0.00E+00	8.82E+03
TE-129M	1.17E+04	4.36E+03	1.85E+03	4.01E+03	4.88E+04	0.00E+00	5.88E+04
TE-129	3.19E+01	1.20E+01	7.77E+00	2.45E+01	1.34E+02	0.00E+00	2.41E+01
TE-131M	1.76E+03	8.60E+02	7.16E+02	1.36E+03	8.71E+03	0.00E+00	8.53E+04
TE-131	2.00E+01	8.36E+00	6.32E+00	1.65E+01	8.77E+01	0.00E+00	2.83E+00
TE-132	2.56E+03	1.66E+03	1.55E+03	1.83E+03	1.60E+04	0.00E+00	7.83E+04
I-130	4.88E+01	1.44E+02	5.68E+01	1.22E+04	2.24E+02	0.00E+00	1.24E+02
I-131	2.68E+02	3.84E+02	2.20E+02	1.26E+05	6.58E+02	0.00E+00	1.01E+02
I-132	1.31E+01	3.50E+01	1.23E+01	1.23E+03	5.58E+01	0.00E+00	6.58E+00
I-133	9.16E+01	1.59E+02	4.86E+01	2.34E+04	2.78E+02	0.00E+00	1.43E+02
I-134	6.84E+00	1.86E+01	6.64E+00	3.22E+02	2.95E+01	0.00E+00	1.62E-02
I-135	2.86E+01	7.48E+01	2.76E+01	4.93E+03	1.20E+02	0.00E+00	8.45E+01
CS-134	4.14E+04	9.84E+04	8.04E+04	0.00E+00	3.18E+04	1.06E+04	1.72E+03
CS-136	4.33E+03	1.71E+04	1.23E+04	0.00E+00	9.51E+03	1.30E+03	1.94E+03
CS-137	5.30E+04	7.25E+04	4.75E+04	0.00E+00	2.46E+04	8.18E+03	1.40E+03
CS-138	3.67E+01	7.25E+01	3.59E+01	0.00E+00	5.33E+01	5.26E+00	3.09E-04
BA-139	6.47E+00	4.61E-03	1.89E-01	0.00E+00	4.31E-03	2.61E-03	1.15E+01
BA-140	1.35E+03	1.70E+00	8.87E+01	0.00E+00	5.78E-01	9.73E-01	2.79E+03
BA-141	3.14E+00	2.37E-03	1.06E-01	0.00E+00	2.21E-03	1.35E-03	1.48E-09
BA-142	1.42E+00	1.46E-03	8.93E-02	0.00E+00	1.23E-03	8.27E-04	2.00E-18
LA-140	1.58E+00	7.95E-01	2.10E-01	0.00E+00	0.00E+00	0.00E+00	5.83E+04
LA-142	8.07E-02	3.67E-02	9.15E-03	0.00E+00	0.00E+00	0.00E+00	2.68E+02
CE-141	3.23E+00	2.18E+00	2.48E-01	0.00E+00	1.01E+00	0.00E+00	8.35E+03
CE-143	5.69E-01	4.21E+02	4.66E-02	0.00E+00	1.85E-01	0.00E+00	1.57E+04
CE-144	1.68E+02	7.04E+01	9.04E+00	0.00E+00	4.17E+01	0.00E+00	5.69E+04
PR-143	5.80E+00	2.33E+00	2.88E-01	0.00E+00	1.34E+00	0.00E+00	2.54E+04
PR-144	1.90E-02	7.88E-03	9.65E-04	0.00E+00	4.45E-03	0.00E+00	2.73E-09
ND-147	3.97E+00	4.59E+00	2.74E-01	0.00E+00	2.68E+00	0.00E+00	2.20E+04
W-187	2.98E+02	2.49E+02	8.71E+01	0.00E+00	0.00E+00	0.00E+00	8.16E+04
NP-239	3.53E-02	3.47E-03	1.91E-03	0.00E+00	1.08E-02	0.00E+00	7.12E+02
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	1.21E+02	2.01E+02	0.00E+00	0.00E+00	0.00E+00	3.07E+03
SR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-97	4.05E-02	1.02E-02	3.74E-03	0.00E+00	1.20E-02	0.00E+00	3.78E+01
CD-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SN-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-134	3.29E+01	2.15E+01	1.32E+01	2.88E+01	2.08E+02	0.00E+00	3.65E-02
CE-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2 - 2

Site Related Teen Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.17E-01	2.17E-01	2.17E-01	2.17E-01	2.17E-01	2.17E-01
BE-7	3.58E-01	8.02E-01	4.01E-01	0.00E+00	8.50E-01	0.00E+00	9.76E+01
NA-24	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02
P-32	5.40E+07	3.35E+06	2.09E+06	0.00E+00	0.00E+00	0.00E+00	4.54E+06
CR-51	0.00E+00	0.00E+00	4.44E+00	2.47E+00	9.73E-01	6.34E+00	7.46E+02
MN-54	0.00E+00	5.33E+03	1.06E+03	0.00E+00	1.59E+03	0.00E+00	1.09E+04
MN-56	0.00E+00	1.43E+02	2.54E+01	0.00E+00	1.81E+02	0.00E+00	9.40E+03
FE-55	3.35E+04	2.37E+04	5.54E+03	0.00E+00	0.00E+00	1.51E+04	1.03E+04
FE-59	5.20E+04	1.21E+05	4.69E+04	0.00E+00	0.00E+00	3.83E+04	2.87E+05
CO-58	0.00E+00	5.10E+02	1.18E+03	0.00E+00	0.00E+00	0.00E+00	7.04E+03
CO-60	0.00E+00	1.48E+03	3.32E+03	0.00E+00	0.00E+00	0.00E+00	1.92E+04
NI-63	5.15E+04	3.64E+03	1.75E+03	0.00E+00	0.00E+00	0.00E+00	5.79E+02
NI-65	2.18E+02	2.79E+01	1.27E+01	0.00E+00	0.00E+00	0.00E+00	1.51E+03
CU-64	0.00E+00	9.53E+01	4.48E+01	0.00E+00	2.41E+02	0.00E+00	7.39E+03
ZN-65	1.46E+05	5.07E+05	2.36E+05	0.00E+00	3.24E+05	0.00E+00	2.15E+05
ZN-69	3.73E+02	7.10E+02	4.97E+01	0.00E+00	4.64E+02	0.00E+00	1.31E+03
BR-83	0.00E+00	0.00E+00	4.41E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	5.55E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-85	0.00E+00	0.00E+00	2.34E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	1.09E+05	5.12E+04	0.00E+00	0.00E+00	0.00E+00	1.61E+04
RB-88	0.00E+00	3.12E+02	1.66E+02	0.00E+00	0.00E+00	0.00E+00	2.67E-05
RB-89	0.00E+00	2.01E+02	1.42E+02	0.00E+00	0.00E+00	0.00E+00	3.09E-07
SR-89	2.79E+04	0.00E+00	8.00E+02	0.00E+00	0.00E+00	0.00E+00	3.33E+03
SR-90	5.27E+05	0.00E+00	1.30E+05	0.00E+00	0.00E+00	0.00E+00	1.48E+04
SR-91	5.12E+02	0.00E+00	2.04E+01	0.00E+00	0.00E+00	0.00E+00	2.32E+03
SR-92	1.94E+02	0.00E+00	8.25E+00	0.00E+00	0.00E+00	0.00E+00	4.93E+03
Y-90	6.57E+00	0.00E+00	1.77E-01	0.00E+00	0.00E+00	0.00E+00	5.42E+04
Y-91M	6.18E-02	0.00E+00	2.36E-03	0.00E+00	0.00E+00	0.00E+00	2.92E+00
Y-91	9.64E+01	0.00E+00	2.58E+00	0.00E+00	0.00E+00	0.00E+00	3.95E+04
Y-92	5.80E-01	0.00E+00	1.68E-02	0.00E+00	0.00E+00	0.00E+00	1.59E+04
Y-93	1.84E+00	0.00E+00	5.03E-02	0.00E+00	0.00E+00	0.00E+00	5.61E+04
ZR-95	1.68E+00	5.29E-01	3.64E-01	0.00E+00	7.78E-01	0.00E+00	1.22E+03
ZR-97	9.65E-02	1.91E-02	8.80E-03	0.00E+00	2.90E-02	0.00E+00	5.17E+03
NB-95	4.86E+00	2.70E+00	1.48E+00	0.00E+00	2.61E+00	0.00E+00	1.15E+04
MO-99	0.00E+00	1.36E+02	2.60E+01	0.00E+00	3.12E+02	0.00E+00	2.44E+02
TC-99M	1.63E-02	4.55E-02	5.89E-01	0.00E+00	6.77E-01	2.52E-02	2.98E+01
TC-101	1.77E-02	2.51E-02	2.47E-01	0.00E+00	4.55E-01	1.53E-02	4.30E-09
RU-103	1.15E+02	0.00E+00	4.93E+01	0.00E+00	4.06E+02	0.00E+00	9.63E+03
RU-105	9.85E+00	0.00E+00	3.82E+00	0.00E+00	1.24E+02	0.00E+00	7.96E+03
RU-106	1.77E+03	0.00E+00	2.23E+02	0.00E+00	3.42E+03	0.00E+00	8.50E+04
AG-110M	4.45E+02	4.22E+02	2.56E+02	0.00E+00	8.04E+02	0.00E+00	1.18E+05
SB-122	4.35E+01	8.47E-01	1.27E+01	5.53E-01	0.00E+00	2.72E+01	9.13E+03
SB-124	5.09E+02	9.40E+00	1.99E+02	1.16E+00	0.00E+00	4.45E+02	1.03E+04
SB-125	3.27E+02	3.58E+00	7.64E+01	3.11E-01	0.00E+00	2.85E+02	2.53E+03

Table 2 - 2

Site Related Teen Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
TE-125M	2.96E+03	1.07E+03	3.96E+02	8.28E+02	0.00E+00	0.00E+00	8.75E+03
TE-127M	7.48E+03	2.65E+03	8.90E+02	1.78E+03	3.03E+04	0.00E+00	1.87E+04
TE-127	1.22E+02	4.33E+01	2.63E+01	8.44E+01	4.95E+02	0.00E+00	9.44E+03
TE-129M	1.26E+04	4.68E+03	2.00E+03	4.07E+03	5.28E+04	0.00E+00	4.74E+04
TE-129	3.47E+01	1.29E+01	8.44E+00	2.48E+01	1.46E+02	0.00E+00	1.90E+02
TE-131M	1.89E+03	9.06E+02	7.55E+02	1.36E+03	9.44E+03	0.00E+00	7.27E+04
TE-131	2.16E+01	8.90E+00	6.75E+00	1.66E+01	9.44E+01	0.00E+00	1.77E+00
TE-132	2.70E+03	1.71E+03	1.61E+03	1.80E+03	1.64E+04	0.00E+00	5.42E+04
I-130	5.06E+01	1.46E+02	5.84E+01	1.19E+04	2.25E+02	0.00E+00	1.12E+02
I-131	2.87E+02	4.02E+02	2.16E+02	1.17E+05	6.92E+02	0.00E+00	7.95E+01
I-132	1.37E+01	3.58E+01	1.29E+01	1.21E+03	5.64E+01	0.00E+00	1.56E+01
I-133	9.87E+01	1.67E+02	5.11E+01	2.34E+04	2.94E+02	0.00E+00	1.27E+02
I-134	7.17E+00	1.90E+01	6.82E+00	3.17E+02	2.99E+01	0.00E+00	2.50E-01
I-135	2.99E+01	7.71E+01	2.86E+01	4.96E+03	1.22E+02	0.00E+00	8.54E+01
CS-134	4.24E+04	9.97E+04	4.63E+04	0.00E+00	3.17E+04	1.21E+04	1.24E+03
CS-136	4.35E+03	1.71E+04	1.15E+04	0.00E+00	9.32E+03	1.47E+03	1.38E+03
CS-137	5.67E+04	7.54E+04	2.63E+04	0.00E+00	2.57E+04	9.97E+03	1.07E+03
CS-138	3.93E+01	7.54E+01	3.77E+01	0.00E+00	5.57E+01	6.48E+00	3.42E-02
BA-139	7.05E+00	4.96E-03	2.05E-01	0.00E+00	4.67E-03	3.42E-03	6.28E+01
BA-140	1.44E+03	1.76E+00	9.28E+01	0.00E+00	5.98E-01	1.19E+00	2.22E+03
BA-141	3.40E+00	2.54E-03	1.14E-01	0.00E+00	2.36E-03	1.74E-03	7.25E-06
BA-142	1.52E+00	1.52E-03	9.33E-02	0.00E+00	1.28E-03	1.01E-03	4.65E-12
LA-140	1.67E+00	8.20E-01	2.18E-01	0.00E+00	0.00E+00	0.00E+00	4.71E+04
LA-142	8.58E-02	3.81E-02	9.49E-03	0.00E+00	0.00E+00	0.00E+00	1.16E+03
CE-141	3.49E+00	2.33E+00	2.67E-01	0.00E+00	1.10E+00	0.00E+00	6.66E+03
CE-143	6.16E-01	4.48E+02	5.01E-02	0.00E+00	2.01E-01	0.00E+00	1.35E+04
CE-144	1.82E+02	7.55E+01	9.80E+00	0.00E+00	4.51E+01	0.00E+00	4.59E+04
PR-143	6.28E+00	2.51E+00	3.13E-01	0.00E+00	1.46E+00	0.00E+00	2.07E+04
PR-144	2.06E-02	8.44E-03	1.05E-03	0.00E+00	4.84E-03	0.00E+00	2.27E-05
ND-147	4.50E+00	4.89E+00	2.93E-01	0.00E+00	2.87E+00	0.00E+00	1.76E+04
W-187	3.22E+02	2.62E+02	9.19E+01	0.00E+00	0.00E+00	0.00E+00	7.10E+04
NP-239	3.98E-02	3.75E-03	2.08E-03	0.00E+00	1.18E-02	0.00E+00	6.03E+02
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	1.25E+02	2.10E+02	0.00E+00	0.00E+00	0.00E+00	2.33E+03
SR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-97	4.36E-02	1.08E-02	3.95E-03	0.00E+00	1.27E-02	0.00E+00	2.58E+02
CD-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SN-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-134	3.46E+01	2.22E+01	2.32E+01	2.84E+01	2.12E+02	0.00E+00	1.28E+00
CE-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2 - 3

Site Related Child Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	1.81E-01	1.81E-01	1.81E-01	1.81E-01	1.81E-01	1.81E-01
BE-7	4.77E-01	8.08E-01	5.33E-01	0.00E+00	7.96E-01	0.00E+00	4.52E+01
NA-24	4.57E+02	4.57E+02	4.57E+02	4.57E+02	4.57E+02	4.57E+02	4.57E+02
P-32	6.98E+07	3.27E+06	2.69E+06	0.00E+00	0.00E+00	0.00E+00	1.93E+06
CR-51	0.00E+00	0.00E+00	4.86E+00	2.70E+00	7.37E-01	4.92E+00	2.58E+02
MN-54	0.00E+00	4.20E+03	1.12E+03	0.00E+00	1.18E+03	0.00E+00	3.53E+03
MN-56	0.00E+00	1.31E+02	2.96E+01	0.00E+00	1.59E+02	0.00E+00	1.90E+04
FE-55	4.55E+04	2.42E+04	7.48E+03	0.00E+00	0.00E+00	1.37E+04	4.47E+03
FE-59	6.53E+04	1.06E+05	5.27E+04	0.00E+00	0.00E+00	3.07E+04	1.10E+05
CO-58	0.00E+00	4.20E+02	1.29E+03	0.00E+00	0.00E+00	0.00E+00	2.45E+03
CO-60	0.00E+00	1.23E+03	3.64E+03	0.00E+00	0.00E+00	0.00E+00	6.84E+03
NI-63	6.85E+04	3.67E+03	2.33E+03	0.00E+00	0.00E+00	0.00E+00	2.47E+02
NI-65	2.83E+02	2.66E+01	1.55E+01	0.00E+00	0.00E+00	0.00E+00	3.26E+03
CU-64	0.00E+00	9.05E+01	5.47E+01	0.00E+00	2.19E+02	0.00E+00	4.25E+03
ZN-65	1.55E+05	4.12E+05	2.56E+05	0.00E+00	2.59E+05	0.00E+00	7.23E+04
ZN-69	4.94E+02	7.14E+02	6.60E+01	0.00E+00	4.33E+02	0.00E+00	4.50E+04
BR-83	0.00E+00	0.00E+00	5.67E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	6.56E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-85	0.00E+00	0.00E+00	3.02E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	1.06E+05	6.50E+04	0.00E+00	0.00E+00	0.00E+00	6.80E+03
RB-88	0.00E+00	3.00E+02	2.08E+02	0.00E+00	0.00E+00	0.00E+00	1.47E+01
RB-89	0.00E+00	1.85E+02	1.64E+02	0.00E+00	0.00E+00	0.00E+00	1.61E+00
SR-89	3.63E+04	0.00E+00	1.04E+03	0.00E+00	0.00E+00	0.00E+00	1.41E+03
SR-90	4.68E+05	0.00E+00	1.19E+05	0.00E+00	0.00E+00	0.00E+00	6.30E+03
SR-91	6.60E+02	0.00E+00	2.49E+01	0.00E+00	0.00E+00	0.00E+00	1.46E+03
SR-92	2.48E+02	0.00E+00	9.96E+00	0.00E+00	0.00E+00	0.00E+00	4.70E+03
Y-90	8.79E+00	0.00E+00	2.35E-01	0.00E+00	0.00E+00	0.00E+00	2.50E+04
Y-91M	8.17E-02	0.00E+00	2.97E-03	0.00E+00	0.00E+00	0.00E+00	1.60E+02
Y-91	1.29E+02	0.00E+00	3.44E+00	0.00E+00	0.00E+00	0.00E+00	1.71E+04
Y-92	7.70E-01	0.00E+00	2.20E-02	0.00E+00	0.00E+00	0.00E+00	2.22E+04
Y-93	2.44E+00	0.00E+00	6.69E-02	0.00E+00	0.00E+00	0.00E+00	3.63E+04
ZR-95	2.10E+00	4.62E-01	4.11E-01	0.00E+00	6.62E-01	0.00E+00	4.82E+02
ZR-97	1.27E-01	1.83E-02	1.08E-02	0.00E+00	2.63E-02	0.00E+00	2.77E+03
NB-95	5.75E+00	2.24E+00	1.60E+00	0.00E+00	2.10E+00	0.00E+00	4.14E+03
MO-99	0.00E+00	1.31E+02	3.23E+01	0.00E+00	2.79E+02	0.00E+00	1.08E+02
TC-99M	1.99E-02	3.89E-02	6.46E-01	0.00E+00	5.66E-01	1.98E-02	2.22E+01
TC-101	2.30E-02	2.41E-02	3.06E-01	0.00E+00	4.11E-01	1.27E-02	7.66E-02
RU-103	1.48E+02	0.00E+00	5.67E+01	0.00E+00	3.72E+02	0.00E+00	3.82E+03
RU-105	1.30E+01	0.00E+00	4.73E+00	0.00E+00	1.15E+02	0.00E+00	8.50E+03
RU-106	2.36E+03	0.00E+00	2.95E+02	0.00E+00	3.19E+03	0.00E+00	3.68E+04
AG-110M	5.24E+02	3.54E+02	2.83E+02	0.00E+00	6.59E+02	0.00E+00	4.21E+04
SB-122	5.80E+01	8.56E-01	1.70E+01	7.43E-01	0.00E+00	2.36E+01	4.46E+03
SB-124	6.55E+02	8.50E+00	2.29E+02	1.44E+00	0.00E+00	3.63E+02	4.09E+03
SB-125	4.22E+02	3.25E+00	8.85E+01	3.91E-01	0.00E+00	2.35E+02	1.01E+03

Table 2 - 3

Site Related Child Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
TE-125M	3.81E+03	1.03E+03	5.08E+02	1.07E+03	0.00E+00	0.00E+00	3.68E+03
TE-127M	9.67E+03	2.60E+03	1.15E+03	2.31E+03	2.76E+04	0.00E+00	7.83E+03
TE-127	1.58E+02	4.25E+01	3.38E+01	1.09E+02	4.48E+02	0.00E+00	6.15E+03
TE-129M	1.63E+04	4.55E+03	2.53E+03	5.25E+03	4.78E+04	0.00E+00	1.99E+04
TE-129	4.48E+01	1.25E+01	1.06E+01	3.20E+01	1.31E+02	0.00E+00	2.79E+03
TE-131M	2.41E+03	8.33E+02	8.86E+02	1.71E+03	8.06E+03	0.00E+00	3.38E+04
TE-131	2.78E+01	8.46E+00	8.26E+00	2.12E+01	8.40E+01	0.00E+00	1.46E+02
TE-132	3.38E+03	1.50E+03	1.81E+03	2.18E+03	1.39E+04	0.00E+00	1.51E+04
I-130	6.28E+01	1.27E+02	6.54E+01	1.40E+04	1.90E+02	0.00E+00	5.94E+01
I-131	3.70E+02	3.72E+02	2.12E+02	1.23E+05	6.11E+02	0.00E+00	3.31E+01
I-132	1.72E+01	3.16E+01	1.45E+01	1.47E+03	4.84E+01	0.00E+00	3.72E+01
I-133	1.27E+02	1.58E+02	5.96E+01	2.93E+04	2.63E+02	0.00E+00	6.35E+01
I-134	9.02E+00	1.67E+01	7.70E+00	3.85E+02	2.56E+01	0.00E+00	1.11E+01
I-135	3.77E+01	6.78E+01	3.21E+01	6.00E+03	1.04E+02	0.00E+00	5.16E+01
CS-134	5.15E+04	8.44E+04	1.78E+04	0.00E+00	2.62E+04	9.39E+03	4.55E+02
CS-136	5.17E+03	1.42E+04	9.19E+03	0.00E+00	7.56E+03	1.13E+03	4.99E+02
CS-137	7.19E+04	6.88E+04	1.02E+04	0.00E+00	2.24E+04	8.07E+03	4.31E+02
CS-138	5.01E+01	6.97E+01	4.42E+01	0.00E+00	4.90E+01	5.28E+00	3.21E+01
BA-139	9.34E+00	4.99E-03	2.71E-01	0.00E+00	4.35E-03	2.93E-03	5.39E+02
BA-140	1.87E+03	1.64E+00	1.09E+02	0.00E+00	5.35E-01	9.79E-01	9.50E+02
BA-141	4.51E+00	2.53E-03	1.47E-01	0.00E+00	2.19E-03	1.48E-02	2.57E+00
BA-142	1.97E+00	1.42E-03	1.10E-01	0.00E+00	1.15E-03	8.35E-04	2.57E-02
LA-140	2.16E+00	7.55E-01	2.54E-01	0.00E+00	0.00E+00	0.00E+00	2.10E+04
LA-142	1.12E-01	3.57E-02	1.12E-02	0.00E+00	0.00E+00	0.00E+00	7.08E+03
CE-141	4.65E+00	2.32E+00	3.45E-01	0.00E+00	1.02E+00	0.00E+00	2.90E+03
CE-143	8.19E-01	4.44E+02	6.44E-02	0.00E+00	1.86E-01	0.00E+00	6.51E+03
CE-144	2.44E+02	7.64E+01	1.30E+01	0.00E+00	4.23E+01	0.00E+00	1.99E+04
PR-143	8.40E+00	2.52E+00	4.17E-01	0.00E+00	1.37E+00	0.00E+00	9.06E+03
PR-144	2.76E-02	8.53E-03	1.39E-03	0.00E+00	4.51E-03	0.00E+00	1.84E+01
ND-147	5.96E+00	4.83E+00	3.74E-01	0.00E+00	2.65E+00	0.00E+00	7.65E+03
W-187	4.08E+02	2.42E+02	1.08E+02	0.00E+00	0.00E+00	0.00E+00	3.40E+04
NP-239	5.15E-02	3.70E-03	2.60E-03	0.00E+00	1.07E-02	0.00E+00	2.74E+02
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	1.15E+02	2.33E+02	0.00E+00	0.00E+00	0.00E+00	9.43E+02
SR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-97	5.55E-02	1.00E-02	4.68E-03	0.00E+00	1.11E-02	0.00E+00	3.09E+03
CD-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SN-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-134	4.31E+01	1.94E+01	2.59E+01	3.41E+01	1.80E+02	0.00E+00	1.97E+02
CE-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-4

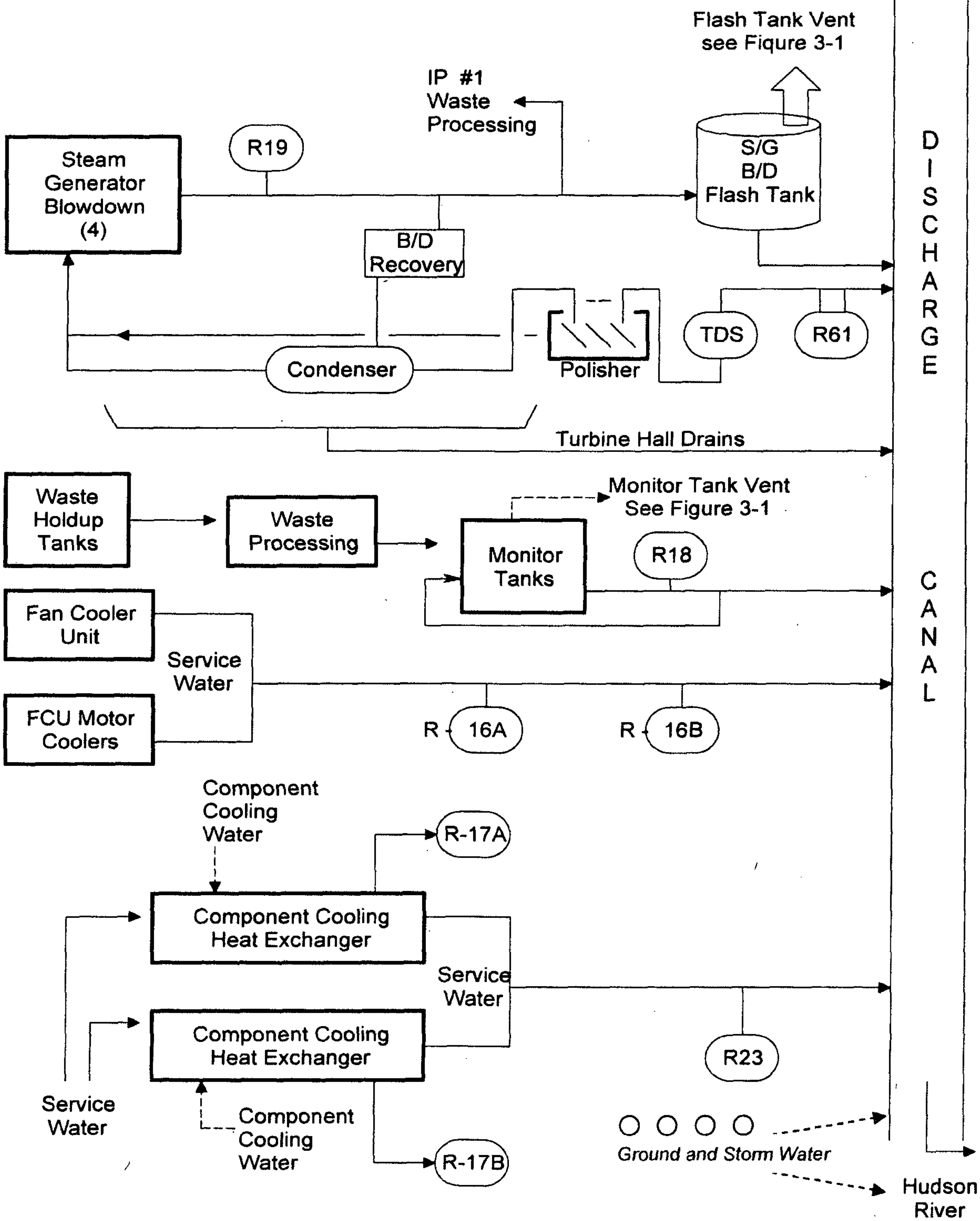
Bio-Accumulation Factors for Liquid Effluent Isotopes
(pCi/kg per pCi/liter)

ISOTOPE	Freshwater Fish BFi	Saltwater Invertebrates BIi	ISOTOPE	Freshwater Fish BFi	Saltwater Invertebrates BIi
H-3	9.000E-01	9.300E-01	TE-125M	4.000E+02	1.000E+02
BE-7	2.000E+00	2.000E+02	TE-127M	4.000E+02	1.000E+02
NA-24	1.000E+02	1.900E-01	TE-127	4.000E+02	1.000E+02
P-32	1.000E+05	3.000E+04	TE-129M	4.000E+02	1.000E+02
CR-51	2.000E+02	2.000E+03	TE-129	4.000E+02	1.000E+02
MN-54	4.000E+02	4.000E+02	TE-131M	4.000E+02	1.000E+02
MN-56	4.000E+02	4.000E+02	TE-131	4.000E+02	1.000E+02
FE-55	1.000E+02	2.000E+04	TE-132	4.000E+02	1.000E+02
FE-59	1.000E+02	2.000E+04	I-130	1.500E+01	5.000E+01
CO-58	5.000E+01	1.000E+03	I-131	1.500E+01	5.000E+01
CO-60	5.000E+01	1.000E+03	I-132	1.500E+01	5.000E+01
NI-63	1.000E+02	2.500E+02	I-133	1.500E+01	5.000E+01
NI-65	1.000E+02	2.500E+02	I-134	1.500E+01	5.000E+01
CU-64	5.000E+01	1.700E+03	I-135	1.500E+01	5.000E+01
ZN-65	2.000E+03	5.000E+04	CS-134	2.240E+02	2.240E+02
ZN-69	2.000E+03	5.000E+04	CS-136	2.240E+02	2.240E+02
BR-83	4.200E+02	3.100E+00	CS-137	2.240E+02	2.240E+02
BR-84	4.200E+02	3.100E+00	CS-138	2.240E+02	2.240E+02
BR-85	4.200E+02	3.100E+00	BA-139	4.000E+00	1.000E+02
RB-86	2.000E+03	1.700E+01	BA-140	4.000E+00	1.000E+02
RB-88	2.000E+03	1.700E+01	BA-141	4.000E+00	1.000E+02
RB-89	2.000E+03	1.700E+01	BA-142	4.000E+00	1.000E+02
SR-89	3.000E+01	2.000E+01	LA-140	2.500E+01	1.000E+03
SR-90	3.000E+01	2.000E+01	LA-142	2.500E+01	1.000E+03
SR-91	3.000E+01	2.000E+01	CE-141	1.000E+00	6.000E+02
SR-92	3.000E+01	2.000E+01	CE-143	1.000E+00	6.000E+02
Y-90	2.500E+01	1.000E+03	CE-144	1.000E+00	6.000E+02
Y-91M	2.500E+01	1.000E+03	PR-143	2.500E+01	1.000E+03
Y-91	2.500E+01	1.000E+03	PR-144	2.500E+01	1.000E+03
Y-92	2.500E+01	1.000E+03	ND-147	2.500E+01	1.000E+03
Y-93	2.500E+01	1.000E+03	W-187	1.200E+03	3.000E+01
ZR-95	3.300E+00	8.000E+01	NP-239	1.000E+01	1.000E+01
ZR-97	3.300E+00	8.000E+01	K-40	0.000E+00	0.000E+00
NB-95	3.000E+02	1.000E+02	CO-57	5.000E+01	1.000E+03
MO-99	1.000E+01	1.000E+01	SR-85	0.000E+00	0.000E+00
TC-99M	1.500E+01	5.000E+01	Y-88	0.000E+00	0.000E+00
TC-101	1.500E+01	5.000E+01	NB-94	3.000E+02	1.000E+02
RU-103	1.000E+01	1.000E+03	NB-97	3.000E+02	1.000E+02
RU-105	1.000E+01	1.000E+03	CD-109	0.000E+00	0.000E+00
RU-106	1.000E+01	1.000E+03	SN-113	0.000E+00	0.000E+00
AG-110M	2.300E+00	5.000E+03	BA-133	0.000E+00	0.000E+00
SB-122	1.000E+00	3.000E+02	TE-134	4.000E+02	1.000E+02
SB-124	1.000E+00	3.000E+02	CE-139	0.000E+00	0.000E+00
SB-125	1.000E+00	3.000E+02	HG-203	0.000E+00	0.000E+00

Bio-Accumulation Factors and DFi's for Noble Gases = 0

Figure 2-1

Radioactive Liquid Waste Effluent System Flow Diagram



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3.0 GASEOUS EFFLUENTS

3.1 Gaseous Effluent Releases - General Information

3.1.1 The surveillance and lower limit of detection requirements for gaseous radioactive effluents are contained in the RECS. Lower limits of detection calculations are addressed in ODCM Part II, Appendix B.

3.1.2 A completed and properly authorized Airborne Radioactive Waste Release Permit shall be issued prior to the release of airborne activity from the waste gas holding system and containment purge. If a containment purge exceeds 150 hours in duration then the purge will be considered a continuous, long term release for reporting purposes (See Section 3.1.16).

3.1.3 Since Indian Point is a two unit site, the derived instantaneous μCi/sec limits delineated in Section 3.2.1 are apportioned to each site. The time-average limits in 3.2.2, 3.2.3, and 3.2.4 are "per reactor" limits and the full dose limits are applicable to IP3.

3.1.4 During Modes 5 and 6, there is no flowpath for a release from the Condenser Air Ejector, and the monthly grab sample described in Radiological Effluent Controls Table 3.4.1-1 is not required. During normal plant operation without a primary to secondary leak, almost all gaseous releases are through the main Plant Vent. A negligible amount may be identified in the Administration Building and Radioactive Machine Shop vents. In the event of extended operation with a primary to secondary leak, low level releases are expected from both the blowdown flash tank vent and condenser air ejector. However, the limits on steam generator leakage are much more restrictive than those for effluent releases. Allocation of portions of the allowable release rate to these various release points is not warranted. If the instantaneous release rate is used (taking advantage of the one hour averaging allowed by 3.3.1 or 3.4.1), then all release points will be considered when establishing the Plant Vent alarm setpoint per ODCM Part II, Section 1.

3.1.5 For releases that are expected to continue for periods over two days, a new release permit will normally be issued each day. Containment purge release permits may be closed, with the release reclassified as continuous building ventilation when activity in containment is sufficiently reduced, at the discretion of the Chemistry Superintendent. However, when plant conditions change that will cause the activity in containment or any other permitted release of extended duration to significantly change, a new permit shall be issued.

3.1.6 Assurance that the combined gaseous releases from Units 2 and 3 do not exceed Section 3.2.1 limits for the site is provided by administrative controls for both units. These controls include apportionment of the 10CFR20 limitations and back-calculating radiation monitor setpoints accordingly. These calculations are discussed in Appendix A.

3.1.7 By mutual agreement with units 2 and 3 Shift Supervisors, one unit can reduce or eliminate discharges for a period of time to allow the other unit to use the full site permissible discharge rate, or a specific portion thereof, for discharge when necessary.

3.1.8 Conservative release rate limitations have been established to aid in controlling time average dose limits. The annual average limit shall normally be used for calculating limitations on discharge. If this limitation unduly restricts an individual release, the quarterly average release rate limit (μCi/sec) may be used for the release provided the quarterly time average dose limit will not be exceeded and the Site Operations Manager or his assistant is in agreement.

The instantaneous limit may be used if the General Manager, Plant Operations or his designee is in agreement. If determined to be required, Chemistry may provide a true instantaneous limit based on the actual or suspected mixture. Along with the permissions above, the Chemistry Superintendent or his designee should review the calculations for application of this true (ODCM) instantaneous limit. An hour is generally used as the default interval in which to determine the proximity to this limit in uCi/sec or mrem/yr.

3.1.9 <u>Containment Pressure Reliefs</u>

Containment pressure reliefs occur frequently enough to be considered continuous releases. Grab samples of containment atmosphere are obtained periodically to ensure the use of accurate mixtures in effluent calculations. To ensure that the release rate will not be exceeded, the containment noble gas monitor (R-12) and the expected flowrate are used to calculate release rates from containment and at the stack effluent. The effluent noble gas monitor in the plant vent is used to verify these calculations.

3.1.10 <u>Composite Particulate Samples</u>

One of the following methods will be used to obtain a composite sample:

- Samples will be taken weekly and integrated monthly; or
- Samples will be taken weekly and counted together once per month.

3.1.11 <u>Gas Storage Tank Activity Limit</u>

The quantity of radioactivity in each gas storage tank is limited to 50,000 Ci of noble gas, per RECS 2.11. This limit was calculated using the equations from Section 5.6.1 of NUREG 0133 and the following parameters:

Ki = 294 mrem-m^3/μCi-yr, Xe-133 equivalent Table B-1 (RG 1.109)

X/Q = 1.03 x 10^{-3} sec/m^3, Indian Point 3 FSAR

Qit must be calculated so that the dose is less than 500 mrem in a year:

$$\text{Qit}=\frac{(500mrem)*\ 3.15E+7\ \sec/yr}{(1E6\mu Ci/Ci)(294mrem-m^3/\mu Ci-yr)(1.03E-3\ \sec/m^3)}=52{,}011\text{Ci};\ \underline{50{,}000\text{ Ci}}$$

This limit assumes 100% Xe-133 as per NUREG 0133. Utilizing the Ki from an expected mixture during RCS degasification

$$Ki = 787\frac{mrem - m^3}{\mu Ci - yr},$$

the gas tank conservative administrative limit should be 19,400 curies.

The basis for assuring that accidental gas releases from liquid holdup tanks do not exceed Section 3.2.1 limits, is Technical Specifications 3.4.16 (≤ 1 μCi/cc Dose Equivalent Iodine-131 in Reactor Coolant). Using the assumptions discussed in FSAR section 14.2.3, the potential total curies in the liquid holdup tanks is limited to less than the conservative limit for the Gas Storage Tanks (19,400 curies).

3.1.12 <u>Gas Storage Tank Surveillance Requirements</u>

There are two methods available to ensure that the activity in the gas storage tank is within the conservative administrative limit (19400 Ci).

$$\frac{1.94E+4 * 1E6\mu Ci/Ci}{525ft^3 * \left(\frac{164.7psia}{14.7psia}\right) * 2.83E4cc/ft^3} = 1.17E+2\mu Ci/cc$$

1. The total gaseous activity will normally be limited to less than 117 μCi/cc. If this concentration limit is exceeded, then the contents of the tank will be monitored and actions taken to ensure the 19,400 curie per tank limit is not exceeded.
2. The waste gas line monitor (R-20) reads in μCi/cc. It allows for control of waste gas tank curie content by limiting the input concentration to 117 μCi/cc, thereby limiting the curies to 19,400.

Large gas decay tanks on fill and CVCS tanks (which are indicative of the gas mixture in or from the reuse system) are continuously monitored for H_2 and O_2 through in-line instrumentation. With either in-line instrument out of service, a grab sample of the tank on receipt shall be taken daily, unless in degassing operation, when the periodicity is every four hours.

Other primary system tank cover gases can be manually directed through these instruments for individual samples.

3.1.13 The normal flow rate measurement for the Radioactive Machine Shop (RAMS) and the Plant Vent (PV) is obtained from the installed process monitor. When the instrument is out of service, the estimated flow from the RAMS is obtained by summing each operable exhaust fan's design flow rate. Estimated flow from the PV is obtained similarly, or from an alternate flow instrument (still considered an estimate). The design system flow rate of 12500 CFM is used for Administration Building ventilation. The process flow rate monitor surveillance requirements specified in RECS Table 3.2-1 are not applicable for the Administration Building, nor are they applicable when the RAMS or PV installed instruments are out of service and rated fan flow is used.

3.1.14 The activity released via the blowdown flash tank vent is determined by obtaining the steam generator blowdown Tritium, Noble Gas, and Iodine activity, partitioned per Regulatory Guide 1.42 "Interim Licensing Policy On As Low As Practicable for Gaseous Radioiodine Releases from Light Water Cooled Nuclear Power Reactors" (from NUREG 0472, Rev3, DRAFT 6, TABLE 3.3-13), or Reference 4, "An Evaluation to Demonstrate the Compliance of the Indian Point Reactors with the Design Objectives of 10CFR50, Appendix I".

3.1.15 Carbon 14 is released at a rate of 9.6 curies per GW(e)/yr based upon studies performed by the New York State Department of Health at Indian Point 3. This is released in a gaseous form, the primary dose from which is in the CO_2 form. Therefore, these are exempt from the dose limits specified in Sections 2.4.1, 2.4.3 and 2.4.4 of the RECS. The Carbon 14 doses resulting from these releases are calculated in accordance with the methodology in Reg. Guide 1.109 and listed in the Radiological Impact on Man section of the Annual Radioactive Effluent Release Report. This calculation is performed using the fraction of carbon 14 released in the CO_2 form (26%).

3.1.16 Evaluations of previous gas decay tank and containment purge releases have been performed. These evaluations indicate that these "Short Term Releases" (less than 500 hours per year and less than 150 hours per quarter) are sufficiently random to utilize the long term meteorological dispersion factor (NUREG 0133, Section 3.3, Page 8). The short-term correction factor, will only be used when non-random releases are to be made an a routine basis.

3.1.17 The liquid waste Monitor Tanks have an airborne release pathway. The original plant design limited the gases through this pathway by reducing the entrained gases to less than 2E-3 μCi/ml. The removal of the CVCS gas stripper under modification 86-3-122 CVCS requires the quantification of these gases when the entrained gaseous activity in the Monitor Tank inlet exceeds 2E-3 μCi/ml. No action is required if the inlet noble gas concentration is less than 2E-3 μCi/ml. This gas release will be quantified by calculating the difference (in μCi's) between the gaseous activity added to the tank and the gaseous activity present in the effluent release sample. This difference will be quantified as an airborne ground level batch release, using a specifically determined ground level dispersion constant (Section 3.5.3).

A separate release permit evaluating this release is not required prior to release. Calculation of this rate of release is not required, however the time average dose contribution shall be calculated and controlled per Sections 3.3 and 3.4 of the ODCM. Section 3.6 provides additional detail relative to the finite cloud correction assumptions for this pathway.

3.1.18 Airborne releases from the Steam Generator Safety or Atmospheric Dump Valves can occur during a Primary to Secondary leak. Tritium, Noble Gas, and Iodine effluent doses are determined using a source term activity (Main Steam or Steam Generator Blowdown), an Iodine partition factor (per Section 3.1.14), and a release rate, determined from Engineering Design Calculation 187 (Steam Generator Atmospherics), or design flowrate (from Steam Generator Safeties) at specific pressures in the Steam Generator.

3.1.19 Other release pathways resulting from Primary to Secondary leakage include the steam driven auxiliary feed pump vent, the gland seal exhaust vent, the air ejector vent, and the Feed Water heater flash tank vent. Offsite doses from these or other abnormal airborne release points are calculated by obtaining the release rate (from system descriptions and/or steam tables corrected for system pressure, as applicable) and source term activity (eg. Main Steam , Reactor Coolant, or best estimate) for Tritium, Noble Gas, and Iodine, partitioned as per Section 3.1.14.

3.1.20 The Monitor Tank vent, the Condenser Air Ejector, and the Gland Seal Exhaust points are ground level releases. Unless otherwise designated, other release points are considered mixed mode, per Section 3.6.

3.2 Gaseous Effluent Dose Calculation Requirements

3.2.1 Section 2.4.1 of the RECS requires that the dose rate due to radioactive materials released in gaseous effluents from the site at or beyond the site boundary shall be limited to:

a) For noble gases: Less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin; and

b) For Iodine 131, Tritium, and for all radioactive materials in particulate form with half lives greater than 8 days: Less than or equal to 1500 mrem/yr to any organ.

The methodologies for performing these calculations are discussed in Sections 3.3.1 and 3.3.2, respectively.

3.2.2 Section 2.4.2 of the RECS requires that the air dose due to noble gases released in gaseous effluents from each reactor unit at or beyond the site boundary shall be limited to:

a) During any calendar quarter: Less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation.

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

The methodology for calculating these doses is discussed in Section 3.3.3.

NOTE: If either of the above limits is exceeded by a factor of two or more, then cumulative dose contributions from direct radiation would be determined by evaluation of existing perimeter and environmental TLDs per Section 2.6. of the RECS.

3.2.3 Section 2.4.3 of the RECS requires that the dose to a member of the general public from Iodine 131, Tritium, and radionuclides in particulate form (half-lives > 8 days) in gaseous effluents released from each reactor unit shall be limited to:

a) Less than or equal to 7.5 mrem to any organ during a calendar quarter

b) Less than or equal to 15 mrem to any organ during a calendar year.

Cumulative dose contributions for the current calendar quarter and current calendar year shall be determined at least once every 31 days. The methodology for calculating these doses is discussed in Section 3.3.4.

NOTE: If either of the previous limits is exceeded by a factor of two or more, then cumulative dose contributions from direct radiation would be determined by evaluation of existing perimeter and environmental TLDs per Section 2.6 of the RECS.

3.2.4 Section 2.4.4 of the RECS requires that for each reactor unit, the appropriate portions of the gaseous radwaste treatment system shall be used to reduce radioactive effluents in gaseous waste prior to their discharge when projected gaseous effluent air dose at the site boundary when averaged over 31 days, would exceed 0.2 mrad for gamma radiation or 0.4 mrad for beta radiation. These doses are projected based on the dose methodology discussed in Section 3.3.3 (noble gas) and 3.3.4 (iodine). The average of previous months' doses is used to project future dose as follows:

$$\begin{bmatrix}\text{Dose}\\ \text{Projection}\end{bmatrix} = \frac{\text{Current Month Dose} + \text{Previous months' Dose}}{\text{number of months used}} \pm \begin{bmatrix}\textit{major}\\ \textit{planned}\\ \textit{evolutions}\end{bmatrix}$$

The term for planned evolutions is routinely determined from previous similar evolutions, such as releases associated with plant shutdown.

The appropriate portions of the ventilation exhaust treatment system shall be used to reduce radioactive materials in gaseous releases when the projected doses averaged over 31 days, would exceed 0.3 mrem to any organ (at nearest residence). Dose due to gaseous releases from the site shall be calculated at least once every 31 days.

3.3 Dose Methodology (Computer Calculation)

3.3.1 Instantaneous Dose Rates - Noble Gas Releases

When the instantaneous limit applies, the process radiation monitor response or release rate can be averaged over a one-hour time interval.

3.3.1.1 The equations developed in this section are used to meet the calculational requirements of paragraph 3.2.1. The magnitude of this pathway is the same for all age groups so there is no critical group.

Based on an agreement with Unit 2, Indian Point Unit 3 utilizes 50% of the site release limit as measured in Ci/sec which translates to 55.4% of the applicable dose rate limit for noble gas releases.

Each unit has different dispersion factors due to their relative positions to the critical sector of the unrestricted area boundary. The conversion from dose rate to Ci/sec was determined with the use of a model which incorporates a finite cloud exposure correction. The methodology is discussed in Section 3.6.

A calculation showing the relationship between Ci/sec and dose rates from Units 2 and 3 is shown in Appendix A. The equations for calculating the dose rate limitations are obtained from NUREG 0133 (Ref. 1, Section 5.2.1). Utilizing the above assumptions, these equations reduce to the following which are to be summed for each nuclide, i. (Note Section 3.1.6 allows use of higher release rates up to the maximum of the allowable maximum permissible discharge rate.)

$$\sum_i \left[(Ki) * \left(\overline{X/Q}\right) * \left(\dot{Q}i\right)\right] \leq 275 \text{ mrem/yr whole body}$$

$$\sum_i \left[(Li + 1.1Mi) * \left(\overline{X/Q}\right) * \left(\dot{Q}i\right)\right] \leq 1{,}766 \text{ mrem/yr to the skin;}$$

<u>Where</u>:

Ki = The total body dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$ (finite cloud correction included, per Table 3-4).

Li = The skin dose factor due to beta emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$, per Table 3-5.

Mi = The air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$ (finite cloud correction included, per Table 3-6).

Ni = The air dose factor due to beta emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$, per Table 3-7.

$\dot{Q}$i = The release rate of radionuclides, i, in gaseous effluent for all release points in $\mu Ci/sec$.

(X/Q) = For all vent releases, the highest calculated annual averaged relative concentration at the critical receptor (SW at 350 meters), 4.47E-6 sec/m^3, as shown on Page 1 of Appendix A.

The Ki, Li, Mi, and Ni factors were obtained from Table B-1 of Regulatory Guide 1.109 and are included in this document as Tables 3-4, 3-5, 3-6, and 3-7 respectively. The Ki and Mi factors have a finite cloud correction factor included.

3.3.1.2 These equations can also be expressed in the following manner:

$(\overline{K})(\dot{Q}t)(\overline{X/Q})$ = mrem/yr dose to whole body

$(\overline{L}+1.1\overline{M})(\overline{X/Q})(\dot{Q}t)$ = mrem/yr dose to skin

Where:

$\dot{Q}$ t = The release rate of all noble gases summed together in μCi/sec, i.e., the sum of all $\dot{Q}$ i.

$$\overline{K} = (1/\dot{Q}t)\sum_{i=1}^{n} (\dot{Q}i)(Ki)$$

$$\overline{L} = (1/\dot{Q}t)\sum_{i=1}^{n} \dot{Q}i)(Li)$$

$$\overline{M} = (1/\dot{Q}t)\sum_{i=1}^{n} \dot{Q}i)(Mi)$$

$$\overline{N} = (1/\dot{Q}t)\sum_{i=1}^{n} (\dot{Q}i)\ Ni)$$

The values of $\overline{K}$, $\overline{L}$, $\overline{M}$, and $\overline{N}$ are listed in Table 3-8 for the unrestricted area boundary.

3.3.2 Instantaneous Dose Rates - I-131, Part w/>8 day t½ , and H-3

The equation developed in this section is used to meet the calculational requirements of RECS 2.4.1. The critical organ is considered to be the child thyroid as stated in Section 4.0 of the RECS. Based on different dispersion to the critical sector of the unrestricted area boundary for units 2 and 3, 50% of the site release limit (in Ci/sec) translates to 67.2% of the applicable dose rate limit for unit 3 (see Appendix A). The equation for calculating the dose rate limitation is abbreviated from that shown in NUREG 0133 (Ref. 1, Section 5.2.1, Pg. 25) in that ground plane and milk pathways are not considered due to insignificant contribution compared to the inhalation pathway . Utilizing the above assumptions, this equation reduces to the following:

$$\sum_{i} (Pi * (X/Q) * \dot{Q}i) \text{ must be less than 1008 mrem/yr}$$

Where:

Pi = The dose parameter for radionuclides other than noble gases for the inhalation pathway in mrem/yr per μCi/m^3. These parameters (calculated in Section 3.3.2.1) are calculated separately for each isotope, age group, and organ.

$\dot{Q}i$ = The release rate of radionuclide 131 and particulates, i, in gaseous effluents for all release points in µCi/sec.

X/Q = 4.47E-6 sec/m^3. The annual average dispersion parameter for the inhalation pathway at the controlling location (350 meters SW) due to all vent releases (see Page 1 of Appendix A and Section 3.5).

3.3.2.1 Calculation of Pi(in): Inhalation Dose Factor

Pi (inhalation) = K' (BR) DFAi (mrem/yr per µCi/m^3)

Where:

K' = A constant of conversion, 10^6 pCi/µCi

BR = The breathing rate of each age group as per 3.3.4.5.a (Table E-5 of Reg. Guide 1.109).

DFAi = The inhalation dose factor for each age group, organ, and nuclide, in mrem/pCi. These values are taken from Reg Guide 1.109, Table E-7 through E-9 and are reproduced in Tables 3-1a through 3-1d.

3.3.3 Time Average Dose - Noble Gas Release

3.3.3.1 The equations in this section are used to meet the calculational requirements of Paragraphs 3.2.2 and 3.2.4. All releases at IP3NPP are assumed to be mixed mode unless indicated otherwise. The magnitude for this pathway is the same for all age groups so there is no critical group. Dispersion parameters are discussed in Section 3.5.

3.3.3.2 The equation for calculating the dose limitations are obtained from NUREG 0133 (Ref. 1, Section 5.3). The doses are evaluated at the unrestricted area boundary in the worst meteorological section (SSW sector at 380 meters). These equations reduce to the following:

$$gamma\ \ air\ mrad = 3.17E-8 * \sum_i \mathrm{Mi}\,[(\mathrm{X/Q})\,(\tilde{\mathrm{Q}}\mathrm{i}) + (\mathrm{x/q})\,(\tilde{\mathrm{q}}\mathrm{i}) + (\mathrm{x/q_{mt}})\,(\tilde{\mathrm{q}}\mathrm{i}_{mt})]$$

$$beta\ \ air\ mrad = 3.17E-8 * \sum_i \mathrm{Ni}\,[(\mathrm{X/Q})\,(\tilde{\mathrm{Q}}\mathrm{i}) + (\mathrm{x/q})\,(\tilde{\mathrm{q}}\mathrm{i}) + (\mathrm{x/q_{mt}})\,(\tilde{\mathrm{q}}\mathrm{i}_{mt})]$$

Where:

Air dose limits are as follows:

	Any Calendar Quarter	Any Calendar Year
Gamma Air	*5 mrad*	*10 mrad*
Beta Air	*10 mrad*	*20 mrad*

(X/Q) =The highest calculated annual average relative concentration for the unrestricted area boundary in the SW sector at 350 meters for long term releases (greater than 500 hrs/yr or 150 hrs/qtr or as noted in 3.1.16), 4.47E-6 sec/m^3.

(x/q) = The relative concentration for the unrestricted area boundary for short term releases (equal to or less than 500 hrs/yr or 150 hrs/qtr and not random as defined in NUREG 0133, Section 3.3). This value is calculated as per Section 3.5.

(x/q_{mt})=The relative concentration for the unrestricted area boundary for ground level releases from the monitor tank vents in the SW sector at 350 meters, per Section 3.5.3, in sec/m^3.

Mi = The air dose factor due to gamma emission for each identified noble gas radionuclide in mrad/yr per μCi/m^3.

Ni = The air dose factor due to beta emissions for each identified noble gas radionuclide in mrad/yr per μCi/m^3.

$\tilde{q}i_{mt}$ = The total releases of noble gas radionuclides in monitor tank vents in μCi. Releases shall be cumulative over the calendar quarter or years as appropriate.

$\tilde{q}i$ = The total release of noble gas radionuclides in gaseous effluents, i, for short term releases (equal to or less than 500 hrs/yr or 150 hrs/qtr and not random as defined in NUREG 0133, Section 3.3) from all vents, in μCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

$\tilde{Q}i$ = The total release of noble gas radionuclides in gaseous effluents, i, for long term releases (greater than 500 hrs/yr or 150 hrs/qtr or as noted in 3.1.16) from all vents in μCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

3.17 E-8 = The inverse of the number of seconds in a year.

The air dose factors Mi and Ni were obtained from Table B-1 of Regulatory Guide 1.109 and are listed in Table 3-6 and 3-7 respectively. The M air dose factors are finite cloud corrected.

3.3.4 Time Averaged Dose - Radioiodine 131, Part w/t½ >8 days, and Tritium

3.3.4.1 The equations in this section are used to meet the calculational requirements of Paragraphs 3.2.3 and 3.2.4.

3.3.4.2 The pathways considered in this analysis are inhalation, ground plane, and vegetable ingestion at the nearest resident. The meat and milk ingestion pathways are not considered because of the lack of milk-producing cows within ten miles of the plant, and because of the high degree of commercial, industrial, and residential land usage in the area, as defined by the land use census. Doses are calculated at the nearest resident using meteorological data from the worst sector (SSW sector at 1525 meters) for conservativism.

3.3.4.3 The equations for calculating the dose limitations are obtained from NUREG 0133 (Ref. 1, Section 5.3). These equations reduce to the following :

During any calendar quarter:

$$(3.17\,E\text{-}08)*\sum_i \left(Ri\,(W\,\tilde{Q}i \;+\; w\,\tilde{q}i\right) \text{ must be less than } 7.5 \text{ mrem}$$

During any calendar year:

$$(3.17\,E\text{-}08)*\sum_i \left(Ri\,(W\,\tilde{Q}i \;+\; w\,\tilde{q}i\right) \text{ must be less than } 15 \text{ mrem}$$

Where:

$\tilde{Q}i$ = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for long term releases as defined in Section 3.1.16, in µCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

$\tilde{q}i$ = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for short term releases as defined in Section 3.1.16, in µCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

W = The dispersion or deposition parameter (based on meteorological data defined in Section 3.5) for estimating the dose to an individual at the nearest resident for long term releases as defined in Section 3.1.16.

w = The vent dispersion or deposition parameter for estimating the dose to an individual at the nearest resident for short term releases (as defined in Section 3.1.16) and calculated as in Section 3.5.

3.17 E-08 = The inverse number of seconds in a year.

Ri = The dose factor for each identified pathway, organ, and radionuclide, i, in $m^2 \cdot$mrem/yr per μCi/sec or mrem/yr per $\mu Ci/m^3$. These dose factors are determined as described in Sections 3.3.4.5a-d.

3.3.4.4 Utilizing the assumptions contained in Section 3.3.4.3, these equations for the nearest resident reduce to the following:

$$DN = (3.17E\text{-}8)\sum_i [Ri(I)*[Wn(in)\tilde{Q}i + wn(in)\tilde{q}i] + (Ri(G) + Ri(V))*[Wn(dep)\tilde{Q}i + wn(dep)\tilde{q}i]]$$

Where:

DN = total dose at the nearest residence, and must be less than or equal to 7.5 mrem per quarter, and less than or equal to 15 mrem Annually.

Wn(in) = The highest calculated annual average dispersion parameter for the inhalation pathway for the nearest residence in the unrestricted area located in the SSW sector at 1574 meters, 1.02E-6 sec/m^3.

wn(in) = The dispersion parameter for the inhalation pathway for the nearest residence in the unrestricted area located in the SSW sector at 1574 meters, 1.02E-6 sec/m^3, corrected for short term releases.

Wn(dep)= The highest calculated annual average deposition parameter for the nearest residence in the unrestricted area located in the South sector at 1133 meters, 7.45E-9 m^{-2} for all isotopes except Tritium, which uses the X/Q value instead (1.02E-6 sec/m^3).

wn(dep)= The deposition parameter for the nearest residence in the unrestricted area located in the South sector at 1133 meters, 7.45E-9 m^{-2} for all isotopes except Tritium, which uses the X/Q value instead (1.02E-6 sec/m^3), corrected for short term releases.

$\tilde{Q}i$ = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for long term releases as defined earlier, (uCi).

$\tilde{q}i$ = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for short term releases as defined earlier (uCi).

Ri (I): Inhalation pathway factor for each radionuclide, i.

Ri (G): Ground plane pathway factor for each radionuclide, i.

Ri (V): Vegetation pathway factor for each radionuclide, i.

3.3.4.5 Calculation of Dose Factors

3.3.4.5.a <u>Calculation of Ri (I) (X/Q) Inhalation Pathway Factor</u>

$$Ri\ (I)_{(X/Q)} = K'[(BR)\ a]\ [(DFAi)\ a](\text{mrem/yr per } \mu\text{Ci/m}^3)$$

<u>Where</u>:

K' = Constant of unit conversion, 10^6 pCi/uCi

(BR) a = Breathing rate of the receptor of age group (a) in m^3/yr.

(from Regulatory Guide 1.109, Table E-5)

Infant = 1400 (m^3/yr)

Child = 3700 (m^3/yr)

Adult/Teen = 8000 (m^3/yr)

(DFAi) a = The maximum organ inhalation dose factor for the receptor of age group (a) for the ith radionuclide in mrem/pCi. The total body is considered as an organ in the selection of (DFAi)a.

Child and infant inhalation dose factors are generally more restrictive, however, doses from each age group are calculated separately. The (DFAi)a values are listed in Tables 3-1a through 3-1d. The Ri values for the inhalation pathway are listed in Table 3-10a through 3-10d.

3.3.4.5.b <u>Calculation of Ri(G)(D/Q) Ground Plane Pathway Factor</u>

$$Ri(G)_{(D/Q)} = \frac{K'K''(SF)(DFGi)(1-e^{(-kit)})}{Ki} = \frac{m^2 \cdot mrem/yr}{uCi/\sec}$$

<u>Where:</u>

K' = A constant of conversion, 10^6 pCi/μCi.

K" = A constant of conversion, 8760 hr/yr.

ki = Decay constant for the ith radionuclide sec^{-1}.

t = The exposure time, 4.73 x 10^8 sec (15 years).

DFGi = The ground plane dose conversion factor for ith radionuclide (mrem/hr per pCi/m^2).

SF = Shielding factor (dimensionless) = 0.7 (from Table E-15 of Regulatory Guide 1.109).

The values of DFGi were obtained from Table E-6 of Regulatory Guide 1.109 and are listed in Table 3-2. These values were used to calculate Ri(G), which is the same for all age groups and organs and is listed in Table 3-12.

3.3.4.5.c Calculation of Ri(V)(D/Q) - Vegetation Pathway Factor

$$Ri(V)_{(D/Q)} = \frac{K'(r)}{Yv(ki+kw)} * (DFLi)a * [(UaL)fL * e^{(-kitL)} + (UaS)fg * e^{(-kith)}]$$

Where:

K' = Constant of conversion, 10^6 pCi/μCi

r = Dimensionless correction factor for Iodine and Particulate from Table E-15 of Reg Guide 1.109, as follows:

0.2 for particulates 1.0 for radioiodine

$DFLi_a$ = Reg Guide 1.109 dose factor for each nuclide, in mrem/pCi, for each age group.

UaL = Consumption rate of fresh leafy vegetation by the receptor in age group (a) in kg/yr.

ki = Decay constant for the radionuclide, in sec^{-1}

UaS = Consumption rate of non-leafy vegetables by the receptor in age group (a) in kg/yr.

fL = The fraction of the annual intake of leafy vegetation grown locally.

fg = The fraction of the annual intake of non-leafy vegetation grown locally.

kw = Decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73E-7 sec^{-1} (corresponding to a 14 day half-life).

tL = The average time between harvest of leafy vegetation and its consumption in seconds.

th = The average time between harvest of stored vegetation and its consumption in seconds.

Yv = The vegetation area density in kg/m^2.

The concentration of Tritium in vegetation is based on the airborne concentration rather than the deposition. Therefore, the Ri(V) is based on X/Q:

$$(RiV)_{(X/Q)} = K'K''[(UaL)fL+(UaS)fg](DFLi)a\ (0.75)(0.5/H)\ (\text{mrem/yr per } \mu Ci/m^3)$$

<u>Where</u>:

K" = A constant of unit conversion, 1000 gm/kg

H = Absolute humidity of the atmosphere in gm/m^3. This value may be considered as 8 gm/m^3 (NUREG 0133, pg 27) in lieu of site specific information.

0.75 = The fraction of total feed that is water

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

DFLia for each age group is given in Tables 3-3a through 3-3d.

Ri(V) values are listed in Table 3-11a through 3-11c.

Ri(V) Parameters Are From The Following Sources:

PARAMETER	VALUE	Reg Guide 1.109 Table
r (dimensionless)	1.0 for radioiodines	E-15
	0.2 for particulates	
(DFLi) a (mrem/pCi)	Each radionuclide	E-11 to E-14
UaL (kg/yr) - infant	0	E-5
- child	26	E-5
- teen	42	E-5
- adult	64	E-5
UaS (kg/yr) - infant	0	E-5
- child	520	E-5
- teen	630	E-5
- adult	520	E-5
fL (dimensionless)	1.0	E-15
fg (dimensionless)	0.76	E-15
tL (seconds)	8.6E4 (1 day)	E-15
th (seconds)	5.18E6 (60 days)	E-15
Yv (kg/m^2)	2.0	E-15

3.4 Backup Simplified Dose Methodology

The dose calculation procedures described in this section are provided for use as a backup whenever the primary computer methodology cannot be followed.

3.4.1 Instantaneous Dose Rates - Noble Gas Releases

Note: When the instantaneous limit applies, the process radiation monitor response or release rate can be averaged over a one-hour time interval.

3.4.1.1 This section describes the alternative calculational methods to meet the requirements of Paragraph 3.2.1. These methods provide calculational results as per section 3.3.1.

3.4.1.2 To determine an acceptable noble gas instantaneous release rate in μCi/sec, a standard isotopic mixture of noble gases may be assumed. This isotopic mixture was measured for a mixture of isotopes typical of reactor coolant with exposed fuel. This requirement is evaluated at the worst sector of the unrestricted area boundary. Based on this isotopic mixture, standard Ks, Ls, Ms, and Ns (lower case s denotes a weighted sum, see Table 3-8) can be determined using the technique presented in paragraph 3.3.1.2 and Ki, Li, Mi, and Ni values from Tables 3.4-7. The data and results of this calculation are shown in Table 3-8.

3.4.1.3 The isotopic mixture chosen was obtained from a reactor coolant sample during an operating period with exposed fuel. Table 3-8 contains the mixture data and the fractional relative abundance of each isotope. These standard factors can be used with the equations and limits presented in Section 3.3.1.

3.4.1.4 Utilizing the equations from Paragraph 3.3.1.2 and the values from Table 3-8, conservative unit 3 maximum release limits for all noble gases in μCi/sec are calculated in Appendix A and summarized below:

Maximum instantaneous release rates:

$$\dot{Q}t \le \frac{266}{Ks(X/Q)} \le \frac{266}{(8.49E+2)(4.47E-6)} \le 7.00E+4\frac{\mu Ci}{\sec}(Whole\,Body)$$

$$\dot{Q}t \le \frac{1806}{(Ls+1.1Ms)(X/Q)} \le \frac{1806}{(2306)(4.47E-6)} \le 1.75E+5\frac{\mu Ci}{\sec}\ (Skin)$$

3.4.1.5 For individual release rate determinations, alternate computer codes and/or a Hand Calculation Template serve as back up methodologies should the primary computer method be inoperable. These methods comply with calculations in Section 3.3.1.

3.4.2 Instantaneous Dose Rates-I-131, Particulates w/t½ >8 days, & H-3

3.4.2.1 This section describes the alternative calculational method to meet the requirements of Paragraph 3.2.1. The purposes of this method is to provide backup calculational techniques, both computer aided and hand calculated, which approximate section 3.3.2.

3.4.2.2 To determine an acceptable iodine and particulate release rate, it is assumed that the limit on these releases shall be met if the total noble gas concentration in the VC is at least a factor of 20,000 more than the concentration of radioiodine and long lived particulates or VC iodines and long lived particulates are less than 1E-7 µCi/cc. This has historically been the case and this assures that the noble gas activity will be limiting.

3.4.2.3 Backup instantaneous dose rate calculations can be performed with an alternate computer code or by formatted hand calculations. These methods are identical to section 3.3.2.

3.4.3 Time Averaged Dose - Noble Gas Releases

3.4.3.1 This section describes alternative methods of meeting the requirements of Paragraphs 3.2.2 and 3.2.4, and the alternative methods of implementing the calculation techniques presented in Section 3.3.3.

3.4.3.2 The values of $\overline{Ki}$, $\overline{Li}$, $\overline{Mi}$, and $\overline{Ni}$ for the Plant Vent (PV) mixed mode releases and the Monitor Tank (MT) ground plane releases are determined for each release using the dispersion parameter for the site boundary in the worst sector. The calculations are as follows:

$$PV\overline{Ki} = (Ki)*(X/Q)PV \quad \text{and} \quad MT\overline{Ki} = (\overline{Ki})*(X/Q)MT$$

$$PV\overline{Li} = (Li)*(X/Q)PV \quad \text{and} \quad MTLi = (\overline{Li})*(X/Q)MT$$

$$PV\overline{Mi} = (Mi)*(X/Q)PV \quad \text{and} \quad MTMi = (\overline{Mi})*(X/Q)MT$$

$$PV\overline{Ni} = (Ni)*(X/Q)MT \quad \text{and} \quad MTNi = (\overline{Ni})*(X/Q)MT$$

Where:

Ki = The total body dose factor due to gamma emissions for each identified noble gas radionuclide in mrem/yr per µCi/m^3 (finite cloud correction used).

Li = The skin dose factor due to beta emissions for each identified noble gas radionuclide in mrem/yr per $\mu Ci/m^3$.

Mi = The air dose factor due to gamma emissions for each identified noble gas radionuclide in mrem/yr per $\mu Ci/m^3$ (finite cloud correction used).

Ni = The air dose factor due to beta emissions for each identified noble gas radionuclide in mrad/yr per $\mu Ci/m^3$.

(X/Q)PV = The highest calculated annual average dispersion parameter for the noble gas pathway at the unrestricted area boundary, 4.47E-6 sec/m^3 and applicable to plant vent mixed mode releases.

(X/Q)MT = The highest calculated annual average X/Q for ground level monitor tank noble gas release pathway, 5.00E-5 sec/m^3.

3.4.3.3 Determine weighted average dose factors as follows:

All values of Ki, Li, Mi, and Ni are shown in Table 3-4 through 3-7 for the unrestricted area boundary.

Each of the following expressions is summed over all the nuclides:

PV Kt = $\sum[Ki*(Ci/Ct)]$

PV Lt = $\sum[Li*(Ci/Ct)]$

PV Mt = $\sum[Mi*(Ci/Ct)]$

PV Nt = $\sum[Ni*(Ci/Ct)]$

For the monitor tank pathway, MTKt, MTLt, MTMt, and MTNt are calculated in the same way as for plant vent (PV) releases above, except that Ci and Ct apply to gaseous activity for the monitor tank vent pathway.

Where:

Ci = Concentration of isotope i (μCi/cc) in analysis, t (for either PV or MT pathway)

Ct = Concentration of all noble gas isotopes (μCi/cc) for a specific analysis, *t*, (for either the PV or MT pathway)

These calculations can be performed by hand (via formatted procedure) or by using alternate computer codes to compute all or part of the dose calculation.

3.4.3.4 Calculate resultant doses and compare with limits as per 3.3.3. The sum of all releases in a calendar quarter or calendar year should be compared to the limits of Section 3.2.2 and 3.2.4 as appropriate for gamma air dose and beta air dose.

3.4.4 Time Averaged Dose-Iodine 131 and Particulates w/t½ days& H-3

3.4.4.1 This section describes the alternate methods of meeting the requirements of Paragraphs 3.2.3 and 3.2.4 and of implementing the calculational techniques presented in Section 3.3.4.

3.4.4.2 If the primary computer method is inoperable, dose calculations can be performed by:

a) an alternate computer code which complies with Section 3.3.4, using all identified Iodine and Particulate isotopes;

- or -

b) hand calculations (via a formalized departmental procedure) which comply with Section 3.3.4.

3.4.4.3 Sum the Iodine, Particulate, and Tritium dose contributions and compare quarterly and annual totals to the limits described in Section 3.2.3.

3.5 Calculation of Meteorological Dispersion Factors

3.5.1 For the purpose of these calculations, the site boundary was taken to be the unrestricted area boundary. The distances to the site boundary and nearest residents are shown in Table 3-9 for each of the 16 major compass sectors. Site boundary distances at IPEC are measured from the applicable unit's Plant Vent, while distances to the nearest resident in each of these sectors is measured from a common point, the unit 1 superheater stack.

In the sectors where the Hudson River forms the site or exclusion area boundary, the near shore is assumed as the boundary of the "unrestricted area", because, in general, IPEC does not attempt to control population on the river. Potential confusion regarding the near or far shore for this application is effectively removed per the definition of "unrestricted area" in NUREG 0133 (Ref. 1, Section 2.2, Page 6). This section states that these criteria do "not include areas over water bodies" and the river is therefore not applicable for evaluating the maximum unrestricted area boundary concentrations.

3.5.2 The atmospheric transport and diffusion model used in the evaluation of dispersion and deposition factors is the sector-average straight-line model in Regulatory Guide 1.111 (Ref. 15) for mixed-mode releases with plume-rise effects, downwash, and building-wake correction.

The analyses were carried out using the AEOLUS-3 computer code (Ref. 16) and are documented in detail in Ref. 17. Hourly meteorological data was collected from 1981 through 1990, and updated with data from 1992 to 2002, in accordance with the accuracy requirements of Regulatory Guide 1.23 (Ref. 18). The data recovery index for these periods was in excess of 99%.

Comparison of the new meteorological data with previous data continues to show little difference in the overall dispersion conditions at the site. In the analyses, wind-speed coefficients in Regulatory Guide 1.111 were used to extrapolate the measured wind speeds to the height of the main vent (on top of the primary containment). Also, the regulatory plume entrainment model was used to determine plume partitioning between ground-level and elevated releases, and no credit was taken for decay and depletion in transit.

Recirculation effects were accounted for by confining in-valley flows within the valley out to a distance of 10 miles (up or down the valley) and allowing a portion of them to return to the site without additional dilution.

3.5.3 To meet the calculational requirements of Paragraphs 3.2.1, 3.2.2, and 3.2.4 the annual average dispersion factors are calculated approximately once every ten years, for each compass sector at the site unrestricted area boundary. The most restrictive meteorological dispersion and deposition factors determined from this accumulation of data is currently presented in Attachment A.

The distances to the site boundary and nearest resident in each sector were determined from the land use census and global positioning technology, and are listed in Table 3-9.

For the monitor tank release pathway, ground level dispersion values (X/Q) were assessed using the methodology discussed in Section 3.5.2. The most restrictive X/Q was determined to be in the SW sector at 350m with a value of 5.00E-5 sec/m^3 (concentration X/Q per Ref. 21). This value is specific only to the Monitor Tank pathway for noble gas dose at the site boundary.

3.5.4 To meet the calculational requirements of Paragraph 3.2.3 (Iodines and Particulates), the annual average deposition and dispersion parameters were calculated for the nearest residents in each of the compass sectors.

Because no real dairy exists within 5 miles of the power plant, the grass-cow-milk pathway and its dispersion factor are not included.

Dispersion and deposition parameters for the nearest resident were calculated using the models and data described in Sec. 3.5.2 above and are as follows:

Wn(in) = The highest calculated annual average dispersion parameters for the inhalation pathway for the nearest residence in the unrestricted area, per Attachment A.

Wn(dep)= The highest calculated annual average deposition parameters for the ground plane and vegetation pathways for the nearest residence in the unrestricted area, per Attachment A.

For Tritium in the vegetation pathway, Wn(in) is used.

NOTE: For the monitor tank pathway, iodines and particulates are effectively removed by demineralization, therefore dispersion parameters are not needed for this pathway.

3.5.5 To meet the calculational requirements of Paragraphs 3.2.2, 3.2.3 and 3.2.4 and the calculation methodologies described in Sections 3.3.4 and 3.3.3, short term release dispersion and deposition factors may need to be calculated.

For this document, short term release dispersion and deposition factors are determined from the long term annual average parameters and a method presented by Sagendorf in NUREG 0324 (Ref. 5) as recommended by NUREG 0133 (Ref. 1, Section 3.3, Page 8). This method makes use of a factor (F), developed for a particular compass sector and distance, which is simply multiplied by the annual average dispersion or deposition parameter for the same sector and distance to develop the corresponding short-term parameter.

This factor is defined as:

$$F = [NTOTAL/8760]^m$$

<u>Where:</u>

F = The non-dimensional correction factor used to convert annual average dispersion or deposition factors to short term dispersion or deposition factors.

NTOTAL = The total duration of a short-term release (or releases) in hours, during a chosen reporting period.

$$m = \frac{\log(ANMX / F15MX)}{\log(8760)}$$

8760 = The total number of hours in a year.

ANMX = The calculated historical average dispersion (sec/m^3) or deposition (m^{-2}) factor for the compass sector and distance of interest.

F15MX = The short term dispersion (sec/m^3) or deposition (m^{-2}) factor for the compass sector and distance of interest. This is the 15th percentile value such that worse weather conditions can only exist 15% of the time and better weather conditions 85% of the time.

The atmospheric transport and diffusion model used in the evaluation of short-term dispersion and deposition parameters (F15MX) is the Gaussian plume-centerline model in Regulatory Guide 1.145 (Ref. 19), adapted for mixed-mode releases with plume-rise effects, downwash, building-wake correction and plume meander considerations.

As was the case with the annual average parameters, the analyses were carried out using the AEOLUS-3 computer code (Ref. 16) and the most recent 10-year hourly meteorological data. They are documented in detail in Reference 17.

Note that, in line with the guidance in NUREG-0133 (Ref. 1, Sec. 5.3.1, page 29), short-term releases (equal to or less than 500 hours per year) are considered to be cumulative over the calendar quarter or year, as appropriate. However, from Sec. 3.1.16 of the ODCM Part II, and in line with Sec. 3.3, page 8 of NUREG-0133, gas-decay tank releases and containment purges have been determined to be sufficiently random so as to permit use of the long-term dispersion and deposition parameters for assessment of their radiological impact.

3.5.6 The short term 15th percentile dispersion or deposition factor for use in the equation of the preceding paragraphs and the simplified F factor equation for mixed-mode releases to critical locations of each IPEC unit are as follows:

a) Site Boundary Noble Gas:

		Unit 2	Unit 3
F15MX	=	7.724E-5 sec/m^3	1.590E-4 sec/m^3
ANMX	=	2.219E-6 sec/m^3	4.470E-6 sec/m^3
m = $\frac{\log(ANMX / F15MX)}{\log(8760)}$	=	-0.391	-0.393
F =		[NTOTAL/8760]$^{-0.391}$	[NTOTAL/8760]$^{-0.393}$

b) Nearest Residence Inhalation:

		Unit 2	Unit 3
F15MX	=	4.992E-5 sec/m^3	4.888E-5 sec/m^3
ANMX	=	1.030E-6 sec/m^3	1.016E-6 sec/m^3
m = $\frac{\log(ANMX / F15MX)}{\log(8760)}$	=	-0.428	-0.427
F =		[NTOTAL/8760]$^{-0.428}$	[NTOTAL/8760]$^{-0.427}$

c) Nearest Residence Deposition:

		Unit 2	Unit 3
F15MX	=	3.995E-7 m^{-2}	4.019E-7 m^{-2}
ANMX	=	7.517E-9 m^{-2}	7.451E-9 m^{-2}
m = $\frac{\log(ANMX / F15MX)}{\log(8760)}$	=	-0.438	-0.439
F =		[NTOTAL/8760]$^{-0.438}$	[NTOTAL/8760]$^{-0.439}$

d) The slopes ("m") for ground level short term correction factors are calculated in a similar fashion, from ground level data found in Reference 17:

	Unit 2	Unit 3
Site Boundary Noble Gas:	-0.390	-0.397
Nearest Resident Inhalation:	-0.427	-0.427
Nearest Resident Deposition:	-0.455	-0.455

3.6 Justification for and Use of Finite Cloud Assumption for Assessing Site Boundary Dose

Two models are available for the computation of doses from external gamma radiation:

a) The semi-infinite cloud model, which is conservatively applicable only for ground-level releases assumes ground level airborne concentrations are the same throughout a cloud that is large in extent relative to the photon path lengths in air.

b) The finite-cloud model, which takes into consideration the actual plume dimensions and the elevation above the receptor.

The semi-infinite cloud model (which is normally used in a variety of applications because of its simplicity) has two drawbacks:

1. It could be overly conservative for receptors close to the release point (particularly for ground-level releases under stable conditions with limited plume dispersion) due to the basis that the high concentration at the receptor is assumed to exist everywhere, and;

2. It is not suitable for elevated releases since gamma radiation emanating from the radioactive cloud could still reach a receptor on the ground even though the plume is still aloft (the concentration at ground level is equal to zero).

For practical applications, it is possible to define isotope-dependent finite-cloud correction factors to express the difference in external radiation exposures between a finite cloud (which may be either at ground level or elevated) and a semi-finite cloud. Physically, when such a correction factor is applied to the calculated ground-level concentration resulting from a given plume, it will define the equivalent concentration in a semi-infinite cloud which would yield the same external exposure as the finite cloud. Such a correction factor is a function of both the airborne radionuclide energy and of plume dispersion under the prevailing conditions. At distant receptors, where the plume dimensions reach limiting conditions, such correction factors reduce to unity.

The AEOLUS-3 code (which was used for the determination of the annual average dispersion and deposition parameters listed in Section 3.5), also has the capability of providing a basis for computation of isotope-specific finite-cloud correction factors based on the models in "Meteorology and Atomic Energy" (Ref. 20, Sec. 7.5.2). The code was used (along with the mixed-mode release option and the 10-year hourly meteorological data base) for the determination of the correction factors as would be applicable at the IPEC site boundary. Note that the correction factors can be viewed as adjustment factors to the dose conversion factors in Regulatory Guide 1.109 (Ref. 3) for immersion in semi-infinite clouds. The nuclide specific correction factors and adjusted dose factors are presented in Tables 3-4 and 3-6 for the IP3 site boundary.

For the monitor tank pathway (ground release concentration X/Q), use of the finite cloud corrected data presented in tables 3-4 and 3-6 will provide a conservative result. The conservativism is due to the indicated correction factors for the mixed mode case yielding larger correction factors per nuclide. However, in the event that a ground level specific finite cloud correction factor is desired (which will yield lower calculated doses) the Xe-133 gamma X/Q value may be used as described in Reference 21.

3.7 Direct Radiation Measurements and Total Dose Calculations (40CFR190)

Per RECS 3.6, the direct radiation component for potential offsite dose is determined by Radiological Engineering (using References 26 through 29) as follows:

Direct Radiation Dose = VC + IRWSF + SGM + $RMHA_i$ + etc ...

where;

VC	=	The Vapor Containment structure
IRWSF	=	The Interim Radioactive Waste Storage Facility
SGM	=	The Steam Generator Mausoleum
RMHA	=	A Radioactive Material Handling Area, as posted
i	=	The ith RMHA

Other structures or tanks are included as determined by Radiological Engineering.

The calculations in References 26 through 29 were performed in order to meet the requirements of NRC Generic Letter 81-38, 11/10/1981, Storage of Low-Level Radioactive Wastes at Power Reactor Sites.

> "Offsite doses from onsite storage must be sufficiently low to account for other uranium fuel cycle sources (e.g., an additional dose of <1 mrem/year is not likely to cause the limits of 40 CFR 190 to be exceeded). On site dose limits will be controlled per 10 CFR 20..."

The IRWSF, SGM, and RMHAs fence line dose rates are limited by department procedures to keep dose rates at the SITE BOUNDARY fence < 1 mrem/yr based on calculations performed in References 26 through 29. These calculations contain realistic occupancy factors for the SITE BOUNDARY fence and the nearest neighbor.

3.8 Gaseous Effluent Dose to MEMBERS OF THE PUBLIC Visiting the Site

Per RECS Section 4 (bases) and the discussion regarding gaseous effluent dose rate, visiting MEMBERS OF THE PUBLIC will receive negligible dose, as calculated per ODCM Part II, Sections 3.3.3 and 3.3.4, due the application of multiplicative occupancy factors. These factors are determined by comparing the expected hours on site to 8760 hours (the number of hours in a year, which is used in the calculations demonstrated in Sections 3.3.3 and 3.3.4). Examples of these calculations are as follows:

example 1: Several students visit the site for an 8-hour guided tour.
Their occupancy factor is: 8 / 8760 or **.0009**.

example 2: A man drives his wife to work and drops her off at the security gate each morning, with a total stay-time on site for 2 minutes per day. His occupancy factor is calculated as follows:

2 min/60 min per hour =.0333 hr ; 0.0333 / 8760 = **3.8E-6**

These factors, when multiplied by doses calculated per Sections 3.3.3 and 3.3.4, demonstrate that dose to these MEMBERS OF THE PUBLIC is negligible, despite any potential reduction in the atmospheric dispersion.

Table 3-1a

ADULT INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06
P-32	1.65E-04	9.64E-06	6.26E-06	0.00E+00	0.00E+00	0.00E+00	1.08E-05
Cr-51	0.00E+00	0.00E+00	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
Mn-54	0.00E+00	4.95E-06	7.87E-07	0.00E+00	1.23E-06	1.75E-04	9.67E-06
Mn-56	0.00E+00	1.55E-10	2.29E-11	0.00E+00	1.63E-10	1.18E-06	2.53E-06
Fe-55	3.07E-06	2.12E-06	4.93E-07	0.00E+00	0.00E+00	9.01E-06	7.54E-07
Fe-59	1.47E-06	3.47E-06	1.32E-06	0.00E+00	0.00E+00	1.27E-04	2.35E-05
Co-58	0.00E+00	1.98E-07	2.59E-07	0.00E+00	0.00E+00	1.16E-04	1.33E-05
Co-60	0.00E+00	1.44E-06	1.85E-06	0.00E+00	0.00E+00	7.46E-04	3.56E-05
Ni-63	5.40E-05	3.93E-06	1.81E-06	0.00E+00	0.00E+00	2.23E-05	1.67E-06
Ni-65	1.92E-10	2.62E-11	1.14E-11	0.00E+00	0.00E+00	7.00E-07	1.54E-06
Cu-64	0.00E+00	1.83E-10	7.69E-11	0.00E+00	5.78E-10	8.48E-07	6.12E-06
Zn-65	4.05E-06	1.29E-05	5.82E-06	0.00E+00	8.62E-06	1.08E-04	6.68E-06
Zn-69	4.23E-12	8.14E-12	5.65E-13	0.00E+00	5.27E-12	1.15E-07	2.04E-09
Br-83	0.00E+00	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.90E-08
Br-84	0.00E+00	0.00E+00	3.91E-08	0.00E+00	0.00E+00	0.00E+00	2.05E-13
Br-85	0.00E+00	0.00E+00	1.60E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.69E-05	7.37E-06	0.00E+00	0.00E+00	0.00E+00	2.08E-06
Rb-88	0.00E+00	4.84E-08	2.41E-08	0.00E+00	0.00E+00	0.00E+00	4.18E-19
Rb-89	0.00E+00	3.20E-08	2.12E-08	0.00E+00	0.00E+00	0.00E+00	1.16E-21
Sr-89	3.80E-05	0.00E+00	1.09E-06	0.00E+00	0.00E+00	1.75E-04	4.37E-05
Sr-90	1.24E-02	0.00E+00	7.62E-04	0.00E+00	0.00E+00	1.20E-03	9.02E-05
Sr-91	7.74E-09	0.00E+00	3.13E-10	0.00E+00	0.00E+00	4.56E-06	2.39E-05
Sr-92	8.43E-10	0.00E+00	3.64E-11	0.00E+00	0.00E+00	2.06E-06	5.38E-06
Y-90	2.61E-07	0.00E+00	7.01E-09	0.00E+00	0.00E+00	2.12E-05	6.32E-05
Y-91m	3.26E-11	0.00E+00	1.27E-12	0.00E+00	0.00E+00	2.40E-07	1.66E-10
Y-91	5.78E-05	0.00E+00	1.55E-06	0.00E+00	0.00E+00	2.13E-04	4.81E-05
Y-92	1.29E-09	0.00E+00	3.77E-11	0.00E+00	0.00E+00	1.96E-06	9.19E-06
Y-93	1.18E-08	0.00E+00	3.26E-10	0.00E+00	0.00E+00	6.06E-06	5.27E-05
Zr-95	1.34E-05	4.30E-06	2.91E-06	0.00E+00	6.77E-06	2.21E-04	1.88E-05
Zr-97	1.21E-08	2.45E-09	1.13E-09	0.00E+00	3.71E-09	9.84E-06	6.54E-05
Nb-95	1.76E-06	9.77E-07	5.26E-07	0.00E+00	9.67E-07	6.31E-05	1.30E-05
Mo-99	0.00E+00	1.51E-08	2.87E-09	0.00E+00	3.64E-08	1.14E-05	3.10E-05
Tc-99m	1.29E-13	3.64E-13	4.63E-12	0.00E+00	5.52E-12	9.55E-08	5.20E-07
Tc-101	5.22E-15	7.52E-15	7.38E-14	0.00E+00	1.35E-13	4.99E-08	1.36E-21
Ru-103	1.91E-07	0.00E+00	8.23E-08	0.00E+00	7.29E-07	6.31E-05	1.38E-05
Ru-105	9.88E-11	0.00E+00	3.89E-11	0.00E+00	1.27E-10	1.37E-06	6.02E-06
Ru-106	8.64E-06	0.00E+00	1.09E-06	0.00E+00	1.67E-05	1.17E-03	1.14E-04
Ag-110m	1.35E-06	1.25E-06	7.43E-07	0.00E+00	2.46E-06	5.79E-04	3.78E-05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	3.90E-06	7.36E-08	1.55E-06	9.44E-09	0.00E+00	3.10E-04	5.08E-05
Sb-125	6.67E-06	7.44E-08	1.58E-06	6.75E-09	0.00E+00	2.18E-04	1.26E-05

Table 3-1a

ADULT INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	4.27E-07	1.98E-07	5.84E-08	1.31E-07	1.55E-06	3.92E-05	8.83E-06
Te-127m	1.58E-06	7.21E-07	1.96E-07	4.11E-07	5.72E-06	1.20E-04	1.87E-05
Te-127	1.75E-10	8.03E-11	3.87E-11	1.32E-10	6.37E-10	8.14E-07	7.17E-06
Te-129m	1.22E-06	5.84E-07	1.98E-07	4.30E-07	4.57E-06	1.45E-04	4.79E-05
Te-129	6.22E-12	2.99E-12	1.55E-12	4.87E-12	2.34E-11	2.42E-07	1.96E-08
Te-131m	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05
Te-131	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09
Te-132	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05
I-130	5.72E-07	1.68E-06	6.60E-07	1.42E-04	2.61E-06	0.00E+00	9.61E-07
I-131	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	0.00E+00	7.85E-07
I-132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	0.00E+00	5.08E-08
I-133	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	0.00E+00	1.11E-06
I-134	8.05E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	0.00E+00	1.26E-10
I-135	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	0.00E+00	6.56E-07
Cs-134	4.66E-05	1.06E-04	9.10E-05	0.00E+00	3.59E-05	1.22E-05	1.30E-06
Cs-136	4.88E-06	1.83E-05	1.38E-05	0.00E+00	1.07E-05	1.50E-06	1.46E-06
Cs-137	5.98E-05	7.76E-05	5.35E-05	0.00E+00	2.78E-05	9.40E-06	1.05E-06
Cs-138	4.14E-08	7.76E-08	4.05E-08	0.00E+00	6.00E-08	6.07E-09	2.33E-13
Ba-139	1.17E-10	8.32E-14	3.42E-12	0.00E+00	7.78E-14	4.70E-07	1.12E-07
Ba-140	4.88E-06	6.13E-09	3.21E-07	0.00E+00	2.09E-09	1.59E-04	2.73E-05
Ba-141	1.25E-11	9.41E-15	4.20E-13	0.00E+00	8.75E-15	2.42E-07	1.45E-17
Ba-142	3.29E-12	3.38E-15	2.07E-13	0.00E+00	2.86E-15	1.49E-07	1.96E-26
La-140	4.30E-08	2.17E-08	5.73E-09	0.00E+00	0.00E+00	1.70E-05	5.73E-05
La-142	8.54E-11	3.88E-11	9.65E-12	0.00E+00	0.00E+00	7.91E-07	2.64E-07
Ce-141	2.49E-06	1.69E-06	1.91E-07	0.00E+00	7.83E-07	4.52E-05	1.50E-05
Ce-143	2.33E-08	1.72E-08	1.91E-09	0.00E+00	7.60E-09	9.97E-06	2.83E-05
Ce-144	4.29E-04	1.79E-04	2.30E-05	0.00E+00	1.06E-04	9.72E-04	1.02E-04
Pr-143	1.17E-06	4.69E-07	5.80E-08	0.00E+00	2.70E-07	3.51E-05	2.50E-05
Pr-144	3.76E-12	1.56E-12	1.91E-13	0.00E+00	8.81E-13	1.27E-07	2.69E-18
Nd-147	6.59E-07	7.62E-07	4.56E-08	0.00E+00	4.45E-07	2.76E-05	2.16E-05
W-187	1.06E-09	8.85E-10	3.10E-10	0.00E+00	0.00E+00	3.63E-06	1.94E-05
Np-239	2.87E-08	2.82E-09	1.55E-09	0.00E+00	8.75E-09	4.70E-06	1.49E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	8.65E-08	8.39E-08	0.00E+00	0.00E+00	4.62E-05	3.93E-06
Sr-85	4.00E-06	0.00E+00	9.70E-05	0.00E+00	0.00E+00	6.00E-05	7.60E-06
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.78E-11	7.03E-12	2.56E-12	0.00E+00	8.18E-12	3.00E-07	3.02E-08
Cd-109	0.00E+00	4.90E-05	1.60E-06	0.00E+00	4.70E-05	9.10E-05	8.20E-06
Sn-113	8.20E-06	2.70E-07	5.60E-07	1.70E-07	0.00E+00	1.20E-04	1.50E-06
Ba-133	9.50E-06	4.20E-07	2.50E-06	0.00E+00	2.10E-09	1.90E-04	1.00E-05
Te-134	3.84E-12	3.22E-12	1.57E-12	3.44E-12	2.18E-11	4.34E-07	2.97E-11
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-1b

TEEN INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
P-32	2.36E-04	1.37E-05	8.95E-06	0.00E+00	0.00E+00	0.00E+00	1.16E-05
Cr-51	0.00E+00	0.00E+00	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
Mn-54	0.00E+00	6.39E-06	1.05E-06	0.00E+00	1.59E-06	2.48E-04	8.35E-06
Mn-56	0.00E+00	2.12E-10	3.15E-11	0.00E+00	2.24E-10	1.90E-06	7.18E-06
Fe-55	4.18E-06	2.98E-06	6.93E-07	0.00E+00	0.00E+00	1.55E-05	7.99E-07
Fe-59	1.99E-06	4.62E-06	1.79E-06	0.00E+00	0.00E+00	1.91E-04	2.23E-05
Co-58	0.00E+00	2.59E-07	3.47E-07	0.00E+00	0.00E+00	1.68E-04	1.19E-05
Co-60	0.00E+00	1.89E-06	2.48E-06	0.00E+00	0.00E+00	1.09E-03	3.24E-05
Ni-63	7.25E-05	5.43E-06	2.47E-06	0.00E+00	0.00E+00	3.84E-05	1.77E-06
Ni-65	2.73E-10	3.66E-11	1.59E-11	0.00E+00	0.00E+00	1.17E-06	4.59E-06
Cu-64	0.00E+00	2.54E-10	1.06E-10	0.00E+00	8.01E-10	1.39E-06	7.68E-06
Zn-65	4.82E-06	1.67E-05	7.80E-06	0.00E+00	1.08E-05	1.55E-04	5.83E-06
Zn-69	6.04E-12	1.15E-11	8.07E-13	0.00E+00	7.53E-12	1.98E-07	3.56E-08
Br-83	0.00E+00	0.00E+00	4.30E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	5.41E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.29E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.38E-05	1.05E-05	0.00E+00	0.00E+00	0.00E+00	2.21E-06
Rb-88	0.00E+00	6.82E-08	3.40E-08	0.00E+00	0.00E+00	0.00E+00	3.65E-15
Rb-89	0.00E+00	4.40E-08	2.91E-08	0.00E+00	0.00E+00	0.00E+00	4.22E-17
Sr-89	5.43E-05	0.00E+00	1.56E-06	0.00E+00	0.00E+00	3.02E-04	4.64E-05
Sr-90	1.35E-02	0.00E+00	8.35E-04	0.00E+00	0.00E+00	2.06E-03	9.56E-05
Sr-91	1.10E-08	0.00E+00	4.39E-10	0.00E+00	0.00E+00	7.59E-06	3.24E-05
Sr-92	1.19E-09	0.00E+00	5.08E-11	0.00E+00	0.00E+00	3.43E-06	1.49E-05
Y-90	3.73E-07	0.00E+00	1.00E-08	0.00E+00	0.00E+00	3.66E-05	6.99E-05
Y-91m	4.63E-11	0.00E+00	1.77E-12	0.00E+00	0.00E+00	4.00E-07	3.77E-09
Y-91	8.26E-05	0.00E+00	2.21E-06	0.00E+00	0.00E+00	3.67E-04	5.11E-05
Y-92	1.84E-09	0.00E+00	5.36E-11	0.00E+00	0.00E+00	3.35E-06	2.06E-05
Y-93	1.69E-08	0.00E+00	4.65E-10	0.00E+00	0.00E+00	1.04E-05	7.24E-05
Zr-95	1.82E-05	5.73E-06	3.94E-06	0.00E+00	8.42E-06	3.36E-04	1.86E-05
Zr-97	1.72E-08	3.40E-09	1.57E-09	0.00E+00	5.15E-09	1.62E-05	7.88E-05
Nb-95	2.32E-06	1.29E-06	7.08E-07	0.00E+00	1.25E-06	9.39E-05	1.21E-05
Mo-99	0.00E+00	2.11E-08	4.03E-09	0.00E+00	5.14E-08	1.92E-05	3.36E-05
Tc-99m	1.73E-13	4.83E-13	6.24E-12	0.00E+00	7.20E-12	1.44E-07	7.66E-07
Tc-101	7.40E-15	1.05E-14	1.03E-13	0.00E+00	1.90E-13	8.34E-08	1.09E-16
Ru-103	2.63E-07	0.00E+00	1.12E-07	0.00E+00	9.29E-07	9.79E-05	1.36E-05
Ru-105	1.40E-10	0.00E+00	5.42E-11	0.00E+00	1.76E-10	2.27E-06	1.13E-05
Ru-106	1.23E-05	0.00E+00	1.55E-06	0.00E+00	2.38E-05	2.01E-03	1.20E-04
Ag-110m	1.73E-06	1.64E-06	9.99E-07	0.00E+00	3.13E-06	8.44E-04	3.41E-05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	5.38E-06	9.92E-08	2.10E-06	1.22E-08	0.00E+00	4.81E-04	4.98E-05
Sb-125	9.23E-06	1.01E-07	2.15E-06	8.80E-09	0.00E+00	3.42E-04	1.24E-05

Table 3-1b

TEEN INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	6.10E-07	2.80E-07	8.34E-08	1.75E-07	0.00E+00	6.70E-05	9.38E-06
Te-127m	2.25E-06	1.02E-06	2.73E-07	5.48E-07	8.17E-06	2.07E-04	1.99E-05
Te-127	2.51E-10	1.14E-10	5.52E-11	1.77E-10	9.10E-10	1.40E-06	1.01E-05
Te-129m	1.74E-06	8.23E-07	2.81E-07	5.72E-07	6.49E-06	2.47E-04	5.06E-05
Te-129	8.87E-12	4.22E-12	2.20E-12	6.48E-12	3.32E-11	4.12E-07	2.02E-07
Te-131m	1.23E-08	7.51E-09	5.03E-09	9.06E-09	5.49E-08	2.97E-05	7.76E-05
Te-131	1.97E-12	1.04E-12	6.30E-13	1.55E-12	7.72E-12	2.92E-07	1.89E-09
Te-132	4.50E-08	3.63E-08	2.74E-08	3.07E-08	2.44E-07	5.61E-05	5.79E-05
I-130	7.80E-07	2.24E-06	8.96E-07	1.86E-04	3.44E-06	0.00E+00	1.14E-06
I-131	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	0.00E+00	8.11E-07
I-132	1.99E-07	5.47E-07	1.97E-07	1.89E-05	8.65E-07	0.00E+00	1.59E-07
I-133	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	0.00E+00	1.29E-06
I-134	1.11E-07	2.90E-07	1.05E-07	4.94E-06	4.58E-07	0.00E+00	2.55E-09
I-135	4.62E-07	1.18E-06	4.36E-07	7.76E-05	1.86E-06	0.00E+00	8.69E-07
Cs-134	6.28E-05	1.41E-04	6.86E-05	0.00E+00	4.69E-05	1.83E-05	1.22E-06
Cs-136	6.44E-06	2.42E-05	1.71E-05	0.00E+00	1.38E-05	2.22E-06	1.36E-06
Cs-137	8.38E-05	1.06E-04	3.89E-05	0.00E+00	3.80E-05	1.51E-05	1.06E-06
Cs-138	5.82E-08	1.07E-07	5.58E-08	0.00E+00	8.28E-08	9.84E-09	3.38E-11
Ba-139	1.67E-10	1.18E-13	4.87E-12	0.00E+00	1.11E-13	8.08E-07	8.06E-07
Ba-140	6.84E-06	8.38E-09	4.40E-07	0.00E+00	2.85E-09	2.54E-04	2.86E-05
Ba-141	1.78E-11	1.32E-14	5.93E-13	0.00E+00	1.23E-14	4.11E-07	9.33E-14
Ba-142	4.62E-12	4.63E-15	2.84E-13	0.00E+00	3.92E-15	2.39E-07	5.99E-20
La-140	5.99E-08	2.95E-08	7.82E-09	0.00E+00	0.00E+00	2.68E-05	6.09E-05
La-142	1.20E-10	5.31E-11	1.32E-11	0.00E+00	0.00E+00	1.27E-06	1.50E-06
Ce-141	3.55E-06	2.37E-06	2.71E-07	0.00E+00	1.11E-06	7.67E-05	1.58E-05
Ce-143	3.32E-08	2.42E-08	2.70E-09	0.00E+00	1.08E-08	1.63E-05	3.19E-05
Ce-144	6.11E-04	2.53E-04	3.28E-05	0.00E+00	1.51E-04	1.67E-03	1.08E-04
Pr-143	1.67E-06	6.64E-07	8.28E-08	0.00E+00	3.86E-07	6.04E-05	2.67E-05
Pr-144	5.37E-12	2.20E-12	2.72E-13	0.00E+00	1.26E-12	2.19E-07	2.94E-14
Nd-147	9.83E-07	1.07E-06	6.41E-08	0.00E+00	6.28E-07	4.65E-05	2.28E-05
W-187	1.50E-09	1.22E-09	4.29E-10	0.00E+00	0.00E+00	5.92E-06	2.21E-05
Np-239	4.23E-08	3.99E-09	2.21E-09	0.00E+00	1.25E-08	8.11E-06	1.65E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.18E-07	1.15E-07	0.00E+00	0.00E+00	7.33E-05	3.93E-06
Sr-85	5.00E-06	0.00E+00	1.30E-06	0.00E+00	0.00E+00	8.80E-05	6.90E-06
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	3.93E-11	9.72E-12	3.55E-12	0.00E+00	1.14E-11	4.91E-07	2.71E-07
Cd-109	0.00E+00	1.00E-04	3.40E-06	0.00E+00	6.70E-05	1.60E-04	8.60E-06
Sn-113	1.50E-05	4.70E-07	9.70E-07	2.90E-07	0.00E+00	2.00E-04	1.50E-06
Ba-133	4.70E-05	8.00E-07	3.30E-06	0.00E+00	2.80E-09	2.90E-04	9.70E-06
Te-134	5.31E-12	4.35E-12	3.64E-12	4.46E-12	2.91E-11	6.75E-07	1.37E-09
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-1c

CHILD INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P-32	7.04E-04	3.09E-05	2.67E-05	0.00E+00	0.00E+00	0.00E+00	1.14E-05
Cr-51	0.00E+00	0.00E+00	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
Mn-54	0.00E+00	1.16E-05	2.57E-06	0.00E+00	2.71E-06	4.26E-04	6.19E-06
Mn-56	0.00E+00	4.48E-10	8.43E-11	0.00E+00	4.52E-10	3.55E-06	3.33E-05
Fe-55	1.28E-05	6.80E-06	2.10E-06	0.00E+00	0.00E+00	3.00E-05	7.75E-07
Fe-59	5.59E-06	9.04E-06	4.51E-06	0.00E+00	0.00E+00	3.43E-04	1.91E-05
Co-58	0.00E+00	4.79E-07	8.55E-07	0.00E+00	0.00E+00	2.99E-04	9.29E-06
Co-60	0.00E+00	3.55E-06	6.12E-06	0.00E+00	0.00E+00	1.91E-03	2.60E-05
Ni-63	2.22E-04	1.25E-05	7.56E-06	0.00E+00	0.00E+00	7.43E-05	1.71E-06
Ni-65	8.08E-10	7.99E-11	4.44E-11	0.00E+00	0.00E+00	2.21E-06	2.27E-05
Cu-64	0.00E+00	5.39E-10	2.90E-10	0.00E+00	1.63E-09	2.59E-06	9.92E-06
Zn-65	1.15E-05	3.06E-05	1.90E-05	0.00E+00	1.93E-05	2.69E-04	4.41E-06
Zn-69	1.81E-11	2.61E-11	2.41E-12	0.00E+00	1.58E-11	3.84E-07	2.75E-06
Br-83	0.00E+00	0.00E+00	1.28E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.48E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	6.84E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	5.36E-05	3.09E-05	0.00E+00	0.00E+00	0.00E+00	2.16E-06
Rb-88	0.00E+00	1.52E-07	9.90E-08	0.00E+00	0.00E+00	0.00E+00	4.66E-09
Rb-89	0.00E+00	9.33E-08	7.83E-08	0.00E+00	0.00E+00	0.00E+00	5.11E-10
Sr-89	1.62E-04	0.00E+00	4.66E-06	0.00E+00	0.00E+00	5.83E-04	4.52E-05
Sr-90	2.73E-02	0.00E+00	1.74E-03	0.00E+00	0.00E+00	3.99E-03	9.28E-05
Sr-91	3.28E-08	0.00E+00	1.24E-09	0.00E+00	0.00E+00	1.44E-05	4.70E-05
Sr-92	3.54E-09	0.00E+00	1.42E-10	0.00E+00	0.00E+00	6.49E-06	6.55E-05
Y-90	1.11E-06	0.00E+00	2.99E-08	0.00E+00	0.00E+00	7.07E-05	7.24E-05
Y-91m	1.37E-10	0.00E+00	4.98E-12	0.00E+00	0.00E+00	7.60E-07	4.64E-07
Y-91	2.47E-04	0.00E+00	6.59E-06	0.00E+00	0.00E+00	7.10E-04	4.97E-05
Y-92	5.50E-09	0.00E+00	1.57E-10	0.00E+00	0.00E+00	6.46E-06	6.46E-05
Y-93	5.04E-08	0.00E+00	1.38E-09	0.00E+00	0.00E+00	2.01E-05	1.05E-04
Zr-95	5.13E-05	1.13E-05	1.00E-05	0.00E+00	1.61E-05	6.03E-04	1.65E-05
Zr-97	5.07E-08	7.34E-09	4.32E-09	0.00E+00	1.05E-08	3.06E-05	9.49E-05
Nb-95	6.35E-06	2.48E-06	1.77E-06	0.00E+00	2.33E-06	1.66E-04	1.00E-05
Mo-99	0.00E+00	4.66E-08	1.15E-08	0.00E+00	1.06E-07	3.66E-05	3.42E-05
Tc-99m	4.81E-13	9.41E-13	1.56E-11	0.00E+00	1.37E-11	2.57E-07	1.30E-06
Tc-101	2.19E-14	2.30E-14	2.91E-13	0.00E+00	3.92E-13	1.58E-07	4.41E-09
Ru-103	7.55E-07	0.00E+00	2.90E-07	0.00E+00	1.90E-06	1.79E-04	1.21E-05
Ru-105	4.13E-10	0.00E+00	1.50E-10	0.00E+00	3.63E-10	4.30E-06	2.69E-05
Ru-106	3.68E-05	0.00E+00	4.57E-06	0.00E+00	4.97E-05	3.87E-03	1.16E-04
Ag-110m	4.56E-06	3.08E-06	2.47E-06	0.00E+00	5.74E-06	1.48E-03	2.71E-05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	1.55E-05	2.00E-07	5.41E-06	3.41E-08	0.00E+00	8.76E-04	4.43E-05
Sb-125	2.66E-05	2.05E-07	5.59E-06	2.46E-08	0.00E+00	6.27E-04	1.09E-05

Table 3-1c

CHILD INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	1.82E-06	6.29E-07	2.47E-07	5.20E-07	0.00E+00	1.29E-04	9.13E-06
Te-127m	6.72E-06	2.31E-06	8.16E-07	1.64E-06	1.72E-05	4.00E-04	1.93E-05
Te-127	7.49E-10	2.57E-10	1.65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
Te-129m	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
Te-129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
Te-131m	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
Te-131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
Te-132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
I-130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	0.00E+00	1.38E-06
I-131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	0.00E+00	7.68E-07
I-132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	0.00E+00	8.65E-07
I-133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	0.00E+00	1.48E-06
I-134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	0.00E+00	2.58E-07
I-135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	0.00E+00	1.20E-06
Cs-134	1.76E-04	2.74E-04	6.07E-05	0.00E+00	8.93E-05	3.27E-05	1.04E-06
Cs-136	1.76E-05	4.62E-05	3.14E-05	0.00E+00	2.58E-05	3.93E-06	1.13E-06
Cs-137	2.45E-04	2.23E-04	3.47E-05	0.00E+00	7.63E-05	2.81E-05	9.78E-07
Cs-138	1.71E-07	2.27E-07	1.50E-07	0.00E+00	1.68E-07	1.84E-08	7.29E-08
Ba-139	4.98E-10	2.66E-13	1.45E-11	0.00E+00	2.33E-13	1.56E-06	1.56E-05
Ba-140	2.00E-05	1.75E-08	1.17E-06	0.00E+00	5.71E-09	4.71E-04	2.75E-05
Ba-141	5.29E-11	2.95E-14	1.72E-12	0.00E+00	2.56E-14	7.89E-07	7.44E-08
Ba-142	1.35E-11	9.73E-15	7.54E-13	0.00E+00	7.87E-15	4.44E-07	7.41E-10
La-140	1.74E-07	6.08E-08	2.04E-08	0.00E+00	0.00E+00	4.94E-05	6.10E-05
La-142	3.50E-10	1.11E-10	3.49E-11	0.00E+00	0.00E+00	2.35E-06	2.05E-05
Ce-141	1.06E-05	5.28E-06	7.83E-07	0.00E+00	2.31E-06	1.47E-04	1.53E-05
Ce-143	9.89E-08	5.37E-08	7.77E-09	0.00E+00	2.26E-08	3.12E-05	3.44E-05
Ce-144	1.83E-03	5.72E-04	9.77E-05	0.00E+00	3.17E-04	3.23E-03	1.05E-04
Pr-143	4.99E-06	1.50E-06	2.47E-07	0.00E+00	8.11E-07	1.17E-04	2.63E-05
Pr-144	1.61E-11	4.99E-12	8.10E-13	0.00E+00	2.64E-12	4.23E-07	5.32E-08
Nd-147	2.92E-06	2.36E-06	1.84E-07	0.00E+00	1.30E-06	8.87E-05	2.22E-05
W-187	4.41E-09	2.61E-09	1.17E-09	0.00E+00	0.00E+00	1.11E-05	2.46E-05
Np-239	1.26E-07	9.04E-09	6.35E-09	0.00E+00	2.63E-08	1.57E-05	1.73E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	2.44E-07	2.88E-07	0.00E+00	0.00E+00	1.37E-04	3.58E-06
Sr-85	1.20E-05	0.00E+00	3.20E-06	0.00E+00	0.00E+00	1.50E-04	5.50E-06
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	1.16E-10	2.08E-11	9.73E-12	0.00E+00	2.31E-11	9.24E-07	7.51E-06
Cd-109	0.00E+00	1.90E-04	8.00E-06	0.00E+00	1.70E-04	3.00E-04	8.10E-06
Sn-113	3.80E-05	8.90E-07	2.30E-06	7.10E-07	0.00E+00	3.60E-04	1.30E-06
Ba-133	1.10E-04	1.10E-06	1.00E-05	0.00E+00	5.40E-09	5.20E-04	8.30E-06
Te-134	1.53E-11	8.81E-12	9.40E-12	1.24E-11	5.71E-11	1.23E-06	4.87E-07
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-1d

INFANT INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P-32	1.45E-03	8.03E-05	5.53E-05	0.00E+00	0.00E+00	0.00E+00	1.15E-05
Cr-51	0.00E+00	0.00E+00	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
Mn-54	0.00E+00	1.81E-05	3.56E-06	0.00E+00	3.56E-06	7.14E-04	5.04E-06
Mn-56	0.00E+00	1.10E-09	1.58E-10	0.00E+00	7.86E-10	8.95E-06	5.12E-05
Fe-55	1.41E-05	8.39E-06	2.38E-06	0.00E+00	0.00E+00	6.21E-05	7.82E-07
Fe-59	9.69E-06	1.68E-05	6.77E-06	0.00E+00	0.00E+00	7.25E-04	1.77E-05
Co-58	0.00E+00	8.71E-07	1.30E-06	0.00E+00	0.00E+00	5.55E-04	7.95E-06
Co-60	0.00E+00	5.73E-06	8.41E-06	0.00E+00	0.00E+00	3.22E-03	2.28E-05
Ni-63	2.42E-04	1.46E-05	8.29E-06	0.00E+00	0.00E+00	1.49E-04	1.73E-06
Ni-65	1.71E-09	2.03E-10	8.79E-11	0.00E+00	0.00E+00	5.80E-06	3.58E-05
Cu-64	0.00E+00	1.34E-09	5.53E-10	0.00E+00	2.84E-09	6.64E-06	1.07E-05
Zn-65	1.38E-05	4.47E-05	2.22E-05	0.00E+00	2.32E-05	4.62E-04	3.67E-05
Zn-69	3.85E-11	6.91E-11	5.13E-12	0.00E+00	2.87E-11	1.05E-06	9.44E-06
Br-83	0.00E+00	0.00E+00	2.72E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	2.86E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.46E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.36E-04	6.30E-05	0.00E+00	0.00E+00	0.00E+00	2.17E-06
Rb-88	0.00E+00	3.98E-07	2.05E-07	0.00E+00	0.00E+00	0.00E+00	2.42E-07
Rb-89	0.00E+00	2.29E-07	1.47E-07	0.00E+00	0.00E+00	0.00E+00	4.87E-08
Sr-89	2.84E-04	0.00E+00	8.15E-06	0.00E+00	0.00E+00	1.45E-03	4.57E-05
Sr-90	2.92E-02	0.00E+00	1.85E-03	0.00E+00	0.00E+00	8.03E-03	9.36E-05
Sr-91	6.83E-08	0.00E+00	2.47E-09	0.00E+00	0.00E+00	3.76E-05	5.24E-05
Sr-92	7.50E-09	0.00E+00	2.79E-10	0.00E+00	0.00E+00	1.70E-05	1.00E-04
Y-90	2.35E-06	0.00E+00	6.30E-08	0.00E+00	0.00E+00	1.92E-04	7.43E-05
Y-91m	2.91E-10	0.00E+00	9.90E-12	0.00E+00	0.00E+00	1.99E-06	1.68E-06
Y-91	4.20E-04	0.00E+00	1.12E-05	0.00E+00	0.00E+00	1.75E-03	5.02E-05
Y-92	1.17E-08	0.00E+00	3.29E-10	0.00E+00	0.00E+00	1.75E-05	9.04E-05
Y-93	1.07E-07	0.00E+00	2.91E-09	0.00E+00	0.00E+00	5.46E-05	1.19E-04
Zr-95	8.24E-05	1.99E-05	1.45E-05	0.00E+00	2.22E-05	1.25E-03	1.55E-05
Zr-97	1.07E-07	1.83E-08	8.36E-09	0.00E+00	1.85E-08	7.88E-05	1.00E-04
Nb-95	1.12E-05	4.59E-06	2.70E-06	0.00E+00	3.37E-06	3.42E-04	9.05E-06
Mo-99	0.00E+00	1.18E-07	2.31E-08	0.00E+00	1.89E-07	9.63E-05	3.48E-05
Tc-99m	9.98E-13	2.06E-12	2.66E-11	0.00E+00	2.22E-11	5.79E-07	1.45E-06
Tc-101	4.65E-14	5.88E-14	5.80E-13	0.00E+00	6.99E-13	4.17E-07	6.03E-07
Ru-103	1.44E-06	0.00E+00	4.85E-07	0.00E+00	3.03E-06	3.94E-04	1.15E-05
Ru-105	8.74E-10	0.00E+00	2.93E-10	0.00E+00	6.42E-10	1.12E-05	3.46E-05
Ru-106	6.20E-05	0.00E+00	7.77E-06	0.00E+00	7.61E-05	8.26E-03	1.17E-04
Ag-110m	7.13E-06	5.16E-06	3.57E-06	0.00E+00	7.80E-06	2.62E-03	2.36E-05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	2.71E-05	3.97E-07	8.56E-06	7.18E-08	0.00E+00	1.89E-03	4.22E-05
Sb-125	3.69E-05	3.41E-07	7.78E-06	4.45E-08	0.00E+00	1.17E-03	1.05E-05

Table 3-1d

INFANT INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	3.40E-06	1.42E-06	4.70E-07	1.16E-06	0.00E+00	3.19E-04	9.22E-06
Te-127m	1.19E-05	4.93E-06	1.48E-06	3.48E-06	2.68E-05	9.37E-04	1.95E-05
Te-127	1.59E-05	6.81E-10	3.49E-10	1.32E-09	3.47E-09	7.39E-06	1.74E-05
Te-129m	1.01E-05	4.35E-06	1.59E-06	3.91E-06	2.27E-05	1.20E-03	4.93E-05
Te-129	5.63E-11	2.48E-11	1.34E-11	4.82E-11	1.25E-10	2.14E-06	1.88E-05
Te-131m	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
Te-131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
Te-132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I-130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	0.00E+00	1.42E-06
I-131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	0.00E+00	7.56E-07
I-132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	0.00E+00	1.36E-06
I-133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	0.00E+00	1.54E-06
I-134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	0.00E+00	9.21E-07
I-135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	0.00E+00	1.31E-06
Cs-134	2.83E-04	5.02E-04	5.32E-05	0.00E+00	1.36E-04	5.69E-05	9.53E-07
Cs-136	3.45E-05	9.61E-05	3.78E-05	0.00E+00	4.03E-05	8.40E-06	1.02E-06
Cs-137	3.92E-04	4.37E-04	3.25E-05	0.00E+00	1.23E-04	5.09E-05	9.53E-07
Cs-138	3.61E-07	5.58E-07	2.84E-07	0.00E+00	2.93E-07	4.67E-08	6.26E-07
Ba-139	1.06E-09	7.03E-13	3.07E-11	0.00E+00	4.23E-13	4.25E-06	3.64E-05
Ba-140	4.00E-05	4.00E-08	2.07E-06	0.00E+00	9.59E-09	1.14E-03	2.74E-05
Ba-141	1.12E-10	7.70E-14	3.55E-12	0.00E+00	4.64E-14	2.12E-06	3.39E-06
Ba-142	2.84E-11	2.36E-14	1.40E-12	0.00E+00	1.36E-14	1.11E-06	4.95E-07
La-140	3.61E-07	1.43E-07	3.68E-08	0.00E+00	0.00E+00	1.20E-04	6.06E-05
La-142	7.36E-10	2.69E-10	6.46E-11	0.00E+00	0.00E+00	5.87E-06	4.25E-05
Ce-141	1.98E-05	1.19E-05	1.42E-06	0.00E+00	3.75E-06	3.69E-04	1.54E-05
Ce-143	2.09E-07	1.38E-07	1.58E-08	0.00E+00	4.03E-08	8.30E-05	3.55E-05
Ce-144	2.28E-03	8.65E-04	1.26E-04	0.00E+00	3.84E-04	7.03E-03	1.06E-04
Pr-143	1.00E-05	3.74E-06	4.99E-07	0.00E+00	1.41E-06	3.09E-04	2.66E-05
Pr-144	3.42E-11	1.32E-11	1.72E-12	0.00E+00	4.80E-12	1.15E-06	3.06E-06
Nd-147	5.67E-06	5.81E-06	3.57E-07	0.00E+00	2.25E-06	2.30E-04	2.23E-05
W-187	9.26E-09	6.44E-09	2.23E-09	0.00E+00	0.00E+00	2.83E-05	2.54E-05
Np-239	2.65E-07	2.37E-08	1.34E-08	0.00E+00	4.73E-08	4.25E-05	1.78E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	4.65E-07	4.58E-07	0.00E+00	0.00E+00	2.71E-04	3.47E-06
Sr-85	2.70E-05	0.00E+00	5.40E-06	0.00E+00	0.00E+00	3.00E-04	4.80E-06
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.44E-10	5.21E-11	1.88E-11	0.00E+00	4.07E-11	2.37E-06	1.92E-05
Cd-109	0.00E+00	2.60E-04	1.00E-05	0.00E+00	2.00E-04	6.20E-04	8.00E-06
Sn-113	6.00E-05	1.60E-06	3.60E-06	1.30E-06	0.00E+00	7.80E-04	1.20E-06
Ba-133	1.90E-04	1.70E-06	1.30E-05	0.00E+00	8.90E-09	9.10E-04	7.70E-06
Te-134	3.18E-11	2.04E-11	1.68E-11	2.91E-11	9.59E-11	2.93E-06	2.53E-06
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-2

Total Body & Skin Ground Plane Dose Factors (mrem/hr per pCi/m^2)
with Isotope half-life and Stable Element Tranfer Data (Fm, cow)

Isotope	Halflife	unit	Fm	Ground Plane Dose Factors TotBody(DFg)	Skin(DFs)
H-3	12.350	Y	1.00E-02	0.00E+00	0.00E+00
Be-7	53.300	D	1.00E-04	0.00E+00	0.00E+00
Na-24	15.000	H	4.00E-02	2.50E-08	2.90E-08
P-32	14.290	D	2.50E-02	0.00E+00	0.00E+00
Cr-51	27.704	D	2.20E-03	2.20E-10	2.60E-10
Mn-54	312.500	D	2.50E-04	5.80E-09	6.80E-09
Mn-56	2.578	H	2.50E-04	1.10E-08	1.30E-08
Fe-55	2.700	Y	1.20E-03	0.00E+00	0.00E+00
Fe-59	44.529	D	1.20E-03	8.00E-09	9.40E-09
Co-58	70.800	D	1.00E-03	7.00E-09	8.20E-09
Co-60	5.271	Y	1.00E-03	1.70E-08	2.00E-08
Ni-63	96.000	Y	6.70E-03	0.00E+00	0.00E+00
Ni-65	2.520	H	6.70E-03	3.70E-09	4.30E-09
Cu-64	12.701	H	1.40E-02	1.50E-09	1.70E-09
Zn-65	243.900	D	3.90E-02	4.00E-09	4.60E-09
Zn-69	0.950	H	3.90E-02	0.00E+00	0.00E+00
Br-83	2.390	H	5.00E-02	6.40E-11	9.30E-11
Br-84	0.530	H	5.00E-02	1.20E-08	1.40E-08
Br-85	0.050	H	5.00E-02	0.00E+00	0.00E+00
Rb-86	18.660	D	3.00E-02	6.30E-10	7.20E-10
Rb-88	0.297	H	3.00E-02	3.50E-09	4.00E-09
Rb-89	0.253	H	3.00E-02	1.50E-08	1.80E-08
Sr-89	50.500	D	8.00E-04	5.60E-13	6.50E-13
Sr-90	29.120	Y	8.00E-04	0.00E+00	0.00E+00
Sr-91	9.500	H	8.00E-04	7.10E-09	8.30E-09
Sr-92	2.710	H	8.00E-04	9.00E-09	1.00E-08
Y-90	2.667	D	1.00E-05	2.20E-12	2.60E-12
Y-91m	0.829	H	1.00E-05	3.80E-09	4.40E-09
Y-91	58.510	D	1.00E-05	2.40E-11	2.70E-11
Y-92	3.540	H	1.00E-05	1.60E-09	1.90E-09
Y-93	10.100	H	1.00E-05	5.70E-10	7.80E-10
Zr-95	63.980	D	5.00E-06	5.00E-09	5.80E-09
Zr-97	16.900	H	5.00E-06	5.50E-09	6.40E-09
Nb-95	35.150	D	2.50E-03	5.10E-09	6.00E-09
Mo-99	2.750	D	7.50E-03	1.90E-09	2.20E-09
Tc-99m	6.020	H	2.50E-02	9.60E-10	1.10E-09
Tc-101	0.237	H	2.50E-02	2.70E-09	3.00E-09
Ru-103	39.280	D	1.00E-06	3.60E-09	4.20E-09
Ru-105	4.440	H	1.00E-06	4.50E-09	5.10E-09
Ru-106	368.200	D	1.00E-06	1.50E-09	1.80E-09
Ag-110m	249.900	D	5.00E-02	1.80E-08	2.10E-08
Sb-122	2.700	D	1.50E-03	0.00E+00	0.00E+00
Sb-124	60.200	D	1.50E-03	1.30E-08	1.50E-08
Sb-125	2.770	Y	1.50E-03	3.10E-09	3.50E-09

Table 3-2

Total Body & Skin Ground Plane Dose Factors (mrem/hr per pCi/m^2)
with Isotope half-life and Stable Element Tranfer Data (Fm, cow)

Isotope	Halflife	unit	Fm	Ground Plane Dose Factors TotBody(DFg)	Skin(DFs)
Te-125m	58.000	D	1.00E-03	3.50E-11	4.80E-11
Te-127m	109.000	D	1.00E-03	1.10E-12	1.30E-12
Te-127	9.350	H	1.00E-03	1.00E-11	1.10E-11
Te-129m	33.600	D	1.00E-03	7.70E-10	9.00E-10
Te-129	1.160	H	1.00E-03	7.10E-10	8.40E-10
Te-131m	30.000	H	1.00E-03	8.40E-09	9.90E-09
Te-131	0.417	H	1.00E-03	2.20E-09	2.60E-06
Te-132	3.258	D	1.00E-03	1.70E-09	2.00E-09
I-130	12.360	H	6.00E-03	1.40E-08	1.70E-08
I-131	8.040	D	6.00E-03	2.80E-09	3.40E-09
I-132	2.300	H	6.00E-03	1.70E-08	2.00E-08
I-133	20.800	H	6.00E-03	3.70E-09	4.50E-09
I-134	0.877	H	6.00E-03	1.60E-08	1.90E-08
I-135	6.610	H	6.00E-03	1.20E-08	1.40E-08
Cs-134	2.062	Y	1.20E-02	1.20E-08	1.40E-08
Cs-136	13.100	D	1.20E-02	1.50E-08	1.70E-08
Cs-137	30.000	Y	1.20E-02	4.20E-09	4.90E-09
Cs-138	0.537	H	1.20E-02	2.10E-08	2.40E-08
Ba-139	1.378	H	4.00E-04	2.40E-09	2.70E-09
Ba-140	12.740	D	4.00E-04	2.10E-09	2.40E-09
Ba-141	0.304	H	4.00E-04	4.30E-09	4.90E-09
Ba-142	0.177	H	4.00E-04	7.90E-09	9.00E-09
La-140	1.678	D	5.00E-06	1.50E-08	1.70E-08
La-142	1.542	H	5.00E-06	1.50E-08	1.80E-08
Ce-141	32.501	D	1.00E-04	5.50E-10	6.20E-10
Ce-143	33.000	H	1.00E-04	2.20E-09	2.50E-09
Ce-144	284.300	D	1.00E-04	3.20E-10	3.70E-10
Pr-143	13.560	D	5.00E-06	0.00E+00	0.00E+00
Pr-144	0.288	H	5.00E-06	2.00E-10	2.30E-10
Nd-147	10.980	D	5.00E-06	1.00E-09	1.20E-09
W-187	23.900	H	5.00E-04	3.10E-09	3.60E-09
Np-239	2.360	D	5.00E-06	9.50E-10	1.10E-09
K-40	1.28E+09	Y	1.00E-02	0.00E+00	0.00E+00
Co-57	270.900	D	1.00E-03	9.10E-10	1.00E-09
Sr-85	64.840	D	8.00E-04	0.00E+00	0.00E+00
Y-88	106.640	D	1.00E-05	0.00E+00	0.00E+00
Nb-94	2.03E+04	Y	2.50E-03	0.00E+00	0.00E+00
Nb-97	1.202	H	2.50E-03	4.60E-09	5.40E-09
Cd-109	1.271	Y	1.20E-04	0.00E+00	0.00E+00
Sn-113	115.100	D	2.50E-03	0.00E+00	0.00E+00
Ba-133	10.740	Y	4.00E-04	0.00E+00	0.00E+00
Te-134	0.697	H	1.00E-03	1.00E-09	1.20E-09
Ce-139	137.660	D	1.00E-04	0.00E+00	0.00E+00
Hg-203	46.600	D	3.80E-02	0.00E+00	0.00E+00

Table 3-3a

ADULT INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07
Be-7	2.77E-09	6.26E-09	3.10E-09	0.00E+00	6.58E-09	0.00E+00	1.08E-06
Na-24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P-32	1.93E-04	1.20E-05	7.46E-06	0.00E+00	0.00E+00	0.00E+00	2.17E-05
Cr-51	0.00E+00	0.00E+00	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
Mn-54	0.00E+00	4.57E-06	8.72E-07	0.00E+00	1.36E-06	0.00E+00	1.40E-05
Mn-56	0.00E+00	1.15E-07	2.04E-08	0.00E+00	1.46E-07	0.00E+00	3.67E-06
Fe-55	2.75E-06	1.90E-06	4.43E-07	0.00E+00	0.00E+00	1.06E-06	1.09E-06
Fe-59	4.34E-06	1.02E-05	3.91E-06	0.00E+00	0.00E+00	2.85E-06	3.40E-05
Co-58	0.00E+00	7.45E-07	1.67E-06	0.00E+00	0.00E+00	0.00E+00	1.51E-05
Co-60	0.00E+00	2.14E-06	4.72E-06	0.00E+00	0.00E+00	0.00E+00	4.02E-05
Ni-63	1.30E-04	9.01E-06	4.36E-06	0.00E+00	0.00E+00	0.00E+00	1.88E-06
Ni-65	5.28E-07	6.86E-08	3.13E-08	0.00E+00	0.00E+00	0.00E+00	1.74E-06
Cu-64	0.00E+00	8.33E-08	3.91E-08	0.00E+00	2.10E-07	0.00E+00	7.10E-06
Zn-65	4.84E-06	1.54E-05	6.96E-06	0.00E+00	1.03E-05	0.00E+00	9.70E-06
Zn-69	1.03E-08	1.97E-08	1.37E-09	0.00E+00	1.28E-08	0.00E+00	2.96E-09
Br-83	0.00E+00	0.00E+00	4.02E-08	0.00E+00	0.00E+00	0.00E+00	5.79E-08
Br-84	0.00E+00	0.00E+00	5.21E-08	0.00E+00	0.00E+00	0.00E+00	4.09E-13
Br-85	0.00E+00	0.00E+00	2.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.11E-05	9.83E-06	0.00E+00	0.00E+00	0.00E+00	4.16E-06
Rb-88	0.00E+00	6.05E-08	3.21E-08	0.00E+00	0.00E+00	0.00E+00	8.36E-19
Rb-89	0.00E+00	4.01E-08	2.82E-08	0.00E+00	0.00E+00	0.00E+00	2.33E-21
Sr-89	3.08E-04	0.00E+00	8.84E-06	0.00E+00	0.00E+00	0.00E+00	4.94E-05
Sr-90	7.58E-03	0.00E+00	1.86E-03	0.00E+00	0.00E+00	0.00E+00	2.19E-04
Sr-91	5.67E-06	0.00E+00	2.29E-07	0.00E+00	0.00E+00	0.00E+00	2.70E-05
Sr-92	2.15E-06	0.00E+00	9.30E-08	0.00E+00	0.00E+00	0.00E+00	4.26E-05
Y-90	9.62E-09	0.00E+00	2.58E-10	0.00E+00	0.00E+00	0.00E+00	1.02E-04
Y-91m	9.09E-11	0.00E+00	3.52E-12	0.00E+00	0.00E+00	0.00E+00	2.67E-10
Y-91	1.41E-07	0.00E+00	3.77E-09	0.00E+00	0.00E+00	0.00E+00	7.76E-05
Y-92	8.45E-10	0.00E+00	2.47E-11	0.00E+00	0.00E+00	0.00E+00	1.48E-05
Y-93	2.68E-09	0.00E+00	7.40E-11	0.00E+00	0.00E+00	0.00E+00	8.50E-05
Zr-95	3.04E-08	9.75E-09	6.60E-09	0.00E+00	1.53E-08	0.00E+00	3.09E-05
Zr-97	1.68E-09	3.39E-10	1.55E-10	0.00E+00	5.12E-10	0.00E+00	1.05E-04
Nb-95	6.22E-09	3.46E-09	1.86E-09	0.00E+00	3.42E-09	0.00E+00	2.10E-05
Mo-99	0.00E+00	4.31E-06	8.20E-07	0.00E+00	9.76E-06	0.00E+00	9.99E-06
Tc-99m	2.47E-10	6.98E-10	8.89E-09	0.00E+00	1.06E-08	3.42E-10	4.13E-07
Tc-101	2.54E-10	3.66E-10	3.59E-09	0.00E+00	6.59E-09	1.87E-10	1.10E-21
Ru-103	1.85E-07	0.00E+00	7.97E-08	0.00E+00	7.06E-07	0.00E+00	2.16E-05
Ru-105	1.54E-08	0.00E+00	6.08E-09	0.00E+00	1.99E-07	0.00E+00	9.42E-06
Ru-106	2.75E-06	0.00E+00	3.48E-07	0.00E+00	5.31E-06	0.00E+00	1.78E-04
Ag-110m	1.60E-07	1.48E-07	8.79E-08	0.00E+00	2.91E-07	0.00E+00	6.04E-05
Sb-122	2.00E-07	4.60E-09	6.90E-08	3.10E-09	0.00E+00	1.20E-07	7.60E-05
Sb-124	2.80E-06	5.30E-08	1.10E-06	6.80E-09	0.00E+00	2.18E-06	7.95E-05
Sb-125	1.79E-06	2.00E-08	4.26E-07	1.82E-09	0.00E+00	1.38E-06	1.97E-05

Table 3-3a

ADULT INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	0.00E+00	1.07E-05
Te-127m	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	0.00E+00	2.27E-05
Te-127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	0.00E+00	8.68E-06
Te-129m	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	0.00E+00	5.79E-05
Te-129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	0.00E+00	2.37E-08
Te-131m	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	0.00E+00	8.40E-05
Te-131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	0.00E+00	2.79E-09
Te-132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	0.00E+00	7.71E-05
I-130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	0.00E+00	1.92E-06
I-131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	0.00E+00	1.57E-06
I-132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	0.00E+00	1.02E-07
I-133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	0.00E+00	2.22E-06
I-134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	0.00E+00	2.51E-10
I-135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	0.00E+00	1.31E-06
Cs-134	6.22E-05	1.48E-04	1.21E-04	0.00E+00	4.79E-05	1.59E-05	2.59E-06
Cs-136	6.51E-06	2.57E-05	1.85E-05	0.00E+00	1.43E-05	1.96E-06	2.92E-06
Cs-137	7.97E-05	1.09E-04	7.14E-05	0.00E+00	3.70E-05	1.23E-05	2.11E-06
Cs-138	5.52E-08	1.09E-07	5.40E-08	0.00E+00	8.01E-08	7.91E-09	4.65E-13
Ba-139	9.70E-08	6.91E-11	2.84E-09	0.00E+00	6.46E-11	3.92E-11	1.72E-07
Ba-140	2.03E-05	2.55E-08	1.33E-06	0.00E+00	8.67E-09	1.46E-08	4.18E-05
Ba-141	4.71E-08	3.56E-11	1.59E-09	0.00E+00	3.31E-11	2.02E-11	2.22E-17
Ba-142	2.13E-08	2.19E-11	1.34E-09	0.00E+00	1.85E-11	1.24E-11	3.00E-26
La-140	2.50E-09	1.26E-09	3.33E-10	0.00E+00	0.00E+00	0.00E+00	9.25E-05
La-142	1.28E-10	5.82E-11	1.45E-11	0.00E+00	0.00E+00	0.00E+00	4.25E-07
Ce-141	9.36E-09	6.33E-09	7.18E-10	0.00E+00	2.94E-09	0.00E+00	2.42E-05
Ce-143	1.65E-09	1.22E-06	1.35E-10	0.00E+00	5.37E-10	0.00E+00	4.56E-05
Ce-144	4.88E-07	2.04E-07	2.62E-08	0.00E+00	1.21E-07	0.00E+00	1.65E-04
Pr-143	9.20E-09	3.69E-09	4.56E-10	0.00E+00	2.13E-09	0.00E+00	4.03E-05
Pr-144	3.01E-11	1.25E-11	1.53E-12	0.00E+00	7.05E-12	0.00E+00	4.33E-18
Nd-147	6.29E-09	7.27E-09	4.35E-10	0.00E+00	4.25E-09	0.00E+00	3.49E-05
W-187	1.03E-07	8.61E-08	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.82E-05
Np-239	1.19E-09	1.17E-10	6.45E-11	0.00E+00	3.65E-10	0.00E+00	2.40E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.75E-07	2.91E-07	0.00E+00	0.00E+00	0.00E+00	4.44E-06
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	5.22E-11	1.32E-11	4.82E-12	0.00E+00	1.54E-11	0.00E+00	4.87E-08
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	3.24E-08	2.12E-08	1.30E-08	2.83E-08	2.05E-07	0.00E+00	3.59E-11
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-3b

TEEN INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07
Be-7	3.96E-09	8.87E-09	4.43E-09	0.00E+00	9.40E-09	0.00E+00	1.08E-06
Na-24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P-32	2.76E-04	1.71E-05	1.07E-05	0.00E+00	0.00E+00	0.00E+00	2.32E-05
Cr-51	0.00E+00	0.00E+00	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
Mn-54	0.00E+00	5.90E-06	1.17E-06	0.00E+00	1.76E-06	0.00E+00	1.21E-05
Mn-56	0.00E+00	1.58E-07	2.81E-08	0.00E+00	2.00E-07	0.00E+00	1.04E-05
Fe-55	3.78E-06	2.68E-06	6.25E-07	0.00E+00	0.00E+00	1.70E-06	1.16E-06
Fe-59	5.87E-06	1.37E-05	5.29E-06	0.00E+00	0.00E+00	4.32E-06	3.24E-05
Co-58	0.00E+00	9.72E-07	2.24E-06	0.00E+00	0.00E+00	0.00E+00	1.34E-05
Co-60	0.00E+00	2.81E-06	6.33E-06	0.00E+00	0.00E+00	0.00E+00	3.66E-05
Ni-63	1.77E-04	1.25E-05	6.00E-06	0.00E+00	0.00E+00	0.00E+00	1.99E-06
Ni-65	7.49E-07	9.57E-08	4.36E-08	0.00E+00	0.00E+00	0.00E+00	5.19E-06
Cu-64	0.00E+00	1.15E-07	5.41E-08	0.00E+00	2.91E-07	0.00E+00	8.92E-06
Zn-65	5.76E-06	2.00E-05	9.33E-06	0.00E+00	1.28E-05	0.00E+00	8.47E-06
Zn-69	1.47E-08	2.80E-08	1.96E-09	0.00E+00	1.83E-08	0.00E+00	5.16E-08
Br-83	0.00E+00	0.00E+00	5.74E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	7.22E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	3.05E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.98E-05	1.40E-05	0.00E+00	0.00E+00	0.00E+00	4.41E-06
Rb-88	0.00E+00	8.52E-08	4.54E-08	0.00E+00	0.00E+00	0.00E+00	7.30E-15
Rb-89	0.00E+00	5.50E-08	3.89E-08	0.00E+00	0.00E+00	0.00E+00	8.43E-17
Sr-89	4.40E-04	0.00E+00	1.26E-05	0.00E+00	0.00E+00	0.00E+00	5.24E-05
Sr-90	8.30E-03	0.00E+00	2.05E-03	0.00E+00	0.00E+00	0.00E+00	2.33E-04
Sr-91	8.07E-06	0.00E+00	3.21E-07	0.00E+00	0.00E+00	0.00E+00	3.66E-05
Sr-92	3.05E-06	0.00E+00	1.30E-07	0.00E+00	0.00E+00	0.00E+00	7.77E-05
Y-90	1.37E-08	0.00E+00	3.69E-10	0.00E+00	0.00E+00	0.00E+00	1.13E-04
Y-91m	1.29E-10	0.00E+00	4.93E-12	0.00E+00	0.00E+00	0.00E+00	6.09E-09
Y-91	2.01E-07	0.00E+00	5.39E-09	0.00E+00	0.00E+00	0.00E+00	8.24E-05
Y-92	1.21E-09	0.00E+00	3.50E-11	0.00E+00	0.00E+00	0.00E+00	3.32E-05
Y-93	3.83E-09	0.00E+00	1.05E-10	0.00E+00	0.00E+00	0.00E+00	1.17E-04
Zr-95	4.12E-08	1.30E-08	8.94E-09	0.00E+00	1.91E-08	0.00E+00	3.00E-05
Zr-97	2.37E-09	4.69E-10	2.16E-10	0.00E+00	7.11E-10	0.00E+00	1.27E-04
Nb-95	8.22E-09	4.56E-09	2.51E-09	0.00E+00	4.42E-09	0.00E+00	1.95E-05
Mo-99	0.00E+00	6.03E-06	1.15E-06	0.00E+00	1.38E-05	0.00E+00	1.08E-05
Tc-99m	3.32E-10	9.26E-10	1.20E-08	0.00E+00	1.38E-08	5.14E-10	6.08E-07
Tc-101	3.60E-10	5.12E-10	5.03E-09	0.00E+00	9.26E-09	3.12E-10	8.75E-17
Ru-103	2.55E-07	0.00E+00	1.09E-07	0.00E+00	8.99E-07	0.00E+00	2.13E-05
Ru-105	2.18E-08	0.00E+00	8.46E-09	0.00E+00	2.75E-07	0.00E+00	1.76E-05
Ru-106	3.92E-06	0.00E+00	4.94E-07	0.00E+00	7.56E-06	0.00E+00	1.88E-04
Ag-110m	2.05E-07	1.94E-07	1.18E-07	0.00E+00	3.70E-07	0.00E+00	5.45E-05
Sb-122	3.30E-07	6.42E-09	9.64E-08	4.19E-09	0.00E+00	2.06E-07	6.92E-05
Sb-124	3.86E-06	7.12E-08	1.51E-06	8.79E-09	0.00E+00	3.37E-06	7.81E-05
Sb-125	2.48E-06	2.71E-08	5.79E-07	2.36E-09	0.00E+00	2.16E-06	1.92E-05

Table 3-3b

TEEN INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	3.83E-06	1.38E-06	5.12E-07	1.07E-06	0.00E+00	0.00E+00	1.13E-05
Te-127m	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	0.00E+00	2.41E-05
Te-127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	0.00E+00	1.22E-05
Te-129m	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	0.00E+00	6.12E-05
Te-129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	0.00E+00	2.45E-07
Te-131m	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	0.00E+00	9.39E-05
Te-131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	0.00E+00	2.29E-09
Te-132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	0.00E+00	7.00E-05
I-130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	0.00E+00	2.29E-06
I-131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	0.00E+00	1.62E-06
I-132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	0.00E+00	3.18E-07
I-133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	0.00E+00	2.58E-06
I-134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	0.00E+00	5.10E-09
I-135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	0.00E+00	1.74E-06
Cs-134	8.37E-05	1.97E-04	9.14E-05	0.00E+00	6.26E-05	2.39E-05	2.45E-06
Cs-136	8.59E-06	3.38E-05	2.27E-05	0.00E+00	1.84E-05	2.90E-06	2.72E-06
Cs-137	1.12E-04	1.49E-04	5.19E-05	0.00E+00	5.07E-05	1.97E-05	2.12E-06
Cs-138	7.76E-08	1.49E-07	7.45E-08	0.00E+00	1.10E-07	1.28E-08	6.76E-11
Ba-139	1.39E-07	9.78E-11	4.05E-09	0.00E+00	9.22E-11	6.74E-11	1.24E-06
Ba-140	2.84E-05	3.48E-08	1.83E-06	0.00E+00	1.18E-08	2.34E-08	4.38E-05
Ba-141	6.71E-08	5.01E-11	2.24E-09	0.00E+00	4.65E-11	3.43E-11	1.43E-13
Ba-142	2.99E-08	2.99E-11	1.84E-09	0.00E+00	2.53E-11	1.99E-11	9.18E-20
La-140	3.48E-09	1.71E-09	4.55E-10	0.00E+00	0.00E+00	0.00E+00	9.82E-05
La-142	1.79E-10	7.95E-11	1.98E-11	0.00E+00	0.00E+00	0.00E+00	2.42E-06
Ce-141	1.33E-08	8.88E-09	1.02E-09	0.00E+00	4.18E-09	0.00E+00	2.54E-05
Ce-143	2.35E-09	1.71E-06	1.91E-10	0.00E+00	7.67E-10	0.00E+00	5.14E-05
Ce-144	6.96E-07	2.88E-07	3.74E-08	0.00E+00	1.72E-07	0.00E+00	1.75E-04
Pr-143	1.31E-08	5.23E-09	6.52E-10	0.00E+00	3.04E-09	0.00E+00	4.31E-05
Pr-144	4.30E-11	1.76E-11	2.18E-12	0.00E+00	1.01E-11	0.00E+00	4.74E-14
Nd-147	9.38E-09	1.02E-08	6.11E-10	0.00E+00	5.99E-09	0.00E+00	3.68E-05
W-187	1.46E-07	1.19E-07	4.17E-08	0.00E+00	0.00E+00	0.00E+00	3.22E-05
Np-239	1.76E-09	1.66E-10	9.22E-11	0.00E+00	5.21E-10	0.00E+00	2.67E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	2.38E-07	3.99E-07	0.00E+00	0.00E+00	0.00E+00	4.44E-06
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	7.37E-11	1.83E-11	6.68E-12	0.00E+00	2.14E-11	0.00E+00	4.37E-07
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	4.47E-08	2.87E-08	3.00E-08	3.67E-08	2.74E-07	0.00E+00	1.66E-09
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-3c

CHILD INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
Be-7	1.18E-08	2.00E-08	1.32E-08	0.00E+00	1.97E-08	0.00E+00	1.12E-06
Na-24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P-32	8.25E-04	3.86E-05	3.18E-05	0.00E+00	0.00E+00	0.00E+00	2.28E-05
Cr-51	0.00E+00	0.00E+00	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
Mn-54	0.00E+00	1.07E-05	2.85E-06	0.00E+00	3.00E-06	0.00E+00	8.98E-06
Mn-56	0.00E+00	3.34E-07	7.54E-08	0.00E+00	4.04E-07	0.00E+00	4.84E-05
Fe-55	1.15E-05	6.10E-06	1.89E-06	0.00E+00	0.00E+00	3.45E-06	1.13E-06
Fe-59	1.65E-05	2.67E-05	1.33E-05	0.00E+00	0.00E+00	7.74E-06	2.78E-05
Co-58	0.00E+00	1.80E-06	5.51E-06	0.00E+00	0.00E+00	0.00E+00	1.05E-05
Co-60	0.00E+00	5.29E-06	1.56E-05	0.00E+00	0.00E+00	0.00E+00	2.93E-05
Ni-63	5.38E-04	2.88E-05	1.83E-05	0.00E+00	0.00E+00	0.00E+00	1.94E-06
Ni-65	2.22E-06	2.09E-07	1.22E-07	0.00E+00	0.00E+00	0.00E+00	2.56E-05
Cu-64	0.00E+00	2.45E-07	1.48E-07	0.00E+00	5.92E-07	0.00E+00	1.15E-05
Zn-65	1.37E-05	3.65E-05	2.27E-05	0.00E+00	2.30E-05	0.00E+00	6.41E-06
Zn-69	4.38E-08	6.33E-08	5.85E-09	0.00E+00	3.84E-08	0.00E+00	3.99E-06
Br-83	0.00E+00	0.00E+00	1.71E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.98E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	9.12E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	6.70E-05	4.12E-05	0.00E+00	0.00E+00	0.00E+00	4.31E-06
Rb-88	0.00E+00	1.90E-07	1.32E-07	0.00E+00	0.00E+00	0.00E+00	9.32E-09
Rb-89	0.00E+00	1.17E-07	1.04E-07	0.00E+00	0.00E+00	0.00E+00	1.02E-09
Sr-89	1.32E-03	0.00E+00	3.77E-05	0.00E+00	0.00E+00	0.00E+00	5.11E-05
Sr-90	1.70E-02	0.00E+00	4.31E-03	0.00E+00	0.00E+00	0.00E+00	2.29E-04
Sr-91	2.40E-05	0.00E+00	9.06E-07	0.00E+00	0.00E+00	0.00E+00	5.30E-05
Sr-92	9.03E-06	0.00E+00	3.62E-07	0.00E+00	0.00E+00	0.00E+00	1.71E-04
Y-90	4.11E-08	0.00E+00	1.10E-09	0.00E+00	0.00E+00	0.00E+00	1.17E-04
Y-91m	3.82E-10	0.00E+00	1.39E-11	0.00E+00	0.00E+00	0.00E+00	7.48E-07
Y-91	6.02E-07	0.00E+00	1.61E-08	0.00E+00	0.00E+00	0.00E+00	8.02E-05
Y-92	3.60E-09	0.00E+00	1.03E-10	0.00E+00	0.00E+00	0.00E+00	1.04E-04
Y-93	1.14E-08	0.00E+00	3.13E-10	0.00E+00	0.00E+00	0.00E+00	1.70E-04
Zr-95	1.16E-07	2.55E-08	2.27E-08	0.00E+00	3.65E-08	0.00E+00	2.66E-05
Zr-97	6.99E-09	1.01E-09	5.96E-10	0.00E+00	1.45E-09	0.00E+00	1.53E-04
Nb-95	2.25E-08	8.76E-09	6.26E-09	0.00E+00	8.23E-09	0.00E+00	1.62E-05
Mo-99	0.00E+00	1.33E-05	3.29E-06	0.00E+00	2.84E-05	0.00E+00	1.10E-05
Tc-99m	9.23E-10	1.81E-09	3.00E-08	0.00E+00	2.63E-08	9.19E-10	1.03E-06
Tc-101	1.07E-09	1.12E-09	1.42E-08	0.00E+00	1.91E-08	5.92E-10	3.56E-09
Ru-103	7.31E-07	0.00E+00	2.81E-07	0.00E+00	1.84E-06	0.00E+00	1.89E-05
Ru-105	6.45E-08	0.00E+00	2.34E-08	0.00E+00	5.67E-07	0.00E+00	4.21E-05
Ru-106	1.17E-05	0.00E+00	1.46E-06	0.00E+00	1.58E-05	0.00E+00	1.82E-04
Ag-110m	5.39E-07	3.64E-07	2.91E-07	0.00E+00	6.78E-07	0.00E+00	4.33E-05
Sb-122	9.83E-07	1.45E-08	2.88E-07	1.26E-08	0.00E+00	4.00E-07	7.56E-05
Sb-124	1.11E-05	1.44E-07	3.88E-06	2.44E-08	0.00E+00	6.15E-06	6.93E-05
Sb-125	7.15E-06	5.51E-08	1.50E-06	6.63E-09	0.00E+00	3.98E-06	1.71E-05

Table 3-3c

CHILD INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	1.14E-05	3.09E-06	1.52E-06	3.20E-06	0.00E+00	0.00E+00	1.10E-05
Te-127m	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	0.00E+00	2.34E-05
Te-127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	0.00E+00	1.84E-05
Te-129m	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	0.00E+00	5.94E-05
Te-129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	0.00E+00	8.34E-06
Te-131m	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	0.00E+00	1.01E-04
Te-131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	0.00E+00	4.36E-07
Te-132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	0.00E+00	4.50E-05
I-130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	0.00E+00	2.76E-06
I-131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	0.00E+00	1.54E-06
I-132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	0.00E+00	1.73E-06
I-133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	0.00E+00	2.95E-06
I-134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	0.00E+00	5.16E-07
I-135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	0.00E+00	2.40E-06
Cs-134	2.34E-04	3.84E-04	8.10E-05	0.00E+00	1.19E-04	4.27E-05	2.07E-06
Cs-136	2.35E-05	6.46E-05	4.18E-05	0.00E+00	3.44E-05	5.13E-06	2.27E-06
Cs-137	3.27E-04	3.13E-04	4.62E-05	0.00E+00	1.02E-04	3.67E-05	1.96E-06
Cs-138	2.28E-07	3.17E-07	2.01E-07	0.00E+00	2.23E-07	2.40E-08	1.46E-07
Ba-139	4.14E-07	2.21E-10	1.20E-08	0.00E+00	1.93E-10	1.30E-10	2.39E-05
Ba-140	8.31E-05	7.28E-08	4.85E-06	0.00E+00	2.37E-08	4.34E-08	4.21E-05
Ba-141	2.00E-07	1.12E-10	6.51E-09	0.00E+00	9.69E-11	6.58E-10	1.14E-07
Ba-142	8.74E-08	6.29E-11	4.88E-09	0.00E+00	5.09E-11	3.70E-11	1.14E-09
La-140	1.01E-08	3.53E-09	1.19E-09	0.00E+00	0.00E+00	0.00E+00	9.84E-05
La-142	5.24E-10	1.67E-10	5.23E-11	0.00E+00	0.00E+00	0.00E+00	3.31E-05
Ce-141	3.97E-08	1.98E-08	2.94E-09	0.00E+00	8.68E-09	0.00E+00	2.47E-05
Ce-143	6.99E-09	3.79E-06	5.49E-10	0.00E+00	1.59E-09	0.00E+00	5.55E-05
Ce-144	2.08E-06	6.52E-07	1.11E-07	0.00E+00	3.61E-07	0.00E+00	1.70E-04
Pr-143	3.93E-08	1.18E-08	1.95E-09	0.00E+00	6.39E-09	0.00E+00	4.24E-05
Pr-144	1.29E-10	3.99E-11	6.49E-12	0.00E+00	2.11E-11	0.00E+00	8.59E-08
Nd-147	2.79E-08	2.26E-08	1.75E-09	0.00E+00	1.24E-08	0.00E+00	3.58E-05
W-187	4.29E-07	2.54E-07	1.14E-07	0.00E+00	0.00E+00	0.00E+00	3.57E-05
Np-239	5.25E-09	3.77E-10	2.65E-10	0.00E+00	1.09E-09	0.00E+00	2.79E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	4.93E-07	9.98E-07	0.00E+00	0.00E+00	0.00E+00	4.04E-06
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.17E-10	3.92E-11	1.83E-11	0.00E+00	4.35E-11	0.00E+00	1.21E-05
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	1.29E-07	5.80E-08	7.74E-08	1.02E-07	5.37E-07	0.00E+00	5.89E-07
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-3d

INFANT INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
Be-7	2.26E-08	4.72E-08	2.51E-08	0.00E+00	3.34E-08	0.00E+00	1.11E-06
Na-24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P-32	1.70E-03	1.00E-04	6.59E-05	0.00E+00	0.00E+00	0.00E+00	2.30E-05
Cr-51	0.00E+00	0.00E+00	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
Mn-54	0.00E+00	1.99E-05	4.51E-06	0.00E+00	4.41E-06	0.00E+00	7.31E-06
Mn-56	0.00E+00	8.18E-07	1.41E-07	0.00E+00	7.03E-07	0.00E+00	7.43E-05
Fe-55	1.39E-05	8.98E-06	2.40E-06	0.00E+00	0.00E+00	4.39E-06	1.14E-06
Fe-59	3.08E-05	5.38E-05	2.12E-05	0.00E+00	0.00E+00	1.59E-05	2.57E-05
Co-58	0.00E+00	3.60E-06	8.98E-06	0.00E+00	0.00E+00	0.00E+00	8.97E-06
Co-60	0.00E+00	1.08E-05	2.55E-05	0.00E+00	0.00E+00	0.00E+00	2.57E-05
Ni-63	6.34E-04	3.92E-05	2.20E-05	0.00E+00	0.00E+00	0.00E+00	1.95E-06
Ni-65	4.70E-06	5.32E-07	2.42E-07	0.00E+00	0.00E+00	0.00E+00	4.05E-05
Cu-64	0.00E+00	6.09E-07	2.82E-07	0.00E+00	1.03E-06	0.00E+00	1.25E-05
Zn-65	1.84E-05	6.31E-05	2.91E-05	0.00E+00	3.06E-05	0.00E+00	5.33E-05
Zn-69	9.33E-08	1.68E-07	1.25E-08	0.00E+00	6.98E-08	0.00E+00	1.37E-05
Br-83	0.00E+00	0.00E+00	3.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	3.82E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.94E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.70E-04	8.40E-05	0.00E+00	0.00E+00	0.00E+00	4.35E-06
Rb-88	0.00E+00	4.98E-07	2.73E-07	0.00E+00	0.00E+00	0.00E+00	4.85E-07
Rb-89	0.00E+00	2.86E-07	1.97E-07	0.00E+00	0.00E+00	0.00E+00	9.74E-08
Sr-89	2.51E-03	0.00E+00	7.20E-05	0.00E+00	0.00E+00	0.00E+00	5.16E-05
Sr-90	1.85E-02	0.00E+00	4.71E-03	0.00E+00	0.00E+00	0.00E+00	2.31E-04
Sr-91	5.00E-05	0.00E+00	1.81E-06	0.00E+00	0.00E+00	0.00E+00	5.92E-05
Sr-92	1.92E-05	0.00E+00	7.13E-07	0.00E+00	0.00E+00	0.00E+00	2.07E-04
Y-90	8.69E-08	0.00E+00	2.33E-09	0.00E+00	0.00E+00	0.00E+00	1.20E-04
Y-91m	8.10E-10	0.00E+00	2.76E-11	0.00E+00	0.00E+00	0.00E+00	2.70E-06
Y-91	1.13E-06	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	8.10E-05
Y-92	7.65E-09	0.00E+00	2.15E-10	0.00E+00	0.00E+00	0.00E+00	1.46E-04
Y-93	2.43E-08	0.00E+00	6.62E-10	0.00E+00	0.00E+00	0.00E+00	1.92E-04
Zr-95	2.06E-07	5.02E-08	3.56E-08	0.00E+00	5.41E-08	0.00E+00	2.50E-05
Zr-97	1.48E-08	2.54E-09	1.16E-09	0.00E+00	2.56E-09	0.00E+00	1.62E-04
Nb-95	4.20E-08	1.73E-08	1.00E-08	0.00E+00	1.24E-08	0.00E+00	1.46E-05
Mo-99	0.00E+00	3.40E-05	6.63E-06	0.00E+00	5.08E-05	0.00E+00	1.12E-05
Tc-99m	1.92E-09	3.96E-09	5.10E-08	0.00E+00	4.26E-08	2.07E-09	1.15E-06
Tc-101	2.27E-09	2.86E-09	2.83E-08	0.00E+00	3.40E-08	1.56E-09	4.86E-07
Ru-103	1.48E-06	0.00E+00	4.95E-07	0.00E+00	3.08E-06	0.00E+00	1.80E-05
Ru-105	1.36E-07	0.00E+00	4.58E-08	0.00E+00	1.00E-06	0.00E+00	5.41E-05
Ru-106	2.41E-05	0.00E+00	3.01E-06	0.00E+00	2.85E-05	0.00E+00	1.83E-04
Ag-110m	9.96E-07	7.27E-07	4.81E-07	0.00E+00	1.04E-06	0.00E+00	3.77E-05
Sb-122	2.10E-06	3.85E-08	6.13E-07	3.14E-08	0.00E+00	1.09E-06	7.65E-05
Sb-124	2.14E-05	3.15E-07	6.63E-06	5.68E-08	0.00E+00	1.34E-05	6.60E-05
Sb-125	1.23E-05	1.19E-07	2.53E-06	1.54E-08	0.00E+00	7.72E-06	1.64E-05

Table 3-3d

INFANT INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	2.33E-05	7.79E-06	3.15E-06	7.84E-06	0.00E+00	0.00E+00	1.11E-05
Te-127m	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	0.00E+00	2.36E-05
Te-127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	0.00E+00	2.10E-05
Te-129m	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	0.00E+00	5.97E-05
Te-129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	0.00E+00	2.27E-05
Te-131m	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	0.00E+00	1.03E-04
Te-131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	0.00E+00	7.11E-06
Te-132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	0.00E+00	3.81E-05
I-130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	0.00E+00	2.83E-06
I-131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	0.00E+00	1.51E-06
I-132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	0.00E+00	2.73E-06
I-133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	0.00E+00	3.08E-06
I-134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	0.00E+00	1.84E-06
I-135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	0.00E+00	2.62E-06
Cs-134	3.77E-04	7.03E-04	7.10E-05	0.00E+00	1.81E-04	7.42E-05	1.91E-06
Cs-136	4.59E-05	1.35E-04	5.04E-05	0.00E+00	5.38E-05	1.10E-05	2.05E-06
Cs-137	5.22E-04	6.11E-04	4.33E-05	0.00E+00	1.64E-04	6.64E-05	1.91E-06
Cs-138	4.81E-07	7.82E-07	3.79E-07	0.00E+00	3.90E-07	6.09E-08	1.25E-06
Ba-139	8.81E-07	5.84E-10	2.55E-08	0.00E+00	3.51E-10	3.54E-10	5.58E-05
Ba-140	1.71E-04	1.71E-07	8.81E-06	0.00E+00	4.06E-08	1.05E-07	4.20E-05
Ba-141	4.25E-07	2.91E-10	1.34E-08	0.00E+00	1.75E-10	1.77E-10	5.19E-06
Ba-142	1.84E-07	1.53E-10	9.06E-09	0.00E+00	8.81E-11	9.26E-11	7.59E-07
La-140	2.11E-08	8.32E-09	2.14E-09	0.00E+00	0.00E+00	0.00E+00	9.77E-05
La-142	1.10E-09	4.04E-10	9.67E-11	0.00E+00	0.00E+00	0.00E+00	6.86E-05
Ce-141	7.87E-08	4.80E-08	5.65E-09	0.00E+00	1.48E-08	0.00E+00	2.48E-05
Ce-143	1.48E-08	9.82E-06	1.12E-09	0.00E+00	2.86E-09	0.00E+00	5.73E-05
Ce-144	2.98E-06	1.22E-06	1.67E-07	0.00E+00	4.93E-07	0.00E+00	1.71E-04
Pr-143	8.13E-08	3.04E-08	4.03E-09	0.00E+00	1.13E-08	0.00E+00	4.29E-05
Pr-144	2.74E-10	1.06E-10	1.38E-11	0.00E+00	3.84E-11	0.00E+00	4.93E-06
Nd-147	5.53E-08	5.68E-08	3.48E-09	0.00E+00	2.19E-08	0.00E+00	3.60E-05
W-187	9.03E-07	6.28E-07	2.17E-07	0.00E+00	0.00E+00	0.00E+00	3.69E-05
Np-239	1.11E-08	9.93E-10	5.61E-10	0.00E+00	1.98E-09	0.00E+00	2.87E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.15E-06	1.87E-06	0.00E+00	0.00E+00	0.00E+00	3.92E-06
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3 - 4

TOTAL BODY DOSE FACTORS

Ki

FROM NOBLE GASES (GAMMA)

NUCLIDE	Gamma TB*	X	(pCi/uCi)	X	FINITE CLOUD ** CORRECTION FACTOR	=	Ki***
Kr-83m	7.56E-08		1.00E+6		5.78E-01		4.37E-02
Kr-85m	1.17E-03		1.00E+6		4.46E-01		5.22E+02
Kr-85	1.61E-05		1.00E+6		3.85E-01		6.19E+00
Kr-87	5.92E-03		1.00E+6		3.09E-01		1.83E+03
Kr-88	1.47E-02		1.00E+6		2.88E-01		4.23E+03
Kr-89	1.66E-02		1.00E+6		3.03E-01		5.03E+03
Kr-90	1.56E-02		1.00E+6		3.29E-01		5.13E+03
Xe-131m	9.15E-05		1.00E+6		5.62E-01		5.14E+01
Xe-133m	2.51E-04		1.00E+6		5.12E-01		1.29E+02
Xe-133	2.94E-04		1.00E+6		5.78E-01		1.70E+02
Xe-135m	3.12E-03		1.00E+6		3.87E-01		1.21E+03
Xe-135	1.81E-03		1.00E+6		4.55E-01		8.24E+02
Xe-137	1.42E-03		1.00E+6		3.65E-01		5.18E+02
Xe-138	8.83E-03		1.00E+6		3.14E-01		2.77E+03
Ar-41	8.84E-03		1.00E+6		3.21E-01		2.84E+03

* From Regulatory Guide 1.109, Table B-1 (mrem/yr per pCi/cu mtr)

** The finite cloud correction factor is described in Section 3.6.

*** Ki (mrem/yr per uCi/cu mtr)

Table 3 - 5

SKIN DOSE FACTORS

Li

FROM NOBLE GASES (BETA)

NUCLIDE	Beta Skin*	X (pCi/uCi)	= Li**
Kr-83m	0.00E+00	1.00E+6	0.00E+00
Kr-85m	1.46E-03	1.00E+6	1.46E+03
Kr-85	1.34E-03	1.00E+6	1.34E+03
Kr-87	9.73E-03	1.00E+6	9.73E+03
Kr-88	2.37E-03	1.00E+6	2.37E+03
Kr-89	1.01E-02	1.00E+6	1.01E+04
Kr-90	7.29E-03	1.00E+6	7.29E+03
Xe-131m	4.76E-04	1.00E+6	4.76E+02
Xe-133m	9.94E-04	1.00E+6	9.94E+02
Xe-133	3.06E-04	1.00E+6	3.06E+02
Xe-135m	7.11E-04	1.00E+6	7.11E+02
Xe-135	1.86E-03	1.00E+6	1.86E+03
Xe-137	1.22E-02	1.00E+6	1.22E+04
Xe-138	4.13E-03	1.00E+6	4.13E+03
Ar-41	2.69E-03	1.00E+6	2.69E+03

* From Regulatory Guide 1.109, Table B-1 (mrem/yr per pCi/cu mtr)

** Li (mrem/yr per uCi/cu mtr)

Table 3 - 6

AIR DOSE FACTORS

Mi

FROM NOBLE GASES (GAMMA)

NUCLIDE	Gamma*	X	(pCi/uCi)	X	FINITE CLOUD ** CORRECTION FACTOR	=	Mi***
Kr-83m	1.93E-05		1.00E+6		5.78E-01		1.12E+01
Kr-85m	1.23E-03		1.00E+6		4.46E-01		5.49E+02
Kr-85	1.72E-05		1.00E+6		3.85E-01		6.62E+00
Kr-87	6.17E-03		1.00E+6		3.09E-01		1.91E+03
Kr-88	1.52E-02		1.00E+6		2.88E-01		4.37E+03
Kr-89	1.73E-02		1.00E+6		3.03E-01		5.24E+03
Kr-90	1.63E-02		1.00E+6		3.29E-01		5.36E+03
Xe-131m	1.56E-04		1.00E+6		5.62E-01		8.77E+01
Xe-133m	3.27E-04		1.00E+6		5.12E-01		1.68E+02
Xe-133	3.53E-04		1.00E+6		5.78E-01		2.04E+02
Xe-135m	3.36E-03		1.00E+6		3.87E-01		1.30E+03
Xe-135	1.92E-03		1.00E+6		4.55E-01		8.74E+02
Xe-137	1.51E-03		1.00E+6		3.65E-01		5.51E+02
Xe-138	9.21E-03		1.00E+6		3.14E-01		2.89E+03
Ar-41	9.30E-03		1.00E+6		3.21E-01		2.99E+03

* From Regulatory Guide 1.109, Table B-1 (mrad/yr per pCi/cu mtr)

** The finite cloud correction factor is described in Section 3.6.

*** Mi (mrad/yr per uCi/cu mtr)

Table 3 - 7

AIR DOSE FACTORS

Ni

FROM NOBLE GASES (BETA)

NUCLIDE	Beta*	X (pCi/uCi)	= Ni**
Kr-83m	2.88E-04	1.00E+6	2.88E+02
Kr-85m	1.97E-03	1.00E+6	1.97E+03
Kr-85	1.95E-03	1.00E+6	1.95E+03
Kr-87	1.03E-02	1.00E+6	1.03E+04
Kr-88	2.93E-03	1.00E+6	2.93E+03
Kr-89	1.06E-02	1.00E+6	1.06E+04
Kr-90	7.83E-03	1.00E+6	7.83E+03
Xe-131m	1.11E-03	1.00E+6	1.11E+03
Xe-133m	1.48E-03	1.00E+6	1.48E+03
Xe-133	1.05E-03	1.00E+6	1.05E+03
Xe-135m	7.39E-04	1.00E+6	7.39E+02
Xe-135	2.46E-03	1.00E+6	2.46E+03
Xe-137	1.27E-02	1.00E+6	1.27E+04
Xe-138	4.75E-03	1.00E+6	4.75E+03
Ar-41	3.28E-03	1.00E+6	3.28E+03

* From Regulatory Guide 1.109, Table B-1 (mrad/yr per pCi/cu mtr)

** Ni (mrad/yr per uCi/cu mtr)

TABLE 3 – 8

NOBLE GAS DOSE FACTORS

For Instantaneous and Time Average Mixtures at the Site Boundary

Radionuclide	Instantaneous Mix (%)	Time Average Mix (%)
Kr-85m	3.09	
Kr-85	0	18.98
Kr-87	2.80	
Kr-88	5.22	
Xe-131m	0	0.162
Xe-133m	1.39	0.485
Xe-133	56.8	78.1
Xe-135m	1.34	
Xe-135	19.2	2.21
Xe-138	2.81	
Ar-41	7.43	
Total	100	100

Unit 2 effective instantaneous dose factors	Unit 3 effective instantaneous dose factors	units	Unit 2 effective average dose factors	Unit 3 effective average dose factors
$\overline{K} = 1507$	$\overline{K} = 849$	mrem/yr per uCi/m^3	$\overline{K} = 237$	$\overline{K} = 153$
$\overline{L} = 1310$	$\overline{L} = 1310$	mrem/yr per uCi/m^3	$\overline{L} = 540$	$\overline{L} = 540$
$\overline{M} = 1601$	$\overline{M} = 905$	mrad/yr per uCi/m^3	$\overline{M} = 281$	$\overline{M} = 181$
$\overline{N} = 1977$	$\overline{N} = 1977$	mrad/yr per uCi/m^3	$\overline{N} = 1254$	$\overline{N} = 1254$

Instantaneous Mixture Basis:

This mix defines the shared-site noble gas limits between the two units, and is used for administrative guidelines for instantaneous releases based on an RCS noble gas mix at 1.6 yrs into a 24-month cycle, with two failed fuel rods, per Reference 30. These mixtures provide conservative application for calculating setpoints per 10CFR20, in terms of uCi/sec before an actual sample of the release is available, per Appendix A.

Time Averaged Release Mixture Basis:

This mix defines the routine (time-averaged) releases from either unit. It was derived from average noble-gas releases from year 2000-2003 at IPEC units 2 and 3 per Reference 30. They are used in conjunction with calculations to determine representative quarterly and annual time averaged release rates in curies per second for administrative purposes only, per Appendix A.

TABLE 3 – 9

LOCATIONS OF SITE BOUNDARY AND NEAREST RESIDENCE

Sector by compass point	Distance to Site Boundary from Unit 2 Plant Vent, in meters	Distance to Site Boundary from Unit 3 Plant Vent, in meters	Distance to nearest residence, from Unit 1 superheater, in meters
N	**RIVER**	**RIVER**	**1788.1**
NNE	**RIVER**	**RIVER**	**3111.3**
NE	**550**	**744**	**1907.3**
ENE	**600**	**775**	**1478.2**
E	**662**	**785**	**1370.9**
ESE	**569**	**622**	**715.2**
SE	**553**	**564**	**1168.2**
SSE	**569**	**551**	**1239.7**
S	**700**	**566**	**1132.5**
SSW	**755**	**480**	**1573.5**
SW	**544**	**350**	**3015.9**
WSW	**RIVER**	**RIVER**	**2169.6**
W	**RIVER**	**RIVER**	**1918.7**
WNW	**RIVER**	**RIVER**	**1752.4**
NW	**RIVER**	**RIVER**	**1692.7**
NNW	**RIVER**	**RIVER**	**1609.3**

Distances to the Site Boundary are unit-specific and measured from the applicable unit's Plant Vent release point. Distances to the Nearest Residence are measured from the Unit 1 Superheater Stack for both Units 2 and 3, per Reference 31.

Table 3-10a

ADULT INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04
P-32	1.32E+06	7.71E+04	5.01E+04	0.00E+00	0.00E+00	0.00E+00	8.64E+04
Cr-51	0.00E+00	0.00E+00	1.00E+02	5.95E+01	2.28E+01	1.44E+04	3.32E+03
Mn-54	0.00E+00	3.96E+04	6.30E+03	0.00E+00	9.84E+03	1.40E+06	7.74E+04
Mn-56	0.00E+00	1.24E+00	1.83E-01	0.00E+00	1.30E+00	9.44E+03	2.02E+04
Fe-55	2.46E+04	1.70E+04	3.94E+03	0.00E+00	0.00E+00	7.21E+04	6.03E+03
Fe-59	1.18E+04	2.78E+04	1.06E+04	0.00E+00	0.00E+00	1.02E+06	1.88E+05
Co-58	0.00E+00	1.58E+03	2.07E+03	0.00E+00	0.00E+00	9.28E+05	1.06E+05
Co-60	0.00E+00	1.15E+04	1.48E+04	0.00E+00	0.00E+00	5.97E+06	2.85E+05
Ni-63	4.32E+05	3.14E+04	1.45E+04	0.00E+00	0.00E+00	1.78E+05	1.34E+04
Ni-65	1.54E+00	2.10E-01	9.12E-02	0.00E+00	0.00E+00	5.60E+03	1.23E+04
Cu-64	0.00E+00	1.46E+00	6.15E-01	0.00E+00	4.62E+00	6.78E+03	4.90E+04
Zn-65	3.24E+04	1.03E+05	4.66E+04	0.00E+00	6.90E+04	8.64E+05	5.34E+04
Zn-69	3.38E-02	6.51E-02	4.52E-03	0.00E+00	4.22E-02	9.20E+02	1.63E+01
Br-83	0.00E+00	0.00E+00	2.41E+02	0.00E+00	0.00E+00	0.00E+00	2.32E+02
Br-84	0.00E+00	0.00E+00	3.13E+02	0.00E+00	0.00E+00	0.00E+00	1.64E-03
Br-85	0.00E+00	0.00E+00	1.28E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.35E+05	5.90E+04	0.00E+00	0.00E+00	0.00E+00	1.66E+04
Rb-88	0.00E+00	3.87E+02	1.93E+02	0.00E+00	0.00E+00	0.00E+00	3.34E-09
Rb-89	0.00E+00	2.56E+02	1.70E+02	0.00E+00	0.00E+00	0.00E+00	9.28E-12
Sr-89	3.04E+05	0.00E+00	8.72E+03	0.00E+00	0.00E+00	1.40E+06	3.50E+05
Sr-90	9.92E+07	0.00E+00	6.10E+06	0.00E+00	0.00E+00	9.60E+06	7.22E+05
Sr-91	6.19E+01	0.00E+00	2.50E+00	0.00E+00	0.00E+00	3.65E+04	1.91E+05
Sr-92	6.74E+00	0.00E+00	2.91E-01	0.00E+00	0.00E+00	1.65E+04	4.30E+04
Y-90	2.09E+03	0.00E+00	5.61E+01	0.00E+00	0.00E+00	1.70E+05	5.06E+05
Y-91m	2.61E-01	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.92E+03	1.33E+00
Y-91	4.62E+05	0.00E+00	1.24E+04	0.00E+00	0.00E+00	1.70E+06	3.85E+05
Y-92	1.03E+01	0.00E+00	3.02E-01	0.00E+00	0.00E+00	1.57E+04	7.35E+04
Y-93	9.44E+01	0.00E+00	2.61E+00	0.00E+00	0.00E+00	4.85E+04	4.22E+05
Zr-95	1.07E+05	3.44E+04	2.33E+04	0.00E+00	5.42E+04	1.77E+06	1.50E+05
Zr-97	9.68E+01	1.96E+01	9.04E+00	0.00E+00	2.97E+01	7.87E+04	5.23E+05
Nb-95	1.41E+04	7.82E+03	4.21E+03	0.00E+00	7.74E+03	5.05E+05	1.04E+05
Mo-99	0.00E+00	1.21E+02	2.30E+01	0.00E+00	2.91E+02	9.12E+04	2.48E+05
Tc-99m	1.03E-03	2.91E-03	3.70E-02	0.00E+00	4.42E-02	7.64E+02	4.16E+03
Tc-101	4.18E-05	6.02E-05	5.90E-04	0.00E+00	1.08E-03	3.99E+02	1.09E-11
Ru-103	1.53E+03	0.00E+00	6.58E+02	0.00E+00	5.83E+03	5.05E+05	1.10E+05
Ru-105	7.90E-01	0.00E+00	3.11E-01	0.00E+00	1.02E+00	1.10E+04	4.82E+04
Ru-106	6.91E+04	0.00E+00	8.72E+03	0.00E+00	1.34E+05	9.36E+06	9.12E+05
Ag-110m	1.08E+04	1.00E+04	5.94E+03	0.00E+00	1.97E+04	4.63E+06	3.02E+05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	3.12E+04	5.89E+02	1.24E+04	7.55E+01	0.00E+00	2.48E+06	4.06E+05
Sb-125	5.34E+04	5.95E+02	1.26E+04	5.40E+01	0.00E+00	1.74E+06	1.01E+05

Table 3-10a

ADULT INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	3.42E+03	1.58E+03	4.67E+02	1.05E+03	1.24E+04	3.14E+05	7.06E+04
Te-127m	1.26E+04	5.77E+03	1.57E+03	3.29E+03	4.58E+04	9.60E+05	1.50E+05
Te-127	1.40E+00	6.42E-01	3.10E-01	1.06E+00	5.10E+00	6.51E+03	5.74E+04
Te-129m	9.76E+03	4.67E+03	1.58E+03	3.44E+03	3.66E+04	1.16E+06	3.83E+05
Te-129	4.98E-02	2.39E-02	1.24E-02	3.90E-02	1.87E-01	1.94E+03	1.57E+02
Te-131m	6.99E+01	4.36E+01	2.90E+01	5.50E+01	3.09E+02	1.46E+05	5.56E+05
Te-131	1.11E-02	5.95E-03	3.59E-03	9.36E-03	4.37E-02	1.39E+03	1.84E+01
Te-132	2.60E+02	2.15E+02	1.62E+02	1.90E+02	1.46E+03	2.88E+05	5.10E+05
I-130	4.58E+03	1.34E+04	5.28E+03	1.14E+06	2.09E+04	0.00E+00	7.69E+03
I-131	2.52E+04	3.58E+04	2.05E+04	1.19E+07	6.13E+04	0.00E+00	6.28E+03
I-132	1.16E+03	3.26E+03	1.16E+03	1.14E+05	5.18E+03	0.00E+00	4.06E+02
I-133	8.64E+03	1.48E+04	4.52E+03	2.15E+06	2.58E+04	0.00E+00	8.88E+03
I-134	6.44E+02	1.73E+03	6.15E+02	2.98E+04	2.75E+03	0.00E+00	1.01E+00
I-135	2.68E+03	6.98E+03	2.57E+03	4.48E+05	1.11E+04	0.00E+00	5.25E+03
Cs-134	3.73E+05	8.48E+05	7.28E+05	0.00E+00	2.87E+05	9.76E+04	1.04E+04
Cs-136	3.90E+04	1.46E+05	1.10E+05	0.00E+00	8.56E+04	1.20E+04	1.17E+04
Cs-137	4.78E+05	6.21E+05	4.28E+05	0.00E+00	2.22E+05	7.52E+04	8.40E+03
Cs-138	3.31E+02	6.21E+02	3.24E+02	0.00E+00	4.80E+02	4.86E+01	1.86E-03
Ba-139	9.36E-01	6.66E-04	2.74E-02	0.00E+00	6.22E-04	3.76E+03	8.96E+02
Ba-140	3.90E+04	4.90E+01	2.57E+03	0.00E+00	1.67E+01	1.27E+06	2.18E+05
Ba-141	1.00E-01	7.53E-05	3.36E-03	0.00E+00	7.00E-05	1.94E+03	1.16E-07
Ba-142	2.63E-02	2.70E-05	1.66E-03	0.00E+00	2.29E-05	1.19E+03	1.57E-16
La-140	3.44E+02	1.74E+02	4.58E+01	0.00E+00	0.00E+00	1.36E+05	4.58E+05
La-142	6.83E-01	3.10E-01	7.72E-02	0.00E+00	0.00E+00	6.33E+03	2.11E+03
Ce-141	1.99E+04	1.35E+04	1.53E+03	0.00E+00	6.26E+03	3.62E+05	1.20E+05
Ce-143	1.86E+02	1.38E+02	1.53E+01	0.00E+00	6.08E+01	7.98E+04	2.26E+05
Ce-144	3.43E+06	1.43E+06	1.84E+05	0.00E+00	8.48E+05	7.78E+06	8.16E+05
Pr-143	9.36E+03	3.75E+03	4.64E+02	0.00E+00	2.16E+03	2.81E+05	2.00E+05
Pr-144	3.01E-02	1.25E-02	1.53E-03	0.00E+00	7.05E-03	1.02E+03	2.15E-08
Nd-147	5.27E+03	6.10E+03	3.65E+02	0.00E+00	3.56E+03	2.21E+05	1.73E+05
W-187	8.48E+00	7.08E+00	2.48E+00	0.00E+00	0.00E+00	2.90E+04	1.55E+05
Np-239	2.30E+02	2.26E+01	1.24E+01	0.00E+00	7.00E+01	3.76E+04	1.19E+05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	6.92E+02	6.71E+02	0.00E+00	0.00E+00	3.70E+05	3.14E+04
Sr-85	3.20E+04	0.00E+00	7.76E+05	0.00E+00	0.00E+00	4.80E+05	6.08E+04
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.22E-01	5.62E-02	2.05E-02	0.00E+00	6.54E-02	2.40E+03	2.42E+02
Cd-109	0.00E+00	3.92E+05	1.28E+04	0.00E+00	3.76E+05	7.28E+05	6.56E+04
Sn-113	6.56E+04	2.16E+03	4.48E+03	1.36E+03	0.00E+00	9.60E+05	1.20E+04
Ba-133	7.60E+04	3.36E+03	2.00E+04	0.00E+00	1.68E+01	1.52E+06	8.00E+04
Te-134	3.07E-02	2.58E-02	1.26E-02	2.75E-02	1.74E-01	3.47E+03	2.38E-01
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-10b

TEEN INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04
P-32	1.89E+06	1.10E+05	7.16E+04	0.00E+00	0.00E+00	0.00E+00	9.28E+04
Cr-51	0.00E+00	0.00E+00	1.35E+02	7.50E+01	3.07E+01	2.10E+04	3.00E+03
Mn-54	0.00E+00	5.11E+04	8.40E+03	0.00E+00	1.27E+04	1.98E+06	6.68E+04
Mn-56	0.00E+00	1.70E+00	2.52E-01	0.00E+00	1.79E+00	1.52E+04	5.74E+04
Fe-55	3.34E+04	2.38E+04	5.54E+03	0.00E+00	0.00E+00	1.24E+05	6.39E+03
Fe-59	1.59E+04	3.70E+04	1.43E+04	0.00E+00	0.00E+00	1.53E+06	1.78E+05
Co-58	0.00E+00	2.07E+03	2.78E+03	0.00E+00	0.00E+00	1.34E+06	9.52E+04
Co-60	0.00E+00	1.51E+04	1.98E+04	0.00E+00	0.00E+00	8.72E+06	2.59E+05
Ni-63	5.80E+05	4.34E+04	1.98E+04	0.00E+00	0.00E+00	3.07E+05	1.42E+04
Ni-65	2.18E+00	2.93E-01	1.27E-01	0.00E+00	0.00E+00	9.36E+03	3.67E+04
Cu-64	0.00E+00	2.03E+00	8.48E-01	0.00E+00	6.41E+00	1.11E+04	6.14E+04
Zn-65	3.86E+04	1.34E+05	6.24E+04	0.00E+00	8.64E+04	1.24E+06	4.66E+04
Zn-69	4.83E-02	9.20E-02	6.46E-03	0.00E+00	6.02E-02	1.58E+03	2.85E+02
Br-83	0.00E+00	0.00E+00	3.44E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.33E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.83E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.90E+05	8.40E+04	0.00E+00	0.00E+00	0.00E+00	1.77E+04
Rb-88	0.00E+00	5.46E+02	2.72E+02	0.00E+00	0.00E+00	0.00E+00	2.92E-05
Rb-89	0.00E+00	3.52E+02	2.33E+02	0.00E+00	0.00E+00	0.00E+00	3.38E-07
Sr-89	4.34E+05	0.00E+00	1.25E+04	0.00E+00	0.00E+00	2.42E+06	3.71E+05
Sr-90	1.08E+08	0.00E+00	6.68E+06	0.00E+00	0.00E+00	1.65E+07	7.65E+05
Sr-91	8.80E+01	0.00E+00	3.51E+00	0.00E+00	0.00E+00	6.07E+04	2.59E+05
Sr-92	9.52E+00	0.00E+00	4.06E-01	0.00E+00	0.00E+00	2.74E+04	1.19E+05
Y-90	2.98E+03	0.00E+00	8.00E+01	0.00E+00	0.00E+00	2.93E+05	5.59E+05
Y-91m	3.70E-01	0.00E+00	1.42E-02	0.00E+00	0.00E+00	3.20E+03	3.02E+01
Y-91	6.61E+05	0.00E+00	1.77E+04	0.00E+00	0.00E+00	2.94E+06	4.09E+05
Y-92	1.47E+01	0.00E+00	4.29E-01	0.00E+00	0.00E+00	2.68E+04	1.65E+05
Y-93	1.35E+02	0.00E+00	3.72E+00	0.00E+00	0.00E+00	8.32E+04	5.79E+05
Zr-95	1.46E+05	4.58E+04	3.15E+04	0.00E+00	6.74E+04	2.69E+06	1.49E+05
Zr-97	1.38E+02	2.72E+01	1.26E+01	0.00E+00	4.12E+01	1.30E+05	6.30E+05
Nb-95	1.86E+04	1.03E+04	5.66E+03	0.00E+00	1.00E+04	7.51E+05	9.68E+04
Mo-99	0.00E+00	1.69E+02	3.22E+01	0.00E+00	4.11E+02	1.54E+05	2.69E+05
Tc-99m	1.38E-03	3.86E-03	4.99E-02	0.00E+00	5.76E-02	1.15E+03	6.13E+03
Tc-101	5.92E-05	8.40E-05	8.24E-04	0.00E+00	1.52E-03	6.67E+02	8.72E-07
Ru-103	2.10E+03	0.00E+00	8.96E+02	0.00E+00	7.43E+03	7.83E+05	1.09E+05
Ru-105	1.12E+00	0.00E+00	4.34E-01	0.00E+00	1.41E+00	1.82E+04	9.04E+04
Ru-106	9.84E+04	0.00E+00	1.24E+04	0.00E+00	1.90E+05	1.61E+07	9.60E+05
Ag-110m	1.38E+04	1.31E+04	7.99E+03	0.00E+00	2.50E+04	6.75E+06	2.73E+05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	4.30E+04	7.94E+02	1.68E+04	9.76E+01	0.00E+00	3.85E+06	3.98E+05
Sb-125	7.38E+04	8.08E+02	1.72E+04	7.04E+01	0.00E+00	2.74E+06	9.92E+04

Table 3-10b

TEEN INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	4.88E+03	2.24E+03	6.67E+02	1.40E+03	0.00E+00	5.36E+05	7.50E+04
Te-127m	1.80E+04	8.16E+03	2.18E+03	4.38E+03	6.54E+04	1.66E+06	1.59E+05
Te-127	2.01E+00	9.12E-01	4.42E-01	1.42E+00	7.28E+00	1.12E+04	8.08E+04
Te-129m	1.39E+04	6.58E+03	2.25E+03	4.58E+03	5.19E+04	1.98E+06	4.05E+05
Te-129	7.10E-02	3.38E-02	1.76E-02	5.18E-02	2.66E-01	3.30E+03	1.62E+03
Te-131m	9.84E+01	6.01E+01	4.02E+01	7.25E+01	4.39E+02	2.38E+05	6.21E+05
Te-131	1.58E-02	8.32E-03	5.04E-03	1.24E-02	6.18E-02	2.34E+03	1.51E+01
Te-132	3.60E+02	2.90E+02	2.19E+02	2.46E+02	1.95E+03	4.49E+05	4.63E+05
I-130	6.24E+03	1.79E+04	7.17E+03	1.49E+06	2.75E+04	0.00E+00	9.12E+03
I-131	3.54E+04	4.91E+04	2.64E+04	1.46E+07	8.40E+04	0.00E+00	6.49E+03
I-132	1.59E+03	4.38E+03	1.58E+03	1.51E+05	6.92E+03	0.00E+00	1.27E+03
I-133	1.22E+04	2.05E+04	6.22E+03	2.92E+06	3.59E+04	0.00E+00	1.03E+04
I-134	8.88E+02	2.32E+03	8.40E+02	3.95E+04	3.66E+03	0.00E+00	2.04E+01
I-135	3.70E+03	9.44E+03	3.49E+03	6.21E+05	1.49E+04	0.00E+00	6.95E+03
Cs-134	5.02E+05	1.13E+06	5.49E+05	0.00E+00	3.75E+05	1.46E+05	9.76E+03
Cs-136	5.15E+04	1.94E+05	1.37E+05	0.00E+00	1.10E+05	1.78E+04	1.09E+04
Cs-137	6.70E+05	8.48E+05	3.11E+05	0.00E+00	3.04E+05	1.21E+05	8.48E+03
Cs-138	4.66E+02	8.56E+02	4.46E+02	0.00E+00	6.62E+02	7.87E+01	2.70E-01
Ba-139	1.34E+00	9.44E-04	3.90E-02	0.00E+00	8.88E-04	6.46E+03	6.45E+03
Ba-140	5.47E+04	6.70E+01	3.52E+03	0.00E+00	2.28E+01	2.03E+06	2.29E+05
Ba-141	1.42E-01	1.06E-04	4.74E-03	0.00E+00	9.84E-05	3.29E+03	7.46E-04
Ba-142	3.70E-02	3.70E-05	2.27E-03	0.00E+00	3.14E-05	1.91E+03	4.79E-10
La-140	4.79E+02	2.36E+02	6.26E+01	0.00E+00	0.00E+00	2.14E+05	4.87E+05
La-142	9.60E-01	4.25E-01	1.06E-01	0.00E+00	0.00E+00	1.02E+04	1.20E+04
Ce-141	2.84E+04	1.90E+04	2.17E+03	0.00E+00	8.88E+03	6.14E+05	1.26E+05
Ce-143	2.66E+02	1.94E+02	2.16E+01	0.00E+00	8.64E+01	1.30E+05	2.55E+05
Ce-144	4.89E+06	2.02E+06	2.62E+05	0.00E+00	1.21E+06	1.34E+07	8.64E+05
Pr-143	1.34E+04	5.31E+03	6.62E+02	0.00E+00	3.09E+03	4.83E+05	2.14E+05
Pr-144	4.30E-02	1.76E-02	2.18E-03	0.00E+00	1.01E-02	1.75E+03	2.35E-04
Nd-147	7.86E+03	8.56E+03	5.13E+02	0.00E+00	5.02E+03	3.72E+05	1.82E+05
W-187	1.20E+01	9.76E+00	3.43E+00	0.00E+00	0.00E+00	4.74E+04	1.77E+05
Np-239	3.38E+02	3.19E+01	1.77E+01	0.00E+00	1.00E+02	6.49E+04	1.32E+05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	9.44E+02	9.20E+02	0.00E+00	0.00E+00	5.86E+05	3.14E+04
Sr-85	4.00E+04	0.00E+00	1.04E+04	0.00E+00	0.00E+00	7.04E+05	5.52E+04
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	3.14E-01	7.78E-02	2.84E-02	0.00E+00	9.12E-02	3.93E+03	2.17E+03
Cd-109	0.00E+00	8.00E+05	2.72E+04	0.00E+00	5.36E+05	1.28E+06	6.88E+04
Sn-113	1.20E+05	3.76E+03	7.76E+03	2.32E+03	0.00E+00	1.60E+06	1.20E+04
Ba-133	3.76E+05	6.40E+03	2.64E+04	0.00E+00	2.24E+01	2.32E+06	7.76E+04
Te-134	4.25E-02	3.48E-02	2.91E-02	3.57E-02	2.33E-01	5.40E+03	1.10E+01
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-10c

CHILD INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04
P-32	2.60E+06	1.14E+05	9.88E+04	0.00E+00	0.00E+00	0.00E+00	4.22E+04
Cr-51	0.00E+00	0.00E+00	1.54E+02	8.55E+01	2.43E+01	1.70E+04	1.08E+03
Mn-54	0.00E+00	4.29E+04	9.51E+03	0.00E+00	1.00E+04	1.58E+06	2.29E+04
Mn-56	0.00E+00	1.66E+00	3.12E-01	0.00E+00	1.67E+00	1.31E+04	1.23E+05
Fe-55	4.74E+04	2.52E+04	7.77E+03	0.00E+00	0.00E+00	1.11E+05	2.87E+03
Fe-59	2.07E+04	3.34E+04	1.67E+04	0.00E+00	0.00E+00	1.27E+06	7.07E+04
Co-58	0.00E+00	1.77E+03	3.16E+03	0.00E+00	0.00E+00	1.11E+06	3.44E+04
Co-60	0.00E+00	1.31E+04	2.26E+04	0.00E+00	0.00E+00	7.07E+06	9.62E+04
Ni-63	8.21E+05	4.63E+04	2.80E+04	0.00E+00	0.00E+00	2.75E+05	6.33E+03
Ni-65	2.99E+00	2.96E-01	1.64E-01	0.00E+00	0.00E+00	8.18E+03	8.40E+04
Cu-64	0.00E+00	1.99E+00	1.07E+00	0.00E+00	6.03E+00	9.58E+03	3.67E+04
Zn-65	4.26E+04	1.13E+05	7.03E+04	0.00E+00	7.14E+04	9.95E+05	1.63E+04
Zn-69	6.70E-02	9.66E-02	8.92E-03	0.00E+00	5.85E-02	1.42E+03	1.02E+04
Br-83	0.00E+00	0.00E+00	4.74E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	5.48E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.53E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.98E+05	1.14E+05	0.00E+00	0.00E+00	0.00E+00	7.99E+03
Rb-88	0.00E+00	5.62E+02	3.66E+02	0.00E+00	0.00E+00	0.00E+00	1.72E+01
Rb-89	0.00E+00	3.45E+02	2.90E+02	0.00E+00	0.00E+00	0.00E+00	1.89E+00
Sr-89	5.99E+05	0.00E+00	1.72E+04	0.00E+00	0.00E+00	2.16E+06	1.67E+05
Sr-90	1.01E+08	0.00E+00	6.44E+06	0.00E+00	0.00E+00	1.48E+07	3.43E+05
Sr-91	1.21E+02	0.00E+00	4.59E+00	0.00E+00	0.00E+00	5.33E+04	1.74E+05
Sr-92	1.31E+01	0.00E+00	5.25E-01	0.00E+00	0.00E+00	2.40E+04	2.42E+05
Y-90	4.11E+03	0.00E+00	1.11E+02	0.00E+00	0.00E+00	2.62E+05	2.68E+05
Y-91m	5.07E-01	0.00E+00	1.84E-02	0.00E+00	0.00E+00	2.81E+03	1.72E+03
Y-91	9.14E+05	0.00E+00	2.44E+04	0.00E+00	0.00E+00	2.63E+06	1.84E+05
Y-92	2.04E+01	0.00E+00	5.81E-01	0.00E+00	0.00E+00	2.39E+04	2.39E+05
Y-93	1.86E+02	0.00E+00	5.11E+00	0.00E+00	0.00E+00	7.44E+04	3.89E+05
Zr-95	1.90E+05	4.18E+04	3.70E+04	0.00E+00	5.96E+04	2.23E+06	6.11E+04
Zr-97	1.88E+02	2.72E+01	1.60E+01	0.00E+00	3.88E+01	1.13E+05	3.51E+05
Nb-95	2.35E+04	9.18E+03	6.55E+03	0.00E+00	8.62E+03	6.14E+05	3.70E+04
Mo-99	0.00E+00	1.72E+02	4.25E+01	0.00E+00	3.92E+02	1.35E+05	1.27E+05
Tc-99m	1.78E-03	3.48E-03	5.77E-02	0.00E+00	5.07E-02	9.51E+02	4.81E+03
Tc-101	8.10E-05	8.51E-05	1.08E-03	0.00E+00	1.45E-03	5.85E+02	1.63E+01
Ru-103	2.79E+03	0.00E+00	1.07E+03	0.00E+00	7.03E+03	6.62E+05	4.48E+04
Ru-105	1.53E+00	0.00E+00	5.55E-01	0.00E+00	1.34E+00	1.59E+04	9.95E+04
Ru-106	1.36E+05	0.00E+00	1.69E+04	0.00E+00	1.84E+05	1.43E+07	4.29E+05
Ag-110m	1.69E+04	1.14E+04	9.14E+03	0.00E+00	2.12E+04	5.48E+06	1.00E+05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	5.74E+04	7.40E+02	2.00E+04	1.26E+02	0.00E+00	3.24E+06	1.64E+05
Sb-125	9.84E+04	7.59E+02	2.07E+04	9.10E+01	0.00E+00	2.32E+06	4.03E+04

Table 3-10c

CHILD INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	6.73E+03	2.33E+03	9.14E+02	1.92E+03	0.00E+00	4.77E+05	3.38E+04
Te-127m	2.49E+04	8.55E+03	3.02E+03	6.07E+03	6.36E+04	1.48E+06	7.14E+04
Te-127	2.77E+00	9.51E-01	6.10E-01	1.96E+00	7.07E+00	1.00E+04	5.62E+04
Te-129m	1.92E+04	6.85E+03	3.04E+03	6.33E+03	5.03E+04	1.76E+06	1.82E+05
Te-129	9.77E-02	3.50E-02	2.38E-02	7.14E-02	2.57E-01	2.93E+03	2.55E+04
Te-131m	1.34E+02	5.92E+01	5.07E+01	9.77E+01	4.00E+02	2.06E+05	3.08E+05
Te-131	2.17E-02	8.44E-03	6.59E-03	1.70E-02	5.88E-02	2.05E+03	1.33E+03
Te-132	4.81E+02	2.72E+02	2.63E+02	3.17E+02	1.77E+03	3.77E+05	1.38E+05
I-130	8.18E+03	1.64E+04	8.44E+03	1.85E+06	2.45E+04	0.00E+00	5.11E+03
I-131	4.81E+04	4.81E+04	2.73E+04	1.62E+07	7.88E+04	0.00E+00	2.84E+03
I-132	2.12E+03	4.07E+03	1.88E+03	1.94E+05	6.25E+03	0.00E+00	3.20E+03
I-133	1.66E+04	2.03E+04	7.70E+03	3.85E+06	3.38E+04	0.00E+00	5.48E+03
I-134	1.17E+03	2.16E+03	9.95E+02	5.07E+04	3.30E+03	0.00E+00	9.55E+02
I-135	4.92E+03	8.73E+03	4.14E+03	7.92E+05	1.34E+04	0.00E+00	4.44E+03
Cs-134	6.51E+05	1.01E+06	2.25E+05	0.00E+00	3.30E+05	1.21E+05	3.85E+03
Cs-136	6.51E+04	1.71E+05	1.16E+05	0.00E+00	9.55E+04	1.45E+04	4.18E+03
Cs-137	9.07E+05	8.25E+05	1.28E+05	0.00E+00	2.82E+05	1.04E+05	3.62E+03
Cs-138	6.33E+02	8.40E+02	5.55E+02	0.00E+00	6.22E+02	6.81E+01	2.70E+02
Ba-139	1.84E+00	9.84E-04	5.36E-02	0.00E+00	8.62E-04	5.77E+03	5.77E+04
Ba-140	7.40E+04	6.48E+01	4.33E+03	0.00E+00	2.11E+01	1.74E+06	1.02E+05
Ba-141	1.96E-01	1.09E-04	6.36E-03	0.00E+00	9.47E-05	2.92E+03	2.75E+02
Ba-142	4.99E-02	3.60E-05	2.79E-03	0.00E+00	2.91E-05	1.64E+03	2.74E+00
La-140	6.44E+02	2.25E+02	7.55E+01	0.00E+00	0.00E+00	1.83E+05	2.26E+05
La-142	1.29E+00	4.11E-01	1.29E-01	0.00E+00	0.00E+00	8.70E+03	7.59E+04
Ce-141	3.92E+04	1.95E+04	2.90E+03	0.00E+00	8.55E+03	5.44E+05	5.66E+04
Ce-143	3.66E+02	1.99E+02	2.87E+01	0.00E+00	8.36E+01	1.15E+05	1.27E+05
Ce-144	6.77E+06	2.12E+06	3.61E+05	0.00E+00	1.17E+06	1.20E+07	3.89E+05
Pr-143	1.85E+04	5.55E+03	9.14E+02	0.00E+00	3.00E+03	4.33E+05	9.73E+04
Pr-144	5.96E-02	1.85E-02	3.00E-03	0.00E+00	9.77E-03	1.57E+03	1.97E+02
Nd-147	1.08E+04	8.73E+03	6.81E+02	0.00E+00	4.81E+03	3.28E+05	8.21E+04
W-187	1.63E+01	9.66E+00	4.33E+00	0.00E+00	0.00E+00	4.11E+04	9.10E+04
Np-239	4.66E+02	3.34E+01	2.35E+01	0.00E+00	9.73E+01	5.81E+04	6.40E+04
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	9.03E+02	1.07E+03	0.00E+00	0.00E+00	5.07E+05	1.32E+04
Sr-85	4.44E+04	0.00E+00	1.18E+04	0.00E+00	0.00E+00	5.55E+05	2.04E+04
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	4.29E-01	7.70E-02	3.60E-02	0.00E+00	8.55E-02	3.42E+03	2.78E+04
Cd-109	0.00E+00	7.03E+05	2.96E+04	0.00E+00	6.29E+05	1.11E+06	3.00E+04
Sn-113	1.41E+05	3.29E+03	8.51E+03	2.63E+03	0.00E+00	1.33E+06	4.81E+03
Ba-133	4.07E+05	4.07E+03	3.70E+04	0.00E+00	2.00E+01	1.92E+06	3.07E+04
Te-134	5.66E-02	3.26E-02	3.48E-02	4.59E-02	2.11E-01	4.55E+03	1.80E+03
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-10d

INFANT INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04
P-32	2.03E+06	1.12E+05	7.74E+04	0.00E+00	0.00E+00	0.00E+00	1.61E+04
Cr-51	0.00E+00	0.00E+00	8.95E+01	5.75E+01	1.32E+01	1.28E+04	3.57E+02
Mn-54	0.00E+00	2.53E+04	4.98E+03	0.00E+00	4.98E+03	1.00E+06	7.06E+03
Mn-56	0.00E+00	1.54E+00	2.21E-01	0.00E+00	1.10E+00	1.25E+04	7.17E+04
Fe-55	1.97E+04	1.17E+04	3.33E+03	0.00E+00	0.00E+00	8.69E+04	1.09E+03
Fe-59	1.36E+04	2.35E+04	9.48E+03	0.00E+00	0.00E+00	1.02E+06	2.48E+04
Co-58	0.00E+00	1.22E+03	1.82E+03	0.00E+00	0.00E+00	7.77E+05	1.11E+04
Co-60	0.00E+00	8.02E+03	1.18E+04	0.00E+00	0.00E+00	4.51E+06	3.19E+04
Ni-63	3.39E+05	2.04E+04	1.16E+04	0.00E+00	0.00E+00	2.09E+05	2.42E+03
Ni-65	2.39E+00	2.84E-01	1.23E-01	0.00E+00	0.00E+00	8.12E+03	5.01E+04
Cu-64	0.00E+00	1.88E+00	7.74E-01	0.00E+00	3.98E+00	9.30E+03	1.50E+04
Zn-65	1.93E+04	6.26E+04	3.11E+04	0.00E+00	3.25E+04	6.47E+05	5.14E+04
Zn-69	5.39E-02	9.67E-02	7.18E-03	0.00E+00	4.02E-02	1.47E+03	1.32E+04
Br-83	0.00E+00	0.00E+00	3.81E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.04E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.90E+05	8.82E+04	0.00E+00	0.00E+00	0.00E+00	3.04E+03
Rb-88	0.00E+00	5.57E+02	2.87E+02	0.00E+00	0.00E+00	0.00E+00	3.39E+02
Rb-89	0.00E+00	3.21E+02	2.06E+02	0.00E+00	0.00E+00	0.00E+00	6.82E+01
Sr-89	3.98E+05	0.00E+00	1.14E+04	0.00E+00	0.00E+00	2.03E+06	6.40E+04
Sr-90	4.09E+07	0.00E+00	2.59E+06	0.00E+00	0.00E+00	1.12E+07	1.31E+05
Sr-91	9.56E+01	0.00E+00	3.46E+00	0.00E+00	0.00E+00	5.26E+04	7.34E+04
Sr-92	1.05E+01	0.00E+00	3.91E-01	0.00E+00	0.00E+00	2.38E+04	1.40E+05
Y-90	3.29E+03	0.00E+00	8.82E+01	0.00E+00	0.00E+00	2.69E+05	1.04E+05
Y-91m	4.07E-01	0.00E+00	1.39E-02	0.00E+00	0.00E+00	2.79E+03	2.35E+03
Y-91	5.88E+05	0.00E+00	1.57E+04	0.00E+00	0.00E+00	2.45E+06	7.03E+04
Y-92	1.64E+01	0.00E+00	4.61E-01	0.00E+00	0.00E+00	2.45E+04	1.27E+05
Y-93	1.50E+02	0.00E+00	4.07E+00	0.00E+00	0.00E+00	7.64E+04	1.67E+05
Zr-95	1.15E+05	2.79E+04	2.03E+04	0.00E+00	3.11E+04	1.75E+06	2.17E+04
Zr-97	1.50E+02	2.56E+01	1.17E+01	0.00E+00	2.59E+01	1.10E+05	1.40E+05
Nb-95	1.57E+04	6.43E+03	3.78E+03	0.00E+00	4.72E+03	4.79E+05	1.27E+04
Mo-99	0.00E+00	1.65E+02	3.23E+01	0.00E+00	2.65E+02	1.35E+05	4.87E+04
Tc-99m	1.40E-03	2.88E-03	3.72E-02	0.00E+00	3.11E-02	8.11E+02	2.03E+03
Tc-101	6.51E-05	8.23E-05	8.12E-04	0.00E+00	9.79E-04	5.84E+02	8.44E+02
Ru-103	2.02E+03	0.00E+00	6.79E+02	0.00E+00	4.24E+03	5.52E+05	1.61E+04
Ru-105	1.22E+00	0.00E+00	4.10E-01	0.00E+00	8.99E-01	1.57E+04	4.84E+04
Ru-106	8.68E+04	0.00E+00	1.09E+04	0.00E+00	1.07E+05	1.16E+07	1.64E+05
Ag-110m	9.98E+03	7.22E+03	5.00E+03	0.00E+00	1.09E+04	3.67E+06	3.30E+04
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	3.79E+04	5.56E+02	1.20E+04	1.01E+02	0.00E+00	2.65E+06	5.91E+04
Sb-125	5.17E+04	4.77E+02	1.09E+04	6.23E+01	0.00E+00	1.64E+06	1.47E+04

Table 3-10d

INFANT INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	4.76E+03	1.99E+03	6.58E+02	1.62E+03	0.00E+00	4.47E+05	1.29E+04
Te-127m	1.67E+04	6.90E+03	2.07E+03	4.87E+03	3.75E+04	1.31E+06	2.73E+04
Te-127	2.23E+04	9.53E-01	4.89E-01	1.85E+00	4.86E+00	1.03E+04	2.44E+04
Te-129m	1.41E+04	6.09E+03	2.23E+03	5.47E+03	3.18E+04	1.68E+06	6.90E+04
Te-129	7.88E-02	3.47E-02	1.88E-02	6.75E-02	1.75E-01	3.00E+03	2.63E+04
Te-131m	1.07E+02	5.50E+01	3.63E+01	8.93E+01	2.65E+02	1.99E+05	1.19E+05
Te-131	1.74E-02	8.22E-03	5.00E-03	1.58E-02	3.99E-02	2.06E+03	8.22E+03
Te-132	3.72E+02	2.37E+02	1.76E+02	2.79E+02	1.03E+03	3.40E+05	4.41E+04
I-130	6.36E+03	1.39E+04	5.57E+03	1.60E+06	1.53E+04	0.00E+00	1.99E+03
I-131	3.79E+04	4.44E+04	1.96E+04	1.48E+07	5.18E+04	0.00E+00	1.06E+03
I-132	1.69E+03	3.54E+03	1.26E+03	1.69E+05	3.95E+03	0.00E+00	1.90E+03
I-133	1.32E+04	1.92E+04	5.60E+03	3.56E+06	2.24E+04	0.00E+00	2.16E+03
I-134	9.21E+02	1.88E+03	6.65E+02	4.45E+04	2.09E+03	0.00E+00	1.29E+03
I-135	3.86E+03	7.60E+03	2.77E+03	6.96E+05	8.47E+03	0.00E+00	1.83E+03
Cs-134	3.96E+05	7.03E+05	7.45E+04	0.00E+00	1.90E+05	7.97E+04	1.33E+03
Cs-136	4.83E+04	1.35E+05	5.29E+04	0.00E+00	5.64E+04	1.18E+04	1.43E+03
Cs-137	5.49E+05	6.12E+05	4.55E+04	0.00E+00	1.72E+05	7.13E+04	1.33E+03
Cs-138	5.05E+02	7.81E+02	3.98E+02	0.00E+00	4.10E+02	6.54E+01	8.76E+02
Ba-139	1.48E+00	9.84E-04	4.30E-02	0.00E+00	5.92E-04	5.95E+03	5.10E+04
Ba-140	5.60E+04	5.60E+01	2.90E+03	0.00E+00	1.34E+01	1.60E+06	3.84E+04
Ba-141	1.57E-01	1.08E-04	4.97E-03	0.00E+00	6.50E-05	2.97E+03	4.75E+03
Ba-142	3.98E-02	3.30E-05	1.96E-03	0.00E+00	1.90E-05	1.55E+03	6.93E+02
La-140	5.05E+02	2.00E+02	5.15E+01	0.00E+00	0.00E+00	1.68E+05	8.48E+04
La-142	1.03E+00	3.77E-01	9.04E-02	0.00E+00	0.00E+00	8.22E+03	5.95E+04
Ce-141	2.77E+04	1.67E+04	1.99E+03	0.00E+00	5.25E+03	5.17E+05	2.16E+04
Ce-143	2.93E+02	1.93E+02	2.21E+01	0.00E+00	5.64E+01	1.16E+05	4.97E+04
Ce-144	3.19E+06	1.21E+06	1.76E+05	0.00E+00	5.38E+05	9.84E+06	1.48E+05
Pr-143	1.40E+04	5.24E+03	6.99E+02	0.00E+00	1.97E+03	4.33E+05	3.72E+04
Pr-144	4.79E-02	1.85E-02	2.41E-03	0.00E+00	6.72E-03	1.61E+03	4.28E+03
Nd-147	7.94E+03	8.13E+03	5.00E+02	0.00E+00	3.15E+03	3.22E+05	3.12E+04
W-187	1.30E+01	9.02E+00	3.12E+00	0.00E+00	0.00E+00	3.96E+04	3.56E+04
Np-239	3.71E+02	3.32E+01	1.88E+01	0.00E+00	6.62E+01	5.95E+04	2.49E+04
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	6.51E+02	6.41E+02	0.00E+00	0.00E+00	3.79E+05	4.86E+03
Sr-85	3.78E+04	0.00E+00	7.56E+03	0.00E+00	0.00E+00	4.20E+05	6.72E+03
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	3.42E-01	7.29E-02	2.63E-02	0.00E+00	5.70E-02	3.32E+03	2.69E+04
Cd-109	0.00E+00	3.64E+05	1.40E+04	0.00E+00	2.80E+05	8.68E+05	1.12E+04
Sn-113	8.40E+04	2.24E+03	5.04E+03	1.82E+03	0.00E+00	1.09E+06	1.68E+03
Ba-133	2.66E+05	2.38E+03	1.82E+04	0.00E+00	1.25E+01	1.27E+06	1.08E+04
Te-134	4.45E-02	2.86E-02	2.35E-02	4.07E-02	1.34E-01	4.10E+03	3.54E+03
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-11a

ADULT INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03
Be-7	9.36E+04	2.11E+05	1.05E+05	0.00E+00	2.22E+05	0.00E+00	3.65E+07
Na-24	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05
P-32	1.40E+09	8.73E+07	5.43E+07	0.00E+00	0.00E+00	0.00E+00	1.58E+08
Cr-51	0.00E+00	0.00E+00	4.64E+04	2.78E+04	1.02E+04	6.16E+04	1.17E+07
Mn-54	0.00E+00	3.13E+08	5.97E+07	0.00E+00	9.31E+07	0.00E+00	9.58E+08
Mn-56	0.00E+00	1.59E+01	2.82E+00	0.00E+00	2.02E+01	0.00E+00	5.07E+02
Fe-55	2.10E+08	1.45E+08	3.38E+07	0.00E+00	0.00E+00	8.08E+07	8.31E+07
Fe-59	1.26E+08	2.96E+08	1.13E+08	0.00E+00	0.00E+00	8.27E+07	9.86E+08
Co-58	0.00E+00	3.07E+07	6.89E+07	0.00E+00	0.00E+00	0.00E+00	6.23E+08
Co-60	0.00E+00	1.67E+08	3.69E+08	0.00E+00	0.00E+00	0.00E+00	3.14E+09
Ni-63	1.04E+10	7.21E+08	3.49E+08	0.00E+00	0.00E+00	0.00E+00	1.50E+08
Ni-65	6.15E+01	7.99E+00	3.64E+00	0.00E+00	0.00E+00	0.00E+00	2.03E+02
Cu-64	0.00E+00	9.20E+03	4.32E+03	0.00E+00	2.32E+04	0.00E+00	7.84E+05
Zn-65	3.17E+08	1.01E+09	4.56E+08	0.00E+00	6.75E+08	0.00E+00	6.36E+08
Zn-69	8.73E-06	1.67E-05	1.16E-06	0.00E+00	1.09E-05	0.00E+00	2.51E-06
Br-83	0.00E+00	0.00E+00	3.11E+00	0.00E+00	0.00E+00	0.00E+00	4.47E+00
Br-84	0.00E+00	0.00E+00	2.48E-11	0.00E+00	0.00E+00	0.00E+00	1.94E-16
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.19E+08	1.02E+08	0.00E+00	0.00E+00	0.00E+00	4.33E+07
Rb-88	0.00E+00	3.43E-22	1.82E-22	0.00E+00	0.00E+00	0.00E+00	4.74E-33
Rb-89	0.00E+00	1.39E-26	9.74E-27	0.00E+00	0.00E+00	0.00E+00	8.05E-40
Sr-89	9.96E+09	0.00E+00	2.86E+08	0.00E+00	0.00E+00	0.00E+00	1.60E+09
Sr-90	6.05E+11	0.00E+00	1.48E+11	0.00E+00	0.00E+00	0.00E+00	1.75E+10
Sr-91	3.05E+05	0.00E+00	1.23E+04	0.00E+00	0.00E+00	0.00E+00	1.45E+06
Sr-92	4.27E+02	0.00E+00	1.85E+01	0.00E+00	0.00E+00	0.00E+00	8.45E+03
Y-90	1.33E+04	0.00E+00	3.56E+02	0.00E+00	0.00E+00	0.00E+00	1.41E+08
Y-91m	5.22E-09	0.00E+00	2.02E-10	0.00E+00	0.00E+00	0.00E+00	1.53E-08
Y-91	5.11E+06	0.00E+00	1.37E+05	0.00E+00	0.00E+00	0.00E+00	2.81E+09
Y-92	9.15E-01	0.00E+00	2.68E-02	0.00E+00	0.00E+00	0.00E+00	1.60E+04
Y-93	1.70E+02	0.00E+00	4.68E+00	0.00E+00	0.00E+00	0.00E+00	5.38E+06
Zr-95	1.17E+06	3.77E+05	2.55E+05	0.00E+00	5.91E+05	0.00E+00	1.19E+09
Zr-97	3.37E+02	6.81E+01	3.11E+01	0.00E+00	1.03E+02	0.00E+00	2.11E+07
Nb-95	1.43E+05	7.94E+04	4.27E+04	0.00E+00	7.85E+04	0.00E+00	4.82E+08
Mo-99	0.00E+00	6.15E+06	1.17E+06	0.00E+00	1.39E+07	0.00E+00	1.43E+07
Tc-99m	3.10E+00	8.77E+00	1.12E+02	0.00E+00	1.33E+02	4.30E+00	5.19E+03
Tc-101	8.22E-31	1.18E-30	1.16E-29	0.00E+00	2.13E-29	6.05E-31	3.56E-42
Ru-103	4.76E+06	0.00E+00	2.05E+06	0.00E+00	1.82E+07	0.00E+00	5.56E+08
Ru-105	5.39E+01	0.00E+00	2.13E+01	0.00E+00	6.96E+02	0.00E+00	3.29E+04
Ru-106	1.93E+08	0.00E+00	2.44E+07	0.00E+00	3.72E+08	0.00E+00	1.25E+10
Ag-110m	1.05E+07	9.75E+06	5.79E+06	0.00E+00	1.92E+07	0.00E+00	3.98E+09
Sb-122	2.80E+05	6.43E+03	9.65E+04	4.34E+03	0.00E+00	1.68E+05	1.06E+08
Sb-124	1.04E+08	1.96E+06	4.07E+07	2.52E+05	0.00E+00	8.07E+07	2.94E+09
Sb-125	1.37E+08	1.53E+06	3.25E+07	1.39E+05	0.00E+00	1.05E+08	1.50E+09

Table 3-11a

ADULT INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	9.66E+07	3.50E+07	1.29E+07	2.90E+07	3.93E+08	0.00E+00	3.86E+08
Te-127m	3.49E+08	1.25E+08	4.26E+07	8.92E+07	1.42E+09	0.00E+00	1.17E+09
Te-127	5.66E+03	2.03E+03	1.22E+03	4.19E+03	2.31E+04	0.00E+00	4.47E+05
Te-129m	2.51E+08	9.38E+07	3.98E+07	8.63E+07	1.05E+09	0.00E+00	1.27E+09
Te-129	7.62E-04	2.87E-04	1.86E-04	5.85E-04	3.20E-03	0.00E+00	5.75E-04
Te-131m	9.12E+05	4.46E+05	3.72E+05	7.06E+05	4.52E+06	0.00E+00	4.43E+07
Te-131	1.50E-15	6.27E-16	4.74E-16	1.23E-15	6.57E-15	0.00E+00	2.13E-16
Te-132	4.30E+06	2.78E+06	2.61E+06	3.07E+06	2.68E+07	0.00E+00	1.32E+08
I-130	3.92E+05	1.16E+06	4.57E+05	9.81E+07	1.81E+06	0.00E+00	9.96E+05
I-131	8.08E+07	1.16E+08	6.62E+07	3.79E+10	1.98E+08	0.00E+00	3.05E+07
I-132	5.76E+01	1.54E+02	5.39E+01	5.39E+03	2.45E+02	0.00E+00	2.89E+01
I-133	2.09E+06	3.63E+06	1.11E+06	5.33E+08	6.33E+06	0.00E+00	3.26E+06
I-134	9.65E-05	2.62E-04	9.38E-05	4.54E-03	4.17E-04	0.00E+00	2.29E-07
I-135	3.90E+04	1.02E+05	3.77E+04	6.73E+06	1.64E+05	0.00E+00	1.15E+05
Cs-134	4.67E+09	1.11E+10	9.08E+09	0.00E+00	3.59E+09	1.19E+09	1.94E+08
Cs-136	4.24E+07	1.68E+08	1.21E+08	0.00E+00	9.32E+07	1.28E+07	1.90E+07
Cs-137	6.36E+09	8.70E+09	5.70E+09	0.00E+00	2.95E+09	9.81E+08	1.68E+08
Cs-138	3.91E-11	7.73E-11	3.83E-11	0.00E+00	5.68E-11	5.61E-12	3.30E-16
Ba-139	2.68E-02	1.91E-05	7.86E-04	0.00E+00	1.79E-05	1.08E-05	4.76E-02
Ba-140	1.28E+08	1.61E+05	8.38E+06	0.00E+00	5.46E+04	9.20E+04	2.63E+08
Ba-141	1.15E-21	8.70E-25	3.89E-23	0.00E+00	8.09E-25	4.94E-25	5.43E-31
Ba-142	2.46E-39	2.53E-42	1.55E-40	0.00E+00	2.14E-42	1.43E-42	0.00E+00
La-140	1.98E+03	9.98E+02	2.64E+02	0.00E+00	0.00E+00	0.00E+00	7.33E+07
La-142	1.41E-04	6.43E-05	1.60E-05	0.00E+00	0.00E+00	0.00E+00	4.69E-01
Ce-141	1.97E+05	1.33E+05	1.51E+04	0.00E+00	6.19E+04	0.00E+00	5.10E+08
Ce-143	9.98E+02	7.38E+05	8.16E+01	0.00E+00	3.25E+02	0.00E+00	2.76E+07
Ce-144	3.29E+07	1.38E+07	1.77E+06	0.00E+00	8.16E+06	0.00E+00	1.11E+10
Pr-143	6.26E+04	2.51E+04	3.10E+03	0.00E+00	1.45E+04	0.00E+00	2.74E+08
Pr-144	3.09E-26	1.28E-26	1.57E-27	0.00E+00	7.23E-27	0.00E+00	4.44E-33
Nd-147	3.33E+04	3.85E+04	2.31E+03	0.00E+00	2.25E+04	0.00E+00	1.85E+08
W-187	3.82E+04	3.19E+04	1.12E+04	0.00E+00	0.00E+00	0.00E+00	1.05E+07
Np-239	1.43E+03	1.41E+02	7.76E+01	0.00E+00	4.39E+02	0.00E+00	2.89E+07
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.17E+07	1.95E+07	0.00E+00	0.00E+00	0.00E+00	2.97E+08
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.15E-06	5.45E-07	1.99E-07	0.00E+00	6.35E-07	0.00E+00	2.01E-03
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	3.56E-08	2.33E-08	1.43E-08	3.11E-08	2.25E-07	0.00E+00	3.95E-11
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-11b

TEEN INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03
Be-7	1.43E+05	3.20E+05	1.60E+05	0.00E+00	3.39E+05	0.00E+00	3.90E+07
Na-24	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05
P-32	1.61E+09	9.97E+07	6.24E+07	0.00E+00	0.00E+00	0.00E+00	1.35E+08
Cr-51	0.00E+00	0.00E+00	6.17E+04	3.43E+04	1.35E+04	8.81E+04	1.04E+07
Mn-54	0.00E+00	4.54E+08	9.01E+07	0.00E+00	1.36E+08	0.00E+00	9.32E+08
Mn-56	0.00E+00	1.43E+01	2.55E+00	0.00E+00	1.81E+01	0.00E+00	9.44E+02
Fe-55	3.26E+08	2.31E+08	5.39E+07	0.00E+00	0.00E+00	1.47E+08	1.00E+08
Fe-59	1.79E+08	4.18E+08	1.61E+08	0.00E+00	0.00E+00	1.32E+08	9.88E+08
Co-58	0.00E+00	4.36E+07	1.00E+08	0.00E+00	0.00E+00	0.00E+00	6.01E+08
Co-60	0.00E+00	2.49E+08	5.60E+08	0.00E+00	0.00E+00	0.00E+00	3.24E+09
Ni-63	1.61E+10	1.13E+09	5.45E+08	0.00E+00	0.00E+00	0.00E+00	1.81E+08
Ni-65	5.72E+01	7.31E+00	3.33E+00	0.00E+00	0.00E+00	0.00E+00	3.97E+02
Cu-64	0.00E+00	8.34E+03	3.92E+03	0.00E+00	2.11E+04	0.00E+00	6.47E+05
Zn-65	4.24E+08	1.47E+09	6.86E+08	0.00E+00	9.42E+08	0.00E+00	6.23E+08
Zn-69	8.18E-06	1.56E-05	1.09E-06	0.00E+00	1.02E-05	0.00E+00	2.87E-05
Br-83	0.00E+00	0.00E+00	2.91E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	2.25E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.74E+08	1.29E+08	0.00E+00	0.00E+00	0.00E+00	4.05E+07
Rb-88	0.00E+00	3.17E-22	1.69E-22	0.00E+00	0.00E+00	0.00E+00	2.71E-29
Rb-89	0.00E+00	1.25E-26	8.82E-27	0.00E+00	0.00E+00	0.00E+00	1.91E-35
Sr-89	1.51E+10	0.00E+00	4.33E+08	0.00E+00	0.00E+00	0.00E+00	1.80E+09
Sr-90	7.51E+11	0.00E+00	1.85E+11	0.00E+00	0.00E+00	0.00E+00	2.11E+10
Sr-91	2.85E+05	0.00E+00	1.13E+04	0.00E+00	0.00E+00	0.00E+00	1.29E+06
Sr-92	3.97E+02	0.00E+00	1.69E+01	0.00E+00	0.00E+00	0.00E+00	1.01E+04
Y-90	1.24E+04	0.00E+00	3.34E+02	0.00E+00	0.00E+00	0.00E+00	1.02E+08
Y-91m	4.86E-09	0.00E+00	1.86E-10	0.00E+00	0.00E+00	0.00E+00	2.29E-07
Y-91	7.84E+06	0.00E+00	2.10E+05	0.00E+00	0.00E+00	0.00E+00	3.21E+09
Y-92	8.60E-01	0.00E+00	2.49E-02	0.00E+00	0.00E+00	0.00E+00	2.36E+04
Y-93	1.59E+02	0.00E+00	4.36E+00	0.00E+00	0.00E+00	0.00E+00	4.86E+06
Zr-95	1.72E+06	5.43E+05	3.73E+05	0.00E+00	7.98E+05	0.00E+00	1.25E+09
Zr-97	3.12E+02	6.18E+01	2.85E+01	0.00E+00	9.37E+01	0.00E+00	1.67E+07
Nb-95	1.93E+05	1.07E+05	5.89E+04	0.00E+00	1.04E+05	0.00E+00	4.57E+08
Mo-99	0.00E+00	5.65E+06	1.08E+06	0.00E+00	1.29E+07	0.00E+00	1.01E+07
Tc-99m	2.74E+00	7.63E+00	9.89E+01	0.00E+00	1.14E+02	4.24E+00	5.01E+03
Tc-101	7.64E-31	1.09E-30	1.07E-29	0.00E+00	1.97E-29	6.62E-31	1.86E-37
Ru-103	6.81E+06	0.00E+00	2.91E+06	0.00E+00	2.40E+07	0.00E+00	5.69E+08
Ru-105	5.00E+01	0.00E+00	1.94E+01	0.00E+00	6.31E+02	0.00E+00	4.04E+04
Ru-106	3.10E+08	0.00E+00	3.90E+07	0.00E+00	5.97E+08	0.00E+00	1.48E+10
Ag-110m	1.52E+07	1.43E+07	8.72E+06	0.00E+00	2.74E+07	0.00E+00	4.03E+09
Sb-122	3.03E+05	5.89E+03	8.85E+04	3.85E+03	0.00E+00	1.89E+05	6.35E+07
Sb-124	1.54E+08	2.84E+06	6.02E+07	3.50E+05	0.00E+00	1.34E+08	3.11E+09
Sb-125	2.14E+08	2.34E+06	5.00E+07	2.04E+05	0.00E+00	1.86E+08	1.66E+09

Table 3-11b

TEEN INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	1.48E+08	5.34E+07	1.98E+07	4.14E+07	0.00E+00	0.00E+00	4.37E+08
Te-127m	5.51E+08	1.96E+08	6.56E+07	1.31E+08	2.24E+09	0.00E+00	1.37E+09
Te-127	5.34E+03	1.89E+03	1.15E+03	3.68E+03	2.16E+04	0.00E+00	4.12E+05
Te-129m	3.62E+08	1.34E+08	5.73E+07	1.17E+08	1.51E+09	0.00E+00	1.36E+09
Te-129	7.14E-04	2.66E-04	1.74E-04	5.10E-04	3.00E-03	0.00E+00	3.90E-03
Te-131m	8.44E+05	4.05E+05	3.38E+05	6.09E+05	4.22E+06	0.00E+00	3.25E+07
Te-131	1.39E-15	5.75E-16	4.36E-16	1.07E-15	6.10E-15	0.00E+00	1.14E-16
Te-132	3.91E+06	2.47E+06	2.33E+06	2.61E+06	2.37E+07	0.00E+00	7.84E+07
I-130	3.51E+05	1.01E+06	4.05E+05	8.28E+07	1.56E+06	0.00E+00	7.80E+05
I-131	7.69E+07	1.08E+08	5.78E+07	3.14E+10	1.85E+08	0.00E+00	2.13E+07
I-132	5.19E+01	1.36E+02	4.88E+01	4.58E+03	2.14E+02	0.00E+00	5.92E+01
I-133	1.94E+06	3.29E+06	1.00E+06	4.59E+08	5.76E+06	0.00E+00	2.49E+06
I-134	8.73E-05	2.31E-04	8.31E-05	3.85E-03	3.65E-04	0.00E+00	3.05E-06
I-135	3.52E+04	9.07E+04	3.36E+04	5.83E+06	1.43E+05	0.00E+00	1.00E+05
Cs-134	7.10E+09	1.67E+10	7.75E+09	0.00E+00	5.31E+09	2.03E+09	2.08E+08
Cs-136	4.34E+07	1.71E+08	1.15E+08	0.00E+00	9.30E+07	1.47E+07	1.37E+07
Cs-137	1.01E+10	1.35E+10	4.69E+09	0.00E+00	4.59E+09	1.78E+09	1.92E+08
Cs-138	3.61E-11	6.93E-11	3.47E-11	0.00E+00	5.12E-11	5.96E-12	3.15E-14
Ba-139	2.52E-02	1.78E-05	7.35E-04	0.00E+00	1.67E-05	1.22E-05	2.25E-01
Ba-140	1.37E+08	1.68E+05	8.85E+06	0.00E+00	5.70E+04	1.13E+05	2.12E+08
Ba-141	1.08E-21	8.04E-25	3.59E-23	0.00E+00	7.46E-25	5.50E-25	2.29E-27
Ba-142	2.27E-39	2.27E-42	1.40E-40	0.00E+00	1.92E-42	1.51E-42	0.00E+00
La-140	1.81E+03	8.89E+02	2.37E+02	0.00E+00	0.00E+00	0.00E+00	5.11E+07
La-142	1.30E-04	5.76E-05	1.43E-05	0.00E+00	0.00E+00	0.00E+00	1.75E+00
Ce-141	2.83E+05	1.89E+05	2.17E+04	0.00E+00	8.89E+04	0.00E+00	5.40E+08
Ce-143	9.33E+02	6.79E+05	7.58E+01	0.00E+00	3.04E+02	0.00E+00	2.04E+07
Ce-144	5.27E+07	2.18E+07	2.83E+06	0.00E+00	1.30E+07	0.00E+00	1.33E+10
Pr-143	7.00E+04	2.80E+04	3.49E+03	0.00E+00	1.63E+04	0.00E+00	2.30E+08
Pr-144	2.89E-26	1.18E-26	1.47E-27	0.00E+00	6.80E-27	0.00E+00	3.19E-29
Nd-147	3.62E+04	3.94E+04	2.36E+03	0.00E+00	2.31E+04	0.00E+00	1.42E+08
W-187	3.55E+04	2.90E+04	1.02E+04	0.00E+00	0.00E+00	0.00E+00	7.84E+06
Np-239	1.39E+03	1.31E+02	7.28E+01	0.00E+00	4.11E+02	0.00E+00	2.11E+07
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.79E+07	3.00E+07	0.00E+00	0.00E+00	0.00E+00	3.33E+08
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.00E-06	4.95E-07	1.81E-07	0.00E+00	5.79E-07	0.00E+00	1.18E-02
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	3.23E-08	2.07E-08	2.17E-08	2.65E-08	1.98E-07	0.00E+00	1.20E-09
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-11c

CHILD INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	4.01E+03	4.01E+03	4.01E+03	4.01E+03	4.01E+03	4.01E+03
Be-7	3.37E+05	5.72E+05	3.77E+05	0.00E+00	5.63E+05	0.00E+00	3.20E+07
Na-24	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05
P-32	3.37E+09	1.58E+08	1.30E+08	0.00E+00	0.00E+00	0.00E+00	9.31E+07
Cr-51	0.00E+00	0.00E+00	1.17E+05	6.50E+04	1.78E+04	1.19E+05	6.21E+06
Mn-54	0.00E+00	6.65E+08	1.77E+08	0.00E+00	1.86E+08	0.00E+00	5.58E+08
Mn-56	0.00E+00	1.88E+01	4.24E+00	0.00E+00	2.27E+01	0.00E+00	2.72E+03
Fe-55	8.01E+08	4.25E+08	1.32E+08	0.00E+00	0.00E+00	2.40E+08	7.87E+07
Fe-59	3.97E+08	6.42E+08	3.20E+08	0.00E+00	0.00E+00	1.86E+08	6.68E+08
Co-58	0.00E+00	6.44E+07	1.97E+08	0.00E+00	0.00E+00	0.00E+00	3.76E+08
Co-60	0.00E+00	3.78E+08	1.12E+09	0.00E+00	0.00E+00	0.00E+00	2.10E+09
Ni-63	3.95E+10	2.11E+09	1.34E+09	0.00E+00	0.00E+00	0.00E+00	1.42E+08
Ni-65	1.05E+02	9.89E+00	5.77E+00	0.00E+00	0.00E+00	0.00E+00	1.21E+03
Cu-64	0.00E+00	1.10E+04	6.64E+03	0.00E+00	2.66E+04	0.00E+00	5.16E+05
Zn-65	8.12E+08	2.16E+09	1.35E+09	0.00E+00	1.36E+09	0.00E+00	3.80E+08
Zn-69	1.51E-05	2.18E-05	2.02E-06	0.00E+00	1.32E-05	0.00E+00	1.37E-03
Br-83	0.00E+00	0.00E+00	5.37E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	3.82E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.52E+08	2.78E+08	0.00E+00	0.00E+00	0.00E+00	2.91E+07
Rb-88	0.00E+00	4.37E-22	3.04E-22	0.00E+00	0.00E+00	0.00E+00	2.15E-23
Rb-89	0.00E+00	1.64E-26	1.46E-26	0.00E+00	0.00E+00	0.00E+00	1.43E-28
Sr-89	3.59E+10	0.00E+00	1.03E+09	0.00E+00	0.00E+00	0.00E+00	1.39E+09
Sr-90	1.24E+12	0.00E+00	3.15E+11	0.00E+00	0.00E+00	0.00E+00	1.67E+10
Sr-91	5.24E+05	0.00E+00	1.98E+04	0.00E+00	0.00E+00	0.00E+00	1.16E+06
Sr-92	7.28E+02	0.00E+00	2.92E+01	0.00E+00	0.00E+00	0.00E+00	1.38E+04
Y-90	2.30E+04	0.00E+00	6.17E+02	0.00E+00	0.00E+00	0.00E+00	6.56E+07
Y-91m	8.91E-09	0.00E+00	3.24E-10	0.00E+00	0.00E+00	0.00E+00	1.74E-05
Y-91	1.86E+07	0.00E+00	4.99E+05	0.00E+00	0.00E+00	0.00E+00	2.48E+09
Y-92	1.58E+00	0.00E+00	4.53E-02	0.00E+00	0.00E+00	0.00E+00	4.58E+04
Y-93	2.93E+02	0.00E+00	8.04E+00	0.00E+00	0.00E+00	0.00E+00	4.37E+06
Zr-95	3.86E+06	8.48E+05	7.55E+05	0.00E+00	1.21E+06	0.00E+00	8.84E+08
Zr-97	5.70E+02	8.24E+01	4.86E+01	0.00E+00	1.18E+02	0.00E+00	1.25E+07
Nb-95	4.12E+05	1.60E+05	1.15E+05	0.00E+00	1.51E+05	0.00E+00	2.97E+08
Mo-99	0.00E+00	7.71E+06	1.91E+06	0.00E+00	1.65E+07	0.00E+00	6.38E+06
Tc-99m	4.71E+00	9.24E+00	1.53E+02	0.00E+00	1.34E+02	4.69E+00	5.26E+03
Tc-101	1.41E-30	1.47E-30	1.87E-29	0.00E+00	2.51E-29	7.78E-31	4.68E-30
Ru-103	1.53E+07	0.00E+00	5.88E+06	0.00E+00	3.85E+07	0.00E+00	3.96E+08
Ru-105	9.16E+01	0.00E+00	3.32E+01	0.00E+00	8.05E+02	0.00E+00	5.98E+04
Ru-106	7.45E+08	0.00E+00	9.30E+07	0.00E+00	1.01E+09	0.00E+00	1.16E+10
Ag-110m	3.21E+07	2.17E+07	1.73E+07	0.00E+00	4.04E+07	0.00E+00	2.58E+09
Sb-122	5.58E+05	8.24E+03	1.64E+05	7.16E+03	0.00E+00	2.27E+05	4.30E+07
Sb-124	3.52E+08	4.56E+06	1.23E+08	7.73E+05	0.00E+00	1.95E+08	2.20E+09
Sb-125	4.99E+08	3.84E+06	1.05E+08	4.63E+05	0.00E+00	2.78E+08	1.19E+09

Table 3-11c

CHILD INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	3.51E+08	9.50E+07	4.67E+07	9.84E+07	0.00E+00	0.00E+00	3.38E+08
Te-127m	1.32E+09	3.56E+08	1.57E+08	3.16E+08	3.77E+09	0.00E+00	1.07E+09
Te-127	9.85E+03	2.65E+03	2.11E+03	6.81E+03	2.80E+04	0.00E+00	3.85E+05
Te-129m	8.41E+08	2.35E+08	1.31E+08	2.71E+08	2.47E+09	0.00E+00	1.03E+09
Te-129	1.32E-03	3.69E-04	3.14E-04	9.43E-04	3.87E-03	0.00E+00	8.23E-02
Te-131m	1.54E+06	5.33E+05	5.68E+05	1.10E+06	5.16E+06	0.00E+00	2.16E+07
Te-131	2.57E-15	7.83E-16	7.64E-16	1.97E-15	7.77E-15	0.00E+00	1.35E-14
Te-132	7.00E+06	3.10E+06	3.74E+06	4.51E+06	2.88E+07	0.00E+00	3.12E+07
I-130	6.16E+05	1.24E+06	6.41E+05	1.37E+08	1.86E+06	0.00E+00	5.82E+05
I-131	1.43E+08	1.44E+08	8.17E+07	4.75E+10	2.36E+08	0.00E+00	1.28E+07
I-132	9.22E+01	1.69E+02	7.79E+01	7.86E+03	2.59E+02	0.00E+00	1.99E+02
I-133	3.53E+06	4.37E+06	1.65E+06	8.11E+08	7.28E+06	0.00E+00	1.76E+06
I-134	1.55E-04	2.88E-04	1.32E-04	6.62E-03	4.40E-04	0.00E+00	1.91E-04
I-135	6.26E+04	1.13E+05	5.33E+04	9.97E+06	1.73E+05	0.00E+00	8.58E+04
Cs-134	1.60E+10	2.63E+10	5.55E+09	0.00E+00	8.15E+09	2.93E+09	1.42E+08
Cs-136	8.17E+07	2.25E+08	1.45E+08	0.00E+00	1.20E+08	1.78E+07	7.90E+06
Cs-137	2.39E+10	2.29E+10	3.38E+09	0.00E+00	7.46E+09	2.68E+09	1.43E+08
Cs-138	6.57E-11	9.13E-11	5.79E-11	0.00E+00	6.43E-11	6.91E-12	4.21E-11
Ba-139	4.65E-02	2.48E-05	1.35E-03	0.00E+00	2.17E-05	1.46E-05	2.69E+00
Ba-140	2.75E+08	2.41E+05	1.60E+07	0.00E+00	7.84E+04	1.44E+05	1.39E+08
Ba-141	1.99E-21	1.11E-24	6.47E-23	0.00E+00	9.62E-25	6.53E-24	1.13E-21
Ba-142	4.11E-39	2.96E-42	2.29E-40	0.00E+00	2.39E-42	1.74E-42	5.36E-41
La-140	3.25E+03	1.14E+03	3.83E+02	0.00E+00	0.00E+00	0.00E+00	3.17E+07
La-142	2.35E-04	7.49E-05	2.35E-05	0.00E+00	0.00E+00	0.00E+00	1.48E+01
Ce-141	6.56E+05	3.27E+05	4.86E+04	0.00E+00	1.43E+05	0.00E+00	4.08E+08
Ce-143	1.72E+03	9.31E+05	1.35E+02	0.00E+00	3.91E+02	0.00E+00	1.36E+07
Ce-144	1.27E+08	3.98E+07	6.78E+06	0.00E+00	2.21E+07	0.00E+00	1.04E+10
Pr-143	1.46E+05	4.37E+04	7.23E+03	0.00E+00	2.37E+04	0.00E+00	1.57E+08
Pr-144	5.37E-26	1.66E-26	2.70E-27	0.00E+00	8.79E-27	0.00E+00	3.58E-23
Nd-147	7.15E+04	5.79E+04	4.48E+03	0.00E+00	3.18E+04	0.00E+00	9.17E+07
W-187	6.47E+04	3.83E+04	1.72E+04	0.00E+00	0.00E+00	0.00E+00	5.38E+06
Np-239	2.57E+03	1.84E+02	1.29E+02	0.00E+00	5.33E+02	0.00E+00	1.36E+07
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	2.99E+07	6.04E+07	0.00E+00	0.00E+00	0.00E+00	2.45E+08
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	3.64E-06	6.57E-07	3.07E-07	0.00E+00	7.29E-07	0.00E+00	2.03E-01
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	5.76E-08	2.59E-08	3.46E-08	4.56E-08	2.40E-07	0.00E+00	2.63E-07
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-12

Total Body & Skin Ground Plane Dose Factors Ri(G) and Ri(S)

(m^2 * mrem/yr per uCi/sec)

Isotope	Decay Constant (sec^{-1})	Ri(G)	Ri(S)
H-3	1.780E-09	0.00E+00	0.00E+00
Be-7	1.505E-07	0.00E+00	0.00E+00
Na-24	1.284E-05	1.19E+07	1.39E+07
P-32	5.614E-07	0.00E+00	0.00E+00
Cr-51	2.896E-07	4.66E+06	5.51E+06
Mn-54	2.567E-08	1.39E+09	1.62E+09
Mn-56	7.467E-05	9.03E+05	1.07E+06
Fe-55	8.141E-09	0.00E+00	0.00E+00
Fe-59	1.802E-07	2.72E+08	3.20E+08
Co-58	1.133E-07	3.79E+08	4.44E+08
Co-60	4.170E-09	2.15E+10	2.53E+10
Ni-63	2.290E-10	0.00E+00	0.00E+00
Ni-65	7.641E-05	2.97E+05	3.45E+05
Cu-64	1.516E-05	6.07E+05	6.88E+05
Zn-65	3.289E-08	7.46E+08	8.58E+08
Zn-69	2.027E-04	0.00E+00	0.00E+00
Br-83	8.056E-05	4.87E+03	7.08E+03
Br-84	3.633E-04	2.03E+05	2.36E+05
Br-85	3.851E-03	0.00E+00	0.00E+00
Rb-86	4.299E-07	8.99E+06	1.03E+07
Rb-88	6.490E-04	3.31E+04	3.78E+04
Rb-89	7.600E-04	1.21E+05	1.45E+05
Sr-89	1.589E-07	2.16E+04	2.51E+04
Sr-90	7.548E-10	0.00E+00	0.00E+00
Sr-91	2.027E-05	2.15E+06	2.51E+06
Sr-92	7.105E-05	7.77E+05	8.63E+05
Y-90	3.008E-06	4.48E+03	5.30E+03
Y-91m	2.324E-04	1.00E+05	1.16E+05
Y-91	1.371E-07	1.07E+06	1.21E+06
Y-92	5.439E-05	1.80E+05	2.14E+05
Y-93	1.906E-05	1.83E+05	2.51E+05
Zr-95	1.254E-07	2.45E+08	2.84E+08
Zr-97	1.139E-05	2.96E+06	3.44E+06
Nb-95	2.282E-07	1.37E+08	1.61E+08
Mo-99	2.917E-06	3.99E+06	4.62E+06
Tc-99m	3.198E-05	1.84E+05	2.11E+05
Tc-101	8.136E-04	2.04E+04	2.26E+04
Ru-103	2.042E-07	1.08E+08	1.26E+08
Ru-105	4.337E-05	6.36E+05	7.21E+05
Ru-106	2.179E-08	4.22E+08	5.07E+08
Ag-110m	3.210E-08	3.44E+09	4.01E+09
Sb-122	2.971E-06	0.00E+00	0.00E+00
Sb-124	1.333E-07	5.98E+08	6.90E+08
Sb-125	7.935E-09	2.34E+09	2.64E+09

Table 3-12

Total Body & Skin Ground Plane Dose Factors Ri(G) and Ri(S)

(m^2 * mrem/yr per uCi/sec)

Isotope	Decay Constant (sec^{-1})	Ri(G)	Ri(S)
Te-125m	1.383E-07	1.55E+06	2.13E+06
Te-127m	7.360E-08	9.16E+04	1.08E+05
Te-127	2.059E-05	2.98E+03	3.28E+03
Te-129m	2.388E-07	1.98E+07	2.31E+07
Te-129	1.660E-04	2.62E+04	3.10E+04
Te-131m	6.418E-06	8.03E+06	9.46E+06
Te-131	4.621E-04	2.92E+04	3.45E+07
Te-132	2.462E-06	4.23E+06	4.98E+06
I-130	1.558E-05	5.51E+06	6.69E+06
I-131	9.978E-07	1.72E+07	2.09E+07
I-132	8.371E-05	1.25E+06	1.46E+06
I-133	9.257E-06	2.45E+06	2.98E+06
I-134	2.196E-04	4.47E+05	5.30E+05
I-135	2.913E-05	2.53E+06	2.95E+06
Cs-134	1.066E-08	6.86E+09	8.00E+09
Cs-136	6.124E-07	1.50E+08	1.70E+08
Cs-137	7.327E-10	1.03E+10	1.20E+10
Cs-138	3.588E-04	3.59E+05	4.10E+05
Ba-139	1.397E-04	1.05E+05	1.19E+05
Ba-140	6.297E-07	2.04E+07	2.34E+07
Ba-141	6.323E-04	4.17E+04	4.75E+04
Ba-142	1.090E-03	4.44E+04	5.06E+04
La-140	4.781E-06	1.92E+07	2.18E+07
La-142	1.249E-04	7.36E+05	8.84E+05
Ce-141	2.468E-07	1.37E+07	1.54E+07
Ce-143	5.835E-06	2.31E+06	2.63E+06
Ce-144	2.822E-08	6.95E+07	8.04E+07
Pr-143	5.916E-07	0.00E+00	0.00E+00
Pr-144	6.685E-04	1.83E+03	2.11E+03
Nd-147	7.306E-07	8.39E+06	1.01E+07
W-187	8.056E-06	2.36E+06	2.74E+06
Np-239	3.399E-06	1.71E+06	1.98E+06
K-40	1.717E-17	0.00E+00	0.00E+00
Co-57	2.961E-08	1.88E+08	2.07E+08
Sr-85	1.237E-07	0.00E+00	0.00E+00
Y-88	7.523E-08	0.00E+00	0.00E+00
Nb-94	1.083E-12	0.00E+00	0.00E+00
Nb-97	1.602E-04	1.76E+05	2.07E+05
Cd-109	1.729E-08	0.00E+00	0.00E+00
Sn-113	6.970E-08	0.00E+00	0.00E+00
Ba-133	2.047E-09	0.00E+00	0.00E+00
Te-134	2.764E-04	2.22E+04	2.66E+04
Ce-139	5.828E-08	0.00E+00	0.00E+00
Hg-203	1.722E-07	0.00E+00	0.00E+00

APPENDIX A

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

Primary Assumptions:

1. Units 2 and 3 effective dose factors (KLMN) are equivalent, except for site-specific finite cloud correction, as required.

2. Each unit shares 50% of the total allowable release rate, $\dot{Q}$, in Ci/sec. Therefore, $\dot{Q}3 = \dot{Q}2$ for instantaneous releases.

Given the following long-term meteorological data:

Unit 1/2:

Unit 1 or 2 Release Points	Receptor	Concentration X/Q (sec/m^3)	Finite-Cloud Gamma X/Q (sec/m^3) - Xe133	Deposition D/Q (1/m^2)
Primary Vent Releases	Site Boundary	2.219E-06 [SSW, 755 m]	1.974E-06 [SSW, 755 m]	1.407E-08 [SSW, 755 m]
	Nearest Residence	1.030E-06 [SSW, 1574 m]	9.714E-07 [SSW, 1574 m]	7.517E-09 [S, 1133 m]
Ground Level Releases	Site Boundary	2.873E-05 [SSW, 440 m]	1.215E-05 [SSW, 440 m]	8.759E-08 [SSW, 440 m]
	Nearest Residence	5.158E-06 [SSW, 1374 m]	3.068E-06 [SSW, 1374 m]	1.878E-08 [S, 933 m]

Unit 3:

Unit 3 Release Point	Receptor	Concentration X/Q (sec/m^3)	Finite-Cloud Gamma X/Q (sec/m^3) - Xe133	Deposition D/Q (1/m^2)
Primary Vent Releases	Site Boundary	4.473E-06 [SW, 350 m]	3.171E-06 [SSW, 480 m]	2.599E-08 [SSW, 480 m]
	Nearest Residence	1.016E-06 [SSW, 1574 m]	9.606E-07 [SSW, 1574 m]	7.451E-09 [S, 1133 m]
Ground Level Releases	Site Boundary	6.980E-05 [SSW, 250 m]	2.350E-05 [SSW, 250 m]	2.012E-07 [SSW, 250 m]
	Nearest Residence	5.158E-06 [SSW, 1374 m]	3.068E-06 [SSW, 1374 m]	1.878E-08 [S, 933 m]

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

Instantaneous Release Rates vs Dose Rates

Indian Point units 2 and 3 share a common site boundary limit of 500 mrem/yr. This 500 mrem/yr limit was divided between the units based upon a 50-50 split of the release rate in μCi/sec. Because each unit has its own X/Q and K-bar, equal μCi/sec discharges from each plant will result in different dose rates for each plant at the most restrictive site boundary location. In order to define the split of the 500 mrem/yr limit, IPEC units 2 and 3 must base the dose split on the mixture presented in Table 3-8.

Dose Split Between IP2 and IP3

A. Instantaneous Dose Rates and Calculation of Allowable Release Rate in uCi/sec:

i. Whole Body Dose Rate Calculations:

Given:

a) site limit is 500 mrem/yr

b) IP3 worst sector X/Q = 4.47E-6 sec/m^3

c) IP3 K-bar for instantaneous mixture = 849 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$

d) IP2 worst sector X/Q = 2.22E-6 sec/m^3

e) IP2 K-bar for instantaneous mixture = 1507 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$

f) $\dot{Q}$ = μCi/sec

Solve for $\dot{Q}$:

$\dot{Q}$ [(X/Q_3) (K bar_3) + (X/Q_2) (K bar_2)] = 500 mrem/yr

$\dot{Q}$ [(4.47E-6) (849) + (2.22E-6) (1507)] = 500 mrem/yr

Solving for $\dot{Q}$, a default back-calculated instantaneous release rate for either unit:

$\dot{Q}$ = **7.00E+4 μCi/sec**

In other words, if both units were releasing at this rate, with the default instantaneous mixture identified in Table 3-8, IPEC would be releasing at 500 mrem/yr (the RECS and 10CFR20 release rate limit).

Since this value assumes ALL releases are included (per unit), a partitioning factor should be applied for each applicable release point when this limit is used. Should it become necessary to "borrow" from the other unit, isotopic mixtures from specific sample results should replace the dose factors used in this default calculation. Without specific sample data, the default SITE release rate limit is then: **1.40E5 uCi/sec.**

APPENDIX A

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

ii. Skin Dose Rate Calculations:

Given:

a) site limit is 3,000 mrem/yr

b) IP3 worst sector X/Q = 4.47E-6 sec/m^3

c) IP3 (Li + 1.1 Mi) = 2306 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$

d) IP2 X/Q for SSW sector = 2.22E-6 sec/m^3

e) IP2 (Li + 1.1 Mi) = 3071 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$

f) $\dot{Q}$ = uCi/sec

Solve for $\dot{Q}$:

$\dot{Q}$ [(X/Q)$_3$ (Li + 1.1 Mi)$_3$ + (X/Q)$_2$ (Li + 1.1 Mi)$_2$] = 3,000 mrem/yr

$\dot{Q}$ [(4.47E-6) (2306) + (2.22E-6) (3071)] = 3,000 mrem/yr

$\dot{Q}$ = 1.75E+5 μCi/sec (less restrictive than Whole Body)

iii. Solve for WB dose rate commitments per site (with $\dot{Q}$ = 7.00E+4 uCi/sec)

Indian Point 2:

(7.00E+4 μCi/sec) (2.22E-6 sec/m^3) (1507 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$) = **234 mrem/yr**

Indian Point 3:

(7.00E+4 μCi/sec) (4.47E-6 sec/m^3) (849 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$) = **266 mrem/yr**

The less restrictive skin dose rate limit for each unit (information only):

Unit 2: (1.75E+5 uCi/sec) (2.22E-6 sec/m^3) (3071 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$) = 1194 mrem/yr

Unit 3: (1.75E+5 uCi/sec) (4.47E-6 sec/m^3) (2306 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$) = 1806 mrem/yr

APPENDIX A

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

RELEASE RATE LIMITS FOR QUARTERLY AND ANNUAL AVERAGE NOBLE GAS RELEASES

	For a Calendar Quarter	For a Calendar Year
Gamma air dose	5 mrad limit	10 mrad limit
Beta air dose	10 mrad limit	20 mrad limit

I. Assumptions:

1. Doses are delivered to the air at the site boundary.
2. Finite cloud geometry is assumed for noble gas releases at site boundary.
3. X/Q for Unit 2 = 2.22E-6 sec/m^3, ($\dot{Q}$ = release rate uCi/sec)
4. X/Q for Unit 3 = 4.47E-6 sec/m^3, ($\dot{Q}$ = release rate uCi/sec)
5. Gamma and Beta air dose factors (M and N), Corrected for finite cloud geometry (as described on Table 3-8) are as follows:

Unit 2 effective average dose factors	Unit 3 effective average dose factors	Units
$\overline{M}$ = 281	$\overline{M}$ = 181	mrad/yr per uCi/m^3
$\overline{N}$ = 1254	$\overline{N}$ = 1254	mrad/yr per uCi/m^3

II. Calculation of Quarterly Release Rates:

a) for gamma dose: ($\dot{Q}$)*[(M)(X/Q)] less than or equal to 5 mrad/qtr

b) for beta dose: ($\dot{Q}$)*[(N)(X/Q)] less than or equal to 10 mrad/qtr

		unit 2	unit 3
gamma dose rate	$\dot{Q} = \dfrac{5mrad/qtr}{(1/4yr)(M)(X/Q)}$	= 3.21E+4 μCi/sec	2.47E+4 μCi/sec
beta dose rate	$\dot{Q} = \dfrac{10mrad/qtr}{(1/4yr)(N)(X/Q)}$	= 1.44E+4 μCi/sec	7.14E+3 μCi/sec

Based on the above analysis, the beta dose is limiting for time average doses. Therefore, the allowable quarterly average release rates are 1.44E+4 μCi/sec for unit 2 and 7.14E+3 μCi/sec for unit 3.

III. Calculation of Calendar Year Release Rate

Annual limits are one half of quarterly limits. Therefore, using Beta air dose as most limiting, the maximum annual average release rates are 7.20E+3 μCi/sec for unit 2 and 3.57E+3 μCi/sec for unit 3.

APPENDIX A

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

ALLOWABLE INSTANTANEOUS RELEASE RATE for I-131 & Particulates w/ T½ > 8 DAYS)

Given: Wv(in): X/Q at the Site Boundary for IP3 = 4.47E-6 sec/m^3

Wv(in): X/Q at the Site Boundary for IP2 = 2.22E-6 sec/m^3

$$\text{PI(c)} = 1.62\text{ E7 } \frac{mrem/yr}{\mu Ci/m^3}$$

Assumed Pathway: Child Inhalation at Unrestricted Area Boundary

Solve the following equation for $\dot{Q}$:

[($\dot{Q}$)PI(c)(Wv(in)) Unit 3] + [($\dot{Q}$)PI(c)(Wv(in)) Unit 2] = 1500 mrem/yr

IP3: $(\dot{Q})\text{PI(c)(Wv(in))3} = \dot{Q} * 1.62\text{E7} \frac{mrem/yr}{\mu Ci/m^3} 4.47\text{E-6 s/m}^3 = \dot{Q} * 72.4 \frac{mrem/yr}{\mu Ci/\sec}$

IP2: $(\dot{Q})\text{PI(c)(Wv(in))2} = \dot{Q} * 1.62\text{E7} \frac{mrem/yr}{\mu Ci/m^3} 2.22\text{E-6 s/m}^3 = \dot{Q} * 36.0 \frac{mrem/yr}{\mu Ci/\sec}$

The sum equals : (108) ($\dot{Q}$) mrem/yr per uCi/sec

Limit is 1500 mrem/yr per site:

Therefore: $108 * \dot{Q} \frac{mrem/yr}{\mu Ci/\sec} = 1500$ mrem/yr

$\dot{Q}$ = 1.38E+1 µCi/sec (for each unit)

IP3 Dose Contribution: $1.38\text{E+1} \frac{\mu Ci}{\sec} * 1.62E7 \frac{mrem}{yr}\frac{m^3}{\mu Ci} * 4.47E-6 \frac{\sec}{m^3}$ = 1003 mrem/yr

IP2 Dose Contribution: $1.38\text{E+1} \frac{\mu Ci}{\sec} * 1.62E7 \frac{mrem}{yr}\frac{m^3}{\mu Ci} * 2.22E-6 \frac{\sec}{m^3}$ = 497 mrem/yr

Sum = 1500 mrem/yr

Approximately a 67 / 33 % dose split for IP3 and IP2 respectively.

APPENDIX A

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

ALLOWABLE RELEASE RATES FOR IODINE / PARTICULATE

TIME AVERAGE QUARTERLY AND ANNUAL DOSE LIMITS AT THE NEAREST RESIDENT

Dose factors for the child, thyroid (for Iodine 131) are used for this category as a conservative assumption since this nuclide has the highest thyroid dose factor of all iodines and particulates, and its most significant effect in on the child age group. The H-3 dose factor is about 4 orders of magnitude less significant and its contribution to the total dose is considered negligible. The back-calculated release rate for Iodine and Particulate is as follows:

Given:	Unit 2	Unit 3
X/Q (in sec/m^3 at the nearest resident)	1.03E-6	1.02E-6
D/Q (in m^{-2} at the nearest resident)	7.52E-9	7.45E-9

RI(c) = 1.62E+7 $\frac{mrem/yr}{\mu Ci/m^3}$, child thyroid inhalation dose factor for I-131 (for both units)

RG = 1.72E+7 m^2 $\frac{mrem/yr}{\mu Ci/\sec}$, ground plane dose factor for I-131 (for both units)

RV(c) = 4.75E+10 m^2 $\frac{mrem/yr}{\mu Ci/\sec}$, child thyroid vegetation dose factor for I-131 (for both units)

Calculating the allowable time average release rate by solving the following equation for $\dot{Q}$:

$\dot{Q}$ [(RIc)(X/Q) + (RG)(D/Q) + (RVc)(D/Q)] = limit in mrem/yr

	Unit 2	Unit 3
$\dot{Q}$ (RIc)(X/Q) in mrem/yr per uCi/sec =	16.7 * $\dot{Q}$	16.5 * $\dot{Q}$
$\dot{Q}$ (RG) (D/Q) in mrem/yr per uCi/sec =	0.129 * $\dot{Q}$	0.128 * $\dot{Q}$
$\dot{Q}$ (RVc)(D/Q) in mrem/yr per uCi/sec =	357 * $\dot{Q}$	354 * $\dot{Q}$
The sum for each unit (X * $\dot{Q}$) in mrem/yr per uCi/sec.	**374** * $\dot{Q}$	**371** * $\dot{Q}$

Quarterly time average limit is 7.5 mrem to any organ (or 30 mrem/yr). Solving for $\dot{Q}$ yields:

(IP2) $\dot{Q} * 374 \frac{mrem/yr}{\mu Ci/\sec}$ = 30 mrem/yr $\dot{Q}$ = 8.02E-2 μCi/sec **(Quarterly Limit)**

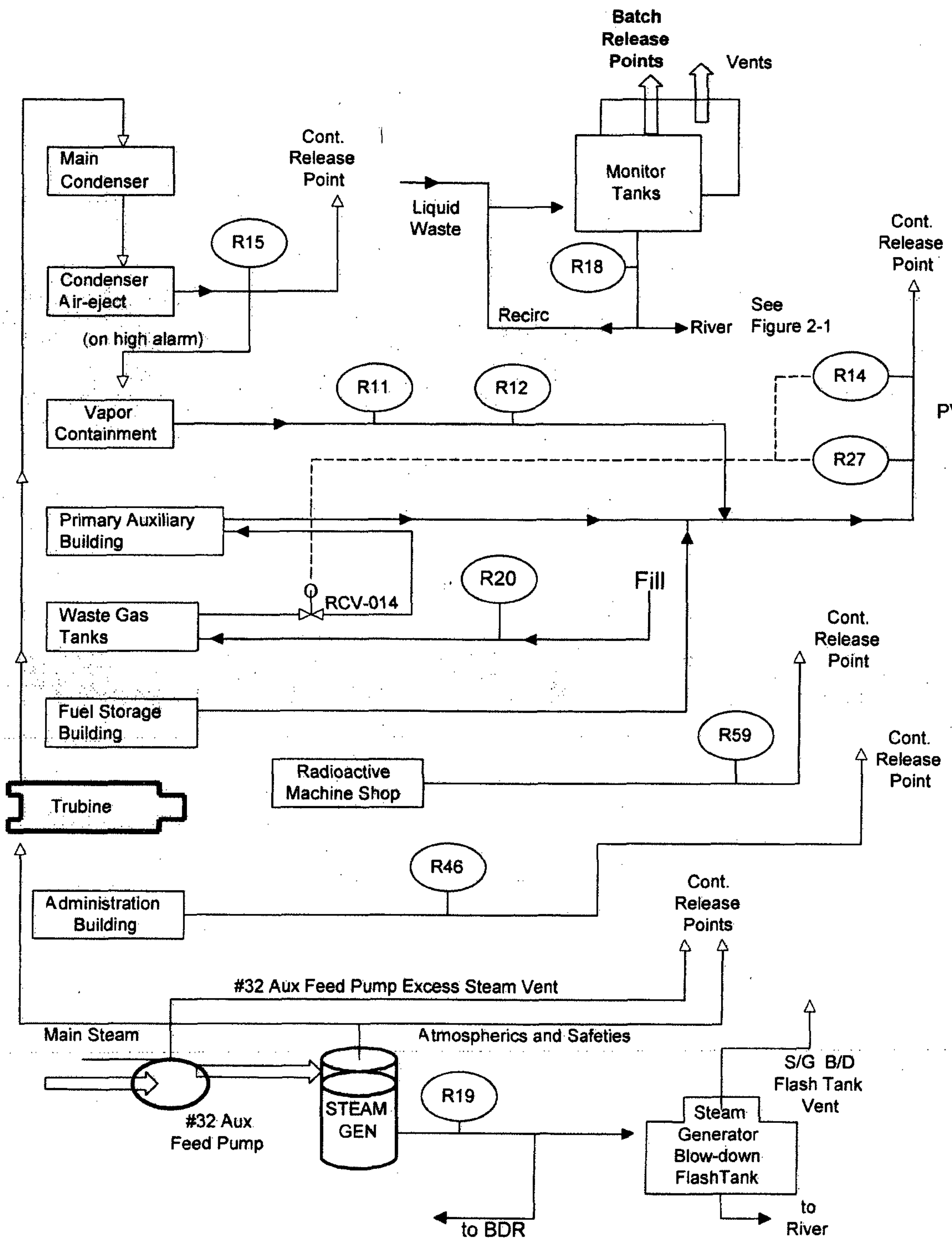
Annual limit is ½ quarterly limit, or 15 mrem to any organ/yr = 4.01E-2 μCi/sec **(Annual Limit)**

(IP3) $\dot{Q} * 371 \frac{mrem/yr}{\mu Ci/\sec}$ = 30 mrem/yr $\dot{Q}$ = 8.10E-2 μCi/sec **(Quarterly Limit)**

Annual limit is ½ quarterly limit, or 15 mrem to any organ/yr = 4.05E-2 μCi/sec **(Annual Limit)**

Figure 3-1

Gaseous Radioactive Waste Effluent System Flow Diagram



4.0 SAMPLE LOCATIONS

Figure 4-1 is a map which shows the location of environmental sampling points within 2 miles of the Indian Point Plant. Figure 4-2 is a map providing the same information for points at greater distances from the plant. Figure 4-3 shows additional environmental sample points within a ten mile radius of the plant. 1/07

Table 4-1 provides a description of all environmental sample locations and the sample types collected at each of these locations. The air sample locations were chosen considering the highest average annual D/Q sectors and the practicality of locating continuous air samplers.

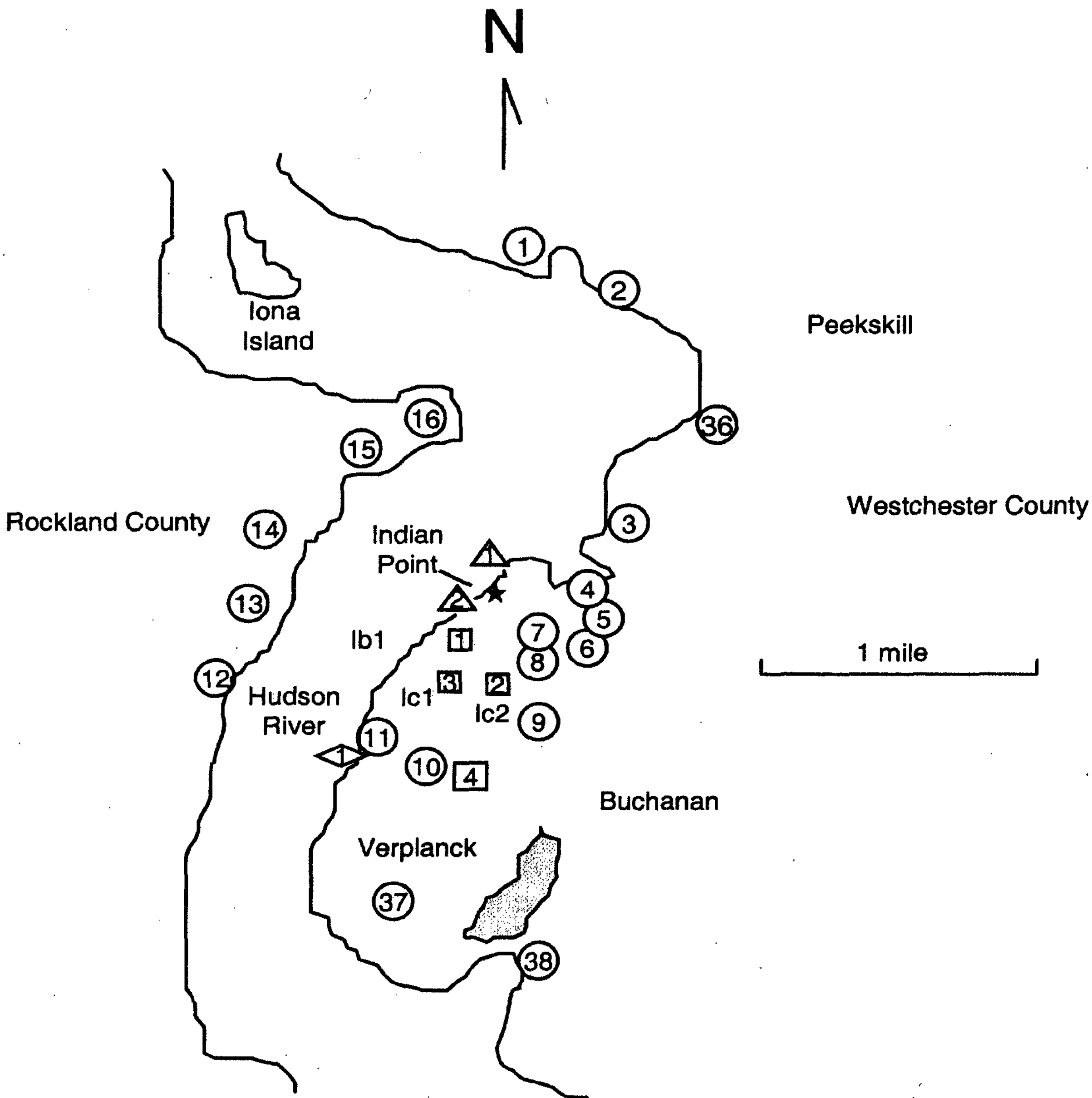
All distances on these tables are measured from the unit 1 stack. 1/07

The Ground Water Monitoring Program interfaces with the REMP at selected boundary locations where Monitoring Wells have been established to assist in early warning of potential effluent or REMP concerns. Boundary interface locations are included in the REMP (Table 4-1, page 4). All other ground water sampling locations are defined in the Ground Water Monitoring Program and station procedures. 1/07

FIGURE 4-1

ENVIRONMENTAL SAMPLING POINTS

SAMPLING LOCATIONS
Within Two Miles of Indian Point



Key:
- △ - Waterborne: Surface (HR) Wa#
- ○ - Direct Radiation Sample Location DR#
- □ - Air Particulate & Radioiodine A#
- ◇ - HR Shoreline Sediment Wc#

Ic# - Broadleaf Vegetation

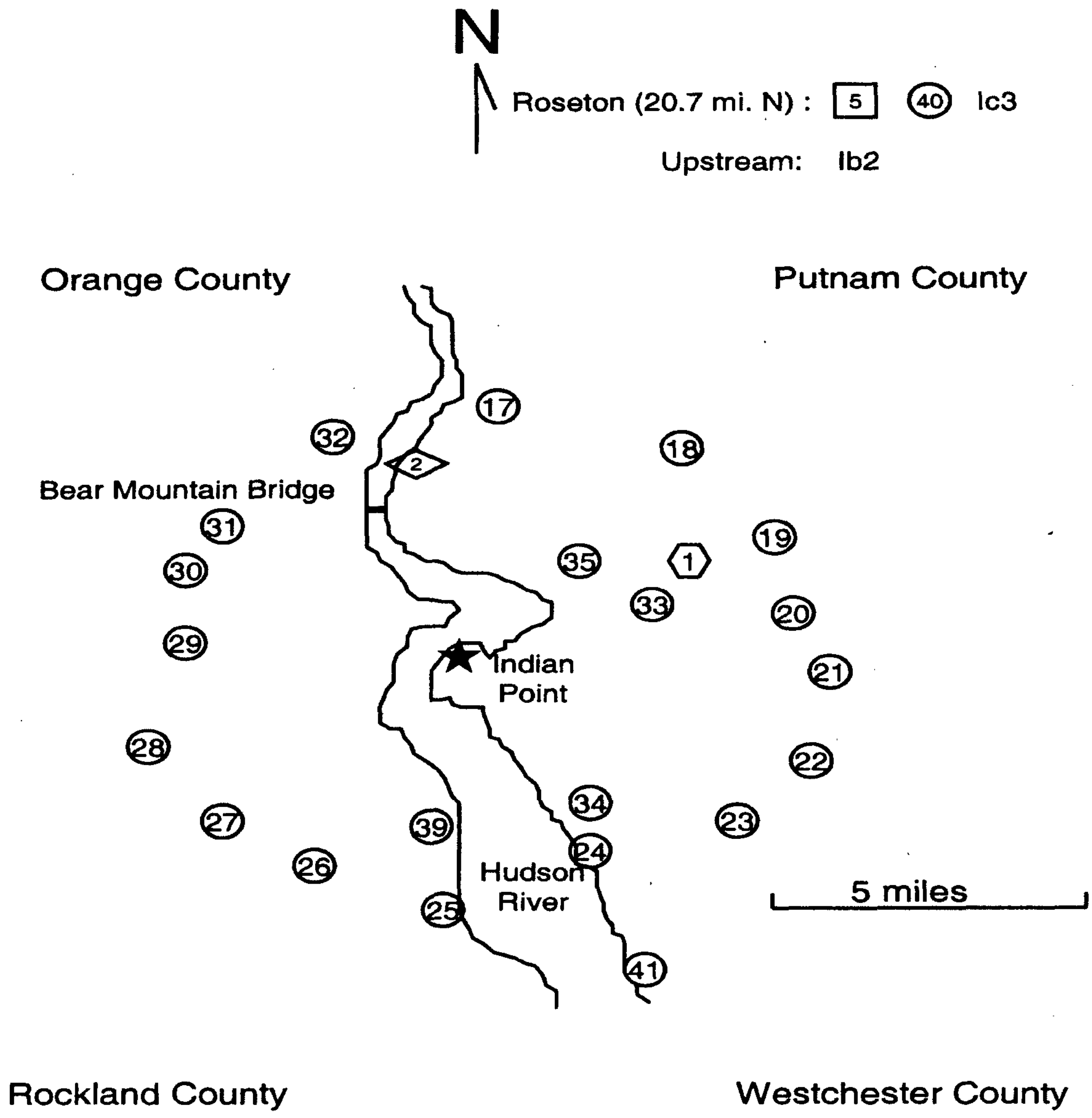
Ib1 - Fish and Invertebrates (where available downstream)

FIGURE 4-2

ENVIRONMENTAL SAMPLING POINTS

SAMPLING LOCATIONS
Within Ten Miles of Indian Point

1/07



Key:
- ○ - Direct Radiation Sample Location DR#
- □ - Air Particulate & Radioiodine A#
- ◇ - HR Shoreline Sediment Wc#
- ⬡ - Waterborne: Drinking Wb#

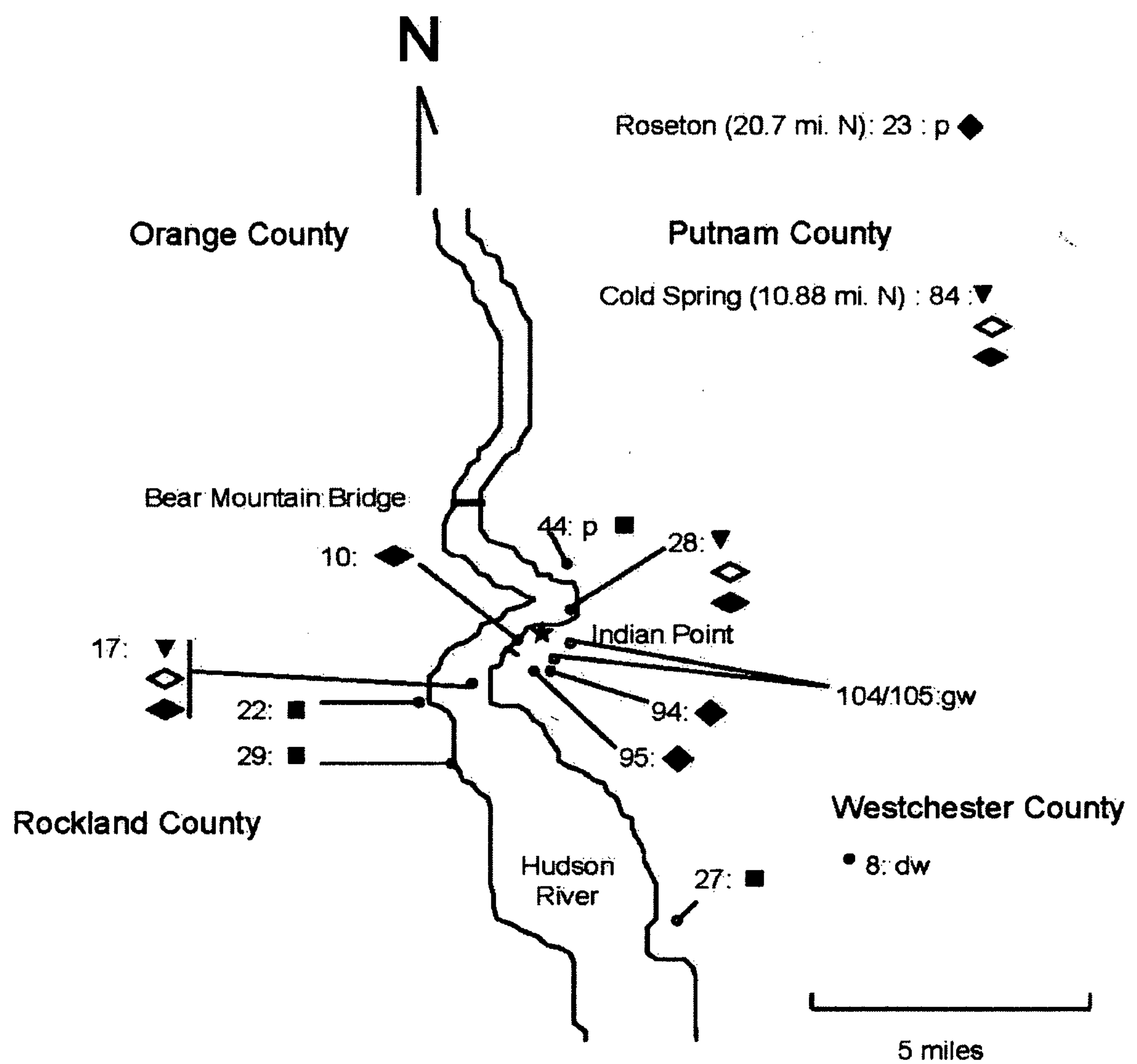
Ic3 - Broadleaf Vegetation
Ib2 - Fish and Invertebrates (where available upstream)

FIGURE 4-3

ENVIRONMENTAL SAMPLING POINTS

ADDITIONAL SAMPLING LOCATIONS

1/07



1/07

Key:
- ■ - Air Particulate & Radioiodine
- ▼ - Aquatic Vegetation
- ◆ - HR Bottom Sediment
- p - Precipitation
- dw - Drinking Water
- ◇ - HR Shoreline Sediment
- ◆ - Soil
- gw – Ground Water Boundary Monitoring (see detailed site map)

TABLE 4-1
(Page 1 of 4)

ENVIRONMENTAL SAMPLING POINTS

SAMPLE DESIGNATION/ STATION	LOCATION	DISTANCE	1/07
DR1/57	Roa Hook	2.0 mi – N	
DR2/59	Old Pemart Avenue	1.8 mi – NNE	
DR3/90	Charles Point	0.88 mi – NE	
DR4/28	Lents Cove	0.45 mi – ENE	
DR5/35	Broadway and Bleakley Avenue	0.37 mi – E	
DR6/88	Reuter-Stokes Pole #6	0.32 mi – ESE	
DR7/14	Water Meter House	0.3 mi – SE	
DR8/03	Service Center Building	0.35 mi – SSE	
DR9/34	South East Corner of Site	0.52 mi – S	
DR10/05	NYU Tower	0.88 mi – SSW	
DR11/53	White Beach	0.92 mi – SW	
DR12/74	West Shore Drive – South	1.59 mi – WSW	
DR13/76	West Shore Drive – North	1.21 mi – W	
DR14/78	Rt. 9W, across from R/S #14	1.2 mi – WNW	
DR15/80	Rt. 9W - South of Ayers Road	1.02 mi – NW	
DR16/82	Ayers Road	1.01 mi – NNW	
DR17/58	Rt. 9D – Garrison	5.41 mi – N	
DR18/60	Gallows Hill Road and Sprout Brook Road	5.02 mi – NNE	
DR19/62	West Brook Drive (near the Community Center)	5.03 mi – NE	
DR20/64	Lincoln Road – Cortlandt (School Parking Lot)	4.6 mi – ENE	
DR21/66	Croton Ave. – Cortlandt	4.87 mi – E	
DR22/67	Colabaugh Pond Rd. – Cortlandt	4.5 mi – ESE	
DR23/69	Mt. Airy & Windsor Road	4.97 mi – SE	
DR24/92	Warren Rd. – Cortlandt	3.84 mi – SSE	
DR25/71	Warren Ave. – Haverstraw	4.83 mi – S	
DR26/72	Railroad Ave. & 9W Haverstraw	4.53 mi – SSW	
DR27/73	Willow Grove Rd. & Captain Faldermeyer Drive	4.97 mi – SW	
DR28/81	Palisades Parkway, Lake Welch Exit	4.96 mi – WSW	
DR29/77	Palisades Parkway	4.15 mi – W	
DR30/79	Anthony Wayne Park	4.57 mi – WNW	
DR31/75	Palisades Parkway	4.65 mi – NW	
DR32/83	Rt. 9W Fort Montgomery	4.82 mi – NNW	
DR33/33	Hamilton Street (Substation)	2.88 mi – NE	
DR34/38	Furnace Dock (Substation)	3.43 mi – SE	
DR35/89	Highland Ave. & Sprout Brook Rd. (near Rock Cut)	2.89 mi – NNE	
DR36/61	Lower South Street and Franklin Street	1.3 mi – NE	
DR37/56	Verplanck – Broadway & 6th St.	1.25 mi – SSW	
DR38/20	Cortlandt Yacht Club (aka Montrose Marina)	1.5 mi – S	
DR39/29	Grassy Point	3.37 mi – SSW	
DR40/23	Roseton ***(control station)***	20.7 mi – N	1/07
DR41/27	Croton Point	6.36 mi – SSE	

TABLE 4-1
(Page 2 of 4)

ENVIRONMENTAL SAMPLING POINTS

1/07

SAMPLE DESIGNATION/ STATION	LOCATION	DISTANCE
	Airborne	
A1/4	Algonquin Gas Line	0.28 mi – SW
A2/94	IPEC Training Center	0.39 mi – S
A3/95	Meteorological Tower	0.46 mi – SSW
A4/5	NYU Tower	0.88 mi – SSW
A5/23	*Roseton	20.7 mi – N
	Waterborne – Surface (Hudson River Water)	
Wa1/9	*Plant Inlet (Hudson River Intake)	0.16 mi – W
Wa2/10	Discharge Canal (Mixing Zone)	0.3 mi – WSW
	Waterborne – Drinking	
Wb1/7	Camp Field Reservoir	3.4 mi – NE
	Soil From Shoreline	
Wc1/53	White Beach	0.92 mi – SW
Wc2/50	*Manitou Inlet	4.48 mi – NNW

Exposure Pathway/Sample: Milk

There are no milch animals whose milk is used for human consumption within 8 km distance of Indian Point; therefore, no milk samples are taken.

Exposure Pathway/Sample: Ingestion-Fish and Invertebrates

The RECS designate two required sample locations labeled Ib1/25 and Ib2/23. The downstream Ib1 location and samples will be chosen where it is likely to be affected by plant discharge. Ib2 will be a location upstream that is not likely to be affected by plant discharge. The following species along with other commercially/recreationally important species are considered acceptable:

Striped Bass	Pumpkin Seed	American Eel
Bluegill Sunfish	White Catfish	Crabs
White Perch	Blueback Herring	

Exposure Pathway/Sample: Ingestion-Food Products (Broad Leaf Vegetation)

Ic1/95	Meteorological Tower	0.46 mi - SSW
Ic2/94	IPEC Training Center	0.39 mi - S
Ic3/23	*Roseton	20.7 mi - N

*Control Station

TABLE 4-1
(Page 3 of 4)

ENVIRONMENTAL SAMPLING POINTS

SAMPLE DESIGNATION/ STATION	LOCATION	DISTANCE	SAMPLE TYPES	
DR8/3	Service Center Building	0.35 mi – SSE	3	1/07
A1/4	Algonquin Gas Line	0.28 mi – SW	1,2	
A4, DR10/5	NYU Tower	0.88 mi – SSW	1,2,3	
Wb1/7	Camp Field Reservoir	3.4 mi – NE	6	
**/8	Croton Reservoir	6.3 mi - SE	6	1/07
Wa1/9	*Plant Inlet (Hudson River Intake)	0.16 mi - W	7	
Wa2/10	Discharge Canal (Mixing Zone)	0.3 mi - WSW	7,8	
DR7/14	Water Meter House	0.3 mi – SE	3	
**/17	Off Verplanck	1.5 mi – SSW	8,9,10	1/07
DR38/20	Cortlandt Yacht Club (AKA Montrose Marina)	1.5 mi – S	3	
**/22	Lovett Power Plant	1.6 mi – WSW	1,2	1/07
Ib2,A5,DR40,Ic3/23	*Roseton	20.7 mi – N	1,2,3,4,5,11,12	
Ib1/25	where available, downstream	N/A	12	
DR41/27	Croton Point	6.36 mi – SSE	1,2,3	
DR4/28	Lents Cove	0.45 mi - ENE	3,8,9,10	
DR39/29	Grassy Point	3.37 mi – SSW	1,2,3	
DR33/33	Hamilton Street (Substation)	2.88 mi – NE	3	
DR9/34	South East Corner of Site	0.52 mi – S	3	
DR5/35	Broadway & Bleakley Avenue	0.37 mi – E	3	
DR34/38	Furnace Dock (Substation)	3.43 mi – SE	3	
**/44	Peekskill Gas Holder Building	1.84 mi – NE	1,2,11	1/07
Wc2/50	*Manitou Inlet	4.48 mi – NNW	10	
Wc1, DR11/53	White Beach	0.92 mi – SW	3,10	
DR37/56	Verplanck – Broadway & 6th Street	1.25 mi - SSW	3	
DR1/57	Roa Hook	2.0 mi – N	3	
DR17/58	Rt. 9D Garrison	5.41 mi – N	3	
DR2/59	Old Pemart Ave.	1.8 mi – NNE	3	
DR18/60	Gallows Hill Road and Sprout Brook Road	5.02 mi – NNE	3	
DR36/61	Lower South Street and Franklin Street	1.3 mi – NE	3	
DR19/62	West Brook Drive (near the Community Center)	5.03 mi – NE	3	
DR20/64	Lincoln Road – Cortlandt (School Parking Lot)	4.6 mi – ENE	3	
DR21/66	Croton Ave. – Cortlandt	4.87 mi – E	3	
DR22/67	Colabaugh Pond Rd. – Cortlandt	4.5 mi – ESE	3	
DR23/69	Mt. Airy & Windsor Road	4.97 mi – SE	3	

* Control Station

** Items are in excess of RECS requirements | 1/07

TABLE 4-1
(Page 4 of 4)

ENVIRONMENTAL SAMPLING POINTS

1/07

SAMPLE DESIGNATION/ STATION	LOCATION	DISTANCE	SAMPLE TYPES
DR25/71	Warren Avenue – Haverstraw	4.83 mi – S	3
DR26/72	Railroad Ave. & 9W – Haverstraw	4.53 mi – SSW	3
DR27/73	Willow Grove Rd. & Captain Faldermeyer Dr	4.97 mi – SW	3
DR12/74	West Shore Drive – South	1.59 mi – WSW	3
DR31/75	Palisades Parkway	4.65 mi – NW	3
DR13/76	West Shore Drive – North	1.21 mi – W	3
DR29/77	Palisades Parkway	4.15 mi – W	3
DR14/78	Rte. 9W, across from R/S #14	1.2 mi – WNW	3
DR30/79	Anthony Wayne Park	4.57 mi – WNW	3
DR15/80	Rte. 9W – South of Ayers Road	1.02 mi – NW	3
DR28/81	Palisades Parkway, Lake Welch Exit	4.96 mi – WSW	3
DR16/82	Ayers Road	1.01 mi – NNW	3
DR32/83	Rte. 9W – Fort Montgomery	4.82 mi – NNW	3
**/84	Cold Spring	10.88 mi – N	8,9,10
**/85	Quality Control		6
DR6/88	Reuter-Stokes Pole #6	0.32 mi – ESE	3
DR35/89	Highland Ave. & Sprout Brook Rd (rock cut)	2.89 mi – NNE	3
DR3/90	Charles Point	0.88 mi – NE	3
DR24/92	Warren Rd. – Cortlandt	3.84 mi – SSE	3
A2, Ic2/94	IPEC Training Center	0.39 mi – S	1,2,4,5
A3, Ic1/95	Meteorological Tower	0.46 mi - SSW	1,2,4,5
MW-40/104	Boundary Well #40	0.21 mi - SW	13
MW-51/105	Boundary Well #51	0.18 mi - SSW	13

1/07

1/07

** Items are in excess of RECS requirements

Sample types are:

1. Air particulates
2. Radioiodine
3. Direct gamma
4. Broadleaf vegetation
5. Soil
6. Drinking water
7. Hudson River (H.R.) water
8. H.R. bottom sediment-silt
9. H.R. aquatic vegetation
10. H.R. shoreline soil
11. Fallout
12. Fish and invertebrates
13. Ground water boundary monitoring (see ODCM Part II, Figure 1-1)

1/07

APPENDIX B

DETECTION CAPABILITIES

The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{\frac{2.71}{T_s} + 3.29 s_b * \sqrt{1+(\frac{T_b}{T_s})}}{E * V * k * Y * e^{-\lambda t}}$$

<u>where</u>:

LLD =	The lower limit of detection as defined above (as picocurie per unit mass or volume)
T_s =	The sample counting time in minutes
s_b =	The standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)
T_b =	The background count time in minutes
E =	The counting efficiency (as counts per transformation)
V =	The sample size (in units of mass or volume)
k =	A constant for the number of transformations per minute per unit of activity (normally, 2.22E+6 dpm per μCi)
Y =	The fractional radiochemical yield (when applicable)
λ =	The radioactive decay constant for the particular radionuclide
t =	The elapsed time between midpoint of sample collection and time of counting
Note:	The above LLD formula accounts for differing background and sample count times. The IP3 Radiological Environmental Monitoring Program, REMP, uses an LLD formula that assumes equal background and sample count times, in accordance with the RECS. When the above LLD formula is more appropriate for the effluents program, it may be used.

The constants 2.71 and 3.29 and the general LLD equation were derived from the following two sources:

1) Currie, L.A. "Limits for Qualitative Detection of Quantitative Determination". (Anal. Chem. 40:586-593, 1968); and,

2) Mayer, Dauer "Application of Systematic Error Bounds to Detection Limits for Practical Counting". (HP Journal 65(1): 89-91, 1993)

The value of Sb used in the calculation of the LLD for a detection system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance. In calculating the LLD for a radionuclide determined by gamma ray spectrometry, the background shall include the typical contributions of other radionuclides normally present in the samples. Typical values of E, V, Y, and t shall be used in the calculation. The background count rate is calculated from the background counts that are determined to be within ± one FWHM (Full-Width-at-Half-Maximum) energy band about the energy of the gamma ray peak used for the quantitative analysis for that radionuclide.

It should be recognized that the LLD is defined as an <u>a priori</u> (before the fact) limit representing the capability of a measurement process and not as an <u>a posteriori</u> (after the fact) limit for a particular measurement.

To handle the <u>a posteriori</u> problem, a decision level must be defined. The remainder of Appendix B discusses the use of the Critical Level concept. Following an experimental observation, one must decide whether or not a real signal was, in fact, detected. This type of binary qualitative decision is subject to two kinds of error: deciding that the radioactive material is present when it is not (a: Type I error), and the converse, failing to decide that it is present when it is (b: Type II error). The maximum acceptable Type I error (a), together with the standard deviation, Snet, of the net signal when the net signal equals zero, establish the Critical Level, Lc, upon which decisions may be based.

Operationally, an observed signal, S, must exceed L_c to yield the decision, detected.

$$L_c = k_a s_b(1+T_b/T_s)^{0.5}$$

<u>where</u>:

k_a is related to the standardized normal distribution and corresponds to a probability level of <u>1-a</u>. For instance, selection of a = 0.01 corresponds to a 99% confidence level that activity is present. When determining the Lc for different measurement processes, it is allowable to set a at less than or equal to 0.05 as long as the following condition is met:

To set <u>a</u> for L_c determination at less than 0.05, the equation for the LLD (which places <u>a</u> less than or equal to 0.05) should be employed to verify that the calculated LLD is less than or equal to the LLDs specified in the IP-3 RECS. This calculation, if necessary, will be performed on a case by case basis.

Unit 2 ODCM Revision 10 Justification Package

Prepared by: Steven Sandike **Brief Summary of Changes** January, 2007

ODCM Part I

1 *Added definition of Pri to Sec Leak in D1.1 (from U3 ODCM).*

2 *Added Service Water and Turbine Hall Drains to Table D3.1.1-1 and clarified differentiation between sampling and analysis.*

3 *Added notes (i) and (j) to the Notes following Table D3.1.1-1 for Feedwater/TH Drains, and need for beta analyses.*

4 *Listed effective tanks in DLCO 3.1.4.*

5 *Reworded DSR 3.1.4.1 to identify that the determination is performed in accordance with the ODCM.*

6 *Clarified VCPR sample requirements in Table 3.2.1-1, footnote (i) for periods when both VC Rad Mons (R-41& 42) are OOS.*

7 *Clarified Table 3.3.1-1, (2a), adding footnote (g), specifying which SW monitors are required when systems are in service.*

8 *Clarified Condition "G" in DLCO 3.3.2 to stipulate this condition refers to gas decay tanks.*

9 *Added Sr-90 requirements to the REMP in Table D 3.5.1-1, Sections 3c (sediment) and 4b (Fish / Invertebrates).*

10 *Added Site Boundary Monitoring Well sample requirements to Table D 3.5.1-1 as Section 3d per the GWMP.*

11 *Added Sr-90 to Tables D 3.5.1-2 and D 3.5.1-3 with note identifying the GWMP interface with the REMP.*

12 *Added clarification for the meaning of LLD in Table D 3.5.1-3, note c, from U3 ODCM.*

13 *Expanded the explanation of the UNRESTRICTED AREA maps in section D 4.1, and added specific map for release points.*

14 *Add additional verbiage to Section D 5.1 to include all of U3 ODCM information for the joint annual REMP report.*

15 *Added Section 5.6 to identify the Ground Water Monitoring Program and its key components.*

ODCM Part II

16 *Added a discussion of IE Bulletin 80-10 program (from U3 ODCM) to Section 1.1.*

17 *Added a section describing concentration limits on tanks to comply with the 10 curie limit (from U3 ODCM) to Section 1.1.*

18 *Added a paragraph to Section 1.1 to identify potentially necessary additional release quantification from the GWMP.*

19 *Added References 24 and 25 regarding the GWMP.*

20 *Added ground and storm water representation to Appendix B.*

21 *Modified Appendix G, pages 5-7 to show "additional" sample points, rather than "RECS or non-RECS".*

22 *Denoted samples that are NOT required by RECS in Appendix G (pages 3 and 4).*

23 *Added Boundary Wells (MW-40 and MW-51) to Appendix G, page 4, and explained note 13 as supporting GWMP.*

Each change is discussed in detail on the following pages. This information is to be included in the OSRC presentation, the 50.59 package, and the next Annual Effluent Release Report sent to the Commission per Reg Guide 1.21

Unit 2 ODCM Revision 10 Justification Package

item # 1 of 23 Jan, 2007

OBJECTIVE:

Add definition of Pri to Sec Leak in D1.1 (from U3 ODCM).

DESCRIPTION OF CHANGES:

Added the definition of Pri to Sec Leak from Unit 3 ODCM into the definition section of U2 ODCM.

IMPACT:

None.

JUSTIFICATION:

This definition includes detailed criteria from plant parameters to differentiate diffusion of H-3 through the SG U-tubes, from an actual Primary to Secondary Leak. It has been in station procedures and the unit 3 ODCM for several years and was added to the U2 ODCM for completeness and to better prepare for the upcoming merge of ODCMs into one document.

Unit 2 ODCM Revision 10 Justification Package

item # 2 of 23 Jan, 2007

OBJECTIVE:

Add Service Water and Turbine Hall Drains to Table D3.1.1-1 and clarify differentiation between sampling and analysis.

DESCRIPTION OF CHANGES:

Added Service Water and Turbine Hall Drains to this table, in addition to the earlier entry, which had been simply entitled "Continuous Releases". Clarified the differences between Sample and analysis frequency where composites were involved.

IMPACT:

None.

JUSTIFICATION:

This section of the RECS, following NUREG 1301, simply splits batch and continuous liquid effluent sampling requirements into two general categories. However, as not all continuous releases have the same requirements. These two types of continuous releases were added as separate lines. These criteria have not changed, but were copied into the Unit 2 ODCM from the Unit 3 ODCM and station procedures in preparation of merging the ODCMs, and for completeness and accuracy with regard to these special continuous releases.

Unit 2 ODCM Revision 10 Justification Package

item # 3 of 23 Jan, 2007

OBJECTIVE:

Add notes (i) and (j) to the Notes following Table D3.1.1-1 for Feedwater/TH Drains. Identify beta analyses required when gamma activity is detected for these pathways.

DESCRIPTION OF CHANGES:

Added notes (i) and (j) to the Notes following Table D3.1.1-1 for Feedwater/TH Drains. Add the Beta analyses requirement when gamma activity is detected for these pathways.

IMPACT:

None.

JUSTIFICATION:

These two new types of continuous releases were added to the ODCM on separate lines to ensure completeness and assist in merging the document with Unit 3's ODCM. The requirement for Beta analyses only applies if gamma isotopes are present for these streams, as they are not normally monitored for Beta emitters. Beta activity in these systems would be identified either from known SG Tube leaks (already monitored via SG blowdown) or documented Service Water leaks. These criteria have not changed, but were copied into the Unit 2 ODCM from the Unit 3 ODCM and station procedures in preparation of merging the ODCMs, and for completeness and accuracy with regard to these special continuous releases.

Unit 2 ODCM Revision 10 Justification Package

item # 4 of 23 Jan, 2007

OBJECTIVE:

List effective tanks in DLCO 3.1.4.

DESCRIPTION OF CHANGES:

Listed the effected tanks within the DLCO, rather than just the bases.

IMPACT:

None.

JUSTIFICATION:

This clarification enhancement was performed to provide the brief list of effected tanks directly within the LCO, rather than leave this information to only the BASES. The CONDITION statement refers to "*...limits in any listed tank*". It was not clear (without actually listing the tanks below this phrase), exactly WHICH tanks were effected by this LCO. While it may be an expectation to refer to the BASES section for this kind of information, there are only two permanent tanks involved in this LCO, and it was much more clear to simply list them within the LCO. Additionally, this improvement helps to consolidate methodologies between ODCMs, as unit 3 ODCM lists the tanks effected in unit 3.

Unit 2 ODCM Revision 10 Justification Package

item # 5 of 23 Jan, 2007

OBJECTIVE:

Reword DSR 3.1.4.1 to identify that the determination is performed in accordance with the ODCM.

DESCRIPTION OF CHANGES:

Reworded DSR 3.1.4.1 to identify that a DETERMINATION is to be performed in accordance with the ODCM.

IMPACT:

None.

JUSTIFICATION:

Adding this explanation ensures that a grab sample of an idle tank is not automatically required to demonstrate compliance with this surveillance. While isolating, recirculating, and sampling are always an option, "determining" that the curie level of an outdoor tank can also be accomplished by tracking the curie contents from inlet concentrations and volume added, which in many case, is zero.

Station procedures, as well as this section of the ODCM, limit the concentration in these tanks such that ten curies cannot be approached at any time. This improvement will ensure there is a means of determining the curie content, while precluding mandated significant resource expenditure for idle tanks which can otherwise be proven well below the ten curie limit.

Unit 2 ODCM Revision 10 Justification Package

 Jan, 2007

OBJECTIVE:

Clarify VCPR sample requirements when both R-41 and R-42 are OOS (no VC rad monitor available).

DESCRIPTION OF CHANGES:

Clarify Table D 3.2.1-1, Note (i) to provide VCPR sample requirements when both R-41 and R-42 are OOS (no VC rad monitor available). While this note had previously identified the requirement for a VC noble gas grab sample when R-42 was OOS, the additional requirement of two independent samples was added if the particulate monitor is also OOS.

IMPACT:

None. Plant lower tier procedures already had incorporated this clarification.

JUSTIFICATION:

These criteria were added to the ODCM for clarity and completeness as a result of the generally incomplete guidance for VCPR applications in the NUREG 1301. Lower tier procedures include this guidance at both operating units, when both VC rad monitors are OOS. While a noble gas grab sample would suffice when the gas monitor was OOS, the lack of the particulate monitor as well indicates no automatic isolation at the source. Therefore, additional assurance of absence of risk appears warranted.

Unit 2 ODCM Revision 10 Justification Package

item # 7 of 23 Jan, 2007

OBJECTIVE:

Clarify Table 3.3.1-1, (2a) and add footnote (g) to specify which SW monitors are required when systems are in service.

DESCRIPTION OF CHANGES:

Identified in four distinct lines, the Service Water monitor requirements, to clarify the redundancy of R-46/53 (FCUs), but still identify the need for individual channels (one per instrument) for the other Service Water effluent lines. Added Note (g) to ensure requirements were clearly specified.

IMPACT:

None. Plant lower tier procedures already had incorporated this clarification.

JUSTIFICATION:

These criteria were added to the ODCM for clarity and completeness as a result of less specific guidance in earlier revisions. While either R-46 or R-53 satisfies the requirement for FCU SW effluent, the other SW lines listed require the applicable monitor to be in service while there is a Service Water effluent. This improvement from the simplistic listing in NUREG 0472 is consistent with the FSAR description, NUREG 1301, system descriptions, and industry benchmarking.

Unit 2 ODCM Revision 10 Justification Package

item # 8 of 23

Jan, 2007

OBJECTIVE:

Clarify Condition "G" in DLCO 3.3.2 to stipulate this condition refers to gas decay tanks.

DESCRIPTION OF CHANGES:

Clarify DLCO 3.3.2, Condition "G", that this stipulation applies to gas decay tanks. (Inserted "gas decay tank" prior to "release" in the completion time block).

IMPACT:

None.

JUSTIFICATION:

This clarification was necessary as a result of inadvertent omission of the gas decay tank reference when this LCO was converted into NUREG 1431 format for ITS. As a result, it had occasionally been inappropriately applied to Plant Vent applications. NUREG 1301 clearly stipulates this control with regard to *gas decay tank* releases with an inoperable radiation monitor.

Unit 2 ODCM Revision 10 Justification Package

item # 9 of 23 Jan, 2007

OBJECTIVE:

Add Sr-90 requirements to the REMP in Table D 3.5.1-1, Sec 3c (sediment) and 4b (Fish/Inv).

DESCRIPTION OF CHANGES:

Added a requirement for analysis of Sr-90 in Shoreline Sediment, Ground Water, and Fish/Invertebrates in Table 2.7-1. Clarified that for the ingestion pathway, this analysis involves edible portions of fish and invertebrates, in 2nd column (Section 4b)

IMPACT:

Fish, Ground Water, and Shoreline Sediment samples for the REMP will now require Sr-90 analyses.

JUSTIFICATION:

Sr-90 was added to these tables as a commitment from the Ground Water investigation. While the old values of ETSR in 1977 were evaluated for application, a new dose basis for the values selected was performed per IPEC-CHM-06-026. This memo establishes LLDs and Reporting Levels by comparisons to ratios of other isotopes and EPA drinking water standards, as well as a determination of ensuring the LLD represents 10% or less of the annual critical organ dose contribution for Sr-90 in both water and fish. The resulting LLDs dropped slightly from those in practice when Sr-90 was last required in the REMP.

Reporting levels were then extrapolated from comparisons to other nuclides and to the drinking water guidelines.

The memo also made clear the distinction between these values (applying solely to the REMP) and values determined for use in the Ground Water Monitoring Program (GWMP), which may involve other criteria. Reporting levels and LLDs for ground water are included in the GWMP and station procedures.

Unit 2 ODCM Revision 10 Justification Package

item # 10 of 23 Jan, 2007

OBJECTIVE:

Add Site Boundary Monitoring Well sample requirements to Table D 3.5.1-1 as Section 3d per the GWMP.

DESCRIPTION OF CHANGES:

Added Site Boundary Monitoring Well sample requirements to Table D 3.5.1-1 in Section 3d. Identified 2 wells, sampled quarterly for gamma spec, H-3, and Sr-90.

IMPACT:

Increased annual operating cost and new procedural requirements for the REMP.

JUSTIFICATION:

Analyzing for these isotopes on the way to the site boundary will help define the extent of any potential plume. It will give an early warning of possible movement toward the actual site boundary in these directions. This effort is required by the NEI initiative and a commitment to the NRC and local stakeholders (NL-06-033, #2 and #3).

OBJECTIVE:

Add Sr-90 to Tables D3.5.1-2 and D3.5.1-3 with note identifying the GWMP interface with the REMP.

DESCRIPTION OF CHANGES:

Reporting Levels and LLDs for Sr-90 were reinstated into these tables, as a result of adding the requirement to analyze for this isotope. Added a note to ensure there is a clear understanding of the interface between the GWMP and the REMP (such that LLDs and Reporting Levels are understood to be potentially different between the two).

IMPACT:

None. Vendor labs have verified ability to meet LLDs.

JUSTIFICATION:

Sr-90 was added to these tables as a commitment from the Ground Water investigation. While the old values of ETSR in 1977 were evaluated for application, a new dose basis for the values selected was performed per IPEC-CHM-06-026. This memo establishes LLDs and Reporting Levels by comparisons to ratios of other isotopes and EPA drinking water standards, as well as a determination of ensuring the LLD represents 10% or less of the annual critical organ dose contribution for Sr-90 in both water and fish. The resulting LLDs dropped slightly from those in practice when Sr-90 was last required in the REMP.

Reporting levels were then extrapolated from comparisons to other nuclides and to the drinking water guidelines.

The memo also made clear the distinction between these values (applying solely to the REMP) and values determined for use in the Ground Water Monitoring Program (GWMP), which may involve other criteria. Reporting levels and LLDs for ground water are included in the GWMP and station procedures.

Unit 2 ODCM Revision 10 Justification Package

item # 12 of 23 Jan, 2007

OBJECTIVE:

Add clarification for the meaning of LLD in Table D 3.5.1-3, note c, from U3 ODCM.

DESCRIPTION OF CHANGES:

The definition of LLD in note (c) at the end of this table was expanded to include the differentiation between a priori and a posteriori measurements.

IMPACT:

None.

JUSTIFICATION:

The added definition from U3 ODCM was added here to U2 ODCM to ensure complete understanding of the application and purpose of the REMP LLDs, as well as to continue the effort to merge the station's ODCMs into one document. This enhancement to the definition is in addition to NUREG 1301 requirements, but consistent with industry standard understanding of the term "LLD".

Unit 2 ODCM Revision 10 Justification Package

item # 13 of 23 Jan, 2007

OBJECTIVE:

Expand the explanation of the UNRESTRICTED AREA maps in section D 4.1, and add a specific map for release points.

DESCRIPTION OF CHANGES:

Indicated the GWMP Boundary Wells (MW-40 and MW-51) on the site boundary map, and removed the confusing complexity of identifying release points on this map. Included a second, more detailed map of the power block area, specifically for identifying release points. Section D 4.1.1 was also updated to include a description of the maps included in the ODCM for this purpose.

IMPACT:

None.

JUSTIFICATION:

A map showing the unrestricted area and effluent release points is required by NUREG 1301.

Using 2 maps more clearly complies with these requirements. The maps include all the desired functionality, and allow for the addition of locating the GWMP boundary wells.

The location of these new Monitoring Wells ("boundary wells" per the NEI initiative) cannot be shown on other REMP maps, due to the fact that the REMP maps indicate sample locations OFFSITE. Since boundary wells are WITHIN the site boundary, a map associated with the UNRESTRICTED AREA serves as an ideal location for this additional purpose.

Unit 2 ODCM Revision 10 Justification Package

item # 14 of 23 Jan, 2007

OBJECTIVE:

Add additional verbiage to Section D 5.1 to include all of U3 ODCM information for the joint annual REMP report.

DESCRIPTION OF CHANGES:

Add the due date for the report, and all the additional information from the U3 ODCM to this section describing the requirements of the annual radiological environmental operating report.

IMPACT:

None. The REMP continues to be a site-wide enterprise and one set of regulations apply.

JUSTIFICATION:

The items listed under Section D 5.1 were taken directly from NUREG 1301. More detail had been included in Unit 3's equivalent section. This added detail included a due date for the report and a reference to the Radiological Assessment Branch Technical Position, Rev 1, November 1979. Unit 2 had not been required to list or comply with this assessment in earlier versions of the ODCM. These criteria have applied, however, to the site's unified REMP even before consolidation, per NUREG 0133 and 1301, which identifies the potential for combining REMP-related efforts and reports for multiple units on one site. Therefore, for completeness and to facilitate the pending effort to merge the ODCMs into one, these criteria are now specified directly in both ODCMs.

Unit 2 ODCM Revision 10 Justification Package

Jan, 2007

OBJECTIVE:

Add Section 5.6 to identify the Ground Water Monitoring Program and its key components.

DESCRIPTION OF CHANGES:

Add a section to the Admin portion of the RECS to ensure licensing basis inclusion of the GWMP and comply with commitments NL-06-033, #4 and #5.

IMPACT:

Lower tier procedures as well as an SMM are drafted for implementing the GWMP.

JUSTIFICATION:

This new section is added to the RECS Admin Requirements to ensure the GWMP maintains a tie to the licensing basis requirements and NRC commitments, as well as the NEI initiative. Placing the overview and general requirements of the program (defined in the SMM for GWMP) here in the RECS ensures continued connection with the licensing basis, in a similar fashion as the effluents and environmental monitoring programs.

Unit 2 ODCM Revision 10 Justification Package

item # 16 of 23 Jan, 2007

OBJECTIVE:

Add a discussion of IE Bulletin 80-10 program (from U3 ODCM) to Section 1.1.

DESCRIPTION OF CHANGES:

Included a paragraph of the interface between the ODCM and the 80-10 program in Section 1.1, as already identified in the Unit 3 ODCM.

IMPACT:

None.

JUSTIFICATION:

This section is added for clarity and completeness, to facilitate eventual merging of the site's ODCMs, and to ensure the current Unit 2 ODCM includes specific examples of how the ODCM and 80-10 programs interact. These include storm drains and the Spent Fuel Pool aux cooling systems.

Unit 2 ODCM Revision 10 Justification Package

item # 17 of 23 Jan, 2007

OBJECTIVE:

Add a paragraph to Section 1.1, describing concentration limits on tanks to comply with the 10 curie limit.

DESCRIPTION OF CHANGES:

Add the equivalent U3 ODCM paragraph describing how outdoor liquid tank curie levels are controlled by limiting the concentration of the tanks. Included are specific calculations showing the volume and back-calculated concentration in the tank corresponding to 10 curies. Additionally, a phrase is added to identify the option of determining the curie content from volumes and inlet concentrations.

IMPACT:

None. Station lower tier procedures (IP-SMM-CY-001, Radioactive Effluents Control Program, and others) already include these tank concentration limits.

JUSTIFICATION:

Adding these criteria to the ODCM maintains the licensing basis methodology already employed to ensure the tanks remain less than 10 curies. The verbiage and equations were copied from the U3 ODCM (and made applicable to the Unit 2 tanks) to facilitate the pending merge of these documents into a site ODCM.

Unit 2 ODCM Revision 10 Justification Package

item # 18 of 23 Jan, 2007

OBJECTIVE:

Add a paragraph to Section 1.1 to identify potentially necessary additional release quantification from the GWMP.

DESCRIPTION OF CHANGES:

Summarize the inputs to the process of quantifying groundwater's contribution to offsite dose, in a similar fashion to the discussion of inputs to other quantification methodologies, per NL-06-033, #1. These inputs include source term, release rate, and the dilution factor.

IMPACT:

None.

JUSTIFICATION:

Quantification methodologies for all effluent calculations are discussed in this section of the ODCM (Calculational Methodologies). Hence, an overview of the Ground Water calculational inputs is added to this section of the ODCM. Once these inputs are gathered, this step refers to Reg Guide 1.109 processes like other liquid effluent, for determining the offsite dose. Beyond the basic tenants of quantifying ground water effluent, the details of this quantification process, like other liquid and airborne pathways, are provided in station procedures.

Unit 2 ODCM Revision 10 Justification Package

item # 19 of 23 Jan, 2007

OBJECTIVE:

Add References 24 and 25 regarding the GWMP.

DESCRIPTION OF CHANGES:

The bases for GWMP release rates and dilution factors are added as References 32 and 33.

IMPACT:

None.

JUSTIFICATION:

Release rate and dilution flow quantification bases are provided in these references. They involve approved methodologies for determining these inputs and are included as references for completeness.

Unit 2 ODCM Revision 10 Justification Package

item # 20 of 23 Jan, 2007

OBJECTIVE:

Add ground and storm water representation to Appendix B.

DESCRIPTION OF CHANGES:

Added representation of these pathways to the flow diagram.

IMPACT:

None.

JUSTIFICATION:

This effort results in a more complete representation of all liquid effluent.

Unit 2 ODCM Revision 10 Justification Package

item # 21 of 23 Jan, 2007

OBJECTIVE:

Modify Appendix G, pages 5-7 to show "additional" sample points, rather than "RECS or non-RECS".

DESCRIPTION OF CHANGES:

Discontinue the differentiation of RECS and NON-RECS atop the pages of sample locations. Instead, samples that are in excess of RECS requirements are denoted in the list of locations.

IMPACT:

None.

JUSTIFICATION:

Data from extra sample locations will continue to be collected for historical purposes. The attempt to differentiate RECS and NON-RECS locations generated confusion with regard to the fact that all locations listed in the ODCM are required by the "ODCM", if not the "RECS". This effort was a hold-over from pre-ITS implementation and has no purpose in our more modern ODCMs, all of which is governed by the 50.59 process.

Simplifying, all samples listed are required due to their presence in the ODCM, and those in excess of the RECS are so designated.

Unit 2 ODCM Revision 10 Justification Package

item # 22 of 23 Jan, 2007

OBJECTIVE:

Denote samples that are NOT required by RECS in Appendix G (pages 3 and 4).

DESCRIPTION OF CHANGES:

In place of identifying sample locations as RECS or NON-RECS, this verbiage was replaced by a notation for each effected sample location as being in excess of RECS requirements.

IMPACT:

None

JUSTIFICATION:

This improvement clarifies that although all samples are required by the ODCM, some are in excess of RECS requirements. Samples listed are continued for historical purposes. This update reduces confusion with regard to RECS and NON-RECS sampling by eliminating those terms in favor of notation identifying effected sample location as being "in excess of RECS requirements".

Unit 2 ODCM Revision 10 Justification Package

item # 23 of 23 Jan, 2007

OBJECTIVE:

Add Boundary Wells (MW-40 and MW-51) to Appendix G, page 4, and explain note 13 as supporting GWMP.

DESCRIPTION OF CHANGES:

Added boundary well sample requirements to the REMP per NL-06-033, #2, and #3.

IMPACT:

Increased annual operating cost and new procedural requirements for the REMP.
NEM procedures are updated for this inclusion.
References of this interface are drafted in the GWMP implementing procedures.

JUSTIFICATION:

The commitment to add these boundary wells to the REMP was driven from the NEI ground water initiative. The interface between the REMP and the GWMP is identified as these boundary wells in the REMP, and are added to the ODCM in excess of the requirements of NUREG 1301.

Entergy Nuclear Northeast

Indian Point Units 1, 2

TITLE: **OFFSITE DOSE CALCULATION MANUAL**

(ODCM)

Rev. 10

WRITTEN BY:	Steve Sandike	12-7-06 date
REVIEWED BY:	[illegible]	1/10/07 date
OSRC REVIEW:	Donna Lynn Mtg# 07-001	1/10/07 date
APPROVED BY:	[illegible]	1/18/07 date
EFFECTIVE DATE:	1-19-7	date

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PART I – RADIOLOGICAL EFFLUENT CONTROLS

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The OFFSITE DOSE CALCULATION MANUAL (ODCM) is established and maintained pursuant to Technical Specifications Section 5.5.1. The ODCM consists of two parts: Radiological Effluent Controls, Part I, and Calculational Methodologies, Part II.

Part I, Radiological Effluent Controls, includes: (1) The Radioactive Effluent Control Specifications (RECS) and Radiological Environmental Monitoring Programs (REMP) required by Technical Specification 5.5.1 and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Radioactive Effluent Release Reports required by Technical Specifications 5.6.2 and 5.6.3 respectively.

Part II, Calculational Methodologies: provides the methodology to manually calculate radiation dose rates and doses to individual persons in UNRESTRICTED AREAS in the vicinity of Indian Point due to the routine release of gaseous and liquid effluents. Long term cumulative effects are usually calculated through computer programs employing approved methodology, often using real-time meteorology in the case of gaseous effluents. Other computer programs are utilized to routinely estimate the doses due to radioactivity in liquid effluents. Manual dose calculations are performed when computerized calculations are not available. The ODCM also provides setpoint methodology that is applied to effluent monitors and optionally to other process monitors. Reference numbers are bracketed [ ] to assist users.

The ODCM implements the Units 1 and 2 Radiological Effluent Control Specifications with respect to 10CFR20 Appendix B (pre-1994) permissible concentration criteria and also the design objectives of 10CFR50 Appendix I. The ODCM implements the methodology of Reg. Guide 1.109 "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50 Appendix I" and NUREG-0133 "Guidance Manual for Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants." Other references may be cited to permit reasonable handling of a situation not covered by either of the two cited references. Simplifying assumptions have been made and justified to permit formulation of more workable methodologies for implementing RECS dose calculation requirements.

D 1.0 USE AND APPLICATION

D 1.1 Definitions

-----NOTE-----

Terms defined in Technical Specifications and the following additional defined terms appear in capitalized type and are applicable throughout these specifications and bases.

Term	Definition
GASEOUS RADWASTE TREATMENT SYSTEM	A GASEOUS RADWASTE TREATMENT SYSTEM is any system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system offgases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.
MEMBER(S) OF THE PUBLIC	MEMBER(S) OF THE PUBLIC includes all persons who are not occupationally associated with the site. This category does not include employees of the utility, their contractors or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries.
MAXIMUM PERMISSIBLE CONCENTRATION WATER (MPCW)	MPCW is that concentration of a radionuclide equal to the most conservative of the soluble or insoluble liquid concentration limits specified in (pre-1984) 10CFR20, Appendix B, Table II, Column 2.
OFFSITE DOSE CALCULATION MANUAL	The OFFSITE DOSE CALCULATION MANUAL shall contain the current methodology and parameters used in the calculation of offsite doses due to radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring alarm/trip setpoints, and in the conduct of the environmental radiological monitoring program.
PRIMARY TO SECONDARY LEAK	A PRIMARY TO SECONDARY LEAK is defined by a quantifiable leak rate equal to or greater than 0.5 gpd, AND a) The presence of fission or activation products in the secondary fluid, verified as Steam Generator U-tube leaks (and not from other known contamination, such as IVSWS leaks), OR b) Tritium activity in the secondary fluid indicating an increase above historical baseline (normal diffusion) of 5.00E-6 uCi/ml or greater.
PROCESS CONTROL PROGRAM	The PROCESS CONTROL PROGRAM is a manual containing and/or referencing selected operational information concerning the solidification of radioactive wastes from liquid systems.

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D 1.1 Definitions

PURGE - PURGING	PURGE or PURGING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.
SITE BOUNDARY	The SITE BOUNDARY is that line beyond which the land is neither owned, leased, nor otherwise controlled by either Entergy Nuclear Indian Point 2 (ENIP2), Entergy Nuclear Operations, Inc. (ENO), or other site licensee.
SOLIDIFICATION	SOLIDIFICATION is the conversion of wet wastes into a form that meets shipping and burial ground requirements.
SOURCE CHECK	A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.
UNRESTRICTED AREA	An UNRESTRICTED AREA is any area at or beyond the SITE BOUNDARY, access to which is not controlled by either ENIP2, ENO, or other site licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. (See Figure D 4.1-1)
VENTILATION EXHAUST TREATMENT SYSTEM	A VENTILATION EXHAUST TREATMENT SYSTEM is 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 adsorbers 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.
VENTING	VENTING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is not provided or required.

1.0 USE AND APPLICATION

1.2 Logical Connectors

Logical Connectors are discussed in Section 1.2 of the Technical Specifications and are applicable throughout the Offsite Dose Calculation Manual and Bases.

1.3 Completion Times

Completion Times are discussed in Section 1.3 of the Technical Specifications and are applicable throughout the Offsite Dose Calculation Manual and Bases.

1.4 Frequency

Frequency is discussed in Section 1.4 of the Technical Specifications and is applicable throughout the Offsite Dose Calculation Manual and Bases

Indian Point 2

Offsite Dose Calculation Manual

PART I – RADIOACTIVE EFFLUENT CONTROLS

D 3.0 ODCM Limiting Condition for Operation (DLCO) Applicability

DLCO 3.0.1 DLCOs shall be met during the MODES or other specified condition in the Applicability, except as provided in DLCO 3.0.2.

DLCO 3.0.2 Upon discovery of a failure to meet a DLCO, the Required Actions of the associated Conditions shall be met, except as provided in DLCO 3.0.5.

If the DLCO is met or is no longer applicable prior to expiration of the specified Completion Time(s), completion of the Required Action(s) is not required unless otherwise stated.

DLCO 3.0.3 When a DLCO is not met and the associated ACTIONS are not met, an associated ACTION is not provided, or if directed by the associated ACTIONS, action shall be initiated within 1 hour to:

a. Restore compliance with the DLCO or associated ACTIONS, and

b. Enter the circumstances into the Corrective Action Program.

-----------------------------------NOTE--------------------------------
DLCO 3.0.3.b shall be completed if DLCO 3.0.3 is entered.

Exceptions to this Specification are stated in the individual Specifications.

DLCO 3.0.4 Not Applicable to ODCM Specifications.

DLCO 3.0.5 Equipment removed from service or declared inoperable to comply with ACTIONS may be returned to service under administrative control solely to perform testing required to demonstrate its OPERABILITY or the OPERABILITY of other equipment. This is an exception to TRO 3.0.B for the system returned to service under administrative control to perform the testing required to demonstrate OPERABILITY.

D 3.0 ODCM Surveillance Requirement (DSR) Applicability

DSR 3.0.1 DSRs shall be met during the MODES or other specified conditions in the Applicability for individual DLCOs, unless otherwise stated in the DSR. Failure to meet a Surveillance, whether such failure is experienced during the performance of the Surveillance or between performances of the Surveillance, shall be failure to meet the DLCO. Failure to perform a Surveillance within the specified Frequency shall be failure to meet the DLCO except as provided in DSR 3.0.3. Surveillances do not have to be performed on inoperable equipment or variables outside specified limits.

DSR 3.0.2 The specified Frequency for each DSR is met if the Surveillance is performed within 1.25 times the interval specified in the Frequency, as measured from the previous performance or as measured from the time a specified condition of the Frequency is met.

For Frequencies specified as "once," the above interval extension does not apply.

If a Completion Time requires periodic performance on a "once per . . ." basis, the above Frequency extension applies to each performance after the initial performance.

Exceptions to this Specification are stated in the individual Specifications.

DSR 3.0.3 If it is discovered that a Surveillance was not performed within its specified Frequency, then compliance with the requirement to declare the DLCO not met may be delayed, from the time of discovery, up to 24 hours or up to the limit of the specified Frequency, whichever is greater. This delay period is permitted to allow performance of the Surveillance. A risk evaluation shall be performed for any Surveillance delayed greater than 24 hours and the risk impact shall be managed.

If the Surveillance is not performed within the delay period, the DLCO must immediately be declared not met, and the applicable Condition(s) must be entered.

When the Surveillance is performed within the delay period and the Surveillance is not met, the DLCO must immediately be declared not met, and the applicable Condition(s) must be entered.

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.1 Liquid Effluents Concentration

DLCO 3.1.1 The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (Figure D 4.1-1) shall be limited to:

a. The MPCW concentrations as defined in D1.1 for radionuclides other than dissolved or entrained noble gases; and

b. 2×10^{-4} µCi/ml total activity concentration for dissolved or entrained noble gases.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeds limits.	A.1 Initiate action to restore concentration to within limits.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.1.1.1	Perform radioactive liquid waste sampling and activity analysis.	In accordance with Table D 3.1.1-1
DSR 3.1.1.2	Verify the results of the DSR 3.1.1.1 analyses to assure that the concentrations at the point of release are maintained within the limits of DLCO 3.1.1.	In accordance with Table D 3.1.1-1

Table D 3.1.1-1 (Page 1 of 2)
Radioactive Liquid Waste Sampling and Analysis

LIQUID RELEASE TYPE	SAMPLE TYPE	SAMPLE FREQUENCY	MINIMUM ANALYSIS FREQUENCY	SAMPLE ANALYSIS	LOWER LIMIT OF DETECTION (LLD) in uCi/ml, (a),(g),(c)
1. Batch Waste Release Tanks (b) eg, *Waste Tanks, SG Draindowns, etc*	Grab Sample	Each Batch (h)	Each Batch (h)	Principal Gamma Emitters Mo-99, Ce-144 I-131	5E-7 5E-6 1E-6
	Grab Sample	One batch per 31 days (h)	31 days	Dissolved and Entrained Gases (gamma emitters)	1E-5
	Composite (d)	Each batch (h)	31 days	H-3 Gross Alpha	1E-5 1E-7
	Composite (d)	Each batch (h)	92 days	Sr-89, Sr-90	5E-8
				Fe-55	1E-6
2. Continuous Releases (e) *eg, SG Blowdown, NCD, SFDS, etc*	Composite (d)	Composite	7 days	Principal Gamma Emitters (c) Mo-99, Ce-144 I-131	5E-7 5E-6 1E-6
	Grab Sample	31 days	31 days	Dissolved and Entrained Gases (gamma emitters)	1E-5
	Composite (d)	Composite	31 days	H-3	1E-5
				Gross Alpha	1E-7
			92 days	Sr-89, Sr-90	5E-8
				Fe-55	1E-6
3. Service Water (in Radiologically Controlled Areas)	Grab Sample	31 days	31 days	Gamma and Beta emitters (j)	Per liquid batch releases, above.
4. Turbine Hall Drains, SG Feedwater (i)	Composite (d)	Composite	7 days	Gamma and Beta emitters (j)	Per liquid batch releases, above.

Table D 3.1.1-1 (Page 2 of 2)
Radioactive Liquid Waste Sampling and Analysis

(a) The LLD is defined as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal. The LLD shall be determined in accordance with the methodology and parameters in the ODCM. 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 posterior (after-the-fact) limit for a particular measurement.

(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 by the method described in Part II, Section 1.4 to assure representative sampling.

(c) The principal gamma emitters for which the LLD applies include the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. Ce-144 shall also be measured, but with an LLD of $5 \times 10^{-6} \mu Ci/ml$. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identified, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report pursuant to Specification D 5.2.

(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, e.g., from a volume of a system that has an input flow during the continuous release.

(f) When operational or other limitations preclude specific gamma radionuclide analysis in batch releases, the provisions of Regulatory Guide 1.21 (Revision 1), Appendix A Section C.4 and Appendix A, Section B shall be followed.

(g) For certain radionuclides with low gamma yield or low energies, or for certain radionuclide mixtures, it may not be possible to measure radionuclides in concentration near the LLD. Under these circumstances, the LLD may be increased in inverse proportion to the magnitude of the gamma yield (i.e., $5 \times 10^{-7}/I$ where I is the photon abundance expressed as a decimal fraction).

(h) Complete prior to each release.

(i) Steam Generator Feedwater and Turbine Hall Drains are adequately monitored from Steam Generator Blowdown Composites. Increased monitoring need only be performed when a Primary to Secondary leak exists, as defined in RECS Section D.1.1.

(j) Beta emitters need only be analyzed if gamma emitters have been positively identified.

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D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.2 Liquid Effluents Dose

DLCO 3.1.2 The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials released in liquid effluents from each unit to UNRESTRICTED AREAS (Figure D 4.1-1) shall be limited to:

a. ≤ 1.5 mrem to the whole body and ≤ 5 mrem to any organ during any calendar quarter; and

b. ≤ 3 mrem to the whole body and ≤ 10 mrem to any organ during any calendar year.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated dose to a MEMBER OF THE PUBLIC from the release of radioactive materials in liquid effluents to UNRESTRICTED AREAS exceeds limits.	A.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that (1) Identifies the cause(s) for exceeding the limit(s) and (2) 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 DLCO 3.1.2.	30 days

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Calculated dose to a MEMBER OF THE PUBLIC from the release of radioactive materials in liquid effluents exceeds 2 times the limits.	B.1 Calculate the annual dose to a MEMBER OF THE PUBLIC which includes contributions from direct radiation from the units (including outside storage tanks, etc.).	Immediately
	AND	
	B.2 Verify that the limits of DLCO 3.4 have not been exceeded.	Immediately
C. Required Action B.2 and Associated Completion time not met.	C.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report, as defined in 10 CFR 20.2203 (a)(4), of Required Action A.1 shall also include the following: (1) The corrective action(s) to be taken to prevent recurrence of exceeding the limits of DLCO 3.4 and the schedule for achieving conformance, (2) An analysis that estimates the 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), and (3) Describes the levels of radiation and concentrations of radioactive material involved and the cause of the exposure levels or concentrations.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.1.2.1	Determine cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year.	31 days

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.3 Liquid Radwaste Treatment System

DLCO 3.1.3 The Liquid Radwaste Treatment System shall be in operation when projected liquid effluent doses, from each unit, to UNRESTRICTED AREAS (Figure D 4.1-1) would be:

a. > 0.06 mrem to the total body in a 31 day period; or

b. >0.2 mrem to any organ in a 31 day period.

APPLICABILITY: Prior to each release.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive liquid waste being discharged without treatment. <u>AND</u> Projected doses due to the liquid effluent, from the unit, to UNRESTRICTED AREAS would exceed limits.	A.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that includes: (1) An explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability, (2) Action(s) taken to restore the inoperable equipment to OPERABLE status, and (3) Summary description of action(s) taken to prevent a recurrence.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.1.3.1	Project the doses due to liquid effluents from each unit to UNRESTRICTED AREAS.	31 days

D 3.1 LIQUID EFFLUENTS

D 3.1.4 Liquid Holdup Tanks

DLCO 3.1.4 Radioactive liquid contained in unprotected outdoor liquid storage tanks shall be limited to ≤ 10 Curies, excluding tritium and dissolved or entrained gases.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Level of radioactivity exceeds the limits in any listed tank: *PWST* *RWST* *Waste Distillate Storage Tanks* *Outdoor Temporary Tanks*	A.1 Suspend addition of radioactive material.	Immediately
	<u>AND</u> A.2 Initiate measures to reduce content to within the limits.	48 hours
	<u>AND</u> A.3 Describe the events leading to the condition in the Radioactive Effluent Release Report.	Prior to submittal of next Radioactive Effluent Release Report

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SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.1.4.1	Determine that the quantity of radioactivity in outdoor liquid unprotected tanks (listed above) does not exceed the limit.	31 days, during periods where radioactive liquid is being added to the tanks, in accordance with the methodology and parameters of the ODCM

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D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.1 Gaseous Effluents Dose Rate

DLCO 3.2.1 The dose rate from radioactive materials released in gaseous effluents from the site to areas at or beyond the SITE BOUNDARY (Figure D 4.1-1) shall be limited to:

a. For noble gases, ≤ 500 mrem/yr to the whole body and ≤ 3000 mrem/yr to the skin and

b. For I-131, tritium (H-3) and all radionuclides in particulate form with half-lives > 8 days, ≤ 1500 mrem/yr to any organ.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The dose rate(s) at or beyond the SITE BOUNDARY due to radioactive gaseous effluents exceeds limits.	A.1 Restore the release rate to within the limit.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.2.1.1	The dose rate from noble gases in gaseous effluents shall be determined to be within the limits of DLCO 3.2.1.a.	In accordance with Table D 3.2.1-1
DSR 3.2.1.2	The dose rate from I-131, H-3 and all radionuclides in particulate form with half-lives > 8 days in gaseous effluents shall be determined to be within the limits of DLCO 3.2.1.b.	In accordance with Table D 3.2.1-1

Table D 3.2.1-1 (Page 1 of 2)
Radioactive Gaseous Waste Sampling and Analysis

GASEOUS RELEASE TYPE		SAMPLE TYPE	SAMPLE FREQUENCY	ANALYSIS FREQUENCY	SAMPLE ANALYSIS	SAMPLE LOWER LIMIT OF DETECTION (LLD) (a)
1. Waste Gas Storage Tank		Grab Sample	Each Tank (h)	Each Tank (h)	Principal Noble Gas (NG) Gamma Emitters (b)	1E-4 μCi/cc
2. Vapor Containment	Purge	Grab Sample	Each Purge (h)	Each Purge (h)	Principal NG Gamma Emitters (b)	1E-4 μCi/cc
	Press Relief	Grab Sample	31 days (i)	31 days (i)	Principal NG Gamma Emitters (b)	1E-4 μCi/cc
3. Condenser Air Ejector		Grab Sample	31 days	31 days	Principal NG Gamma Emitters (b)	1E-4 μCi/cc
4. Continuous Ventilation: a. Main Plant Vent (unit 2) b. Stack Vent (unit 1)		Grab Sample	31 days (c)	31 days (c)	Principal NG Gamma Emitters (b)	1E-4 μCi/cc
		H-3 Specific	Continuous	31 days (e)	H-3	1E-6 μCi/cc
		Charcoal Sample	Continuous (f)	7 days (c), (g)	I-131	1E-12 μCi/cc
		Particulate Sample	Continuous (f)	7 days (c), (g)	Principal Gamma Emitters (b) (I-131, Others)	1E-11 μCi/cc
		Composite Particulate Sample	Continuous (f)	31 days	Gross Alpha	1E-11 μCi/cc
		Composite Particulate Sample	Continuous (f)	92 days	Sr-89 / Sr-90	1E-11 μCi/cc
		Noble Gas Monitor	Continuous (f)	Continuous (f)	Noble Gases Gross Beta or Gamma	1E-6 μCi/cc (d)

Table D 3.2.1-1 (Page 2 of 2)
Radioactive Gaseous Waste Sampling and Analysis

(a) The LLD is defined, for purposes of these Specifications, 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. The LLD shall be determined in accordance with the methodology and parameters in the ODCM.

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.

(b) The principal gamma emitters for which the LLD Control 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. Other identifiable gamma peaks (I-131 in particulate form, for example), together with those of the above nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report pursuant to Section D 5.2.

(c) IF following a shutdown, startup, or a thermal power change (within one hour) exceeding 15 percent of RATED THERMAL POWER, analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has increased by a factor of 3 or more, AND the noble gas monitor shows that effluent activity has increased by a factor of 3 or more THEN:

1) Sample the main Plant Vent (unit 2) for Noble Gases within 24 hours, AND

2) Sample the main Plant Vent (unit 2) for Iodine and Particulate once per 24 hours for at least 7 days with analyses completed within 48 hours of sample changeout. The LLDs of these samples may be increased by a factor of 10.

(d) This value is the established Radiation Monitor sensitivity (minimum).

(e) Grab samples can be used as alternative to continuous sampling, provided the periodicity of these grab samples is increased from monthly to once per 24 hours when the refueling canal is flooded, or at least once per 7 days when spent fuel is in the Spent Fuel Pool.

(f) The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Specifications D 3.2.1, D 3.2.2 and D 3.2.3.

(g) Continuous 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.

Additionally, IF routine Iodine sampling indicates I-131 in the main Plant Vent (unit 2) or the Stack Vent (unit 1), THEN collect a 24 hour sample from the applicable vent (within 48 hours) for short-lived Iodine isotope quantification, on a periodicity not to exceed once per 31 days. The LLDs of these samples may be increased by a factor of 10.

(h) Complete prior to each release.

(i) Vapor Containment noble gas shall be sampled at least monthly to ensure Pressure Reliefs are quantified with an accurate isotopic mixture. Containment noble gas radiation monitor readings can be used for quantification of Pressure Reliefs, provided the monitor readings are consistent with those observed during recent (at least monthly) grab samples. Sample data is adjusted by the noble gas radiation monitor reading for purposes of quantification of each release. Should the monitor be inoperable, a containment noble gas grab sample is required within 24 hours prior to the Pressure Relief. Should BOTH the containment noble gas and particulate monitors be inoperable, two independent samples of the VC are required prior to a Pressure Relief. | 1/07

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.2 Gaseous Effluent Dose - Noble Gas

DLCO 3.2.2 The air dose from noble gases released in gaseous effluents from each unit to areas at or beyond the SITE BOUNDARY (Figure D 4.1-1) shall be limited to:

a. ≤ 5 mrad to the whole body from gamma radiation and ≤ 10 mrad to the skin from beta radiation during any calendar quarter, and

b. ≤ 10 mrad to the whole body from gamma radiation and ≤ 20 mrad to the skin from beta radiation during any calendar year.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. The calculated air dose at or beyond the SITE BOUNDARY due to noble gases released in gaseous effluents exceeds limits.	A.1	Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that (1) Identifies the cause(s) for exceeding the limit(s) and (2) 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 DLCO 3.2.2.	30 days

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Calculated dose to a MEMBER OF THE PUBLIC from the release of radioactive materials in airborne effluents exceeds 2 times the limits.	B.1 Calculate the annual dose to a MEMBER OF THE PUBLIC which includes contributions from direct radiation from the units (including outside storage tanks, etc.).	Immediately
	<u>AND</u>	
	B.2 Verify that the limits of DLCO 3.4 have not been exceeded.	Immediately
C. Required Action B.2 and Associated Completion time not met.	C.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report, as defined in 10 CFR 20.2203 (a)(4), of Required Action A.1 shall also include the following: (1) The corrective action(s) to be taken to prevent recurrence of exceeding the limits of DLCO 3.4 and the schedule for achieving conformance, (2) An analysis that estimates the 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), and (3) Describes the levels of radiation and concentrations of radioactive material involved and the cause of the exposure levels or concentrations.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.2.2.1	Determine cumulative dose contributions for the current calendar quarter and current calendar year.	31 days

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.3 Gaseous Effluent Dose – Iodine and Particulate

DLCO 3.2.3 The dose to a MEMBER OF THE PUBLIC from I-131, tritium, and all radionuclides in particulate form with half-lives > 8 days, in gaseous effluents, released from each unit to areas at or beyond the SITE BOUNDARY (Figure D 4.1-1) shall be limited to:

a. ≤ 7.5 mrem to any organ during any calendar quarter, and

b. ≤ 15 mrem to any organ during any calendar year.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The dose from I-131, tritium, and radioactive material in particulate form with half-lives > 8 days released in gaseous effluents at or beyond the SITE BOUNDARY exceeds limits.	A.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that (1) Identifies the cause(s) for exceeding the limit(s) and (2) 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 DLCO 3.2.3.	30 days

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Calculated dose to a MEMBER OF THE PUBLIC from the release of radioactive materials in liquid effluents exceeds 2 times the limits.	B.1 Calculate the annual dose to a MEMBER OF THE PUBLIC which includes contributions from direct radiation from the units (including outside storage tanks, etc.).	Immediately
	<u>AND</u>	
	B.2 Verify that the limits of DLCO 3.4 have not been exceeded.	Immediately
C. Required Action B.2 and Associated Completion time not met.	C.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report, as defined in 10 CFR 20.2203 (a)(4), of Required Action A.1 shall also include the following: (1) The corrective action(s) to be taken to prevent recurrence of exceeding the limits of DLCO 3.4 and the schedule for achieving conformance, (2) An analysis that estimates the 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), and (3) Describes the levels of radiation and concentrations of radioactive material involved and the cause of the exposure levels or concentrations.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.2.3.1	Determine cumulative dose contributions for the current calendar quarter and current calendar year for I-131, tritium, and radioactive material in particulate form with half-lives > 8 days.	31 days

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.4 Gaseous Radwaste Treatment System

DLCO 3.2.4 The GASEOUS RADWASTE TREATMENT SYSTEM shall be in operation when projected gaseous effluent doses, from each unit, at and beyond the SITE BOUNDARY (Figure D 4.1-1) would be:

a. > 0.2 mrad for gamma radiation; and

b. > 0.4 mrad for beta radiation in a 31 day period.

APPLICABILITY: Prior to each release.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive gaseous waste is being discharged without treatment. AND Projected doses due to the gaseous effluent, from the unit, at and beyond the SITE BOUNDARY would exceed limits.	A.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that includes the following: (1) Identification of any inoperable equipment or subsystems and the reason for the inoperability, (2) Action(s) taken to restore the inoperable equipment to OPERABLE status, and (3) Summary description of action(s) taken to prevent a recurrence.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.2.4.1	Project the doses due to gaseous effluents from each unit at and beyond the SITE BOUNDARY.	31 days

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.5 Ventilation Exhaust Treatment System

DLCO 3.2.5 The VENTILATION EXHAUST TREATMENT SYSTEM shall be in operation when projected gaseous effluent doses, from each unit, at and beyond the SITE BOUNDARY (Figure D 4.1-1) would be:

a. > 0.2 mrad air dose from gamma radiation; and

b. > 0.4 mrad air dose from beta radiation in a 31 day period; or

c. > 0.3 mrem to any organ in a 31 day period.

APPLICABILITY: Prior to each release.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive gaseous waste is being discharged without treatment. AND Projected doses due to gaseous effluent, from each unit, to areas at or beyond the SITE BOUNDARY would exceed limits.	A.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that includes the following: (1) Identification of any inoperable equipment or subsystems and the reason for the inoperability, (2) Action(s) taken to restore the inoperable equipment to OPERABLE status, and (3) Summary description of action(s) taken to prevent a recurrence.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.2.5.1	Project the doses from gaseous releases from each unit to areas at and beyond the SITE BOUNDARY when the GASEOUS RADWASTE TREATMENT SYSTEMS are not being fully utilized.	31 days

D 3.2 GASEOUS EFFLUENTS

D 3.2.6 Gas Storage Tanks

DLCO 3.2.6 The radioactivity contained in each gas storage tank shall be limited to ≤ 29,761 Curies of noble gas (considered as Xe-133).

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Level of radioactivity exceeds the limits.	A.1 Suspend addition of radioactive material.	Immediately
	<u>AND</u>	
	A.2 Reduce content to within the limits.	48 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.2.6.1	Sample and analyze radioactive material contained in gas storage tank for level of radioactivity.	24 hours during addition of radioactive material to the tank

D 3.3 INSTRUMENTATION

D 3.3.1 Radioactive Liquid Effluent Monitoring Instrumentation

DLCO 3.3.1 The radioactive liquid effluent monitoring instrumentation channels shown in Table D 3.3.1-1 shall be OPERABLE with:

a. The minimum OPERABLE channel(s) in service.

b. The alarm/trip setpoints set to ensure that the limits of DLCO 3.1.1 are not exceeded..

APPLICABILITY: According to Table D 3.3.1-1.

ACTIONS

--NOTE--
Separate condition entry is allowed for each channel.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required.	A.1 Suspend the release of radioactive liquid effluents monitored by the affected channel.	Immediately
	<u>OR</u>	
	A.2 Declare the channel inoperable.	Immediately
	<u>OR</u>	
	A.3 Change the setpoint so it is acceptably conservative.	Immediately

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. One or more required channels inoperable.	B.1 Enter the Condition referenced in Table D 3.3.1-1 for the channel.	Immediately
	AND	
	B.2 Restore inoperable channel(s) to OPERABLE status.	30 days
C. As required by Required Action B.1 and referenced in Table D 3.3.1-1.	C.1 Analyze at least 2 independent samples in accordance with Table D 3.1.1-1.	Prior to initiating a release
	AND	
	C.2 ----------NOTE--------------- Verification Action will be performed by at least 2 separate technically qualified members of the facility staff. ---------------------------------	
	Independently verify the release rate calculations and discharge line valving.	Prior to initiating a release
D. As required by Required Action B.1 and referenced in Table D 3.3.1-1.	D.1 Collect and analyze grab samples for radioactivity at a limit of detection of at least 5×10^{-7} μCi/ml.	12 hours AND Once per 12 hours thereafter

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
E. As required by Required Action B.1 and referenced in Table D 3.3.1-1.	E.1 Collect and analyze grab samples for radioactivity at a limit of detection of at least 5 x 10^{-7} μCi/ml, when specific activity is > 0.01 μCi/gm DOSE EQUIVALENT I-131.	12 hours AND Once per 12 hours thereafter
	OR	
	E.2 Collect and analyze grab samples for radioactivity at a limit of detection of at least 5 x 10^{-7} μCi/ml, when specific activity is ≤ 0.01 μCi/gm DOSE EQUIVALENT I-131.	24 hours AND Once per 24 hours thereafter
F. As required by Required Action B.1 and referenced in Table D 3.3.1-1.	F.1 --------------NOTE----------- Pump performance curves generated in place may be used to estimate flow. ------------------------------- Estimate the flow rate during actual releases.	4 hours AND Once per 4 hours thereafter
G. As required by Required Action B.1 and referenced in Table D 3.3.1-1.	G.1 Estimate tank liquid level.	Immediately AND During liquid additions to the tank
H. Required Action B.2 and associated Completion Time not met.	H.1 Explain in the next Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.	In accordance with Radioactive Effluent Release Report

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
I. Required Action and associated Completion Time for Condition C, D, E, or F not met.	I.1 Suspend liquid effluent releases monitored by the inoperable channel(s).	Immediately
J. Required Action and associated Completion Time for Condition G not met.	J.1 Suspend liquid additions to the tank monitored by the inoperable channel(s).	Immediately

SURVEILLANCE REQUIREMENTS

-- NOTE --
Refer to Table D 3.3.1-1 to determine which DSRs apply for each function.

SURVEILLANCE		FREQUENCY
DSR 3.3.1.1	Perform CHANNEL CHECK.	24 hours
DSR 3.3.1.2	Perform CHANNEL CHECK by verifying indication of flow during periods of release.	24 hours on any day on which continuous, periodic, or batch releases are made
DSR 3.3.1.3	Perform SOURCE CHECK.	Prior to release
DSR 3.3.1.4	Perform SOURCE CHECK.	31 days
DSR 3.3.1.5	Perform CHANNEL OPERATIONAL TEST	92 days

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
DSR 3.3.1.6	Perform CHANNEL OPERATIONAL TEST. The CHANNEL OPERATIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation (or control panel indications/display) occurs if the instrument indicates measured levels above the alarm/trip setpoint	92 days
DSR 3.3.1.7	Perform CHANNEL OPERATIONAL TEST. The CHANNEL OPERATIONAL TEST shall also demonstrate control room alarm annunciation (or control panel indications/display) occurs if any of the following conditions exist, instrument indicates measured levels above the alarm setpoint, instrument controls not set in operate mode.	92 days
DSR 3.3.1.8	Perform CHANNEL CALIBRATION	92 DAYS
DSR 3.3.1.9	Perform CHANNEL CALIBRATION.	24 months

Table D 3.3.1-1 (page 1 of 2)
Radioactive Liquid Effluent Monitoring Instrumentation

INSTRUMENT	APPLICABILITY OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER INSTRUMENT	CONDITIONS REFERENCED FROM REQUIRED ACTION B.1	SURVEILLANCE REQUIREMENTS
1. Gross Radioactivity Monitors Providing Alarm and Automatic Termination of Release				
a. Liquid Radwaste Effluent Line (R-54)	(a)	1	C	DSR 3.3.1.1 DSR 3.3.1.3 DSR 3.3.1.6 (e) DSR 3.3.1.9 (d)
b. Steam Generator Effluent Blowdown Line (R-49)	(a)	1	E	DSR 3.3.1.1 DSR 3.3.1.4 DSR 3.3.1.6 (e) DSR 3.3.1.9 (d)
2. Gross Beta or Gamma Radioactivity Monitors Providing Alarm but not Providing Automatic Termination of Release				
a. Service Water Effluent Lines - VC FCU (R-46 or R-53) - 21 CCW HX (R-39) - 22 CCW HX (R-40) - Sec Boiler BPS (R-52)	(a)	1 (g)	D	DSR 3.3.1.1 DSR 3.3.1.4 DSR 3.3.1.7 (e) DSR 3.3.1.9 (d)
b. Unit 1 – Secondary Boiler Blowdown Effluent Line (R-51)	(a)	1	D	DSR 3.3.1.1 DSR 3.3.1.4 DSR 3.3.1.7 (e) DSR 3.3.1.9 (d)
c. Unit 1 – Sphere Foundation Drain Sump Effluent Line (R-62)	(a)	1	D	DSR 3.3.1.1 DSR 3.3.1.4 DSR 3.3.1.7 (e) DSR 3.3.1.9 (d)
3. Flow Rate Measurement Devices				
a. Liquid Radwaste Effluent Line	(a)	1	F	DSR 3.3.1.2 DSR 3.3.1.5 DSR 3.3.1.9
b. Steam Generator Blowdown Effluent Line	(a)	1	F	DSR 3.3.1.2 DSR 3.3.1.5 DSR 3.3.1.9
c. North Curtain Drain Effluent Line (f)	(a)	1	F	DSR 3.3.1.2 DSR 3.3.1.9
d. Sphere Foundation Drain Sump (f)	(a)	1	F	DSR 3.3.1.2 DSR 3.3.1.9

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Table D 3.3.1-1 (page 2 of 2)
Radioactive Liquid Effluent Monitoring Instrumentation

INSTRUMENT	APPLICABILITY OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER INSTRUMENT	CONDITIONS REFERENCED FROM REQUIRED ACTION B.1	SURVEILLANCE REQUIREMENTS
4. Tank Level Indicating Devices (c)				
a. 13 Waste Distillate Storage Tank	(a)	1	G	DSR 3.3.1.1 (b) DSR 3.3.1.5 DSR 3.3.1.9
b. 14 Waste Distillate Storage Tank	(a)	1	G	DSR 3.3.1.1 (b) DSR 3.3.1.5 DSR 3.3.1.9
c. Primary Water Storage Tank	(a)	1	G	DSR 3.3.1.1 (b) DSR 3.3.1.5 DSR 3.3.1.9
d. Refueling Water Storage Tank	(a)	1	G	DSR 3.3.1.1 (b) DSR 3.3.1.5 DSR 3.3.1.8

(a) During release via this pathway. Channels shall be OPERABLE and in service on a continuous basis, except that outages are permitted, within the time frame of the specified action for the purpose of maintenance and performance of required CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION or CHANNEL OPERATIONAL TEST.

(b) During liquid addition to the associated tank.

(c) 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 do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system.

(d) Radioactive calibration standards used for CHANNEL CALIBRATIONS shall be analyzed with instrumentation which is calibrated with NBS (NIST) traceable standards. Standards from suppliers who participate in measurement assurance activities with NBS (NIST) are acceptable). NBS or National Institute of Standards and Technology (NIST) are acceptable traceable standards.

(e) Test will include: Low sample flow, no counts per minute failure, and alarm setpoint reached. The CHANNEL OPERATIONAL TEST does not include testing or trouble shooting and equipment diagnostic capabilities provided with the monitor installation.

(f) Flow rate for these continuous intermittent release pathways is normally obtained from a flow totalizer on the system outlet.

(g) One instrument per operating Service Water system is required. For example, R-46 and R-53 (VC FCUs) are redundant, but operating 22 Component Cooling Water Heat Exchanger would require R-40 to be in service. 1/07

D 3.3 INSTRUMENTATION

D 3.3.2 Radioactive Gaseous Effluent Monitoring Instrumentation

DLCO 3.3.2 The radioactive gaseous effluent monitoring instrumentation channels shown in Table D 3.3.2-1 shall be OPERABLE with:

a. The minimum OPERABLE channel(s) in service.

b. The alarm/trip setpoints set to ensure that the limits of DLCO 3.2.1 are not exceeded.

APPLICABILITY: According to Table D 3.3.2-1.

ACTIONS

--NOTE--
Separate condition entry is allowed for each channel.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required.	A.1 Suspend the release of radioactive gaseous effluents monitored by the affected channel.	Immediately
	<u>OR</u>	
	A.2 Declare the channel inoperable.	Immediately
	<u>OR</u>	
	A.3 Change the setpoint so it is acceptably conservative.	Immediately
B. One or more channels inoperable.	B.1 Enter the Condition referenced in Table D 3.3.2-1 for the channel.	Immediately
	<u>AND</u>	
	B.2 Restore inoperable channel(s) to OPERABLE status.	30 days

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. As required by Required Action B.1 and referenced in Table D 3.3.2-1.	C.1 Take grab samples. AND C.2 Analyze samples for gross activity.	12 hours AND Once per 12 hours thereafter 24 hours from time of sampling completion
D. As required by Required Action B.1 and referenced in Table D 3.3.2-1.	D.1 Estimate the flow rate for the inoperable channel(s).	4 hours AND Once per 4 hours thereafter
E. As required by Required Action B.1 and referenced in Table D 3.3.2-1.	E.1 Continuously collect samples using auxiliary sampling equipment as required in Table D 3.2.1-1.	8 hours

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
F. As required by Required Action B.1 and referenced in Table D 3.3.2-1.	F.1 Determine radioactive content of gas decay tank is in compliance with DLCO 3.2.1.	24 hours AND Once per 24 hours thereafter
G. As required by Required Action B.1 and referenced in Table D 3.3.2-1, for gas decay tank releases.	G.1 Analyze at least 2 independent samples in accordance with Table D 3.2.1-1. AND G.2 -----------NOTE--------------- Verification Action will be performed by at least 2 separate technically qualified members of the facility staff. --------------------------------- Independently verify the release rate calculations and discharge line valving.	Prior to initiating a gas decay tank release Prior to initiating a gas decay tank release
H. Required Action B.2 and associated Completion Time not met.	H.1 Explain in the next Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.	In accordance with Radioactive Effluent Release Report frequency
I. Required Action and associated Completion Time for Condition C, D, E or F not met.	I.1 Suspend gaseous effluent releases monitored by the inoperable channel(s).	Immediately
J. Required Action and associated Completion Time for Condition G not met.	J.1 Suspend gaseous effluent releases from Waste Gas Holdup System.	Immediately

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SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.3.2.1	Perform CHANNEL CHECK.	24 hours
DSR 3.3.2.2	Perform CHANNEL CHECK.	7 days
DSR 3.3.2.3	Perform SOURCE CHECK.	Prior to release
DSR 3.3.2.4	Perform SOURCE CHECK.	31 days
DSR 3.3.2.5	Perform CHANNEL OPERATIONAL TEST. The CHANNEL OPERATIONAL TEST shall also demonstrate the automatic isolation capability of this pathway and that control room alarm annunciation (or control panel indications/display) occurs if the instrument indicates measured levels above the alarm/trip setpoint.	92 days
DSR 3.3.2.6	Perform CHANNEL OPERATIONAL TEST. The CHANNEL OPERATIONAL TEST shall also demonstrate control room alarm annunciation (or control panel indications/display) occurs if any of the following conditions exist, instrument indicates measured levels above the alarm setpoint, instrument controls not set in operate mode.	92 days
DSR 3.3.2.7	Perform CHANNEL CALIBRATION.	18 months
DSR 3.3.2.8	Perform CHANNEL CALIBRATION.	24 months

Table D 3.3.2-1 (page 1 of 2)
Radioactive Gaseous Effluent Monitoring Instrumentation

INSTRUMENT	APPLICABILITY OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER INSTRUMENT	CONDITIONS REFERENCED FROM REQUIRED ACTION B.1	SURVEILLANCE REQUIREMENTS
1. Waste Gas Holdup System				
a. Noble Gas Activity Monitor Providing Alarm (R-50)	(b)	1	F	DSR 3.3.2.1 DSR 3.3.2.4 DSR 3.3.2.6 (d) DSR 3.3.2.8 (c)
2. Condenser Evacuation System				
a. Noble Gas Activity (R-45)	(a)	1	C	DSR 3.3.2.1 DSR 3.3.2.4 DSR 3.3.2.6 (e) DSR 3.3.2.8 (c)
3. Plant Vent				
Radiation Monitor:				
a. Noble Gas Activity Radiation Monitor (R-44)	(a) & (b)	1	C & G	DSR 3.3.2.1 DSR 3.3.2.4 DSR 3.3.2.5 (d) DSR 3.3.2.8 (c)
Other Effluent Instrumentation:				
b. Iodine Sampler	(a)	1	E	DSR 3.3.2.2
c. Particulate Sampler	(a)	1	E	DSR 3.3.2.2
d. Flow-Rate Monitor	(a)	1	D	DSR 3.3.2.1 DSR 3.3.2.7
e. Sample Flow-Rate Monitor	(a)	1	D	DSR 3.3.2.1 DSR 3.3.2.8

Table D 3.3.2-1 (page 2 of 2)
Radioactive Gaseous Effluent Monitoring Instrumentation

INSTRUMENT	APPLICABILITY OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER INSTRUMENT	CONDITIONS REFERENCED FROM REQUIRED ACTION B.1	SURVEILLANCE REQUIREMENTS
4. Main Stack Effluent (Unit 1)				
Radiation Monitor:				
a. Noble Gas Activity Monitor (R-60)	(a)	1	C	DSR 3.3.2.1 DSR 3.3.2.4 DSR 3.3.2.6 (d) DSR 3.3.2.8 (c)
Other Effluent Instrumentation:				
b. Iodine Sampler	(a)	1	E	DSR 3.3.2.2
c. Particulate Sampler	(a)	1	E	DSR 3.3.2.2
d. Flow-Rate Monitor	(a)	1	D	DSR 3.3.2.1 DSR 3.3.2.7
e. Sample Flow-Rate Monitor	(a)	1	D	DSR 3.3.2.1 DSR 3.3.2.8

(a) During release via this pathway. Channels shall be OPERABLE and in service on a continuous basis, except that outages are permitted, within the time frame of the specified action for the purpose of maintenance and performance of required CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION or CHANNEL OPERATIONAL TEST.

(b) During waste gas holdup system operation (treatment for primary system off-gases).

(c) Radioactive Calibration Standards used for channel calibrations shall be traceable to the National Bureau of Standards or an aliquot of calibration gas shall be analyzed with instrumentation which is calibrated with NBS traceable standards (standards from suppliers who participate in measurement assurance activities with NBS are acceptable). NBS or National Institute of Standards and Technology (NIST) are acceptable traceable standards.

(d) Test will include: Low sample flow, no counts per minute failure, and alarm setpoint reached. The CHANNEL OPERATIONAL TEST (COT) does NOT include testing of troubleshooting and equipment diagnostic capabilities provided with the monitor installation.

(e) Test will include: no counts per minute failure and alarm setpoint reached. The COT does NOT include testing of troubleshooting and equipment diagnostic capabilities provided with the monitor installation.

D 3.4 RADIOACTIVE EFFLUENTS TOTAL DOSE

D 3.4.1 Radioactive Effluents Total Dose

DLCO 3.4.1 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 ≤ 25 mrem to the whole body or any organ, except the thyroid, which shall be limited to ≤ 75 mrem.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Estimated dose or dose commitment due to direct radiation and the release of radioactive materials in liquid or gaseous effluents exceeds the limits.	A.1 Verify the condition resulting in doses exceeding these limits has been corrected.	Immediately
B. Required Action and associated Completion Time not met.	B.1 -------------NOTE------------ This is the Special Report required by D 3.1.2, D 3.2.2, or D 3.2.3 supplemented with the following. ---------------------------------	
	Submit a Special Report, pursuant to D 5.3, including a request for a variance in accordance with the provisions of 40 CFR 190. This submission is considered a timely request, and a variance is granted until staff action on the request is complete.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.4.1.1	Perform a cumulative dose calculation due to radioactive material in gaseous and liquid effluents to determine compliance with DLCO 3.4.1.	12 months

D 3.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

D 3.5.1 Monitoring Program

DLCO 3.5.1 The Radiological Environmental Monitoring Program shall be conducted as specified in Table D 3.5.1-1.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radiological Environmental Monitoring Program not conducted as specified in Table D 3.5.1-1.	A.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.	In accordance with the Annual Radiological Environmental Operating Report frequency
B. Level of radioactivity in an environmental sampling medium at a specified location exceeds the reporting levels of Table D 3.5.1-2 when averaged over any calendar quarter. <u>OR</u>	B.1 ------------NOTES------------ 1. Only applicable if the radioactivity/radionuclides are the result of plant effluents. 2. For radionuclides other than those in Table D 3.5.1-2, this report shall indicate the methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC. ------------------------------------	

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
More than one of the radionuclides in Table D 3.5.1-2 are detected in the environmental sampling medium and $\frac{\text{Concentration 1}}{\text{reporting level 1}} + \frac{\text{concentration 2}}{\text{reporting level 2}} + \ldots \geq 1.0.$ OR Radionuclides other than those in Table D 3.5.1-2 are detected in an environmental sampling medium at a specified location which are the result of plant effluents and the potential annual dose to a MEMBER OF THE PUBLIC from all radionuclides is ≥ the calendar year limits of Specifications D 3.1.2, D 3.2.2 or D 3.2.3.	Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that (1) Identifies the cause(s) for exceeding the limit(s) and (2) Defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of Specifications D 3.1.2, D 3.2.2, or D 3.2.3.	30 days
	OR	
	B.2 ------------NOTES------------ 1.Only applicable if the radioactivity/radionuclides are not the result of plant effluents. 2.For radionuclides other than those in Table D 3.5.1-2, this report shall indicate the methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC. -----------------------------------	
	Report and describe the condition in the Annual Radiological Environmental Operating Report.	In accordance with the Annual Radiological Environmental Operating Report frequency

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Milk or fresh leafy vegetation samples unavailable from one or more of the sample locations required by Table D 3.5.1-1.	C.1 Identify specific locations for obtaining replacement samples and add them to the Radiological Environmental Monitoring Program.	30 days
	<u>AND</u>	
	C.2 Delete the specific locations from which samples were unavailable from the Radiological Environmental Monitoring Program.	30 days
	<u>AND</u>	
	C.3 Pursuant to D 5.2, submit in the next Radioactive Effluent Release Report documentation for a change in the ODCM reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples and justifying the selection of the new location(s) for obtaining samples.	In accordance with the Radioactive Effluent Release Report
D. Environmental samples required in Table D 3.5.1-1 are unobtainable due to sampling equipment malfunctions.	D.1 Ensure all efforts are made to complete corrective action(s).	Prior to the end of the next sampling period
	<u>AND</u>	
	D.2 Report all deviations from the sampling schedule in the Annual Radiological Environmental Operating Report.	In accordance with the Annual Radiological Environmental Operating Report

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
E. Samples required by Table D 3.5.1-1 not obtained in the media of choice, at the most desired location, or at the most desired time.	E.1	Choose suitable alternative media and locations for the pathway in question.	30 days
	AND		
	E.2	Make appropriate substitutions in the Radiological Environmental Monitoring Program.	30 days
	AND		
	E.3	Submit in the next Radioactive Effluent Release Report documentation for a change in the ODCM reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples for that pathway and justifying the selection of the new location(s) for obtaining samples.	In accordance with the Radioactive Effluent Release Report

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.5.1.1	Collect and analyze radiological environmental monitoring samples pursuant to the requirements of Table D 3.5.1-1 and the detection capabilities required by Table D 3.5.1-3.	In accordance with Table D 3.5.1-1

Table D 3.5.1-1 (page 1 of 3)
Radiological Environmental Monitoring Program

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF SAMPLES STATIONS	SAMPLE LOCATIONS (a)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
1. Direct Radiation	41 routine monitoring stations (b) (DR1-DR41)	(1) An inner ring of stations (DR1-DR16), one in each meteorological sector in the general area of the SITE BOUNDARY (2) An outer ring of stations (DR17-DR32), one in each meteorological sector in the 6 to 8 km range from the site (3) The balance of the stations (DR33-DR41), should be placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control stations	Quarterly	Gamma dose quarterly
2. Airborne Radioiodine and Particulates	5 locations (A1-A5)	(1) 3 samples (A1-A3) from offsite locations close to the site boundary in different sectors, of the highest calculated annual average ground level D/Q (2) 1 sample (A4) from the vicinity of an established year-round community having the highest calculated annual average ground level D/Q (3) 1 sample (A5) from a control location, 15-30 km distant and in the least prevalent wind direction (c)	Continuous sampler operation with sample collection weekly or more frequently if required by dust loading	Radioiodine canister: Analyze weekly for I-131 Particulate sampler: (1) Analyze for gross beta radioactivity ≥ 24 hours following filter change (d). (2) Perform gamma isotopic analysis on each sample (e) in which gross beta activity is > 10 times the previous yearly mean of control samples. (3) Gamma isotopic analysis of composite sample (e) (by location) once per 3 months.
3. Waterborne				
a. Surface (f)	1 sample 1 sample	Upstream (Wa1) Downstream (Wa2)	Composite sample over a one month period (g)	(1) Gamma isotopic analysis of each sample (e) once per month. (2) Composite and analyze for H-3 quarterly.
b. Drinking	1 sample	Nearest water supply (Wb1)	Grab sample: Monthly	(1) Gross beta and gamma isotopic analyses(e) of each sample monthly. (2) Composite and analyze for H-3 quarterly.

Table D 3.5.1-1 (page 2 of 3)
Radiological Environmental Monitoring Program

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF SAMPLES	SAMPLE LOCATIONS (a)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS	
3. Waterborne (continued)					
c. Sediment from Shoreline	2 samples	Downstream area (Wc1) with existing or potential recreational value Upstream area (Wc2) control sample	Twice per year at least 90 days apart	Gamma isotopic analysis (e), H-3, and Sr-90, of each sample semiannually.	| 1/07
d. Ground Water	2 samples	Site Boundary Monitoring Wells, drilled near the SW site boundary	Quarterly	Gamma isotopic analysis (e), H-3, and Sr-90, of each sample quarterly.	| 1/07
4. Ingestion					
a. Milk	(1) 3 samples from MILK SAMPLING LOCATIONS	In 3 locations (la1-la3) within 5 km having the highest dose potential	Twice per month when animals are on pasture; monthly at other times	(1) Gamma isotopic (e) and I-131 analysis of each sample twice per month April through December (2) Gamma isotopic (g) and I-131 analysis of each sample once per month January through March if required	
	(2) If there are none, then 1 sample from MILK SAMPLING LOCATIONS	In each of 3 areas (la1-la3) 5 to 8 km distance, if available, where doses are calculated to be > 1mrem per year (h)			
	(3) 1 sample from a MILK SAMPLING LOCATION	At a control location (la4), 15 to 30 km distant and in the least prevalent wind direction	Concurrently with indicator locations		
b. Fish and Invertebrates	(1) 1 sample each from edible portions of commercially or recreationally important species	In the vicinity of a plant discharge area (lb1)	Sample in season, or Semiannually if sample is not seasonal	Gamma isotopic analysis of each sample (e), and Sr-90.	| 1/07
	(2) 1 sample of the same species	If available in areas not influenced by plant discharge (lb2)			

Table D 3.5.1-1 (page 3 of 3)
Radiological Environmental Monitoring Program

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF SAMPLES	SAMPLE LOCATIONS (a)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
4. Ingestion (continued)				
c. Food Products	(1) Samples of 3 different kinds of broad leaf vegetation (such as vegetables) (2) 1 sample of each of the similar broad leaf vegetation.	Grown nearest to each of 2 different offsite locations of highest predicted annual average ground level D/Q if milk sampling is not performed (Ic1-Ic2) Grown 15 to 30 km distant in the least prevalent wind direction if milk sampling is not performed (Ic3)	Monthly when available	Gamma isotopic (e) and I-131 analysis

(a) The code letters in parenthesis, e.g., DR1, A1 define generic sample locations. Specific parameters of distance and direction sector from the centerline of one reactor, and additional descriptions where pertinent, shall be provided for each and every sample location in Table D 3.5.1-1. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978, and to Radiological Assessment Branch Technical Position on Environmental Monitoring, Revision 1, November 1979. Deviations are permitted from the required sampling schedule if specimens are unobtainable because of such circumstances as hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons.

(b) One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to integrating dosimeters. Each of the 40 routine monitoring stations shall be equipped with 2 or more dosimeters or with 1 instrument for measuring and recording dose rate continuously. For the purpose of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; 2 or more phosphors in a packet are considered as 2 or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation.

(c) The purpose of these samples 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, which provide valid background data, may be substituted.

(d) Airborne particulate sample filters shall be analyzed for gross beta activity 24 hours or more after sampling to allow for radon and thoron daughter decay.

(e) Gamma isotopic analysis means the identification and quantification of gamma –emitting radionuclides that may be attributable to the effluents from the facility.

(f) The "upstream" samples shall be taken near the intake structures as described in the ODCM. The ""downstream" sample shall be taken from the mixing zone at the diffuser of the discharge canal.

(g) In this program, a composite sample is one in which the quantity (aliquot) shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.

(h) The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

Table D 3.5.1-2 (page 1 of 1)
Reporting Levels for Radioactivity in Environmental Samples **

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RADIONUCLIDE ANALYSIS	WATER (pCi/L)	AIRBORNE PARTIUCLATE 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		
Sr-90 ***	8*		40		
Zr-95	400				
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-140	200			300	
La-140	200			300	

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* Values provided are for drinking water pathways. If no drinking water pathway exists, higher values are allowed, as follows:

H-3	30,000 pCi/L (This is a 40 CFR 141 value)
Sr-90	12 pCi/L
I-131	20 pCi/L

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** These reporting levels are associated only with the REMP requirements. The Ground Water Monitoring Program may involve unique reporting level criteria, independent of the REMP, and defined in station procedures.

*** Sr-90 is added to this table due to its potential pathway via ground water.

Table D 3.5.1-3 (page 1 of 2)
Detection Capabilities for Environmental Sample Analysis (a) (e)

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LOWER LIMIT OF DETECTION (LLD) (b) (c)

RADIONUCLIDE ANALYSIS	WATER (pCi/L)	AIRBORNE PARTIUCLATE OR GASES (pCi/m³)	FISH (pCi/kg, wet)	MILK (pCi/L)	FOOD PRODUCTS (pCi/kg, wet)	SEDIMENT (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	2,000 (d)					
Mn-54	15		130			
Fe-59	30		260			
Co-58	15		130			
Co-60	15		130			
Zn-65	30		260			
Sr-90 (f)	1		5			5000
Zr-95	15					
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	15			15		
La-140	15			15		

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Table D 3.5.1-3 (page 2 of 2)
Detection Capabilities for Environmental Sample Analysis

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 pursuant to Specification D 5.1.

(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.

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 pursuant to RECS D 5.1.

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(d) These LLDs are for drinking water samples. If no drinking water pathway exists, the LLDs may be increased to 3,000 for H-3 and 15 for I-131.

(e) These required lower limits of detection are associated only with the REMP requirements. The Ground Water Monitoring Program may involve unique reporting level criteria, independent of the REMP, and defined in station procedures.

(f) Sr-90 is added to this table due to its potential pathway via ground water.

D 3.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

D 3.5.2 Land Use Census

DLCO 3.5.2 A land use census shall:

a. Be conducted,

b. Identify within a distance of 8 km (5 miles) the location, in each of the 16 meteorological sectors, of the nearest milk animal and the nearest residence, and the nearest garden (broad leaf vegetation sampling controlled by Table D 3.5.1-1, part 4.c may be performed in lieu of the garden census) of > 50 m^2 (500 ft^2) producing broad leaf vegetation, and

c. For elevated releases, identify within a distance of 3 miles the locations, in each of the 16 meteorological sectors, of all milk animals and all gardens > 50 m^2 producing broad leaf vegetation.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Land use census identifies location(s) that yields a calculated dose, dose commitment, or D/Q value > than the values currently being calculated in DSR 3.2.3.1.	A.1 Identify the new location(s) in the next Radioactive Effluent Release Report.	In accordance with the Radioactive Effluent Release Report

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Land use census identifies location(s) that yields a calculated dose, or dose commitment (via the same exposure pathway) a factor > 2 than at a location from which samples are currently being obtained in accordance with Table D 3.5.1-1.	B.1 Add the new location(s) to the Radiological Environmental Monitoring Program.	30 days
	AND	
	B.2 Delete the sampling location(s), excluding the control station location, having the lowest calculated dose, dose commitment(s) or D/Q value, via the same exposure pathway, from the Radiological Environmental Monitoring Program.	After October 31 of the year in which the land use census was conducted
	AND	
	B.3 Submit in the next Radioactive Effluent Release Report documentation for a change in the ODCM including revised figure(s) and table(s) for the ODCM reflecting the new location(s) with information supporting the change in sampling locations.	In accordance with the Radioactive Effluent Release Report

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.5.2.1	Conduct the land use census during the growing season 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.	366 days
DSR 3.5.2.2	Report the results of the land use census in the Annual Radiological Environmental Operating Report.	In accordance with the Annual Radiological Environmental Operating Report

D 3.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

D 3.5.3 Interlaboratory Comparison Program

DLCO 3.5.3 The Interlaboratory Comparison Program shall be described in the ODCM.

AND

Analyses shall be performed on all radioactive materials, supplied as part of an Interlaboratory Comparison Program that has been approved by the Commission.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Analyses not performed as required.	A.1 Report the corrective actions taken to prevent a recurrence to the NRC in the Annual Radiological Environmental Operating Report.	In accordance with the Annual Radiological Environmental Operating Report

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.5.3.1	Report a summary of the results obtained as part of the Interlaboratory Comparison Program in the Annual Radiological Environmental Operating Report.	In accordance with the Annual Radiological Environmental Operating Report

D 3.6 SOLID RADIOACTIVE WASTE

D 3.6.1 Solid Radwaste Treatment System

DLCO 3.6.1 The appropriate equipment of the Solid Radwaste Treatment System shall be in operation process wet radioactive wastes in accordance with the Process Control Program.

APPLICABILITY: During solid radwaste processing

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive solid waste does not comply with Process Control Program requirements.	A.1 Suspend shipments of solid radioactive waste.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.6.1.1	Verify solidification of specimens in accordance with the Processing Control Program.	Prior to each shipment
DSR 3.6.1.2	Record the following information for each class of solid waste (as defined by 10 CFR Part 61) shipped offsite during the Radioactive Effluent Release Report period: a. Container volume, b. total curie quantity (specify determined by measurement or estimate), c. principal radionuclides (specify determined by measurement or estimate), d. source of waste and processing employed (e.g., dewatered spent resin, compacted dry waste, evaporator bottoms), e. type of container (e.g., LSA Type A, Type B, Large Quantity), and f. solidification agent or absorbent (e.g., cement, urea formaldehyde).	Prior to each shipment

D 3.6 SOLID RADIOACTIVE WASTE

D 3.6.1 Solid Radwaste Treatment System

DLCO 3.6.1 The appropriate equipment of the Solid Radwaste Treatment System shall be in operation process wet radioactive wastes in accordance with the Process Control Program.

APPLICABILITY: During solid radwaste processing

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive solid waste does not comply with Process Control Program requirements.	A.1 Suspend shipments of solid radioactive waste.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.6.1.1	Verify solidification of specimens in accordance with the Processing Control Program.	Prior to each shipment
DSR 3.6.1.2	Record the following information for each class of solid waste (as defined by 10 CFR Part 61) shipped offsite during the Radioactive Effluent Release Report period: a. Container volume, b. total curie quantity (specify determined by measurement or estimate), c. principal radionuclides (specify determined by measurement or estimate), d. source of waste and processing employed (e.g., dewatered spent resin, compacted dry waste, evaporator bottoms), e. type of container (e.g., LSA Type A, Type B, Large Quantity), and f. solidification agent or absorbent (e.g., cement, urea formaldehyde).	Prior to each shipment

D 4.0 DESIGN FEATURES

D 4.1 UNRESTRICTED AREA

D 4.1.1 The definition of UNRESTRICED AREA used in implementing the Radiological Effluent Controls (RECS or ODCM Part I) has been expanded over that in 10 CFR 20.1003. For calculations performed pursuant to 10 CFR 50.36a, the concept of UNRESTRICTED AREAS refers to areas "at or beyond the SITE BOUNDARY" and does not include areas over water bodies. 1/07

A map representing the UNRESTRICTED AREA is shown in Figure D 4.1-1

Information which will allow identification of structures and release points for radioactive gaseous and liquid effluents is shown in Figure D 4.1-2.

D 4.1.2 For the purpose of satisfying 10 CFR Part 20, the "Restricted Area" is the same as the "Exclusion Area" defined in Figure 2.2-2 of Section 2.2 of the UFSAR.

Figure D 4.1-1 MAP DEFINING UNRESTRICTED AREAS FOR RADIOACTIVE GASEOUS AND LIQUID EFFLUENTS

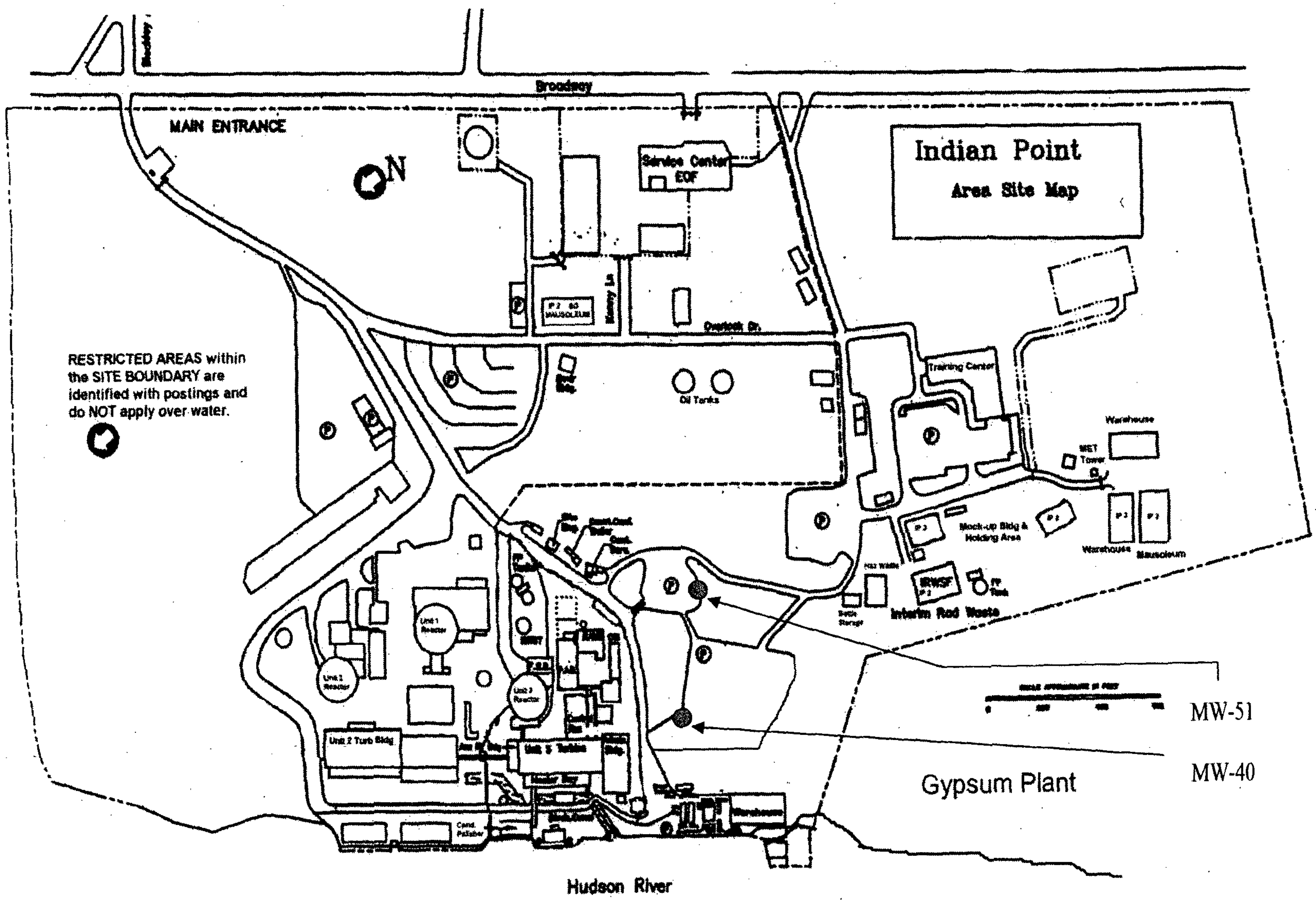
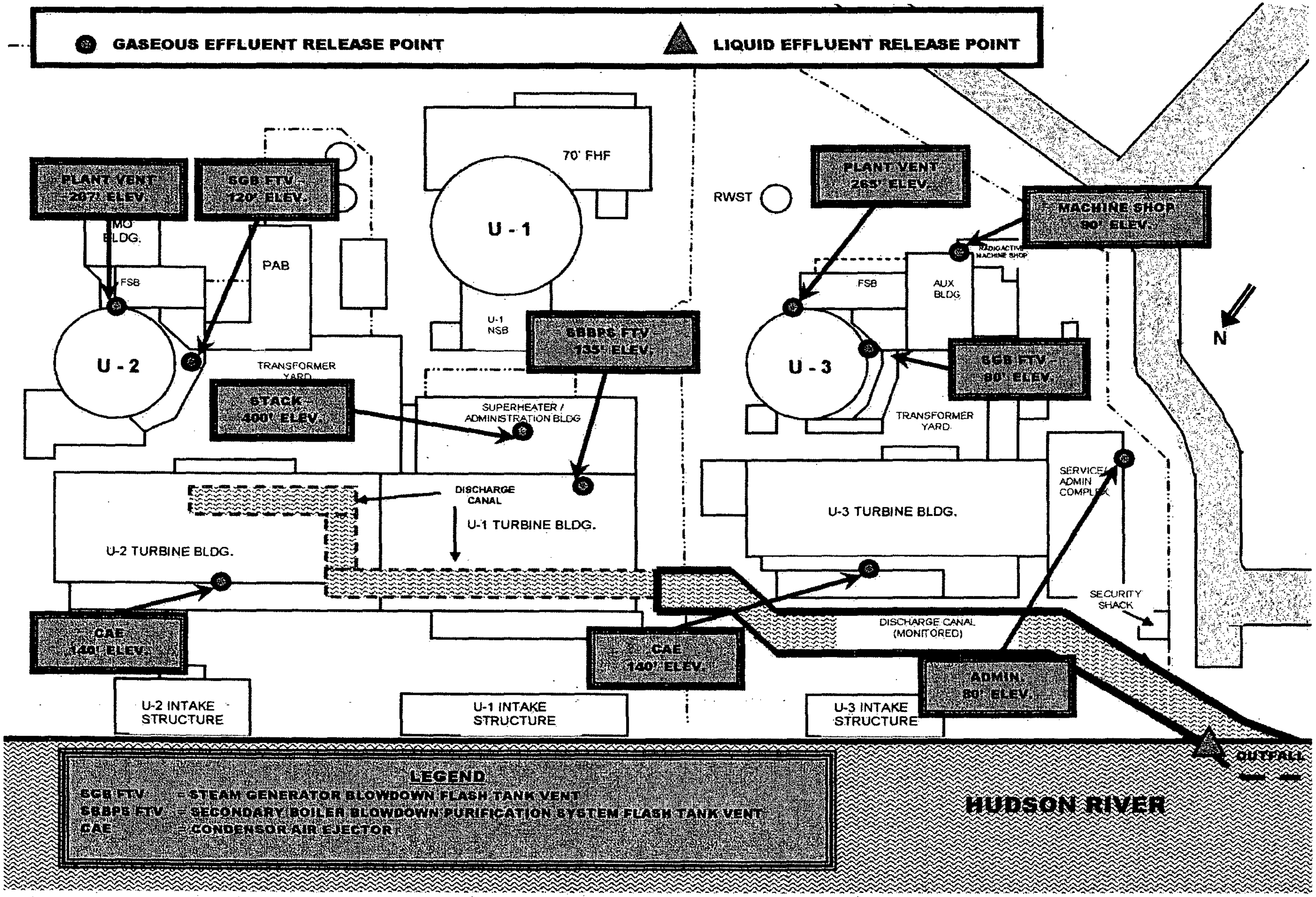


Figure D 4.1-2 MAP DEFINING RELEASE POINTS



D 5.0 ADMINISTRATIVE CONTROLS

D 5.1 Annual Radiological Environmental Operating Report

An annual Radiological Environmental Operating Report covering the operation of the unit during the previous calendar year shall be submitted prior to May 15th of each year, according to Technical Specification 5.6.2. A single submittal may be made for a multiple unit station.

The Annual Radiological Environmental Operating Report shall include:

- Summaries, interpretations, and an analysis of trends of the results of the Radiological Environmental Monitoring Program for the report period, including a comparison, as appropriate, with preoperational studies, with operational controls, and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment.

- At least two legible maps covering all sampling locations keyed to a table giving distances and directions from the centerline of one reactor. One map shall cover stations near the site boundary and the second shall include the more distant stations.

- The results of analysis of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the locations specified in the tables and figures in the ODCM, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual 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. 1/07

- A summary description of the Radiological Environmental Monitoring Program.

- A discussion of the reasons for not conducting the Radiological Environmental Monitoring Program as specified by D 3.5.1 and the plans for preventing recurrence.

- A discussion of environmental sample measurements that exceed the reporting levels of Table D 3.5.1-2 but are not the result of plant effluents.

- A discussion of all deviations from the sampling schedule of Table D 3.5.1-1.

- A discussion of the contributing factors for cases in which the LLD required by Table D 3.5.1-3 was not achievable.

- A discussion of identifiable nuclide peaks, including those of nuclides specified in Table D 3.5.1-3.

- The results of the land use census.

- The corrective actions taken to prevent a recurrence if the Interlaboratory Comparison Program is not being performed as required.

- The results of licensee participation in the Interlaboratory Comparison Program.

D 5.0 ADMINISTRATIVE CONTROLS

D 5.2 Radioactive Effluent Release Report

The Radioactive Effluent Release Report to be submitted by May 1 of each year shall include:

a. A summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof.

b. An annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distribution of wind speed, wind direction, and atmospheric stability. In lieu of submission with the Radioactive Effluent Release Report, the licensee has the option of retaining this summary of required meteorological data onsite in a file that shall be provided to the NRC upon request

c. An assessment of the radiation doses due to the radioactive liquid and gaseous effluents releases from the unit or station during the previous calendar year.

d. An assessment of the radiation doses from radioactive liquid and gaseous effluents to members of the public due to their activities inside the SITE BOUNDARY (Figure D 4.1-1) during the report period. All assumptions used in making these assessments, i.e., specific activity, exposure time and location, shall be included in these reports. Gaseous pathway doses are determined from sampling and measurements at the exhaust points, coupled with the use of annual-averaged meteorological data collected from a period of live data to verify its validity. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the Offsite Dose Calculation Manual (ODCM).

   Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in Regulatory Guide 1.109, Rev. 1, October 1977.

e. The following information for each class of solid waste (in compliance with 10 CFR Part 61) shipped offsite during the report period:

   1. Container volume,

   2. total curie quantity (specify whether determined by measurement or estimate),

D 5.2 Radioactive Effluent Release Report (continued)

3. principal radionuclides (specify whether determined by measurement or estimate),

4. source of waste and processing employed (e.g., dewatered spent resin, compacted dry-waste, evaporator bottoms),

5. type of container (e.g., LSA, Type A, Type B, Large Quantity), and

6. solidification agent or absorbent (e.g., cement, urea formaldehyde).

f. A list and description of unplanned releases from the site to UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

g. Any changes made during the reporting period to the Process Control Program (PCP) and to the Offsite Dose Calculation Manual (ODCM), as well as a listing of new locations for dose calculations and/or environmental monitoring identified by the land use census pursuant to Specification D 3.5.2.

D 5.0 ADMINISTRATIVE CONTROLS

D 5.3 Special Reports

Special reports shall be submitted to the NRC Regional Administrator of the Region I Office within the time period specified for each report. These reports shall be submitted covering the activities identified below pursuant to the applicable Specification:

a. Radioactive Effluents (Specifications D 3.1, D 3.2 and D 3.4)

b. Radiological environmental monitoring (Specification D 3.5)

D 5.0 ADMINISTRATIVE CONTROLS

D 5.4 Major Changes to Radioactive Waste Systems

Licensee initiated major changes to the radioactive waste systems (liquid, gaseous and solid) shall be reported to the Commission in the Radioactive Effluent Release Report for the period in which the change was made. The discussion of each change shall contain:

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

b. sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information,

c. a detailed description of the equipment, components and processes involved and the interfaces with other plant systems,

d an evaluation of the change, which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the license application and amendments thereto,

e. an evaluation of the change, which shows the expected maximum exposures to individuals in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the license application and amendments thereto,

f. a comparison of the predicted releases of radioactive materials in liquid and gaseous effluents and in solid waste to the actual releases for the period in which the changes are to be made;

g. an estimate of the exposure to plant operating personnel as a result of the change, and

h. documentation of the fact that the change was reviewed and found acceptable by the OSRC.

D 5.0 ADMINISTRATIVE CONTROLS

D 5.5 Process Control Program

Licensee initiated changes to the Process Control Program (PCP):

a. Shall be submitted to the Commission in the Annual Radioactive Effluent Release Report for the period in which the change(s) was made. This submittal shall contain:

   1. sufficiently detailed information to totally support the rationale for the change without benefit of additional or supplemental information,

   2. a determination that the change did not reduce the overall conformance of the solidified waste product to existing criteria for solid wastes, and

   3. documentation of the fact that the change has been reviewed and found acceptable by the OSRC.

b. Shall become effective upon review and acceptance by the OSRC.

D 5.6 Ground Water Monitoring Program (GWMP)

The GWMP shall be defined in station procedures and shall include detailed information regarding the following:

- Purpose and scope of the program
- Sample locations, types, and species analyzed
- Methods of archiving and retrieving historical records of analytical results
- Reporting instructions, including limits of detection
- Summary information characterizing the condition of site ground water
- An annual summary report for submittal to the NRC and/or general publication

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Indian Point 2

Offsite Dose Calculation Manual

Part I (RECS)

BASES

3.0 APPLICABILITY

BASES

DLCOs 3.0.1, 3.0.2, and 3.0.5, and DSRs 3.0.1, 3.0.2, and 3.0.3 reflect parallel requirements in the Technical Specifications. Refer to Technical Specification Bases for appropriate discussions.

ODCM Specification DLCO 3.0.3, in lieu of imposing a plant shutdown as paralleled in Technical Specification LCO 3.0.3, requires: (a) an Action to initiate efforts to restore compliance with the ODCM or associated Actions; and (b) an Action that requires entering the circumstances into the Corrective Action Program (CAP). These requirements ensure that the appropriate actions continue to be focused on and that the circumstances concerning failure to comply with the ODCM Actions would be reviewed. This review will be conducted in accordance with the procedural guidance for CAP Notifications.

There are no ODCM 3.0 Specifications that parallel Technical Specification LCO 3.0.4 or SR 3.0.4. Restrictions in entering MODES or other specified conditions in the Applicability have historically not been applied to ODCM Specifications. There are also no ODCM 3.0 Specifications that parallel Technical Specification LCO 3.0.6 and LCO 3.0.7, which allow for exceptions and revisions of other Technical Specifications. They are not applicable to the ODCM since it is not permitted to allow the ODCM to revise a Technical Specification.

(Note, currently no identified ODCM DLCOs support Technical Specification systems; however, this discussion is presented to address the philosophy that would be applied.) An allowance similar to Technical Specification LCO 3.0.6 does not apply to the ODCM. When a Technical Specification supported system LCO is discovered to be not met solely due to a ODCM support system DLCO not met, appropriate Technical Specification ACTIONS are required to be entered immediately. This applies even in instances where the ODCM contains a delay prior to declaring a Technical Specification supported system inoperable. In this case, certain ODCM inoperabilities may not directly impact the OPERABILITY of the Technical Specification supported system and delayed declaration of inoperability of the supported system is acceptable. In other cases, discovered support system inoperabilities that directly result in supported system inability to perform the safety function, should result in immediate declaration of inoperability of the supported system.

Technical Specification LCO 3.0.7 has no parallel in the ODCM since it provides for explicit changes to specified Technical Specifications by the Section 3.1.8 Specifications. However, in the event that LCO 3.0.7 provides for changes to the Technical Specification MODE definitions by the Section 3.1.8 Specifications, the revised MODE definitions apply to all plant references, including ODCM references.

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.1 Liquid Effluent Concentrations

BASES

It is expected that the release of radioactive materials in liquid and gaseous effluents to UNRESTRICTED AREAS will not exceed the concentration limits specified in 10 CFR Part 20 and should be as low as reasonably achievable (ALARA) in accordance with the requirement of 10 CFR 50.36a. While providing reasonable assurance that the design objectives will be met, these Specifications permit the flexibility of operation, compatible with considerations of health and safety, to ensure that the public is provided a dependable source of power under unusual operating conditions which may temporarily result in releases higher than the design objective levels but still within the concentration limits specified in 10 CFR Part 20. It is expected that using this operational flexibility under unusual operation conditions, and exerting every effort to keep levels of radioactive materials in liquid and gaseous wastes as low as reasonably achievable, releases will not exceed a small fraction of the concentration limits specified in 10 CFR Part 20.

The design objectives have been developed based on operating experience, taking into account a combination of variables including defective fuel, primary system leakage, primary to secondary system leakage, steam generator blowdown and the performance of the various waste treatment systems, and are consistent with 10 CFR Part 50.36a.

The Indian Point site is a multiple-unit site. There exist shared radwaste treatment systems and shared effluent release points. Where site limits must be met, the effluents of all the units will be combined to determine site compliance. For instances where unit-specific information may be required for radwaste processed or released via a shared system, the effluents shall be proportioned among the units sharing the system(s) in accordance with the methods and agreements set forth in the ODCM.

This specification is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than the concentration levels specified in 10 CFR Part 20. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, to a member of the public and (2) the limits of 10 CFR Part 20.1302 to the population. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its MPC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

This specification applies to the release of liquid effluents from all units on site.

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.2 Liquid Effluents Dose

BASES

This Specification is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The DLCO 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 will be kept "as low as reasonably achievable". Also, for fresh water sites to UNRESTRICTED AREA 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 concentration in the finished drinking water that are in excess of the requirements of 40 CFR 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 10 CFR Part 50, Appendix I", Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I", April 1977.

In addition to the limiting conditions for operation, the reporting requirements specify that the licensee shall identify the cause whenever the dose from the release of radioactive materials in liquid waste effluent exceeds the above limits and describe the proposed program of action to reduce such releases to design objective levels on a timely basis.

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.3 Liquid Radwaste Treatment System

BASES

This Specification requires that the licensee maintain and operate appropriate equipment installed in the liquid waste systems, when necessary, to provide assurance that the releases of radioactive materials in liquid effluents will be kept "as low as reasonably achievable". This Specification implements the requirements of 10 CFR 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I to 10 CFR Part 50 for liquid effluents.

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.4 Liquid Holdup Tanks

BASES

The tanks listed in this Specification include 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. These tanks include the following:

a. Refueling Water Storage Tank

b. Primary Water Storage Tank

c. 13 Waste Distillate Storage Tank

d. 14 Waste Distillate Storage Tank

e. Outside Temporary tank

Restricting the quantity of radioactive material contained in the specified tanks provides assurance that, in the event of an uncontrolled release of any such tank's contents, the resulting concentration would be less than the limits of 10 CFR 20 at the nearest potable water supply and the nearest surface water supply in an UNRESTRICTED AREA.

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.1 Gaseous Effluents Dose Rate

BASES

This Control provides 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 at or beyond the SITE BOUNDARY in excess of the design objectives of Appendix I to 10 CFR Part 50. This Control is provided to ensure that gaseous effluents from all units on the site will be appropriately controlled. It provides operational flexibility for releasing gaseous effluents to satisfy the Section II.A and II.C design objectives of Appendix I to 10 CFR Part 50. For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of that MEMBER OF THE PUBLIC will usually be sufficiently low to compensate for the reduced atmospheric dispersion of gaseous effluents relative to 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 rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrem/year to the total body or to less than or equal to 3000 mrem/year to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a child via the inhalation pathway to less than or equal to 1500 mrem/year. This Control does not affect the requirement to comply with the annual limitations of 10 CFR 20.

This Control applies to the release of gaseous effluents from all units at the site.

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.2 Gaseous Effluents Dose – Noble Gas

BASES

This Specification is provided to implement the requirements of Sections II.B, III.A, and IV.A of Appendix I to 10 CFR Part 50. The DLCO 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 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 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases form Light-Water Cooled Reactors," Revision 1, July 1977. The ODCM equations provided for determining the doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

This Control applies to the release of gaseous effluents from Indian Point Units Nos. 1 and 2.

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.3 Gaseous Effluents Dose – Iodine and Particulate

BASES

This Specification is provided to implement the requirements of Section II.C, III.A and IV.A of Appendix I to 10 CFR Part 50. The DLCOs 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 reasonably achievable." The ODCM calculational methods specified in 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 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 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate specifications for iodine-131, tritium, and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man in the 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.

This Control applies to the release of gaseous effluents from Indian Point Units Nos. 1 and 2.

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.4 Gaseous Radwaste Treatment System

BASES

This Specification requires that the appropriate portions of the Gaseous Radwaste Treatment System be used, when specified, to provide reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as reasonably achievable." This Specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

This Specification applies to the release of gaseous effluents from Indian Point Units Nos. 1 and 2.

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.5 Ventilation Exhaust Treatment System

BASES

This Specification requires that the appropriate portions of the Ventilation Exhaust Treatment System be used, when specified, to provide reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as reasonably achievable." This Specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

This Specification applies to the release of gaseous effluents from Indian Point Units Nos. 1 and 2.

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.6 Gas Storage Tanks

BASES

The tanks included in this Specification are those tanks for which the quantity of radioactivity contained is not limited directly or indirectly by other specifications to a quantity that is less than the quantity that provides assurance that, in the event of an uncontrolled release of the tank's contents, the resulting total body exposure to a MEMBER OF THE PUBLIC at the nearest SITE BOUNDARY will not exceed 0.5 rem in an event of 2 hours duration.

Restricting the quantity of radioactivity contained in each gas storage tank provides assurances that, in the event of an uncontrolled release of the tank's contents, the resulting total body exposure to a MEMBER OF THE PUBLIC at the nearest SITE BOUNDARY will not exceed 0.5 rem. This is consistent with Branch Technical Position ETSB 11-5 in NUREG-0800, July 1981.

D 3.3 INSTRUMENTATION

D 3.3.1 Radioactive Liquid Effluent Monitoring Instrumentation

BASES

The radioactive liquid effluent instrumentation, required OPERABLE by this Specification, is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases. The alarm/trip setpoints for these instruments shall be calculated in accordance with methods set forth in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR 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 10 CFR Part 50. The purpose of tank level indicating devices is to assure the detection and control of leaks that, if not controlled, could potentially result in the transport of radioactive materials to UNRESTRICTED AREAS.

D 3.3 INSTRUMENTATION

D 3.3.2 Radioactive Gaseous Effluent Monitoring Instrumentation

BASES

The radioactive gaseous effluent instrumentation, required OPERABLE by this Specification, is provided to monitor and control, as applicable, the releases of radioactive materials in 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 10 CFR Part 20. This instrumentation also includes provisions for monitoring the concentrations of potentially explosive gas mixtures in the waste gas holdup system. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design criteria 60, 63 and 64 in Appendix A to 10 CFR Part 50.

D 3.4 RADIOACTIVE EFFLUENTS TOTAL DOSE

D 3.4.1 Radioactive Effluents Total Dose

BASES

This Specification is provided to meet the dose limitation of 40 CFR Part 190 that has been incorporated into 10 CFR Part 20 by 46 FR 18525. The Specification requires the preparation and submittal of a special report whenever the calculated doses from plant-generated radioactive effluents and direct radiation exceed 25 mrem to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem.

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 40 CFR 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 40 CFR Part 190 limits. For the purposes of the special report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contribution from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the special report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR Part 190.11 and 10 CFR Part 20.2203(a)(4), is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in Specifications D 3.1.1 and D 3.2.1. 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.

D 3.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

D 3.5.1 Radiological Environmental Monitoring Program

BASES

The radiological environmental monitoring program required by this specification 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 10 CFR 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. 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 D 3.5.1-3 are considered optimum for routine environmental measurements in industrial laboratories. 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.

D 3.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

D 3.5.2 Land Use Census

BASES

This specification 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 the 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 10 CFR Part 50. Restricting the census to gardens of greater than 50 m2 provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/year) 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 (i.e., similar to lettuce and cabbage), and (2) a vegetation yield of 2 kg/m2.

D 3.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

D 3.5.3 Interlaboratory Comparison Program

BASES

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 (developed using the guidance in Regulatory Guide 1.21, Revision 1, April 1974 and Regulatory Guide 4.1, Revision 1, April 1975) in order to demonstrate that the results are valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

D 3.6 SOLID RADWASTE TREATMENT SYSTEM

D 3.6.1 Solid Radwaste Treatment System

BASES

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

Indian Point 2

Offsite Dose Calculation Manual

PART II – CALCULATIONAL METHODOLOGIES

1.0 LIQUID EFFLUENT METHODOLGY

1.1 Liquid Effluent Model Assumptions and Information

Concentrations of radionuclides in liquid wastes are determined by sampling and analyses in accordance with the Radiological Effluent Controls (RECS). The types of releases include both batch (Distillate Tanks), and continuous (Steam Generator Blowdown, North Curtain Drain, Sphere Foundation Drain Sump, etc).

All activity concentration determinations for liquid releases are performed in a manner to ensure results are representative of the bulk water. Distillate Storage Tanks are well-mixed through agitation or recirculation of contents (at least two tank contents volumes prior to sampling). Continuous Steam Generator releases are sampled daily for compositing on a weekly basis. Other continuous pathways are sampled at least weekly for generation of a flow-proportional composite. Volume calculations are derived from tank volume for batch releases, and measured flow rate or totalizer readings for continuous releases.

After mixing a tank for batch release, a sample(s) is taken to allow calculations for monitor setpoint, maximum discharge flow rate and, optionally, a monitor conversion factor (uCi/ml per net cpm) as provided in Appendices E and F. Calculations of setpoints and conversion factors are performed for continuous boiler blowdown discharges to the river primarily from the most recent radioactivity analysis. If there has been a significant change in the composition of the discharge, the conversion factor may need adjustment. Simplifications to these requirements can be made in conservative approved setpoint calculations, monitor conversion factor computations, and in standard operating procedures, as long as the instantaneous concentration limits are not exceeded when considering the several release paths.

A completed and authorized discharge permit, prepared by SOP, is required prior to batch releases. Each tank discharged requires its own permit. Continuous releases should be documented but do not require a permit. Both batch and continuous releases generally include concentration limiting criteria for additional assurance of compliance with effluent regulations with minimum dilution flow.

A near-field dilution factor may be assumed with regard to dose (Part 50 compliance) calculations only. In accordance with NUREG-0133, New York University has determined that the appropriate value for use at IPEC is 5.0 [Ref. 18].

Several normally non-radioactive systems are periodically analyzed for radioactivity. Examples include the Spent Fuel Pool Auxiliary Heat Exchanger Secondary Cooling System (when in use), and Site Storm Drains, etc. The monitoring program for these types of release points is consistent with the direction set forth in NRC IE Bulletin 80-10 "Contamination of Non-radioactive Systems and Resulting Potential for Unmonitored, Uncontrolled Release of Radioactivity to Environment". Should a system become contaminated, releases are evaluated and quantified (as either batch or continuous) in accordance with the requirements listed in the RECS and the IPEC 80-10 program, or as defined in the Ground Water Monitoring Program. 1/07

Radioactivity content in outdoor tanks is to be limited to less than 10 curies, excluding tritium and noble gas, as per the RECS. Compliance with this requirement is demonstrated by limiting the radioactive concentration in these tanks to the value which results in 10 curies when the tank is at full liquid capacity, except as modified below. The radioactive concentration limits for these tanks are:

<u>RWST</u>: $$\frac{10\,curies \times 10^{6}\,\mu Ci/curie}{358{,}500 gal \times 3785 ml/gal} = 7.3 \times 10^{-3}\,\mu Ci/ml$$

<u>PWST</u>: $$\frac{10\,\text{curies} \times 10^{6}\,\mu\text{Ci}/\text{curie}}{165{,}000\text{gals} \times 3785\text{ml}/\text{gal}} = 1.6 \times 10^{-2}\,\mu\text{Ci}/\text{ml}$$

<u>13 & 14 WDST</u>:
$$\frac{10\ \text{curies} \times 10^{6}\,\mu\text{Ci}/\text{curie}}{23{,}577\,\text{gals} \times 3785\,\text{ml}/\text{gal}} = 1.1 \times 10^{-1}\,\mu\text{Ci}/\text{ml}$$

<u>Outside Temporary Tanks</u>:
$$\frac{10\ curies \times 10^{-6}\,\mu Ci/curie}{Volume\ (gal) \times 3785 ml/\ gal} = \mu Ci/ml$$

1/07

Integrated curies in a tank can similarly be determined by calculating the curies added from known inlet concentrations and volumes, which would then be combined with previously determined tank curie levels.

Investigations from the Ground Water Monitoring Program (GWMP) may result in a determination of liquid effluent. A quantification and dose assessment of radioactive groundwater or storm water leaving the site shall be performed at least annually.

> This quantification shall include, as a minimum, the source term from samples obtained near the effluent points of each applicable pathway (eg, ground water wells nearest the site boundary), and a determination of release rate and dilution flow.
>
> > Release rates to the river from both the bedrock pathways and collective storm drain pathways are provided from modeling by hydrologists, as determined from the annual average rainfall, the condition of the surface area over the effected zones, and other studies of ground water movement, per Reference 24.
> >
> > Dilution flow is directly measured in the Discharge Canal for the Storm Drain component. For groundwater reaching the Hudson via a direct path under the canal, a dilution factor equivalent to a 6-hour half-tidal surge in the effected area of the Hudson applies, as discussed in Reference 25.
>
> Dose calculations are otherwise then completed per Section 1.4, with results included in the annual effluent report, as defined in the GWMP.

See Table 1-1 for a listing of applicable liquid effluent control specifications.

1.2 Determination of Setpoints for Liquid Effluent Monitors

Section 4.1 and Appendix E identify methods of establishing liquid effluent radiation monitor setpoints. Normally, a calculation is performed with each release to determine the Allowed Diluted Concentration (ADC). However, a method is also provided in Attachment E to use an isotope-specific fraction of the Maximum Permissible Concentration. The ADC method is preferred because it includes an estimate of the impact of Beta emitters to the proximity of the 10CFR20 limit, despite the fact that the radiation monitor sees only gamma radiation. A diluted concentration limit of 2E-4 uCi/ml is applied to all dissolved and entrained noble gases.

Radiation Monitor Setpoints and associated compliance with 10CFR20 involve an awareness of all radioactive liquid waste releases on site. For example, setpoints may be increased with additional dilution flow "borrowed" from unit 3, provided there is documented communication between the shift managers. Conservatively, a minimum dilution flow of 100,000 gpm is normally dedicated to one unit's routine liquid effluent to ensure sufficient operational margin to comply with 10CFR20 limitations.

The Liquid Radwaste Effluent monitor shall alarm and suspend a release in the event that setpoints are exceeded or approached. The setpoints derived in Section 4.1 and Appendix E ensure diluted concentrations of each isotope is below the required MPC for all release pathways and modes. The setpoint does not account for decay or dispersion beyond the restricted area boundary and thus conservatively controls the effect at the junction of the discharge canal and river.

Monitor conversion factors are generally determined experimentally with actual plant fluid or with calibration mixtures. Noble gases may contribute to monitor response and must be included in the determination of a monitor conversion factor, as shown in Appendix F. The general requirements for setpoints and conversion factors apply to all releases.

1.3 Determining the Dose for Radioactive Liquid Effluents

The RECS require a calculation at least once per 31 days, to verify required operation of the radwaste cleanup systems when cumulative releases of radioactivity in liquid effluents are expected to cause a dose in excess of 0.06 mrem total body, or 0.2 mrem to any organ. The 10CFR50 quarterly and annual time averaged limits are also defined in the RECS as follows:

	Total Body	Any Organ
Quarterly limit	1.5 mrem	5 mrem
Annual limit	3 mrem	10 mrem

The drinking water pumping station on the Hudson River (Chelsea) is beyond the distance requiring impact consideration. Similarly, REMP samples and calculations of doses from historical shoreline deposits indicate that potable water and shoreline deposit pathways need not be considered for offsite dose calculations. Therefore, consumption of fish and shellfish (invertebrates) alone is considered.

The Hudson River at Indian Point is a mixture of fresh and saltwater. The average salinity of the river is about 15% of ocean salinity so that there is an admixture of freshwater and saltwater fish and shellfish in the plant environs. Using data provided from References 18 and 20, the optimum bioaccumulation factors for Indian Point are the values from Reg Guide 1.109 for fresh water fish and salt water invertebrates, coupled with those site-specific values identified in the referenced studies. Resulting site-specific bioaccumulation and dose factors, as well as their justification are further explained in part II of the Indian Point 3 ODCM, section 2.6.

Carbon 14 is released at a rate of .07 curies per GW(e)/yr with an average make up rate of 0.5 gal/min based upon studies performed by the New York State Department of Health. The estimate of Carbon 14 releases are included in the Radiological Impact on Man section of the Annual Radioactive Effluent Release Report. Although the calculations use the same models, these estimates are not included in dose calculations for routine releases due to their inflated contribution from natural causes.

1.4 Dose Calculations

The organ dose from all radionuclides i released in a specific calendar period, T, is:

$$D_T = \sum_i \left(A_i DF_i \sum_j \Delta t_j c_{ij} F'\right) \qquad \text{(L-1)}$$

Where:

D_T ≡ organ dose commitment (mrem)

A_i ≡ site related ingestion dose commitment factor (mrem/hr per μCi/ml) for nuclide i

Δt_j ≡ incremental release period j for release of nuclide i within the calendar period (hours)

DF_i ≡ Environmental Transit Time factor (t_p from RG 1.109 and unitless), represented as $e^{-\lambda t}$, where *t* is the delay between sampling and start of release, and λ is the decay constant (sec^{-1}) for nuclide i. This term is conservatively set to 1.0, but may be applied as needed, in rare cases of short-lived isotopes in liquid waste.

c_{ij} ≡ undiluted concentration of nuclide i during release period Δt_j (μCi/ml)

F' ≡ near-field average dilution (unitless)

= liquid radioactive waste flow/ (circulating flow x K)

K ≡ site specific applicable factor (determined by New York University to have a value of 5)

To better manage a hand calculation, a limited analysis based on the dominant contributors to dose can be performed. The 1988-90 data shows that, in order of decreasing impact, the following nuclides require consideration in the limited analysis: Cs-137, Cs-134, Ni-63, H-3, Co-60. It is advisable to also include Fe-55, Co-58, and any Iodine identified, especially in Steam Generator Blowdown, where Iodine can dominate the total activity.

From Appendix E, with the dilution applied to the isotopic concentrations, the equation becomes:

$$D_T = \sum_i (A_i DF \sum_j \Delta t_j C_{ij}) \qquad \text{(L-2)}$$

where;

$C_{ij} = (f/F) \times c_{ij}$ = dilute concentration

From NUREG-0133 (page 17), the summary dose factor is defined as:

$$A_{iT} = K[(UF)BF_i + (UI)BI_i]DF_i \qquad \text{(L-3)}$$

Where:

A_{iT} = Composite dose parameter for the total body or critical organ for nuclide, i, for all appropriate pathways, mrem/hr per μCi/ml.

K = Units conversion factor, $114155 = \frac{(1E6pCi/\mu Ci) * (1E3ml/kg)}{8760\ hr/yr}$

UF = kg/yr fish consumption from Table E-5 of Regulatory Guide 1.109:

21 Adult	6.9 Child
16 Teen	0 Infant

BFi = Fresh Water Fish Bioaccumulation factor for nuclide, i, in pCi/kg per pCi/l from Table A-1 of Regulatory Guide 1.109.

UI = kg/yr invertebrate consumption from Table E-5 of Regulatory Guide 1.109:

5.0 Adult	1.7 Child
3.8 Teen	0 Infant

BIi = Salt Water Invertebrates Bioaccumulation factor for nuclide, i, in pCi/kg per pCi/l from Table A-1 of Regulatory Guide 1.109.

DF_i = Dose conversion factor for nuclide i, for age groups in pre-selected organs, T, in mrem/pCi, from Tables E-11, 12 & 13 of Regulatory Guide 1.109.

Compiled A_{iT} factors for 3 age groups and various organs for the maximum exposed individual are provided in Tables 1.2, 1.3, and 1.4. Bio-accumulation factors for liquid effluent isotopes are provided in Table 1.5. These tables include all isotopes found in Reg Guide 1.109. Some non-routine isotopes and site-specific data were added from studies at Indian Point units 2 and 3, including bioaccumulation factors for Antimony, Silver, Cesium, and Niobium.

TABLE 1-1

SUMMARY OF LIQUID RECS

DOSE RATE RECS

The diluted concentration of each isotope in UNRESTRICTED AREAS is limited to the Maximum Permissible Concentration identified per RECS Section D1.1. The diluted concentration of dissolved or entrained noble gases are limited to 2E-4 uCi/ml.

DOSE RECS

Dose commitment to any member of public in UNRESTRICTED AREAS is limited to:

1) In any calendar quarter, 1.5 mrem to the total body and 5 mrem to any organ.

2) In a calendar year, 3 mrem to the total body and 10 mrem to any organ.

PROJECTIONS

Projection of liquid doses shall be computed at least every 31 days, as follows:

$$\begin{bmatrix} \text{Dose} \\ \text{Projection} \end{bmatrix} = \frac{\text{Current Month Dose} + \text{Previous months' Dose}}{\text{number of months used}} \pm \begin{bmatrix} major \\ planned \\ evolutions \end{bmatrix}$$

The term for planned evolutions is routinely determined from previous similar evolutions, such as releases associated with plant shutdown.

If projected doses would exceed the limits in the RECS:

0.06 mrem total body, or
0.2 mrem critical organ,

clean-up treatment systems are required to be operational.

TABLE 1-2

Site Related Adult Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.82E-01	2.82E-01	2.82E-01	2.82E-01	2.82E-01	2.82E-01
BE-7	3.29E-01	7.45E-01	3.69E-01	0.00E+00	7.83E-01	0.00E+00	1.28E+02
NA-24	4.08E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02
P-32	4.96E+07	3.08E+06	1.92E+06	0.00E+00	0.00E+00	0.00E+00	5.57E+06
CR-51	0.00E+00	0.00E+00	4.31E+00	2.58E+00	9.50E-01	5.72E+00	1.08E+03
MN-54	0.00E+00	5.43E+03	1.04E+03	0.00E+00	1.61E+03	0.00E+00	1.66E+04
MN-56	0.00E+00	1.37E+02	2.42E+01	0.00E+00	1.73E+02	0.00E+00	4.36E+03
FE-55	3.21E+04	2.21E+04	5.16E+03	0.00E+00	0.00E+00	1.24E+04	1.27E+04
FE-59	5.06E+04	1.19E+05	4.56E+04	0.00E+00	0.00E+00	3.32E+04	3.96E+05
CO-58	0.00E+00	5.15E+02	1.15E+03	0.00E+00	0.00E+00	0.00E+00	1.04E+04
CO-60	0.00E+00	1.48E+03	3.26E+03	0.00E+00	0.00E+00	0.00E+00	2.78E+04
NI-63	4.97E+04	3.45E+03	1.67E+03	0.00E+00	0.00E+00	0.00E+00	7.19E+02
NI-65	2.02E+02	2.62E+01	1.20E+01	0.00E+00	0.00E+00	0.00E+00	6.65E+02
CU-64	0.00E+00	9.08E+01	4.26E+01	0.00E+00	2.29E+02	0.00E+00	7.74E+03
ZN-65	1.61E+05	5.13E+05	2.32E+05	0.00E+00	3.43E+05	0.00E+00	3.23E+05
ZN-69	3.43E+02	6.57E+02	4.57E+01	0.00E+00	4.27E+02	0.00E+00	9.87E+01
BR-83	0.00E+00	0.00E+00	4.05E+01	0.00E+00	0.00E+00	0.00E+00	5.84E+01
BR-84	0.00E+00	0.00E+00	5.25E+01	0.00E+00	0.00E+00	0.00E+00	4.13E-04
BR-85	0.00E+00	0.00E+00	2.16E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	1.01E+05	4.72E+04	0.00E+00	0.00E+00	0.00E+00	2.00E+04
RB-88	0.00E+00	2.91E+02	1.54E+02	0.00E+00	0.00E+00	0.00E+00	4.02E-09
RB-89	0.00E+00	1.93E+02	1.35E+02	0.00E+00	0.00E+00	0.00E+00	1.12E-11
SR-89	2.57E+04	0.00E+00	7.37E+02	0.00E+00	0.00E+00	0.00E+00	4.12E+03
SR-90	6.32E+05	0.00E+00	1.55E+05	0.00E+00	0.00E+00	0.00E+00	1.82E+04
SR-91	4.72E+02	0.00E+00	1.91E+01	0.00E+00	0.00E+00	0.00E+00	2.25E+03
SR-92	1.79E+02	0.00E+00	7.75E+00	0.00E+00	0.00E+00	0.00E+00	3.55E+03
Y-90	6.07E+00	0.00E+00	1.63E-01	0.00E+00	0.00E+00	0.00E+00	6.43E+04
Y-91M	5.73E-02	0.00E+00	2.22E-03	0.00E+00	0.00E+00	0.00E+00	1.68E-01
Y-91	8.89E+01	0.00E+00	2.38E+00	0.00E+00	0.00E+00	0.00E+00	4.89E+04
Y-92	5.33E-01	0.00E+00	1.56E-02	0.00E+00	0.00E+00	0.00E+00	9.33E+03
Y-93	1.69E+00	0.00E+00	4.67E-02	0.00E+00	0.00E+00	0.00E+00	5.36E+04
ZR-95	1.63E+00	5.22E-01	3.54E-01	0.00E+00	8.20E-01	0.00E+00	1.66E+03
ZR-97	9.00E-02	1.82E-02	8.30E-03	0.00E+00	2.74E-02	0.00E+00	5.63E+03
NB-95	4.83E+00	2.69E+00	1.44E+00	0.00E+00	2.65E+00	0.00E+00	1.63E+04
MO-99	0.00E+00	1.28E+02	2.43E+01	0.00E+00	2.90E+02	0.00E+00	2.97E+02
TC-99M	1.59E-02	4.50E-02	5.73E-01	0.00E+00	6.84E-01	2.21E-02	2.66E+01
TC-101	1.64E-02	2.36E-02	2.32E-01	0.00E+00	4.25E-01	1.21E-02	7.09E-14
RU-103	1.10E+02	0.00E+00	4.74E+01	0.00E+00	4.20E+02	0.00E+00	1.28E+04
RU-105	9.16E+00	0.00E+00	3.62E+00	0.00E+00	1.18E+02	0.00E+00	5.60E+03
RU-106	1.64E+03	0.00E+00	2.07E+02	0.00E+00	3.16E+03	0.00E+00	1.06E+05
AG-110M	4.58E+02	4.23E+02	2.51E+02	0.00E+00	8.32E+02	0.00E+00	1.73E+05
SB-122	3.47E+01	7.99E-01	1.20E+01	5.38E-01	0.00E+00	2.08E+01	1.32E+04
SB-124	4.86E+02	9.20E+00	1.91E+02	1.18E+00	0.00E+00	3.79E+02	1.38E+04
SB-125	3.11E+02	3.47E+00	7.40E+01	3.16E-01	0.00E+00	2.40E+02	3.42E+03

TABLE 1-2

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(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
TE-125M	2.72E+03	9.87E+02	3.65E+02	8.19E+02	1.11E+04	0.00E+00	1.09E+04
TE-127M	6.88E+03	2.46E+03	8.38E+02	1.76E+03	2.79E+04	0.00E+00	2.31E+04
TE-127	1.12E+02	4.01E+01	2.42E+01	8.28E+01	4.55E+02	0.00E+00	8.82E+03
TE-129M	1.17E+04	4.36E+03	1.85E+03	4.01E+03	4.88E+04	0.00E+00	5.88E+04
TE-129	3.19E+01	1.20E+01	7.77E+00	2.45E+01	1.34E+02	0.00E+00	2.41E+01
TE-131M	1.76E+03	8.60E+02	7.16E+02	1.36E+03	8.71E+03	0.00E+00	8.53E+04
TE-131	2.00E+01	8.36E+00	6.32E+00	1.65E+01	8.77E+01	0.00E+00	2.83E+00
TE-132	2.56E+03	1.66E+03	1.55E+03	1.83E+03	1.60E+04	0.00E+00	7.83E+04
I-130	4.88E+01	1.44E+02	5.68E+01	1.22E+04	2.24E+02	0.00E+00	1.24E+02
I-131	2.68E+02	3.84E+02	2.20E+02	1.26E+05	6.58E+02	0.00E+00	1.01E+02
I-132	1.31E+01	3.50E+01	1.23E+01	1.23E+03	5.58E+01	0.00E+00	6.58E+00
I-133	9.16E+01	1.59E+02	4.86E+01	2.34E+04	2.78E+02	0.00E+00	1.43E+02
I-134	6.84E+00	1.86E+01	6.64E+00	3.22E+02	2.95E+01	0.00E+00	1.62E-02
I-135	2.86E+01	7.48E+01	2.76E+01	4.93E+03	1.20E+02	0.00E+00	8.45E+01
CS-134	4.14E+04	9.84E+04	8.04E+04	0.00E+00	3.18E+04	1.06E+04	1.72E+03
CS-136	4.33E+03	1.71E+04	1.23E+04	0.00E+00	9.51E+03	1.30E+03	1.94E+03
CS-137	5.30E+04	7.25E+04	4.75E+04	0.00E+00	2.46E+04	8.18E+03	1.40E+03
CS-138	3.67E+01	7.25E+01	3.59E+01	0.00E+00	5.33E+01	5.26E+00	3.09E-04
BA-139	6.47E+00	4.61E-03	1.89E-01	0.00E+00	4.31E-03	2.61E-03	1.15E+01
BA-140	1.35E+03	1.70E+00	8.87E+01	0.00E+00	5.78E-01	9.73E-01	2.79E+03
BA-141	3.14E+00	2.37E-03	1.06E-01	0.00E+00	2.21E-03	1.35E-03	1.48E-09
BA-142	1.42E+00	1.46E-03	8.93E-02	0.00E+00	1.23E-03	8.27E-04	2.00E-18
LA-140	1.58E+00	7.95E-01	2.10E-01	0.00E+00	0.00E+00	0.00E+00	5.83E+04
LA-142	8.07E-02	3.67E-02	9.15E-03	0.00E+00	0.00E+00	0.00E+00	2.68E+02
CE-141	3.23E+00	2.18E+00	2.48E-01	0.00E+00	1.01E+00	0.00E+00	8.35E+03
CE-143	5.69E-01	4.21E+02	4.66E-02	0.00E+00	1.85E-01	0.00E+00	1.57E+04
CE-144	1.68E+02	7.04E+01	9.04E+00	0.00E+00	4.17E+01	0.00E+00	5.69E+04
PR-143	5.80E+00	2.33E+00	2.88E-01	0.00E+00	1.34E+00	0.00E+00	2.54E+04
PR-144	1.90E-02	7.88E-03	9.65E-04	0.00E+00	4.45E-03	0.00E+00	2.73E-09
ND-147	3.97E+00	4.59E+00	2.74E-01	0.00E+00	2.68E+00	0.00E+00	2.20E+04
W-187	2.98E+02	2.49E+02	8.71E+01	0.00E+00	0.00E+00	0.00E+00	8.16E+04
NP-239	3.53E-02	3.47E-03	1.91E-03	0.00E+00	1.08E-02	0.00E+00	7.12E+02
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	1.21E+02	2.01E+02	0.00E+00	0.00E+00	0.00E+00	3.07E+03
SR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-97	4.05E-02	1.02E-02	3.74E-03	0.00E+00	1.20E-02	0.00E+00	3.78E+01
CD-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SN-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-134	3.29E+01	2.15E+01	1.32E+01	2.88E+01	2.08E+02	0.00E+00	3.65E-02
CE-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 1-3

Site Related Teen Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.17E-01	2.17E-01	2.17E-01	2.17E-01	2.17E-01	2.17E-01
BE-7	3.58E-01	8.02E-01	4.01E-01	0.00E+00	8.50E-01	0.00E+00	9.76E+01
NA-24	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02
P-32	5.40E+07	3.35E+06	2.09E+06	0.00E+00	0.00E+00	0.00E+00	4.54E+06
CR-51	0.00E+00	0.00E+00	4.44E+00	2.47E+00	9.73E-01	6.34E+00	7.46E+02
MN-54	0.00E+00	5.33E+03	1.06E+03	0.00E+00	1.59E+03	0.00E+00	1.09E+04
MN-56	0.00E+00	1.43E+02	2.54E+01	0.00E+00	1.81E+02	0.00E+00	9.40E+03
FE-55	3.35E+04	2.37E+04	5.54E+03	0.00E+00	0.00E+00	1.51E+04	1.03E+04
FE-59	5.20E+04	1.21E+05	4.69E+04	0.00E+00	0.00E+00	3.83E+04	2.87E+05
CO-58	0.00E+00	5.10E+02	1.18E+03	0.00E+00	0.00E+00	0.00E+00	7.04E+03
CO-60	0.00E+00	1.48E+03	3.32E+03	0.00E+00	0.00E+00	0.00E+00	1.92E+04
NI-63	5.15E+04	3.64E+03	1.75E+03	0.00E+00	0.00E+00	0.00E+00	5.79E+02
NI-65	2.18E+02	2.79E+01	1.27E+01	0.00E+00	0.00E+00	0.00E+00	1.51E+03
CU-64	0.00E+00	9.53E+01	4.48E+01	0.00E+00	2.41E+02	0.00E+00	7.39E+03
ZN-65	1.46E+05	5.07E+05	2.36E+05	0.00E+00	3.24E+05	0.00E+00	2.15E+05
ZN-69	3.73E+02	7.10E+02	4.97E+01	0.00E+00	4.64E+02	0.00E+00	1.31E+03
BR-83	0.00E+00	0.00E+00	4.41E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	5.55E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-85	0.00E+00	0.00E+00	2.34E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	1.09E+05	5.12E+04	0.00E+00	0.00E+00	0.00E+00	1.61E+04
RB-88	0.00E+00	3.12E+02	1.66E+02	0.00E+00	0.00E+00	0.00E+00	2.67E-05
RB-89	0.00E+00	2.01E+02	1.42E+02	0.00E+00	0.00E+00	0.00E+00	3.09E-07
SR-89	2.79E+04	0.00E+00	8.00E+02	0.00E+00	0.00E+00	0.00E+00	3.33E+03
SR-90	5.27E+05	0.00E+00	1.30E+05	0.00E+00	0.00E+00	0.00E+00	1.48E+04
SR-91	5.12E+02	0.00E+00	2.04E+01	0.00E+00	0.00E+00	0.00E+00	2.32E+03
SR-92	1.94E+02	0.00E+00	8.25E+00	0.00E+00	0.00E+00	0.00E+00	4.93E+03
Y-90	6.57E+00	0.00E+00	1.77E-01	0.00E+00	0.00E+00	0.00E+00	5.42E+04
Y-91M	6.18E-02	0.00E+00	2.36E-03	0.00E+00	0.00E+00	0.00E+00	2.92E+00
Y-91	9.64E+01	0.00E+00	2.58E+00	0.00E+00	0.00E+00	0.00E+00	3.95E+04
Y-92	5.80E-01	0.00E+00	1.68E-02	0.00E+00	0.00E+00	0.00E+00	1.59E+04
Y-93	1.84E+00	0.00E+00	5.03E-02	0.00E+00	0.00E+00	0.00E+00	5.61E+04
ZR-95	1.68E+00	5.29E-01	3.64E-01	0.00E+00	7.78E-01	0.00E+00	1.22E+03
ZR-97	9.65E-02	1.91E-02	8.80E-03	0.00E+00	2.90E-02	0.00E+00	5.17E+03
NB-95	4.86E+00	2.70E+00	1.48E+00	0.00E+00	2.61E+00	0.00E+00	1.15E+04
MO-99	0.00E+00	1.36E+02	2.60E+01	0.00E+00	3.12E+02	0.00E+00	2.44E+02
TC-99M	1.63E-02	4.55E-02	5.89E-01	0.00E+00	6.77E-01	2.52E-02	2.98E+01
TC-101	1.77E-02	2.51E-02	2.47E-01	0.00E+00	4.55E-01	1.53E-02	4.30E-09
RU-103	1.15E+02	0.00E+00	4.93E+01	0.00E+00	4.06E+02	0.00E+00	9.63E+03
RU-105	9.85E+00	0.00E+00	3.82E+00	0.00E+00	1.24E+02	0.00E+00	7.96E+03
RU-106	1.77E+03	0.00E+00	2.23E+02	0.00E+00	3.42E+03	0.00E+00	8.50E+04
AG-110M	4.45E+02	4.22E+02	2.56E+02	0.00E+00	8.04E+02	0.00E+00	1.18E+05
SB-122	4.35E+01	8.47E-01	1.27E+01	5.53E-01	0.00E+00	2.72E+01	9.13E+03
SB-124	5.09E+02	9.40E+00	1.99E+02	1.16E+00	0.00E+00	4.45E+02	1.03E+04
SB-125	3.27E+02	3.58E+00	7.64E+01	3.11E-01	0.00E+00	2.85E+02	2.53E+03

TABLE 1-3

Site Related Teen Ingestion Dose Commitment Factors (Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
TE-125M	2.96E+03	1.07E+03	3.96E+02	8.28E+02	0.00E+00	0.00E+00	8.75E+03
TE-127M	7.48E+03	2.65E+03	8.90E+02	1.78E+03	3.03E+04	0.00E+00	1.87E+04
TE-127	1.22E+02	4.33E+01	2.63E+01	8.44E+01	4.95E+02	0.00E+00	9.44E+03
TE-129M	1.26E+04	4.68E+03	2.00E+03	4.07E+03	5.28E+04	0.00E+00	4.74E+04
TE-129	3.47E+01	1.29E+01	8.44E+00	2.48E+01	1.46E+02	0.00E+00	1.90E+02
TE-131M	1.89E+03	9.06E+02	7.55E+02	1.36E+03	9.44E+03	0.00E+00	7.27E+04
TE-131	2.16E+01	8.90E+00	6.75E+00	1.66E+01	9.44E+01	0.00E+00	1.77E+00
TE-132	2.70E+03	1.71E+03	1.61E+03	1.80E+03	1.64E+04	0.00E+00	5.42E+04
I-130	5.06E+01	1.46E+02	5.84E+01	1.19E+04	2.25E+02	0.00E+00	1.12E+02
I-131	2.87E+02	4.02E+02	2.16E+02	1.17E+05	6.92E+02	0.00E+00	7.95E+01
I-132	1.37E+01	3.58E+01	1.29E+01	1.21E+03	5.64E+01	0.00E+00	1.56E+01
I-133	9.87E+01	1.67E+02	5.11E+01	2.34E+04	2.94E+02	0.00E+00	1.27E+02
I-134	7.17E+00	1.90E+01	6.82E+00	3.17E+02	2.99E+01	0.00E+00	2.50E-01
I-135	2.99E+01	7.71E+01	2.86E+01	4.96E+03	1.22E+02	0.00E+00	8.54E+01
CS-134	4.24E+04	9.97E+04	4.63E+04	0.00E+00	3.17E+04	1.21E+04	1.24E+03
CS-136	4.35E+03	1.71E+04	1.15E+04	0.00E+00	9.32E+03	1.47E+03	1.38E+03
CS-137	5.67E+04	7.54E+04	2.63E+04	0.00E+00	2.57E+04	9.97E+03	1.07E+03
CS-138	3.93E+01	7.54E+01	3.77E+01	0.00E+00	5.57E+01	6.48E+00	3.42E-02
BA-139	7.05E+00	4.96E-03	2.05E-01	0.00E+00	4.67E-03	3.42E-03	6.28E+01
BA-140	1.44E+03	1.76E+00	9.28E+01	0.00E+00	5.98E-01	1.19E+00	2.22E+03
BA-141	3.40E+00	2.54E-03	1.14E-01	0.00E+00	2.36E-03	1.74E-03	7.25E-06
BA-142	1.52E+00	1.52E-03	9.33E-02	0.00E+00	1.28E-03	1.01E-03	4.65E-12
LA-140	1.67E+00	8.20E-01	2.18E-01	0.00E+00	0.00E+00	0.00E+00	4.71E+04
LA-142	8.58E-02	3.81E-02	9.49E-03	0.00E+00	0.00E+00	0.00E+00	1.16E+03
CE-141	3.49E+00	2.33E+00	2.67E-01	0.00E+00	1.10E+00	0.00E+00	6.66E+03
CE-143	6.16E-01	4.48E+02	5.01E-02	0.00E+00	2.01E-01	0.00E+00	1.35E+04
CE-144	1.82E+02	7.55E+01	9.80E+00	0.00E+00	4.51E+01	0.00E+00	4.59E+04
PR-143	6.28E+00	2.51E+00	3.13E-01	0.00E+00	1.46E+00	0.00E+00	2.07E+04
PR-144	2.06E-02	8.44E-03	1.05E-03	0.00E+00	4.84E-03	0.00E+00	2.27E-05
ND-147	4.50E+00	4.89E+00	2.93E-01	0.00E+00	2.87E+00	0.00E+00	1.76E+04
W-187	3.22E+02	2.62E+02	9.19E+01	0.00E+00	0.00E+00	0.00E+00	7.10E+04
NP-239	3.98E-02	3.75E-03	2.08E-03	0.00E+00	1.18E-02	0.00E+00	6.03E+02
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	1.25E+02	2.10E+02	0.00E+00	0.00E+00	0.00E+00	2.33E+03
SR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-97	4.36E-02	1.08E-02	3.95E-03	0.00E+00	1.27E-02	0.00E+00	2.58E+02
CD-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SN-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-134	3.46E+01	2.22E+01	2.32E+01	2.84E+01	2.12E+02	0.00E+00	1.28E+00
CE-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 1-4

Site Related Child Ingestion Dose Commitment Factors (Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	1.81E-01	1.81E-01	1.81E-01	1.81E-01	1.81E-01	1.81E-01
BE-7	4.77E-01	8.08E-01	5.33E-01	0.00E+00	7.96E-01	0.00E+00	4.52E+01
NA-24	4.57E+02	4.57E+02	4.57E+02	4.57E+02	4.57E+02	4.57E+02	4.57E+02
P-32	6.98E+07	3.27E+06	2.69E+06	0.00E+00	0.00E+00	0.00E+00	1.93E+06
CR-51	0.00E+00	0.00E+00	4.86E+00	2.70E+00	7.37E-01	4.92E+00	2.58E+02
MN-54	0.00E+00	4.20E+03	1.12E+03	0.00E+00	1.18E+03	0.00E+00	3.53E+03
MN-56	0.00E+00	1.31E+02	2.96E+01	0.00E+00	1.59E+02	0.00E+00	1.90E+04
FE-55	4.55E+04	2.42E+04	7.48E+03	0.00E+00	0.00E+00	1.37E+04	4.47E+03
FE-59	6.53E+04	1.06E+05	5.27E+04	0.00E+00	0.00E+00	3.07E+04	1.10E+05
CO-58	0.00E+00	4.20E+02	1.29E+03	0.00E+00	0.00E+00	0.00E+00	2.45E+03
CO-60	0.00E+00	1.23E+03	3.64E+03	0.00E+00	0.00E+00	0.00E+00	6.84E+03
NI-63	6.85E+04	3.67E+03	2.33E+03	0.00E+00	0.00E+00	0.00E+00	2.47E+02
NI-65	2.83E+02	2.66E+01	1.55E+01	0.00E+00	0.00E+00	0.00E+00	3.26E+03
CU-64	0.00E+00	9.05E+01	5.47E+01	0.00E+00	2.19E+02	0.00E+00	4.25E+03
ZN-65	1.55E+05	4.12E+05	2.56E+05	0.00E+00	2.59E+05	0.00E+00	7.23E+04
ZN-69	4.94E+02	7.14E+02	6.60E+01	0.00E+00	4.33E+02	0.00E+00	4.50E+04
BR-83	0.00E+00	0.00E+00	5.67E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	6.56E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-85	0.00E+00	0.00E+00	3.02E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	1.06E+05	6.50E+04	0.00E+00	0.00E+00	0.00E+00	6.80E+03
RB-88	0.00E+00	3.00E+02	2.08E+02	0.00E+00	0.00E+00	0.00E+00	1.47E+01
RB-89	0.00E+00	1.85E+02	1.64E+02	0.00E+00	0.00E+00	0.00E+00	1.61E+00
SR-89	3.63E+04	0.00E+00	1.04E+03	0.00E+00	0.00E+00	0.00E+00	1.41E+03
SR-90	4.68E+05	0.00E+00	1.19E+05	0.00E+00	0.00E+00	0.00E+00	6.30E+03
SR-91	6.60E+02	0.00E+00	2.49E+01	0.00E+00	0.00E+00	0.00E+00	1.46E+03
SR-92	2.48E+02	0.00E+00	9.96E+00	0.00E+00	0.00E+00	0.00E+00	4.70E+03
Y-90	8.79E+00	0.00E+00	2.35E-01	0.00E+00	0.00E+00	0.00E+00	2.50E+04
Y-91M	8.17E-02	0.00E+00	2.97E-03	0.00E+00	0.00E+00	0.00E+00	1.60E+02
Y-91	1.29E+02	0.00E+00	3.44E+00	0.00E+00	0.00E+00	0.00E+00	1.71E+04
Y-92	7.70E-01	0.00E+00	2.20E-02	0.00E+00	0.00E+00	0.00E+00	2.22E+04
Y-93	2.44E+00	0.00E+00	6.69E-02	0.00E+00	0.00E+00	0.00E+00	3.63E+04
ZR-95	2.10E+00	4.62E-01	4.11E-01	0.00E+00	6.62E-01	0.00E+00	4.82E+02
ZR-97	1.27E-01	1.83E-02	1.08E-02	0.00E+00	2.63E-02	0.00E+00	2.77E+03
NB-95	5.75E+00	2.24E+00	1.60E+00	0.00E+00	2.10E+00	0.00E+00	4.14E+03
MO-99	0.00E+00	1.31E+02	3.23E+01	0.00E+00	2.79E+02	0.00E+00	1.08E+02
TC-99M	1.99E-02	3.89E-02	6.46E-01	0.00E+00	5.66E-01	1.98E-02	2.22E+01
TC-101	2.30E-02	2.41E-02	3.06E-01	0.00E+00	4.11E-01	1.27E-02	7.66E-02
RU-103	1.48E+02	0.00E+00	5.67E+01	0.00E+00	3.72E+02	0.00E+00	3.82E+03
RU-105	1.30E+01	0.00E+00	4.73E+00	0.00E+00	1.15E+02	0.00E+00	8.50E+03
RU-106	2.36E+03	0.00E+00	2.95E+02	0.00E+00	3.19E+03	0.00E+00	3.68E+04
AG-110M	5.24E+02	3.54E+02	2.83E+02	0.00E+00	6.59E+02	0.00E+00	4.21E+04
SB-122	5.80E+01	8.56E-01	1.70E+01	7.43E-01	0.00E+00	2.36E+01	4.46E+03
SB-124	6.55E+02	8.50E+00	2.29E+02	1.44E+00	0.00E+00	3.63E+02	4.09E+03
SB-125	4.22E+02	3.25E+00	8.85E+01	3.91E-01	0.00E+00	2.35E+02	1.01E+03

TABLE 1-4

Site Related Child Ingestion Dose Commitment Factors (Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
TE-125M	3.81E+03	1.03E+03	5.08E+02	1.07E+03	0.00E+00	0.00E+00	3.68E+03
TE-127M	9.67E+03	2.60E+03	1.15E+03	2.31E+03	2.76E+04	0.00E+00	7.83E+03
TE-127	1.58E+02	4.25E+01	3.38E+01	1.09E+02	4.48E+02	0.00E+00	6.15E+03
TE-129M	1.63E+04	4.55E+03	2.53E+03	5.25E+03	4.78E+04	0.00E+00	1.99E+04
TE-129	4.48E+01	1.25E+01	1.06E+01	3.20E+01	1.31E+02	0.00E+00	2.79E+03
TE-131M	2.41E+03	8.33E+02	8.86E+02	1.71E+03	8.06E+03	0.00E+00	3.38E+04
TE-131	2.78E+01	8.46E+00	8.26E+00	2.12E+01	8.40E+01	0.00E+00	1.46E+02
TE-132	3.38E+03	1.50E+03	1.81E+03	2.18E+03	1.39E+04	0.00E+00	1.51E+04
I-130	6.28E+01	1.27E+02	6.54E+01	1.40E+04	1.90E+02	0.00E+00	5.94E+01
I-131	3.70E+02	3.72E+02	2.12E+02	1.23E+05	6.11E+02	0.00E+00	3.31E+01
I-132	1.72E+01	3.16E+01	1.45E+01	1.47E+03	4.84E+01	0.00E+00	3.72E+01
I-133	1.27E+02	1.58E+02	5.96E+01	2.93E+04	2.63E+02	0.00E+00	6.35E+01
I-134	9.02E+00	1.67E+01	7.70E+00	3.85E+02	2.56E+01	0.00E+00	1.11E+01
I-135	3.77E+01	6.78E+01	3.21E+01	6.00E+03	1.04E+02	0.00E+00	5.16E+01
CS-134	5.15E+04	8.44E+04	1.78E+04	0.00E+00	2.62E+04	9.39E+03	4.55E+02
CS-136	5.17E+03	1.42E+04	9.19E+03	0.00E+00	7.56E+03	1.13E+03	4.99E+02
CS-137	7.19E+04	6.88E+04	1.02E+04	0.00E+00	2.24E+04	8.07E+03	4.31E+02
CS-138	5.01E+01	6.97E+01	4.42E+01	0.00E+00	4.90E+01	5.28E+00	3.21E+01
BA-139	9.34E+00	4.99E-03	2.71E-01	0.00E+00	4.35E-03	2.93E-03	5.39E+02
BA-140	1.87E+03	1.64E+00	1.09E+02	0.00E+00	5.35E-01	9.79E-01	9.50E+02
BA-141	4.51E+00	2.53E-03	1.47E-01	0.00E+00	2.19E-03	1.48E-02	2.57E+00
BA-142	1.97E+00	1.42E-03	1.10E-01	0.00E+00	1.15E-03	8.35E-04	2.57E-02
LA-140	2.16E+00	7.55E-01	2.54E-01	0.00E+00	0.00E+00	0.00E+00	2.10E+04
LA-142	1.12E-01	3.57E-02	1.12E-02	0.00E+00	0.00E+00	0.00E+00	7.08E+03
CE-141	4.65E+00	2.32E+00	3.45E-01	0.00E+00	1.02E+00	0.00E+00	2.90E+03
CE-143	8.19E-01	4.44E+02	6.44E-02	0.00E+00	1.86E-01	0.00E+00	6.51E+03
CE-144	2.44E+02	7.64E+01	1.30E+01	0.00E+00	4.23E+01	0.00E+00	1.99E+04
PR-143	8.40E+00	2.52E+00	4.17E-01	0.00E+00	1.37E+00	0.00E+00	9.06E+03
PR-144	2.76E-02	8.53E-03	1.39E-03	0.00E+00	4.51E-03	0.00E+00	1.84E+01
ND-147	5.96E+00	4.83E+00	3.74E-01	0.00E+00	2.65E+00	0.00E+00	7.65E+03
W-187	4.08E+02	2.42E+02	1.08E+02	0.00E+00	0.00E+00	0.00E+00	3.40E+04
NP-239	5.15E-02	3.70E-03	2.60E-03	0.00E+00	1.07E-02	0.00E+00	2.74E+02
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	1.15E+02	2.33E+02	0.00E+00	0.00E+00	0.00E+00	9.43E+02
SR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-97	5.55E-02	1.00E-02	4.68E-03	0.00E+00	1.11E-02	0.00E+00	3.09E+03
CD-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SN-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-134	4.31E+01	1.94E+01	2.59E+01	3.41E+01	1.80E+02	0.00E+00	1.97E+02
CE-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 1-5

Bio-Accumulation Factors for Liquid Effluent Isotopes
(pCi/kg per pCi/liter)

ISOTOPE	Freshwater Fish BFi	Saltwater Invertebrates BIi	ISOTOPE	Freshwater Fish BFi	Saltwater Invertebrates BIi
H-3	9.000E-01	9.300E-01	TE-125M	4.000E+02	1.000E+02
BE-7	2.000E+00	2.000E+02	TE-127M	4.000E+02	1.000E+02
NA-24	1.000E+02	1.900E-01	TE-127	4.000E+02	1.000E+02
P-32	1.000E+05	3.000E+04	TE-129M	4.000E+02	1.000E+02
CR-51	2.000E+02	2.000E+03	TE-129	4.000E+02	1.000E+02
MN-54	4.000E+02	4.000E+02	TE-131M	4.000E+02	1.000E+02
MN-56	4.000E+02	4.000E+02	TE-131	4.000E+02	1.000E+02
FE-55	1.000E+02	2.000E+04	TE-132	4.000E+02	1.000E+02
FE-59	1.000E+02	2.000E+04	I-130	1.500E+01	5.000E+01
CO-58	5.000E+01	1.000E+03	I-131	1.500E+01	5.000E+01
CO-60	5.000E+01	1.000E+03	I-132	1.500E+01	5.000E+01
NI-63	1.000E+02	2.500E+02	I-133	1.500E+01	5.000E+01
NI-65	1.000E+02	2.500E+02	I-134	1.500E+01	5.000E+01
CU-64	5.000E+01	1.700E+03	I-135	1.500E+01	5.000E+01
ZN-65	2.000E+03	5.000E+04	CS-134	2.240E+02	2.240E+02
ZN-69	2.000E+03	5.000E+04	CS-136	2.240E+02	2.240E+02
BR-83	4.200E+02	3.100E+00	CS-137	2.240E+02	2.240E+02
BR-84	4.200E+02	3.100E+00	CS-138	2.240E+02	2.240E+02
BR-85	4.200E+02	3.100E+00	BA-139	4.000E+00	1.000E+02
RB-86	2.000E+03	1.700E+01	BA-140	4.000E+00	1.000E+02
RB-88	2.000E+03	1.700E+01	BA-141	4.000E+00	1.000E+02
RB-89	2.000E+03	1.700E+01	BA-142	4.000E+00	1.000E+02
SR-89	3.000E+01	2.000E+01	LA-140	2.500E+01	1.000E+03
SR-90	3.000E+01	2.000E+01	LA-142	2.500E+01	1.000E+03
SR-91	3.000E+01	2.000E+01	CE-141	1.000E+00	6.000E+02
SR-92	3.000E+01	2.000E+01	CE-143	1.000E+00	6.000E+02
Y-90	2.500E+01	1.000E+03	CE-144	1.000E+00	6.000E+02
Y-91M	2.500E+01	1.000E+03	PR-143	2.500E+01	1.000E+03
Y-91	2.500E+01	1.000E+03	PR-144	2.500E+01	1.000E+03
Y-92	2.500E+01	1.000E+03	ND-147	2.500E+01	1.000E+03
Y-93	2.500E+01	1.000E+03	W-187	1.200E+03	3.000E+01
ZR-95	3.300E+00	8.000E+01	NP-239	1.000E+01	1.000E+01
ZR-97	3.300E+00	8.000E+01	K-40	0.000E+00	0.000E+00
NB-95	3.000E+02	1.000E+02	CO-57	5.000E+01	1.000E+03
MO-99	1.000E+01	1.000E+01	SR-85	0.000E+00	0.000E+00
TC-99M	1.500E+01	5.000E+01	Y-88	0.000E+00	0.000E+00
TC-101	1.500E+01	5.000E+01	NB-94	3.000E+02	1.000E+02
RU-103	1.000E+01	1.000E+03	NB-97	3.000E+02	1.000E+02
RU-105	1.000E+01	1.000E+03	CD-109	0.000E+00	0.000E+00
RU-106	1.000E+01	1.000E+03	SN-113	0.000E+00	0.000E+00
AG-110M	2.300E+00	5.000E+03	BA-133	0.000E+00	0.000E+00
SB-122	1.000E+00	3.000E+02	TE-134	4.000E+02	1.000E+02
SB-124	1.000E+00	3.000E+02	CE-139	0.000E+00	0.000E+00
SB-125	1.000E+00	3.000E+02	HG-203	0.000E+00	0.000E+00

Bio-Accumulation Factors and DFi's for Noble Gases = 0

2.0 GASEOUS EFFLUENT METHODOLOGIES

2.1 Gaseous Effluent Model Assumptions and Information

Gaseous effluents discharge primarily through the Unit 2 plant vent (el 267') and to a much lesser extent through the following:

- o Unit 1 Stack (el 400');
- o Secondary Boiler Blowdown Flash Tank, i.e. Blowdown Tank Vent (el 120');
- o Secondary Boiler Blowdown Purification System Vent (el 165');
- o Unit 2 Condenser Air Ejector Vent (el 75');
- o Maintenance and Outage Building Exhaust.

Airborne releases up to early 1992 have been treated as ground releases. Site specific data collection in 1992 and again in 2004 has provided 10-yr averaged meteorological dispersion and deposition data for mixed-mode releases, as well as the application of Finite Cloud correction (applied to Revision 4 of this manual and thereafter). The methodology for finite cloud and mixed-mode realistic releases was provided in NYPA Calculation IP3-CALC-RAD-00001 Rev. 0, and updated in Entech Engineering Reports P115-196-EC1 through EC3. Specific dispersion and deposition factors are given in Appendix A, along with ground-level factors, appropriate for condenser air ejector releases. A discussion of the derivation of the resulting equations and their use can be found in IPEC unit 3 ODCM, sections 3.5 and 3.6.

Dose and setpoint calculations employ historical annual average dispersion factors in the highest of sixteen sectors. The sector annual average methodology is defended on the basis that there are no seasonal or daily biases in the times in which releases occur.

Tables 2-2 through 2-12 include dose factors for all nuclides expected in effluents. Should a nuclide be detected that is not represented in these tables, the dose factors are determined from applicable references and the pertinent calculations performed in accordance with this manual. Conversely, nuclides that are represented in these tables but not detected are reported absent from the sample and assigned a zero value. Lower limits of detection (LLD) methods are described in Section 5.0.

Condenser Air Ejector (CAE) releases may become significant for computations of cumulative dose, but are not significant for instantaneous setpoint consideration. As a result, radiation monitor setpoints for CAE releases are selected to assure less than 1% instantaneous impact at release rates limits. Station procedures provide methodology to calculate release rate setpoints in accordance with 10CFR20 and show the relative insignificance of this pathway with respect to approaching the applicable release rate limits.

Because the limits in 10CFR20 for individuals in unrestricted areas apply to site effluents, some adjustment must be made for the fact that both units 2 and 3 discharge gaseous effluents and that the unit 3 vent is closer to the critical sector site boundary than unit 2's. The partition, then, is not precisely 50-50. The noble gas dose is split approximately 53%/47% (IP3/IP2), while the organ dose from Iodine and Particulate is split approximately 67%/33%.

Appendix I demonstrates the equivalent uCi/sec from instantaneous, quarterly, and annual dose rate limitations for use in setpoint calculations or management of effluent release rate. The annual limit is normally used for routine Plant Vent release rates. The quarterly limit may be applied with permission from the Site Operations Manager. The instantaneous limit may be applied with permission from the General Manager – Plant Operations (per Section 4.2).

All releases (including batch) are considered "long term" in relation to the definition in NUREG 0133 because they total greater than 500 hours and are sufficiently random. However, if short-term releases occur, the appropriate short-term dispersion factor should be utilized. Such factors can be derived from the cited calculation in unit 3's ODCM or taken from another appropriate reference. The impact of short-term releases is considered simultaneously with all other releases with regard to setpoint selection and dose or dose rate computations.

Normally, releases of noble gases are the most limiting with regard to approaching site limits. For this reason and because it is considered impractical to apply trip points and alarms to integrating monitors sensitive to iodines and particulates, radiation monitor trip points for release points are based on the noble gas component of gaseous effluents.

Because the particulate and iodine contribution to receptor dose equivalents is historically very low, and full analytical results from associated radiochemical analyses require months to complete, releases are administratively controlled from noble gas values. Typically, the ratio of noble gas to iodine is greater than 10,000. The ratio is conservatively reduced to 100 when applied to the design basis accident scenario for IPEC to ensure Iodine is conservatively modeled in accident calculations after a SG Tube Rupture. Despite this modeling used to justify administratively using noble gas setpoints for control, actual calculations are performed in detail after-the-fact, per the ODCM, in the case of any actual Iodine or particulate releases.

The RECS require a dose projection at least once per 31 days to determine the need for use of the cleanup systems. Although most of these systems are in service at all times, cleanup systems such as iodine removal charcoal beds or gas tank holdup would be required if the 31-day dose projection approached the associated limits in the RECS. Proximity to these limits can be evaluated at any time from the use of a database tracking system for 10CFR50 doses to date.

Carbon 14 is released at a rate of 9.6 curies per GW(e)/yr based upon studies performed by the New York State Department of Health at Indian Point 3. This is released in a gaseous form, the primary dose from which is in the CO_2 form. Therefore, these are exempt from the dose limits specified in Sections 2.4.1, 2.4.3 and 2.4.4 of the RECS. The Carbon 14 doses resulting from these releases are calculated in accordance with the methodology in Reg. Guide 1.109 and listed in the Radiological Impact on Man section of the Annual Radioactive Effluent Release Report. This calculation is performed using the fraction of Carbon-14 released in the CO_2 form (26%).

Though the methodologies for calculating doses for noble gases, iodines and particulates allow for accurate dose modeling with any type of mixture, it is beneficial to back-calculate release rates (uCi/sec) for use in Operations procedures with a standard conservative mix. Mixtures established in Table 2-8, and methodology demonstrated in Appendix I were used to derive annual, quarterly, and instantaneous release rate setpoints shown is Section 4.2.

Table 2-1 is a compilation of gaseous RECS dose and dose rate criteria. The dose rate criteria are used in radiation monitor setpoint calculations in Appendix I. The integrated dose limits are applied in the database tracking mechanism for 10CFR50 compliance.

Tables 2-2 through 2-12 are listings of dose factors, descriptions of various release mixtures, distances to the site boundary and nearest residence, and other data required to calculate doses in the following sections.

2.2 Determination of Releases from Indirectly Monitored Sources

The effluents from the Blowdown Flash Tank Vent and the Secondary Purification System Vent are not directly monitored. This section describes appropriate methodology for determining release rates from these vents. The methodology is based on NUREG-0133 Section 5.6.3. Usually, only H-3 and potentially I-131 and I-133 are of interest.

A determination of the iodine releases via a flash tank can be made by calculating the iodine content in secondary water and using the following equation:

$q = CRf\ (1\text{-}SQ)$ (release rate from tank vent in μCi/sec)

Where:

$C \equiv$ iodine concentration in secondary coolant water (μCi/ml) averaged over a time not in excess of one week

$R \equiv$ letdown rate to the tank (ml/sec)

$f \equiv$ The fraction of liquid flashed in the tank as determined by a heat balance taken around the tank at the applicable reactor power level

$SQ \equiv$ measured steam quality, or an assumed value of 0.85, at the vent

Appendix D provides guidance on the calculation of f. C and R are process variables and SQ is assumed to be 0.85 in the absence of a measurement.

2.3 Noble Gas Releases Dose Rates for Total Body and Skin

The following is the calculational method for determining instantaneous noble gas dose rates to the total body and skin. According to approved maximum-individual methodology, all releases use the annual average meteorological constants, unless a ground level or short-term release is identified. Maximum total body and skin dose rates are assumed to occur in the critical receptor (highest dose). Ground level X/Q values are used for Condenser Air Ejector releases.

The total body dose rate from noble gas releases is:

$$DR_{TB} = (X/Q) \sum_i K_i q_i \qquad \text{(G-1)}$$

and the skin dose rate from noble gas releases is:

$$DR_{SKIN} = 1.1\,(X/Q)\,\Sigma\, M_i q_i + (X/Q)\,\Sigma\, L_i q_i \qquad \text{(G-2)}$$

<u>Where</u>:

DR_{TB}	$\equiv$	total body dose rate from noble gas releases (mrem/yr)
DR_{SKIN}	$\equiv$	skin dose rate from noble gas releases (mrem/yr)
(X/Q)	$\equiv$	highest of 16 sectors site boundary annual average relative concentration (sec/m^3)
K_i	$\equiv$	whole body dose transfer factor for nuclide i (mrem/yr per μCi/m^3) [from RG 1.109]
L_i	$\equiv$	beta skin dose transfer factor for nuclide i (mrem/yr per μCi/m^3) [from RG 1.109]
M_i	$\equiv$	air dose transfer factor for gamma emissions of nuclide i (mrad/yr per μCi/m^3) [from RG 1.109]
1.1	$\equiv$	conversion from gamma air dose rate to tissue dose equivalent rate (mrem/mrad)
q_i	$\equiv$	release rate of nuclide i (μCi/sec)
q_t	$\equiv$	total release rate of all noble gas nuclides, (μCi/sec)

From an evaluation of past releases, a simplification introduced in Section 2.1 can be adopted for total body dose rate calculations. If the appropriate long-term distribution of q (the total releases of noble gases) is known, then it follows that there is some weighted factor which, multiplied by q, yields the same dose rate computed by using equation G-1.

$$DR_{TB} = (X/Q)\, K_{eff}\; q_t$$

Where :

K_{eff} = Weighted average of all isotopes' K factor per the following general equation:

$$K_{eff} = (1/q_t)\sum_{i=1}^{n} (q_i)\,(Ki)$$

Leading to:

$$DR_{TB} = (X/Q)\, K_{eff}\, q_t \qquad \text{(G-3)}$$

When this type of calculation is performed for Radiation Monitor setpoint calculations, a conservative factor (not to exceed 1.25) may be applied as a final step to reflect maximum expected radiation monitor error. Simply multiply the final Dose Rate by the chosen factor.

K_{eff} is normally calculated with each release. For setpoint calculations, a back-calculation (similar to that of Appendix I), is performed with an expected K_{eff} such that uCi/cc or uCi/sec values can be obtained. Values of K_i and other noble gas dose factors are taken from Tables 2-4 through 2-7 of this section.

2.4 Determining the Radioiodine, 8-day Particulate and Tritium Instantaneous Dose Rates from Gaseous Releases

Total dose rates for radioiodine, 8-day particulate and tritium releases are calculated for 4 age groups and each organ at the critical site boundary location. Typically, a computer code calculates and reports dose rate for each organ and age group at the highest site boundary location. Although ground plane and milk pathways are also included in the reference source (NUREG-0133), only the inhalation pathway is applicable to IPEC. The ground plane pathway has been shown to be insignificant, and the land use census identifies no milk pathway at the site boundary. Since it is very unlikely that a milch animal will ever be identified at the site boundary, the terms in NUREG-0133 for this pathway need not be included routinely, and simply added if the land use census should later include this pathway.

Therefore, the general equation for the single organ dose rate is:

$$DR = (X/Q) \sum_i (P_i * q_i) \quad \text{(inhalation only)} \qquad \text{(G-4)}$$

Where:

DR = single organ total dose rate (mrem/year)

X/Q = as previously defined

P_i = dose parameters for inhalation pathway (mrem/year per $\mu Ci/m^3$) for nuclide i

q_i = release rate of nuclide i (μCi/sec)

Computed values of P_i for all age groups, organs, and nuclides for the inhalation pathway are represented in Tables 2-2a through 2-2d in this section. X/Q values may be obtained from Appendix A or other source as allowed in Section 2.1.

Should the land use census be updated to include a the cow-milk pathway, the equation above would be updated as follows:

$$DR_t = [Pi_t * (X/Q) * q_t] + [Pm_t * (X/Q)_5 * q_t] \quad \text{(mrem/year)} \qquad \text{(G-5)}$$

Where:

Pi_t = inhalation dose parameter for all pathways for all organs except bone (bone = 0) in mrem/yr per $\mu Ci/m^3$

Pm_t = milk ingestion dose parameter (bone = 0) in mrem/yr per $\mu Ci/m^3$

X/Q = as previously defined

X/Q_5 = highest of 16 sectors 5 mile annual average relative concentration, in sec/ m^3 (only used when the 5-mile cow-milk pathway is utilized)

q_t = total Iodine and Particulate, H-3 release rate, in μCi/sec

The parameter Pi is calculated as follows:

$$Pi = K' * BR * DF_i \tag{G-6}$$

Where;

K' = Conversion constant 1E6 pCi/uCi

BR = Breathing rate for each age group per Reg Guide 1.109, Table E-5, as follows:

Infant	=	1400 m^3/yr
Child	=	3700 m^3/yr
Adult/Teen	=	8000 m^3/yr

DF_i = Inhalation dose factor for each age group, organ, and nuclide, in mrem/pCi. These values were taken from Reg Guide 1.109, Tables E-7 through E-9, reproduced in Tables 2-2a through 2-2d.

The age group and organ with the highest dose rate is the limiting organ.

For practical reasons, monitor setpoints for the total control of gaseous releases will not depend directly on the monitor responses to radioiodines, 8-day particulate and tritium. The noble gas monitors can be used to indirectly control release rates such that the instantaneous organ dose rates are maintained below the RECS or administrative limits.

If a computer code is not available, a simple calculation using Iodine dose factors can yield a bounding dose rate. Total organ dose rate to the thyroid by radioiodines can be considered for instantaneous releases as follows:

$$DR_T \approx DR_{thy} = (X/Q)\,[\Sigma^* P_i^* q_i]_{iodines} \text{ (inhalation only)} \tag{G-7}$$

2.5 Gamma Air Dose for Noble Gas Releases

RECS require calculation of gamma air dose from cumulative noble gas releases. The dose for any selected time (month, quarter, year) is:

$$gamma\ \ air\ \ mrad = 3.17E-8*\sum_i Mi\,[(X/Q)(\tilde{Q}i)+(x/q)(\tilde{q}i)] \tag{G-8}$$

Where;

Gamma Air dose is limited to 5 mrad per quarter and 10 mrad per year;

(X/Q) = The highest calculated annual average relative concentration for the unrestricted area boundary in the controlling sector for long term releases (greater than 500 hours/year or 150 hours/quarter), in sec/m^3

(x/q) = The relative concentration for the unrestricted area boundary for short term releases (equal to or less than 500 hours/year or 150 hours/quarter and NOT sufficiently random as defined in NUREG 0133, Section 3.3).

Mi = The air dose factor due to gamma emission for each identified noble gas radionuclide in mrad/yr per μCi/m^3.

Ni = The air dose factor due to beta emissions for each identified noble gas radionuclide in mrad/yr per μCi/m^3.

$\widetilde{q}i$ = The total release of noble gas radionuclides in gaseous effluents, i, for short term releases (equal to or less than 500 hours/year or 150 hours/quarter and NOT random as defined in NUREG 0133, Section 3.3) from all vents, in μCi, over the calendar quarter or year as appropriate.

$\widetilde{Q}i$ = The total release of noble gas radionuclides in gaseous effluents, i, for long term releases (greater than 500 hours/year or 150 hours/quarter) from all vents in μCi, over the calendar quarter or year as appropriate.

Q_t = The total release rate of all noble gas nuclides, in uCi/sec (the sum of all Q_i).

3.17 E-8 = The inverse of the number of seconds in a year.

The air dose factors Mi and Ni were obtained from Table B-1 of Reg Guide 1.109 and are listed in Table 2-6 and 2-7. The M air dose factors are finite cloud corrected.

A single effective gamma air dose rate factor of noble gases can be derived from a known mixture by weighting each isotope's factor (M) and deriving M_{eff} in similar fashion to the earlier expression K_{eff}:

$$M_{eff} = \frac{\sum_i M_i Q_i}{\sum_i Q_i} = \frac{\sum_i M_i Q_i}{Q_t}$$

Which leads to:

$$D^{air,\ gamma} = (X/Q) * (M_{eff}) * Q_t \qquad \text{(G-9)}$$

Monthly, quarterly, and annual gamma air doses are computed with actual release data (with an appropriately weighted M factor). Doses are also projected for the 31-day dose projection requirements to allow comparison with RECS limits.

2.6 Beta Air Dose for Noble Gas Releases

In similar fashion, the beta air dose from cumulative releases of noble gases can be calculated. The dose for any selected time (month, quarter, year) is:

$$beta\ \ air\ \ mrad = 3.17E-8*\sum_{i} Ni\,[(X/Q)(\tilde{Q}i)+(x/q)(\tilde{q}i)] \qquad \text{(G-10)}$$

Where beta air mrad is limited to 10 mrad per quarter and 20 mrad per year, with other terms defined in previous steps.

One can also determine N_{eff} in a similar fashion to M_{eff}:

$$N_{eff} = \frac{\sum_{i} N_i Q_i}{Q_t}$$

and also write

$$D^{air,\,beta} = (X/Q)N_{eff}\,Q_t \qquad \text{(G-11)}$$

Monthly, quarterly, and annual beta air doses are computed with actual release data (with an appropriately weighted N factor). Doses are also projected for the 31-day dose projection requirements to allow comparison with RECS limits.

2.7 Determining the Radioiodines, 8-Day Particulate and Tritium Cumulative Doses from Gaseous Releases

The pathways considered in this analysis are inhalation, ground plane, and vegetable ingestion at the nearest resident. The meat and milk ingestion pathways are not considered because of the lack of milk-producing animals within ten miles of the plant, and because of the high degree of commercial, industrial, and residential land usage in the area, as defined by the land use census. Doses are calculated at a critical receptor, identified as the nearest resident with the worst meteorological data. Although the nearest resident is in the ESE direction, the worst sector and most conservative data for dose calculations is in the SSW, per Table 2-9, Appendix I, and Reference 9.

The equations for calculating the dose limitations are obtained from NUREG 0133 and reduce to the following :

During any calendar quarter:

$$(3.17\,E-08\,)*\sum_{i}\ (Ri\,(W\,\tilde{Q}i\ +\ w\tilde{q}i\,)\ must\ be\ less\ than\ 7.5\ mrem \qquad \text{(G-12)}$$

During any calendar year:

$$(3.17\,E-08)*\sum_{i}(Ri(W\tilde{Q}i + w\tilde{q}i)\ \textit{must be less than 15 mrem} \qquad \text{(G-13)}$$

<u>Where</u>:

$\tilde{Q}i$ = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for long term releases, in µCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

$\tilde{q}i$ = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for short term releases, in µCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

W = The dispersion or deposition parameter for estimating the dose to an individual at the nearest resident for long term releases.

w = The vent dispersion or deposition parameter for estimating the dose to an individual at the nearest resident for short term releases.

3.17 E-08 = The inverse number of seconds in a year.

Ri = The dose factor for each identified pathway, organ, and radionuclide, i, in m^2 - mrem/yr per µCi/sec, or mrem/yr per µCi/m^3. These dose factors are determined as described the following steps.

Utilizing the assumptions above, these equations for the nearest resident reduce to the following:

$$DN=(3.17E-8)\sum_{i}[Ri(I)*[Wn(in)\tilde{Q}i+wn(in)\tilde{q}i]+(Ri(G)+Ri(V))*[Wn(dep)\tilde{Q}i+wn(dep)\tilde{q}i]] \qquad \text{(G-14)}$$

Where:

DN = total dose at the nearest residence, and must be less than or equal to 7.5 mrem per quarter, and less than or equal to 15 mrem annually.

Wn(in) = The highest calculated annual average dispersion parameter for the inhalation pathway for the nearest residence in the unrestricted area at the controlling location, in sec/m^3.

wn(in) = The dispersion parameter for the inhalation pathway for the nearest residence in the unrestricted area at the controlling location, in sec/m^3, corrected for short term releases.

Wn(dep) = The highest calculated annual average deposition parameter for the nearest residence in the unrestricted area at the controlling location, in m^{-2} , for all isotopes except Tritium, which uses the X/Q value instead (sec/m^3).

wn(dep)= The deposition parameter for the nearest residence in the unrestricted area at the controlling location, in m^{-2} , for all isotopes except Tritium, which uses the X/Q value instead (sec/m^3), corrected for short term releases.

$\widetilde{Q}i$ = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for long term releases as defined earlier, (uCi).

$\widetilde{q}i$ = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for short term releases as defined earlier (uCi).

Ri (I) = Inhalation pathway factor for each radionuclide, i.

= K' * [(BR) a] * [(DFi) a] (mrem/yr per $\mu Ci/m^3$) (G-15)

Where;

K' = 1E6 pCi/uCi

BRa = Age-specific breathing rate (see 2.4)

DFia= Inhalation dose factor for age group, organ, and isotope, per Table 2-2a through 2-2d (from Reg Guide 1.109, Tables E-7 through E-10).

Ri (G) = Ground plane pathway factor for each radionuclide, i.

$$= \frac{K'K''(SF)(DFGi)(1-e^{(-kit)})}{Ki} = \frac{m^2 \cdot mrem/yr}{uCi/\sec} \qquad \text{(G-16)}$$

Where:

K' = 1E6 pCi/μCi and K" = 8760 hr/yr

ki = Decay constant for the ith radionuclide, sec^{-1}.

t = The exposure time, 4.73×10^8 sec (15 years)

DFGi = The ground plane dose conversion factor for ith radionuclide, in mrem/hr per pCi/m^2 (Table 2.2e, from Reg Guide 1.109 Table E-6).

SF = Shielding factor (dimensionless) = 0.7 (from Reg Guide 1.109, Table E-15).

Ri (V) = Vegetation pathway factor for each radionuclide, i.

$$= \frac{K'(r)}{Yv(ki + kw)} * (DFLi)a * [(UaL)fL * e^{(-kitL)} + (UaS)fg * e^{(-kith)}] \quad \text{(G-17)}$$

Where:

K' = 1E6 pCi/μCi

r = Dimensionless correction factor for the fraction of deposited activity retained on crops for Iodine and Particulate from Table E-15 of Reg Guide 1.109, as follows:

0.2 for particulates   1.0 for radioiodine

DFLia = Ingestion dose factors for each nuclide in mrem/pCi (Tables 2-3a thru 2-3d, from Reg Guide 1.109 Tables E-11 through E-14).

UaL = Consumption rate of fresh leafy vegetation by the receptor in age group (a) in kg/yr (Reg Guide 1.109, Table E-5).

ki = Decay constant for the radionuclide, in sec^{-1}

UaS = Consumption rate of non-leafy vegetables by the receptor in age group (a) in kg/yr (Reg Guide 1.109, Table E-5).

fL = The fraction of the annual intake of leafy vegetation grown locally (Reg Guide 1.109, Table E-15).

fg = The fraction of the annual intake of non-leafy vegetation grown locally (Reg Guide 1.109, Table E-15).

kw = Decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73E-7 sec^{-1} (corresponding to a 14 day half-life from Reg Guide 1.109, Table E-15).

tL = The average time between harvest of leafy vegetation and its consumption in seconds (Reg Guide 1.109, Table E-15).

th = The average time between harvest of stored vegetation and its consumption in seconds (Reg Guide 1.109, Table E-15).

Yv = The vegetation area density in kg/m^2 (Reg Guide 1.109, Table E-15).

For tritium, the concentration in vegetation is based on airborne concentration rather than deposition. Therefore, for Ri(V) is based on X/Q instead of D/Q:.

$$RiV_{(H-3)} = K'K''[(UaL)fL+(UaS)fg](DFi)a\ (0.75)(0.5/H)\ (\text{mrem/yr per } \mu Ci/m^3) \qquad (G-18)$$

Where:

K" = A constant of unit conversion, 1000 gm/kg

H = Absolute humidity of the atmosphere in gm/m^3 . This value may be considered as 8 gm/m^3 (NUREG 0133, pg 34) in lieu of site specific information.

0.75 = The fraction of total feed that is water (NUREG 0133, pg 34).

0.5 = The ratio of the specific activity of the feed grass water to the atmospheric water (NUREG 0133, pg 34).

DFia for each age group is given in Tables 2-3a through 2-3d (from Reg Guide 1.109 Tables E-11 through E-14).

Ri(I), Ri(V), and Ri(G) values are listed in Tables 2-10a-d, 2-11a-c, and 2-12.

Ri(V) Parameters:

PARAMETER	VALUE	Reg Guide 1.109 Source Table
R (dimensionless)	1.0 for radioiodines	E-15
	0.2 for particulates	
(DFLi) a (mrem/pCi)	Each radionuclide	E-11 to E-14
UaL (kg/yr) - infant	0	E-5
- child	26	E-5
- teen	42	E-5
- adult	64	E-5
UaS (kg/yr) - infant	0	E-5
- child	520	E-5
- teen	630	E-5
- adult	520	E-5
fL (dimensionless)	1.0	E-15
fg (dimensionless)	0.76	E-15
tL (seconds)	8.6E4 (1 day)	E-15
th (seconds)	5.18E6 (60 days)	E-15
Yv (kg/m^2)	2.0	E-15

Total organ dose is the sum of all pathway doses, calculated separately for each age group and organ, from all applicable nuclides.

2.8 Gas Storage Tank Activity Limit

NUREG-0133 Section 5.6.1 provides the expression for tank activity in terms of Xe-133 equivalent, assuming no potential tank interconnections:

$$Q_{133}= \frac{(500 mrem) * \ 3.15E+7 \ \sec/yr}{(1E6 \mu Ci/Ci)(294 mrem - m^3/\mu Ci - yr)(1.81E-3 \ \sec/m^3)} = \underline{29,761 \text{ Ci}}$$

Where;

294 mrem-m^3/μCi-yr = the Xe-133 whole body dose factor from Reg Guide 1.109, table B-1 (K).

1.81E-3 sec/m^3 = Design Basis Accident X/Q from Indian Point 2 FSAR

2.8.1 Actual Limits

An actual curie limit may be calculated by substituting the actual mixture K_{eff} into the equation above. For example, the K_{eff} for the accident mix computed using Table 14.2-5 of the FSAR is 476 mrem-m^3/μCi-yr. Thus, the actual activity limit (for an expected mixture of radionuclides, not just Xe-133) is:

$$Q_{133}= \frac{(500 mrem) * \ 3.15E+7 \ \sec/yr}{(1E6 \mu Ci/Ci)(476 mrem - m^3/\mu Ci - yr)(1.81E-3 \ \sec/m^3)} = \underline{18,300 \text{ Ci}}$$

Similar calculations could be performed with actual K_{eff} and X/Q data.

2.8.2 R-50 Setpoints

As demonstrated above, the setpoints calculated from NUREG 0133 modeling assume Xe-133 equivalent and no tank interconnections (29,761 Ci of Xe-133 equivalent or 18,300 Ci for an expected accident mixture).

However, the tanks are, in fact, generally interconnected, requiring a more conservative approach. The unit 2 FSAR (14.2.3) has established a specific gas decay tank limit of 6000 Ci each. This value is based on the original RECS required 29,761 curies of Xe-133 equivalent, divided into 4 large and all 6 small gas decay tanks. Given the actual atmospheric volume of the tanks (525 ft^3 for each large and 40 ft^3 for each small), the total volume is approximately 4.5 tanks:

$$\frac{29{,}761}{4.5} = \underline{6000 \ Ci} \quad Xe-133 \, Equivalent$$

Warn setpoints are established by procedure, usually with consideration for measured tank contents and anticipated release rate.

2.8.3 Indirect Radiation Monitoring

In the event R-50 becomes inoperable, but a depressurized sample can be taken, the quantity limits can still be verified.

Compliance with the appropriate quantity limit is assured if the following inequality holds:

$$[A]_m < \frac{14.7\,(Q)}{(14.7 + P)V}$$

or

$$[A]_{eq} < \frac{14.7\,(Q133)}{(14.7 + P)V}$$

Where:

$[A]_m$ ≡ total measured depressurized sample concentration (μCi/cc)

$[A]_{eq}$ ≡ Xe-133 equivalent measured depressurized sample concentration (μCi/cc)

V ≡ tank volume (cc)

P ≡ tank pressure (psig)

Q ≡ activity limit for selected mix (μCi)

Q133 ≡ dose equivalent Xe-133 activity limit (μCi)

2.8.4 Routine Setpoint/Sampling Conservatism

In accidental releases of large magnitude (tank failure) it is assumed that the entire tank contents escapes through the rupture point. In some routine releases, the tank pressure decreases to a value around 1 atmosphere (0 psig) so that the tank is never fully voided. The setpoint conservatism vary by a factor, which accounts for incomplete tank emptying, equal to 1+(14.7/P). Note that for lower tank pressures, the conservatism is higher. Procedures may account for this conservatism in establishing specific tank release setpoints.

TABLE 2-1

SUMMARY OF GASEOUS RECS

DOSE RATE RECS

At or beyond the SITE BOUNDARY:

500 mrem/yr per site; noble gases, whole body.
3000 mrem/yr per site, noble gases, skin.
1500 mrem/yr per site; iodine-131, tritium, 8 day particulates; any organ.

DOSE RECS

Air Dose at the SITE BOUNDARY is limited to:

5 mrad per quarter and 10 mrad per year for noble gases, gamma air dose
10 mrad per quarter and 20 mrad per year for noble gases, beta air dose

Maximum Individual Dose to a Member of the Public at the nearest resident is limited to:

7.5 mrem per qtr and 15 mrem per yr for Iodine, H-3, & 8 day particulates to any organ

REAL MEMBER OF THE PUBLIC

25 mrem/yr, all sources, whole body or any organ except thyroid.
75 mrem/yr, all sources, thyroid.

PROJECTIONS

Projections of airborne doses shall be computed at least every 31 days as follows:

$$\begin{bmatrix}\text{Dose}\\ \text{Projection}\end{bmatrix} = \frac{\text{Current Month Dose} + \text{Previous months' Dose}}{\text{number of months used}} \pm \begin{bmatrix}\textit{major}\\ \textit{planned}\\ \textit{evolutions}\end{bmatrix}$$

The term for planned evolutions is routinely determined from previous similar evolutions, such as releases associated with plant shutdown.

If projected doses would exceed the limits in the RECS:

0.2 mrad gamma air dose, or
0.4 mrad beta air dose, or
0.3 mrem to any organ at the nearest residence,

clean-up treatment systems are required to be operational.

Table 2-2a

ADULT INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06
P-32	1.65E-04	9.64E-06	6.26E-06	0.00E+00	0.00E+00	0.00E+00	1.08E-05
Cr-51	0.00E+00	0.00E+00	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
Mn-54	0.00E+00	4.95E-06	7.87E-07	0.00E+00	1.23E-06	1.75E-04	9.67E-06
Mn-56	0.00E+00	1.55E-10	2.29E-11	0.00E+00	1.63E-10	1.18E-06	2.53E-06
Fe-55	3.07E-06	2.12E-06	4.93E-07	0.00E+00	0.00E+00	9.01E-06	7.54E-07
Fe-59	1.47E-06	3.47E-06	1.32E-06	0.00E+00	0.00E+00	1.27E-04	2.35E-05
Co-58	0.00E+00	1.98E-07	2.59E-07	0.00E+00	0.00E+00	1.16E-04	1.33E-05
Co-60	0.00E+00	1.44E-06	1.85E-06	0.00E+00	0.00E+00	7.46E-04	3.56E-05
Ni-63	5.40E-05	3.93E-06	1.81E-06	0.00E+00	0.00E+00	2.23E-05	1.67E-06
Ni-65	1.92E-10	2.62E-11	1.14E-11	0.00E+00	0.00E+00	7.00E-07	1.54E-06
Cu-64	0.00E+00	1.83E-10	7.69E-11	0.00E+00	5.78E-10	8.48E-07	6.12E-06
Zn-65	4.05E-06	1.29E-05	5.82E-06	0.00E+00	8.62E-06	1.08E-04	6.68E-06
Zn-69	4.23E-12	8.14E-12	5.65E-13	0.00E+00	5.27E-12	1.15E-07	2.04E-09
Br-83	0.00E+00	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.90E-08
Br-84	0.00E+00	0.00E+00	3.91E-08	0.00E+00	0.00E+00	0.00E+00	2.05E-13
Br-85	0.00E+00	0.00E+00	1.60E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.69E-05	7.37E-06	0.00E+00	0.00E+00	0.00E+00	2.08E-06
Rb-88	0.00E+00	4.84E-08	2.41E-08	0.00E+00	0.00E+00	0.00E+00	4.18E-19
Rb-89	0.00E+00	3.20E-08	2.12E-08	0.00E+00	0.00E+00	0.00E+00	1.16E-21
Sr-89	3.80E-05	0.00E+00	1.09E-06	0.00E+00	0.00E+00	1.75E-04	4.37E-05
Sr-90	1.24E-02	0.00E+00	7.62E-04	0.00E+00	0.00E+00	1.20E-03	9.02E-05
Sr-91	7.74E-09	0.00E+00	3.13E-10	0.00E+00	0.00E+00	4.56E-06	2.39E-05
Sr-92	8.43E-10	0.00E+00	3.64E-11	0.00E+00	0.00E+00	2.06E-06	5.38E-06
Y-90	2.61E-07	0.00E+00	7.01E-09	0.00E+00	0.00E+00	2.12E-05	6.32E-05
Y-91m	3.26E-11	0.00E+00	1.27E-12	0.00E+00	0.00E+00	2.40E-07	1.66E-10
Y-91	5.78E-05	0.00E+00	1.55E-06	0.00E+00	0.00E+00	2.13E-04	4.81E-05
Y-92	1.29E-09	0.00E+00	3.77E-11	0.00E+00	0.00E+00	1.96E-06	9.19E-06
Y-93	1.18E-08	0.00E+00	3.26E-10	0.00E+00	0.00E+00	6.06E-06	5.27E-05
Zr-95	1.34E-05	4.30E-06	2.91E-06	0.00E+00	6.77E-06	2.21E-04	1.88E-05
Zr-97	1.21E-08	2.45E-09	1.13E-09	0.00E+00	3.71E-09	9.84E-06	6.54E-05
Nb-95	1.76E-06	9.77E-07	5.26E-07	0.00E+00	9.67E-07	6.31E-05	1.30E-05
Mo-99	0.00E+00	1.51E-08	2.87E-09	0.00E+00	3.64E-08	1.14E-05	3.10E-05
Tc-99m	1.29E-13	3.64E-13	4.63E-12	0.00E+00	5.52E-12	9.55E-08	5.20E-07
Tc-101	5.22E-15	7.52E-15	7.38E-14	0.00E+00	1.35E-13	4.99E-08	1.36E-21
Ru-103	1.91E-07	0.00E+00	8.23E-08	0.00E+00	7.29E-07	6.31E-05	1.38E-05
Ru-105	9.88E-11	0.00E+00	3.89E-11	0.00E+00	1.27E-10	1.37E-06	6.02E-06
Ru-106	8.64E-06	0.00E+00	1.09E-06	0.00E+00	1.67E-05	1.17E-03	1.14E-04
Ag-110m	1.35E-06	1.25E-06	7.43E-07	0.00E+00	2.46E-06	5.79E-04	3.78E-05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	3.90E-06	7.36E-08	1.55E-06	9.44E-09	0.00E+00	3.10E-04	5.08E-05
Sb-125	6.67E-06	7.44E-08	1.58E-06	6.75E-09	0.00E+00	2.18E-04	1.26E-05

Table 2-2a

ADULT INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	4.27E-07	1.98E-07	5.84E-08	1.31E-07	1.55E-06	3.92E-05	8.83E-06
Te-127m	1.58E-06	7.21E-07	1.96E-07	4.11E-07	5.72E-06	1.20E-04	1.87E-05
Te-127	1.75E-10	8.03E-11	3.87E-11	1.32E-10	6.37E-10	8.14E-07	7.17E-06
Te-129m	1.22E-06	5.84E-07	1.98E-07	4.30E-07	4.57E-06	1.45E-04	4.79E-05
Te-129	6.22E-12	2.99E-12	1.55E-12	4.87E-12	2.34E-11	2.42E-07	1.96E-08
Te-131m	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05
Te-131	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09
Te-132	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05
I-130	5.72E-07	1.68E-06	6.60E-07	1.42E-04	2.61E-06	0.00E+00	9.61E-07
I-131	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	0.00E+00	7.85E-07
I-132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	0.00E+00	5.08E-08
I-133	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	0.00E+00	1.11E-06
I-134	8.05E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	0.00E+00	1.26E-10
I-135	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	0.00E+00	6.56E-07
Cs-134	4.66E-05	1.06E-04	9.10E-05	0.00E+00	3.59E-05	1.22E-05	1.30E-06
Cs-136	4.88E-06	1.83E-05	1.38E-05	0.00E+00	1.07E-05	1.50E-06	1.46E-06
Cs-137	5.98E-05	7.76E-05	5.35E-05	0.00E+00	2.78E-05	9.40E-06	1.05E-06
Cs-138	4.14E-08	7.76E-08	4.05E-08	0.00E+00	6.00E-08	6.07E-09	2.33E-13
Ba-139	1.17E-10	8.32E-14	3.42E-12	0.00E+00	7.78E-14	4.70E-07	1.12E-07
Ba-140	4.88E-06	6.13E-09	3.21E-07	0.00E+00	2.09E-09	1.59E-04	2.73E-05
Ba-141	1.25E-11	9.41E-15	4.20E-13	0.00E+00	8.75E-15	2.42E-07	1.45E-17
Ba-142	3.29E-12	3.38E-15	2.07E-13	0.00E+00	2.86E-15	1.49E-07	1.96E-26
La-140	4.30E-08	2.17E-08	5.73E-09	0.00E+00	0.00E+00	1.70E-05	5.73E-05
La-142	8.54E-11	3.88E-11	9.65E-12	0.00E+00	0.00E+00	7.91E-07	2.64E-07
Ce-141	2.49E-06	1.69E-06	1.91E-07	0.00E+00	7.83E-07	4.52E-05	1.50E-05
Ce-143	2.33E-08	1.72E-08	1.91E-09	0.00E+00	7.60E-09	9.97E-06	2.83E-05
Ce-144	4.29E-04	1.79E-04	2.30E-05	0.00E+00	1.06E-04	9.72E-04	1.02E-04
Pr-143	1.17E-06	4.69E-07	5.80E-08	0.00E+00	2.70E-07	3.51E-05	2.50E-05
Pr-144	3.76E-12	1.56E-12	1.91E-13	0.00E+00	8.81E-13	1.27E-07	2.69E-18
Nd-147	6.59E-07	7.62E-07	4.56E-08	0.00E+00	4.45E-07	2.76E-05	2.16E-05
W-187	1.06E-09	8.85E-10	3.10E-10	0.00E+00	0.00E+00	3.63E-06	1.94E-05
Np-239	2.87E-08	2.82E-09	1.55E-09	0.00E+00	8.75E-09	4.70E-06	1.49E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	8.65E-08	8.39E-08	0.00E+00	0.00E+00	4.62E-05	3.93E-06
Sr-85	4.00E-06	0.00E+00	9.70E-05	0.00E+00	0.00E+00	6.00E-05	7.60E-06
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.78E-11	7.03E-12	2.56E-12	0.00E+00	8.18E-12	3.00E-07	3.02E-08
Cd-109	0.00E+00	4.90E-05	1.60E-06	0.00E+00	4.70E-05	9.10E-05	8.20E-06
Sn-113	8.20E-06	2.70E-07	5.60E-07	1.70E-07	0.00E+00	1.20E-04	1.50E-06
Ba-133	9.50E-06	4.20E-07	2.50E-06	0.00E+00	2.10E-09	1.90E-04	1.00E-05
Te-134	3.84E-12	3.22E-12	1.57E-12	3.44E-12	2.18E-11	4.34E-07	2.97E-11
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-2b

TEEN INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
P-32	2.36E-04	1.37E-05	8.95E-06	0.00E+00	0.00E+00	0.00E+00	1.16E-05
Cr-51	0.00E+00	0.00E+00	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
Mn-54	0.00E+00	6.39E-06	1.05E-06	0.00E+00	1.59E-06	2.48E-04	8.35E-06
Mn-56	0.00E+00	2.12E-10	3.15E-11	0.00E+00	2.24E-10	1.90E-06	7.18E-06
Fe-55	4.18E-06	2.98E-06	6.93E-07	0.00E+00	0.00E+00	1.55E-05	7.99E-07
Fe-59	1.99E-06	4.62E-06	1.79E-06	0.00E+00	0.00E+00	1.91E-04	2.23E-05
Co-58	0.00E+00	2.59E-07	3.47E-07	0.00E+00	0.00E+00	1.68E-04	1.19E-05
Co-60	0.00E+00	1.89E-06	2.48E-06	0.00E+00	0.00E+00	1.09E-03	3.24E-05
Ni-63	7.25E-05	5.43E-06	2.47E-06	0.00E+00	0.00E+00	3.84E-05	1.77E-06
Ni-65	2.73E-10	3.66E-11	1.59E-11	0.00E+00	0.00E+00	1.17E-06	4.59E-06
Cu-64	0.00E+00	2.54E-10	1.06E-10	0.00E+00	8.01E-10	1.39E-06	7.68E-06
Zn-65	4.82E-06	1.67E-05	7.80E-06	0.00E+00	1.08E-05	1.55E-04	5.83E-06
Zn-69	6.04E-12	1.15E-11	8.07E-13	0.00E+00	7.53E-12	1.98E-07	3.56E-08
Br-83	0.00E+00	0.00E+00	4.30E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	5.41E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.29E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.38E-05	1.05E-05	0.00E+00	0.00E+00	0.00E+00	2.21E-06
Rb-88	0.00E+00	6.82E-08	3.40E-08	0.00E+00	0.00E+00	0.00E+00	3.65E-15
Rb-89	0.00E+00	4.40E-08	2.91E-08	0.00E+00	0.00E+00	0.00E+00	4.22E-17
Sr-89	5.43E-05	0.00E+00	1.56E-06	0.00E+00	0.00E+00	3.02E-04	4.64E-05
Sr-90	1.35E-02	0.00E+00	8.35E-04	0.00E+00	0.00E+00	2.06E-03	9.56E-05
Sr-91	1.10E-08	0.00E+00	4.39E-10	0.00E+00	0.00E+00	7.59E-06	3.24E-05
Sr-92	1.19E-09	0.00E+00	5.08E-11	0.00E+00	0.00E+00	3.43E-06	1.49E-05
Y-90	3.73E-07	0.00E+00	1.00E-08	0.00E+00	0.00E+00	3.66E-05	6.99E-05
Y-91m	4.63E-11	0.00E+00	1.77E-12	0.00E+00	0.00E+00	4.00E-07	3.77E-09
Y-91	8.26E-05	0.00E+00	2.21E-06	0.00E+00	0.00E+00	3.67E-04	5.11E-05
Y-92	1.84E-09	0.00E+00	5.36E-11	0.00E+00	0.00E+00	3.35E-06	2.06E-05
Y-93	1.69E-08	0.00E+00	4.65E-10	0.00E+00	0.00E+00	1.04E-05	7.24E-05
Zr-95	1.82E-05	5.73E-06	3.94E-06	0.00E+00	8.42E-06	3.36E-04	1.86E-05
Zr-97	1.72E-08	3.40E-09	1.57E-09	0.00E+00	5.15E-09	1.62E-05	7.88E-05
Nb-95	2.32E-06	1.29E-06	7.08E-07	0.00E+00	1.25E-06	9.39E-05	1.21E-05
Mo-99	0.00E+00	2.11E-08	4.03E-09	0.00E+00	5.14E-08	1.92E-05	3.36E-05
Tc-99m	1.73E-13	4.83E-13	6.24E-12	0.00E+00	7.20E-12	1.44E-07	7.66E-07
Tc-101	7.40E-15	1.05E-14	1.03E-13	0.00E+00	1.90E-13	8.34E-08	1.09E-16
Ru-103	2.63E-07	0.00E+00	1.12E-07	0.00E+00	9.29E-07	9.79E-05	1.36E-05
Ru-105	1.40E-10	0.00E+00	5.42E-11	0.00E+00	1.76E-10	2.27E-06	1.13E-05
Ru-106	1.23E-05	0.00E+00	1.55E-06	0.00E+00	2.38E-05	2.01E-03	1.20E-04
Ag-110m	1.73E-06	1.64E-06	9.99E-07	0.00E+00	3.13E-06	8.44E-04	3.41E-05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	5.38E-06	9.92E-08	2.10E-06	1.22E-08	0.00E+00	4.81E-04	4.98E-05
Sb-125	9.23E-06	1.01E-07	2.15E-06	8.80E-09	0.00E+00	3.42E-04	1.24E-05

Table 2-2b

TEEN INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	6.10E-07	2.80E-07	8.34E-08	1.75E-07	0.00E+00	6.70E-05	9.38E-06
Te-127m	2.25E-06	1.02E-06	2.73E-07	5.48E-07	8.17E-06	2.07E-04	1.99E-05
Te-127	2.51E-10	1.14E-10	5.52E-11	1.77E-10	9.10E-10	1.40E-06	1.01E-05
Te-129m	1.74E-06	8.23E-07	2.81E-07	5.72E-07	6.49E-06	2.47E-04	5.06E-05
Te-129	8.87E-12	4.22E-12	2.20E-12	6.48E-12	3.32E-11	4.12E-07	2.02E-07
Te-131m	1.23E-08	7.51E-09	5.03E-09	9.06E-09	5.49E-08	2.97E-05	7.76E-05
Te-131	1.97E-12	1.04E-12	6.30E-13	1.55E-12	7.72E-12	2.92E-07	1.89E-09
Te-132	4.50E-08	3.63E-08	2.74E-08	3.07E-08	2.44E-07	5.61E-05	5.79E-05
I-130	7.80E-07	2.24E-06	8.96E-07	1.86E-04	3.44E-06	0.00E+00	1.14E-06
I-131	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	0.00E+00	8.11E-07
I-132	1.99E-07	5.47E-07	1.97E-07	1.89E-05	8.65E-07	0.00E+00	1.59E-07
I-133	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	0.00E+00	1.29E-06
I-134	1.11E-07	2.90E-07	1.05E-07	4.94E-06	4.58E-07	0.00E+00	2.55E-09
I-135	4.62E-07	1.18E-06	4.36E-07	7.76E-05	1.86E-06	0.00E+00	8.69E-07
Cs-134	6.28E-05	1.41E-04	6.86E-05	0.00E+00	4.69E-05	1.83E-05	1.22E-06
Cs-136	6.44E-06	2.42E-05	1.71E-05	0.00E+00	1.38E-05	2.22E-06	1.36E-06
Cs-137	8.38E-05	1.06E-04	3.89E-05	0.00E+00	3.80E-05	1.51E-05	1.06E-06
Cs-138	5.82E-08	1.07E-07	5.58E-08	0.00E+00	8.28E-08	9.84E-09	3.38E-11
Ba-139	1.67E-10	1.18E-13	4.87E-12	0.00E+00	1.11E-13	8.08E-07	8.06E-07
Ba-140	6.84E-06	8.38E-09	4.40E-07	0.00E+00	2.85E-09	2.54E-04	2.86E-05
Ba-141	1.78E-11	1.32E-14	5.93E-13	0.00E+00	1.23E-14	4.11E-07	9.33E-14
Ba-142	4.62E-12	4.63E-15	2.84E-13	0.00E+00	3.92E-15	2.39E-07	5.99E-20
La-140	5.99E-08	2.95E-08	7.82E-09	0.00E+00	0.00E+00	2.68E-05	6.09E-05
La-142	1.20E-10	5.31E-11	1.32E-11	0.00E+00	0.00E+00	1.27E-06	1.50E-06
Ce-141	3.55E-06	2.37E-06	2.71E-07	0.00E+00	1.11E-06	7.67E-05	1.58E-05
Ce-143	3.32E-08	2.42E-08	2.70E-09	0.00E+00	1.08E-08	1.63E-05	3.19E-05
Ce-144	6.11E-04	2.53E-04	3.28E-05	0.00E+00	1.51E-04	1.67E-03	1.08E-04
Pr-143	1.67E-06	6.64E-07	8.28E-08	0.00E+00	3.86E-07	6.04E-05	2.67E-05
Pr-144	5.37E-12	2.20E-12	2.72E-13	0.00E+00	1.26E-12	2.19E-07	2.94E-14
Nd-147	9.83E-07	1.07E-06	6.41E-08	0.00E+00	6.28E-07	4.65E-05	2.28E-05
W-187	1.50E-09	1.22E-09	4.29E-10	0.00E+00	0.00E+00	5.92E-06	2.21E-05
Np-239	4.23E-08	3.99E-09	2.21E-09	0.00E+00	1.25E-08	8.11E-06	1.65E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.18E-07	1.15E-07	0.00E+00	0.00E+00	7.33E-05	3.93E-06
Sr-85	5.00E-06	0.00E+00	1.30E-06	0.00E+00	0.00E+00	8.80E-05	6.90E-06
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	3.93E-11	9.72E-12	3.55E-12	0.00E+00	1.14E-11	4.91E-07	2.71E-07
Cd-109	0.00E+00	1.00E-04	3.40E-06	0.00E+00	6.70E-05	1.60E-04	8.60E-06
Sn-113	1.50E-05	4.70E-07	9.70E-07	2.90E-07	0.00E+00	2.00E-04	1.50E-06
Ba-133	4.70E-05	8.00E-07	3.30E-06	0.00E+00	2.80E-09	2.90E-04	9.70E-06
Te-134	5.31E-12	4.35E-12	3.64E-12	4.46E-12	2.91E-11	6.75E-07	1.37E-09
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-2c

CHILD INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P-32	7.04E-04	3.09E-05	2.67E-05	0.00E+00	0.00E+00	0.00E+00	1.14E-05
Cr-51	0.00E+00	0.00E+00	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
Mn-54	0.00E+00	1.16E-05	2.57E-06	0.00E+00	2.71E-06	4.26E-04	6.19E-06
Mn-56	0.00E+00	4.48E-10	8.43E-11	0.00E+00	4.52E-10	3.55E-06	3.33E-05
Fe-55	1.28E-05	6.80E-06	2.10E-06	0.00E+00	0.00E+00	3.00E-05	7.75E-07
Fe-59	5.59E-06	9.04E-06	4.51E-06	0.00E+00	0.00E+00	3.43E-04	1.91E-05
Co-58	0.00E+00	4.79E-07	8.55E-07	0.00E+00	0.00E+00	2.99E-04	9.29E-06
Co-60	0.00E+00	3.55E-06	6.12E-06	0.00E+00	0.00E+00	1.91E-03	2.60E-05
Ni-63	2.22E-04	1.25E-05	7.56E-06	0.00E+00	0.00E+00	7.43E-05	1.71E-06
Ni-65	8.08E-10	7.99E-11	4.44E-11	0.00E+00	0.00E+00	2.21E-06	2.27E-05
Cu-64	0.00E+00	5.39E-10	2.90E-10	0.00E+00	1.63E-09	2.59E-06	9.92E-06
Zn-65	1.15E-05	3.06E-05	1.90E-05	0.00E+00	1.93E-05	2.69E-04	4.41E-06
Zn-69	1.81E-11	2.61E-11	2.41E-12	0.00E+00	1.58E-11	3.84E-07	2.75E-06
Br-83	0.00E+00	0.00E+00	1.28E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.48E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	6.84E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	5.36E-05	3.09E-05	0.00E+00	0.00E+00	0.00E+00	2.16E-06
Rb-88	0.00E+00	1.52E-07	9.90E-08	0.00E+00	0.00E+00	0.00E+00	4.66E-09
Rb-89	0.00E+00	9.33E-08	7.83E-08	0.00E+00	0.00E+00	0.00E+00	5.11E-10
Sr-89	1.62E-04	0.00E+00	4.66E-06	0.00E+00	0.00E+00	5.83E-04	4.52E-05
Sr-90	2.73E-02	0.00E+00	1.74E-03	0.00E+00	0.00E+00	3.99E-03	9.28E-05
Sr-91	3.28E-08	0.00E+00	1.24E-09	0.00E+00	0.00E+00	1.44E-05	4.70E-05
Sr-92	3.54E-09	0.00E+00	1.42E-10	0.00E+00	0.00E+00	6.49E-06	6.55E-05
Y-90	1.11E-06	0.00E+00	2.99E-08	0.00E+00	0.00E+00	7.07E-05	7.24E-05
Y-91m	1.37E-10	0.00E+00	4.98E-12	0.00E+00	0.00E+00	7.60E-07	4.64E-07
Y-91	2.47E-04	0.00E+00	6.59E-06	0.00E+00	0.00E+00	7.10E-04	4.97E-05
Y-92	5.50E-09	0.00E+00	1.57E-10	0.00E+00	0.00E+00	6.46E-06	6.46E-05
Y-93	5.04E-08	0.00E+00	1.38E-09	0.00E+00	0.00E+00	2.01E-05	1.05E-04
Zr-95	5.13E-05	1.13E-05	1.00E-05	0.00E+00	1.61E-05	6.03E-04	1.65E-05
Zr-97	5.07E-08	7.34E-09	4.32E-09	0.00E+00	1.05E-08	3.06E-05	9.49E-05
Nb-95	6.35E-06	2.48E-06	1.77E-06	0.00E+00	2.33E-06	1.66E-04	1.00E-05
Mo-99	0.00E+00	4.66E-08	1.15E-08	0.00E+00	1.06E-07	3.66E-05	3.42E-05
Tc-99m	4.81E-13	9.41E-13	1.56E-11	0.00E+00	1.37E-11	2.57E-07	1.30E-06
Tc-101	2.19E-14	2.30E-14	2.91E-13	0.00E+00	3.92E-13	1.58E-07	4.41E-09
Ru-103	7.55E-07	0.00E+00	2.90E-07	0.00E+00	1.90E-06	1.79E-04	1.21E-05
Ru-105	4.13E-10	0.00E+00	1.50E-10	0.00E+00	3.63E-10	4.30E-06	2.69E-05
Ru-106	3.68E-05	0.00E+00	4.57E-06	0.00E+00	4.97E-05	3.87E-03	1.16E-04
Ag-110m	4.56E-06	3.08E-06	2.47E-06	0.00E+00	5.74E-06	1.48E-03	2.71E-05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	1.55E-05	2.00E-07	5.41E-06	3.41E-08	0.00E+00	8.76E-04	4.43E-05
Sb-125	2.66E-05	2.05E-07	5.59E-06	2.46E-08	0.00E+00	6.27E-04	1.09E-05

Table 2-2c

CHILD INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	1.82E-06	6.29E-07	2.47E-07	5.20E-07	0.00E+00	1.29E-04	9.13E-06
Te-127m	6.72E-06	2.31E-06	8.16E-07	1.64E-06	1.72E-05	4.00E-04	1.93E-05
Te-127	7.49E-10	2.57E-10	1.65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
Te-129m	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
Te-129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
Te-131m	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
Te-131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
Te-132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
I-130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	0.00E+00	1.38E-06
I-131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	0.00E+00	7.68E-07
I-132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	0.00E+00	8.65E-07
I-133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	0.00E+00	1.48E-06
I-134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	0.00E+00	2.58E-07
I-135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	0.00E+00	1.20E-06
Cs-134	1.76E-04	2.74E-04	6.07E-05	0.00E+00	8.93E-05	3.27E-05	1.04E-06
Cs-136	1.76E-05	4.62E-05	3.14E-05	0.00E+00	2.58E-05	3.93E-06	1.13E-06
Cs-137	2.45E-04	2.23E-04	3.47E-05	0.00E+00	7.63E-05	2.81E-05	9.78E-07
Cs-138	1.71E-07	2.27E-07	1.50E-07	0.00E+00	1.68E-07	1.84E-08	7.29E-08
Ba-139	4.98E-10	2.66E-13	1.45E-11	0.00E+00	2.33E-13	1.56E-06	1.56E-05
Ba-140	2.00E-05	1.75E-08	1.17E-06	0.00E+00	5.71E-09	4.71E-04	2.75E-05
Ba-141	5.29E-11	2.95E-14	1.72E-12	0.00E+00	2.56E-14	7.89E-07	7.44E-08
Ba-142	1.35E-11	9.73E-15	7.54E-13	0.00E+00	7.87E-15	4.44E-07	7.41E-10
La-140	1.74E-07	6.08E-08	2.04E-08	0.00E+00	0.00E+00	4.94E-05	6.10E-05
La-142	3.50E-10	1.11E-10	3.49E-11	0.00E+00	0.00E+00	2.35E-06	2.05E-05
Ce-141	1.06E-05	5.28E-06	7.83E-07	0.00E+00	2.31E-06	1.47E-04	1.53E-05
Ce-143	9.89E-08	5.37E-08	7.77E-09	0.00E+00	2.26E-08	3.12E-05	3.44E-05
Ce-144	1.83E-03	5.72E-04	9.77E-05	0.00E+00	3.17E-04	3.23E-03	1.05E-04
Pr-143	4.99E-06	1.50E-06	2.47E-07	0.00E+00	8.11E-07	1.17E-04	2.63E-05
Pr-144	1.61E-11	4.99E-12	8.10E-13	0.00E+00	2.64E-12	4.23E-07	5.32E-08
Nd-147	2.92E-06	2.36E-06	1.84E-07	0.00E+00	1.30E-06	8.87E-05	2.22E-05
W-187	4.41E-09	2.61E-09	1.17E-09	0.00E+00	0.00E+00	1.11E-05	2.46E-05
Np-239	1.26E-07	9.04E-09	6.35E-09	0.00E+00	2.63E-08	1.57E-05	1.73E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	2.44E-07	2.88E-07	0.00E+00	0.00E+00	1.37E-04	3.58E-06
Sr-85	1.20E-05	0.00E+00	3.20E-06	0.00E+00	0.00E+00	1.50E-04	5.50E-06
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	1.16E-10	2.08E-11	9.73E-12	0.00E+00	2.31E-11	9.24E-07	7.51E-06
Cd-109	0.00E+00	1.90E-04	8.00E-06	0.00E+00	1.70E-04	3.00E-04	8.10E-06
Sn-113	3.80E-05	8.90E-07	2.30E-06	7.10E-07	0.00E+00	3.60E-04	1.30E-06
Ba-133	1.10E-04	1.10E-06	1.00E-05	0.00E+00	5.40E-09	5.20E-04	8.30E-06
Te-134	1.53E-11	8.81E-12	9.40E-12	1.24E-11	5.71E-11	1.23E-06	4.87E-07
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-2d

INFANT INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P-32	1.45E-03	8.03E-05	5.53E-05	0.00E+00	0.00E+00	0.00E+00	1.15E-05
Cr-51	0.00E+00	0.00E+00	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
Mn-54	0.00E+00	1.81E-05	3.56E-06	0.00E+00	3.56E-06	7.14E-04	5.04E-06
Mn-56	0.00E+00	1.10E-09	1.58E-10	0.00E+00	7.86E-10	8.95E-06	5.12E-05
Fe-55	1.41E-05	8.39E-06	2.38E-06	0.00E+00	0.00E+00	6.21E-05	7.82E-07
Fe-59	9.69E-06	1.68E-05	6.77E-06	0.00E+00	0.00E+00	7.25E-04	1.77E-05
Co-58	0.00E+00	8.71E-07	1.30E-06	0.00E+00	0.00E+00	5.55E-04	7.95E-06
Co-60	0.00E+00	5.73E-06	8.41E-06	0.00E+00	0.00E+00	3.22E-03	2.28E-05
Ni-63	2.42E-04	1.46E-05	8.29E-06	0.00E+00	0.00E+00	1.49E-04	1.73E-06
Ni-65	1.71E-09	2.03E-10	8.79E-11	0.00E+00	0.00E+00	5.80E-06	3.58E-05
Cu-64	0.00E+00	1.34E-09	5.53E-10	0.00E+00	2.84E-09	6.64E-06	1.07E-05
Zn-65	1.38E-05	4.47E-05	2.22E-05	0.00E+00	2.32E-05	4.62E-04	3.67E-05
Zn-69	3.85E-11	6.91E-11	5.13E-12	0.00E+00	2.87E-11	1.05E-06	9.44E-06
Br-83	0.00E+00	0.00E+00	2.72E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	2.86E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.46E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.36E-04	6.30E-05	0.00E+00	0.00E+00	0.00E+00	2.17E-06
Rb-88	0.00E+00	3.98E-07	2.05E-07	0.00E+00	0.00E+00	0.00E+00	2.42E-07
Rb-89	0.00E+00	2.29E-07	1.47E-07	0.00E+00	0.00E+00	0.00E+00	4.87E-08
Sr-89	2.84E-04	0.00E+00	8.15E-06	0.00E+00	0.00E+00	1.45E-03	4.57E-05
Sr-90	2.92E-02	0.00E+00	1.85E-03	0.00E+00	0.00E+00	8.03E-03	9.36E-05
Sr-91	6.83E-08	0.00E+00	2.47E-09	0.00E+00	0.00E+00	3.76E-05	5.24E-05
Sr-92	7.50E-09	0.00E+00	2.79E-10	0.00E+00	0.00E+00	1.70E-05	1.00E-04
Y-90	2.35E-06	0.00E+00	6.30E-08	0.00E+00	0.00E+00	1.92E-04	7.43E-05
Y-91m	2.91E-10	0.00E+00	9.90E-12	0.00E+00	0.00E+00	1.99E-06	1.68E-06
Y-91	4.20E-04	0.00E+00	1.12E-05	0.00E+00	0.00E+00	1.75E-03	5.02E-05
Y-92	1.17E-08	0.00E+00	3.29E-10	0.00E+00	0.00E+00	1.75E-05	9.04E-05
Y-93	1.07E-07	0.00E+00	2.91E-09	0.00E+00	0.00E+00	5.46E-05	1.19E-04
Zr-95	8.24E-05	1.99E-05	1.45E-05	0.00E+00	2.22E-05	1.25E-03	1.55E-05
Zr-97	1.07E-07	1.83E-08	8.36E-09	0.00E+00	1.85E-08	7.88E-05	1.00E-04
Nb-95	1.12E-05	4.59E-06	2.70E-06	0.00E+00	3.37E-06	3.42E-04	9.05E-06
Mo-99	0.00E+00	1.18E-07	2.31E-08	0.00E+00	1.89E-07	9.63E-05	3.48E-05
Tc-99m	9.98E-13	2.06E-12	2.66E-11	0.00E+00	2.22E-11	5.79E-07	1.45E-06
Tc-101	4.65E-14	5.88E-14	5.80E-13	0.00E+00	6.99E-13	4.17E-07	6.03E-07
Ru-103	1.44E-06	0.00E+00	4.85E-07	0.00E+00	3.03E-06	3.94E-04	1.15E-05
Ru-105	8.74E-10	0.00E+00	2.93E-10	0.00E+00	6.42E-10	1.12E-05	3.46E-05
Ru-106	6.20E-05	0.00E+00	7.77E-06	0.00E+00	7.61E-05	8.26E-03	1.17E-04
Ag-110m	7.13E-06	5.16E-06	3.57E-06	0.00E+00	7.80E-06	2.62E-03	2.36E-05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	2.71E-05	3.97E-07	8.56E-06	7.18E-08	0.00E+00	1.89E-03	4.22E-05
Sb-125	3.69E-05	3.41E-07	7.78E-06	4.45E-08	0.00E+00	1.17E-03	1.05E-05

Table 2-2d

INFANT INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	3.40E-06	1.42E-06	4.70E-07	1.16E-06	0.00E+00	3.19E-04	9.22E-06
Te-127m	1.19E-05	4.93E-06	1.48E-06	3.48E-06	2.68E-05	9.37E-04	1.95E-05
Te-127	1.59E-05	6.81E-10	3.49E-10	1.32E-09	3.47E-09	7.39E-06	1.74E-05
Te-129m	1.01E-05	4.35E-06	1.59E-06	3.91E-06	2.27E-05	1.20E-03	4.93E-05
Te-129	5.63E-11	2.48E-11	1.34E-11	4.82E-11	1.25E-10	2.14E-06	1.88E-05
Te-131m	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
Te-131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
Te-132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I-130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	0.00E+00	1.42E-06
I-131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	0.00E+00	7.56E-07
I-132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	0.00E+00	1.36E-06
I-133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	0.00E+00	1.54E-06
I-134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	0.00E+00	9.21E-07
I-135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	0.00E+00	1.31E-06
Cs-134	2.83E-04	5.02E-04	5.32E-05	0.00E+00	1.36E-04	5.69E-05	9.53E-07
Cs-136	3.45E-05	9.61E-05	3.78E-05	0.00E+00	4.03E-05	8.40E-06	1.02E-06
Cs-137	3.92E-04	4.37E-04	3.25E-05	0.00E+00	1.23E-04	5.09E-05	9.53E-07
Cs-138	3.61E-07	5.58E-07	2.84E-07	0.00E+00	2.93E-07	4.67E-08	6.26E-07
Ba-139	1.06E-09	7.03E-13	3.07E-11	0.00E+00	4.23E-13	4.25E-06	3.64E-05
Ba-140	4.00E-05	4.00E-08	2.07E-06	0.00E+00	9.59E-09	1.14E-03	2.74E-05
Ba-141	1.12E-10	7.70E-14	3.55E-12	0.00E+00	4.64E-14	2.12E-06	3.39E-06
Ba-142	2.84E-11	2.36E-14	1.40E-12	0.00E+00	1.36E-14	1.11E-06	4.95E-07
La-140	3.61E-07	1.43E-07	3.68E-08	0.00E+00	0.00E+00	1.20E-04	6.06E-05
La-142	7.36E-10	2.69E-10	6.46E-11	0.00E+00	0.00E+00	5.87E-06	4.25E-05
Ce-141	1.98E-05	1.19E-05	1.42E-06	0.00E+00	3.75E-06	3.69E-04	1.54E-05
Ce-143	2.09E-07	1.38E-07	1.58E-08	0.00E+00	4.03E-08	8.30E-05	3.55E-05
Ce-144	2.28E-03	8.65E-04	1.26E-04	0.00E+00	3.84E-04	7.03E-03	1.06E-04
Pr-143	1.00E-05	3.74E-06	4.99E-07	0.00E+00	1.41E-06	3.09E-04	2.66E-05
Pr-144	3.42E-11	1.32E-11	1.72E-12	0.00E+00	4.80E-12	1.15E-06	3.06E-06
Nd-147	5.67E-06	5.81E-06	3.57E-07	0.00E+00	2.25E-06	2.30E-04	2.23E-05
W-187	9.26E-09	6.44E-09	2.23E-09	0.00E+00	0.00E+00	2.83E-05	2.54E-05
Np-239	2.65E-07	2.37E-08	1.34E-08	0.00E+00	4.73E-08	4.25E-05	1.78E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	4.65E-07	4.58E-07	0.00E+00	0.00E+00	2.71E-04	3.47E-06
Sr-85	2.70E-05	0.00E+00	5.40E-06	0.00E+00	0.00E+00	3.00E-04	4.80E-06
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.44E-10	5.21E-11	1.88E-11	0.00E+00	4.07E-11	2.37E-06	1.92E-05
Cd-109	0.00E+00	2.60E-04	1.00E-05	0.00E+00	2.00E-04	6.20E-04	8.00E-06
Sn-113	6.00E-05	1.60E-06	3.60E-06	1.30E-06	0.00E+00	7.80E-04	1.20E-06
Ba-133	1.90E-04	1.70E-06	1.30E-05	0.00E+00	8.90E-09	9.10E-04	7.70E-06
Te-134	3.18E-11	2.04E-11	1.68E-11	2.91E-11	9.59E-11	2.93E-06	2.53E-06
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-2e

Total Body & Skin Ground Plane Dose Factors (mrem/hr per pCi/m^2) with Isotope half-life and Stable Element Tranfer Data (Fm, cow)

Isotope	Halflife	unit	Fm	Ground Plane Dose Factors TotBody(DFg)	Skin(DFs)
H-3	12.350	Y	1.00E-02	0.00E+00	0.00E+00
Be-7	53.300	D	1.00E-04	0.00E+00	0.00E+00
Na-24	15.000	H	4.00E-02	2.50E-08	2.90E-08
P-32	14.290	D	2.50E-02	0.00E+00	0.00E+00
Cr-51	27.704	D	2.20E-03	2.20E-10	2.60E-10
Mn-54	312.500	D	2.50E-04	5.80E-09	6.80E-09
Mn-56	2.578	H	2.50E-04	1.10E-08	1.30E-08
Fe-55	2.700	Y	1.20E-03	0.00E+00	0.00E+00
Fe-59	44.529	D	1.20E-03	8.00E-09	9.40E-09
Co-58	70.800	D	1.00E-03	7.00E-09	8.20E-09
Co-60	5.271	Y	1.00E-03	1.70E-08	2.00E-08
Ni-63	96.000	Y	6.70E-03	0.00E+00	0.00E+00
Ni-65	2.520	H	6.70E-03	3.70E-09	4.30E-09
Cu-64	12.701	H	1.40E-02	1.50E-09	1.70E-09
Zn-65	243.900	D	3.90E-02	4.00E-09	4.60E-09
Zn-69	0.950	H	3.90E-02	0.00E+00	0.00E+00
Br-83	2.390	H	5.00E-02	6.40E-11	9.30E-11
Br-84	0.530	H	5.00E-02	1.20E-08	1.40E-08
Br-85	0.050	H	5.00E-02	0.00E+00	0.00E+00
Rb-86	18.660	D	3.00E-02	6.30E-10	7.20E-10
Rb-88	0.297	H	3.00E-02	3.50E-09	4.00E-09
Rb-89	0.253	H	3.00E-02	1.50E-08	1.80E-08
Sr-89	50.500	D	8.00E-04	5.60E-13	6.50E-13
Sr-90	29.120	Y	8.00E-04	0.00E+00	0.00E+00
Sr-91	9.500	H	8.00E-04	7.10E-09	8.30E-09
Sr-92	2.710	H	8.00E-04	9.00E-09	1.00E-08
Y-90	2.667	D	1.00E-05	2.20E-12	2.60E-12
Y-91m	0.829	H	1.00E-05	3.80E-09	4.40E-09
Y-91	58.510	D	1.00E-05	2.40E-11	2.70E-11
Y-92	3.540	H	1.00E-05	1.60E-09	1.90E-09
Y-93	10.100	H	1.00E-05	5.70E-10	7.80E-10
Zr-95	63.980	D	5.00E-06	5.00E-09	5.80E-09
Zr-97	16.900	H	5.00E-06	5.50E-09	6.40E-09
Nb-95	35.150	D	2.50E-03	5.10E-09	6.00E-09
Mo-99	2.750	D	7.50E-03	1.90E-09	2.20E-09
Tc-99m	6.020	H	2.50E-02	9.60E-10	1.10E-09
Tc-101	0.237	H	2.50E-02	2.70E-09	3.00E-09
Ru-103	39.280	D	1.00E-06	3.60E-09	4.20E-09
Ru-105	4.440	H	1.00E-06	4.50E-09	5.10E-09
Ru-106	368.200	D	1.00E-06	1.50E-09	1.80E-09
Ag-110m	249.900	D	5.00E-02	1.80E-08	2.10E-08
Sb-122	2.700	D	1.50E-03	0.00E+00	0.00E+00
Sb-124	60.200	D	1.50E-03	1.30E-08	1.50E-08
Sb-125	2.770	Y	1.50E-03	3.10E-09	3.50E-09

Table 2-2e

Total Body & Skin Ground Plane Dose Factors (mrem/hr per pCi/m^2)
with Isotope half-life and Stable Element Tranfer Data (Fm, cow)

Isotope	Halflife	unit	Fm	Ground Plane Dose Factors TotBody(DFg)	Ground Plane Dose Factors Skin(DFs)
Te-125m	58.000	D	1.00E-03	3.50E-11	4.80E-11
Te-127m	109.000	D	1.00E-03	1.10E-12	1.30E-12
Te-127	9.350	H	1.00E-03	1.00E-11	1.10E-11
Te-129m	33.600	D	1.00E-03	7.70E-10	9.00E-10
Te-129	1.160	H	1.00E-03	7.10E-10	8.40E-10
Te-131m	30.000	H	1.00E-03	8.40E-09	9.90E-09
Te-131	0.417	H	1.00E-03	2.20E-09	2.60E-06
Te-132	3.258	D	1.00E-03	1.70E-09	2.00E-09
I-130	12.360	H	6.00E-03	1.40E-08	1.70E-08
I-131	8.040	D	6.00E-03	2.80E-09	3.40E-09
I-132	2.300	H	6.00E-03	1.70E-08	2.00E-08
I-133	20.800	H	6.00E-03	3.70E-09	4.50E-09
I-134	0.877	H	6.00E-03	1.60E-08	1.90E-08
I-135	6.610	H	6.00E-03	1.20E-08	1.40E-08
Cs-134	2.062	Y	1.20E-02	1.20E-08	1.40E-08
Cs-136	13.100	D	1.20E-02	1.50E-08	1.70E-08
Cs-137	30.000	Y	1.20E-02	4.20E-09	4.90E-09
Cs-138	0.537	H	1.20E-02	2.10E-08	2.40E-08
Ba-139	1.378	H	4.00E-04	2.40E-09	2.70E-09
Ba-140	12.740	D	4.00E-04	2.10E-09	2.40E-09
Ba-141	0.304	H	4.00E-04	4.30E-09	4.90E-09
Ba-142	0.177	H	4.00E-04	7.90E-09	9.00E-09
La-140	1.678	D	5.00E-06	1.50E-08	1.70E-08
La-142	1.542	H	5.00E-06	1.50E-08	1.80E-08
Ce-141	32.501	D	1.00E-04	5.50E-10	6.20E-10
Ce-143	33.000	H	1.00E-04	2.20E-09	2.50E-09
Ce-144	284.300	D	1.00E-04	3.20E-10	3.70E-10
Pr-143	13.560	D	5.00E-06	0.00E+00	0.00E+00
Pr-144	0.288	H	5.00E-06	2.00E-10	2.30E-10
Nd-147	10.980	D	5.00E-06	1.00E-09	1.20E-09
W-187	23.900	H	5.00E-04	3.10E-09	3.60E-09
Np-239	2.360	D	5.00E-06	9.50E-10	1.10E-09
K-40	1.28E+09	Y	1.00E-02	0.00E+00	0.00E+00
Co-57	270.900	D	1.00E-03	9.10E-10	1.00E-09
Sr-85	64.840	D	8.00E-04	0.00E+00	0.00E+00
Y-88	106.640	D	1.00E-05	0.00E+00	0.00E+00
Nb-94	2.03E+04	Y	2.50E-03	0.00E+00	0.00E+00
Nb-97	1.202	H	2.50E-03	4.60E-09	5.40E-09
Cd-109	1.271	Y	1.20E-04	0.00E+00	0.00E+00
Sn-113	115.100	D	2.50E-03	0.00E+00	0.00E+00
Ba-133	10.740	Y	4.00E-04	0.00E+00	0.00E+00
Te-134	0.697	H	1.00E-03	1.00E-09	1.20E-09
Ce-139	137.660	D	1.00E-04	0.00E+00	0.00E+00
Hg-203	46.600	D	3.80E-02	0.00E+00	0.00E+00

Table 2-3a

ADULT INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07
Be-7	2.77E-09	6.26E-09	3.10E-09	0.00E+00	6.58E-09	0.00E+00	1.08E-06
Na-24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P-32	1.93E-04	1.20E-05	7.46E-06	0.00E+00	0.00E+00	0.00E+00	2.17E-05
Cr-51	0.00E+00	0.00E+00	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
Mn-54	0.00E+00	4.57E-06	8.72E-07	0.00E+00	1.36E-06	0.00E+00	1.40E-05
Mn-56	0.00E+00	1.15E-07	2.04E-08	0.00E+00	1.46E-07	0.00E+00	3.67E-06
Fe-55	2.75E-06	1.90E-06	4.43E-07	0.00E+00	0.00E+00	1.06E-06	1.09E-06
Fe-59	4.34E-06	1.02E-05	3.91E-06	0.00E+00	0.00E+00	2.85E-06	3.40E-05
Co-58	0.00E+00	7.45E-07	1.67E-06	0.00E+00	0.00E+00	0.00E+00	1.51E-05
Co-60	0.00E+00	2.14E-06	4.72E-06	0.00E+00	0.00E+00	0.00E+00	4.02E-05
Ni-63	1.30E-04	9.01E-06	4.36E-06	0.00E+00	0.00E+00	0.00E+00	1.88E-06
Ni-65	5.28E-07	6.86E-08	3.13E-08	0.00E+00	0.00E+00	0.00E+00	1.74E-06
Cu-64	0.00E+00	8.33E-08	3.91E-08	0.00E+00	2.10E-07	0.00E+00	7.10E-06
Zn-65	4.84E-06	1.54E-05	6.96E-06	0.00E+00	1.03E-05	0.00E+00	9.70E-06
Zn-69	1.03E-08	1.97E-08	1.37E-09	0.00E+00	1.28E-08	0.00E+00	2.96E-09
Br-83	0.00E+00	0.00E+00	4.02E-08	0.00E+00	0.00E+00	0.00E+00	5.79E-08
Br-84	0.00E+00	0.00E+00	5.21E-08	0.00E+00	0.00E+00	0.00E+00	4.09E-13
Br-85	0.00E+00	0.00E+00	2.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.11E-05	9.83E-06	0.00E+00	0.00E+00	0.00E+00	4.16E-06
Rb-88	0.00E+00	6.05E-08	3.21E-08	0.00E+00	0.00E+00	0.00E+00	8.36E-19
Rb-89	0.00E+00	4.01E-08	2.82E-08	0.00E+00	0.00E+00	0.00E+00	2.33E-21
Sr-89	3.08E-04	0.00E+00	8.84E-06	0.00E+00	0.00E+00	0.00E+00	4.94E-05
Sr-90	7.58E-03	0.00E+00	1.86E-03	0.00E+00	0.00E+00	0.00E+00	2.19E-04
Sr-91	5.67E-06	0.00E+00	2.29E-07	0.00E+00	0.00E+00	0.00E+00	2.70E-05
Sr-92	2.15E-06	0.00E+00	9.30E-08	0.00E+00	0.00E+00	0.00E+00	4.26E-05
Y-90	9.62E-09	0.00E+00	2.58E-10	0.00E+00	0.00E+00	0.00E+00	1.02E-04
Y-91m	9.09E-11	0.00E+00	3.52E-12	0.00E+00	0.00E+00	0.00E+00	2.67E-10
Y-91	1.41E-07	0.00E+00	3.77E-09	0.00E+00	0.00E+00	0.00E+00	7.76E-05
Y-92	8.45E-10	0.00E+00	2.47E-11	0.00E+00	0.00E+00	0.00E+00	1.48E-05
Y-93	2.68E-09	0.00E+00	7.40E-11	0.00E+00	0.00E+00	0.00E+00	8.50E-05
Zr-95	3.04E-08	9.75E-09	6.60E-09	0.00E+00	1.53E-08	0.00E+00	3.09E-05
Zr-97	1.68E-09	3.39E-10	1.55E-10	0.00E+00	5.12E-10	0.00E+00	1.05E-04
Nb-95	6.22E-09	3.46E-09	1.86E-09	0.00E+00	3.42E-09	0.00E+00	2.10E-05
Mo-99	0.00E+00	4.31E-06	8.20E-07	0.00E+00	9.76E-06	0.00E+00	9.99E-06
Tc-99m	2.47E-10	6.98E-10	8.89E-09	0.00E+00	1.06E-08	3.42E-10	4.13E-07
Tc-101	2.54E-10	3.66E-10	3.59E-09	0.00E+00	6.59E-09	1.87E-10	1.10E-21
Ru-103	1.85E-07	0.00E+00	7.97E-08	0.00E+00	7.06E-07	0.00E+00	2.16E-05
Ru-105	1.54E-08	0.00E+00	6.08E-09	0.00E+00	1.99E-07	0.00E+00	9.42E-06
Ru-106	2.75E-06	0.00E+00	3.48E-07	0.00E+00	5.31E-06	0.00E+00	1.78E-04
Ag-110m	1.60E-07	1.48E-07	8.79E-08	0.00E+00	2.91E-07	0.00E+00	6.04E-05
Sb-122	2.00E-07	4.60E-09	6.90E-08	3.10E-09	0.00E+00	1.20E-07	7.60E-05
Sb-124	2.80E-06	5.30E-08	1.10E-06	6.80E-09	0.00E+00	2.18E-06	7.95E-05
Sb-125	1.79E-06	2.00E-08	4.26E-07	1.82E-09	0.00E+00	1.38E-06	1.97E-05

Table 2-3a

ADULT INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	0.00E+00	1.07E-05
Te-127m	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	0.00E+00	2.27E-05
Te-127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	0.00E+00	8.68E-06
Te-129m	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	0.00E+00	5.79E-05
Te-129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	0.00E+00	2.37E-08
Te-131m	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	0.00E+00	8.40E-05
Te-131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	0.00E+00	2.79E-09
Te-132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	0.00E+00	7.71E-05
I-130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	0.00E+00	1.92E-06
I-131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	0.00E+00	1.57E-06
I-132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	0.00E+00	1.02E-07
I-133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	0.00E+00	2.22E-06
I-134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	0.00E+00	2.51E-10
I-135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	0.00E+00	1.31E-06
Cs-134	6.22E-05	1.48E-04	1.21E-04	0.00E+00	4.79E-05	1.59E-05	2.59E-06
Cs-136	6.51E-06	2.57E-05	1.85E-05	0.00E+00	1.43E-05	1.96E-06	2.92E-06
Cs-137	7.97E-05	1.09E-04	7.14E-05	0.00E+00	3.70E-05	1.23E-05	2.11E-06
Cs-138	5.52E-08	1.09E-07	5.40E-08	0.00E+00	8.01E-08	7.91E-09	4.65E-13
Ba-139	9.70E-08	6.91E-11	2.84E-09	0.00E+00	6.46E-11	3.92E-11	1.72E-07
Ba-140	2.03E-05	2.55E-08	1.33E-06	0.00E+00	8.67E-09	1.46E-08	4.18E-05
Ba-141	4.71E-08	3.56E-11	1.59E-09	0.00E+00	3.31E-11	2.02E-11	2.22E-17
Ba-142	2.13E-08	2.19E-11	1.34E-09	0.00E+00	1.85E-11	1.24E-11	3.00E-26
La-140	2.50E-09	1.26E-09	3.33E-10	0.00E+00	0.00E+00	0.00E+00	9.25E-05
La-142	1.28E-10	5.82E-11	1.45E-11	0.00E+00	0.00E+00	0.00E+00	4.25E-07
Ce-141	9.36E-09	6.33E-09	7.18E-10	0.00E+00	2.94E-09	0.00E+00	2.42E-05
Ce-143	1.65E-09	1.22E-06	1.35E-10	0.00E+00	5.37E-10	0.00E+00	4.56E-05
Ce-144	4.88E-07	2.04E-07	2.62E-08	0.00E+00	1.21E-07	0.00E+00	1.65E-04
Pr-143	9.20E-09	3.69E-09	4.56E-10	0.00E+00	2.13E-09	0.00E+00	4.03E-05
Pr-144	3.01E-11	1.25E-11	1.53E-12	0.00E+00	7.05E-12	0.00E+00	4.33E-18
Nd-147	6.29E-09	7.27E-09	4.35E-10	0.00E+00	4.25E-09	0.00E+00	3.49E-05
W-187	1.03E-07	8.61E-08	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.82E-05
Np-239	1.19E-09	1.17E-10	6.45E-11	0.00E+00	3.65E-10	0.00E+00	2.40E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.75E-07	2.91E-07	0.00E+00	0.00E+00	0.00E+00	4.44E-06
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	5.22E-11	1.32E-11	4.82E-12	0.00E+00	1.54E-11	0.00E+00	4.87E-08
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	3.24E-08	2.12E-08	1.30E-08	2.83E-08	2.05E-07	0.00E+00	3.59E-11
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-3b

TEEN INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07
Be-7	3.96E-09	8.87E-09	4.43E-09	0.00E+00	9.40E-09	0.00E+00	1.08E-06
Na-24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P-32	2.76E-04	1.71E-05	1.07E-05	0.00E+00	0.00E+00	0.00E+00	2.32E-05
Cr-51	0.00E+00	0.00E+00	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
Mn-54	0.00E+00	5.90E-06	1.17E-06	0.00E+00	1.76E-06	0.00E+00	1.21E-05
Mn-56	0.00E+00	1.58E-07	2.81E-08	0.00E+00	2.00E-07	0.00E+00	1.04E-05
Fe-55	3.78E-06	2.68E-06	6.25E-07	0.00E+00	0.00E+00	1.70E-06	1.16E-06
Fe-59	5.87E-06	1.37E-05	5.29E-06	0.00E+00	0.00E+00	4.32E-06	3.24E-05
Co-58	0.00E+00	9.72E-07	2.24E-06	0.00E+00	0.00E+00	0.00E+00	1.34E-05
Co-60	0.00E+00	2.81E-06	6.33E-06	0.00E+00	0.00E+00	0.00E+00	3.66E-05
Ni-63	1.77E-04	1.25E-05	6.00E-06	0.00E+00	0.00E+00	0.00E+00	1.99E-06
Ni-65	7.49E-07	9.57E-08	4.36E-08	0.00E+00	0.00E+00	0.00E+00	5.19E-06
Cu-64	0.00E+00	1.15E-07	5.41E-08	0.00E+00	2.91E-07	0.00E+00	8.92E-06
Zn-65	5.76E-06	2.00E-05	9.33E-06	0.00E+00	1.28E-05	0.00E+00	8.47E-06
Zn-69	1.47E-08	2.80E-08	1.96E-09	0.00E+00	1.83E-08	0.00E+00	5.16E-08
Br-83	0.00E+00	0.00E+00	5.74E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	7.22E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	3.05E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.98E-05	1.40E-05	0.00E+00	0.00E+00	0.00E+00	4.41E-06
Rb-88	0.00E+00	8.52E-08	4.54E-08	0.00E+00	0.00E+00	0.00E+00	7.30E-15
Rb-89	0.00E+00	5.50E-08	3.89E-08	0.00E+00	0.00E+00	0.00E+00	8.43E-17
Sr-89	4.40E-04	0.00E+00	1.26E-05	0.00E+00	0.00E+00	0.00E+00	5.24E-05
Sr-90	8.30E-03	0.00E+00	2.05E-03	0.00E+00	0.00E+00	0.00E+00	2.33E-04
Sr-91	8.07E-06	0.00E+00	3.21E-07	0.00E+00	0.00E+00	0.00E+00	3.66E-05
Sr-92	3.05E-06	0.00E+00	1.30E-07	0.00E+00	0.00E+00	0.00E+00	7.77E-05
Y-90	1.37E-08	0.00E+00	3.69E-10	0.00E+00	0.00E+00	0.00E+00	1.13E-04
Y-91m	1.29E-10	0.00E+00	4.93E-12	0.00E+00	0.00E+00	0.00E+00	6.09E-09
Y-91	2.01E-07	0.00E+00	5.39E-09	0.00E+00	0.00E+00	0.00E+00	8.24E-05
Y-92	1.21E-09	0.00E+00	3.50E-11	0.00E+00	0.00E+00	0.00E+00	3.32E-05
Y-93	3.83E-09	0.00E+00	1.05E-10	0.00E+00	0.00E+00	0.00E+00	1.17E-04
Zr-95	4.12E-08	1.30E-08	8.94E-09	0.00E+00	1.91E-08	0.00E+00	3.00E-05
Zr-97	2.37E-09	4.69E-10	2.16E-10	0.00E+00	7.11E-10	0.00E+00	1.27E-04
Nb-95	8.22E-09	4.56E-09	2.51E-09	0.00E+00	4.42E-09	0.00E+00	1.95E-05
Mo-99	0.00E+00	6.03E-06	1.15E-06	0.00E+00	1.38E-05	0.00E+00	1.08E-05
Tc-99m	3.32E-10	9.26E-10	1.20E-08	0.00E+00	1.38E-08	5.14E-10	6.08E-07
Tc-101	3.60E-10	5.12E-10	5.03E-09	0.00E+00	9.26E-09	3.12E-10	8.75E-17
Ru-103	2.55E-07	0.00E+00	1.09E-07	0.00E+00	8.99E-07	0.00E+00	2.13E-05
Ru-105	2.18E-08	0.00E+00	8.46E-09	0.00E+00	2.75E-07	0.00E+00	1.76E-05
Ru-106	3.92E-06	0.00E+00	4.94E-07	0.00E+00	7.56E-06	0.00E+00	1.88E-04
Ag-110m	2.05E-07	1.94E-07	1.18E-07	0.00E+00	3.70E-07	0.00E+00	5.45E-05
Sb-122	3.30E-07	6.42E-09	9.64E-08	4.19E-09	0.00E+00	2.06E-07	6.92E-05
Sb-124	3.86E-06	7.12E-08	1.51E-06	8.79E-09	0.00E+00	3.37E-06	7.81E-05
Sb-125	2.48E-06	2.71E-08	5.79E-07	2.36E-09	0.00E+00	2.16E-06	1.92E-05

Table 2-3b

TEEN INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	3.83E-06	1.38E-06	5.12E-07	1.07E-06	0.00E+00	0.00E+00	1.13E-05
Te-127m	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	0.00E+00	2.41E-05
Te-127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	0.00E+00	1.22E-05
Te-129m	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	0.00E+00	6.12E-05
Te-129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	0.00E+00	2.45E-07
Te-131m	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	0.00E+00	9.39E-05
Te-131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	0.00E+00	2.29E-09
Te-132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	0.00E+00	7.00E-05
I-130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	0.00E+00	2.29E-06
I-131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	0.00E+00	1.62E-06
I-132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	0.00E+00	3.18E-07
I-133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	0.00E+00	2.58E-06
I-134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	0.00E+00	5.10E-09
I-135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	0.00E+00	1.74E-06
Cs-134	8.37E-05	1.97E-04	9.14E-05	0.00E+00	6.26E-05	2.39E-05	2.45E-06
Cs-136	8.59E-06	3.38E-05	2.27E-05	0.00E+00	1.84E-05	2.90E-06	2.72E-06
Cs-137	1.12E-04	1.49E-04	5.19E-05	0.00E+00	5.07E-05	1.97E-05	2.12E-06
Cs-138	7.76E-08	1.49E-07	7.45E-08	0.00E+00	1.10E-07	1.28E-08	6.76E-11
Ba-139	1.39E-07	9.78E-11	4.05E-09	0.00E+00	9.22E-11	6.74E-11	1.24E-06
Ba-140	2.84E-05	3.48E-08	1.83E-06	0.00E+00	1.18E-08	2.34E-08	4.38E-05
Ba-141	6.71E-08	5.01E-11	2.24E-09	0.00E+00	4.65E-11	3.43E-11	1.43E-13
Ba-142	2.99E-08	2.99E-11	1.84E-09	0.00E+00	2.53E-11	1.99E-11	9.18E-20
La-140	3.48E-09	1.71E-09	4.55E-10	0.00E+00	0.00E+00	0.00E+00	9.82E-05
La-142	1.79E-10	7.95E-11	1.98E-11	0.00E+00	0.00E+00	0.00E+00	2.42E-06
Ce-141	1.33E-08	8.88E-09	1.02E-09	0.00E+00	4.18E-09	0.00E+00	2.54E-05
Ce-143	2.35E-09	1.71E-06	1.91E-10	0.00E+00	7.67E-10	0.00E+00	5.14E-05
Ce-144	6.96E-07	2.88E-07	3.74E-08	0.00E+00	1.72E-07	0.00E+00	1.75E-04
Pr-143	1.31E-08	5.23E-09	6.52E-10	0.00E+00	3.04E-09	0.00E+00	4.31E-05
Pr-144	4.30E-11	1.76E-11	2.18E-12	0.00E+00	1.01E-11	0.00E+00	4.74E-14
Nd-147	9.38E-09	1.02E-08	6.11E-10	0.00E+00	5.99E-09	0.00E+00	3.68E-05
W-187	1.46E-07	1.19E-07	4.17E-08	0.00E+00	0.00E+00	0.00E+00	3.22E-05
Np-239	1.76E-09	1.66E-10	9.22E-11	0.00E+00	5.21E-10	0.00E+00	2.67E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	2.38E-07	3.99E-07	0.00E+00	0.00E+00	0.00E+00	4.44E-06
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	7.37E-11	1.83E-11	6.68E-12	0.00E+00	2.14E-11	0.00E+00	4.37E-07
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	4.47E-08	2.87E-08	3.00E-08	3.67E-08	2.74E-07	0.00E+00	1.66E-09
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-3c

CHILD INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
Be-7	1.18E-08	2.00E-08	1.32E-08	0.00E+00	1.97E-08	0.00E+00	1.12E-06
Na-24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P-32	8.25E-04	3.86E-05	3.18E-05	0.00E+00	0.00E+00	0.00E+00	2.28E-05
Cr-51	0.00E+00	0.00E+00	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
Mn-54	0.00E+00	1.07E-05	2.85E-06	0.00E+00	3.00E-06	0.00E+00	8.98E-06
Mn-56	0.00E+00	3.34E-07	7.54E-08	0.00E+00	4.04E-07	0.00E+00	4.84E-05
Fe-55	1.15E-05	6.10E-06	1.89E-06	0.00E+00	0.00E+00	3.45E-06	1.13E-06
Fe-59	1.65E-05	2.67E-05	1.33E-05	0.00E+00	0.00E+00	7.74E-06	2.78E-05
Co-58	0.00E+00	1.80E-06	5.51E-06	0.00E+00	0.00E+00	0.00E+00	1.05E-05
Co-60	0.00E+00	5.29E-06	1.56E-05	0.00E+00	0.00E+00	0.00E+00	2.93E-05
Ni-63	5.38E-04	2.88E-05	1.83E-05	0.00E+00	0.00E+00	0.00E+00	1.94E-06
Ni-65	2.22E-06	2.09E-07	1.22E-07	0.00E+00	0.00E+00	0.00E+00	2.56E-05
Cu-64	0.00E+00	2.45E-07	1.48E-07	0.00E+00	5.92E-07	0.00E+00	1.15E-05
Zn-65	1.37E-05	3.65E-05	2.27E-05	0.00E+00	2.30E-05	0.00E+00	6.41E-06
Zn-69	4.38E-08	6.33E-08	5.85E-09	0.00E+00	3.84E-08	0.00E+00	3.99E-06
Br-83	0.00E+00	0.00E+00	1.71E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.98E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	9.12E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	6.70E-05	4.12E-05	0.00E+00	0.00E+00	0.00E+00	4.31E-06
Rb-88	0.00E+00	1.90E-07	1.32E-07	0.00E+00	0.00E+00	0.00E+00	9.32E-09
Rb-89	0.00E+00	1.17E-07	1.04E-07	0.00E+00	0.00E+00	0.00E+00	1.02E-09
Sr-89	1.32E-03	0.00E+00	3.77E-05	0.00E+00	0.00E+00	0.00E+00	5.11E-05
Sr-90	1.70E-02	0.00E+00	4.31E-03	0.00E+00	0.00E+00	0.00E+00	2.29E-04
Sr-91	2.40E-05	0.00E+00	9.06E-07	0.00E+00	0.00E+00	0.00E+00	5.30E-05
Sr-92	9.03E-06	0.00E+00	3.62E-07	0.00E+00	0.00E+00	0.00E+00	1.71E-04
Y-90	4.11E-08	0.00E+00	1.10E-09	0.00E+00	0.00E+00	0.00E+00	1.17E-04
Y-91m	3.82E-10	0.00E+00	1.39E-11	0.00E+00	0.00E+00	0.00E+00	7.48E-07
Y-91	6.02E-07	0.00E+00	1.61E-08	0.00E+00	0.00E+00	0.00E+00	8.02E-05
Y-92	3.60E-09	0.00E+00	1.03E-10	0.00E+00	0.00E+00	0.00E+00	1.04E-04
Y-93	1.14E-08	0.00E+00	3.13E-10	0.00E+00	0.00E+00	0.00E+00	1.70E-04
Zr-95	1.16E-07	2.55E-08	2.27E-08	0.00E+00	3.65E-08	0.00E+00	2.66E-05
Zr-97	6.99E-09	1.01E-09	5.96E-10	0.00E+00	1.45E-09	0.00E+00	1.53E-04
Nb-95	2.25E-08	8.76E-09	6.26E-09	0.00E+00	8.23E-09	0.00E+00	1.62E-05
Mo-99	0.00E+00	1.33E-05	3.29E-06	0.00E+00	2.84E-05	0.00E+00	1.10E-05
Tc-99m	9.23E-10	1.81E-09	3.00E-08	0.00E+00	2.63E-08	9.19E-10	1.03E-06
Tc-101	1.07E-09	1.12E-09	1.42E-08	0.00E+00	1.91E-08	5.92E-10	3.56E-09
Ru-103	7.31E-07	0.00E+00	2.81E-07	0.00E+00	1.84E-06	0.00E+00	1.89E-05
Ru-105	6.45E-08	0.00E+00	2.34E-08	0.00E+00	5.67E-07	0.00E+00	4.21E-05
Ru-106	1.17E-05	0.00E+00	1.46E-06	0.00E+00	1.58E-05	0.00E+00	1.82E-04
Ag-110m	5.39E-07	3.64E-07	2.91E-07	0.00E+00	6.78E-07	0.00E+00	4.33E-05
Sb-122	9.83E-07	1.45E-08	2.88E-07	1.26E-08	0.00E+00	4.00E-07	7.56E-05
Sb-124	1.11E-05	1.44E-07	3.88E-06	2.44E-08	0.00E+00	6.15E-06	6.93E-05
Sb-125	7.15E-06	5.51E-08	1.50E-06	6.63E-09	0.00E+00	3.98E-06	1.71E-05

Table 2-3c

CHILD INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	1.14E-05	3.09E-06	1.52E-06	3.20E-06	0.00E+00	0.00E+00	1.10E-05
Te-127m	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	0.00E+00	2.34E-05
Te-127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	0.00E+00	1.84E-05
Te-129m	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	0.00E+00	5.94E-05
Te-129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	0.00E+00	8.34E-06
Te-131m	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	0.00E+00	1.01E-04
Te-131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	0.00E+00	4.36E-07
Te-132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	0.00E+00	4.50E-05
I-130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	0.00E+00	2.76E-06
I-131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	0.00E+00	1.54E-06
I-132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	0.00E+00	1.73E-06
I-133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	0.00E+00	2.95E-06
I-134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	0.00E+00	5.16E-07
I-135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	0.00E+00	2.40E-06
Cs-134	2.34E-04	3.84E-04	8.10E-05	0.00E+00	1.19E-04	4.27E-05	2.07E-06
Cs-136	2.35E-05	6.46E-05	4.18E-05	0.00E+00	3.44E-05	5.13E-06	2.27E-06
Cs-137	3.27E-04	3.13E-04	4.62E-05	0.00E+00	1.02E-04	3.67E-05	1.96E-06
Cs-138	2.28E-07	3.17E-07	2.01E-07	0.00E+00	2.23E-07	2.40E-08	1.46E-07
Ba-139	4.14E-07	2.21E-10	1.20E-08	0.00E+00	1.93E-10	1.30E-10	2.39E-05
Ba-140	8.31E-05	7.28E-08	4.85E-06	0.00E+00	2.37E-08	4.34E-08	4.21E-05
Ba-141	2.00E-07	1.12E-10	6.51E-09	0.00E+00	9.69E-11	6.58E-10	1.14E-07
Ba-142	8.74E-08	6.29E-11	4.88E-09	0.00E+00	5.09E-11	3.70E-11	1.14E-09
La-140	1.01E-08	3.53E-09	1.19E-09	0.00E+00	0.00E+00	0.00E+00	9.84E-05
La-142	5.24E-10	1.67E-10	5.23E-11	0.00E+00	0.00E+00	0.00E+00	3.31E-05
Ce-141	3.97E-08	1.98E-08	2.94E-09	0.00E+00	8.68E-09	0.00E+00	2.47E-05
Ce-143	6.99E-09	3.79E-06	5.49E-10	0.00E+00	1.59E-09	0.00E+00	5.55E-05
Ce-144	2.08E-06	6.52E-07	1.11E-07	0.00E+00	3.61E-07	0.00E+00	1.70E-04
Pr-143	3.93E-08	1.18E-08	1.95E-09	0.00E+00	6.39E-09	0.00E+00	4.24E-05
Pr-144	1.29E-10	3.99E-11	6.49E-12	0.00E+00	2.11E-11	0.00E+00	8.59E-08
Nd-147	2.79E-08	2.26E-08	1.75E-09	0.00E+00	1.24E-08	0.00E+00	3.58E-05
W-187	4.29E-07	2.54E-07	1.14E-07	0.00E+00	0.00E+00	0.00E+00	3.57E-05
Np-239	5.25E-09	3.77E-10	2.65E-10	0.00E+00	1.09E-09	0.00E+00	2.79E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	4.93E-07	9.98E-07	0.00E+00	0.00E+00	0.00E+00	4.04E-06
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.17E-10	3.92E-11	1.83E-11	0.00E+00	4.35E-11	0.00E+00	1.21E-05
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	1.29E-07	5.80E-08	7.74E-08	1.02E-07	5.37E-07	0.00E+00	5.89E-07
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-3d

INFANT INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
Be-7	2.26E-08	4.72E-08	2.51E-08	0.00E+00	3.34E-08	0.00E+00	1.11E-06
Na-24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P-32	1.70E-03	1.00E-04	6.59E-05	0.00E+00	0.00E+00	0.00E+00	2.30E-05
Cr-51	0.00E+00	0.00E+00	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
Mn-54	0.00E+00	1.99E-05	4.51E-06	0.00E+00	4.41E-06	0.00E+00	7.31E-06
Mn-56	0.00E+00	8.18E-07	1.41E-07	0.00E+00	7.03E-07	0.00E+00	7.43E-05
Fe-55	1.39E-05	8.98E-06	2.40E-06	0.00E+00	0.00E+00	4.39E-06	1.14E-06
Fe-59	3.08E-05	5.38E-05	2.12E-05	0.00E+00	0.00E+00	1.59E-05	2.57E-05
Co-58	0.00E+00	3.60E-06	8.98E-06	0.00E+00	0.00E+00	0.00E+00	8.97E-06
Co-60	0.00E+00	1.08E-05	2.55E-05	0.00E+00	0.00E+00	0.00E+00	2.57E-05
Ni-63	6.34E-04	3.92E-05	2.20E-05	0.00E+00	0.00E+00	0.00E+00	1.95E-06
Ni-65	4.70E-06	5.32E-07	2.42E-07	0.00E+00	0.00E+00	0.00E+00	4.05E-05
Cu-64	0.00E+00	6.09E-07	2.82E-07	0.00E+00	1.03E-06	0.00E+00	1.25E-05
Zn-65	1.84E-05	6.31E-05	2.91E-05	0.00E+00	3.06E-05	0.00E+00	5.33E-05
Zn-69	9.33E-08	1.68E-07	1.25E-08	0.00E+00	6.98E-08	0.00E+00	1.37E-05
Br-83	0.00E+00	0.00E+00	3.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	3.82E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.94E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.70E-04	8.40E-05	0.00E+00	0.00E+00	0.00E+00	4.35E-06
Rb-88	0.00E+00	4.98E-07	2.73E-07	0.00E+00	0.00E+00	0.00E+00	4.85E-07
Rb-89	0.00E+00	2.86E-07	1.97E-07	0.00E+00	0.00E+00	0.00E+00	9.74E-08
Sr-89	2.51E-03	0.00E+00	7.20E-05	0.00E+00	0.00E+00	0.00E+00	5.16E-05
Sr-90	1.85E-02	0.00E+00	4.71E-03	0.00E+00	0.00E+00	0.00E+00	2.31E-04
Sr-91	5.00E-05	0.00E+00	1.81E-06	0.00E+00	0.00E+00	0.00E+00	5.92E-05
Sr-92	1.92E-05	0.00E+00	7.13E-07	0.00E+00	0.00E+00	0.00E+00	2.07E-04
Y-90	8.69E-08	0.00E+00	2.33E-09	0.00E+00	0.00E+00	0.00E+00	1.20E-04
Y-91m	8.10E-10	0.00E+00	2.76E-11	0.00E+00	0.00E+00	0.00E+00	2.70E-06
Y-91	1.13E-06	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	8.10E-05
Y-92	7.65E-09	0.00E+00	2.15E-10	0.00E+00	0.00E+00	0.00E+00	1.46E-04
Y-93	2.43E-08	0.00E+00	6.62E-10	0.00E+00	0.00E+00	0.00E+00	1.92E-04
Zr-95	2.06E-07	5.02E-08	3.56E-08	0.00E+00	5.41E-08	0.00E+00	2.50E-05
Zr-97	1.48E-08	2.54E-09	1.16E-09	0.00E+00	2.56E-09	0.00E+00	1.62E-04
Nb-95	4.20E-08	1.73E-08	1.00E-08	0.00E+00	1.24E-08	0.00E+00	1.46E-05
Mo-99	0.00E+00	3.40E-05	6.63E-06	0.00E+00	5.08E-05	0.00E+00	1.12E-05
Tc-99m	1.92E-09	3.96E-09	5.10E-08	0.00E+00	4.26E-08	2.07E-09	1.15E-06
Tc-101	2.27E-09	2.86E-09	2.83E-08	0.00E+00	3.40E-08	1.56E-09	4.86E-07
Ru-103	1.48E-06	0.00E+00	4.95E-07	0.00E+00	3.08E-06	0.00E+00	1.80E-05
Ru-105	1.36E-07	0.00E+00	4.58E-08	0.00E+00	1.00E-06	0.00E+00	5.41E-05
Ru-106	2.41E-05	0.00E+00	3.01E-06	0.00E+00	2.85E-05	0.00E+00	1.83E-04
Ag-110m	9.96E-07	7.27E-07	4.81E-07	0.00E+00	1.04E-06	0.00E+00	3.77E-05
Sb-122	2.10E-06	3.85E-08	6.13E-07	3.14E-08	0.00E+00	1.09E-06	7.65E-05
Sb-124	2.14E-05	3.15E-07	6.63E-06	5.68E-08	0.00E+00	1.34E-05	6.60E-05
Sb-125	1.23E-05	1.19E-07	2.53E-06	1.54E-08	0.00E+00	7.72E-06	1.64E-05

Table 2-3d

INFANT INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	2.33E-05	7.79E-06	3.15E-06	7.84E-06	0.00E+00	0.00E+00	1.11E-05
Te-127m	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	0.00E+00	2.36E-05
Te-127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	0.00E+00	2.10E-05
Te-129m	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	0.00E+00	5.97E-05
Te-129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	0.00E+00	2.27E-05
Te-131m	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	0.00E+00	1.03E-04
Te-131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	0.00E+00	7.11E-06
Te-132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	0.00E+00	3.81E-05
I-130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	0.00E+00	2.83E-06
I-131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	0.00E+00	1.51E-06
I-132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	0.00E+00	2.73E-06
I-133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	0.00E+00	3.08E-06
I-134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	0.00E+00	1.84E-06
I-135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	0.00E+00	2.62E-06
Cs-134	3.77E-04	7.03E-04	7.10E-05	0.00E+00	1.81E-04	7.42E-05	1.91E-06
Cs-136	4.59E-05	1.35E-04	5.04E-05	0.00E+00	5.38E-05	1.10E-05	2.05E-06
Cs-137	5.22E-04	6.11E-04	4.33E-05	0.00E+00	1.64E-04	6.64E-05	1.91E-06
Cs-138	4.81E-07	7.82E-07	3.79E-07	0.00E+00	3.90E-07	6.09E-08	1.25E-06
Ba-139	8.81E-07	5.84E-10	2.55E-08	0.00E+00	3.51E-10	3.54E-10	5.58E-05
Ba-140	1.71E-04	1.71E-07	8.81E-06	0.00E+00	4.06E-08	1.05E-07	4.20E-05
Ba-141	4.25E-07	2.91E-10	1.34E-08	0.00E+00	1.75E-10	1.77E-10	5.19E-06
Ba-142	1.84E-07	1.53E-10	9.06E-09	0.00E+00	8.81E-11	9.26E-11	7.59E-07
La-140	2.11E-08	8.32E-09	2.14E-09	0.00E+00	0.00E+00	0.00E+00	9.77E-05
La-142	1.10E-09	4.04E-10	9.67E-11	0.00E+00	0.00E+00	0.00E+00	6.86E-05
Ce-141	7.87E-08	4.80E-08	5.65E-09	0.00E+00	1.48E-08	0.00E+00	2.48E-05
Ce-143	1.48E-08	9.82E-06	1.12E-09	0.00E+00	2.86E-09	0.00E+00	5.73E-05
Ce-144	2.98E-06	1.22E-06	1.67E-07	0.00E+00	4.93E-07	0.00E+00	1.71E-04
Pr-143	8.13E-08	3.04E-08	4.03E-09	0.00E+00	1.13E-08	0.00E+00	4.29E-05
Pr-144	2.74E-10	1.06E-10	1.38E-11	0.00E+00	3.84E-11	0.00E+00	4.93E-06
Nd-147	5.53E-08	5.68E-08	3.48E-09	0.00E+00	2.19E-08	0.00E+00	3.60E-05
W-187	9.03E-07	6.28E-07	2.17E-07	0.00E+00	0.00E+00	0.00E+00	3.69E-05
Np-239	1.11E-08	9.93E-10	5.61E-10	0.00E+00	1.98E-09	0.00E+00	2.87E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.15E-06	1.87E-06	0.00E+00	0.00E+00	0.00E+00	3.92E-06
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-4

TOTAL BODY DOSE FACTORS

Ki

FROM NOBLE GASES (GAMMA)

NUCLIDE	Gamma TB*	X	(pCi/uCi)	X	FINITE CLOUD ** CORRECTION FACTOR	=	Ki***
Kr-83m	7.56E-08		1.00E+6		8.86E-01		6.70E-02
Kr-85m	1.17E-03		1.00E+6		7.49E-01		8.76E+02
Kr-85	1.61E-05		1.00E+6		6.73E-01		1.08E+01
Kr-87	5.92E-03		1.00E+6		5.68E-01		3.36E+03
Kr-88	1.47E-02		1.00E+6		5.40E-01		7.93E+03
Kr-89	1.66E-02		1.00E+6		5.60E-01		9.30E+03
Kr-90	1.56E-02		1.00E+6		5.97E-01		9.31E+03
Xe-131m	9.15E-05		1.00E+6		8.67E-01		7.94E+01
Xe-133m	2.51E-04		1.00E+6		8.17E-01		2.05E+02
Xe-133	2.94E-04		1.00E+6		8.86E-01		2.60E+02
Xe-135m	3.12E-03		1.00E+6		6.75E-01		2.11E+03
Xe-135	1.81E-03		1.00E+6		7.60E-01		1.38E+03
Xe-137	1.42E-03		1.00E+6		6.46E-01		9.18E+02
Xe-138	8.83E-03		1.00E+6		5.75E-01		5.07E+03
Ar-41	8.84E-03		1.00E+6		5.89E-01		5.21E+03

* From Regulatory Guide 1.109, Table B-1 (mrem/yr per pCi/cu mtr)

** The finite cloud correction factor is described in Section 2.1.

*** Ki (mrem/yr per uCi/cu mtr)

Table 2-5

SKIN DOSE FACTORS

Li

FROM NOBLE GASES (BETA)

NUCLIDE	Beta Skin*	X (pCi/uCi)	= Li**
Kr-83m	0.00E+00	1.00E+6	0.00E+00
Kr-85m	1.46E-03	1.00E+6	1.46E+03
Kr-85	1.34E-03	1.00E+6	1.34E+03
Kr-87	9.73E-03	1.00E+6	9.73E+03
Kr-88	2.37E-03	1.00E+6	2.37E+03
Kr-89	1.01E-02	1.00E+6	1.01E+04
Kr-90	7.29E-03	1.00E+6	7.29E+03
Xe-131m	4.76E-04	1.00E+6	4.76E+02
Xe-133m	9.94E-04	1.00E+6	9.94E+02
Xe-133	3.06E-04	1.00E+6	3.06E+02
Xe-135m	7.11E-04	1.00E+6	7.11E+02
Xe-135	1.86E-03	1.00E+6	1.86E+03
Xe-137	1.22E-02	1.00E+6	1.22E+04
Xe-138	4.13E-03	1.00E+6	4.13E+03
Ar-41	2.69E-03	1.00E+6	2.69E+03

* From Regulatory Guide 1.109, Table B-1 (mrem/yr per pCi/cu mtr)

** Li (mrem/yr per uCi/cu mtr)

Table 2-6

AIR DOSE FACTORS

Mi

FROM NOBLE GASES (GAMMA)

NUCLIDE	Gamma*	X	(pCi/uCi)	X	FINITE CLOUD ** CORRECTION FACTOR	=	Mi***
Kr-83m	1.93E-05		1.00E+6		8.86E-01		1.71E+01
Kr-85m	1.23E-03		1.00E+6		7.49E-01		9.21E+02
Kr-85	1.72E-05		1.00E+6		6.73E-01		1.16E+01
Kr-87	6.17E-03		1.00E+6		5.68E-01		3.50E+03
Kr-88	1.52E-02		1.00E+6		5.40E-01		8.20E+03
Kr-89	1.73E-02		1.00E+6		5.60E-01		9.69E+03
Kr-90	1.63E-02		1.00E+6		5.97E-01		9.73E+03
Xe-131m	1.56E-04		1.00E+6		8.67E-01		1.35E+02
Xe-133m	3.27E-04		1.00E+6		8.17E-01		2.67E+02
Xe-133	3.53E-04		1.00E+6		8.86E-01		3.13E+02
Xe-135m	3.36E-03		1.00E+6		6.75E-01		2.27E+03
Xe-135	1.92E-03		1.00E+6		7.60E-01		1.46E+03
Xe-137	1.51E-03		1.00E+6		6.46E-01		9.76E+02
Xe-138	9.21E-03		1.00E+6		5.75E-01		5.29E+03
Ar-41	9.30E-03		1.00E+6		5.89E-01		5.48E+03

* From Regulatory Guide 1.109, Table B-1 (mrad/yr per pCi/cu mtr)

** The finite cloud correction factor is described in Section 2.1.

*** Mi (mrad/yr per uCi/cu mtr)

Table 2-7

AIR DOSE FACTORS

Ni

FROM NOBLE GASES (BETA)

NUCLIDE	Beta*	X	(pCi/uCi)	=	Ni**
Kr-83m	2.88E-04		1.00E+6		2.88E+02
Kr-85m	1.97E-03		1.00E+6		1.97E+03
Kr-85	1.95E-03		1.00E+6		1.95E+03
Kr-87	1.03E-02		1.00E+6		1.03E+04
Kr-88	2.93E-03		1.00E+6		2.93E+03
Kr-89	1.06E-02		1.00E+6		1.06E+04
Kr-90	7.83E-03		1.00E+6		7.83E+03
Xe-131m	1.11E-03		1.00E+6		1.11E+03
Xe-133m	1.48E-03		1.00E+6		1.48E+03
Xe-133	1.05E-03		1.00E+6		1.05E+03
Xe-135m	7.39E-04		1.00E+6		7.39E+02
Xe-135	2.46E-03		1.00E+6		2.46E+03
Xe-137	1.27E-02		1.00E+6		1.27E+04
Xe-138	4.75E-03		1.00E+6		4.75E+03
Ar-41	3.28E-03		1.00E+6		3.28E+03

* From Regulatory Guide 1.109, Table B-1 (mrad/yr per pCi/cu mtr)

** Ni (mrad/yr per uCi/cu mtr)

TABLE 2 – 8

NOBLE GAS DOSE FACTORS

For Instantaneous and Time Average Mixtures at the Site Boundary

Radionuclide	Instantaneous Mix (%)	Time Average Mix (%)
Kr-85m	3.09	
Kr-85	0	18.98
Kr-87	2.80	
Kr-88	5.22	
Xe-131m	0	0.162
Xe-133m	1.39	0.485
Xe-133	56.8	78.1
Xe-135m	1.34	
Xe-135	19.2	2.21
Xe-138	2.81	
Ar-41	7.43	
Total	100	100

Unit 2 effective instantaneous dose factors	Unit 3 effective instantaneous dose factors	units	Unit 2 effective average dose factors	Unit 3 effective average dose factors
$\overline{K}$ = 1507	$\overline{K}$ = 849	mrem/yr per uCi/m^3	$\overline{K}$ = 237	$\overline{K}$ = 153
$\overline{L}$ = 1310	$\overline{L}$ = 1310	mrem/yr per uCi/m^3	$\overline{L}$ = 540	$\overline{L}$ = 540
$\overline{M}$ = 1601	$\overline{M}$ = 905	mrad/yr per uCi/m^3	$\overline{M}$ = 281	$\overline{M}$ = 181
$\overline{N}$ = 1977	$\overline{N}$ = 1977	mrad/yr per uCi/m^3	$\overline{N}$ = 1254	$\overline{N}$ = 1254

Instantaneous Mixture Basis:

This mix defines the shared-site noble gas limits between the two units, and is used for administrative guidelines for instantaneous releases based on an RCS noble gas mix at 1.6 yrs into a 24-month cycle, with two failed fuel rods, per Reference 21. These mixtures provide conservative application for calculating setpoints per 10CFR20, in terms of uCi/sec before an actual sample of the release is available, per Appendix I.

Time Averaged Release Mixture Basis:

This mix defines the routine (time-averaged) releases from either unit. It was derived from average noble-gas releases from year 2000-2003 at IPEC units 2 and 3 per Reference 21. They are used in conjunction with calculations to determine representative quarterly and annual time averaged release rates in curies/sec for administrative purposes only, per Appendix I.

TABLE 2 – 9

LOCATIONS OF SITE BOUNDARY AND NEAREST RESIDENCE

Sector by compass point	Distance to Site Boundary from Unit 2 Plant Vent, in meters	Distance to Site Boundary from Unit 3 Plant Vent, in meters	Distance to nearest resident, from Unit 1 superheater, in meters
N	**RIVER**	**RIVER**	**1788.1**
NNE	**RIVER**	**RIVER**	**3111.3**
NE	**550**	**636**	**1907.3**
ENE	**600**	**775**	**1478.2**
E	**662**	**785**	**1370.9**
ESE	**569**	**622**	**715.2**
SE	**553**	**564**	**1168.2**
SSE	**569**	**551**	**1239.7**
S	**700**	**566**	**1132.5**
SSW	**755**	**480**	**1573.5**
SW	**544**	**350**	**3015.9**
WSW	**RIVER**	**RIVER**	**2169.6**
W	**RIVER**	**RIVER**	**1918.7**
WNW	**RIVER**	**RIVER**	**1752.4**
NW	**RIVER**	**RIVER**	**1692.7**
NNW	**RIVER**	**RIVER**	**1609.3**

Distances are measured from the unit-specific Plant Vent to the Site Boundary. The distance to the Nearest Resident is measured from the Unit 1 Superheater Stack for both units 2 and 3. (Reference 22)

Table 2-10a

ADULT INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04
P-32	1.32E+06	7.71E+04	5.01E+04	0.00E+00	0.00E+00	0.00E+00	8.64E+04
Cr-51	0.00E+00	0.00E+00	1.00E+02	5.95E+01	2.28E+01	1.44E+04	3.32E+03
Mn-54	0.00E+00	3.96E+04	6.30E+03	0.00E+00	9.84E+03	1.40E+06	7.74E+04
Mn-56	0.00E+00	1.24E+00	1.83E-01	0.00E+00	1.30E+00	9.44E+03	2.02E+04
Fe-55	2.46E+04	1.70E+04	3.94E+03	0.00E+00	0.00E+00	7.21E+04	6.03E+03
Fe-59	1.18E+04	2.78E+04	1.06E+04	0.00E+00	0.00E+00	1.02E+06	1.88E+05
Co-58	0.00E+00	1.58E+03	2.07E+03	0.00E+00	0.00E+00	9.28E+05	1.06E+05
Co-60	0.00E+00	1.15E+04	1.48E+04	0.00E+00	0.00E+00	5.97E+06	2.85E+05
Ni-63	4.32E+05	3.14E+04	1.45E+04	0.00E+00	0.00E+00	1.78E+05	1.34E+04
Ni-65	1.54E+00	2.10E-01	9.12E-02	0.00E+00	0.00E+00	5.60E+03	1.23E+04
Cu-64	0.00E+00	1.46E+00	6.15E-01	0.00E+00	4.62E+00	6.78E+03	4.90E+04
Zn-65	3.24E+04	1.03E+05	4.66E+04	0.00E+00	6.90E+04	8.64E+05	5.34E+04
Zn-69	3.38E-02	6.51E-02	4.52E-03	0.00E+00	4.22E-02	9.20E+02	1.63E+01
Br-83	0.00E+00	0.00E+00	2.41E+02	0.00E+00	0.00E+00	0.00E+00	2.32E+02
Br-84	0.00E+00	0.00E+00	3.13E+02	0.00E+00	0.00E+00	0.00E+00	1.64E-03
Br-85	0.00E+00	0.00E+00	1.28E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.35E+05	5.90E+04	0.00E+00	0.00E+00	0.00E+00	1.66E+04
Rb-88	0.00E+00	3.87E+02	1.93E+02	0.00E+00	0.00E+00	0.00E+00	3.34E-09
Rb-89	0.00E+00	2.56E+02	1.70E+02	0.00E+00	0.00E+00	0.00E+00	9.28E-12
Sr-89	3.04E+05	0.00E+00	8.72E+03	0.00E+00	0.00E+00	1.40E+06	3.50E+05
Sr-90	9.92E+07	0.00E+00	6.10E+06	0.00E+00	0.00E+00	9.60E+06	7.22E+05
Sr-91	6.19E+01	0.00E+00	2.50E+00	0.00E+00	0.00E+00	3.65E+04	1.91E+05
Sr-92	6.74E+00	0.00E+00	2.91E-01	0.00E+00	0.00E+00	1.65E+04	4.30E+04
Y-90	2.09E+03	0.00E+00	5.61E+01	0.00E+00	0.00E+00	1.70E+05	5.06E+05
Y-91m	2.61E-01	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.92E+03	1.33E+00
Y-91	4.62E+05	0.00E+00	1.24E+04	0.00E+00	0.00E+00	1.70E+06	3.85E+05
Y-92	1.03E+01	0.00E+00	3.02E-01	0.00E+00	0.00E+00	1.57E+04	7.35E+04
Y-93	9.44E+01	0.00E+00	2.61E+00	0.00E+00	0.00E+00	4.85E+04	4.22E+05
Zr-95	1.07E+05	3.44E+04	2.33E+04	0.00E+00	5.42E+04	1.77E+06	1.50E+05
Zr-97	9.68E+01	1.96E+01	9.04E+00	0.00E+00	2.97E+01	7.87E+04	5.23E+05
Nb-95	1.41E+04	7.82E+03	4.21E+03	0.00E+00	7.74E+03	5.05E+05	1.04E+05
Mo-99	0.00E+00	1.21E+02	2.30E+01	0.00E+00	2.91E+02	9.12E+04	2.48E+05
Tc-99m	1.03E-03	2.91E-03	3.70E-02	0.00E+00	4.42E-02	7.64E+02	4.16E+03
Tc-101	4.18E-05	6.02E-05	5.90E-04	0.00E+00	1.08E-03	3.99E+02	1.09E-11
Ru-103	1.53E+03	0.00E+00	6.58E+02	0.00E+00	5.83E+03	5.05E+05	1.10E+05
Ru-105	7.90E-01	0.00E+00	3.11E-01	0.00E+00	1.02E+00	1.10E+04	4.82E+04
Ru-106	6.91E+04	0.00E+00	8.72E+03	0.00E+00	1.34E+05	9.36E+06	9.12E+05
Ag-110m	1.08E+04	1.00E+04	5.94E+03	0.00E+00	1.97E+04	4.63E+06	3.02E+05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	3.12E+04	5.89E+02	1.24E+04	7.55E+01	0.00E+00	2.48E+06	4.06E+05
Sb-125	5.34E+04	5.95E+02	1.26E+04	5.40E+01	0.00E+00	1.74E+06	1.01E+05

Table 2-10a

ADULT INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	3.42E+03	1.58E+03	4.67E+02	1.05E+03	1.24E+04	3.14E+05	7.06E+04
Te-127m	1.26E+04	5.77E+03	1.57E+03	3.29E+03	4.58E+04	9.60E+05	1.50E+05
Te-127	1.40E+00	6.42E-01	3.10E-01	1.06E+00	5.10E+00	6.51E+03	5.74E+04
Te-129m	9.76E+03	4.67E+03	1.58E+03	3.44E+03	3.66E+04	1.16E+06	3.83E+05
Te-129	4.98E-02	2.39E-02	1.24E-02	3.90E-02	1.87E-01	1.94E+03	1.57E+02
Te-131m	6.99E+01	4.36E+01	2.90E+01	5.50E+01	3.09E+02	1.46E+05	5.56E+05
Te-131	1.11E-02	5.95E-03	3.59E-03	9.36E-03	4.37E-02	1.39E+03	1.84E+01
Te-132	2.60E+02	2.15E+02	1.62E+02	1.90E+02	1.46E+03	2.88E+05	5.10E+05
I-130	4.58E+03	1.34E+04	5.28E+03	1.14E+06	2.09E+04	0.00E+00	7.69E+03
I-131	2.52E+04	3.58E+04	2.05E+04	1.19E+07	6.13E+04	0.00E+00	6.28E+03
I-132	1.16E+03	3.26E+03	1.16E+03	1.14E+05	5.18E+03	0.00E+00	4.06E+02
I-133	8.64E+03	1.48E+04	4.52E+03	2.15E+06	2.58E+04	0.00E+00	8.88E+03
I-134	6.44E+02	1.73E+03	6.15E+02	2.98E+04	2.75E+03	0.00E+00	1.01E+00
I-135	2.68E+03	6.98E+03	2.57E+03	4.48E+05	1.11E+04	0.00E+00	5.25E+03
Cs-134	3.73E+05	8.48E+05	7.28E+05	0.00E+00	2.87E+05	9.76E+04	1.04E+04
Cs-136	3.90E+04	1.46E+05	1.10E+05	0.00E+00	8.56E+04	1.20E+04	1.17E+04
Cs-137	4.78E+05	6.21E+05	4.28E+05	0.00E+00	2.22E+05	7.52E+04	8.40E+03
Cs-138	3.31E+02	6.21E+02	3.24E+02	0.00E+00	4.80E+02	4.86E+01	1.86E-03
Ba-139	9.36E-01	6.66E-04	2.74E-02	0.00E+00	6.22E-04	3.76E+03	8.96E+02
Ba-140	3.90E+04	4.90E+01	2.57E+03	0.00E+00	1.67E+01	1.27E+06	2.18E+05
Ba-141	1.00E-01	7.53E-05	3.36E-03	0.00E+00	7.00E-05	1.94E+03	1.16E-07
Ba-142	2.63E-02	2.70E-05	1.66E-03	0.00E+00	2.29E-05	1.19E+03	1.57E-16
La-140	3.44E+02	1.74E+02	4.58E+01	0.00E+00	0.00E+00	1.36E+05	4.58E+05
La-142	6.83E-01	3.10E-01	7.72E-02	0.00E+00	0.00E+00	6.33E+03	2.11E+03
Ce-141	1.99E+04	1.35E+04	1.53E+03	0.00E+00	6.26E+03	3.62E+05	1.20E+05
Ce-143	1.86E+02	1.38E+02	1.53E+01	0.00E+00	6.08E+01	7.98E+04	2.26E+05
Ce-144	3.43E+06	1.43E+06	1.84E+05	0.00E+00	8.48E+05	7.78E+06	8.16E+05
Pr-143	9.36E+03	3.75E+03	4.64E+02	0.00E+00	2.16E+03	2.81E+05	2.00E+05
Pr-144	3.01E-02	1.25E-02	1.53E-03	0.00E+00	7.05E-03	1.02E+03	2.15E-08
Nd-147	5.27E+03	6.10E+03	3.65E+02	0.00E+00	3.56E+03	2.21E+05	1.73E+05
W-187	8.48E+00	7.08E+00	2.48E+00	0.00E+00	0.00E+00	2.90E+04	1.55E+05
Np-239	2.30E+02	2.26E+01	1.24E+01	0.00E+00	7.00E+01	3.76E+04	1.19E+05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	6.92E+02	6.71E+02	0.00E+00	0.00E+00	3.70E+05	3.14E+04
Sr-85	3.20E+04	0.00E+00	7.76E+05	0.00E+00	0.00E+00	4.80E+05	6.08E+04
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.22E-01	5.62E-02	2.05E-02	0.00E+00	6.54E-02	2.40E+03	2.42E+02
Cd-109	0.00E+00	3.92E+05	1.28E+04	0.00E+00	3.76E+05	7.28E+05	6.56E+04
Sn-113	6.56E+04	2.16E+03	4.48E+03	1.36E+03	0.00E+00	9.60E+05	1.20E+04
Ba-133	7.60E+04	3.36E+03	2.00E+04	0.00E+00	1.68E+01	1.52E+06	8.00E+04
Te-134	3.07E-02	2.58E-02	1.26E-02	2.75E-02	1.74E-01	3.47E+03	2.38E-01
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-10b

TEEN INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04
P-32	1.89E+06	1.10E+05	7.16E+04	0.00E+00	0.00E+00	0.00E+00	9.28E+04
Cr-51	0.00E+00	0.00E+00	1.35E+02	7.50E+01	3.07E+01	2.10E+04	3.00E+03
Mn-54	0.00E+00	5.11E+04	8.40E+03	0.00E+00	1.27E+04	1.98E+06	6.68E+04
Mn-56	0.00E+00	1.70E+00	2.52E-01	0.00E+00	1.79E+00	1.52E+04	5.74E+04
Fe-55	3.34E+04	2.38E+04	5.54E+03	0.00E+00	0.00E+00	1.24E+05	6.39E+03
Fe-59	1.59E+04	3.70E+04	1.43E+04	0.00E+00	0.00E+00	1.53E+06	1.78E+05
Co-58	0.00E+00	2.07E+03	2.78E+03	0.00E+00	0.00E+00	1.34E+06	9.52E+04
Co-60	0.00E+00	1.51E+04	1.98E+04	0.00E+00	0.00E+00	8.72E+06	2.59E+05
Ni-63	5.80E+05	4.34E+04	1.98E+04	0.00E+00	0.00E+00	3.07E+05	1.42E+04
Ni-65	2.18E+00	2.93E-01	1.27E-01	0.00E+00	0.00E+00	9.36E+03	3.67E+04
Cu-64	0.00E+00	2.03E+00	8.48E-01	0.00E+00	6.41E+00	1.11E+04	6.14E+04
Zn-65	3.86E+04	1.34E+05	6.24E+04	0.00E+00	8.64E+04	1.24E+06	4.66E+04
Zn-69	4.83E-02	9.20E-02	6.46E-03	0.00E+00	6.02E-02	1.58E+03	2.85E+02
Br-83	0.00E+00	0.00E+00	3.44E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.33E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.83E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.90E+05	8.40E+04	0.00E+00	0.00E+00	0.00E+00	1.77E+04
Rb-88	0.00E+00	5.46E+02	2.72E+02	0.00E+00	0.00E+00	0.00E+00	2.92E-05
Rb-89	0.00E+00	3.52E+02	2.33E+02	0.00E+00	0.00E+00	0.00E+00	3.38E-07
Sr-89	4.34E+05	0.00E+00	1.25E+04	0.00E+00	0.00E+00	2.42E+06	3.71E+05
Sr-90	1.08E+08	0.00E+00	6.68E+06	0.00E+00	0.00E+00	1.65E+07	7.65E+05
Sr-91	8.80E+01	0.00E+00	3.51E+00	0.00E+00	0.00E+00	6.07E+04	2.59E+05
Sr-92	9.52E+00	0.00E+00	4.06E-01	0.00E+00	0.00E+00	2.74E+04	1.19E+05
Y-90	2.98E+03	0.00E+00	8.00E+01	0.00E+00	0.00E+00	2.93E+05	5.59E+05
Y-91m	3.70E-01	0.00E+00	1.42E-02	0.00E+00	0.00E+00	3.20E+03	3.02E+01
Y-91	6.61E+05	0.00E+00	1.77E+04	0.00E+00	0.00E+00	2.94E+06	4.09E+05
Y-92	1.47E+01	0.00E+00	4.29E-01	0.00E+00	0.00E+00	2.68E+04	1.65E+05
Y-93	1.35E+02	0.00E+00	3.72E+00	0.00E+00	0.00E+00	8.32E+04	5.79E+05
Zr-95	1.46E+05	4.58E+04	3.15E+04	0.00E+00	6.74E+04	2.69E+06	1.49E+05
Zr-97	1.38E+02	2.72E+01	1.26E+01	0.00E+00	4.12E+01	1.30E+05	6.30E+05
Nb-95	1.86E+04	1.03E+04	5.66E+03	0.00E+00	1.00E+04	7.51E+05	9.68E+04
Mo-99	0.00E+00	1.69E+02	3.22E+01	0.00E+00	4.11E+02	1.54E+05	2.69E+05
Tc-99m	1.38E-03	3.86E-03	4.99E-02	0.00E+00	5.76E-02	1.15E+03	6.13E+03
Tc-101	5.92E-05	8.40E-05	8.24E-04	0.00E+00	1.52E-03	6.67E+02	8.72E-07
Ru-103	2.10E+03	0.00E+00	8.96E+02	0.00E+00	7.43E+03	7.83E+05	1.09E+05
Ru-105	1.12E+00	0.00E+00	4.34E-01	0.00E+00	1.41E+00	1.82E+04	9.04E+04
Ru-106	9.84E+04	0.00E+00	1.24E+04	0.00E+00	1.90E+05	1.61E+07	9.60E+05
Ag-110m	1.38E+04	1.31E+04	7.99E+03	0.00E+00	2.50E+04	6.75E+06	2.73E+05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	4.30E+04	7.94E+02	1.68E+04	9.76E+01	0.00E+00	3.85E+06	3.98E+05
Sb-125	7.38E+04	8.08E+02	1.72E+04	7.04E+01	0.00E+00	2.74E+06	9.92E+04

Table 2-10b

TEEN INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	4.88E+03	2.24E+03	6.67E+02	1.40E+03	0.00E+00	5.36E+05	7.50E+04
Te-127m	1.80E+04	8.16E+03	2.18E+03	4.38E+03	6.54E+04	1.66E+06	1.59E+05
Te-127	2.01E+00	9.12E-01	4.42E-01	1.42E+00	7.28E+00	1.12E+04	8.08E+04
Te-129m	1.39E+04	6.58E+03	2.25E+03	4.58E+03	5.19E+04	1.98E+06	4.05E+05
Te-129	7.10E-02	3.38E-02	1.76E-02	5.18E-02	2.66E-01	3.30E+03	1.62E+03
Te-131m	9.84E+01	6.01E+01	4.02E+01	7.25E+01	4.39E+02	2.38E+05	6.21E+05
Te-131	1.58E-02	8.32E-03	5.04E-03	1.24E-02	6.18E-02	2.34E+03	1.51E+01
Te-132	3.60E+02	2.90E+02	2.19E+02	2.46E+02	1.95E+03	4.49E+05	4.63E+05
I-130	6.24E+03	1.79E+04	7.17E+03	1.49E+06	2.75E+04	0.00E+00	9.12E+03
I-131	3.54E+04	4.91E+04	2.64E+04	1.46E+07	8.40E+04	0.00E+00	6.49E+03
I-132	1.59E+03	4.38E+03	1.58E+03	1.51E+05	6.92E+03	0.00E+00	1.27E+03
I-133	1.22E+04	2.05E+04	6.22E+03	2.92E+06	3.59E+04	0.00E+00	1.03E+04
I-134	8.88E+02	2.32E+03	8.40E+02	3.95E+04	3.66E+03	0.00E+00	2.04E+01
I-135	3.70E+03	9.44E+03	3.49E+03	6.21E+05	1.49E+04	0.00E+00	6.95E+03
Cs-134	5.02E+05	1.13E+06	5.49E+05	0.00E+00	3.75E+05	1.46E+05	9.76E+03
Cs-136	5.15E+04	1.94E+05	1.37E+05	0.00E+00	1.10E+05	1.78E+04	1.09E+04
Cs-137	6.70E+05	8.48E+05	3.11E+05	0.00E+00	3.04E+05	1.21E+05	8.48E+03
Cs-138	4.66E+02	8.56E+02	4.46E+02	0.00E+00	6.62E+02	7.87E+01	2.70E-01
Ba-139	1.34E+00	9.44E-04	3.90E-02	0.00E+00	8.88E-04	6.46E+03	6.45E+03
Ba-140	5.47E+04	6.70E+01	3.52E+03	0.00E+00	2.28E+01	2.03E+06	2.29E+05
Ba-141	1.42E-01	1.06E-04	4.74E-03	0.00E+00	9.84E-05	3.29E+03	7.46E-04
Ba-142	3.70E-02	3.70E-05	2.27E-03	0.00E+00	3.14E-05	1.91E+03	4.79E-10
La-140	4.79E+02	2.36E+02	6.26E+01	0.00E+00	0.00E+00	2.14E+05	4.87E+05
La-142	9.60E-01	4.25E-01	1.06E-01	0.00E+00	0.00E+00	1.02E+04	1.20E+04
Ce-141	2.84E+04	1.90E+04	2.17E+03	0.00E+00	8.88E+03	6.14E+05	1.26E+05
Ce-143	2.66E+02	1.94E+02	2.16E+01	0.00E+00	8.64E+01	1.30E+05	2.55E+05
Ce-144	4.89E+06	2.02E+06	2.62E+05	0.00E+00	1.21E+06	1.34E+07	8.64E+05
Pr-143	1.34E+04	5.31E+03	6.62E+02	0.00E+00	3.09E+03	4.83E+05	2.14E+05
Pr-144	4.30E-02	1.76E-02	2.18E-03	0.00E+00	1.01E-02	1.75E+03	2.35E-04
Nd-147	7.86E+03	8.56E+03	5.13E+02	0.00E+00	5.02E+03	3.72E+05	1.82E+05
W-187	1.20E+01	9.76E+00	3.43E+00	0.00E+00	0.00E+00	4.74E+04	1.77E+05
Np-239	3.38E+02	3.19E+01	1.77E+01	0.00E+00	1.00E+02	6.49E+04	1.32E+05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	9.44E+02	9.20E+02	0.00E+00	0.00E+00	5.86E+05	3.14E+04
Sr-85	4.00E+04	0.00E+00	1.04E+04	0.00E+00	0.00E+00	7.04E+05	5.52E+04
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	3.14E-01	7.78E-02	2.84E-02	0.00E+00	9.12E-02	3.93E+03	2.17E+03
Cd-109	0.00E+00	8.00E+05	2.72E+04	0.00E+00	5.36E+05	1.28E+06	6.88E+04
Sn-113	1.20E+05	3.76E+03	7.76E+03	2.32E+03	0.00E+00	1.60E+06	1.20E+04
Ba-133	3.76E+05	6.40E+03	2.64E+04	0.00E+00	2.24E+01	2.32E+06	7.76E+04
Te-134	4.25E-02	3.48E-02	2.91E-02	3.57E-02	2.33E-01	5.40E+03	1.10E+01
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-10c

CHILD INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04
P-32	2.60E+06	1.14E+05	9.88E+04	0.00E+00	0.00E+00	0.00E+00	4.22E+04
Cr-51	0.00E+00	0.00E+00	1.54E+02	8.55E+01	2.43E+01	1.70E+04	1.08E+03
Mn-54	0.00E+00	4.29E+04	9.51E+03	0.00E+00	1.00E+04	1.58E+06	2.29E+04
Mn-56	0.00E+00	1.66E+00	3.12E-01	0.00E+00	1.67E+00	1.31E+04	1.23E+05
Fe-55	4.74E+04	2.52E+04	7.77E+03	0.00E+00	0.00E+00	1.11E+05	2.87E+03
Fe-59	2.07E+04	3.34E+04	1.67E+04	0.00E+00	0.00E+00	1.27E+06	7.07E+04
Co-58	0.00E+00	1.77E+03	3.16E+03	0.00E+00	0.00E+00	1.11E+06	3.44E+04
Co-60	0.00E+00	1.31E+04	2.26E+04	0.00E+00	0.00E+00	7.07E+06	9.62E+04
Ni-63	8.21E+05	4.63E+04	2.80E+04	0.00E+00	0.00E+00	2.75E+05	6.33E+03
Ni-65	2.99E+00	2.96E-01	1.64E-01	0.00E+00	0.00E+00	8.18E+03	8.40E+04
Cu-64	0.00E+00	1.99E+00	1.07E+00	0.00E+00	6.03E+00	9.58E+03	3.67E+04
Zn-65	4.26E+04	1.13E+05	7.03E+04	0.00E+00	7.14E+04	9.95E+05	1.63E+04
Zn-69	6.70E-02	9.66E-02	8.92E-03	0.00E+00	5.85E-02	1.42E+03	1.02E+04
Br-83	0.00E+00	0.00E+00	4.74E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	5.48E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.53E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.98E+05	1.14E+05	0.00E+00	0.00E+00	0.00E+00	7.99E+03
Rb-88	0.00E+00	5.62E+02	3.66E+02	0.00E+00	0.00E+00	0.00E+00	1.72E+01
Rb-89	0.00E+00	3.45E+02	2.90E+02	0.00E+00	0.00E+00	0.00E+00	1.89E+00
Sr-89	5.99E+05	0.00E+00	1.72E+04	0.00E+00	0.00E+00	2.16E+06	1.67E+05
Sr-90	1.01E+08	0.00E+00	6.44E+06	0.00E+00	0.00E+00	1.48E+07	3.43E+05
Sr-91	1.21E+02	0.00E+00	4.59E+00	0.00E+00	0.00E+00	5.33E+04	1.74E+05
Sr-92	1.31E+01	0.00E+00	5.25E-01	0.00E+00	0.00E+00	2.40E+04	2.42E+05
Y-90	4.11E+03	0.00E+00	1.11E+02	0.00E+00	0.00E+00	2.62E+05	2.68E+05
Y-91m	5.07E-01	0.00E+00	1.84E-02	0.00E+00	0.00E+00	2.81E+03	1.72E+03
Y-91	9.14E+05	0.00E+00	2.44E+04	0.00E+00	0.00E+00	2.63E+06	1.84E+05
Y-92	2.04E+01	0.00E+00	5.81E-01	0.00E+00	0.00E+00	2.39E+04	2.39E+05
Y-93	1.86E+02	0.00E+00	5.11E+00	0.00E+00	0.00E+00	7.44E+04	3.89E+05
Zr-95	1.90E+05	4.18E+04	3.70E+04	0.00E+00	5.96E+04	2.23E+06	6.11E+04
Zr-97	1.88E+02	2.72E+01	1.60E+01	0.00E+00	3.88E+01	1.13E+05	3.51E+05
Nb-95	2.35E+04	9.18E+03	6.55E+03	0.00E+00	8.62E+03	6.14E+05	3.70E+04
Mo-99	0.00E+00	1.72E+02	4.25E+01	0.00E+00	3.92E+02	1.35E+05	1.27E+05
Tc-99m	1.78E-03	3.48E-03	5.77E-02	0.00E+00	5.07E-02	9.51E+02	4.81E+03
Tc-101	8.10E-05	8.51E-05	1.08E-03	0.00E+00	1.45E-03	5.85E+02	1.63E+01
Ru-103	2.79E+03	0.00E+00	1.07E+03	0.00E+00	7.03E+03	6.62E+05	4.48E+04
Ru-105	1.53E+00	0.00E+00	5.55E-01	0.00E+00	1.34E+00	1.59E+04	9.95E+04
Ru-106	1.36E+05	0.00E+00	1.69E+04	0.00E+00	1.84E+05	1.43E+07	4.29E+05
Ag-110m	1.69E+04	1.14E+04	9.14E+03	0.00E+00	2.12E+04	5.48E+06	1.00E+05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	5.74E+04	7.40E+02	2.00E+04	1.26E+02	0.00E+00	3.24E+06	1.64E+05
Sb-125	9.84E+04	7.59E+02	2.07E+04	9.10E+01	0.00E+00	2.32E+06	4.03E+04

Table 2-10c

CHILD INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	6.73E+03	2.33E+03	9.14E+02	1.92E+03	0.00E+00	4.77E+05	3.38E+04
Te-127m	2.49E+04	8.55E+03	3.02E+03	6.07E+03	6.36E+04	1.48E+06	7.14E+04
Te-127	2.77E+00	9.51E-01	6.10E-01	1.96E+00	7.07E+00	1.00E+04	5.62E+04
Te-129m	1.92E+04	6.85E+03	3.04E+03	6.33E+03	5.03E+04	1.76E+06	1.82E+05
Te-129	9.77E-02	3.50E-02	2.38E-02	7.14E-02	2.57E-01	2.93E+03	2.55E+04
Te-131m	1.34E+02	5.92E+01	5.07E+01	9.77E+01	4.00E+02	2.06E+05	3.08E+05
Te-131	2.17E-02	8.44E-03	6.59E-03	1.70E-02	5.88E-02	2.05E+03	1.33E+03
Te-132	4.81E+02	2.72E+02	2.63E+02	3.17E+02	1.77E+03	3.77E+05	1.38E+05
I-130	8.18E+03	1.64E+04	8.44E+03	1.85E+06	2.45E+04	0.00E+00	5.11E+03
I-131	4.81E+04	4.81E+04	2.73E+04	1.62E+07	7.88E+04	0.00E+00	2.84E+03
I-132	2.12E+03	4.07E+03	1.88E+03	1.94E+05	6.25E+03	0.00E+00	3.20E+03
I-133	1.66E+04	2.03E+04	7.70E+03	3.85E+06	3.38E+04	0.00E+00	5.48E+03
I-134	1.17E+03	2.16E+03	9.95E+02	5.07E+04	3.30E+03	0.00E+00	9.55E+02
I-135	4.92E+03	8.73E+03	4.14E+03	7.92E+05	1.34E+04	0.00E+00	4.44E+03
Cs-134	6.51E+05	1.01E+06	2.25E+05	0.00E+00	3.30E+05	1.21E+05	3.85E+03
Cs-136	6.51E+04	1.71E+05	1.16E+05	0.00E+00	9.55E+04	1.45E+04	4.18E+03
Cs-137	9.07E+05	8.25E+05	1.28E+05	0.00E+00	2.82E+05	1.04E+05	3.62E+03
Cs-138	6.33E+02	8.40E+02	5.55E+02	0.00E+00	6.22E+02	6.81E+01	2.70E+02
Ba-139	1.84E+00	9.84E-04	5.36E-02	0.00E+00	8.62E-04	5.77E+03	5.77E+04
Ba-140	7.40E+04	6.48E+01	4.33E+03	0.00E+00	2.11E+01	1.74E+06	1.02E+05
Ba-141	1.96E-01	1.09E-04	6.36E-03	0.00E+00	9.47E-05	2.92E+03	2.75E+02
Ba-142	4.99E-02	3.60E-05	2.79E-03	0.00E+00	2.91E-05	1.64E+03	2.74E+00
La-140	6.44E+02	2.25E+02	7.55E+01	0.00E+00	0.00E+00	1.83E+05	2.26E+05
La-142	1.29E+00	4.11E-01	1.29E-01	0.00E+00	0.00E+00	8.70E+03	7.59E+04
Ce-141	3.92E+04	1.95E+04	2.90E+03	0.00E+00	8.55E+03	5.44E+05	5.66E+04
Ce-143	3.66E+02	1.99E+02	2.87E+01	0.00E+00	8.36E+01	1.15E+05	1.27E+05
Ce-144	6.77E+06	2.12E+06	3.61E+05	0.00E+00	1.17E+06	1.20E+07	3.89E+05
Pr-143	1.85E+04	5.55E+03	9.14E+02	0.00E+00	3.00E+03	4.33E+05	9.73E+04
Pr-144	5.96E-02	1.85E-02	3.00E-03	0.00E+00	9.77E-03	1.57E+03	1.97E+02
Nd-147	1.08E+04	8.73E+03	6.81E+02	0.00E+00	4.81E+03	3.28E+05	8.21E+04
W-187	1.63E+01	9.66E+00	4.33E+00	0.00E+00	0.00E+00	4.11E+04	9.10E+04
Np-239	4.66E+02	3.34E+01	2.35E+01	0.00E+00	9.73E+01	5.81E+04	6.40E+04
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	9.03E+02	1.07E+03	0.00E+00	0.00E+00	5.07E+05	1.32E+04
Sr-85	4.44E+04	0.00E+00	1.18E+04	0.00E+00	0.00E+00	5.55E+05	2.04E+04
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	4.29E-01	7.70E-02	3.60E-02	0.00E+00	8.55E-02	3.42E+03	2.78E+04
Cd-109	0.00E+00	7.03E+05	2.96E+04	0.00E+00	6.29E+05	1.11E+06	3.00E+04
Sn-113	1.41E+05	3.29E+03	8.51E+03	2.63E+03	0.00E+00	1.33E+06	4.81E+03
Ba-133	4.07E+05	4.07E+03	3.70E+04	0.00E+00	2.00E+01	1.92E+06	3.07E+04
Te-134	5.66E-02	3.26E-02	3.48E-02	4.59E-02	2.11E-01	4.55E+03	1.80E+03
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-10d

INFANT INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04
P-32	2.03E+06	1.12E+05	7.74E+04	0.00E+00	0.00E+00	0.00E+00	1.61E+04
Cr-51	0.00E+00	0.00E+00	8.95E+01	5.75E+01	1.32E+01	1.28E+04	3.57E+02
Mn-54	0.00E+00	2.53E+04	4.98E+03	0.00E+00	4.98E+03	1.00E+06	7.06E+03
Mn-56	0.00E+00	1.54E+00	2.21E-01	0.00E+00	1.10E+00	1.25E+04	7.17E+04
Fe-55	1.97E+04	1.17E+04	3.33E+03	0.00E+00	0.00E+00	8.69E+04	1.09E+03
Fe-59	1.36E+04	2.35E+04	9.48E+03	0.00E+00	0.00E+00	1.02E+06	2.48E+04
Co-58	0.00E+00	1.22E+03	1.82E+03	0.00E+00	0.00E+00	7.77E+05	1.11E+04
Co-60	0.00E+00	8.02E+03	1.18E+04	0.00E+00	0.00E+00	4.51E+06	3.19E+04
Ni-63	3.39E+05	2.04E+04	1.16E+04	0.00E+00	0.00E+00	2.09E+05	2.42E+03
Ni-65	2.39E+00	2.84E-01	1.23E-01	0.00E+00	0.00E+00	8.12E+03	5.01E+04
Cu-64	0.00E+00	1.88E+00	7.74E-01	0.00E+00	3.98E+00	9.30E+03	1.50E+04
Zn-65	1.93E+04	6.26E+04	3.11E+04	0.00E+00	3.25E+04	6.47E+05	5.14E+04
Zn-69	5.39E-02	9.67E-02	7.18E-03	0.00E+00	4.02E-02	1.47E+03	1.32E+04
Br-83	0.00E+00	0.00E+00	3.81E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.04E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.90E+05	8.82E+04	0.00E+00	0.00E+00	0.00E+00	3.04E+03
Rb-88	0.00E+00	5.57E+02	2.87E+02	0.00E+00	0.00E+00	0.00E+00	3.39E+02
Rb-89	0.00E+00	3.21E+02	2.06E+02	0.00E+00	0.00E+00	0.00E+00	6.82E+01
Sr-89	3.98E+05	0.00E+00	1.14E+04	0.00E+00	0.00E+00	2.03E+06	6.40E+04
Sr-90	4.09E+07	0.00E+00	2.59E+06	0.00E+00	0.00E+00	1.12E+07	1.31E+05
Sr-91	9.56E+01	0.00E+00	3.46E+00	0.00E+00	0.00E+00	5.26E+04	7.34E+04
Sr-92	1.05E+01	0.00E+00	3.91E-01	0.00E+00	0.00E+00	2.38E+04	1.40E+05
Y-90	3.29E+03	0.00E+00	8.82E+01	0.00E+00	0.00E+00	2.69E+05	1.04E+05
Y-91m	4.07E-01	0.00E+00	1.39E-02	0.00E+00	0.00E+00	2.79E+03	2.35E+03
Y-91	5.88E+05	0.00E+00	1.57E+04	0.00E+00	0.00E+00	2.45E+06	7.03E+04
Y-92	1.64E+01	0.00E+00	4.61E-01	0.00E+00	0.00E+00	2.45E+04	1.27E+05
Y-93	1.50E+02	0.00E+00	4.07E+00	0.00E+00	0.00E+00	7.64E+04	1.67E+05
Zr-95	1.15E+05	2.79E+04	2.03E+04	0.00E+00	3.11E+04	1.75E+06	2.17E+04
Zr-97	1.50E+02	2.56E+01	1.17E+01	0.00E+00	2.59E+01	1.10E+05	1.40E+05
Nb-95	1.57E+04	6.43E+03	3.78E+03	0.00E+00	4.72E+03	4.79E+05	1.27E+04
Mo-99	0.00E+00	1.65E+02	3.23E+01	0.00E+00	2.65E+02	1.35E+05	4.87E+04
Tc-99m	1.40E-03	2.88E-03	3.72E-02	0.00E+00	3.11E-02	8.11E+02	2.03E+03
Tc-101	6.51E-05	8.23E-05	8.12E-04	0.00E+00	9.79E-04	5.84E+02	8.44E+02
Ru-103	2.02E+03	0.00E+00	6.79E+02	0.00E+00	4.24E+03	5.52E+05	1.61E+04
Ru-105	1.22E+00	0.00E+00	4.10E-01	0.00E+00	8.99E-01	1.57E+04	4.84E+04
Ru-106	8.68E+04	0.00E+00	1.09E+04	0.00E+00	1.07E+05	1.16E+07	1.64E+05
Ag-110m	9.98E+03	7.22E+03	5.00E+03	0.00E+00	1.09E+04	3.67E+06	3.30E+04
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	3.79E+04	5.56E+02	1.20E+04	1.01E+02	0.00E+00	2.65E+06	5.91E+04
Sb-125	5.17E+04	4.77E+02	1.09E+04	6.23E+01	0.00E+00	1.64E+06	1.47E+04

Table 2-10d

INFANT INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	4.76E+03	1.99E+03	6.58E+02	1.62E+03	0.00E+00	4.47E+05	1.29E+04
Te-127m	1.67E+04	6.90E+03	2.07E+03	4.87E+03	3.75E+04	1.31E+06	2.73E+04
Te-127	2.23E+04	9.53E-01	4.89E-01	1.85E+00	4.86E+00	1.03E+04	2.44E+04
Te-129m	1.41E+04	6.09E+03	2.23E+03	5.47E+03	3.18E+04	1.68E+06	6.90E+04
Te-129	7.88E-02	3.47E-02	1.88E-02	6.75E-02	1.75E-01	3.00E+03	2.63E+04
Te-131m	1.07E+02	5.50E+01	3.63E+01	8.93E+01	2.65E+02	1.99E+05	1.19E+05
Te-131	1.74E-02	8.22E-03	5.00E-03	1.58E-02	3.99E-02	2.06E+03	8.22E+03
Te-132	3.72E+02	2.37E+02	1.76E+02	2.79E+02	1.03E+03	3.40E+05	4.41E+04
I-130	6.36E+03	1.39E+04	5.57E+03	1.60E+06	1.53E+04	0.00E+00	1.99E+03
I-131	3.79E+04	4.44E+04	1.96E+04	1.48E+07	5.18E+04	0.00E+00	1.06E+03
I-132	1.69E+03	3.54E+03	1.26E+03	1.69E+05	3.95E+03	0.00E+00	1.90E+03
I-133	1.32E+04	1.92E+04	5.60E+03	3.56E+06	2.24E+04	0.00E+00	2.16E+03
I-134	9.21E+02	1.88E+03	6.65E+02	4.45E+04	2.09E+03	0.00E+00	1.29E+03
I-135	3.86E+03	7.60E+03	2.77E+03	6.96E+05	8.47E+03	0.00E+00	1.83E+03
Cs-134	3.96E+05	7.03E+05	7.45E+04	0.00E+00	1.90E+05	7.97E+04	1.33E+03
Cs-136	4.83E+04	1.35E+05	5.29E+04	0.00E+00	5.64E+04	1.18E+04	1.43E+03
Cs-137	5.49E+05	6.12E+05	4.55E+04	0.00E+00	1.72E+05	7.13E+04	1.33E+03
Cs-138	5.05E+02	7.81E+02	3.98E+02	0.00E+00	4.10E+02	6.54E+01	8.76E+02
Ba-139	1.48E+00	9.84E-04	4.30E-02	0.00E+00	5.92E-04	5.95E+03	5.10E+04
Ba-140	5.60E+04	5.60E+01	2.90E+03	0.00E+00	1.34E+01	1.60E+06	3.84E+04
Ba-141	1.57E-01	1.08E-04	4.97E-03	0.00E+00	6.50E-05	2.97E+03	4.75E+03
Ba-142	3.98E-02	3.30E-05	1.96E-03	0.00E+00	1.90E-05	1.55E+03	6.93E+02
La-140	5.05E+02	2.00E+02	5.15E+01	0.00E+00	0.00E+00	1.68E+05	8.48E+04
La-142	1.03E+00	3.77E-01	9.04E-02	0.00E+00	0.00E+00	8.22E+03	5.95E+04
Ce-141	2.77E+04	1.67E+04	1.99E+03	0.00E+00	5.25E+03	5.17E+05	2.16E+04
Ce-143	2.93E+02	1.93E+02	2.21E+01	0.00E+00	5.64E+01	1.16E+05	4.97E+04
Ce-144	3.19E+06	1.21E+06	1.76E+05	0.00E+00	5.38E+05	9.84E+06	1.48E+05
Pr-143	1.40E+04	5.24E+03	6.99E+02	0.00E+00	1.97E+03	4.33E+05	3.72E+04
Pr-144	4.79E-02	1.85E-02	2.41E-03	0.00E+00	6.72E-03	1.61E+03	4.28E+03
Nd-147	7.94E+03	8.13E+03	5.00E+02	0.00E+00	3.15E+03	3.22E+05	3.12E+04
W-187	1.30E+01	9.02E+00	3.12E+00	0.00E+00	0.00E+00	3.96E+04	3.56E+04
Np-239	3.71E+02	3.32E+01	1.88E+01	0.00E+00	6.62E+01	5.95E+04	2.49E+04
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	6.51E+02	6.41E+02	0.00E+00	0.00E+00	3.79E+05	4.86E+03
Sr-85	3.78E+04	0.00E+00	7.56E+03	0.00E+00	0.00E+00	4.20E+05	6.72E+03
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	3.42E-01	7.29E-02	2.63E-02	0.00E+00	5.70E-02	3.32E+03	2.69E+04
Cd-109	0.00E+00	3.64E+05	1.40E+04	0.00E+00	2.80E+05	8.68E+05	1.12E+04
Sn-113	8.40E+04	2.24E+03	5.04E+03	1.82E+03	0.00E+00	1.09E+06	1.68E+03
Ba-133	2.66E+05	2.38E+03	1.82E+04	0.00E+00	1.25E+01	1.27E+06	1.08E+04
Te-134	4.45E-02	2.86E-02	2.35E-02	4.07E-02	1.34E-01	4.10E+03	3.54E+03
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-11a

ADULT INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03
Be-7	9.36E+04	2.11E+05	1.05E+05	0.00E+00	2.22E+05	0.00E+00	3.65E+07
Na-24	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05
P-32	1.40E+09	8.73E+07	5.43E+07	0.00E+00	0.00E+00	0.00E+00	1.58E+08
Cr-51	0.00E+00	0.00E+00	4.64E+04	2.78E+04	1.02E+04	6.16E+04	1.17E+07
Mn-54	0.00E+00	3.13E+08	5.97E+07	0.00E+00	9.31E+07	0.00E+00	9.58E+08
Mn-56	0.00E+00	1.59E+01	2.82E+00	0.00E+00	2.02E+01	0.00E+00	5.07E+02
Fe-55	2.10E+08	1.45E+08	3.38E+07	0.00E+00	0.00E+00	8.08E+07	8.31E+07
Fe-59	1.26E+08	2.96E+08	1.13E+08	0.00E+00	0.00E+00	8.27E+07	9.86E+08
Co-58	0.00E+00	3.07E+07	6.89E+07	0.00E+00	0.00E+00	0.00E+00	6.23E+08
Co-60	0.00E+00	1.67E+08	3.69E+08	0.00E+00	0.00E+00	0.00E+00	3.14E+09
Ni-63	1.04E+10	7.21E+08	3.49E+08	0.00E+00	0.00E+00	0.00E+00	1.50E+08
Ni-65	6.15E+01	7.99E+00	3.64E+00	0.00E+00	0.00E+00	0.00E+00	2.03E+02
Cu-64	0.00E+00	9.20E+03	4.32E+03	0.00E+00	2.32E+04	0.00E+00	7.84E+05
Zn-65	3.17E+08	1.01E+09	4.56E+08	0.00E+00	6.75E+08	0.00E+00	6.36E+08
Zn-69	8.73E-06	1.67E-05	1.16E-06	0.00E+00	1.09E-05	0.00E+00	2.51E-06
Br-83	0.00E+00	0.00E+00	3.11E+00	0.00E+00	0.00E+00	0.00E+00	4.47E+00
Br-84	0.00E+00	0.00E+00	2.48E-11	0.00E+00	0.00E+00	0.00E+00	1.94E-16
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.19E+08	1.02E+08	0.00E+00	0.00E+00	0.00E+00	4.33E+07
Rb-88	0.00E+00	3.43E-22	1.82E-22	0.00E+00	0.00E+00	0.00E+00	4.74E-33
Rb-89	0.00E+00	1.39E-26	9.74E-27	0.00E+00	0.00E+00	0.00E+00	8.05E-40
Sr-89	9.96E+09	0.00E+00	2.86E+08	0.00E+00	0.00E+00	0.00E+00	1.60E+09
Sr-90	6.05E+11	0.00E+00	1.48E+11	0.00E+00	0.00E+00	0.00E+00	1.75E+10
Sr-91	3.05E+05	0.00E+00	1.23E+04	0.00E+00	0.00E+00	0.00E+00	1.45E+06
Sr-92	4.27E+02	0.00E+00	1.85E+01	0.00E+00	0.00E+00	0.00E+00	8.45E+03
Y-90	1.33E+04	0.00E+00	3.56E+02	0.00E+00	0.00E+00	0.00E+00	1.41E+08
Y-91m	5.22E-09	0.00E+00	2.02E-10	0.00E+00	0.00E+00	0.00E+00	1.53E-08
Y-91	5.11E+06	0.00E+00	1.37E+05	0.00E+00	0.00E+00	0.00E+00	2.81E+09
Y-92	9.15E-01	0.00E+00	2.68E-02	0.00E+00	0.00E+00	0.00E+00	1.60E+04
Y-93	1.70E+02	0.00E+00	4.68E+00	0.00E+00	0.00E+00	0.00E+00	5.38E+06
Zr-95	1.17E+06	3.77E+05	2.55E+05	0.00E+00	5.91E+05	0.00E+00	1.19E+09
Zr-97	3.37E+02	6.81E+01	3.11E+01	0.00E+00	1.03E+02	0.00E+00	2.11E+07
Nb-95	1.43E+05	7.94E+04	4.27E+04	0.00E+00	7.85E+04	0.00E+00	4.82E+08
Mo-99	0.00E+00	6.15E+06	1.17E+06	0.00E+00	1.39E+07	0.00E+00	1.43E+07
Tc-99m	3.10E+00	8.77E+00	1.12E+02	0.00E+00	1.33E+02	4.30E+00	5.19E+03
Tc-101	8.22E-31	1.18E-30	1.16E-29	0.00E+00	2.13E-29	6.05E-31	3.56E-42
Ru-103	4.76E+06	0.00E+00	2.05E+06	0.00E+00	1.82E+07	0.00E+00	5.56E+08
Ru-105	5.39E+01	0.00E+00	2.13E+01	0.00E+00	6.96E+02	0.00E+00	3.29E+04
Ru-106	1.93E+08	0.00E+00	2.44E+07	0.00E+00	3.72E+08	0.00E+00	1.25E+10
Ag-110m	1.05E+07	9.75E+06	5.79E+06	0.00E+00	1.92E+07	0.00E+00	3.98E+09
Sb-122	2.80E+05	6.43E+03	9.65E+04	4.34E+03	0.00E+00	1.68E+05	1.06E+08
Sb-124	1.04E+08	1.96E+06	4.07E+07	2.52E+05	0.00E+00	8.07E+07	2.94E+09
Sb-125	1.37E+08	1.53E+06	3.25E+07	1.39E+05	0.00E+00	1.05E+08	1.50E+09

Table 2-11a

ADULT INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	9.66E+07	3.50E+07	1.29E+07	2.90E+07	3.93E+08	0.00E+00	3.86E+08
Te-127m	3.49E+08	1.25E+08	4.26E+07	8.92E+07	1.42E+09	0.00E+00	1.17E+09
Te-127	5.66E+03	2.03E+03	1.22E+03	4.19E+03	2.31E+04	0.00E+00	4.47E+05
Te-129m	2.51E+08	9.38E+07	3.98E+07	8.63E+07	1.05E+09	0.00E+00	1.27E+09
Te-129	7.62E-04	2.87E-04	1.86E-04	5.85E-04	3.20E-03	0.00E+00	5.75E-04
Te-131m	9.12E+05	4.46E+05	3.72E+05	7.06E+05	4.52E+06	0.00E+00	4.43E+07
Te-131	1.50E-15	6.27E-16	4.74E-16	1.23E-15	6.57E-15	0.00E+00	2.13E-16
Te-132	4.30E+06	2.78E+06	2.61E+06	3.07E+06	2.68E+07	0.00E+00	1.32E+08
I-130	3.92E+05	1.16E+06	4.57E+05	9.81E+07	1.81E+06	0.00E+00	9.96E+05
I-131	8.08E+07	1.16E+08	6.62E+07	3.79E+10	1.98E+08	0.00E+00	3.05E+07
I-132	5.76E+01	1.54E+02	5.39E+01	5.39E+03	2.45E+02	0.00E+00	2.89E+01
I-133	2.09E+06	3.63E+06	1.11E+06	5.33E+08	6.33E+06	0.00E+00	3.26E+06
I-134	9.65E-05	2.62E-04	9.38E-05	4.54E-03	4.17E-04	0.00E+00	2.29E-07
I-135	3.90E+04	1.02E+05	3.77E+04	6.73E+06	1.64E+05	0.00E+00	1.15E+05
Cs-134	4.67E+09	1.11E+10	9.08E+09	0.00E+00	3.59E+09	1.19E+09	1.94E+08
Cs-136	4.24E+07	1.68E+08	1.21E+08	0.00E+00	9.32E+07	1.28E+07	1.90E+07
Cs-137	6.36E+09	8.70E+09	5.70E+09	0.00E+00	2.95E+09	9.81E+08	1.68E+08
Cs-138	3.91E-11	7.73E-11	3.83E-11	0.00E+00	5.68E-11	5.61E-12	3.30E-16
Ba-139	2.68E-02	1.91E-05	7.86E-04	0.00E+00	1.79E-05	1.08E-05	4.76E-02
Ba-140	1.28E+08	1.61E+05	8.38E+06	0.00E+00	5.46E+04	9.20E+04	2.63E+08
Ba-141	1.15E-21	8.70E-25	3.89E-23	0.00E+00	8.09E-25	4.94E-25	5.43E-31
Ba-142	2.46E-39	2.53E-42	1.55E-40	0.00E+00	2.14E-42	1.43E-42	0.00E+00
La-140	1.98E+03	9.98E+02	2.64E+02	0.00E+00	0.00E+00	0.00E+00	7.33E+07
La-142	1.41E-04	6.43E-05	1.60E-05	0.00E+00	0.00E+00	0.00E+00	4.69E-01
Ce-141	1.97E+05	1.33E+05	1.51E+04	0.00E+00	6.19E+04	0.00E+00	5.10E+08
Ce-143	9.98E+02	7.38E+05	8.16E+01	0.00E+00	3.25E+02	0.00E+00	2.76E+07
Ce-144	3.29E+07	1.38E+07	1.77E+06	0.00E+00	8.16E+06	0.00E+00	1.11E+10
Pr-143	6.26E+04	2.51E+04	3.10E+03	0.00E+00	1.45E+04	0.00E+00	2.74E+08
Pr-144	3.09E-26	1.28E-26	1.57E-27	0.00E+00	7.23E-27	0.00E+00	4.44E-33
Nd-147	3.33E+04	3.85E+04	2.31E+03	0.00E+00	2.25E+04	0.00E+00	1.85E+08
W-187	3.82E+04	3.19E+04	1.12E+04	0.00E+00	0.00E+00	0.00E+00	1.05E+07
Np-239	1.43E+03	1.41E+02	7.76E+01	0.00E+00	4.39E+02	0.00E+00	2.89E+07
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.17E+07	1.95E+07	0.00E+00	0.00E+00	0.00E+00	2.97E+08
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.15E-06	5.45E-07	1.99E-07	0.00E+00	6.35E-07	0.00E+00	2.01E-03
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	3.56E-08	2.33E-08	1.43E-08	3.11E-08	2.25E-07	0.00E+00	3.95E-11
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-11b

TEEN INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03
Be-7	1.43E+05	3.20E+05	1.60E+05	0.00E+00	3.39E+05	0.00E+00	3.90E+07
Na-24	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05
P-32	1.61E+09	9.97E+07	6.24E+07	0.00E+00	0.00E+00	0.00E+00	1.35E+08
Cr-51	0.00E+00	0.00E+00	6.17E+04	3.43E+04	1.35E+04	8.81E+04	1.04E+07
Mn-54	0.00E+00	4.54E+08	9.01E+07	0.00E+00	1.36E+08	0.00E+00	9.32E+08
Mn-56	0.00E+00	1.43E+01	2.55E+00	0.00E+00	1.81E+01	0.00E+00	9.44E+02
Fe-55	3.26E+08	2.31E+08	5.39E+07	0.00E+00	0.00E+00	1.47E+08	1.00E+08
Fe-59	1.79E+08	4.18E+08	1.61E+08	0.00E+00	0.00E+00	1.32E+08	9.88E+08
Co-58	0.00E+00	4.36E+07	1.00E+08	0.00E+00	0.00E+00	0.00E+00	6.01E+08
Co-60	0.00E+00	2.49E+08	5.60E+08	0.00E+00	0.00E+00	0.00E+00	3.24E+09
Ni-63	1.61E+10	1.13E+09	5.45E+08	0.00E+00	0.00E+00	0.00E+00	1.81E+08
Ni-65	5.72E+01	7.31E+00	3.33E+00	0.00E+00	0.00E+00	0.00E+00	3.97E+02
Cu-64	0.00E+00	8.34E+03	3.92E+03	0.00E+00	2.11E+04	0.00E+00	6.47E+05
Zn-65	4.24E+08	1.47E+09	6.86E+08	0.00E+00	9.42E+08	0.00E+00	6.23E+08
Zn-69	8.18E-06	1.56E-05	1.09E-06	0.00E+00	1.02E-05	0.00E+00	2.87E-05
Br-83	0.00E+00	0.00E+00	2.91E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	2.25E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.74E+08	1.29E+08	0.00E+00	0.00E+00	0.00E+00	4.05E+07
Rb-88	0.00E+00	3.17E-22	1.69E-22	0.00E+00	0.00E+00	0.00E+00	2.71E-29
Rb-89	0.00E+00	1.25E-26	8.82E-27	0.00E+00	0.00E+00	0.00E+00	1.91E-35
Sr-89	1.51E+10	0.00E+00	4.33E+08	0.00E+00	0.00E+00	0.00E+00	1.80E+09
Sr-90	7.51E+11	0.00E+00	1.85E+11	0.00E+00	0.00E+00	0.00E+00	2.11E+10
Sr-91	2.85E+05	0.00E+00	1.13E+04	0.00E+00	0.00E+00	0.00E+00	1.29E+06
Sr-92	3.97E+02	0.00E+00	1.69E+01	0.00E+00	0.00E+00	0.00E+00	1.01E+04
Y-90	1.24E+04	0.00E+00	3.34E+02	0.00E+00	0.00E+00	0.00E+00	1.02E+08
Y-91m	4.86E-09	0.00E+00	1.86E-10	0.00E+00	0.00E+00	0.00E+00	2.29E-07
Y-91	7.84E+06	0.00E+00	2.10E+05	0.00E+00	0.00E+00	0.00E+00	3.21E+09
Y-92	8.60E-01	0.00E+00	2.49E-02	0.00E+00	0.00E+00	0.00E+00	2.36E+04
Y-93	1.59E+02	0.00E+00	4.36E+00	0.00E+00	0.00E+00	0.00E+00	4.86E+06
Zr-95	1.72E+06	5.43E+05	3.73E+05	0.00E+00	7.98E+05	0.00E+00	1.25E+09
Zr-97	3.12E+02	6.18E+01	2.85E+01	0.00E+00	9.37E+01	0.00E+00	1.67E+07
Nb-95	1.93E+05	1.07E+05	5.89E+04	0.00E+00	1.04E+05	0.00E+00	4.57E+08
Mo-99	0.00E+00	5.65E+06	1.08E+06	0.00E+00	1.29E+07	0.00E+00	1.01E+07
Tc-99m	2.74E+00	7.63E+00	9.89E+01	0.00E+00	1.14E+02	4.24E+00	5.01E+03
Tc-101	7.64E-31	1.09E-30	1.07E-29	0.00E+00	1.97E-29	6.62E-31	1.86E-37
Ru-103	6.81E+06	0.00E+00	2.91E+06	0.00E+00	2.40E+07	0.00E+00	5.69E+08
Ru-105	5.00E+01	0.00E+00	1.94E+01	0.00E+00	6.31E+02	0.00E+00	4.04E+04
Ru-106	3.10E+08	0.00E+00	3.90E+07	0.00E+00	5.97E+08	0.00E+00	1.48E+10
Ag-110m	1.52E+07	1.43E+07	8.72E+06	0.00E+00	2.74E+07	0.00E+00	4.03E+09
Sb-122	3.03E+05	5.89E+03	8.85E+04	3.85E+03	0.00E+00	1.89E+05	6.35E+07
Sb-124	1.54E+08	2.84E+06	6.02E+07	3.50E+05	0.00E+00	1.34E+08	3.11E+09
Sb-125	2.14E+08	2.34E+06	5.00E+07	2.04E+05	0.00E+00	1.86E+08	1.66E+09

Table 2-11b

TEEN INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	1.48E+08	5.34E+07	1.98E+07	4.14E+07	0.00E+00	0.00E+00	4.37E+08
Te-127m	5.51E+08	1.96E+08	6.56E+07	1.31E+08	2.24E+09	0.00E+00	1.37E+09
Te-127	5.34E+03	1.89E+03	1.15E+03	3.68E+03	2.16E+04	0.00E+00	4.12E+05
Te-129m	3.62E+08	1.34E+08	5.73E+07	1.17E+08	1.51E+09	0.00E+00	1.36E+09
Te-129	7.14E-04	2.66E-04	1.74E-04	5.10E-04	3.00E-03	0.00E+00	3.90E-03
Te-131m	8.44E+05	4.05E+05	3.38E+05	6.09E+05	4.22E+06	0.00E+00	3.25E+07
Te-131	1.39E-15	5.75E-16	4.36E-16	1.07E-15	6.10E-15	0.00E+00	1.14E-16
Te-132	3.91E+06	2.47E+06	2.33E+06	2.61E+06	2.37E+07	0.00E+00	7.84E+07
I-130	3.51E+05	1.01E+06	4.05E+05	8.28E+07	1.56E+06	0.00E+00	7.80E+05
I-131	7.69E+07	1.08E+08	5.78E+07	3.14E+10	1.85E+08	0.00E+00	2.13E+07
I-132	5.19E+01	1.36E+02	4.88E+01	4.58E+03	2.14E+02	0.00E+00	5.92E+01
I-133	1.94E+06	3.29E+06	1.00E+06	4.59E+08	5.76E+06	0.00E+00	2.49E+06
I-134	8.73E-05	2.31E-04	8.31E-05	3.85E-03	3.65E-04	0.00E+00	3.05E-06
I-135	3.52E+04	9.07E+04	3.36E+04	5.83E+06	1.43E+05	0.00E+00	1.00E+05
Cs-134	7.10E+09	1.67E+10	7.75E+09	0.00E+00	5.31E+09	2.03E+09	2.08E+08
Cs-136	4.34E+07	1.71E+08	1.15E+08	0.00E+00	9.30E+07	1.47E+07	1.37E+07
Cs-137	1.01E+10	1.35E+10	4.69E+09	0.00E+00	4.59E+09	1.78E+09	1.92E+08
Cs-138	3.61E-11	6.93E-11	3.47E-11	0.00E+00	5.12E-11	5.96E-12	3.15E-14
Ba-139	2.52E-02	1.78E-05	7.35E-04	0.00E+00	1.67E-05	1.22E-05	2.25E-01
Ba-140	1.37E+08	1.68E+05	8.85E+06	0.00E+00	5.70E+04	1.13E+05	2.12E+08
Ba-141	1.08E-21	8.04E-25	3.59E-23	0.00E+00	7.46E-25	5.50E-25	2.29E-27
Ba-142	2.27E-39	2.27E-42	1.40E-40	0.00E+00	1.92E-42	1.51E-42	0.00E+00
La-140	1.81E+03	8.89E+02	2.37E+02	0.00E+00	0.00E+00	0.00E+00	5.11E+07
La-142	1.30E-04	5.76E-05	1.43E-05	0.00E+00	0.00E+00	0.00E+00	1.75E+00
Ce-141	2.83E+05	1.89E+05	2.17E+04	0.00E+00	8.89E+04	0.00E+00	5.40E+08
Ce-143	9.33E+02	6.79E+05	7.58E+01	0.00E+00	3.04E+02	0.00E+00	2.04E+07
Ce-144	5.27E+07	2.18E+07	2.83E+06	0.00E+00	1.30E+07	0.00E+00	1.33E+10
Pr-143	7.00E+04	2.80E+04	3.49E+03	0.00E+00	1.63E+04	0.00E+00	2.30E+08
Pr-144	2.89E-26	1.18E-26	1.47E-27	0.00E+00	6.80E-27	0.00E+00	3.19E-29
Nd-147	3.62E+04	3.94E+04	2.36E+03	0.00E+00	2.31E+04	0.00E+00	1.42E+08
W-187	3.55E+04	2.90E+04	1.02E+04	0.00E+00	0.00E+00	0.00E+00	7.84E+06
Np-239	1.39E+03	1.31E+02	7.28E+01	0.00E+00	4.11E+02	0.00E+00	2.11E+07
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.79E+07	3.00E+07	0.00E+00	0.00E+00	0.00E+00	3.33E+08
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.00E-06	4.95E-07	1.81E-07	0.00E+00	5.79E-07	0.00E+00	1.18E-02
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	3.23E-08	2.07E-08	2.17E-08	2.65E-08	1.98E-07	0.00E+00	1.20E-09
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-11c

CHILD INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	4.01E+03	4.01E+03	4.01E+03	4.01E+03	4.01E+03	4.01E+03
Be-7	3.37E+05	5.72E+05	3.77E+05	0.00E+00	5.63E+05	0.00E+00	3.20E+07
Na-24	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05
P-32	3.37E+09	1.58E+08	1.30E+08	0.00E+00	0.00E+00	0.00E+00	9.31E+07
Cr-51	0.00E+00	0.00E+00	1.17E+05	6.50E+04	1.78E+04	1.19E+05	6.21E+06
Mn-54	0.00E+00	6.65E+08	1.77E+08	0.00E+00	1.86E+08	0.00E+00	5.58E+08
Mn-56	0.00E+00	1.88E+01	4.24E+00	0.00E+00	2.27E+01	0.00E+00	2.72E+03
Fe-55	8.01E+08	4.25E+08	1.32E+08	0.00E+00	0.00E+00	2.40E+08	7.87E+07
Fe-59	3.97E+08	6.42E+08	3.20E+08	0.00E+00	0.00E+00	1.86E+08	6.68E+08
Co-58	0.00E+00	6.44E+07	1.97E+08	0.00E+00	0.00E+00	0.00E+00	3.76E+08
Co-60	0.00E+00	3.78E+08	1.12E+09	0.00E+00	0.00E+00	0.00E+00	2.10E+09
Ni-63	3.95E+10	2.11E+09	1.34E+09	0.00E+00	0.00E+00	0.00E+00	1.42E+08
Ni-65	1.05E+02	9.89E+00	5.77E+00	0.00E+00	0.00E+00	0.00E+00	1.21E+03
Cu-64	0.00E+00	1.10E+04	6.64E+03	0.00E+00	2.66E+04	0.00E+00	5.16E+05
Zn-65	8.12E+08	2.16E+09	1.35E+09	0.00E+00	1.36E+09	0.00E+00	3.80E+08
Zn-69	1.51E-05	2.18E-05	2.02E-06	0.00E+00	1.32E-05	0.00E+00	1.37E-03
Br-83	0.00E+00	0.00E+00	5.37E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	3.82E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.52E+08	2.78E+08	0.00E+00	0.00E+00	0.00E+00	2.91E+07
Rb-88	0.00E+00	4.37E-22	3.04E-22	0.00E+00	0.00E+00	0.00E+00	2.15E-23
Rb-89	0.00E+00	1.64E-26	1.46E-26	0.00E+00	0.00E+00	0.00E+00	1.43E-28
Sr-89	3.59E+10	0.00E+00	1.03E+09	0.00E+00	0.00E+00	0.00E+00	1.39E+09
Sr-90	1.24E+12	0.00E+00	3.15E+11	0.00E+00	0.00E+00	0.00E+00	1.67E+10
Sr-91	5.24E+05	0.00E+00	1.98E+04	0.00E+00	0.00E+00	0.00E+00	1.16E+06
Sr-92	7.28E+02	0.00E+00	2.92E+01	0.00E+00	0.00E+00	0.00E+00	1.38E+04
Y-90	2.30E+04	0.00E+00	6.17E+02	0.00E+00	0.00E+00	0.00E+00	6.56E+07
Y-91m	8.91E-09	0.00E+00	3.24E-10	0.00E+00	0.00E+00	0.00E+00	1.74E-05
Y-91	1.86E+07	0.00E+00	4.99E+05	0.00E+00	0.00E+00	0.00E+00	2.48E+09
Y-92	1.58E+00	0.00E+00	4.53E-02	0.00E+00	0.00E+00	0.00E+00	4.58E+04
Y-93	2.93E+02	0.00E+00	8.04E+00	0.00E+00	0.00E+00	0.00E+00	4.37E+06
Zr-95	3.86E+06	8.48E+05	7.55E+05	0.00E+00	1.21E+06	0.00E+00	8.84E+08
Zr-97	5.70E+02	8.24E+01	4.86E+01	0.00E+00	1.18E+02	0.00E+00	1.25E+07
Nb-95	4.12E+05	1.60E+05	1.15E+05	0.00E+00	1.51E+05	0.00E+00	2.97E+08
Mo-99	0.00E+00	7.71E+06	1.91E+06	0.00E+00	1.65E+07	0.00E+00	6.38E+06
Tc-99m	4.71E+00	9.24E+00	1.53E+02	0.00E+00	1.34E+02	4.69E+00	5.26E+03
Tc-101	1.41E-30	1.47E-30	1.87E-29	0.00E+00	2.51E-29	7.78E-31	4.68E-30
Ru-103	1.53E+07	0.00E+00	5.88E+06	0.00E+00	3.85E+07	0.00E+00	3.96E+08
Ru-105	9.16E+01	0.00E+00	3.32E+01	0.00E+00	8.05E+02	0.00E+00	5.98E+04
Ru-106	7.45E+08	0.00E+00	9.30E+07	0.00E+00	1.01E+09	0.00E+00	1.16E+10
Ag-110m	3.21E+07	2.17E+07	1.73E+07	0.00E+00	4.04E+07	0.00E+00	2.58E+09
Sb-122	5.58E+05	8.24E+03	1.64E+05	7.16E+03	0.00E+00	2.27E+05	4.30E+07
Sb-124	3.52E+08	4.56E+06	1.23E+08	7.73E+05	0.00E+00	1.95E+08	2.20E+09
Sb-125	4.99E+08	3.84E+06	1.05E+08	4.63E+05	0.00E+00	2.78E+08	1.19E+09

Table 2-11c

CHILD INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	3.51E+08	9.50E+07	4.67E+07	9.84E+07	0.00E+00	0.00E+00	3.38E+08
Te-127m	1.32E+09	3.56E+08	1.57E+08	3.16E+08	3.77E+09	0.00E+00	1.07E+09
Te-127	9.85E+03	2.65E+03	2.11E+03	6.81E+03	2.80E+04	0.00E+00	3.85E+05
Te-129m	8.41E+08	2.35E+08	1.31E+08	2.71E+08	2.47E+09	0.00E+00	1.03E+09
Te-129	1.32E-03	3.69E-04	3.14E-04	9.43E-04	3.87E-03	0.00E+00	8.23E-02
Te-131m	1.54E+06	5.33E+05	5.68E+05	1.10E+06	5.16E+06	0.00E+00	2.16E+07
Te-131	2.57E-15	7.83E-16	7.64E-16	1.97E-15	7.77E-15	0.00E+00	1.35E-14
Te-132	7.00E+06	3.10E+06	3.74E+06	4.51E+06	2.88E+07	0.00E+00	3.12E+07
I-130	6.16E+05	1.24E+06	6.41E+05	1.37E+08	1.86E+06	0.00E+00	5.82E+05
I-131	1.43E+08	1.44E+08	8.17E+07	4.75E+10	2.36E+08	0.00E+00	1.28E+07
I-132	9.22E+01	1.69E+02	7.79E+01	7.86E+03	2.59E+02	0.00E+00	1.99E+02
I-133	3.53E+06	4.37E+06	1.65E+06	8.11E+08	7.28E+06	0.00E+00	1.76E+06
I-134	1.55E-04	2.88E-04	1.32E-04	6.62E-03	4.40E-04	0.00E+00	1.91E-04
I-135	6.26E+04	1.13E+05	5.33E+04	9.97E+06	1.73E+05	0.00E+00	8.58E+04
Cs-134	1.60E+10	2.63E+10	5.55E+09	0.00E+00	8.15E+09	2.93E+09	1.42E+08
Cs-136	8.17E+07	2.25E+08	1.45E+08	0.00E+00	1.20E+08	1.78E+07	7.90E+06
Cs-137	2.39E+10	2.29E+10	3.38E+09	0.00E+00	7.46E+09	2.68E+09	1.43E+08
Cs-138	6.57E-11	9.13E-11	5.79E-11	0.00E+00	6.43E-11	6.91E-12	4.21E-11
Ba-139	4.65E-02	2.48E-05	1.35E-03	0.00E+00	2.17E-05	1.46E-05	2.69E+00
Ba-140	2.75E+08	2.41E+05	1.60E+07	0.00E+00	7.84E+04	1.44E+05	1.39E+08
Ba-141	1.99E-21	1.11E-24	6.47E-23	0.00E+00	9.62E-25	6.53E-24	1.13E-21
Ba-142	4.11E-39	2.96E-42	2.29E-40	0.00E+00	2.39E-42	1.74E-42	5.36E-41
La-140	3.25E+03	1.14E+03	3.83E+02	0.00E+00	0.00E+00	0.00E+00	3.17E+07
La-142	2.35E-04	7.49E-05	2.35E-05	0.00E+00	0.00E+00	0.00E+00	1.48E+01
Ce-141	6.56E+05	3.27E+05	4.86E+04	0.00E+00	1.43E+05	0.00E+00	4.08E+08
Ce-143	1.72E+03	9.31E+05	1.35E+02	0.00E+00	3.91E+02	0.00E+00	1.36E+07
Ce-144	1.27E+08	3.98E+07	6.78E+06	0.00E+00	2.21E+07	0.00E+00	1.04E+10
Pr-143	1.46E+05	4.37E+04	7.23E+03	0.00E+00	2.37E+04	0.00E+00	1.57E+08
Pr-144	5.37E-26	1.66E-26	2.70E-27	0.00E+00	8.79E-27	0.00E+00	3.58E-23
Nd-147	7.15E+04	5.79E+04	4.48E+03	0.00E+00	3.18E+04	0.00E+00	9.17E+07
W-187	6.47E+04	3.83E+04	1.72E+04	0.00E+00	0.00E+00	0.00E+00	5.38E+06
Np-239	2.57E+03	1.84E+02	1.29E+02	0.00E+00	5.33E+02	0.00E+00	1.36E+07
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	2.99E+07	6.04E+07	0.00E+00	0.00E+00	0.00E+00	2.45E+08
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	3.64E-06	6.57E-07	3.07E-07	0.00E+00	7.29E-07	0.00E+00	2.03E-01
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	5.76E-08	2.59E-08	3.46E-08	4.56E-08	2.40E-07	0.00E+00	2.63E-07
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-12

Total Body & Skin Ground Plane Dose Factors Ri(G) and Ri(S)

(m^2 * mrem/yr per uCi/sec)

Isotope	Decay Constant (sec^{-1})	Ri(G)	Ri(S)
H-3	1.780E-09	0.00E+00	0.00E+00
Be-7	1.505E-07	0.00E+00	0.00E+00
Na-24	1.284E-05	1.19E+07	1.39E+07
P-32	5.614E-07	0.00E+00	0.00E+00
Cr-51	2.896E-07	4.66E+06	5.51E+06
Mn-54	2.567E-08	1.39E+09	1.62E+09
Mn-56	7.467E-05	9.03E+05	1.07E+06
Fe-55	8.141E-09	0.00E+00	0.00E+00
Fe-59	1.802E-07	2.72E+08	3.20E+08
Co-58	1.133E-07	3.79E+08	4.44E+08
Co-60	4.170E-09	2.15E+10	2.53E+10
Ni-63	2.290E-10	0.00E+00	0.00E+00
Ni-65	7.641E-05	2.97E+05	3.45E+05
Cu-64	1.516E-05	6.07E+05	6.88E+05
Zn-65	3.289E-08	7.46E+08	8.58E+08
Zn-69	2.027E-04	0.00E+00	0.00E+00
Br-83	8.056E-05	4.87E+03	7.08E+03
Br-84	3.633E-04	2.03E+05	2.36E+05
Br-85	3.851E-03	0.00E+00	0.00E+00
Rb-86	4.299E-07	8.99E+06	1.03E+07
Rb-88	6.490E-04	3.31E+04	3.78E+04
Rb-89	7.600E-04	1.21E+05	1.45E+05
Sr-89	1.589E-07	2.16E+04	2.51E+04
Sr-90	7.548E-10	0.00E+00	0.00E+00
Sr-91	2.027E-05	2.15E+06	2.51E+06
Sr-92	7.105E-05	7.77E+05	8.63E+05
Y-90	3.008E-06	4.48E+03	5.30E+03
Y-91m	2.324E-04	1.00E+05	1.16E+05
Y-91	1.371E-07	1.07E+06	1.21E+06
Y-92	5.439E-05	1.80E+05	2.14E+05
Y-93	1.906E-05	1.83E+05	2.51E+05
Zr-95	1.254E-07	2.45E+08	2.84E+08
Zr-97	1.139E-05	2.96E+06	3.44E+06
Nb-95	2.282E-07	1.37E+08	1.61E+08
Mo-99	2.917E-06	3.99E+06	4.62E+06
Tc-99m	3.198E-05	1.84E+05	2.11E+05
Tc-101	8.136E-04	2.04E+04	2.26E+04
Ru-103	2.042E-07	1.08E+08	1.26E+08
Ru-105	4.337E-05	6.36E+05	7.21E+05
Ru-106	2.179E-08	4.22E+08	5.07E+08
Ag-110m	3.210E-08	3.44E+09	4.01E+09
Sb-122	2.971E-06	0.00E+00	0.00E+00
Sb-124	1.333E-07	5.98E+08	6.90E+08
Sb-125	7.935E-09	2.34E+09	2.64E+09

Table 2-12

Total Body & Skin Ground Plane Dose Factors Ri(G) and Ri(S)

(m^2 * mrem/yr per uCi/sec)

Isotope	Decay Constant (sec^{-1})	Ri(G)	Ri(S)
Te-125m	1.383E-07	1.55E+06	2.13E+06
Te-127m	7.360E-08	9.16E+04	1.08E+05
Te-127	2.059E-05	2.98E+03	3.28E+03
Te-129m	2.388E-07	1.98E+07	2.31E+07
Te-129	1.660E-04	2.62E+04	3.10E+04
Te-131m	6.418E-06	8.03E+06	9.46E+06
Te-131	4.621E-04	2.92E+04	3.45E+07
Te-132	2.462E-06	4.23E+06	4.98E+06
I-130	1.558E-05	5.51E+06	6.69E+06
I-131	9.978E-07	1.72E+07	2.09E+07
I-132	8.371E-05	1.25E+06	1.46E+06
I-133	9.257E-06	2.45E+06	2.98E+06
I-134	2.196E-04	4.47E+05	5.30E+05
I-135	2.913E-05	2.53E+06	2.95E+06
Cs-134	1.066E-08	6.86E+09	8.00E+09
Cs-136	6.124E-07	1.50E+08	1.70E+08
Cs-137	7.327E-10	1.03E+10	1.20E+10
Cs-138	3.588E-04	3.59E+05	4.10E+05
Ba-139	1.397E-04	1.05E+05	1.19E+05
Ba-140	6.297E-07	2.04E+07	2.34E+07
Ba-141	6.323E-04	4.17E+04	4.75E+04
Ba-142	1.090E-03	4.44E+04	5.06E+04
La-140	4.781E-06	1.92E+07	2.18E+07
La-142	1.249E-04	7.36E+05	8.84E+05
Ce-141	2.468E-07	1.37E+07	1.54E+07
Ce-143	5.835E-06	2.31E+06	2.63E+06
Ce-144	2.822E-08	6.95E+07	8.04E+07
Pr-143	5.916E-07	0.00E+00	0.00E+00
Pr-144	6.685E-04	1.83E+03	2.11E+03
Nd-147	7.306E-07	8.39E+06	1.01E+07
W-187	8.056E-06	2.36E+06	2.74E+06
Np-239	3.399E-06	1.71E+06	1.98E+06
K-40	1.717E-17	0.00E+00	0.00E+00
Co-57	2.961E-08	1.88E+08	2.07E+08
Sr-85	1.237E-07	0.00E+00	0.00E+00
Y-88	7.523E-08	0.00E+00	0.00E+00
Nb-94	1.083E-12	0.00E+00	0.00E+00
Nb-97	1.602E-04	1.76E+05	2.07E+05
Cd-109	1.729E-08	0.00E+00	0.00E+00
Sn-113	6.970E-08	0.00E+00	0.00E+00
Ba-133	2.047E-09	0.00E+00	0.00E+00
Te-134	2.764E-04	2.22E+04	2.66E+04
Ce-139	5.828E-08	0.00E+00	0.00E+00
Hg-203	1.722E-07	0.00E+00	0.00E+00

3.0 TOTAL DOSE DETERMINATIONS

3.1 10CFR190 Dose Evaluation

RECS require that the impact of uranium fuel cycle activities be limited to 25 mrem to the whole body or any organ and 75 mrem to the thyroid of real identifiable individual in any twelve month period. Direct radiation effects are added to the effects of liquid and gaseous effluents. NUREG-133 section 3.8 may be used to show compliance. Site and environmental TLD results may be incorporated along with projected doses to show compliance. Per RECS Section 4 (bases) and the discussion regarding gaseous effluent dose rate, visiting MEMBERS OF THE PUBLIC will receive negligible dose, as calculated per ODCM Part II, Sections 2.5, 2.6, and 2.7, due the application of multiplicative occupancy factors. These factors are determined by comparing the expected hours on site to 8760 hours (the number of hours in a year, which is used in the calculations demonstrated in 2.5, 2.6, 2.7. Examples of these calculations are as follows:

example 1: Several students visit the site for an 8-hour guided tour.
Their occupancy factor is: 8 / 8760 or .0009.

example 2: A man drives his wife to work and drops her off at the security gate each morning, with a total stay-time on site for 2 minutes per day. His occupancy factor is calculated as follows:
2 min/60 min per hour =.0333 hr ; 0.0333 / 8760 = 3.8E-6

These factors, when multiplied by doses calculated per Sections 2.5 through 2.7, demonstrate that dose to these MEMBERS OF THE PUBLIC is negligible, despite any potential reduction in the atmospheric dispersion.

3.2 Doses From Liquid Releases

If doses for real individuals are desired, the same calculational method for cumulative liquid dose can be used. However, more realistic assumptions regarding dilution, diet and occupancy can be employed. Actual levels of radionuclides in consumed foodstuffs, as shown in the Radiological Environmental Monitoring Program (REMP), can provide more meaningful information, in lieu of projected intakes using models only.

3.3 Doses From Atmospheric Releases

Similarly, real individual methodology can be substituted for maximum individual modeling for airborne releases. Specific dose transfer factors can be used in lieu of weighted dose transfer factors. Information on the location and occupancy of real individuals, as well as more precise meteorological information and the consumption of foodstuffs, can be employed to show actual doses.

Data from the land use census can be used to either extend times from food production to consumption or otherwise show that the exposure of the critical receptors is reduced. Also, estimates of direct exposure through calculation may be supplanted by REMP results since these are often more indicative of the true impact at specific locations. Default values used in NUREG-0133 and Reg Guide 1.109 methodology can be supplanted by more specific values.

4.0 SETPOINT CALCULATIONS

The RECS require alarm/trip setpoints for effluent monitors. Setpoints assure that alarm and trip actions occur such that limits of 10CFR20 at the release point in the unrestricted area are not instantaneously exceeded.

4.1 Liquid Effluent Monitor Setpoints

4.1.1 Liquid Effluent Monitors have setpoints based on limiting the concentrations in the discharge canal to the MPCW identified in RECS D1.1 Monitor setpoints are inherently conservative due to the routine use of Circulating Water Pumps for liquid waste releases, and Service Water for continuous releases. In actuality, both Circulating and Service Water systems contribute to site dilution.

Alarm setpoints are calculated as follows:

$$S = [(ADC)\ (F)]/[f] = \text{Maximum alarm setpoint in uCi/ml}$$

where:

F = Available discharge canal dilution flow for this release in gal/min
f = calculated allowable release rate in gal/min

ADC = Allowed Diluted Concentration is the equivalent MPCW for gamma emitting isotopes weighted for total specific activity (beta and gamma emitters). This gamma equivalent MPCW (or ADC) must be used due to the insensitivity of the radiation monitor to beta emitters and the time necessary to analyze liquid releases for these beta emitters. This parameter is further clarified in Attachment E.

4.1.2 The basis for the WARN setpoint for Liquid Waste Effluent monitors (batch releases) is to ensure the contents of the batch tank have not changed since sampling. The warn setpoint for this type of monitor is calculated as follows:

$$WS = (C) * (M)$$

where:

WS	=	Warn setpoint in uCi/ml
C	=	Average monitor reading at time of sample
M	=	A conservative factor based upon the mixing ratio of two tank volumes and an expected monitor response error term (typically 1.25, coinciding with 25%).

Liquid Effluent Radiation Monitor WARN setpoints do not control any auto functions but simply provide indication to operators. WARN setpoints for other monitors are typically set at approximately 75% of the ALARM value.

4.1.3 Methods of determining a valid conversion factor (CF) for liquid effluent monitors are shown in Appendix F. These methods include direct measurement of process fluid with radiochemical analyses, as well as determining the CF from a NIST traceable mixture during primary calibration.

4.1.4 Additional conservatism is required for compliance with 10CFR20 if continuous (blowdown) releases are coincident with batch releases (distillate tanks). Typically, at least 10,000 gpm from Service Water is apportioned to continuous releases to ensure sufficient dilution. However, if there is identified gamma activity in these continuous releases, the required dilution factor may need to be re-evaluated, apportioning circulator flow as necessary.

4.2 Gaseous Monitor Setpoints

4.2.1 Setpoints for gaseous monitors are based on the permissible discharge rates identified in Section 2.1 and demonstrated in Appendix I. These setpoints are inherently conservative due to the assumed mixture (Table 2-8) and the use of the most restrictive setpoints (annual average dose limit), which are used whenever practical. Higher release rates (for alarm setpoint considerations) may be authorized with the proper concurrence, as delineated in Section 2.1.

Permissible Discharge Rates (µCi/sec) at Indian Point Unit 2

Basis of Limit	Iodine/Particulate*	Noble Gases
Annual Average **	4.01E-2	7.20E+3
Quarterly Average **	8.02E-2	1.44E+4
Instantaneous ***	1.38E+1	7.00E+4

* Half-lives greater than 8 days

** These limits are not part of the RECS, but are included for information, as these limits are used for operational control of releases.

*** Derived in Appendix I for purposes of assurance of compliance with 10CFR20.

4.2.2 The Plant Vent radiation monitor (R-44), as well as most others, reads out in uCi/cc, so the maximum alarm set point is calculated as follows:

$$S = D / [(F) * (4.72E+2)]$$

where:

S = Maximum alarm setpoint in µCi/cc

D = Permissible discharge rate in µCi/sec

F = Vent duct flow in ft^3/min

4.72E+2 = unit conversion factor (28317 cc•min/ft^3•60sec)

4.2.3 If the monitor reads and alarms in cpm, the conversion factor must be applied to convert the reading to uCi/cc.

4.2.4 Normally, maximum allowable limits are calculated using a standard nuclide mix (Table 2-8). However, setpoints may be determined based on the actual mix, on a case by case basis. This method is usually performed when the instantaneous release rate is applied. Should this method be applied, extra care should be applied to setpoint partitioning (for all release points) to ensure site dose rate limits are not approached.

4.2.5 During normal operation, the unit Plant Vent is the only significant release point. Hence, monitors on the plant vent are routinely set at the *annual* limit, which is approximately 10% of the conservative *instantaneous* limit.

Monitor setpoints on other pathways are routinely set to 1% of the *instantaneous* limit. If multiple pathways become significant, each pathway's permissible release rate is apportioned with the Plant Vent's to ensure the total discharge rate for all release points remains less than the maximum permissible discharge rate.

4.3 Warn Alarms

Warn alarms are set at the discretion of the CRS, generally 75% of the ALARM. They can be based on an application of 10CFR50 Appendix I limits, or a portion of the expected monitor response from preliminary grab sample results.

5.0 LOWER LIMIT OF DETECTION

The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{\frac{2.71}{T_s} + 3.29 s_b * \sqrt{1 + (\frac{T_b}{T_s})}}{E * V * k * Y * e^{-\lambda t}}$$

where:

LLD = The lower limit of detection as defined above (as picocurie per unit mass or volume)

T_s = The sample counting time in minutes

s_b = The standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)

T_b = The background count time in minutes

E = The counting efficiency (as counts per transformation)

V = The sample size (in units of mass or volume)

k = A constant for the number of transformations per minute per unit of activity (normally, 2.22E+6 dpm per μCi)

Y = The fractional radiochemical yield (when applicable)

λ = The radioactive decay constant for the particular radionuclide

t = The elapsed time between midpoint of sample collection and time of counting

Note: The above LLD formula accounts for differing background and sample count times. The Radiological Environmental Monitoring Program (REMP), uses an LLD formula that assumes equal background and sample count times (per the RECS). For the effluents program, the constants above are more appropriate. The constants 2.71 and 3.29 and the general LLD equation were derived from the following two sources:

1) Currie, L.A. "Limits for Qualitative Detection of Quantitative Determination". (Anal. Chem. 40:586-593, 1968); and,

2) Mayer, Dauer "Application of Systematic Error Bounds to Detection Limits for Practical Counting". (HP Journal 65(1): 89-91, 1993)

The value of Sb used in the calculation of the LLD for a detection system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance. In calculating the LLD for a radionuclide determined by gamma ray spectrometry, the background shall include the typical contributions of other radionuclides normally present in the samples. Typical values of E, V, Y, and t shall be used in the calculation. The background count rate is calculated from the background counts that are determined to be within ± one FWHM (Full-Width-at-Half-Maximum) energy band about the energy of the gamma ray peak used for the quantitative analysis for that radionuclide.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement process and not as an a posteriori (after the fact) limit for a particular measurement.

To handle the a posteriori problem, a decision level must be defined. The Critical Level concept is defined below. Following an experimental observation, one must decide whether or not a real signal was, in fact, detected. This type of binary qualitative decision is subject to two kinds of error:

1) deciding that radioactive material is present when it is not (a: Type I error), and the converse,
2) failing to decide that it is present when it is (b: Type II error).

The maximum acceptable Type I error (a), together with the standard deviation, S_{net}, of the net signal when the net signal equals zero, establish the Critical Level, Lc, upon which decisions may be based.

Operationally, an observed signal, S, must exceed L_c to yield the decision, detected.

$$L_c = k_a s_b (1+T_b/T_s)^{0.5}$$

where:

k_a is related to the standardized normal distribution and corresponds to a probability level of ***1-a***. For instance, selection of ***a = 0.01*** corresponds to a 99% confidence level that activity is present. When determining the Lc for different measurement processes, it is allowable to set ***a*** at less than or equal to 0.05 as long as the following condition is met:

To set ***a*** for L_c determination at less than 0.05, the equation for the LLD (which places ***a*** less than or equal to 0.05) should be employed to verify that the calculated LLD is less than or equal to the LLDs specified in the RECS.

This calculation, if necessary, will be performed on a case by case basis.

REFERENCES

1. Indian Point Unit 2 Technical Specifications.
2. Indian Point Unit 2 Final Safety Analysis Report.
3. 10CFR20, "Standards for Protection Against Radiation."
4. 40CFR190, "Environmental Rad Protection Standards for Nuclear Power Operations."
5. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50 Appendix I."
6. Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants."
7. NUREG-0133, "Guidance Manual for Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants."
8. NUREG-1301, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors."
9. NYPA IP3-CALC-RAD-00001, Rev. 0, "IP3 – Revised ODCM Atmospheric Dispersion Parameters (Multi-Year Hourly Data, Mixed-Mode Releases and Valley Effects, 1994)" and the updated work from Entech Engineering: Reports P115-196-EC1, EC2, and EC3 (2004).
10. G. Knoll, "Radiation Detection and Measurement," (1979)
11. IPI-91-015N, "Commitments from March 26th Meeting on Shared Site Noble Gas Limits."
12. IPI-91-019N, "Corrections to Memo IPI-91-015N."
13. IPI-91-019, "IP2 and IP3 Isotope-Specific Site Boundary Atmospheric Dispersion Parameters (Mixed-Mode Releases)."
14. JNH-91-020, "IP3 – Dispersion Parameters at the Nearest Residences and at 5 Miles."
15. TS (RS) 92-24, "Ingestion Dose Factor Methodology."
16. NPG (RS) 92-88, "Process and Effluent Monitor Energy Calibration."
17. NPG (RS) 92-97, "Effective Stack Height for Blowdown Flash Tank Vent."
18. New York University Medical Center, "Radiological Studies of the Hudson River Progress Report (1987-1988)" (1988).
19. IP-CHM-96-050, "Updated IP3 ODCM and Unit 2 Impact."
20. M.E. Wrenn and J.W. Lentsch, "The Fate of Gamma-Emitting Radionuclides Released into the Hudson River Estuary and an Evaluation of Their Environmental Significance", New York University Medical Center, Institute of Environmental Medicine, 1974.
21. IPEC CHM-04-035, "Nuclide Mixtures for Instantaneous and Time Average Releases".
22. IPEC CHM-05-003, "Site Specific Distances to Site Boundary and Nearest Resident".
23. IPEC-CHM-05-022, "Alternative Methods for Liq Rad Monitor Setpoints/ Conv Factors."
24. IPEC-CHM-06-012, "Updated Ground Water Dose Evaluations", April 2006
25. IPEC-CHM-05-042, "Update to Initial Monitoring Well Offsite Dose Calculation", Dec 05.

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APPENDIX A

DISPERSION and DEPOSITION FACTORS

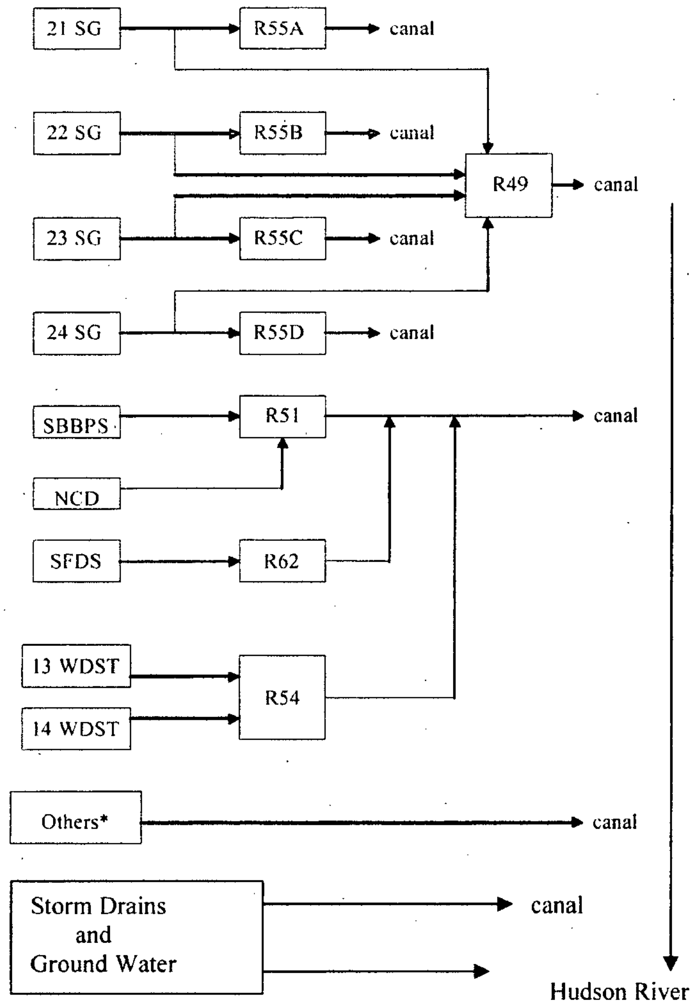
X/Q	highest of 16 sectors site boundary annual average relative concentration (sec/m^3) [SSW]	2.22E-6 (2.87E-5)
$(X/Q)_r$	highest of 16 sectors nearest residence annual average relative concentration (sec/m^3) [SSW]	1.03E-6 (5.16E-6)
$(X/Q)_5$	highest of 16 sectors at 5 miles annual average relative concentration (sec/m^3) [S] (used only when activated)	7.22E-7
D/Q	highest of 16 sectors site boundary annual average relative deposition (1/m^2) [SSW]	1.41E-8 (8.76E-8)
$(D/Q)_r$	highest of 16 sectors nearest residence annual relative deposition (1/m^2) [S]	7.52E-9 (1.88E-8)
$(D/Q)_5$	highest of 16 sectors at 5 miles annual average relative deposition (1/m^2) [S] (used only when activated)	1.34E-9

Notes:

1) Ground-level values are shown parenthetically with each parameter, when applicable.
2) Ground-level deposition factors (D/Q) are provided, but not routinely utilized.
3) The bases information for these meteorological factors is provided in Reference 9.

APPENDIX B

LIQUID EFFLUENT SIMPLIFIED FLOW DIAGRAM



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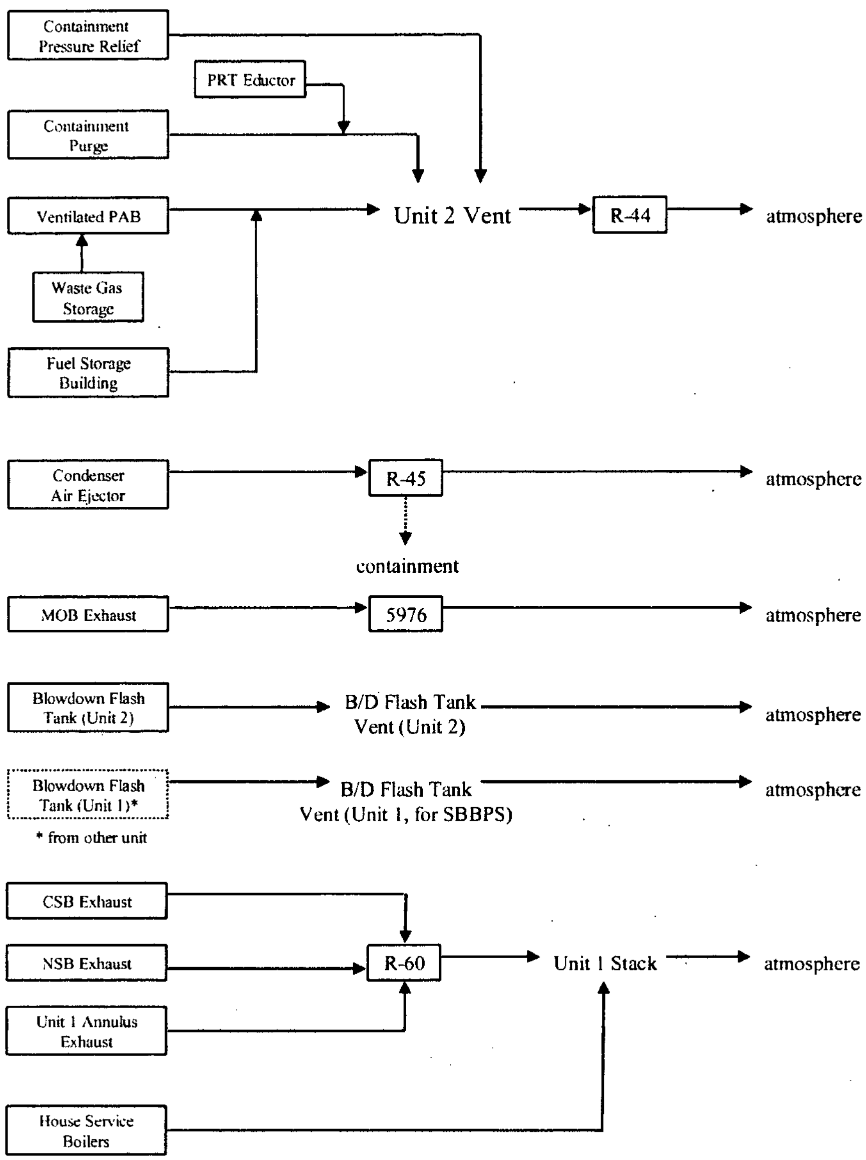
*e.g.: House Service Boilers Blowdown; Steam Condensate; Service Water Return; Utility Tunnel Sump (expectedly <LLD for gamma emitters in effluents). These and other systems are monitored per the IPEC 80-10 compliance program.

APPENDIX C
(Page 2 of 2)

GASEOUS EFFLUENT SIMPLIFIED FLOW DIAGRAM



APPENDIX D

STEAM PARTITION FACTOR CALCULATION (f)

The Steam Partition Factor f for the Unit 2 flash tank vent is given by:

$$f = \frac{{}^{h}BD - 180}{970}$$

For the secondary boiler blowdown purification system flash tank, the factor f is calculated by:

$$f = \frac{{}^{h}BD - 291}{895}$$

Where;

${}^{h}BD$ is the enthalpy of blowdown liquid, as taken from SOP 15.1, "Calorimetric Thermal Power Calculation," in BTU/lbm. A typical value = 500 BTU/lbm.

180 or 291 is the enthalpy of condensed water in each flash tank, in BTU/lbm

970 or 895 is the enthalpy of associated with the latent heat of vaporization in each tank, in BTU/lbm

f = A multiplicative factor used to determine the curies of H-3 escaping the flash tank vent, as follows:

f * SGBD activity (uCi/ml) * SGBD flowrate (gpm) * 3785 ml/gal * min = uCi released from vent

(1-f) * SGBD activity (uCi/ml) * SGBD flowrate (gpm) * 3785 ml/gal * min = Liquid uCi released

APPENDIX E

ALLOWED DILUTED CONCENTRATION (ADC)

The Allowed Diluted Concentration (ADC) is derived and calculated as follows:

$$ADC = \frac{MPCWt * CG}{Total\ activity} \quad or \quad ADC = \frac{MPCWt * CG}{CG + CB} \quad or \quad ADC = \frac{MPCWt}{1 + {}^{CB}\!/_{CG}}$$

Where;

ADC = Allowed diluted concentration in μCi/ml

MPCWt = Maximum permissible concentration in water for all isotopes (beta & gamma), in uCi/ml, as defined in RECS D3.1.1, as follows:

$$MPCWt = \frac{\sum_i Ci}{\sum_i \left\langle {}^{Ci}\!/_{MPCWi} \right\rangle}$$

Where;

Ci and MPCWi = Concentration and MPCW for each isotope

CB = The concentration of the non gamma emitters, in μCi/cc

CG = The concentration of the gamma emitters in uCi/ml

Applications of ADC:

If simultaneous liquid radioactive discharges are being performed from one unit, dilution flows may need to be re-apportioned. This may be performed by allocation or by calculation. The required dilution flow is calculated as follows:

$$E = \frac{Dr * CG}{ADC}$$

where;

Dr = Current release discharge rate, gpm

E = Required dilution for current existing release(s), gpm

The permissible discharge rate is then calculated as follows:

$$D = \frac{ADC * B}{CG}$$

Where:

D = Permissible discharge rate in gal/min

B = Adjusted dilution flow (Available – E, above), in gpm

Note that when there is no other releases (E=0), B simply becomes the available dilution flowrate.

APPENDIX F

CONVERSION FACTORS FOR LIQUID EFFLUENT MONITORS

Monitor conversion factors are derived from circulating a representative sample (or NIST traceable fluid) through the monitor until a stable reading is obtained. The conversion factor is then determined by quantifying the uCi/cc (by gamma spectroscopy or known activity) and dividing this value by the net cpm displayed on the monitor.

Fluid may be recirculated within the monitoring system, or introduced into a closed loop, to provide elevated, stable readings on the monitor. This fluid should be representative of the expected nuclide mixture in the system, as the conversion factor is energy-dependent.

When the process fluid itself is of sufficient activity to provide this function, it is this fluid that is measured and applied to develop a typical conversion factor.

When the process fluid is usually free of contamination, NIST traceable fluid must be injected into the sample chamber to accomplish this task.

Once the sample chamber is providing a stable reading, an alequate of the fluid is measured by gamma spectroscopy to determine the average energy and the monitor's conversion factor.

Conversion Factors for effluent monitors are maintained by Chemistry and updated when standard mixtures change which would warrant an improved average energy representation.

If desired, a more robust method can be applied per Reference 23.

APPENDIX G
(Page 1 of 7)

ENVIRONMENTAL SAMPLING POINTS

SAMPLE DESIGNATION/ STATION	LOCATION	DISTANCE
DR1/57	Roa Hook	2.0 mi – N
DR2/59	Old Pemart Avenue	1.8 mi – NNE
DR3/90	Charles Point	0.88 mi – NE
DR4/28	Lents Cove	0.45 mi – ENE
DR5/35	Broadway and Bleakley Avenue	0.37 mi – E
DR6/88	Reuter-Stokes Pole #6	0.32 mi – ESE
DR7/14	Water Meter House	0.3 mi – SE
DR8/03	Service Center Building	0.35 mi – SSE
DR9/34	South East Corner of Site	0.52 mi – S
DR10/05	NYU Tower	0.88 mi – SSW
DR11/53	White Beach	0.92 mi – SW
DR12/74	West Shore Drive - South	1.59 mi – WSW
DR13/76	West Shore Drive - North	1.21 mi – W
DR14/78	Rt. 9W, across from R/S #14	1.2 mi – WNW
DR15/80	Rt. 9W - South of Ayers Road	1.02 mi – NW
DR16/82	Ayers Road	1.01 mi – NNW
DR17/58	Rt. 9D – Garrison	5.41 mi – N
DR18/60	Gallows Hill Road and Sprout Brook Road	5.02 mi – NNE
DR19/62	West Brook Drive (near the Community Center)	5.03 mi – NE
DR20/64	Lincoln Road – Cortlandt (School Parking Lot)	4.6 mi – ENE
DR21/66	Croton Ave. – Cortlandt	4.87 mi – E
DR22/67	Colabaugh Pond Rd. – Cortlandt	4.5 mi – ESE
DR23/69	Mt. Airy & Windsor Road	4.97 mi – SE
DR24/92	Warren Rd. – Cortlandt	3.84 mi – SSE
DR25/71	Warren Ave. – Haverstraw	4.83 mi – S
DR26/72	Railroad Ave. & 9W Haverstraw	4.53 mi – SSW
DR27/73	Willow Grove Rd. & Captain Faldermeyer Drive	4.97 mi – SW
DR28/81	Palisades Parkway, Lake Welch Exit	4.96 mi – WSW
DR29/77	Palisades Parkway	4.15 mi – W
DR30/79	Anthony Wayne Park	4.57 mi – WNW
DR31/75	Palisades Parkway	4.65 mi – NW
DR32/83	Rt. 9W Fort Montgomery	4.82 mi – NNW
DR33/33	Hamilton Street (Substation)	2.88 mi – NE
DR34/38	Furnace Dock (Substation)	3.43 mi – SE
DR35/89	Highland Ave. & Sprout Brook Rd. (near Rock Cut)	2.89 mi – NNE
DR36/61	Lower South Street and Franklin Street	1.3 mi – NE
DR37/56	Verplanck – Broadway & 6th St.	1.25 mi – SSW
DR38/20	Cortlandt Yacht Club (aka Montrose Marina)	1.5 mi – S
DR39/29	Grassy Point	3.37 mi – SSW
DR40/23	*Roseton	20.7 mi – N
DR41/27	Croton Point	6.36 mi – SSE

* Control Station

APPENDIX G
(Page 2 of 7)

ENVIRONMENTAL SAMPLING POINTS

SAMPLE DESIGNATION/ STATION	LOCATION	DISTANCE
	Airborne	
A1/4	Algonquin Gas Line	0.28 mi – SW
A2/94	IPEC Training Center	0.39 mi – S
A3/95	Meteorological Tower	0.46 mi – SSW
A4/5	NYU Tower	0.88 mi – SSW
A5/23	*Roseton	20.7 mi – N
	Waterborne – Surface (Hudson River Water)	
Wa1/9	*Plant Inlet (Hudson River Intake)	0.16 mi – W
Wa2/10	Discharge Canal (Mixing Zone)	0.3 mi – WSW
	Waterborne – Drinking	
Wb1/7	Camp Field Reservoir	3.4 mi – NE
	Soil From Shoreline	
Wc1/53	White Beach	0.92 mi – SW
Wc2/50	*Manitou Inlet	4.48 mi – NNW

Exposure Pathway/Sample: Milk

There are no milch animals whose milk is used for human consumption within 8 km distance of Indian Point; therefore, no milk samples are taken.

Exposure Pathway/Sample: Ingestion-Fish and Invertebrates

The RECS designate two required sample locations labeled Ib1/25 and Ib2/23. The downstream Ib1 location and samples will be chosen where it is likely to be affected by plant discharge. Ib2 will be a location upstream that is not likely to be affected by plant discharge. The following species along with other commercially/recreationally important species are considered acceptable:

Striped Bass	Pumpkin Seed	American Eel
Bluegill Sunfish	White Catfish	Crabs
White Perch	Blueback Herring	

Exposure Pathway/Sample: Ingestion-Food Products (Broad Leaf Vegetation)

Ic1/95	Meteorological Tower	0.46 mi - SSW
Ic2/94	IPEC Training Center	0.39 mi - S
Ic3/23	*Roseton	20.7 mi - N

*Control Station

APPENDIX G

ENVIRONMENTAL SAMPLING POINTS

SAMPLE DESIGNATION/ STATION	LOCATION	DISTANCE	SAMPLE TYPES	
DR8/3	Service Center Building	0.35 mi – SSE	3	
A1/4	Algonquin Gas Line	0.28 mi – SW	1,2	
A4, DR10/5	NYU Tower	0.88 mi – SSW	1,2,3	
Wb1/7	Camp Field Reservoir	3.4 mi – NE	6	
**/8	Croton Reservoir	6.3 mi - SE	6	1/07
Wa1/9	*Plant Inlet (Hudson River Intake)	0.16 mi - W	7	
Wa2/10	Discharge Canal (Mixing Zone)	0.3 mi - WSW	7,8	
DR7/14	Water Meter House	0.3 mi – SE	3	
**/17	Off Verplanck	1.5 mi – SSW	8,9,10	1/07
DR38/20	Cortlandt Yacht Club (AKA Montrose Marina)	1.5 mi – S	3	
**/22	Lovett Power Plant	1.6 mi – WSW	1,2	1/07
Ib2,A5,DR40,Ic3/23	*Roseton	20.7 mi – N	1,2,3,4,5,11,12	
Ib1/25	*where available, downstream*	N/A	12	
DR41/27	Croton Point	6.36 mi – SSE	1,2,3	
DR4/28	Lents Cove	0.45 mi - ENE	3,8,9,10	
DR39/29	Grassy Point	3.37 mi – SSW	1,2,3	
DR33/33	Hamilton Street (Substation)	2.88 mi – NE	3	
DR9/34	South East Corner of Site	0.52 mi – S	3	
DR5/35	Broadway & Bleakley Avenue	0.37 mi – E	3	
DR34/38	Furnace Dock (Substation)	3.43 mi – SE	3	
**/44	Peekskill Gas Holder Building	1.84 mi – NE	1,2,11	1/07
Wc2/50	*Manitou Inlet	4.48 mi – NNW	10	
Wc1, DR11/53	White Beach	0.92 mi – SW	3,10	
DR37/56	Verplanck – Broadway & 6th Street	1.25 mi - SSW	3	
DR1/57	Roa Hook	2.0 mi – N	3	
DR17/58	Rt. 9D Garrison	5.41 mi – N	3	
DR2/59	Old Pemart Ave.	1.8 mi – NNE	3	
DR18/60	Gallows Hill Road and Sprout Brook Road	5.02 mi – NNE	3	
DR36/61	Lower South Street and Franklin Street	1.3 mi – NE	3	
DR19/62	West Brook Drive (near the Community Center)	5.03 mi – NE	3	
DR20/64	Lincoln Road – Cortlandt (School Parking Lot)	4.6 mi – ENE	3	
DR21/66	Croton Ave. – Cortlandt	4.87 mi – E	3	
DR22/67	Colabaugh Pond Rd. – Cortlandt	4.5 mi – ESE	3	
DR23/69	Mt. Airy & Windsor Road	4.97 mi – SE	3	

* Control Station ** Items are in excess of RECS requirements 1/07

APPENDIX G
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ENVIRONMENTAL SAMPLING POINTS

SAMPLE DESIGNATION/ STATION	LOCATION	DISTANCE	SAMPLE TYPES
DR25/71	Warren Avenue – Haverstraw	4.83 mi – S	3
DR26/72	Railroad Ave. & 9W – Haverstraw	4.53 mi – SSW	3
DR27/73	Willow Grove Rd. & Captain Faldermeyer Dr	4.97 mi – SW	3
DR12/74	West Shore Drive – South	1.59 mi – WSW	3
DR31/75	Palisades Parkway	4.65 mi – NW	3
DR13/76	West Shore Drive – North	1.21 mi – W	3
DR29/77	Palisades Parkway	4.15 mi – W	3
DR14/78	Rte. 9W, across from R/S #14	1.2 mi – WNW	3
DR30/79	Anthony Wayne Park	4.57 mi – WNW	3
DR15/80	Rte. 9W – South of Ayers Road	1.02 mi – NW	3
DR28/81	Palisades Parkway, Lake Welch Exit	4.96 mi – WSW	3
DR16/82	Ayers Road	1.01 mi – NNW	3
DR32/83	Rte. 9W – Fort Montgomery	4.82 mi – NNW	3
**/84	Cold Spring	10.88 mi – N	8,9,10
**/85	Quality Control		6
DR6/88	Reuter-Stokes Pole #6	0.32 mi – ESE	3
DR35/89	Highland Ave. & Sprout Brook Road (near rock cut)	2.89 mi – NNE	3
DR3/90	Charles Point	0.88 mi – NE	3
DR24/92	Warren Rd. – Cortlandt	3.84 mi – SSE	3
A2, Ic2/94	IPEC Training Center	0.39 mi – S	1,2,4,5
A3, Ic1/95	Meteorological Tower	0.46 mi - SSW	1,2,4,5
MW-40/104	Boundary Well #40	0.21 mi - SW	13
MW-51/105	Boundary Well #51	0.18 mi – SSW	13

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** Items are in excess of RECS requirements

Sample types are:

1. Air particulates
2. Radioiodine
3. Direct gamma
4. Broadleaf vegetation
5. Soil
6. Drinking water
7. Hudson River (H.R.) water
8. H.R. bottom sediment-silt
9. H.R. aquatic vegetation
10. H.R. shoreline soil
11. Fallout
12. Fish and invertebrates
13. Ground Water Boundary Monitoring (see ODCM Part I, Figure D 4.1-1)

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APPENDIX G
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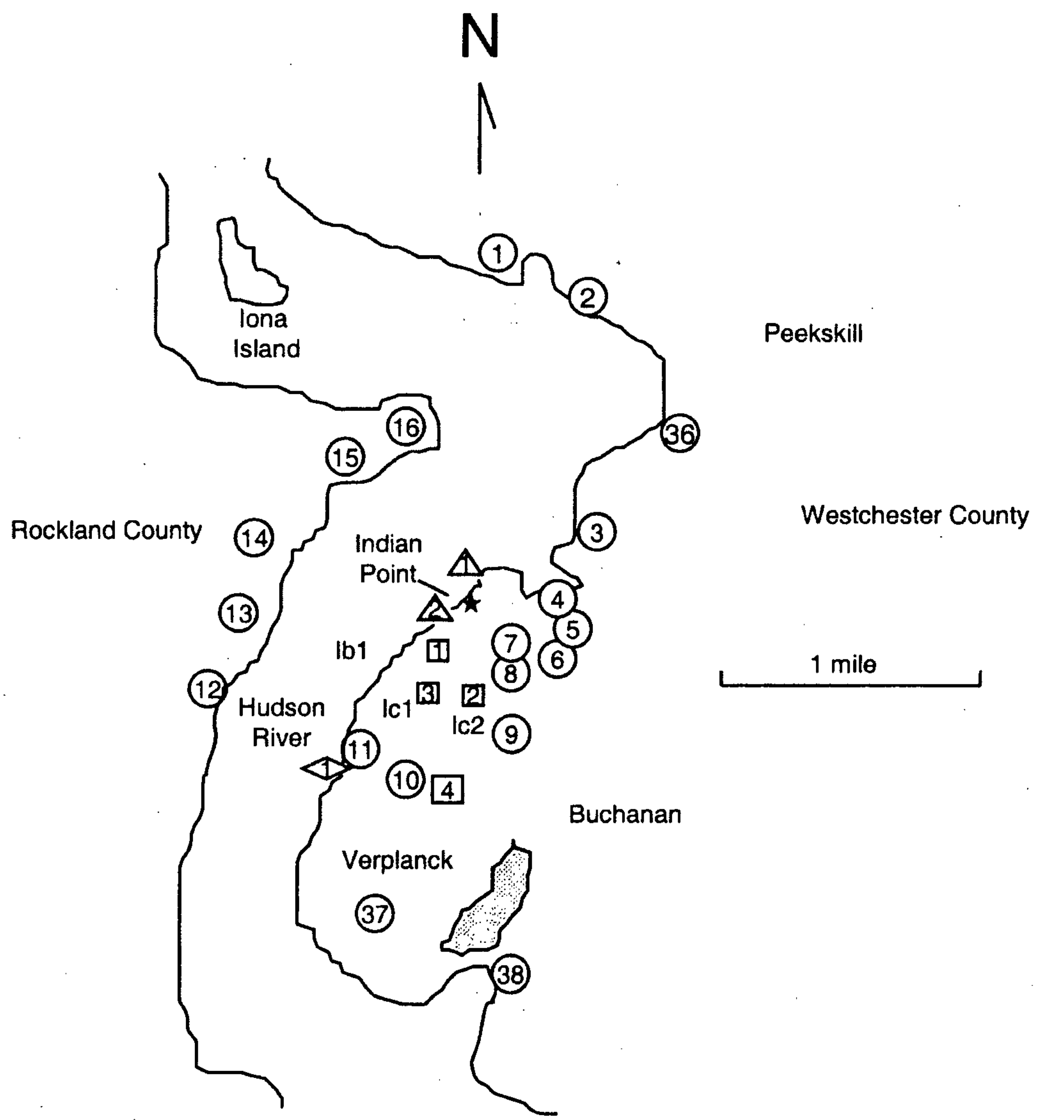
ENVIRONMENTAL SAMPLING POINTS

SAMPLING LOCATIONS
Within Two Miles of Indian Point



Key:
- △ - Waterborne: Surface (HR) Wa#
- ○ - Direct Radiation Sample Location DR#
- □ - Air Particulate & Radioiodine A#
- ◇ - HR Shoreline Sediment Wc#

Ic# - Broadleaf Vegetation
Ib1 - Fish and Invertebrates (where available downstream)

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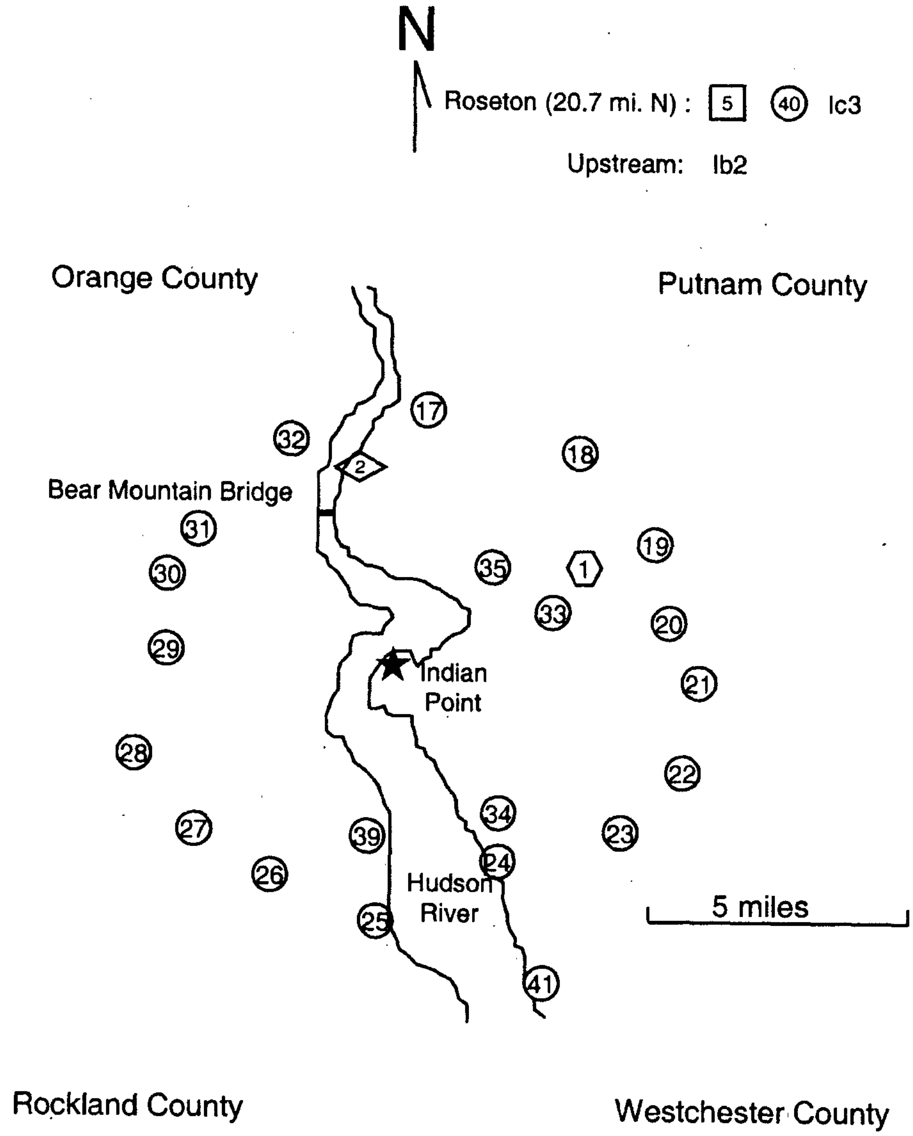
ENVIRONMENTAL SAMPLING POINTS

SAMPLING LOCATIONS
Within Ten Miles of Indian Point



Key:
- ○ - Direct Radiation Sample Location DR#
- □ - Air Particulate & Radioiodine A#
- ◇ - HR Shoreline Sediment Wc#
- ⬡ - Waterborne: Drinking Wb#

Ic3 - Broadleaf Vegetation
Ib2 - Fish and Invertebrates (where available upstream)

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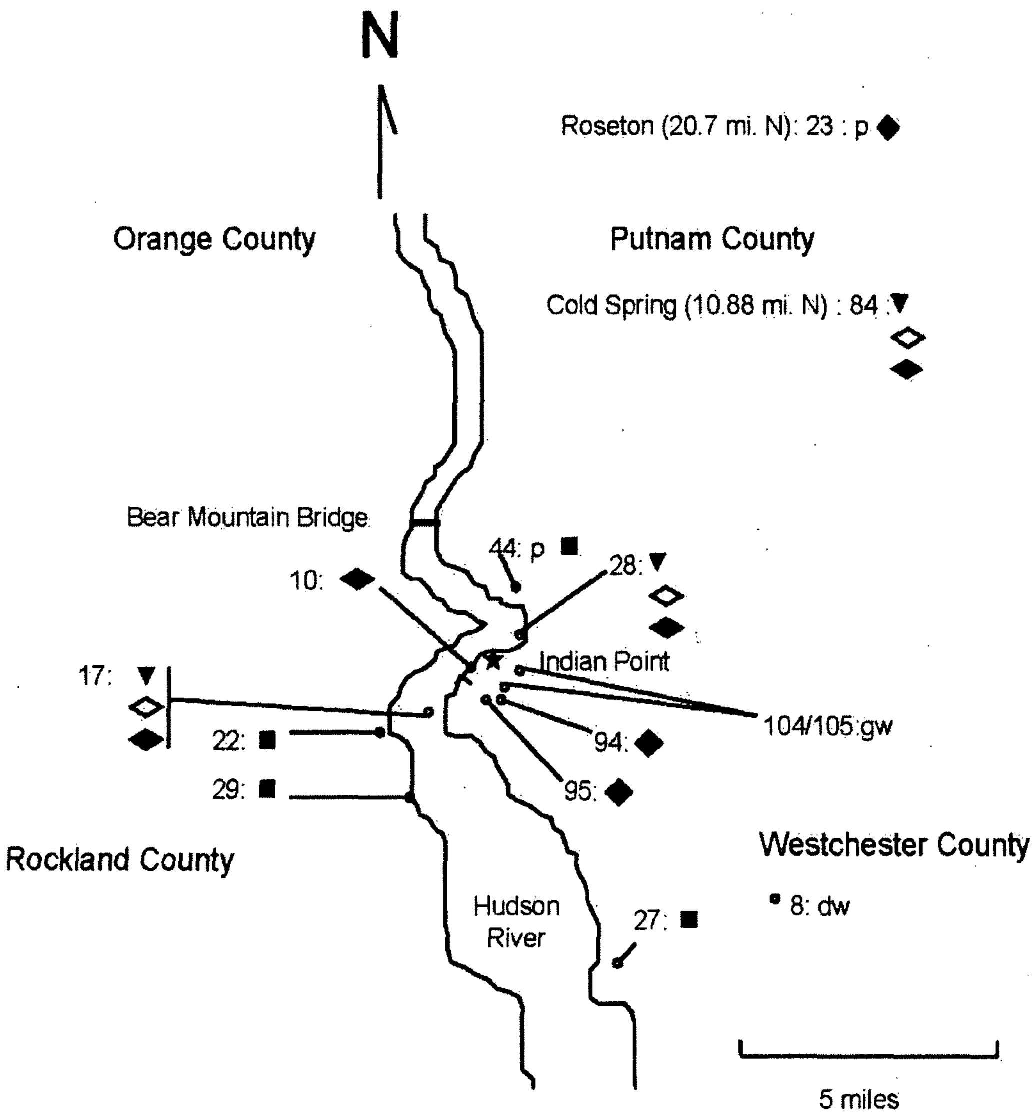
ENVIRONMENTAL SAMPLING POINTS | 1/07

ADDITIONAL SAMPLING LOCATIONS



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Key: ■ - Air Particulate & Radioiodine
▼ - Aquatic Vegetation
◆ - HR Bottom Sediment
p - Precipitation
dw - Drinking Water
◇ - HR Shoreline Sediment
◆ - Soil
gw – Ground Water Boundary Monitoring (see detailed site map) | 1/07

APPENDIX H

INTERLABORATORY COMPARISON PROGRAM

The James A. Fitzpatrick NPP Environmental Laboratory participates in the EPA Interlaboratory Comparison program or comparable program with a certified vendor. Samples of various media containing known activities of radionuclides were sent to participating laboratories for analyses. Results of the analyses are compared to the known values.

Results are reported in term of normalized deviations from a known value. Interlaboratory results are considered acceptable if the laboratory's normalized deviation for a sample is less than 3 or greater than minus 3.

Annual results of participation are summarized in the Annual Environmental Operating Report.

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

Primary Assumptions:

1. Units 2 and 3 effective dose factors (KLMN) are equivalent, except for site-specific finite cloud correction, as required.

2. Each unit shares 50% of the total allowable release rate, $\dot{Q}$, in Ci/sec.
   Therefore, $\dot{Q}3 = \dot{Q}2$ for instantaneous releases.

Given the following long-term meteorological data:

Unit 1/2:

Unit 1 or 2 Release Points	Receptor	Concentration X/Q (sec/m^3)	Finite-Cloud Gamma X/Q (sec/m^3) - Xe133	Deposition D/Q (1/m^2)
Primary Vent Releases	Site Boundary	2.219E-06 [SSW, 755 m]	1.974E-06 [SSW, 755 m]	1.407E-08 [SSW, 755 m]
	Nearest Residence	1.030E-06 [SSW, 1574 m]	9.714E-07 [SSW, 1574 m]	7.517E-09 [S, 1133 m]
Ground Level Releases	Site Boundary	2.873E-05 [SSW, 440 m]	1.215E-05 [SSW, 440 m]	8.759E-08 [SSW, 440 m]
	Nearest Residence	5.158E-06 [SSW, 1374 m]	3.068E-06 [SSW, 1374 m]	1.878E-08 [S, 933 m]

Unit 3:

Unit 3 Release Point	Receptor	Concentration X/Q (sec/m^3)	Finite-Cloud Gamma X/Q (sec/m^3) - Xe133	Deposition D/Q (1/m^2)
Primary Vent Releases	Site Boundary	4.473E-06 [SW, 350 m]	3.171E-06 [SSW, 480 m]	2.599E-08 [SSW, 480 m]
	Nearest Residence	1.016E-06 [SSW, 1574 m]	9.606E-07 [SSW, 1574 m]	7.451E-09 [S, 1133 m]
Ground Level Releases	Site Boundary	6.980E-05 [SSW, 250 m]	2.350E-05 [SSW, 250 m]	2.012E-07 [SSW, 250 m]
	Nearest Residence	5.158E-06 [SSW, 1374 m]	3.068E-06 [SSW, 1374 m]	1.878E-08 [S, 933 m]

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

Instantaneous Release Rates vs Dose Rates

Indian Point units 2 and 3 share a common site boundary limit of 500 mrem/yr. This 500 mrem/yr limit was divided between the units based upon a 50-50 split of the release rate in µCi/sec. Because each unit has its own X/Q and K-bar, equal µCi/sec discharges from each plant will result in different dose rates for each plant at the most restrictive site boundary location. In order to define the split of the 500 mrem/yr limit, IPEC units 2 and 3 must base the dose split on the mixture presented in Table 2-8.

Dose Split Between IP2 and IP3

A. Instantaneous Dose Rates and Calculation of Allowable Release Rate in uCi/sec:

i. Whole Body Dose Rate Calculations:

Given:
a) site limit is 500 mrem/yr

b) IP3 worst sector X/Q = 4.47E-6 sec/m^3

c) IP3 K-bar for instantaneous mixture = 849 $\dfrac{mrem \bullet m^3}{\mu Ci \bullet yr}$

d) IP2 worst sector X/Q = 2.22E-6 sec/m^3

e) IP2 K-bar for instantaneous mixture = 1507 $\dfrac{mrem \bullet m^3}{\mu Ci \bullet yr}$

f) $\dot{Q}$ = µCi/sec

Solve for $\dot{Q}$:

$\dot{Q}$ [(X/Q$_3$) (K bar$_3$) + (X/Q$_2$) (K bar$_2$)] = 500 mrem/yr

$\dot{Q}$ [(4.47E-6) (849) + (2.22E-6) (1507)] = 500 mrem/yr

Solving for $\dot{Q}$, a default back-calculated instantaneous release rate for either unit:

$\dot{Q}$ = **7.00E+4 µCi/sec**

In other words, if both units were releasing at this rate, with the default instantaneous mixture identified in Table 2-8, IPEC would be releasing at 500 mrem/yr (the RECS and 10CFR20 release rate limit).

Since this value assumes ALL releases are included (per unit), a partitioning factor should be applied for each applicable release point when this limit is used. Should it become necessary to "borrow" from the other unit, isotopic mixtures from specific sample results should replace the dose factors used in this default calculation. Without specific sample data, the default SITE release rate limit is then: **1.40E5 uCi/sec**.

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

ii. Skin Dose Rate Calculations:

Given:

a) site limit is 3,000 mrem/yr

b) IP3 worst sector X/Q = 4.47E-6 sec/m^3

c) IP3 (Li + 1.1 Mi) = 2306 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$

d) IP2 X/Q for SSW sector = 2.22E-6 sec/m^3

e) IP2 (Li + 1.1 Mi) = 3071 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$

f) $\dot{Q}$ = uCi/sec

Solve for $\dot{Q}$:

$\dot{Q}$ [(X/Q)$_3$ (Li + 1.1 Mi)$_3$ + (X/Q)$_2$ (Li + 1.1 Mi)$_2$] = 3,000 mrem/yr

$\dot{Q}$ [(4.47E-6) (2306) + (2.22E-6) (3071)] = 3,000 mrem/yr

$\dot{Q}$ = 1.75E+5 μCi/sec (less restrictive than Whole Body)

iii. Solve for WB dose rate commitments per site (with $\dot{Q}$ = 7.00E+4 uCi/sec)

Indian Point 2:

(7.00E+4 μCi/sec) (2.22E-6 sec/m^3) (1507 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$) = **234 mrem/yr**

Indian Point 3:

(7.00E+4 μCi/sec) (4.47E-6 sec/m^3) (849 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$) = **266 mrem/yr**

The less restrictive skin dose rate limit for each unit (information only):

Unit 2: (1.75E+5 uCi/sec) (2.22E-6 sec/m^3) (3071 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$) = 1194 mrem/yr

Unit 3: (1.75E+5 uCi/sec) (4.47E-6 sec/m^3) (2306 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$) = 1806 mrem/yr

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

RELEASE RATE LIMITS FOR QUARTERLY AND ANNUAL AVERAGE NOBLE GAS RELEASES

	For a Calendar Quarter	**For a Calendar Year**
Gamma air dose	5 mrad limit	10 mrad limit
Beta air dose	10 mrad limit	20 mrad limit

I. Assumptions:

1. Doses are delivered to the air at the site boundary.
2. Finite cloud geometry is assumed for noble gas releases at site boundary.
3. X/Q for Unit 2 = 2.22E-6 sec/m^3, ($\dot{Q}$ = release rate uCi/sec)
4. X/Q for Unit 3 = 4.47E-6 sec/m^3, ($\dot{Q}$ = release rate uCi/sec)
5. Gamma and Beta air dose factors (M and N), Corrected for finite cloud geometry (as described on Table 2-8) are as follows:

Unit 2 effective average dose factors	Unit 3 effective average dose factors	Units
$\overline{M}$ = 281	$\overline{M}$ = 181	mrad/yr per uCi/m^3
$\overline{N}$ = 1254	$\overline{N}$ = 1254	mrad/yr per uCi/m^3

II. Calculation of Quarterly Release Rates:

a) for gamma dose: ($\dot{Q}$)*[(M)(X/Q)] less than or equal to 5 mrad/qtr

b) for beta dose: ($\dot{Q}$)*[(N)(X/Q)] less than or equal to 10 mrad/qtr

		unit 2	unit 3
gamma dose rate	$\dot{Q} = \dfrac{5 mrad/qtr}{(1/4yr)(M)(X/Q)}$	= 3.21E+4 µCi/sec	2.47E+4 µCi/sec
beta dose rate	$\dot{Q} = \dfrac{10 mrad/qtr}{(1/4yr)(N)(X/Q)}$	= 1.44E+4 µCi/sec	7.14E+3 µCi/sec

Based on the above analysis, the beta dose is limiting for time average doses. Therefore, the allowable quarterly average release rates are 1.44E+4 µCi/sec for unit 2 and 7.14E+3 µCi/sec for unit 3.

III. Calculation of Calendar Year Release Rate

Annual limits are one half of quarterly limits. Therefore, using Beta air dose as most limiting, the maximum annual average release rates are 7.20E+3 µCi/sec for unit 2 and 3.57E+3 µCi/sec for unit 3.

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

ALLOWABLE INSTANTANEOUS RELEASE RATE for I-131 & Particulates w/ T½ > 8 DAYS)

Given: Wv(in): X/Q at the Site Boundary for IP3 = 4.47E-6 sec/m^3

Wv(in): X/Q at the Site Boundary for IP2 = 2.22E-6 sec/m^3

$$\text{PI(c)} = 1.62\text{ E7 } \frac{mrem/yr}{\mu Ci/m^3}$$

Assumed Pathway: Child Inhalation at Unrestricted Area Boundary

Solve the following equation for $\dot{Q}$:

$$[(\dot{Q})\text{PI(c)(Wv(in)) Unit 3}] + [(\dot{Q})\text{PI(c)(Wv(in)) Unit 2}] = 1500 \text{ mrem/yr}$$

$$\text{IP3: } (\dot{Q})\text{PI(c)(Wv(in))3} = \dot{Q} * 1.62\text{E7 } \frac{mrem/yr}{\mu Ci/m^3} \text{ 4.47E-6 s/}m^3 = \dot{Q} * 72.4 \frac{mrem/yr}{\mu Ci/\sec}$$

$$\text{IP2: } (\dot{Q})\text{PI(c)(Wv(in))2} = \dot{Q} * 1.62\text{E7 } \frac{mrem/yr}{\mu Ci/m^3} \text{ 2.22E-6 s/}m^3 = \dot{Q} * 36.0 \frac{mrem/yr}{\mu Ci/\sec}$$

The sum equals : (108) ($\dot{Q}$) mrem/yr per uCi/sec

Limit is 1500 mrem/yr per site:

$$\text{Therefore: } 108 * \dot{Q} \frac{mrem/yr}{\mu Ci/\sec} = 1500 \text{ mrem/yr}$$

$$\dot{Q} = 1.38\text{E+1 } \mu\text{Ci/sec} \quad \text{(for each unit)}$$

IP3 Dose Contribution: $1.38\text{E+1} \frac{\mu Ci}{\sec} * 1.62E7 \frac{mrem}{yr} \frac{m^3}{\mu Ci} * 4.47E-6 \frac{\sec}{m^3}$ = 1003 mrem/yr

IP2 Dose Contribution: $1.38\text{E+1} \frac{\mu Ci}{\sec} * 1.62E7 \frac{mrem}{yr} \frac{m^3}{\mu Ci} * 2.22E-6 \frac{\sec}{m^3}$ = 497 mrem/yr

Sum = 1500 mrem/yr

Approximately a 67 / 33 % dose split for IP3 and IP2 respectively.

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

ALLOWABLE RELEASE RATES FOR IODINE / PARTICULATE

TIME AVERAGE QUARTERLY AND ANNUAL DOSE LIMITS AT THE NEAREST RESIDENT

Dose factors for the child, thyroid (for Iodine 131) are used for this category as a conservative assumption since this nuclide has the highest thyroid dose factor of all iodines and particulates, and its most significant effect in on the child age group. The H-3 dose factor is about 4 orders of magnitude less significant and its contribution to the total dose is considered negligible. The back-calculated release rate for Iodine and Particulate is as follows:

Given:

	Unit 2	Unit 3
X/Q (in sec/m^3 at the nearest resident)	1.03E-6	1.02E-6
D/Q (in m^{-2} at the nearest resident)	7.52E-9	7.45E-9

RI(c) = 1.62E+7 $\frac{mrem/yr}{\mu Ci/m^3}$, child thyroid inhalation dose factor for I-131 (for both units)

RG = 1.72E+7 m^2 $\frac{mrem/yr}{\mu Ci/\sec}$, ground plane dose factor for I-131 (for both units)

RV(c) = 4.75E+10 m^2 $\frac{mrem/yr}{\mu Ci/\sec}$, child thyroid vegetation dose factor for I-131 (for both units)

Calculating the allowable time average release rate by solving the following equation for $\dot{Q}$:

$\dot{Q}$ [(RIc)(X/Q) + (RG)(D/Q) + (RVc)(D/Q)] = limit in mrem/yr

	Unit 2	Unit 3
$\dot{Q}$ (RIc)(X/Q) in mrem/yr per uCi/sec =	16.7 * $\dot{Q}$	16.5 * $\dot{Q}$
$\dot{Q}$ (RG) (D/Q) in mrem/yr per uCi/sec =	0.129 * $\dot{Q}$	0.128 * $\dot{Q}$
$\dot{Q}$ (RVc)(D/Q) in mrem/yr per uCi/sec =	357 * $\dot{Q}$	354 * $\dot{Q}$
The sum for each unit (X * $\dot{Q}$) in mrem/yr per uCi/sec.	**374 * $\dot{Q}$**	**371 * $\dot{Q}$**

Quarterly time average limit is 7.5 mrem to any organ (or 30 mrem/yr). Solving for $\dot{Q}$ yields:

(IP2) $\dot{Q}$ * 374 $\frac{mrem/yr}{\mu Ci/\sec}$ = 30 mrem/yr $\dot{Q}$ = 8.02E-2 μCi/sec **(Quarterly Limit)**

Annual limit is ½ quarterly limit, or 15 mrem to any organ/yr = 4.01E-2 μCi/sec **(Annual Limit)**

(IP3) $\dot{Q}$ * 371 $\frac{mrem/yr}{\mu Ci/\sec}$ = 30 mrem/yr $\dot{Q}$ = 8.10E-2 μCi/sec **(Quarterly Limit)**

Annual limit is ½ quarterly limit, or 15 mrem to any organ/yr = 4.05E-2 μCi/sec **(Annual Limit)**

Unit 2 ODCM Revision 11 Justification Package

Prepared by: Steven Sandike | **Brief Summary of Changes** | February, 2007

UNIT 2 ODCM Part I

1 *Modified RECS D1.1, Definition of "MPCW" to specifically identify application of NEW 10CFR20 and 10 times the EC values, for implementation of Unit 2 Technical Specification Amendment 250, December 2006.*

2 *Modified RECS BD3.1.1-1, last paragraph to specifically identify application of NEW 10CFR20 and 10 times the EC values, for implementation of Unit 2 Technical Specification Amendment 250, December 2006.*

Note: Other sections of the ODCM involving 10CFR20 applications refer back to these definitions and do not need updating.

Each change is discussed in detail on the following pages. This information is to be included in the OSRC presentation, the 50.59 package, and the next Annual Effluent Release Report sent to the Commission per Reg Guide 1.21

Unit 2 ODCM Revision 11 Justification Package

item # 1 of 2 Feb, 2007

OBJECTIVE:

Update RECS D.1.1-1 definition of "MPCW" to conform with the new 10CFR20 application of EC*10, per **Unit 2 Technical Specification Amendment 250 and TSTF-258**.

DESCRIPTION OF CHANGES:

Changed definition of MPCW in RECS D1.1 to :

"...concentration of a radionuclide equal to *10 times the EFFLUENT CONCENTRATIONS specified in 10CFR20, Appendix B, Table 2, Column 2*."

IMPACT:

None. Lower tier procedures and software are already effective to comply with the Amendment.

JUSTIFICATION:

Per the SER for this Amendment, the error introduced during ITS implementation is resolved. The Technical Specifications now accurately refer to the new 10CFR20 in all applications. The ODCM was updated to capture the correct definition of "MPCW", which had already been established in the RECS as the means of complying with liquid waste instantaneous release rate limits of either version of 10CFR20.

Unit 2 ODCM Revision 11 Justification Package

item # 2 of 2 Feb, 2007

OBJECTIVE:

Update RECS BASES (BD3.1.1-1, last paragraph) to conform with the new 10CFR20 application of EC*10, per **Unit 2 Technical Specification Amendment 250 and TSTF-258.**

DESCRIPTION OF CHANGES:

Updated this passage in the BASES to :

"...will be less than *10 times the EFFLUENT CONCENTRATIONS* specified in 10 CFR Part 20."

IMPACT:

None. Lower tier procedures and software are already effective to comply with the Amendment.

JUSTIFICATION:

Per the SER for this Amendment, the error introduced during ITS implementation is resolved. The Technical Specifications now accurately refer to the new 10CFR20 in all applications. The ODCM was updated to capture the correct definition of "MPCW", which had already been established in the RECS as the means of complying with liquid waste instantaneous release rate limits of either version of 10CFR20.

Entergy Nuclear Northeast

Indian Point Units 1, 2

TITLE: OFFSITE DOSE CALCULATION MANUAL (ODCM)

Rev. 11

WRITTEN BY:	Steve Sandike	2/7/7 date
REVIEWED BY:	[illegible]	2/8/07 date
OSRC REVIEW:	07-005 Donna [illegible]	2/21/07 date
APPROVED BY:	[illegible] For FD	2/21/07 date
EFFECTIVE DATE:	2-26-7	date

D 1.0 USE AND APPLICATION

D 1.1 Definitions

-----NOTE-----

Terms defined in Technical Specifications and the following additional defined terms appear in capitalized type and are applicable throughout these specifications and bases.

Term	Definition
GASEOUS RADWASTE TREATMENT SYSTEM	A GASEOUS RADWASTE TREATMENT SYSTEM is any system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system offgases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.
MEMBER(S) OF THE PUBLIC	MEMBER(S) OF THE PUBLIC includes all persons who are not occupationally associated with the site. This category does not include employees of the utility, their contractors or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries.
MAXIMUM PERMISSIBLE CONCENTRATION WATER (MPCW)	MPCW is that concentration of a radionuclide equal to ten times the EFFLUENT CONCENTRATIONS specified in 10CFR20, Appendix B, Table 2, Column 2. 2/7
OFFSITE DOSE CALCULATION MANUAL	The OFFSITE DOSE CALCULATION MANUAL shall contain the current methodology and parameters used in the calculation of offsite doses due to radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring alarm/trip setpoints, and in the conduct of the environmental radiological monitoring program.
PRIMARY TO SECONDARY LEAK	A PRIMARY TO SECONDARY LEAK is defined by a quantifiable leak rate equal to or greater than 0.5 gpd, AND a) The presence of fission or activation products in the secondary fluid, verified as Steam Generator U-tube leaks (and not from other known contamination, such as IVSWS leaks), OR b) Tritium activity in the secondary fluid indicating an increase above historical baseline (normal diffusion) of 5.00E-6 uCi/ml or greater.
PROCESS CONTROL PROGRAM	The PROCESS CONTROL PROGRAM is a manual containing and/or referencing selected operational information concerning the solidification of radioactive wastes from liquid systems.

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.1 Liquid Effluent Concentrations

BASES

It is expected that the release of radioactive materials in liquid and gaseous effluents to UNRESTRICTED AREAS will not exceed the concentration limits specified in 10 CFR Part 20 and should be as low as reasonably achievable (ALARA) in accordance with the requirement of 10 CFR 50.36a. While providing reasonable assurance that the design objectives will be met, these Specifications permit the flexibility of operation, compatible with considerations of health and safety, to ensure that the public is provided a dependable source of power under unusual operating conditions which may temporarily result in releases higher than the design objective levels but still within the concentration limits specified in 10 CFR Part 20. It is expected that using this operational flexibility under unusual operation conditions, and exerting every effort to keep levels of radioactive materials in liquid and gaseous wastes as low as reasonably achievable, releases will not exceed a small fraction of the concentration limits specified in 10 CFR Part 20.

The design objectives have been developed based on operating experience, taking into account a combination of variables including defective fuel, primary system leakage, primary to secondary system leakage, steam generator blowdown and the performance of the various waste treatment systems, and are consistent with 10 CFR Part 50.36a.

The Indian Point site is a multiple-unit site. There exist shared radwaste treatment systems and shared effluent release points. Where site limits must be met, the effluents of all the units will be combined to determine site compliance. For instances where unit-specific information may be required for radwaste processed or released via a shared system, the effluents shall be proportioned among the units sharing the system(s) in accordance with the methods and agreements set forth in the ODCM.

This specification is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than ten times the EFFLUENT 2/7
CONCENTRATIONS specified in 10 CFR Part 20. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, to a member of the public and (2) the limits of 10 CFR Part 20.1302 to the population. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its MPC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

This specification applies to the release of liquid effluents from all units on site.

IPEC COMBINED ODCM Rev 0 Justification Package

Combines Unit 2 ODCM Rev 11 and Unit 3 Rev 18

Prepared by: Steven Sandike **Brief Summary of Changes** December, 2007

As much as possible, technical or process changes to either ODCM were avoided for this merge, simply combining the elements of both unit ODCMs into one. Cross reference documents have been generated to identify the new location of each page or paragraph of the old ODCMs to the appropriate new location. The new station ODCM is in the format of Unit 2's previous ODCM (per NUREG 1431 and ITS). Several administrative changes were required to move the material from the old ODCMs to new Revision 0 of the IPEC station ODCM. Along with these unavoidable administrative wording changes, several other minor changes are included in this revision, as summarized below.

ODCM Part I

1 *Definitions Section D1.1- modified SITE BOUNDARY & UNRESTRICTED AREA to apply to the site licensee(s).*

2 *Updated Instrumentation sections D3.3.1 and D3.3.2 to include all IPEC effluent instrumentation by ID nomenclature, and appended DSRs as required to ensure all station DSRs could be referenced.*

3 *Modified Table D3.3.1-1, part 4, RWST level instruments, to list the daily channel check, but defer the periodicity of Channel Operability Tests and Calibrations to the appropriate section of unit-specific Technical Specifications.*

4 *Added requirements for the Unit 2 VC Noble Gas Monitor (R-42) similar to those of Unit 3's R-12 in Section D3.3.2, including new footnote (g) from Unit 3's equivalent section. This footnote helps explain the use of the monitor for VCPR quantification.*

5 *Modified Table D3.3.2-1, part 3, VC Noble Gas Monitors, to list the monthly source check, but defer the periodicity of the other surveillances (Channel Check, Operability Tests, and Calibrations) to the appropriate section of the Technical Specifications.*

6 *Modified Table D3.3.2-1, parts 4 and 6, to stipulate a 24-month calibration for the sample flow rate monitors (totalizers).*

7 *Clarified REMP section D3.5.1 4c (broad leaf sample locations) and D3.5.2 (Land Use) to explain the use of the Site Boundary locations (highest D/Q) in lieu of a garden census.*

8 *Modified Section D5.6 to rename the GWMP the "Radiological Ground Water Monitoring Program" (RGWMP), clarify the bullets, and add requirements specifying what kind of information goes into which annual report.*

ODCM Part II

9 *The 5-mile cow milk pathway description and dose equations were removed from the ODCM in 2003 due to the absence of a documented pathway. This information was returned to the ODCM in this revision, with an opening discussion in Section 3.3.4.1 explaining that the USE of this pathway is turned on and off according to the current land use census. Other sections effected include 3.3.4.2, 3.3.4.5.d, 3.5.4, 3.5.6, and Appendix I, each of which shows the return of applicable guidance for determining doses from the Cow-Milk pathway.*

Returning the Cow's Milk Pathway equations and guidance to the ODCM does NOT infer that this pathway was activated. This information was returned to the ODCM, as a result of discussions during a recent in-house audit, to simplify administrative requirements, should the land use census ever identify the need to activate the pathway, in mid-year, for example. When required, this pathway can simply be turned on and documented, without the rigor of re-establishing the modeling and equations in the ODCM at that time, when details of this pathway's calculations may be more difficult to recollect. The change would be documented in the land use census and incorporated in the 10CFR50 effluent tracking software. It would also be documented in the annual effluent report (Reg Guide 1.21), and in station procedures governed under the 10CFR50.59 review process, but the ODCM should not require a change. At the present time, this pathway remains inactivated at IPEC.

Each of the above changes is discussed in detail on the following pages. This information is to be included in the OSRC presentation, the 50.59 package, and the next Annual Effluent Release Report sent to the Commission per Reg Guide 1.21

IPEC COMBINED ODCM Rev 0 Justification Package

Combines Unit 2 ODCM Rev 11 and Unit 3 Rev 18

item # 1 of 9 Dec, 2007

OBJECTIVE:

Modified SITE BOUNDARY & UNRESTRICTED AREA in Definitions Section D1.1, to apply to the site licensee(s) rather than one unit or the other.

DESCRIPTION OF CHANGES:

Changed references to a specific unit to "the licensee(s)".

IMPACT:

None

JUSTIFICATION:

Typographical improvement to ensure applicability across the entire Entergy site. The application of SITE BOUNDARY and UNRESTRICTED AREA in NUREG 0133 and NUREG 1301 are for purposes of applicability to 10CFR20 and releases from the entire SITE.

IPEC COMBINED ODCM Rev 0 Justification Package

Combines Unit 2 ODCM Rev 11 and Unit 3 Rev 18

item # 2 of 9 Dec, 2007

OBJECTIVE:

Update Instrumentation sections D3.3.1 and D3.3..2 to include all IPEC effluent instrumentation by ID nomenclature, and append DSRs as required to ensure all station DSRs could be referenced.

DESCRIPTION OF CHANGES:

ODCM Surveillance Requirements (DSRs) were added to be inclusive while combining ODCMs. Additionally, while RMS already involved specific instrument ID nomenclature, the appropriate identification for other plant (effluent) instrumentation was added to these tables, rather than to simply refer to them by name or description. For example, "R-18" was already identified for the Unit 3 liquid waste radiation monitor, but "LI-181" was added to specifically identify 31 Monitor Tank level instrument.

IMPACT:

None

JUSTIFICATION:

The enhanced tables more clearly demonstrate the specific instrument, while still adopting the necessary format changes for the combined ODCM in NUREG 1431 format. Specific instrument identification was added to clarify compliance with necessary surveillance requirements.

IPEC COMBINED ODCM Rev 0 Justification Package

Combines Unit 2 ODCM Rev 11 and Unit 3 Rev 18

item # 3 of 9 Dec, 2007

OBJECTIVE:

Modify Table D3.3.1, part 4, RWST level instruments, to list the daily channel check, but defer the periodicity of Channel Operability Tests and Calibrations to the appropriate section of unit-specific Technical Specifications

DESCRIPTION OF CHANGES:

Listed the tank level instruments by ID number, and required only the daily channel check in the ODCM. The other requirements for the RWST level instruments, such as channel calibrations, are listed in Technical Specifications 3.5.4 for both units, and Section 3.3.3 (PAM) for unit 2.

IMPACT:

None.

JUSTIFICATION:

NUREG 1301 does NOT require tank level instruments in the ODCM. Typically, however, these instruments are included nonetheless, because they may be used to quantify effluent and to help demonstrate compliance with the ten curie rule from old NUREG 0472 (prior to NUREG 1301).

For the RWST, previous versions of the ODCM(s) listed requirements that were echoed from the Technical Specifications Section 3.5.4 for both units, and Section 3.3.3 for unit 2. In this revision to the ODCM, only the daily channel checks remain in the ODCM. A footnote is added to this revision of the ODCM to reference the specific requirements of Technical Specifications for the Channel Operability Tests and Calibrations. (These tests are actually performed MORE frequently than the periodicity established in Tech Specs, per the site's PM schedule).

The applicable sections of Technical Specifications also list a requirement for Channel Check:

Unit 2	Tech Spec 3.3.3	once per 31 days	(actually performed DAILY)
Unit 3	Tech Spec 3.5.4	once per 7 days	(actually performed DAILY)

A 24 hour frequency requirement for the Channel Check will stay in the ODCM. This conservativism is partly due to the inconsistent approach between units (per above TS reference). Another reason to maintain this conservativism is the fact that ALL tank level instruments were originally identified in Radiological Environmental Technical Specifications (NUREG 0472) for purposes of assurance of compliance with the 10 curie rule. This rule ensured compliance with 10CFR20 release rate limitations in the event of a tank rupture and subsequent effluent concerns.

For these reasons, as well as the fact that the site PM schedule and CCR watch logs continue to apply this periodicity, the new revision of the station ODCM will maintain the daily channel check as a conservative measure to ensure compliance with somewhat divergent Technical Specification requirements for both units.

Other requirements are deferred to Technical Specifications and existing PM schedules.

IPEC COMBINED ODCM Rev 0 Justification Package

Combines Unit 2 ODCM Rev 11 and Unit 3 Rev 18

item # 4 of 9 Dec, 2007

OBJECTIVE:

Add requirements for the Unit 2 VC Noble Gas Monitor (R-42) similar to those of Unit 3's R-12 in Section D3.3.2, including new footnote (g) from Unit 3's equivalent section.

DESCRIPTION OF CHANGES:

Added R-42 requirements to Section D3.3.2 (3a) and footnote (g).

IMPACT:

None.

JUSTIFICATION:

Channel checks, Operability Tests, and Calibrations for these monitors are required per Technical Specifications 3.3.6 and have been ongoing since initial licensing. However, Unit 2's initial license (NUREG 0472) did NOT require listing the VC Noble Gas monitor in this section of the Environmental Technical Specifications, and subsequently, it did not get transferred to the ODCM during ITS.

Years later, older versions of NUREG 0472 and NUREG 1301 did, in fact, include this monitor in the applicable section, and it was applied for Unit 3. Also required in this section of the NUREGs was a Source Check, which to this day, is NOT listed in the Technical Specifications.

Since an operable VC Noble Gas monitor is valuable to ensure accurate quantification of VC Pressure Reliefs, the new combined ODCM uses this latter methodology of inclusion. The details of quantification technique are prescribed in footnote (g).

Application and testing of the VC Noble Gas monitor in this fashion is in keeping with NUREG 1301 and existing Technical Specification requirements.

IPEC COMBINED ODCM Rev 0 Justification Package

Combines Unit 2 ODCM Rev 11 and Unit 3 Rev 18

item # 5 of 9 Dec, 2007

OBJECTIVE:

Modify Table D3.3.2, part 3, VC Noble Gas Monitors, to list the monthly source check, but defer the periodicity of the other surveillances (Channel Check, Operability Tests, and Calibrations) to the appropriate section of the Technical Specifications.

DESCRIPTION OF CHANGES:

Section D3.3.2 now includes the monthly source check requirements for both unit's VC Noble Gas Monitor. While Unit 3's previous revision ALSO echoed the Channel Operability Test and Calibration periodicities, these requirements originate from the Technical Specifications and the appropriate section is referenced in new footnote (g) in this revision of the ODCM. Also included in this footnote is an explanation of the use of the noble gas monitor for VCPR quantification.

IMPACT:

None.

JUSTIFICATION:

Operability Tests and Calibrations for these monitors are required per Technical Specifications 3.3.6. New footnote (g) references this section.

Because the Tech Specs do NOT require a source check, and this check is valuable to ensure accurate quantification of VC Pressure Reliefs, the 31-day source check requirement is maintained in this revision to the ODCM. Footnote (g) ensures connectivity to Technical Specifications and explains the use of the noble gas monitor for VCPR quantification.

It also clarifies that the VC Noble Gas monitor is NOT required in Modes 5 or 6 during VC Ventilation when there is a continuous monitor on the plant vent. This caveat had previously only been explained in Unit 3's ODCM. It was relocated into this footnote for the merging process.

Application and testing of the VC Noble Gas monitor in this fashion is in keeping with NUREG 1301 and existing Technical Specification requirements.

IPEC COMBINED ODCM Rev 0 Justification Package

Combines Unit 2 ODCM Rev 11 and Unit 3 Rev 18

item # 6 of 9 Dec, 2007

OBJECTIVE:

Modify Table D3.3.2-1, parts 4 and 6, to stipulate a 24-month calibration for the sample flow rate monitors (totalizers), instead of the older reference of 18-months

DESCRIPTION OF CHANGES:

Table D3.3.2-1 parts 4 and 6, for Unit 2's Plant Vent and Stack Vent sampling stations, were updated to reference a required 24-month calibration on the installed sampler flow meter (totalizer), in lieu of the older requirement for a calibration every 18 months.

IMPACT:

None.

JUSTIFICATION:

Updating this calibration requirement from 18 to 24 months was expected during ITS (Unit 2 ODCM Rev 6), but was inadvertently missed.

This requirement in previous revisions was identified with the "R" notation, which at the time, was thought to be 18-months. Since the adoption of the 2-yr fuel cycle, these type of periodicities have been re-evaluated, with most going to 24 months. Only those surveillance requirements with a track record of required added attention failed to be updated to a 24-month periodicity. These particular instrument are in fact, totalizer, not flow meters, and are used on a daily basis to track integrated flow through the vents. Both units 2 and 3 have used these instruments for over 25 years, with calibrations performed offsite, or more recently, new meters purchased every two years, with no record of degradation or failure.

During the 80's and 90's, both units performed calibrations at an offsite vendor every 18 months. Per industry experience and vendor suggestion, it was decided that new meters were more economical than continuing to "calibrate" the old ones. Therefore, for over 6 years (longer at unit 2), we have been replacing these totalizers and applying the manufacturers certification at our design flowrate as the compliance with this two year calibration. Performance of these totalizers continues to be excellent.

Summarizing, the bases for establishing a 2-yr calibration for these instruments across the site is:

1) the performance record of these instruments to date,
2) the fact that Unit 3's ODCM moved to 2-yr requirements in 2000,
3) the continued compliance with NUREG 1301, and
4) the desire for a more consolidated site program.

IPEC COMBINED ODCM Rev 0 Justification Package

Combines Unit 2 ODCM Rev 11 and Unit 3 Rev 18

item # 7 of 9 Dec, 2007

OBJECTIVE:

Clarify REMP section D3.5.1 4c (broad leaf sample locations) and D3.5.2 (Land Use) to explain the application of sampling at the Site Boundary locations (highest D/Q) in lieu of a garden census.

DESCRIPTION OF CHANGES:

Adopted the Unit 3 verbiage in these sections, including the use of footnotes (i) and (j) on Table 3.5.1-1, and the words directly from NUREG 1301 for Section D3.5.2, Land Use Census.

IMPACT:

None.

JUSTIFICATION:

The Unit 3 ODCM was modified during implementation of GL 89-01 (per NUREG 1301) to use more precise wording, directly from the NUREG, allowing this method of collection for determining D/Q values. The unit 3 wording has been in service for over 6 years. However, it was not properly applied to Unit 2's ODCM during the ITS project at Unit 2, in 2003. The Unit 3 upgraded wording better connects the bases and justification for broad leaf vegetation sampling and its connection to the land use census. The applicable footnote (j) is discussed in Section D3.5.2, Land Use Census, so there is a documented connection with the bases document (directly from NUREG 1301) for the decisions regarding sampling at the site boundary in lieu of a garden census. Therefore, in this instance, the Unit 3 verbiage, as well as the footnote, were applied to the IPEC ODCM.

IPEC COMBINED ODCM Rev 0 Justification Package

Combines Unit 2 ODCM Rev 11 and Unit 3 Rev 18

item # 8 of 9 Dec, 2007

OBJECTIVE:

Better document the ground water monitoring program in the ODCM.

DESCRIPTION OF CHANGES:

- Modified Section D5.6 to rename the GWMP the "Radiological Ground Water Monitoring Program" (RGWMP).
- Clarified the bullets under D5.6, according to the objectives of the program.
- Added requirements for what kind of information goes into which annual report (D5.6)
- Added specific detail to ODCM Part II, Sec 2.1.16, discussing quantification requirements, including a reference to Attachment J, which includes the details for calculating offsite dose.

IMPACT:

None. The RGWMP implementing documents are already in place (IP-SMM-CY-110 and NEM procedures).

JUSTIFICATION:

The refinements to the RGWMP in 2006 were added to station procedures and needed to be included in this revision of the ODCM. The direction for reporting GW data in annual reports was a direct result of the NEI Industry Groundwater Protection Initiative final guidance document **(NEI 07-07)**. The discussion in ODCM Part II, Section 2.1.16 includes the requirements for quantifying groundwater effluent, but details of this assessment are unique and the staff felt they would be better captured in an Attachment.

Therefore, Section 2.1.16 now references new Attachment J. This attachment explains the hydrological and environmental approaches to acquiring the parameters needed to perform standard dose calculations from previous sections of the ODCM. While the equations for calculating dose are the same, this attachment was felt necessary due to the unique nature of data acquisition for ground water flow rate, dilution flow, and source term data.

Once these parameters are accumulated, dose calculations proceed per approved guidance in the ODCM and its bases documents, NUREG 0133 and 1301.

IPEC COMBINED ODCM Rev 0 Justification Package

Combines Unit 2 ODCM Rev 11 and Unit 3 Rev 18

item # 9 of 9 Dec, 2007

OBJECTIVE:

The 5-mile cow milk pathway description and dose equations need to be returned to the ODCM, with an opening discussion in Section 3.3.4.1 to explain that the USE of this pathway is turned on and off according to the current land use census. Update other sections effected: (3.3.4.2, 3.3.4.5.d, 3.5.4, 3.5.6, and Appendix I) to show the return of applicable guidance for determining doses from the Cow-Milk pathway.

DESCRIPTION OF CHANGES:

Replaced the methodology for determining 5-mile-cow-milk pathway doses, should this pathway be initiated by the Land Use Census. Therefore, Section 3.3.4.1 opens with the explanation that doses from this pathway only apply when it is activated. Section 3.3.4.2 now shows this potential pathway again. Details of the calculation for the dose factor (Ri_c) were returned to Section 3.3.4.5.d.

Discussion of interface with MET data also needed to have the pathway re-established. The MET constants were reapplied to Sections 3.5.4 and 3.5.6, for routine and short-term applications.

The last page of Appendix I was returned, showing the dose limits for this pathway in terms of uCi/sec.

The only additions to this material over what was in earlier ODCMs are the updated MET constants and an additional note to clarify that these parameters are only to be included in dose calculations *when activated by the Land Use Census.*

IMPACT:

None.

JUSTIFICATION:

The cow-milk pathway in the ODCM continues to be defined per NUREG 0133, Reg Guide 1.109, and NUREG 1301. No technical changes were performed from the earlier revision of the ODCMs, which had included this pathway description, other than updating the MET data with the latest information (applied from 1992-2002), and notes describing how it is turned off or on per the land use census.

The intent of this upgrade to return this information to the ODCM (despite this pathway being inactive) was to preclude an ODCM revision, should this pathway ever be enabled by a change to the Land Use Census. Identification of this pathway within the ODCM (whether or not it is activated), and specifically, the detailed calculation for Ri_c, also provides better confidence that this detail will not be lost, should the pathway come in to play in the future. Documentation of the parameters and NUREG 0133 calculation would not have to be created from scratch. Calculation of potential doses via this pathway continue to be a simple option to turn on or off in the 10CFR50 effluent tracking software (RETDAS) and therefore should remain an option and defined in the ODCM. All equations and parameters follow the prescription from NUREG 0133 and Reg Guide 1.109, as they had in Revision 13 and before.

Entergy Nuclear Northeast

Indian Point Energy Center

Units 1, 2, and 3

OFFSITE DOSE CALCULATION MANUAL

(ODCM)

Rev. 0

WRITTEN BY:	Steven R. Sandike	11/30/07 date
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EFFECTIVE DATE:	12/31/07	

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The OFFSITE DOSE CALCULATION MANUAL (ODCM) is established and maintained pursuant to Technical Specifications Section 5.5. for both IPEC units 2 and 3. Previous revisions of each unit's ODCM have been combined to form a station ODCM. The IPEC ODCM consists of two parts:

1) Part I, Radiological Effluent Controls, (RECS) – previously, often referred to as the Radiological Effluent Technical Specifications, or RETS (Section 3.9 of original Unit 2 Technical Specifications, and Appendix B or original Unit 3 Technical Specifications).

2) Part II, Calculational Methodologies (previously often referred to as simply the "ODCM")

Part I, Radiological Effluent Controls, includes the Radiological Effluent Control Specifications (RECS) and Radiological Environmental Monitoring Programs (REMP) required by Technical Specification 5.5. It also includes descriptions of the information that should be included in the Annual Radiological Environmental Operating and Radioactive Effluent Release Reports required by each unit's Technical Specifications.

Part II, Calculational Methodologies, provides the methodology to manually calculate radiation dose rates and doses to individual persons in UNRESTRICTED AREAS in the vicinity of Indian Point due to the routine release of gaseous and liquid effluents. Long term cumulative effects are usually calculated through computer programs employing approved methodology. At IPEC, this method includes the use of ten-year averaged meteorology in the case of gaseous effluents. Other computer programs are utilized to routinely estimate the doses due to radioactivity in liquid effluents. Manual dose calculations are performed when computerized calculations are not available. The ODCM also provides setpoint methodology that is applied to effluent monitors and optionally to other process monitors.

The sources for criteria found in the ODCM and the Radiological Effluent Control Specifications include the following:

- **Liquid Effluent Release Rate:** Diluted concentrations in the discharge canal are limited to ten times the EFFLUENT CONCENTRATIONS identified in 10CFR20 Appendix B.
- **Airborne Effluent Release Rate**: Release rates are limited to corresponding dose rate limits from NUREG 0133 and 0472.
- **Integrated Radiological Effluent Dose**: The design objectives of 10CFR50 Appendix I.

The ODCM and associated tracking software implements the methodology of

1) Reg. Guide 1.109 "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50 Appendix I", and
2) NUREG-0133 "Guidance Manual for Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants."

Other references may be cited to permit reasonable handling of a situation not covered by either of the two cited references. In some cases, site-specific data or reasonable simplifying assumptions are used and justified to permit formulation of more workable methodologies for implementing RECS dose calculation requirements.

Indian Point Energy Center

Offsite Dose Calculation Manual

PART I – RADIOACTIVE EFFLUENT CONTROLS

D 1.0 USE AND APPLICATION

D 1.1 Definitions

---NOTE---
Terms defined in Technical Specifications and the following additional defined terms appear in capitalized type and are applicable throughout these specifications and bases.

Term	Definition
GASEOUS RADWASTE TREATMENT SYSTEM	A GASEOUS RADWASTE TREATMENT SYSTEM is any system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system offgases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.
MEMBER(S) OF THE PUBLIC	MEMBER(S) OF THE PUBLIC includes all persons who are not occupationally associated with the site. This category does not include employees of the utility, their contractors or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries.
MAXIMUM PERMISSIBLE CONCENTRATION WATER (MPCW)	MPCW is that concentration of a radionuclide equal to ten times the EFFLUENT CONCENTRATIONS specified in 10CFR20, Appendix B, Table 2, Column 2.
OFFSITE DOSE CALCULATION MANUAL	The OFFSITE DOSE CALCULATION MANUAL shall contain the current methodology and parameters used in the calculation of offsite doses due to radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring alarm/trip setpoints, and in the conduct of the environmental radiological monitoring program.
PRIMARY TO SECONDARY LEAK	A PRIMARY TO SECONDARY LEAK is defined by a quantifiable leak rate equal to or greater than 0.5 gpd, AND a) The presence of fission or activation products in the secondary fluid, verified as Steam Generator U-tube leaks (and not from other known contamination, such as IVSWS leaks), OR b) Tritium activity in the secondary fluid indicating an increase above historical baseline (normal diffusion) of 5.00E-6 uCi/ml or greater.
PROCESS CONTROL PROGRAM	The PROCESS CONTROL PROGRAM is a manual containing and/or referencing selected operational information concerning the solidification of radioactive wastes from liquid systems.

D 1.1 Definitions

PURGE - PURGING	PURGE or PURGING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.
SITE BOUNDARY	The SITE BOUNDARY is that line beyond which the land is neither owned, leased, nor otherwise controlled by the licensee(s).
SOLIDIFICATION	SOLIDIFICATION is the conversion of wet wastes into a form that meets shipping and burial ground requirements.
SOURCE CHECK	A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.
UNRESTRICTED AREA	An UNRESTRICTED AREA is any area at or beyond the SITE BOUNDARY, access to which is not controlled by the licensee(s) for purposes of protection of individuals from exposure to radiation and radioactive materials. (See Figure D 4.1-1)
VENTILATION EXHAUST TREATMENT SYSTEM	A VENTILATION EXHAUST TREATMENT SYSTEM is 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 adsorbers 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.
VENTING	VENTING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is not provided or required.

1.0 USE AND APPLICATION

1.2 Logical Connectors

Logical Connectors are discussed in Section 1.2 of the Technical Specifications and are applicable throughout the Offsite Dose Calculation Manual and Bases.

1.3 Completion Times

Completion Times are discussed in Section 1.3 of the Technical Specifications and are applicable throughout the Offsite Dose Calculation Manual and Bases.

1.4 Frequency

Frequency is discussed in Section 1.4 of the Technical Specifications and is applicable throughout the Offsite Dose Calculation Manual and Bases

D 3.0 ODCM Limiting Condition for Operation (DLCO) Applicability

DLCO 3.0.1 DLCOs shall be met during the MODES or other specified condition in the Applicability, except as provided in DLCO 3.0.2.

DLCO 3.0.2 Upon discovery of a failure to meet a DLCO, the Required Actions of the associated Conditions shall be met, except as provided in DLCO 3.0.5.

If the DLCO is met or is no longer applicable prior to expiration of the specified Completion Time(s), completion of the Required Action(s) is not required unless otherwise stated.

DLCO 3.0.3 When a DLCO is not met and the associated ACTIONS are not met, an associated ACTION is not provided, or if directed by the associated ACTIONS, action shall be initiated within 1 hour to:

a. Restore compliance with the DLCO or associated ACTIONS, and

b. Enter the circumstances into the Corrective Action Program.

------------------------------------NOTE----------------------------------
DLCO 3.0.3.b shall be completed if DLCO 3.0.3 is entered.

Exceptions to this Specification are stated in the individual Specifications.

DLCO 3.0.4 Not Applicable to ODCM Specifications.

DLCO 3.0.5 Equipment removed from service or declared inoperable to comply with ACTIONS may be returned to service under administrative control solely to perform testing required to demonstrate its OPERABILITY or the OPERABILITY of other equipment. This is an exception to TRO 3.0.B for the system returned to service under administrative control to perform the testing required to demonstrate OPERABILITY.

D 3.0 ODCM Surveillance Requirement (DSR) Applicability

DSR 3.0.1 DSRs shall be met during the MODES or other specified conditions in the Applicability for individual DLCOs, unless otherwise stated in the DSR. Failure to meet a Surveillance, whether such failure is experienced during the performance of the Surveillance or between performances of the Surveillance, shall be failure to meet the DLCO. Failure to perform a Surveillance within the specified Frequency shall be failure to meet the DLCO except as provided in DSR 3.0.3. Surveillances do not have to be performed on inoperable equipment or variables outside specified limits.

DSR 3.0.2 The specified Frequency for each DSR is met if the Surveillance is performed within 1.25 times the interval specified in the Frequency, as measured from the previous performance or as measured from the time a specified condition of the Frequency is met.

For Frequencies specified as "once," the above interval extension does not apply.

If a Completion Time requires periodic performance on a "once per . . ." basis, the above Frequency extension applies to each performance after the initial performance.

Exceptions to this Specification are stated in the individual Specifications.

DSR 3.0.3 If it is discovered that a Surveillance was not performed within its specified Frequency, then compliance with the requirement to declare the DLCO not met may be delayed, from the time of discovery, up to 24 hours or up to the limit of the specified Frequency, whichever is greater. This delay period is permitted to allow performance of the Surveillance. A risk evaluation shall be performed for any Surveillance delayed greater than 24 hours and the risk impact shall be managed.

If the Surveillance is not performed within the delay period, the DLCO must immediately be declared not met, and the applicable Condition(s) must be entered.

When the Surveillance is performed within the delay period and the Surveillance is not met, the DLCO must immediately be declared not met, and the applicable Condition(s) must be entered.

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.1 Liquid Effluents Concentration

DLCO 3.1.1 The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (Figure D 4.1-1) shall be limited to:

a. The MPCW concentrations as defined in D1.1 for radionuclides other than dissolved or entrained noble gases; and

b. 2×10^{-4} µCi/ml total activity concentration for dissolved or entrained noble gases.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeds limits.	A.1 Initiate action to restore concentration to within limits.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.1.1.1	Perform radioactive liquid waste sampling and activity analysis.	In accordance with Table D 3.1.1-1
DSR 3.1.1.2	Verify the results of the DSR 3.1.1.1 analyses to assure that the concentrations at the point of release are maintained within the limits of DLCO 3.1.1.	In accordance with Table D 3.1.1-1

Table D 3.1.1-1 (Page 1 of 2)
Radioactive Liquid Waste Sampling and Analysis

LIQUID RELEASE TYPE	SAMPLE TYPE	SAMPLE FREQUENCY	MINIMUM ANALYSIS FREQUENCY	SAMPLE ANALYSIS	LOWER LIMIT OF DETECTION (LLD) in uCi/ml, (a),(g),(c)
1. Batch Waste Release Tanks (b) *eg, Waste Tanks,* *SG Draindowns, etc*	Grab Sample	Each Batch (h)	Each Batch (h)	Principal Gamma Emitters Mo-99, Ce-144 I-131	5E-7 5E-6 1E-6
	Grab Sample	One batch per 31 days (h)	31 days	Dissolved and Entrained Gases (gamma emitters)	1E-5
	Composite (d)	Each batch (h)	31 days	H-3 Gross Alpha	1E-5 1E-7
	Composite (d)	Each batch (h)	92 days	Sr-89, Sr-90	5E-8
				Fe-55	1E-6
2. Continuous Releases (e) *eg, SG Blowdown,* *U1 NCD,* *U1 SFDS,* *etc*	Composite (d)	Composite	7 days	Principal Gamma Emitters (c) Mo-99, Ce-144 I-131	5E-7 5E-6 1E-6
	Grab Sample	31 days	31 days	Dissolved and Entrained Gases (gamma emitters)	1E-5
	Composite (d)	Composite	31 days	H-3	1E-5
				Gross Alpha	1E-7
			92 days	Sr-89, Sr-90	5E-8
				Fe-55	1E-6
3. Service Water (in Radiologically Controlled Areas)	Grab Sample	31 days	31 days	Gamma and Beta emitters (j)	Per liquid batch releases, above.
4. Turbine Hall Drains, SG Feedwater (i)	Composite (d)	Composite	7 days	Gamma and Beta emitters (j)	Per liquid batch releases, above.

Table D 3.1.1-1 (Page 2 of 2)
Radioactive Liquid Waste Sampling and Analysis

(a) The LLD is defined as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal. The LLD shall be determined in accordance with the methodology and parameters in the ODCM. 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 posterior (after-the-fact) limit for a particular measurement.

(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 by the method described in Part II, Section 1.4 to assure representative sampling.

(c) The principal gamma emitters for which the LLD applies include the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. Ce-144 shall also be measured, but with an LLD of 5×10^{-6} μCi/ml. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identified, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report pursuant to Specification D 5.2.

(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, e.g., from a volume of a system that has an input flow during the continuous release.

(f) When operational or other limitations preclude specific gamma radionuclide analysis in batch releases, the provisions of Regulatory Guide 1.21 (Revision 1), Appendix A Section C.4 and Appendix A, Section B shall be followed.

(g) For certain radionuclides with low gamma yield or low energies, or for certain radionuclide mixtures, it may not be possible to measure radionuclides in concentration near the LLD. Under these circumstances, the LLD may be increased in inverse proportion to the magnitude of the gamma yield (i.e., $5 \times 10^{-7}/I$ where I is the photon abundance expressed as a decimal fraction).

(h) Complete prior to each release.

(i) Steam Generator Feedwater and Turbine Hall Drains are adequately monitored from Steam Generator Blowdown Composites. Increased monitoring need only be performed when a Primary to Secondary leak exists, as defined in RECS Section D.1.1.

(j) Beta emitters need only be analyzed if gamma emitters have been positively identified.

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.2 Liquid Effluents Dose

DLCO 3.1.2 The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials released in liquid effluents from each unit to UNRESTRICTED AREAS (Figure D 4.1-1) shall be limited to:

a. $\leq$ 1.5 mrem to the whole body and $\leq$ 5 mrem to any organ during any calendar quarter; and

b. $\leq$ 3 mrem to the whole body and $\leq$ 10 mrem to any organ during any calendar year.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Calculated dose to a MEMBER OF THE PUBLIC from the release of radioactive materials in liquid effluents to UNRESTRICTED AREAS exceeds limits.	A.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that (1) Identifies the cause(s) for exceeding the limit(s) and (2) 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 DLCO 3.1.2.	30 days

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Calculated dose to a MEMBER OF THE PUBLIC from the release of radioactive materials in liquid effluents exceeds 2 times the limits.	B.1 Calculate the annual dose to a MEMBER OF THE PUBLIC which includes contributions from direct radiation from the units (including outside storage tanks, etc.).	Immediately
	<u>AND</u>	
	B.2 Verify that the limits of DLCO 3.4 have not been exceeded.	Immediately
C. Required Action B.2 and Associated Completion time not met.	C.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report, as defined in 10 CFR 20.2203 (a)(4), of Required Action A.1 shall also include the following: (1) The corrective action(s) to be taken to prevent recurrence of exceeding the limits of DLCO 3.4 and the schedule for achieving conformance, (2) An analysis that estimates the 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), and (3) Describes the levels of radiation and concentrations of radioactive material involved and the cause of the exposure levels or concentrations.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.1.2.1	Determine cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year.	31 days

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.3 Liquid Radwaste Treatment System

DLCO 3.1.3 The Liquid Radwaste Treatment System shall be in operation when projected liquid effluent doses, from each unit, to UNRESTRICTED AREAS (Figure D 4.1-1) would be:

a. > 0.06 mrem to the total body in a 31 day period; or

b. >0.2 mrem to any organ in a 31 day period.

APPLICABILITY: Prior to each release.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive liquid waste being discharged without treatment. AND Projected doses due to the liquid effluent, from the unit, to UNRESTRICTED AREAS would exceed limits.	A.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that includes: (1) An explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability, (2) Action(s) taken to restore the inoperable equipment to OPERABLE status, and (3) Summary description of action(s) taken to prevent a recurrence.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.1.3.1	Project the doses due to liquid effluents from each unit to UNRESTRICTED AREAS.	31 days

D 3.1 LIQUID EFFLUENTS

D 3.1.4 Liquid Holdup Tanks

DLCO 3.1.4 Radioactive liquid contained in unprotected outdoor liquid storage tanks shall be limited to ≤ 10 Curies, excluding tritium and dissolved or entrained gases.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Level of radioactivity exceeds the limits in any listed tank: *U2 & U3 PWSTs* *U2 & U3 RWSTs* *U1 Waste Dist Storage Tanks* *U3 Monitor Tanks* *U3 CPF High/Low TDS Tanks* *Outdoor Temporary Tanks*	A.1 Suspend addition of radioactive material. <u>AND</u> A.2 Initiate measures to reduce content to within the limits. <u>AND</u> A.3 Describe the events leading to the condition in the Radioactive Effluent Release Report.	Immediately 48 hours Prior to submittal of next Radioactive Effluent Release Report

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.1.4.1	Determine that the quantity of radioactivity in outdoor liquid unprotected tanks (listed above) does not exceed the limit.	31 days, during periods where radioactive liquid is being added to the tanks, in accordance with the methodology and parameters of the ODCM

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.1 Gaseous Effluents Dose Rate

DLCO 3.2.1 The dose rate from radioactive materials released in gaseous effluents from the site to areas at or beyond the SITE BOUNDARY (Figure D 4.1-1) shall be limited to:

a. For noble gases, ≤ 500 mrem/yr to the whole body and ≤ 3000 mrem/yr to the skin and

b. For I-131, tritium (H-3) and all radionuclides in particulate form with half-lives > 8 days, ≤ 1500 mrem/yr to any organ.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The dose rate(s) at or beyond the SITE BOUNDARY due to radioactive gaseous effluents exceeds limits.	A.1 Restore the release rate to within the limit.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.2.1.1	The dose rate from noble gases in gaseous effluents shall be determined to be within the limits of DLCO 3.2.1.a.	In accordance with Table D 3.2.1-1
DSR 3.2.1.2	The dose rate from I-131, H-3 and all radionuclides in particulate form with half-lives > 8 days in gaseous effluents shall be determined to be within the limits of DLCO 3.2.1.b.	In accordance with Table D 3.2.1-1

Table D 3.2.1-1 (Page 1 of 2)
Radioactive Gaseous Waste Sampling and Analysis

GASEOUS RELEASE TYPE		SAMPLE TYPE	SAMPLE FREQUENCY	ANALYSIS FREQUENCY	SAMPLE ANALYSIS	SAMPLE LOWER LIMIT OF DETECTION (LLD) (a)
1. Waste Gas Storage Tank		Grab Sample	Each Tank (h)	Each Tank (h)	Principal Noble Gas (NG) Gamma Emitters (b)	1E-4 µCi/cc
2. Vapor Containment	Purge	Grab Sample	Each Purge (h)	Each Purge (h)	Principal NG Gamma Emitters (b)	1E-4 µCi/cc
	Press Relief	Grab Sample	31 days (i)	31 days (i)	Principal NG Gamma Emitters (b)	1E-4 µCi/cc
3. Condenser Air Ejector		Grab Sample	31 days	31 days	Principal NG Gamma Emitters (b)	1E-4 µCi/cc
4. Continuous Ventilation: a. Main Plant Vent (unit 2) b. Stack Vent (unit 1) c. Main Plant Vent (unit 3) d. Radioactive Machine Shop Vent (unit 3) e. Admin Bldg Vent (unit 3)		Grab Sample	31 days (c)	31 days (c)	Principal NG Gamma Emitters (b)	1E-4 µCi/cc
		H-3 Specific	Continuous	31 days (e)	H-3	1E-6 µCi/cc
		Charcoal Sample	Continuous (f)	7 days (c), (g)	I-131	1E-12 µCi/cc
		Particulate Sample	Continuous (f)	7 days (c), (g)	Principal Gamma Emitters (b) (I-131, Others)	1E-11 µCi/cc
		Composite Particulate Sample	Continuous (f)	31 days	Gross Alpha	1E-11 µCi/cc
		Composite Particulate Sample	Continuous (f)	92 days	Sr-89 / Sr-90	1E-11 µCi/cc
		Noble Gas Monitor	Continuous (f)	Continuous (f)	Noble Gases Gross Beta or Gamma	1E-6 µCi/cc (d)

Table D 3.2.1-1 (Page 2 of 2)
Radioactive Gaseous Waste Sampling and Analysis

(a) The LLD is defined, for purposes of these Specifications, 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. The LLD shall be determined in accordance with the methodology and parameters in the ODCM.

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.

(b) The principal gamma emitters for which the LLD Control 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. Other identifiable gamma peaks (I-131 in particulate form, for example), together with those of the above nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report pursuant to Section D 5.2.

(c) IF following a shutdown, startup, or a thermal power change (within one hour) exceeding 15 percent of RATED THERMAL POWER, analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has increased by a factor of 3 or more, AND the noble gas monitor shows that effluent activity has increased by a factor of 3 or more THEN:

1) Sample the main Plant Vent for Noble Gases within 24 hours, AND

2) Sample the main Plant Vent for Iodine and Particulate once per 24 hours for at least 7 days with analyses completed within 48 hours of sample changeout. The LLDs of these samples may be increased by a factor of 10.

(d) This value is the established Radiation Monitor sensitivity (minimum).

(e) Grab samples can be used as alternative to continuous sampling, provided the periodicity of these grab samples is increased from monthly to once per 24 hours when the refueling canal is flooded, or at least once per 7 days when spent fuel is in the Spent Fuel Pool.

(f) The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Specifications D 3.2.1, D 3.2.2 and D 3.2.3.

(g) Continuous 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.

Additionally, IF routine Iodine sampling indicates I-131 in any of the listed continuous streams, THEN collect a 24 hour sample from the applicable vent (within 48 hours) for short-lived Iodine isotope quantification, on a periodicity not to exceed once per 31 days. The LLDs of these samples may be increased by a factor of 10.

(h) Complete prior to each release.

(i) Vapor Containment noble gas shall be sampled at least monthly to ensure Pressure Reliefs are quantified with an accurate isotopic mixture. Containment noble gas radiation monitor readings can be used for quantification of Pressure Reliefs, provided the monitor readings are consistent with those observed during recent (at least monthly) grab samples. Sample data is adjusted by the noble gas radiation monitor reading for purposes of quantification of each release. Should the monitor be inoperable, a containment noble gas grab sample is required within 24 hours prior to the Pressure Relief. Should BOTH the containment noble gas and particulate monitors be inoperable, two independent samples of the VC are required prior to a Pressure Relief.

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.2 Gaseous Effluent Dose - Noble Gas

DLCO 3.2.2 The air dose from noble gases released in gaseous effluents from each unit to areas at or beyond the SITE BOUNDARY (Figure D 4.1-1) shall be limited to:

a. ≤ 5 mrad to the whole body from gamma radiation and
≤ 10 mrad to the skin from beta radiation during any calendar quarter,

and

b. ≤ 10 mrad to the whole body from gamma radiation and
≤ 20 mrad to the skin from beta radiation during any calendar year.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The calculated air dose at or beyond the SITE BOUNDARY due to noble gases released in gaseous effluents exceeds limits.	A.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that (1) Identifies the cause(s) for exceeding the limit(s) and (2) 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 DLCO 3.2.2.	30 days

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Calculated dose to a MEMBER OF THE PUBLIC from the release of radioactive materials in airborne effluents exceeds 2 times the limits.	B.1 Calculate the annual dose to a MEMBER OF THE PUBLIC which includes contributions from direct radiation from the units (including outside storage tanks, etc.).	Immediately
	<u>AND</u>	
	B.2 Verify that the limits of DLCO 3.4 have not been exceeded.	Immediately
C. Required Action B.2 and Associated Completion time not met.	C.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report, as defined in 10 CFR 20.2203 (a)(4), of Required Action A.1 shall also include the following: (1) The corrective action(s) to be taken to prevent recurrence of exceeding the limits of DLCO 3.4 and the schedule for achieving conformance, (2) An analysis that estimates the 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), and (3) Describes the levels of radiation and concentrations of radioactive material involved and the cause of the exposure levels or concentrations.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.2.2.1	Determine cumulative dose contributions for the current calendar quarter and current calendar year.	31 days

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.3 Gaseous Effluent Dose – Iodine and Particulate

DLCO 3.2.3 The dose to a MEMBER OF THE PUBLIC from I-131, tritium, and all radionuclides in particulate form with half-lives > 8 days, in gaseous effluents, released from each unit to areas at or beyond the SITE BOUNDARY (Figure D 4.1-1) shall be limited to:

a. ≤ 7.5 mrem to any organ during any calendar quarter, and

b. ≤ 15 mrem to any organ during any calendar year.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The dose from I-131, tritium, and radioactive material in particulate form with half-lives > 8 days released in gaseous effluents at or beyond the SITE BOUNDARY exceeds limits.	A.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that (1) Identifies the cause(s) for exceeding the limit(s) and (2) 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 DLCO 3.2.3.	30 days

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Calculated dose to a MEMBER OF THE PUBLIC from the release of radioactive materials in liquid effluents exceeds 2 times the limits.	B.1 Calculate the annual dose to a MEMBER OF THE PUBLIC which includes contributions from direct radiation from the units (including outside storage tanks, etc.).	Immediately
	AND	
	B.2 Verify that the limits of DLCO 3.4 have not been exceeded.	Immediately
C. Required Action B.2 and Associated Completion time not met.	C.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report, as defined in 10 CFR 20.2203 (a)(4), of Required Action A.1 shall also include the following: (1) The corrective action(s) to be taken to prevent recurrence of exceeding the limits of DLCO 3.4 and the schedule for achieving conformance, (2) An analysis that estimates the 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), and (3) Describes the levels of radiation and concentrations of radioactive material involved and the cause of the exposure levels or concentrations.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.2.3.1	Determine cumulative dose contributions for the current calendar quarter and current calendar year for I-131, tritium, and radioactive material in particulate form with half-lives > 8 days.	31 days

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.4 Gaseous Radwaste Treatment System

DLCO 3.2.4 The GASEOUS RADWASTE TREATMENT SYSTEM shall be in operation when projected gaseous effluent doses, from each unit, at and beyond the SITE BOUNDARY (Figure D 4.1-1) would be:

a. > 0.2 mrad for gamma radiation; and

b. > 0.4 mrad for beta radiation in a 31 day period.

APPLICABILITY: Prior to each release.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive gaseous waste is being discharged without treatment. <u>AND</u> Projected doses due to the gaseous effluent, from the unit, at and beyond the SITE BOUNDARY would exceed limits.	A.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that includes the following: (1) Identification of any inoperable equipment or subsystems and the reason for the inoperability, (2) Action(s) taken to restore the inoperable equipment to OPERABLE status, and (3) Summary description of action(s) taken to prevent a recurrence.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.2.4.1	Project the doses due to gaseous effluents from each unit at and beyond the SITE BOUNDARY.	31 days

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.5 Ventilation Exhaust Treatment System

DLCO 3.2.5 The VENTILATION EXHAUST TREATMENT SYSTEM shall be in operation when projected gaseous effluent doses, from each unit, at and beyond the SITE BOUNDARY (Figure D 4.1-1) would be:

a. > 0.2 mrad air dose from gamma radiation; and

b. > 0.4 mrad air dose from beta radiation in a 31 day period; or

c. > 0.3 mrem to any organ in a 31 day period.

APPLICABILITY: Prior to each release.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive gaseous waste is being discharged without treatment. AND Projected doses due to gaseous effluent, from each unit, to areas at or beyond the SITE BOUNDARY would exceed limits.	A.1 Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that includes the following: (1) Identification of any inoperable equipment or subsystems and the reason for the inoperability, (2) Action(s) taken to restore the inoperable equipment to OPERABLE status, and (3) Summary description of action(s) taken to prevent a recurrence.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.2.5.1	Project the doses from gaseous releases from each unit to areas at and beyond the SITE BOUNDARY when the GASEOUS RADWASTE TREATMENT SYSTEMS are not being fully utilized.	31 days

D 3.2 GASEOUS EFFLUENTS

D 3.2.6 Gas Storage Tanks

DLCO 3.2.6 The radioactivity contained in each gas storage tank shall be limited to the following unit-specific curie levels of noble gas (considered as Xe-133):

Unit 2: $\leq$ 29,761 Curies   Unit 3: $\leq$ 50,000 Curies

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Level of radioactivity exceeds the limits.	A.1 Suspend addition of radioactive material.	Immediately
	<u>AND</u>	
	A.2 Reduce content to within the limits.	48 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.2.6.1	The quantity of radioactive material contained in each gas storage tank shall be determined to be within the limits above, at least once per 24 hours when radioactive materials are being added to the tank in accordance with the methodology and parameters in the ODCM.	24 hours during addition of radioactive material to the tank

D 3.3 INSTRUMENTATION

D 3.3.1 Radioactive Liquid Effluent Monitoring Instrumentation

DLCO 3.3.1 The unit-specific radioactive liquid effluent monitoring instrumentation channels shown in Table D 3.3.1-1 shall be OPERABLE with:

a. The minimum OPERABLE channel(s) in service.

b. The alarm/trip setpoints set to ensure that the limits of DLCO 3.1.1 are not exceeded.

APPLICABILITY: According to Table D 3.3.1-1 for the applicable unit.

ACTIONS

-- NOTE --
Separate condition entry is allowed for each channel.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required.	A.1 Suspend the release of radioactive liquid effluents monitored by the affected channel.	Immediately
	<u>OR</u>	
	A.2 Declare the channel inoperable.	Immediately
	<u>OR</u>	
	A.3 Change the setpoint so it is acceptably conservative.	Immediately

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. One or more required channels inoperable.	B.1 Enter the Condition referenced in Table D 3.3.1-1 for the channel.	Immediately
	AND	
	B.2 Restore inoperable channel(s) to OPERABLE status.	30 days
C. As required by Required Action B.1 and referenced in Table D 3.3.1-1.	C.1 Analyze at least 2 independent samples in accordance with Table D 3.1.1-1.	Prior to initiating a release
	AND	
	C.2 -----------NOTE---------------- Verification Action will be performed by at least 2 separate technically qualified members of the facility staff. ----------------------------------	
	Independently verify the release rate calculations and discharge line valving.	Prior to initiating a release
D. As required by Required Action B.1 and referenced in Table D 3.3.1-1.	D.1 Collect and analyze grab samples for radioactivity at a limit of detection of at least 5×10^{-7} μCi/ml.	12 hours AND Once per 12 hours thereafter

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
E. As required by Required Action B.1 and referenced in Table D 3.3.1-1.	E.1 Collect and analyze grab samples for radioactivity at a limit of detection of at least 5×10^{-7} µCi/ml, when specific activity is > 0.01 µCi/gm DOSE EQUIVALENT I-131.	12 hours <u>AND</u> Once per 12 hours thereafter
	<u>OR</u>	
	E.2 Collect and analyze grab samples for radioactivity at a limit of detection of at least 5×10^{-7} µCi/ml, when specific activity is ≤ 0.01 µCi/gm DOSE EQUIVALENT I-131.	24 hours <u>AND</u> Once per 24 hours thereafter
F. As required by Required Action B.1 and referenced in Table D 3.3.1-1.	F.1 ---------------NOTE------------ Pump performance curves generated in place may be used to estimate flow. ---------------------------------- Estimate the flow rate during actual releases.	4 hours <u>AND</u> Once per 4 hours thereafter
G. As required by Required Action B.1 and referenced in Table D 3.3.1-1.	G.1 Estimate tank liquid level.	Immediately <u>AND</u> During liquid additions to the tank
H. Required Action B.2 and associated Completion Time not met.	H.1 Explain in the next Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.	In accordance with Radioactive Effluent Release Report

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
I. Required Action and associated Completion Time for Condition C, D, E, or F not met.	I.1 Suspend liquid effluent releases monitored by the inoperable channel(s).	Immediately
J. Required Action and associated Completion Time for Condition G not met.	J.1 Suspend liquid additions to the tank monitored by the inoperable channel(s).	Immediately

SURVEILLANCE REQUIREMENTS

-----NOTE-----
Refer to Table D 3.3.1-1 to determine which DSRs apply for each function.

	SURVEILLANCE	FREQUENCY
DSR 3.3.1.1	Perform CHANNEL CHECK.	24 hours
DSR 3.3.1.2	Perform CHANNEL CHECK by verifying indication of flow during periods of release.	24 hours on any day on which continuous, periodic, or batch releases are made
DSR 3.3.1.3	Perform SOURCE CHECK.	Prior to release
DSR 3.3.1.4	Perform SOURCE CHECK.	31 days
DSR 3.3.1.5	Perform CHANNEL OPERATIONAL TEST	92 days

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
DSR 3.3.1.6	Perform CHANNEL OPERATIONAL TEST. The CHANNEL OPERATIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation (or control panel indications/display) occurs if the instrument indicates measured levels above the alarm/trip setpoint	92 days
DSR 3.3.1.7	Perform CHANNEL OPERATIONAL TEST. The CHANNEL OPERATIONAL TEST shall also demonstrate control room alarm annunciation (or control panel indications/display) occurs if any of the following conditions exist, instrument indicates measured levels above the alarm setpoint, instrument controls not set in operate mode.	92 days
DSR 3.3.1.8	Perform CHANNEL OPERATIONAL TEST	24 months
DSR 3.3.1.9	Perform CHANNEL CALIBRATION	24 months

Table D 3.3.1-1 (page 1 of 3)
Radioactive Liquid Effluent Monitoring Instrumentation – Units 1, 2, and 3

INSTRUMENT	APPLICABILITY OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER INSTRUMENT	CONDITIONS REFERENCED FROM REQUIRED ACTION B.1	SURVEILLANCE REQUIREMENTS
1. **Gross Radioactivity Monitors Providing Alarm and Automatic Termination of Release**				
a. Unit 2 Liquid Radioactive Waste Effluent Line *(R-54)*	(a)	1	C	DSR 3.3.1.1 DSR 3.3.1.3 DSR 3.3.1.6 (e) DSR 3.3.1.9 (d)
b. Unit 2 Steam Generator Effluent Blowdown Line *(R-49)*	(a) (i)	1	E	DSR 3.3.1.1 DSR 3.3.1.4 DSR 3.3.1.6 (e) DSR 3.3.1.9 (d)
c. Unit 3 Liquid Radioactive Waste Effluent Line *(R-18)*	(a)	1	C	DSR 3.3.1.1 DSR 3.3.1.3 DSR 3.3.1.6 (e) DSR 3.3.1.9 (d)
d. Unit 3 Condensate Polisher Facility (CPF) Waste Line *(R-61)*	(a)	1	C	DSR 3.3.1.1 (h) DSR 3.3.1.4 (h) DSR 3.3.1.6 (e) DSR 3.3.1.9 (d)
e. Unit 3 Steam Generator Effluent Blowdown Line *(R-19)*	(a) (i)	1	E	DSR 3.3.1.1 DSR 3.3.1.4 DSR 3.3.1.6 (e) DSR 3.3.1.9 (d)
2. **Gross Beta or Gamma Radioactivity Monitors Providing Alarm but NOT Providing Automatic Termination of Release**				
a. Unit 1 or 2 Service Water or River Water Effluent Lines - VC FCU *(R-46* or *R-53)* - 21 CCW HX *(R-39)* - 22 CCW HX *(R-40)* - SBBPS HX *(R-52)*	(a)	1 (g)	D	DSR 3.3.1.1 DSR 3.3.1.4 DSR 3.3.1.7 (e) DSR 3.3.1.9 (d)
b. Unit 1 Secondary Boiler Blowdown Effluent Line *(R-51)*	(a)	1	D	DSR 3.3.1.1 DSR 3.3.1.4 DSR 3.3.1.7 (e) DSR 3.3.1.9 (d)
c. Unit 1 Sphere Foundation Drain Sump Effluent Line *(R-62)*	(a)	1	D	DSR 3.3.1.1 DSR 3.3.1.4 DSR 3.3.1.7 (e) DSR 3.3.1.9 (d)
d. Unit 3 Service Water Effluent Lines - SW for VC FCU return *(R-16A or R-16B)*	(a)	1 (g)	D	DSR 3.3.1.1 DSR 3.3.1.4 DSR 3.3.1.7 (e) DSR 3.3.1.9 (d)
- SW for CCW Heat Exchanger *(R-23)*	(a)	1	D	DSR 3.3.1.1 DSR 3.3.1.4 DSR 3.3.1.7 (e) DSR 3.3.1.9 (d)

Table D 3.3.1-1 (page 2 of 3)
Radioactive Liquid Effluent Monitoring Instrumentation – Units 1, 2, and 3

INSTRUMENT	APPLICABILITY OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER INSTRUMENT	CONDITIONS REFERENCED FROM REQUIRED ACTION B.1	SURVEILLANCE REQUIREMENTS
3. **Flow Rate Measurement Devices**				
a. Unit 2 Liquid Radwaste Effluent Line *(CT971-FRE, CT971-FIE)*	(a)	1	F	DSR 3.3.1.2 DSR 3.3.1.5 DSR 3.3.1.9
b. Unit 2 Steam Generator Blowdown Effluent Line *(FI-1241 to FI-1244, and FT-1241 to FT-1244)*	(a) (i)	1	F	DSR 3.3.1.2 DSR 3.3.1.5 DSR 3.3.1.9
c. Unit 1 North Curtain Drain Effluent Line (f) *(LW-FE-12)*	(a)	1	F	DSR 3.3.1.2 DSR 3.3.1.9
d. Unit 1 Sphere Foundation Drain Sump (f) *(LW-FZ-100)*	(a)	1	F	DSR 3.3.1.2 DSR 3.3.1.9
e. Unit 3 Liquid Radwaste Effluent Line *(FE-1064, FI-1064)*	(a)	1	F	DSR 3.3.1.2 DSR 3.3.1.5 DSR 3.3.1.9
f. Unit 3 Cond Polisher (CPF) Effluent Line *(3LG-FIT-41, (3LG-FM-41, 3LG-FR-41)*	(a)	1	F	DSR 3.3.1.2 DSR 3.3.1.5 DSR 3.3.1.9
g. Unit 3 Steam Generator Blowdown Effluent Line *(FT-545 to 548, FIR-543,544)*	(a) (i)	1	F	DSR 3.3.1.2 DSR 3.3.1.5 DSR 3.3.1.9
4. **Tank Level Indicating Devices** (c)				
a. Unit 1 Waste Distillate Storage Tank #13 *(CT967-LIE-1, LIE-2)*	(a)	1	G	DSR 3.3.1.1 (b) DSR 3.3.1.5 DSR 3.3.1.9
b. Unit 1 Waste Distillate Storage Tank #14 *(CT974-LIE-1, LIE-2)*	(a)	1	G	DSR 3.3.1.1 (b) DSR 3.3.1.5 DSR 3.3.1.9
c. Unit 2 Primary Water Storage Tank *(LT-1131, LI-1131)*	(a)	1	G	DSR 3.3.1.1 (b) DSR 3.3.1.5 DSR 3.3.1.9
d. Unit 2 Refueling Water Storage Tank *(LI-920, LT-920, LT-5751)*	(a)	1	G	DSR 3.3.1.1 (b) (j)
e. Unit 3 Refueling Water Storage Tank *(LI-920A, LI-920B)*	(a)	1	G	DSR 3.3.1.1 (b) (j)

Table D 3.3.1-1 (page 3 of 3)
Radioactive Liquid Effluent Monitoring Instrumentation – Units 1, 2, and 3

INSTRUMENT	APPLICABILITY OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER INSTRUMENT	CONDITIONS REFERENCED FROM REQUIRED ACTION B.1	SURVEILLANCE REQUIREMENTS
4. **Tank Level Indicating Devices** (c)	(continued)			
f. Unit 3 Primary Water Storage Tank *(LT-1131, LI-1131)*	(a)	1	G	DSR 3.3.1.1 (b) DSR 3.3.1.8 DSR 3.3.1.9
g. Unit 3 Monitor Tank #31 *(LI-181)*	(a)	1	G	DSR 3.3.1.1 (b) DSR 3.3.1.8 DSR 3.3.1.9
h. Unit 3 Monitor Tank #32 *(LI-180)*	(a)	1	G	DSR 3.3.1.1 (b) DSR 3.3.1.8 DSR 3.3.1.9
i. Unit 3 CPF High Total Dissolved Solids Tank *(3-LG-LI-12)*	(a)	1	G	DSR 3.3.1.1 (b) DSR 3.3.1.8 DSR 3.3.1.9 (h)
j. Unit 3 CPF Low Total Dissolved Solids Tank *(3-LG-LI-22)*	(a)	1	G	DSR 3.3.1.1 (b) DSR 3.3.1.8 DSR 3.3.1.9 (h)

NOTES

(a) Applicability is defined as anytime releases are being performed via this pathway. During periods of release, channels shall be OPERABLE and in service on a continuous basis, except that outages are permitted, within the time frame of the specified action, for the purpose of maintenance and performance of required CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, or CHANNEL OPERATIONAL TEST.

(b) During liquid addition to the associated tank.

(c) 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 do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system, as specified in RECS Section D 3.1.4.

(d) Radioactive calibration standards used for CHANNEL CALIBRATIONS shall be analyzed with instrumentation which is calibrated NIST traceable standards. Standards from suppliers who participate in approved measurement assurance activities with NIST are acceptable.

(e) Test will include: Low sample flow, no counts per minute failure, and alarm setpoint reached. The CHANNEL OPERATIONAL TEST does not include testing or trouble shooting, nor the performance of any equipment diagnostic capabilities provided with the monitor installation.

(f) Flow rate for these continuous intermittent release pathways is normally obtained from a flow totalizer on the system outlet.

(g) One instrument per operating Service Water system is required. For example, unit-specific VC FCU monitors are redundant and compensatory actions are only required when BOTH monitors are OOS for any one unit. However, for Unit 2's CCW HX's (R-39 and R-40), the appropriate SW monitor is required to be in service anytime the effected loop is in service.

(h) Channel and Source Checks for R-61 in Unit 3's Condensate Polisher Facility (CPF) are required only during or after a primary to secondary leak, as defined in RECS Section 1. Surveillances on the flow meter and level instruments are performed to be prepared for this type of leak. The level instrument calibration is also required by the SPDES permit.

(i) Applicable for Continuous Steam Generator Blowdown to the environment only. These requirements are not applicable for Batch Steam Generator Draindowns.

(j) Surveillance requirements for the RWST level instruments (CHECKS and CALIBRATIONS) are prescribed in Technical Specifications (Sections 3.3.3 and 3.5.4 for Unit 2 and Section 3.5.4 for Unit 3). However, the requirement for a daily channel check (when making additions to the tank, per earlier footnote b) is maintained in the ODCM per the original licensing bases (NUREG 0472) and the 10 curie rule.

D 3.3 INSTRUMENTATION

D 3.3.2 Radioactive Gaseous Effluent Monitoring Instrumentation

DLCO 3.3.2 The radioactive gaseous effluent monitoring instrumentation channels shown in Table D 3.3.2-1 shall be OPERABLE with:

a. The minimum OPERABLE channel(s) in service.

b. The alarm/trip setpoints set to ensure that the limits of DLCO 3.2.1 are not exceeded.

APPLICABILITY: According to Table D 3.3.2-1.

ACTIONS

-- NOTE --
Separate condition entry is allowed for each channel.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required.	A.1 Suspend the release of radioactive gaseous effluents monitored by the affected channel.	Immediately
	<u>OR</u>	
	A.2 Declare the channel inoperable.	Immediately
	<u>OR</u>	
	A.3 Change the setpoint so it is acceptably conservative.	Immediately
B. One or more channels inoperable.	B.1 Enter the Condition referenced in Table D 3.3.2-1 for the channel.	Immediately
	<u>AND</u>	
	B.2 Restore inoperable channel(s) to OPERABLE status.	30 days

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
C. As required by Required Action B.1 and referenced in Table D 3.3.2-1.	C.1	Take grab samples.	12 hours AND Once per 12 hours thereafter
	AND		
	C.2	Analyze samples for gross activity.	24 hours from time of sampling completion
D. As required by Required Action B.1 and referenced in Table D 3.3.2-1.	D.1	Estimate the flow rate for the inoperable channel(s).	4 hours AND Once per 4 hours thereafter
E. As required by Required Action B.1 and referenced in Table D 3.3.2-1.	E.1	Continuously collect samples using auxiliary sampling equipment as required in Table D 3.2.1-1.	8 hours
F. As required by Required Action B.1 and referenced in Table D 3.3.2-1.	F.1	Determine the radioactive content of the receiving gas decay tank is in compliance with DLCO 3.2.1.	24 hours AND Once per 24 hours thereafter

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
G. As required by Required Action B.1 and referenced in Table D 3.3.2-1, for gas decay tank releases.	G.1 Analyze at least 2 independent samples in accordance with Table D 3.2.1-1. AND G.2 -----------NOTE--------------- Verification Action will be performed by at least 2 separate technically qualified members of the facility staff. ----------------------------------- Independently verify the release rate calculations and discharge line valving.	Prior to initiating a gas decay tank release Prior to initiating a gas decay tank release
H. Required Action B.2 and associated Completion Time not met.	H.1 Explain in the next Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.	In accordance with Radioactive Effluent Release Report frequency
I. Required Action and associated Completion Time for Condition C, D, E or F not met.	I.1 Suspend gaseous effluent releases monitored by the inoperable channel(s).	Immediately
J. Required Action and associated Completion Time for Condition G not met.	J.1 Suspend gaseous effluent releases from Waste Gas Holdup System.	Immediately
K. As required by Required Action B.1 and referenced in Table D 3.3.2-1 (in MODES 1-4 only).	K.1 Take Noble Gas grab samples and analyze for gross activity. K.2 Immediately suspend PURGING the VC.	Prior to venting Vapor Containment (VC)

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.3.2.1	Perform CHANNEL CHECK.	24 hours
DSR 3.3.2.2	Perform CHANNEL CHECK.	7 days
DSR 3.3.2.3	Perform SOURCE CHECK.	Prior to release
DSR 3.3.2.4	Perform SOURCE CHECK.	31 days
DSR 3.3.2.5	Perform CHANNEL OPERATIONAL TEST. The test shall include 1) low sample flow, 2) no counts per minute failure, 3) a demonstration of the automatic isolation capability of this pathway and that control room alarm annunciation (or control panel indications/display) occurs if the instrument indicates measured levels above the alarm/trip setpoint. This test does NOT include testing of troubleshooting and equipment diagnostic capabilities provided with the monitor installation.	92 days
DSR 3.3.2.6	Perform CHANNEL OPERATIONAL TEST. The test shall include 1) low sample flow (except for Condenser Air Ejector monitors), 2) no counts per minute failure, 3) a demonstration that control room alarm annunciation (or control panel indications or display) occurs if the instrument indicates measured levels above the alarm setpoint, or the instrument controls are not set in operate mode. This test does NOT include testing of troubleshooting and equipment diagnostic capabilities provided with the monitor installation.	92 days
DSR 3.3.2.7	Perform CHANNEL CALIBRATION.	24 months

Table D 3.3.2-1 (page 1 of 4)
Radioactive Gaseous Effluent Monitoring Instrumentation – Units 1, 2, and 3

INSTRUMENT and APPLICABLE UNIT (1, 2, or 3)	APPLICABILITY OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER INSTRUMENT	CONDITIONS REFERENCED FROM REQUIRED ACTION B.1	SURVEILLANCE REQUIREMENTS
1. Waste Gas Holdup System				
a. Unit 2 Noble Gas Monitor, providing Alarm, *(R-50)*	(b)	1	F	DSR 3.3.2.1 DSR 3.3.2.4 DSR 3.3.2.6 DSR 3.3.2.7 (c)
b. Unit 3 Noble Gas Monitor, providing Alarm, *(R-20)*	(b)	1	F	DSR 3.3.2.1 DSR 3.3.2.4 DSR 3.3.2.6 DSR 3.3.2.7 (c)
2. Condenser Air Evacuation System				
a. Unit 2 Noble Gas Activity, *(R-45)*	(a)	1	C	DSR 3.3.2.1 DSR 3.3.2.4 DSR 3.3.2.6 (d) DSR 3.3.2.7 (c)
b. Unit 3 Noble Gas Activity, *(R-15)*	(a)	1	C	DSR 3.3.2.1 DSR 3.3.2.4 DSR 3.3.2.6 (d) DSR 3.3.2.7 (c)
3. Vapor Containment Atmosphere				
a. Unit 2 Noble Gas Activity Monitor, providing ALARM and automatic termination of release *(R-42)*	(a)	1	K	DSR 3.3.2.4 (g)
b. Unit 3 Noble Gas Activity Monitor, providing ALARM and automatic termination of release *(R-12)*	(a)	1	K	DSR 3.3.2.4 (g)

Table D 3.3.2-1 (page 2 of 4)
Radioactive Gaseous Effluent Monitoring Instrumentation – Units 1, 2, and 3

INSTRUMENT and APPLICABLE UNIT (1, 2, or 3)	APPLICABILITY OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER INSTRUMENT	CONDITIONS REFERENCED FROM REQUIRED ACTION B.1	SURVEILLANCE REQUIREMENTS
4. **Unit 2 Main Plant Vent**				
Radiation Monitor:				
a. Noble Gas Monitor *(R-44)*	(a) & (b)	1	C & G	DSR 3.3.2.1 DSR 3.3.2.4 DSR 3.3.2.5 DSR 3.3.2.7 (c)
Other Monitoring Equipment:				
b. Iodine Sampler	(a)	1	E	DSR 3.3.2.2
c. Particulate Sampler	(a)	1	E	DSR 3.3.2.2
d. Process Flow-Rate Monitor *(SV2-DPT, SV2-1-DPT, SV2-DPI)*	(a)	1	D	DSR 3.3.2.1 DSR 3.3.2.7
e. Sample Flow-Rate Monitor *(Chem Totalizer)*	(a)	1	D	DSR 3.3.2.1 DSR 3.3.2.7
5. **Unit 3 Main Plant Vent**				
Radiation Monitor:				
a. Noble Gas Monitor(s) *(R-14 or R-27)*	(a) & (b)	1	C & G	DSR 3.3.2.1 DSR 3.3.2.4 DSR 3.3.2.5 DSR 3.3.2.7 (c)
Other Monitoring Equipment:				
b. Iodine Sampler	(a)	1	E	DSR 3.3.2.2
c. Particulate Sampler	(a)	1	E	DSR 3.3.2.2
d. Process Flow-Rate Monitor *(from R-27's Kurz probes and RM80 processing computer)*	(a)	1	D	DSR 3.3.2.1 DSR 3.3.2.7
e. Sample Flow-Rate Monitor *(Chem Totalizer)*	(a)	1	D	DSR 3.3.2.1 DSR 3.3.2.7

Table D 3.3.2-1 (page 3 of 4)
Radioactive Gaseous Effluent Monitoring Instrumentation – Units 1, 2, and 3

INSTRUMENT and APPLICABLE UNIT (1, 2, or 3)	APPLICABILITY OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER INSTRUMENT	CONDITIONS REFERENCED FROM REQUIRED ACTION B.1	SURVEILLANCE REQUIREMENTS
6. **Unit 1 Stack Vent**				
Radiation Monitor:				
a. Noble Gas Monitor *(R-60)*	(a)	1	C	DSR 3.3.2.1 DSR 3.3.2.4 DSR 3.3.2.6 DSR 3.3.2.7 (c)
Other Monitoring Equipment:				
b. Iodine Sampler	(a)	1	E	DSR 3.3.2.2
c. Particulate Sampler	(a)	1	E	DSR 3.3.2.2
d. Process Flow-Rate Monitor *(SV1-DPT, SV1-FR)*	(a)	1	D	DSR 3.3.2.1 DSR 3.3.2.7
e. Sample Flow-Rate Monitor *(Chem Totalizer)*	(a)	1	D	DSR 3.3.2.1 DSR 3.3.2.7
7. **Unit 3 Radioactive Machine Shop (RAMS) Vent**				
Radiation Monitor:				
a. Noble Gas Monitor *(R-59)*	(a)	1	C	DSR 3.3.2.1 DSR 3.3.2.4 DSR 3.3.2.6 DSR 3.3.2.7 (c)
Other Monitoring Equipment:				
b. Iodine Sampler	(a)	1	E	DSR 3.3.2.2
c. Particulate Sampler	(a)	1	E	DSR 3.3.2.2
d. Process Flow-Rate Monitor *(from R-59's RM80 processor)*	(a)	1	D	DSR 3.3.2.1 DSR 3.3.2.7
e. Sample Flow-Rate Monitor *(Chem Totalizer)*	(a)	1	D	DSR 3.3.2.1 DSR 3.3.2.7

Table D 3.3.2-1 (page 4 of 4)
Radioactive Gaseous Effluent Monitoring Instrumentation – Units 1, 2, and 3

INSTRUMENT and APPLICABLE UNIT (1, 2, or 3)	APPLICABILITY OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER INSTRUMENT	CONDITIONS REFERENCED FROM REQUIRED ACTION B.1	SURVEILLANCE REQUIREMENTS
8. **Unit 3 Admin Bldg Vent** (f)				
Radiation Monitor:				
a. Noble Gas Monitor *(R-46)*	(a)	1	C	DSR 3.3.2.1 DSR 3.3.2.4 DSR 3.3.2.6 DSR 3.3.2.7 (c)
Other Monitoring Equipment:				
b. Iodine Sampler	(a)	1	E	DSR 3.3.2.2
c. Particulate Sampler	(a)	1	E	DSR 3.3.2.2
d. Sample Flow-Rate Monitor *(Chem Totalizer)*	(a)	1	D	DSR 3.3.2.1 DSR 3.3.2.7

NOTES

(a) During release via this pathway. Channels shall be OPERABLE and in service on a continuous basis, except that outages are permitted, within the time frame of the specified action for the purpose of maintenance and performance of required CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, or CHANNEL OPERATIONAL TEST.

(b) During waste gas holdup system operation (treatment for primary system off-gases).

(c) Radioactive Calibration Standards used for channel calibrations shall be traceable to the National Institute of Standards and Technology (NIST) or an aliquot of calibration gas shall be analyzed with instrumentation which is calibrated with NIST traceable standards. Standards from suppliers who participate in measurement assurance activities with NIST are acceptable.

(d) The CHANNEL OPERATIONAL TEST for the Condenser Air Ejector monitors does NOT require a loss of sample flow test.

(e) The main Plant Vents for Units 2 and 3 monitors the Fuel Storage Building vents, in addition to ventilation from the Primary Auxiliary Buildings.

(f) The Unit 3 Admin Bldg Controlled Area ventilation system does NOT have an installed process flow meter. Default fan flow is used in lieu of a measurement , per ODCM Part II, Section 3.1.11.

(g) Most surveillance requirements for Vapor Containment monitors are located in Technical Specifications, Section 3.3.6. Source checks, however, are NOT required per Technical Specifications. Since these checks are valuable to ensure accurate quantification of VC Pressure Reliefs (as described below), a monthly source check requirement is listed here, in addition to the requirements of Technical Specifications.

Grab samples of the Vapor Containment atmosphere are routinely collected at least monthly and compared to the gas monitor for use in quantification of VC Pressure Reliefs (by scaling the monitor reading for each release to the reading obtained at time of grab sample). If the noble gas monitor is inoperable, a grab samples shall be taken and analyzed within 24 hours prior to performing a Pressure Relief. During containment building ventilation in Modes 5 or 6, continuous monitoring and automatic termination of release is not required. In this condition, one continuous monitor at the Plant Vent is sufficient.

D 3.4 RADIOACTIVE EFFLUENTS TOTAL DOSE

D 3.4.1 Radioactive Effluents Total Dose

DLCO 3.4.1 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 ≤ 25 mrem to the whole body or any organ, except the thyroid, which shall be limited to ≤ 75 mrem.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Estimated dose or dose commitment due to direct radiation and the release of radioactive materials in liquid or gaseous effluents exceeds the limits.	A.1 Verify the condition resulting in doses exceeding these limits has been corrected.	Immediately
B. Required Action and associated Completion Time not met.	B.1 --------------NOTE------------- This is the Special Report required by D 3.1.2, D 3.2.2, or D 3.2.3 supplemented with the following. ----------------------------------	
	Submit a Special Report, pursuant to D 5.3, including a request for a variance in accordance with the provisions of 40 CFR 190. This submission is considered a timely request, and a variance is granted until staff action on the request is complete.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.4.1.1	Perform a cumulative dose calculation due to radioactive material in gaseous and liquid effluents to determine compliance with DLCO 3.4.1.	12 months

D 3.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

D 3.5.1 Monitoring Program

DLCO 3.5.1 The Radiological Environmental Monitoring Program shall be conducted as specified in Table D 3.5.1-1.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radiological Environmental Monitoring Program not conducted as specified in Table D 3.5.1-1.	A.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.	In accordance with the Annual Radiological Environmental Operating Report frequency
B. Level of radioactivity in an environmental sampling medium at a specified location exceeds the reporting levels of Table D 3.5.1-2 when averaged over any calendar quarter. <u>OR</u>	B.1 ------------NOTES------------ 1. Only applicable if the radioactivity/radionuclides are the result of plant effluents. 2. For radionuclides other than those in Table D 3.5.1-2, this report shall indicate the methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC. ------------------------------------	

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
More than one of the radionuclides in Table D 3.5.1-2 are detected in the environmental sampling medium and $\frac{\text{Concentration 1}}{\text{reporting level 1}} + \frac{\text{concentration 2}}{\text{reporting level 2}} + \ldots \geq 1.0.$ OR Radionuclides other than those in Table D 3.5.1-2 are detected in an environmental sampling medium at a specified location which are the result of plant effluents and the potential annual dose to a MEMBER OF THE PUBLIC from all radionuclides is ≥ the calendar year limits of Specifications D 3.1.2, D 3.2.2 or D 3.2.3.	Prepare and submit to the NRC, pursuant to D 5.3, a Special Report that (1) Identifies the cause(s) for exceeding the limit(s) and (2) Defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of Specifications D 3.1.2, D 3.2.2, or D 3.2.3.	30 days
	OR	
	B.2 ------------NOTES------------ 1. Only applicable if the radioactivity/radionuclides are not the result of plant effluents. 2. For radionuclides other than those in Table D 3.5.1-2, this report shall indicate the methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC. ----------------------------------- Report and describe the condition in the Annual Radiological Environmental Operating Report.	In accordance with the Annual Radiological Environmental Operating Report frequency

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Milk or fresh leafy vegetation samples unavailable from one or more of the sample locations required by Table D 3.5.1-1.	C.1 Identify specific locations for obtaining replacement samples and add them to the Radiological Environmental Monitoring Program.	30 days
	AND	
	C.2 Delete the specific locations from which samples were unavailable from the Radiological Environmental Monitoring Program.	30 days
	AND	
	C.3 Pursuant to D 5.2, submit in the next Radioactive Effluent Release Report documentation for a change in the ODCM reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples and justifying the selection of the new location(s) for obtaining samples.	In accordance with the Radioactive Effluent Release Report
D. Environmental samples required in Table D 3.5.1-1 are unobtainable due to sampling equipment malfunctions.	D.1 Ensure all efforts are made to complete corrective action(s).	Prior to the end of the next sampling period
	AND	
	D.2 Report all deviations from the sampling schedule in the Annual Radiological Environmental Operating Report.	In accordance with the Annual Radiological Environmental Operating Report

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
E. Samples required by Table D 3.5.1-1 not obtained in the media of choice, at the most desired location, or at the most desired time.	E.1	Choose suitable alternative media and locations for the pathway in question.	30 days
	AND		
	E.2	Make appropriate substitutions in the Radiological Environmental Monitoring Program.	30 days
	AND		
	E.3	Submit in the next Radioactive Effluent Release Report documentation for a change in the ODCM reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples for that pathway and justifying the selection of the new location(s) for obtaining samples.	In accordance with the Radioactive Effluent Release Report

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.5.1.1	Collect and analyze radiological environmental monitoring samples pursuant to the requirements of Table D 3.5.1-1 and the detection capabilities required by Table D 3.5.1-3.	In accordance with Table D 3.5.1-1

Table D 3.5.1-1 (page 1 of 3)
Radiological Environmental Monitoring Program

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF SAMPLES STATIONS	SAMPLE LOCATIONS (a)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
1. Direct Radiation	41 routine monitoring stations (b) (DR1-DR41)	(1) An inner ring of stations (DR1-DR16), one in each meteorological sector in the general area of the SITE BOUNDARY (2) An outer ring of stations (DR17-DR32), one in each meteorological sector in the 6 to 8 km range from the site (3) The balance of the stations (DR33-DR41), should be placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control stations	Quarterly	Gamma dose quarterly
2. Airborne Radioiodine and Particulates	5 locations (A1-A5)	(1) 3 samples (A1-A3) from offsite locations close to the site boundary in different sectors, of the highest calculated annual average ground level D/Q (2) 1 sample (A4) from the vicinity of an established year-round community having the highest calculated annual average ground level D/Q (3) 1 sample (A5) from a control location, 15-30 km distant and in the least prevalent wind direction (c)	Continuous sampler operation with sample collection weekly or more frequently if required by dust loading	Radioiodine canister: Analyze weekly for I-131 Particulate sampler: (1) Analyze for gross beta radioactivity $\geq$ 24 hours following filter change (d). (2) Perform gamma isotopic analysis on each sample (e) in which gross beta activity is > 10 times the previous yearly mean of control samples. (3) Gamma isotopic analysis of composite sample (e) (by location) once per 3 months.
3. Waterborne				
a. Surface (f)	1 sample 1 sample	Upstream (Wa1) Downstream (Wa2)	Composite sample over a one month period (g)	(1) Gamma isotopic analysis of each sample (e) once per month. (2) Composite and analyze for H-3 quarterly.
b. Drinking	1 sample	Nearest water supply (Wb1)	Grab sample: Monthly	(1) Gross beta and gamma isotopic analyses(e) of each sample monthly. (2) Composite and analyze for H-3 quarterly.

Table D 3.5.1-1 (page 2 of 3)
Radiological Environmental Monitoring Program

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF SAMPLES	SAMPLE LOCATIONS (a)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
3. Waterborne (continued)				
c. Sediment from Shoreline	2 samples	Downstream area (Wc1) with existing or potential recreational value Upstream area (Wc2) control sample	Twice per year at least 90 days apart	Gamma isotopic analysis (e), H-3, and Sr-90, of each sample semiannually.
d. Ground Water	2 samples	Site Boundary Monitoring Wells, drilled near the SW site boundary	Quarterly	Gamma isotopic analysis (e), H-3, and Sr-90, of each sample quarterly.
4. Ingestion				
a. Milk (i)	(1) 3 samples from MILK SAMPLING LOCATIONS	In 3 locations (Ia1-Ia3) within 5 km having the highest dose potential	Twice per month when animals are on pasture; monthly at other times	(1) Gamma isotopic (e) and I-131 analysis of each sample twice per month April through December
	(2) If there are none, then 1 sample from MILK SAMPLING LOCATIONS	In each of 3 areas (Ia1-Ia3) 5 to 8 km distance, if available, where doses are calculated to be > 1mrem per year (h)		(2) Gamma isotopic (g) and I-131 analysis of each sample once per month January through March if required
	(3) 1 sample from a MILK SAMPLING LOCATION	At a control location (Ia4), 15 to 30 km distant and in the least prevalent wind direction	Concurrently with indicator locations	
b. Fish and Invertebrates	(1) 1 sample each from edible portions of commercially or recreationally important species	In the vicinity of a plant discharge area (Ib1)	Sample in season, or Semiannually if sample is not seasonal	Gamma isotopic analysis of each sample (e), and Sr-90.
	(2) 1 sample of the same species	If available in areas not influenced by plant discharge (Ib2)		

Table D 3.5.1-1 (page 3 of 3)
Radiological Environmental Monitoring Program

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF SAMPLES	SAMPLE LOCATIONS (a)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
4. Ingestion (continued) c. Food Products	(1) Samples of 3 different kinds of broad leaf vegetation (edible or inedible) (j)	Grown nearest to each of 2 different offsite locations of highest predicted annual average ground level D/Q if milk sampling is not performed (Ic1-Ic2)	Monthly when available	Gamma isotopic (e) and I-131 analysis
	(2) 1 sample of each of the similar broad leaf vegetation.	Grown 15 to 30 km distant in the least prevalent wind direction if milk sampling is not performed (Ic3)		

(a) The code letters in parenthesis, e.g., DR1, A1 refer to sample locations specified in ODCM, Part II. Specific parameters of distance and direction sector from the centerline of one reactor, and additional descriptions where pertinent, shall be provided for each and every sample location in Table D 3.5.1-1. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978, and to Radiological Assessment Branch Technical Position on Environmental Monitoring, Revision 1, November 1979. 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 pursuant to D5.1.

(b) One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to integrating dosimeters. Each of the 40 routine monitoring stations shall be equipped with 2 or more dosimeters or with 1 instrument for measuring and recording dose rate continuously. For the purpose of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; 2 or more phosphors in a packet are considered as 2 or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation.

(c) The purpose of these samples 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, which provide valid background data, may be substituted.

(d) Airborne particulate sample filters shall be analyzed for gross beta activity 24 hours or more after sampling to allow for radon and thoron daughter decay.

(e) Gamma isotopic analysis means the identification and quantification of gamma –emitting radionuclides that may be attributable to the effluents from the facility.

(f) The "upstream" samples shall be taken near the intake structures as described in the ODCM. The ""downstream" sample shall be taken from the mixing zone at the diffuser of the discharge canal.

(g) In this program, a composite sample is one in which the quantity (aliquot) shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.

(h) The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

(i) The requirement to obtain and analyze samples from milch animals within 8 km of the site is intended to ensure monitoring of the "cow-milk" and vegetation pathways. Thus, only milch animals whose milk is used for human consumption are considered in the pathway and sample evaluation.

(j) Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the SITE BOUNDARY in each of two different sectors with the highest predicted D/Q in lieu of the garden census.

Table D 3.5.1-2 (page 1 of 1)
Reporting Levels for Radioactivity in Environmental Samples **

RADIONUCLIDE ANALYSIS	WATER (pCi/L)	AIRBORNE PARTIUCLATE 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		
Sr-90 ***	8*		40		
Zr-95	400				
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-140	200			300	
La-140	200			300	

* Values provided are for drinking water pathways. If no drinking water pathway exists, higher values are allowed, as follows:

H-3	30,000 pCi/L (This is a 40 CFR 141 value)
Sr-90	12 pCi/L
I-131	20 pCi/L

** These reporting levels are associated only with the REMP requirements. The Ground Water Monitoring Program may involve unique reporting level criteria, independent of the REMP, and defined in station procedures.

*** Sr-90 is added to this table due to its potential pathway via ground water.

Table D 3.5.1-3 (page 1 of 2)
Detection Capabilities for Environmental Sample Analysis (a) (e)

LOWER LIMIT OF DETECTION (LLD) (b) (c)

RADIONUCLIDE ANALYSIS	WATER (pCi/L)	AIRBORNE PARTIUCLATE 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 (d)					
Mn-54	15		130			
Fe-59	30		260			
Co-58	15		130			
Co-60	15		130			
Zn-65	30		260			
Sr-90 (f)	1		5			5000
Zr-95	15					
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	15			15		
La-140	15			15		

Table D 3.5.1-3 (page 2 of 2)
Detection Capabilities for Environmental Sample Analysis

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 pursuant to Specification D 5.1.

(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.

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 pursuant to RECS D 5.1.

(d) These LLDs are for drinking water samples. If no drinking water pathway exists, the LLDs may be increased to 3,000 for H-3 and 15 for I-131.

(e) These required lower limits of detection are associated only with the REMP requirements. The Ground Water Monitoring Program may involve unique reporting level criteria, independent of the REMP, and defined in station procedures.

(f) Sr-90 is added to this table due to its potential pathway via ground water.

D 3.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

D 3.5.2 Land Use Census

DLCO 3.5.2 A land use census shall:

a. Be conducted.

b. Identify within a distance of 8 km (5 miles) the location, in each of the 16 meteorological sectors, of the nearest milk animal, the nearest residence, and the nearest garden of > 50 m^2 (500 ft^2) producing broad leaf vegetation. Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the SITE BOUNDARY in each of two different direction sectors with the highest predicted D/Qs in lieu of a garden census, per Table D 3.5.1-1, part 4.c.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Land use census identifies location(s) that yields a calculated dose, dose commitment, or D/Q value greater than the values currently being calculated in DSR 3.2.3.1.	A.1 Identify the new location(s) in the next Radioactive Effluent Release Report.	In accordance with the Radioactive Effluent Release Report

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Land use census identifies location(s) that yields a calculated dose, or dose commitment (via the same exposure pathway) a factor greater than 2 than at a location from which samples are currently being obtained in accordance with Table D 3.5.1-1.	B.1 Add the new location(s) to the Radiological Environmental Monitoring Program.	30 days
	AND	
	B.2 Delete the sampling location(s), excluding the control station location, having the lowest calculated dose, dose commitment(s) or D/Q value, via the same exposure pathway, from the Radiological Environmental Monitoring Program.	After October 31 of the year in which the land use census was conducted
	AND	
	B.3 Submit in the next Radioactive Effluent Release Report documentation for a change in the ODCM including revised figure(s) and table(s) for the ODCM reflecting the new location(s) with information supporting the change in sampling locations.	In accordance with the Radioactive Effluent Release Report

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.5.2.1	Conduct the land use census during the growing season 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.	366 days
DSR 3.5.2.2	Report the results of the land use census in the Annual Radiological Environmental Operating Report.	In accordance with the Annual Radiological Environmental Operating Report

D 3.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

D 3.5.3 Interlaboratory Comparison Program

DLCO 3.5.3 The Interlaboratory Comparison Program shall be described in the ODCM.

AND

Analyses shall be performed on all radioactive materials, supplied as part of an Interlaboratory Comparison Program that has been approved by the Commission.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Analyses not performed as required.	A.1 Report the corrective actions taken to prevent a recurrence to the NRC in the Annual Radiological Environmental Operating Report.	In accordance with the Annual Radiological Environmental Operating Report

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.5.3.1	Report a summary of the results obtained as part of the Interlaboratory Comparison Program in the Annual Radiological Environmental Operating Report.	In accordance with the Annual Radiological Environmental Operating Report

D 3.6 SOLID RADIOACTIVE WASTE

D 3.6.1 Solid Radwaste Treatment System

DLCO 3.6.1 The appropriate equipment of the Solid Radwaste Treatment System shall be in operation process wet radioactive wastes in accordance with the Process Control Program.

APPLICABILITY: During solid radwaste processing

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Radioactive solid waste does not comply with Process Control Program requirements.	A.1 Suspend shipments of solid radioactive waste.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
DSR 3.6.1.1	Verify solidification of specimens in accordance with the Processing Control Program.	Prior to each shipment
DSR 3.6.1.2	Record the following information for each class of solid waste (as defined by 10 CFR Part 61) shipped offsite during the Radioactive Effluent Release Report period: a. Container volume, b. total curie quantity (specify determined by measurement or estimate), c. principal radionuclides (specify determined by measurement or estimate), d. source of waste and processing employed (e.g., dewatered spent resin, compacted dry waste, evaporator bottoms), e. type of container (e.g., LSA Type A, Type B, Large Quantity), and f. solidification agent or absorbent (e.g., cement, urea formaldehyde).	Prior to each shipment

D 4.0 DESIGN FEATURES

D 4.1 UNRESTRICTED AREA

D 4.1.1 The definition of UNRESTRICED AREA used in implementing the Radiological Effluent Controls (RECS or ODCM Part I) has been expanded over that in 10 CFR 20.1003. For calculations performed pursuant to 10 CFR 50.36a, the concept of UNRESTRICTED AREAS refers to areas "at or beyond the SITE BOUNDARY" and does not include areas over water bodies.

A map representing the UNRESTRICTED AREA is shown in Figure D 4.1-1

Information which will allow identification of structures and release points for radioactive gaseous and liquid effluents is shown in Figure D 4.1-2.

D 4.1.2 For the purpose of satisfying 10 CFR Part 20, the "Restricted Area" is the same as the "Exclusion Area" defined in the FSARs.

Figure D 4.1-1

MAP DEFINING UNRESTRICTED AREAS
FOR RADIOACTIVE GASEOUS AND LIQUID EFFLUENTS

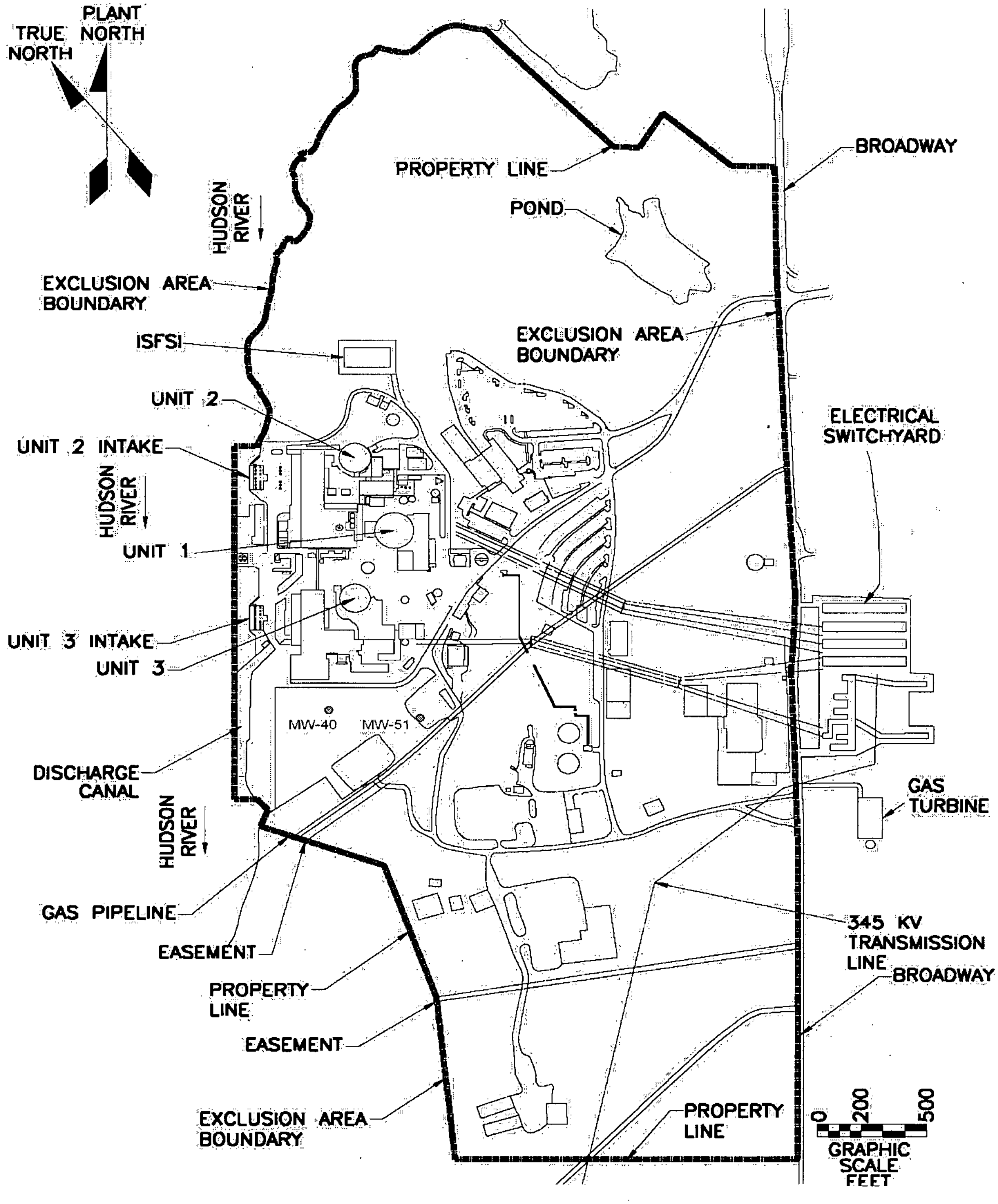
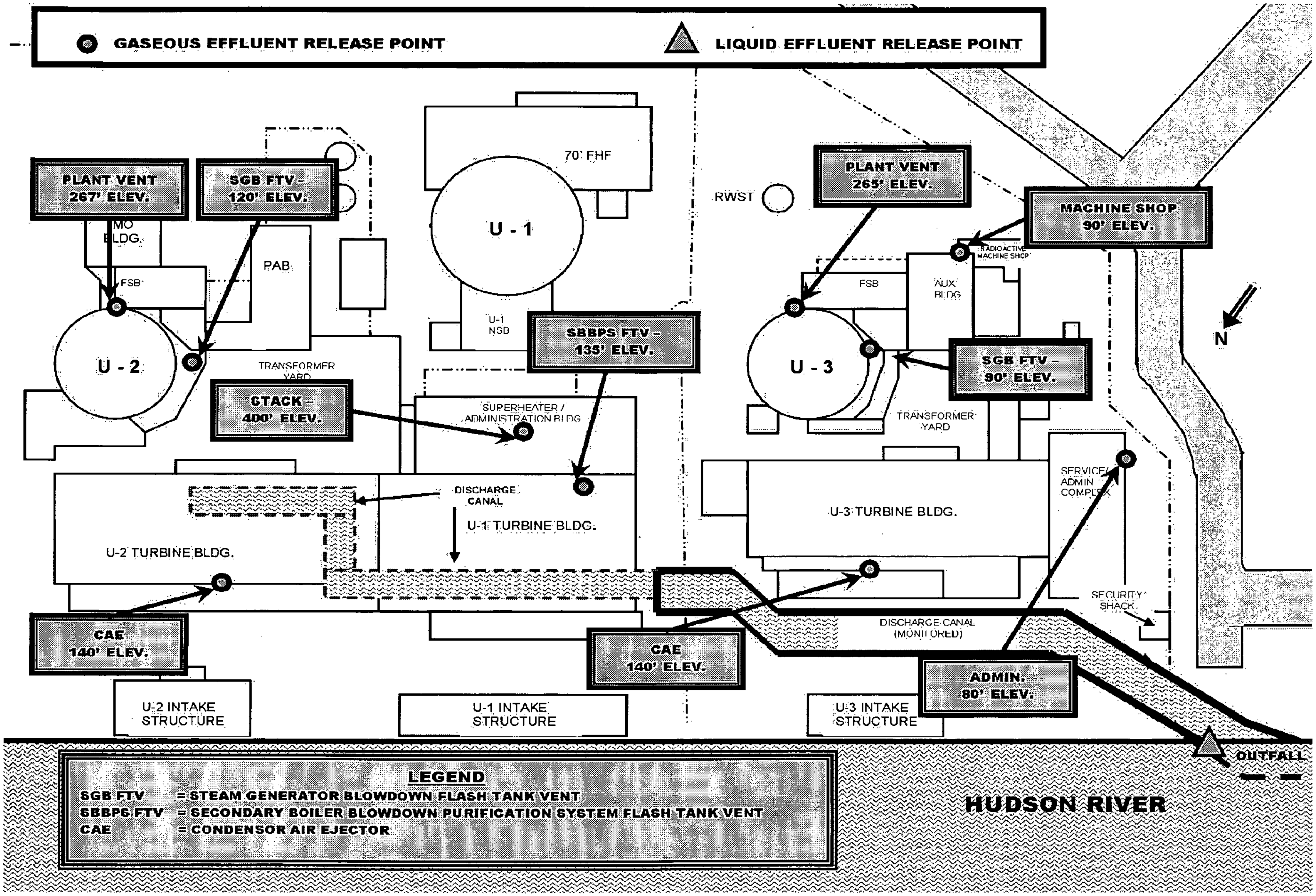


Figure D 4.1-2 MAP DEFINING RELEASE POINTS



D 5.0 ADMINISTRATIVE CONTROLS

D 5.1 Annual Radiological Environmental Operating Report

An annual Radiological Environmental Operating Report covering the operation of the unit during the previous calendar year shall be submitted prior to May 15th of each year. Per the Technical Specification Reporting Requirements, a single submittal may be made for a multiple unit station.

The Annual Radiological Environmental Operating Report shall include:

- Summaries, interpretations, and an analysis of trends of the results of the Radiological Environmental Monitoring Program for the report period, including a comparison, as appropriate, with preoperational studies, with operational controls, and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment.
- At least two legible maps covering all sampling locations keyed to a table giving distances and directions from the centerline of one reactor. One map shall cover stations near the site boundary and the second shall include the more distant stations.
- The results of analysis of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the locations specified in the tables and figures in the ODCM, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual 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.
- A summary description of the Radiological Environmental Monitoring Program.
- A discussion of the reasons for not conducting the Radiological Environmental Monitoring Program as specified by D 3.5.1 and the plans for preventing recurrence.
- A discussion of environmental sample measurements that exceed the reporting levels of Table D 3.5.1-2 but are not the result of plant effluents.
- A discussion of all deviations from the sampling schedule of Table D 3.5.1-1.
- A discussion of the contributing factors for cases in which the LLD required by Table D 3.5.1-3 was not achievable.
- A discussion of identifiable nuclide peaks, including those of nuclides specified in Table D 3.5.1-3.
- The results of the land use census.
- The corrective actions taken to prevent a recurrence if the Interlaboratory Comparison Program is not being performed as required.
- The results of licensee participation in the Interlaboratory Comparison Program.

D 5.0 ADMINISTRATIVE CONTROLS

D 5.2 Radioactive Effluent Release Report

The Radioactive Effluent Release Report to be submitted by May 1 of each year shall include:

a. A summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof.

b. An annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distribution of wind speed, wind direction, and atmospheric stability. In lieu of submission with the Radioactive Effluent Release Report, the licensee has the option of retaining this summary of required meteorological data onsite in a file that shall be provided to the NRC upon request

c. An assessment of the offsite radiation doses due to the radioactive liquid and gaseous effluent releases from the unit or station during the previous calendar year. This assessment shall include potential offsite dose determined with data collected from the Radiological Ground Water Monitoring Program (RGWMP).

d. An assessment of the radiation doses from radioactive liquid and gaseous effluents to members of the public due to their activities inside the SITE BOUNDARY (Figure D 4.1-1) during the report period. All assumptions used in making these assessments, i.e., specific activity, exposure time and location, shall be included in these reports.

   Gaseous pathway doses are determined from sampling and measurements at the exhaust points, coupled with the use of annual-averaged meteorological data collected from a period of live data to verify its validity. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the Offsite Dose Calculation Manual (ODCM).

   Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in Regulatory Guide 1.109, Rev. 1, October 1977.

D 5.2 Radioactive Effluent Release Report (continued)

e. The following information for each class of solid waste (in compliance with 10 CFR Part 61) shipped offsite during the report period:

1. Container volume,

2. total curie quantity (specify whether determined by measurement or estimate),

3. principal radionuclides (specify whether determined by measurement or estimate),

4. source of waste and processing employed (e.g., dewatered spent resin, compacted dry-waste, evaporator bottoms),

5. type of container (e.g., LSA, Type A, Type B, Large Quantity), and

6. solidification agent or absorbent (e.g., cement, urea formaldehyde).

f. A list and description of unplanned releases from the site to UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

g. A summary of data collected for the RGWMP, per D5.6 and NEI 07-07 - Industry Ground Water Protection Initiative.

h. Any changes made during the reporting period to the Process Control Program (PCP) and to the Offsite Dose Calculation Manual (ODCM), as well as a listing of new locations for dose calculations and/or environmental monitoring identified by the land use census pursuant to Specification D 3.5.2.

D 5.0 ADMINISTRATIVE CONTROLS

D 5.3 Special Reports

Special reports shall be submitted to the NRC Regional Administrator of the Region I Office within the time period specified for each report. These reports shall be submitted covering the activities identified below pursuant to the applicable Specification:

a. Radioactive Effluents (Specifications D 3.1, D 3.2 and D 3.4)

b. Radiological Environmental Monitoring (Specification D 3.5)

D 5.0 ADMINISTRATIVE CONTROLS

D 5.4 Major Changes to Radioactive Waste Systems

Licensee initiated major changes to the radioactive waste systems (liquid, gaseous and solid) shall be reported to the Commission in the Radioactive Effluent Release Report for the period in which the change was made. The discussion of each change shall contain:

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

b. sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information,

c. a detailed description of the equipment, components and processes involved and the interfaces with other plant systems,

d an evaluation of the change, which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the license application and amendments thereto,

e. an evaluation of the change, which shows the expected maximum exposures to individuals in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the license application and amendments thereto,

f. a comparison of the predicted releases of radioactive materials in liquid and gaseous effluents and in solid waste to the actual releases for the period in which the changes are to be made;

g. an estimate of the exposure to plant operating personnel as a result of the change, and

h. documentation of the fact that the change was reviewed and found acceptable by the OSRC.

D 5.0 ADMINISTRATIVE CONTROLS

D 5.5 Process Control Program

Licensee initiated changes to the Process Control Program (PCP):

a. Shall be submitted to the Commission in the Annual Radioactive Effluent Release Report for the period in which the change(s) was made. This submittal shall contain:

   1. sufficiently detailed information to totally support the rationale for the change without benefit of additional or supplemental information,

   2. a determination that the change did not reduce the overall conformance of the solidified waste product to existing criteria for solid wastes, and

   3. documentation of the fact that the change has been reviewed and found acceptable by the OSRC.

b. Shall become effective upon review and acceptance by the OSRC.

D 5.6 Radiological Ground Water Monitoring Program (RGWMP)

The RGWMP shall be defined in station procedures and shall include detailed information regarding the following:

- Purpose and scope of the program
- Location and periodicities of samples
- Required radionuclides for analysis, including limits of detection
- Guidance for communication of abnormal results
- An annual report summarizing the radiological condition of ground water.

Elements of the RGWMP program that intersect the REMP shall be included in the Annual Radiological Environmental Operating Report, per D 5.1.

An evaluation of the EFFLUENT impact, and a summary of the sample data from the RGWMP shall be included in the annual Radiological Effluent Release Report, per D 5.2.

Indian Point Energy Center

Offsite Dose Calculation Manual

Part I (RECS)

BASES

3.0 APPLICABILITY

BASES

DLCOs 3.0.1, 3.0.2, and 3.0.5, and DSRs 3.0.1, 3.0.2, and 3.0.3 reflect parallel requirements in the Technical Specifications. Refer to Technical Specification Bases for appropriate discussions.

ODCM Specification DLCO 3.0.3, in lieu of imposing a plant shutdown as paralleled in Technical Specifications, requires: (a) an Action to initiate efforts to restore compliance with the ODCM or associated Actions; and (b) an Action that requires entering the circumstances into the Corrective Action Program (CAP). These requirements ensure that the appropriate actions continue to be focused on and that the circumstances concerning failure to comply with the ODCM Actions would be reviewed. This review will be conducted in accordance with the procedural guidance for CAP Notifications.

There are no ODCM 3.0 Specifications that parallel Technical Specification LCO 3.0.4 or SR 3.0.4. Restrictions in entering MODES or other specified conditions in the Applicability have historically not been applied to ODCM Specifications. There are also no ODCM 3.0 Specifications that parallel Technical Specification LCO 3.0.6 and LCO 3.0.7, which allow for exceptions and revisions of other Technical Specifications. They are not applicable to the ODCM since it is not permitted to allow the ODCM to revise a Technical Specification.

(Note, currently no identified ODCM DLCOs support Technical Specification systems; however, this discussion is presented to address the philosophy that would be applied.) An allowance similar to Technical Specification LCO 3.0.6 does not apply to the ODCM. When a Technical Specification supported system LCO is discovered to be not met solely due to a ODCM support system DLCO not met, appropriate Technical Specification ACTIONS are required to be entered immediately. This applies even in instances where the ODCM contains a delay prior to declaring a Technical Specification supported system inoperable. In this case, certain ODCM inoperabilities may not directly impact the OPERABILITY of the Technical Specification supported system and delayed declaration of inoperability of the supported system is acceptable. In other cases, discovered support system inoperabilities that directly result in supported system inability to perform the safety function, should result in immediate declaration of inoperability of the supported system.

Technical Specification LCO 3.0.7 has no parallel in the ODCM since it provides for explicit changes to specified Technical Specifications by the Section 3.1.8 Specifications. However, in the event that LCO 3.0.7 provides for changes to the Technical Specification MODE definitions by the Section 3.1.8 Specifications, the revised MODE definitions apply to all plant references, including ODCM references.

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.1 Liquid Effluent Concentrations

BASES

It is expected that the release of radioactive materials in liquid and gaseous effluents to UNRESTRICTED AREAS will not exceed a small fraction of the concentration limits specified in 10 CFR Part 20 and should be as low as reasonably achievable (ALARA) in accordance with the requirement of 10 CFR 50.36a. While providing reasonable assurance that the design objectives will be met, these Specifications permit the flexibility of operation, compatible with considerations of health and safety, to ensure that the public is provided a dependable source of power under unusual operating conditions which may temporarily result in releases higher than the design objective levels, but still less than ten times the effluent concentration limits (EC's) specified in 10 CFR Part 20. It is expected that using this operational flexibility under unusual operation conditions, and exerting every effort to keep levels of radioactive materials in liquid and gaseous wastes as low as reasonably achievable, releases will not exceed a small fraction of the concentration limits specified in 10 CFR Part 20.

The design objectives have been developed based on operating experience, taking into account a combination of variables including defective fuel, primary system leakage, primary to secondary system leakage, steam generator blowdown and the performance of the various waste treatment systems, and are consistent with 10 CFR Part 50.36a.

The Indian Point site is a multiple-unit site. There exist shared radwaste treatment systems and shared effluent release points. Where site limits must be met, the effluents of all the units will be combined to determine site compliance. For instances where unit-specific information may be required for radwaste processed or released via a shared system, the effluents shall be proportioned among the units sharing the system(s) in accordance with the methods and agreements set forth in the ODCM.

This specification is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than ten times the EFFLUENT CONCENTRATIONS specified in 10 CFR Part 20. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, to a member of the public and (2) the limits of 10 CFR Part 20.1302 to the population. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its MPC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

This specification applies to the release of liquid effluents from all units on site.

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.2 Liquid Effluents Dose

BASES

This Specification is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The DLCO 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 will be kept "as low as reasonably achievable".

Also, for fresh water sites to UNRESTRICTED AREA 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 concentration in the finished drinking water that are in excess of the requirements of 40 CFR 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 10 CFR Part 50, Appendix I", Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I", April 1977.

In addition to the limiting conditions for operation, the reporting requirements specify that the licensee shall identify the cause whenever the dose from the release of radioactive materials in liquid waste effluent exceeds the above limits and describe the proposed program of action to reduce such releases to design objective levels on a timely basis.

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.3 Liquid Radwaste Treatment System

BASES

This Specification requires that the licensee maintain and operate appropriate equipment installed in the liquid waste systems, when necessary, to provide assurance that the releases of radioactive materials in liquid effluents will be kept "as low as reasonably achievable". This Specification implements the requirements of 10 CFR 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I to 10 CFR Part 50 for liquid effluents.

D 3.1 RADIOACTIVE LIQUID EFFLUENTS

D 3.1.4 Liquid Holdup Tanks

BASES

The tanks listed in this Specification include 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. These tanks include the following:

a. Refueling Water Storage Tanks

b. Primary Water Storage Tanks

c. 13 Waste Distillate Storage Tank

d. 14 Waste Distillate Storage Tank

e. 31 Monitor Tank

f. 32 Monitor Tank

g. Unit 3 CPF High Total Dissolved Solids Tank

h. Unit 3 CPF Low Total Dissolved Solids Tank

i. Any Outside Temporary Tank

Restricting the quantity of radioactive material contained in the specified tanks provides assurance that, in the event of an uncontrolled release of any such tank's contents, the resulting concentration would be less than the limits of 10 CFR 20 at the nearest potable water supply and the nearest surface water supply in an UNRESTRICTED AREA.

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.1 Gaseous Effluents Dose Rate

BASES

This Control provides 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 at or beyond the SITE BOUNDARY in excess of the design objectives of Appendix I to 10 CFR Part 50. This Control is provided to ensure that gaseous effluents from all units on the site will be appropriately controlled. It provides operational flexibility for releasing gaseous effluents to satisfy the Section II.A and II.C design objectives of Appendix I to 10 CFR Part 50. For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of that MEMBER OF THE PUBLIC will usually be sufficiently low to compensate for the reduced atmospheric dispersion of gaseous effluents relative to 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 rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrem/year to the total body or to less than or equal to 3000 mrem/year to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a child via the inhalation pathway to less than or equal to 1500 mrem/year. This Control does not affect the requirement to comply with the annual limitations of 10 CFR 20.

This Control applies to the release of gaseous effluents from all units at the site.

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.2 Gaseous Effluents Dose – Noble Gas

BASES

This Specification is provided to implement the requirements of Sections II.B, III.A, and IV.A of Appendix I to 10 CFR Part 50. The DLCO 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 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 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases form Light-Water Cooled Reactors," Revision 1, July 1977. The ODCM equations provided for determining the doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

This Control applies to the release of gaseous effluents from each unit on site.

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.3 Gaseous Effluents Dose – Iodine and Particulate

BASES

This Specification is provided to implement the requirements of Section II.C, III.A and IV.A of Appendix I to 10 CFR Part 50. The DLCOs 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 reasonably achievable."

The ODCM calculational methods specified in 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 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 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions.

The release rate specifications for iodine-131, tritium, and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man in the 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 (applied where applicable), and (4) deposition on the ground with subsequent exposure of man.

This Control applies to the release of gaseous effluents from each reactor on site.

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.4 Gaseous Radwaste Treatment System

BASES

This Specification requires that the appropriate portions of the Gaseous Radwaste Treatment System be used, when specified, to provide reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as reasonably achievable." This Specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

This Specification applies to the release of gaseous effluents from each reactor on site.

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.5 Ventilation Exhaust Treatment System

BASES

This Specification requires that the appropriate portions of the Ventilation Exhaust Treatment System be used, when specified, to provide reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as reasonably achievable." This Specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

This Specification applies to the release of gaseous effluents from each reactor on site.

D 3.2 RADIOACTIVE GASEOUS EFFLUENTS

D 3.2.6 Gas Storage Tanks

BASES

The tanks included in this Specification are those tanks for which the quantity of radioactivity contained is not limited directly or indirectly by other specifications to a quantity that is less than the quantity that provides assurance that, in the event of an uncontrolled release of the tank's contents, the resulting total body exposure to a MEMBER OF THE PUBLIC at the nearest SITE BOUNDARY will not exceed 0.5 Rem in an event of 2 hours duration.

Restricting the quantity of radioactivity contained in each gas storage tank provides assurances that, in the event of an uncontrolled release of the tank's contents, the resulting total body exposure to a MEMBER OF THE PUBLIC at the nearest SITE BOUNDARY will not exceed 0.5 Rem. This is consistent with Branch Technical Position ETSB 11-5 in NUREG-0800, July 1981, and NUREG 0133.

D 3.3 INSTRUMENTATION

D 3.3.1 Radioactive Liquid Effluent Monitoring Instrumentation

BASES

The radioactive liquid effluent instrumentation, required OPERABLE by this Specification, is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases. The alarm/trip setpoints for these instruments shall be calculated in accordance with methods set forth in the ODCM to ensure that the alarm/trip will occur prior to exceeding ten times the EFFLUENT CONCENTRATION values specified in 10 CFR 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 10 CFR Part 50. The purpose of tank level indicating devices is to assure the detection and control of leaks that, if not controlled, could potentially result in the transport of radioactive materials to UNRESTRICTED AREAS.

D 3.3 INSTRUMENTATION

D 3.3.2 Radioactive Gaseous Effluent Monitoring Instrumentation

BASES

The radioactive gaseous effluent instrumentation, required OPERABLE by this Specification, is provided to monitor and control, as applicable, the releases of radioactive materials in 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 release rates corresponding to effluent dose rates of 0.5 Rem/yr whole body, and 3.0 Rem/yr to the skin.

This instrumentation also includes provisions for monitoring the concentrations of potentially explosive gas mixtures in the waste gas holdup system. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design criteria 60, 63 and 64 in Appendix A to 10 CFR Part 50.

D 3.4 RADIOACTIVE EFFLUENTS TOTAL DOSE

D 3.4.1 Radioactive Effluents Total Dose

BASES

This Specification is provided to meet the dose limitation of 40 CFR Part 190 that has been incorporated into 10 CFR Part 20 by 46 FR 18525. The Specification requires the preparation and submittal of a special report whenever the calculated doses from plant-generated radioactive effluents and direct radiation exceed 25 mrem to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem.

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 40 CFR 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 40 CFR Part 190 limits. For the purposes of the special report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contribution from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered.

If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the special report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR Part 190.11 and 10 CFR Part 20.2203(a)(4), is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 until NRC staff action is completed.

The variance only relates to the limits of 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in Specifications D 3.1.1 and D 3.2.1. 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.

D 3.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

D 3.5.1 Radiological Environmental Monitoring Program

BASES

The radiological environmental monitoring program required by this specification 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 10 CFR 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. 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 D 3.5.1-3 are considered optimum for routine environmental measurements in industrial laboratories.

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.

D 3.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

D 3.5.2 Land Use Census

BASES

This specification 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 the 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 10 CFR 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 (26 kg/year) 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 (i.e., similar to lettuce and cabbage), and (2) a vegetation yield of 2 kg/m^2.

D 3.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

D 3.5.3 Interlaboratory Comparison Program

BASES

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 (developed using the guidance in Regulatory Guide 1.21, Revision 1, April 1974 and Regulatory Guide 4.1, Revision 1, April 1975) in order to demonstrate that the results are valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

D 3.6 SOLID RADWASTE TREATMENT SYSTEM

D 3.6.1 Solid Radwaste Treatment System

BASES

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

INDIAN POINT ENERGY CENTER

OFFSITE DOSE CALCULATION MANUAL

ODCM PART II - CALCULATIONAL METHODOLOGIES

Revision 0

1.0 RADIATION MONITORS AND SETPOINTS

1.1 Effluent Monitoring System Description

Information regarding effluent radiation monitor function and setpoint bases is provided in Tables 1-1 and 1-2. Additionally, Appendices B and C show a schematic of release pathways, including the relative position and application of these monitors.

1.2 Setpoints for Airborne Effluent Monitors

Setpoints for airborne (gaseous) monitors are based on the permissible discharge rate as calculated in Section 3 of the ODCM, Part II, and shown in Appendix I. These setpoints are inherently conservative due to the assumed mixture (Table 3-8). They are tiered in such a way as to ensure proper (higher) authentication is obtained as the selected limit (and expected release rate) increases.

The Annual Limit is used to conservatively establish initial setpoints for routine operation. For releases associated with unit shutdown, etc, additional permission may be obtained to apply the quarterly or instantaneous values, per Section 3.1.8. This method ensures operational control of releases, while precluding approaching the limits of D3.2.1.

The methodology identified in Section 3 and Appendix I is used to generate the following release rate limits (radiation monitor setpoint calculations only use the noble gas rates):

Conservative Permissible Discharge Rates (μCi/sec)					
Type of Limit	Basis	Iodine/Particulate* Unit 2	Iodine/Particulate* Unit 3	Noble Gases Unit 2	Noble Gases Unit 3
Annual Average	ODCM, Part II, App I	**4.01E-2**	**4.05E-2**	**7.20E+3**	**3.57E+3**
Quarterly Average	ODCM, Part II, App I	**8.02E-2**	**8.10E-2**	**1.44E+4**	**7.14E+3**
Instantaneous	RECS D3.2.1 and App I	**1.38E+1**	**1.38E+1**	**7.00E+4**	**7.00E+4**

* Half-lives greater than 8 days

1.2.1 The Plant Vent Wide Range Gas Monitor (R-27) reads in μCi/sec. Therefore, at unit 3, the alarm setpoints are set directly in μCi/sec. (Unit 2 does not apply alarm setpoints to R-27).

1.2.2 If the monitor reads and alarms in μCi/cc, the maximum alarm set point is calculated as follows:

$$S = D \;/\; [(F) * (4.72E+2)] \qquad \text{where;}$$

S = Maximum alarm setpoint in μCi/cc

D = Permissible discharge rate in μCi/sec

F = Vent duct flow in ft^3/min

4.72E+2 = unit conversion factor (28317 cc•min/ft^3•60sec)

1.2.3 If the monitor reads and alarms in cpm, then the maximum alarm setpoint is calculated as follows:

$$S = D / [(F) * (4.72E+2) * (CF)]$$

where:

S, D, F, and 4.72E+2 are defined in the previous step

CF = Rad Monitor Conversion Factor (μCi/cc per net cpm)

1.2.4 Normally, maximum allowable limits are calculated using a standard nuclide mix. However, setpoints may be determined based on the actual mix, on a case by case basis. This method is usually performed when the instantaneous release rate is applied. Should this method be applied, extra care should be applied to setpoint partitioning (for all release points) to ensure site dose rate limits are not approached.

1.2.5 During normal operation, the main plant vent is the only significant release point at either unit. Hence, monitors on the plant vent are routinely set at the *annual* limit, which is approximately 10% of the conservative *instantaneous* limit.

Monitor setpoints on other pathways are routinely set to 1% of the *instantaneous* limit. If multiple pathways become significant, each pathway's permissible release rate is apportioned with the Plant Vent's to ensure the total discharge rate for all release points remains less than the maximum permissible discharge rate.

If necessary, release rates may be apportioned (per 10CFR20 applicability to a site, rather than any one unit) for maximum operational flexibility such that one unit "borrows" routine apportionment from the other unit. This evolution is controlled by station procedures, which require direct communication with the Shift Managers and the Chemistry Department.

1.3 Setpoints for Liquid Effluent Monitors

1.3.1 Liquid Effluent Monitors have setpoints based on limiting the concentrations in the discharge canal to ten times the concentration values in Appendix B, Table 2, Column 2 to 10CFR20 in accordance with 10CFR20.1302(2)(i).

1.3.2 Monitor setpoints are inherently conservative due to the routine use of determining dilution from Circulating Water Pumps at the applicable unit only. In actuality, both Circulating and Service Water systems for the entire site contribute to site dilution.

1.3.3 For monitors that read and alarm in μCi/ml, setpoints are calculated as follows:

S = [(ADC) (F)] / [f] = Maximum alarm setpoint in μCi/ml

where:

F = Available discharge canal dilution flow for this release, in gpm

f = calculated allowable release rate in gpm (Section 2.2.6)

ADC = The Allowed Diluted Concentration is the equivalent MPCW for gamma emitting isotopes weighted for total specific activity (both gamma and beta emitters). This term is necessary to correct the MPCW due to the relatively insignificant effect of beta emitters on the radiation monitor, as described in Section 2.2.6.

1.3.4 Alert or Warn setpoints should be used on batch liquid release monitors to ensure the contents of the batch tank have not changed since sampling. The alert setpoint is calculated as follows:

AS = (C) * (M)

where:

AS = Alert or Warn setpoint in μCi/ml
C = Average monitor reading at time of sample
M = A conservative factor based upon the mixing ratio of two tank volumes and an expected monitor response error term (typically 1.25, coinciding with 25%).

NOTE: Liquid Monitor alert setpoints do not control any auto functions but simply provide indication to the operators. Alert or Warn setpoints for other monitors are typically initially established at approximately 75% of the Alarm value.

TABLE 1 – 1 Unit 2 Effluent Radiation Monitor System Data

CHANNEL	MONITOR DESCRIPTION	SAMPLING LOCATIONS	RANGE	EFFLUENT CONTROL FUNCTIONS
R-42	Containment Gas Monitor	72' Fan Bldg	1E-7 to 1E-2 μCi/cc	Containment Ventilation Isolation
R-44	Plant Vent Radiogas Monitor	88' Fan Bldg	1E-7 to 1E-2 μCi/cc	Shuts RCV-014 (isolating gas tanks), stops VC release fans and shuts VC vent/purge valves.
R-45	Condenser Air Ejector Monitor	In-line detector on the air ejector exhaust header	1E-6 to 1E-1 μCi/cc	Alarm diverts air ejector exhaust to VC and secures steam to priming air ejector re-heaters.
R-50	Waste Gas Disposal System Monitor	98' PAB	0.1 to 1E5 Ci	None. RECS D3.2.6 is assured by setpoint basis per ODCM Part II, Sec 3.1.12.
R-27	Plant Vent Wide-Range Monitor	Drawn from inside Plant Vent, to 85' BAB	1E-7 to1E+5 μCi/cc	None. PV Concentration and release rate information only, for accident applications.
R-60	Unit 1 Stack Vent Radiogas Monitor	Unit 1 Nuclear Services Bldg 100' Elevation	1E-7 to 1E-2 μCi/cc	None
R-46 / 53	Fan Cooler Unit Service Water Return	Adjacent to service water return line from V.C. fan cooler units and motor coolers	1E-7 to 1E-2 μCi/cc	None
R-47	Component Cooling System pump outlet	Adjacent to line monitors on each pump outlet	1E-6 to 1E-2 μCi/ml	None. Setpoints are not based on effluent. They are for ALARA and information only.
R-39 / 40	Component Cooling Heat Exchanger Service Water Monitors	80' PAB	1E-7 to 1E-2 μCi/cc	None
R-54	Waste Disposal Liquid Effluent Monitor	In-line monitor on 70' CSB	1E-7 to 1E-2 μCi/cc	Terminates Distillate Tank releases on alarm
R-49	SG Blowdown Monitor	15' Transformer Yard Housing	1E-6 to 1E+2 μCi/cc	Closes blowdown isolation valves
R-51	Sec Boiler Blowdown Purification	43' Superheater Bldg	1E-7 to 1E-2 μCi/cc	None
R-52	Sec Boiler Blowdown Purification Sys SW	33' Superheater Bldg	1E-7 to 1E-2 μCi/cc	None

TABLE 1 – 2 Unit 3 Effluent Radiation Monitor System Data

CHANNEL	MONITOR DESCRIPTION	SAMPLING LOCATIONS	RANGE	EFFLUENT CONTROL FUNCTIONS
R-12	Containment Gas Monitor	Samples drawn from 32 and 35 Containment Fan Coolers	1E-7 to 1E-1 μCi/cc	Containment Ventilation Isolation
R-14	Plant Vent Radiogas Monitor	In Plant Vent at approximately 105' elevation	1E-6 to 1E-1 μCi/cc	Secures waste gas tank release and Containment Ventilation Isolation
R-15	Condenser Air Ejector Monitor	In-line detector on the air ejector exhaust header	1E-6 to 1E+0 μCi/cc	On alarm, diverts air ejector exhaust to VC and secures steam to priming air ejectors re-heaters
R-20	Waste Gas Disposal System Monitor	Adjacent to line, on suction to waste gas compressors	1E-2 to 1E+3 μCi/cc	None. This setpoint is based on limiting 50,000 Ci per tank, per RECS D3.2.6.
R-27	Plant Vent Wide-Range Monitor	Drawn from inside Plant Vent	1E-7 to 1E+5 μCi/cc	Secure waste gas tank release and Containment Ventilation Isolation
R-46	Administration Building Vent Radiogas Monitor	4th Floor Administration Building Monitor Exhaust Plenum for Controlled Areas	1E+1 to 1E+6 cpm (typically 5.0E-8 to 5.0E-2 μCi/cc)	None
R-59	RAMS Building Vent Radiogas Monitor	55' RAMS Building Monitor Exhaust Plenum	1E-6 to 1E+2 μCi/cc	None
R-16 A/B	Fan Cooler and Motor Cooler Service Water Return	Adjacent to service water return line from V.C. fan cooler units and motor coolers	1E-7 to 1E-1 μCi/cc	None
R-17 A/B	Component Cooling System pump outlet	Adjacent to line monitors on each pump outlet	1E-6 to 1E-1 μCi/ml	None. These setpoints are not based on effluent and are for information only.
R-23	Component Cooling Heat Exchanger Service Water Monitor	Adjacent to line, mounted on SW return from Component Cooling Heat Exchanger	1E-7 to 1E-1 μCi/cc	None
R-18	Waste Disposal Liquid Effluent Monitor	In-line monitor on monitor tank recirc pump discharge	1E-7 to 1E-1 μCi/cc	Terminates monitor tank release on alarm
R-19	SG Blowdown Monitor	PAB blowdown room monitors steam generator blown	1E-6 to 1E+2 μCi/cc	Closes blowdown isolation valves and SG sample valves
R-61	CPF Regen Waste Release Monitor	Recirc line of HTDS/LTDS tanks in CPF (used when primary to secondary leakage exists).	1E-7 to 1E-1 μCi/cc	Terminates HTDS or LTDS tank release. Applicable only in a primary to secondary leak, as defined in RECS D1.1.

2.0 LIQUID EFFLUENTS

2.1 Liquid Effluent Releases - General Information

2.1.1 A completed and properly authorized Liquid Radioactive Waste Permit is required prior to performing any BACTH release (a release of known volume and activity from an isolated source).

2.1.2 All activity determinations for liquid radioactive effluents are performed in such a manner as to be representative of the activity released to the river.

2.1.3 The radioactivity in liquid waste tanks shall be continuously monitored during release except as allowed by RECS D3.3.1. If the flowmeter is inoperable, the flow shall be estimated every four hours by difference in tank level or by discharge pump curves.

2.1.4 Prior to discharge, the radioactive waste tank contents shall be recirculated for at least two tank volumes. After this recirculation, and prior to discharge, a sample shall be taken and analyzed for activity with a portion of the sample set aside for composite analysis. The measured activity shall be used for calculating allowable discharge rate and the alarm setpoint for the liquid waste discharge monitor.

2.1.5 Steam Generators or other CONTINUOUS releases shall be quantified and included in effluent reports, but do not require a pre-release permit. Continuous releases are typically quantified from periodic sampling and the use of radiation monitoring. In Modes 4-6, however, SG Draindowns are typically quantified in BATCH mode.

2.1.6 Assurance that the combined liquid releases from Units 2 and 3 maintain compliance with 10CFR20 is provided by administrative controls which include an administrative minimum dilution of 100,000 gpm for any batch release, and routine use of unit-specific dilution flow for each permitted release.

Upon agreement between both Shift Managers, however, one unit can reduce or eliminate radioactive liquid waste discharges for a period of time to allow the other unit to use the full site dilution flow, or a specified portion thereof. When applying this shared policy, the Shift Managers require the details and duration of this evolution in writing at both CRS work stations.

2.1.7 Steam Generator Blowdown activity is determined by composite samples collected in a manner to be proportional to the rate of flow of individual steam generator to total steam generator blowdown. These samples are then analyzed for the various radionuclides at frequencies specified in the RECS. Due to appropriate compositing, total blowdown flow is then routinely multiplied by average concentrations to determine the actual effluent contribution from Steam Generator Blowdown.

2.1.8 Time average dose calculations (10CFR50) may use total site dilution flow for both units, with the determined dose contributions additive for a site report over any specified period.

2.1.9 The discharge canal flow rate is determined by the use of pump flow characteristics curves. Actual monthly average flow rates and total gallons of dilution are determined by Programs and Components and delivered to Chemistry on a monthly basis. Unit 2 circulator pumps are operated at either low or high speed (approximately 88,000 to 140,000 gpm). Unit 3 circulator pumps have a variable speed capacity, and can produce a range from 65,000 to 140,000 gpm.

2.1.10 Radioactivity content in outdoor tanks is to be limited to less than 10 curies, excluding tritium and noble gas, as per RECS D3.1.4.. Compliance with this requirement is demonstrated by limiting the radioactive concentration in these tanks to the value which results in 10 curies when the tank is at full liquid capacity, except as modified below. The radioactive concentration limits for these tanks are:

RWST: $$\frac{10\,curies \times 10^{6}\,\mu Ci/curie}{358{,}500\,gal \times 3785\,ml/gal} = 7.3\times10^{-3}\,\mu Ci/ml$$

PWST: $$\frac{10\,curies \times 10^{6}\,\mu Ci/curie}{165{,}000\,gals \times 3785\,ml/gal} = 1.6\times10^{-2}\,\mu Ci/ml$$

31 & 32 Monitor Tanks (Unit 3):

$$\frac{10\ curies \times 10^{6}\,\mu Ci/curie}{11{,}750\,gals \times 3785\,ml/gal} = 2.2\times10^{-1}\,\mu Ci/ml$$

13 & 14 Waste Distillate Storage Tanks (Units 1/2):

$$\frac{10\ \text{curies} \times 10^{6}\,\mu\text{Ci/curie}}{23{,}577\,\text{gals} \times 3785\,\text{ml/gal}} = 1.1\times10^{-1}\,\mu\text{Ci/ml}$$

Unit 3's Condensate Polisher High and Low Total Dissolved Solids Tanks:

$$\frac{10\ curies \times 10^{6}\,\mu Ci/curie}{60{,}000\,gals \times 3785\,ml/gal} = 4.4\times10^{-2}\,\mu Ci/ml$$

Outside Temporary Tanks:

$$\frac{10\ curies \times 10^{-6}\,\mu Ci/curie}{Volume\ (gal) \times 3785\,ml/\ gal} = \mu Ci/ml$$

Integrated curies in a tank can similarly be determined by calculating the curies added from known inlet concentrations and volumes, which would then be combined with previously determined tank curie levels.

The refueling water storage tank has the potential to be filled from the reactor cavity with liquid which exceeds the limits stated. Therefore, prior to filling the RWST from the reactor cavity after refueling operations, the reactor cavity (or residual heat removal system) must be sampled for radioactivity and action taken to ensure that the total activity in the tank does not exceed 10 curies.

Outside temporary tanks should not be filled with liquid which could exceed the concentration limit calculated. Therefore, prior to transfer to outside temporary tanks, the source of liquid shall be sampled for radioactivity. If it exceeds the concentration limit calculated, action shall be taken to ensure that the total activity in the tank does not exceed 10 curies.

2.1.11 Turbine hall drains (from sumps in the five foot elevation for units 2 and 3) receive drains from areas containing secondary plant components at sub-atmospheric pressures. These sumps do not meet the intent of a turbine hall drain system as defined in NUREG 0472, however their effluent contribution should be evaluated.

Quantification of effluents is performed on this pathway during a Primary to Secondary Leak , as defined by RECS D1.1. In these cases, releases from this pathway would be quantified by periodic sampling multiplying the source term by a determination of the release rate to the river, generally bounded by secondary system loss or make-up rate.

At elevated Steam Generator activity levels (approximately 1.0E-4 or above), turbine hall drains may require temporary processing, should effluents via this pathway approach the 31-day dose projection limits per RECS D3.1.3. In this case, water at Unit 3 can be directed to the Condensate Polishing Facility prior to release. At Unit 2, a temporary processing skid will need to be applied, or water directed to the Secondary Boiler Blowdown Purification System, or other installed cleanup system.

Activity released via this pathway is determined as follows:

$$\begin{pmatrix}\text{Turbine Hall}\\ \text{Drain}\\ \text{Effluent Activity}\end{pmatrix} = \begin{pmatrix}\text{Feedwater}\\ \text{Specific}\\ \text{Activity}\end{pmatrix} * \begin{pmatrix}\text{Steam Plant} & & \text{SG Blowdown}\\ \text{Makeup} & - & \text{Rate to the}\\ \text{Rate} & & \text{River}\end{pmatrix}$$

2.1.12 Carbon 14 is released at a rate of .07 curies per GW(e)/yr with an average make up rate of 0.5 gal/min based upon studies performed by the New York State Department of Health. The estimate of Carbon 14 releases are included in the Radiological Impact on Man section of the Annual Radioactive Effluent Release Report. These estimates are not included in dose calculations for routine releases.

2.1.13 Several normally non-radioactive systems are periodically analyzed for radioactivity. Examples include Unit 3's Condensate Polisher regenerant waste tank, the Spent Fuel Pool Auxiliary Heat Exchanger Secondary Cooling Systems (when in use), and Site Storm Drains, etc. The monitoring program for these type of release points is consistent with the direction set forth in NRC IE Bulletin 80-10 "Contamination of Non-radioactive Systems and Resulting Potential for Unmonitored, Uncontrolled Release of Radioactivity to Environment". Should a system become contaminated, releases will be evaluated and quantified (as either batch or continuous) in accordance with the requirements listed in the RECS and the IPEC 80-10 program.

2.1.14 The Unit 3 liquid waste monitor tanks have an airborne release pathway. The original plant design limited the gases through this pathway by reducing the entrained gases to less than 2E-3 μCi/ml. When the entrained gas concentration in the monitor tank inlet exceeds 2E-3 μCi/ml, the noble gas release will be quantified by calculating the difference (in μCi's) between the gaseous activity added to the tank and the gaseous activity present in the effluent release sample. This difference will be the activity released through the tank vents and is quantified as an airborne release.

2.1.15 Due to the addition of Hafnium control rods at Unit 3, an offsite dose may need to be calculated for Hafnium isotopes in waste pathways. In the absence of site-specific bioaccumulation and dose factors for Hafnium, factors for Zirconium are used, as suggested in ICRP 30. Should these calculations become necessary, they will be performed per the following sections, and manually added to other totals.

2.1.16 Investigations from the Ground Water Monitoring Program (GWMP) may result in a determination of liquid effluent. A quantification and dose assessment of radioactive groundwater or storm water leaving the site shall be performed at least annually.

This quantification shall include, as a minimum, the source term from samples obtained near the effluent points of each applicable pathway (eg, ground water wells nearest the site boundary), and a determination of release rate and dilution flow.

Release rates to the river from both the bedrock pathways and collective storm drain pathways are provided from modeling by hydrologists. A precipitation mass balance was initially applied (Reference 32), and later verified by an application of the Darcy's Law model. Future determinations will continue to use a combination of these models at various depths, over effected zones, as discussed in Attachment J, Hydrological Verification of Grounwater Flow Rates.

Dilution flow is directly measured in the Discharge Canal for the Storm Drain component. For groundwater reaching the Hudson via a direct path under the canal, a dilution factor equivalent to a 6-hour half-tidal surge in the effected area of the Hudson applies, as discussed in Reference 33.

Dose calculations are otherwise then completed per the following sections.

2.2 Liquid Effluent Concentrations

2.2.1 This section provides a description of the means that will be used to demonstrate compliance with the RECS D3.1.1.

2.2.2 Compliance with the instantaneous limits of 10CFR20 is achieved by allocating dilution flow on a per unit basis, as described in Section 2.1.6. Compliance with 10CFR50 (quarterly and annual limitations) is assured by completing a monthly report which summarizes the time-average releases from the site.

2.2.3 Each isolated liquid waste tank must be recirculated for at least two tank volumes prior to sampling in order to ensure a representative sample is obtained. At Unit 2, this duration is determined from station procedures with every batch release. At Unit 3, a default minimum recirculation time of 4 hours may be used for 31 and 32 monitor tanks in lieu of the actual calculation:

$$\frac{11750\ gals * 2\ Tank\ Volumes}{100\ gal/\min} = 3.9\ Hours \approx 4\ Hours$$

Note: Nominal monitor tank pump flow rate is approximately 135 gpm. For conservativism however, 100 gpm is used for the recirculation flow rate, while 150 gpm is used for the discharge flow rate in all release calculations.

2.2.4 For batch releases, the concentration in liquid effluents prior to dilution in the discharge canal is determined by sampling prior to release. For continuous releases, the concentrations can be determined by either grab sampling, or by direct reading radiation monitor. If the process radiation monitor is utilized, the conversion factor should be verified as appropriate for the mixture being released.

For non-direct reading monitors, the following calculation is used:

$$C = CF * CR$$

C = Concentration of liquid effluent (uCi/ml) prior to dilution

CF = Conversion factor of monitor (uCi/ml per net cpm)

CR = Count rate of monitor (in net cpm)

2.2.5 The final diluted concentration in the canal is determined as follows:

$$CD = (C) * (f) / (F)$$

Where: CD = Diluted concentration in the discharge canal in uCi/ml

C = Pre-dilution liquid concentration in uCi/ml

F = Dilution flow in the discharge canal in gal/min

f = Release rate of liquid effluent in gal/min

2.2.6 <u>Calculation of Maximum Permissible Concentration in Liquid Effluents</u>

a. This section describes the methodology used to ensure compliance with RECS D3.1.1. The discharge canal concentration of radionuclides must be maintained less than those identified as limits (10 times the EC's of 10CFR20). The noble gas limit has been specified as 2E-4 uCi/ml.

These criteria are normally assured by using an ***Allowed Dilution Concentration*** (ADC) on each discrete release. This differs from the ECs given in 10CFR20 Appendix B in that, for radioisotopes that do not have gammas greater than 60 kev emitted during decay, default values are included to estimate their contribution.

The Allowed Diluted Concentration is derived and calculated as follows:

$$ADC = \frac{MPCWt * CG}{Total activity} \quad \text{or} \quad ADC = \frac{MPCWt * CG}{CG + CB} \quad \text{or} \quad ADC = \frac{MPCWt}{1 + {CB}/{CG}}$$

where:

ADC = Allowed diluted concentration in uCi/ml

MPCWt = Maximum permissible concentration in water for all isotopes (beta & gamma), in uCi/ml, as defined in RECS, D1.1, as follows:

$$MPCWt = \frac{\sum_i Ci}{\sum_i \left\langle Ci / MPCWi \right\rangle}$$

Ci and MPCWi = Concentration and MPCW for each isotope

CB = The concentration of the non gamma emitters, in uCi/ml

CG = The concentration of the gamma emitters, in uCi/ml

b. A representative sample must be obtained. For batch releases, at least two tank volumes are recirculated after the tank has been isolated to meet these requirements. The minimum recirculation time is determined as follows:

T = 2 (V) / (G) where;

T = Minimum recirculation time in min

V = Volumes in the tank to be discharged, in gal

G = Recirculation rate in gal/min

c. After the tank has been sampled, the Allowed Diluted Concentration is determined, per the equations above.

d. A determination of other liquid radioactive discharges is evaluated. If other releases are in progress at an affected unit, the radioactive concentrations and discharge rates are included to determine a potentially new required dilution factor.

e. Available dilution flow may be adjusted by physically using more pumps or altering an allocation fraction. Additionally, if required, release rate can be adjusted to comply with diluted concentration limits with existing dilution flow. Typically, however, these measures are not required.

f. The required dilution flow is calculated as follows:

$$E = \frac{Dr * CG}{ADC}$$ where;

Dr = Current release discharge rate, gpm

E = Required dilution for current existing release(s), gpm

CG and ADC are defined in Section 2.2.6.a

g. The permissible discharge rate is calculated as follows:

$$D = \frac{ADC * B}{CG}$$

Where:

D = Permissible discharge rate in gal/min

ADC = Calculated and described in Step 2.2.6.a

CG = Gamma emitter concentration in μCi/ml

B = Adjusted dilution flow from the unit, in gpm, from Step 2.2.6.d, above, as follows:

$$B = \begin{pmatrix} \text{Available} \\ \text{Dilution} \\ \text{Flow} \end{pmatrix} - \begin{pmatrix} \text{Required} \\ \text{Dilution from} \\ \text{other releases, E} \end{pmatrix}$$

Note: With no "other" releases, *B* simply becomes the *Available Dilution Flow*.

2.3 Liquid Effluent Dose Calculation Requirements

2.3.1 RECS D3.1.2 requires that the dose or dose commitment above background to an individual in an unrestricted area from radioactive materials in liquid effluents released from each reactor unit shall be limited:

a) During any calendar quarter: Less than or equal to 1.5 mrem to the total body and to less than or equal to 5 mrem to any organ.

b) During any calendar year: Less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

c) If either of the above limits is exceeded by a factor of two or more, then cumulative dose contributions from direct radiation would be determined by evaluation of existing perimeter and environmental TLDs per RECS D3.4.1.

2.3.2 RECS D3.1.3 requires that appropriate portions of the radwaste treatment system be used to reduce the radioactive material in liquid waste prior to their discharge when the projected dose due to liquid effluent from each reactor unit when averaged over 31 days, would exceed 0.06 mrem to the total body or 0.2 mrem to any organ. Doses due to liquid release shall be projected at least once per 31 days. These doses are projected based on the dose methodology in Section 2.4. or 2.5. The average of previous months' doses is used to project future dose, as follows:

$$\begin{bmatrix} \text{Dose} \\ \text{Projection} \end{bmatrix} = \frac{\text{Current Month Dose} + \text{Previous months' Dose}}{\text{number of months used}} \pm \begin{bmatrix} \textit{major} \\ \textit{planned} \\ \textit{evolutions} \end{bmatrix}$$

The term for planned evolutions is routinely determined from previous similar evolutions, such as releases associated with plant shutdown.

2.4 Dose Methodology (Computer Calculation)

2.4.1 NUREG 0133 (Ref. 1, Section 4.3, Pg. 14) states that cumulative dose contributions should consider the dose contribution from the maximum exposed individual's consumption of fish, invertebrates, and potable water as appropriate. The river near IPEC is considered to be fresh water when in reality it is a tidal estuary and never completely fresh. Observed average chlorosity at IPEC has ranged as high as 2.5 gm/liter or about 13% sea water and 87% fresh water.

Hence, use of the Hudson River for fresh water supply purposes is precluded south of Chelsea (mile point 65) which is the nearest point of potable water supply (approximately 15 miles upstream of IPEC). Radionuclide concentrations in the nearest water supply have been calculated (Ref. 2) to be a factor of at least 500 lower than the river water in the Indian Point area.

Due to the absence of a potable water pathway, RECS D3.1.2 reporting regulations for a 3 mile downstream limit do not apply. There is no exposures from ingestion of drinking water.

Thus, at IPEC, the cumulative dose considers only the dose contributions from the maximum exposed individuals consumption of fish and invertebrates. Tables of dose factors for three age groups were developed as per Section 2.4.3 and are included as Tables 2-1, 2-2, and 2-3. (Infant dose factors are 0 and are not included).

2.4.2 The relationships and methods that form the calculational base for dose accounting for the liquid effluent pathway are described in this section. These relationships can be used to meet the calculational requirements of Section 2.3.1. The cumulative dose factors (Ait) are calculated in Section 2.4.3. The following equation is generally applicable and can be used for any number of isotopes released over a time period:

$$D(T) = \sum_{i=1}^{m} [A_{iT} * \sum_{k=1}^{n} (dt_k)(C_{ik})(F_k)]$$

Where:

m = The total number of isotopes released.

D(T) = The liquid effluent cumulative dose commitment from nuclides to the total body or any organ, T, for the time period k, in mrem.

dt_k = The length of the time period, k over which C_{ik} and F_k are averaged for all liquid releases, in hours. (This can be individual release durations summed, or an entire period duration, defined with each application of this equation.)

C_{ik} = The undiluted liquid effluent average concentration of nuclide, i, in uCi/ml, during time period dt_k from any liquid release.

n = The total number of releases considered.

A_{iT} = The site related ingestion dose commitment factor to the total body or any organ for each identified principal gamma and beta emitter listed in Table 2-1, 2-2, and 2-3, in mrem-ml per hr-uCi.

F_k = The total dilution factor for C_{ik} during any liquid effluent releases; defined as the ratio of the maximum undiluted liquid waste flow during release to the average flow from the site discharge structure to unrestricted receiving waters, times an applicable factor.

The term C_{ik} represents the total undiluted concentration of radioactive material in liquid waste at the release point as determined by the radioactive liquid waste sampling and analysis program as contained in the RECS. All dilution factors beyond the sample point are included in the F_k and A_{iT} terms.

The term F_k is a total dilution factor and is determined as follows:

$$F_k = \frac{\text{Liquid Radioactive Waste Flow}}{[\text{Discharge Structure Exit Flow} * \text{Applicable Factor}]}$$

The liquid radioactive waste flow is the flow from all continuous and batch radioactive effluent releases specified in the RECS from all liquid radioactive waste management systems. The discharge structure exit flow is the average flow during disposal from the discharge structure release point into the receiving body of water. Based on studies by New York University Medical Center (ref. 14 page 7), the appropriate "Applicable Factor" (a mixing factor in the near field), is **5.0**.

For permitting and initial assessment of liquid effluent releases, F_k is first determined with dilution flow concurrent with applicable releases (see Section 2.2). Doses are later recalculated (for the entire site) on a quarterly basis to determine actual doses from quarterly total site dilution volume. This method allows both an immediate and accurate long-term assessment of radiation dose resulting from liquid effluent releases at Indian Point.

2.4.3 Dose Factor for Liquid Effluent Calculations

The equation for dose from liquid effluents requires the use of a dose factor A_{iT} for each nuclide, i, which embodies the dose factors, pathway transfer factor, pathway usage factors, and dilution factors for the points of pathway origin.

IPEC follows the guidance of NUREG 0133 and has calculated A_{iT} for the total body and critical organ of the maximum exposed individual for Adult, Teen and Child doses. Most factors needed in the equation were obtained from Regulatory Guide 1.109 with the following exceptions (see Section 2.6 and Ref 2, 12, 13, 14, and 25):

The fish and invertebrate bioaccumulation factors (BF_i and BI_i) for Cesium, Niobium, Silver, and Antimony, were determined locally.

For Cesium, a site specific factor of 224 was used instead of the 2,000 presented in Table A-1 of the Regulatory Guide for fish. Similarly, a factor of 224 was used for invertebrates instead of the Regulatory Guide value of 1000.

For Silver, the fish and invertebrate factors are 2.3 and 3300, respectively.

For Niobium, the fish and invertebrate factors are 300 and 100 respectively.

For Antimony, the fish and invertebrate factors are 1 and 300 respectively.

The summary dose factor is as follows:

$$A_{iT} = K[(UF)BF_i + (UI)BI_i]Df$$

Where:

A_{iT} = Composite dose parameter for the total body or critical organ for nuclide, i, for all appropriate pathways, mrem/hr per μCi/ml.

K = Units conversion factor, 114155 = $\frac{(1E6pCi/\mu Ci) * (1E3ml/kg)}{8760 \text{ hr/yr}}$

UF = kg/yr fish consumption from Table E-5 of Reg Guide 1.109:

21 Adult	6.9 Child
16 Teen	0 Infant

BFi = Fresh Water Fish Bioaccumulation factor for nuclide, i, in pCi/kg per pCi/l from Table A-1 of Regulatory Guide 1.109.

UI = kg/yr invertebrate consumption from Table E-5 of Regulatory Guide 1.109:

5.0 Adult	1.7 Child
3.8 Teen	0 Infant

BIi = Salt Water Invertebrates Bioaccumulation factor for nuclide, i, in pCi/kg per pCi/l from Table A-1 of Regulatory Guide 1.109.

DF_i = Dose conversion factor for nuclide i, for age groups in pre-selected organs, T, in mrem/pCi, from Tables E-11, 12 & 13 of Regulatory Guide 1.109.

IPEC has compiled A_{iT} factors for 3 age groups and various organs for the maximum exposed individual. These are included as Table 2-1, 2-2, and 2-3. For completeness, this table includes all isotopes found in Reg Guide 1.109, however, several isotopes listed are not routinely identified at IPEC. In addition, the values for Antimony, Silver, Cesium, and Niobium are site specific as previously discussed.

2.5 Backup Simplified Dose Methodology

2.5.1 An alternate computer method which completely complies with Section 2.4 is available should the primary computer system be inoperable.

2.5.2 Hand Calculations which completely comply with Section 2.4 can be employed if the primary and secondary computer codes are inoperable. Because they are time consuming and subject to calculational errors, procedural guidance in the actual flow of calculations should be used to maintain a standard format. These procedures are also used for benchmark tests of the computer codes.

2.6 Site Specific Bio-Accumulation & Dose Factors

2.6.1 As stated in Section 2.4.3 the bioaccumulation factor (BF_i) for Cesium in fish is assumed to be 224 instead of the 2000 listed in Regulatory Guide 1.109 (Ref. 3). Similarly, the bioaccumulation factor for invertebrates is 224. This is based on three facts; 1) the Hudson River at IPEC is not completely fresh, 2) the Bioaccumulation Factor for salt water is 40 (Ref. 2), and 3) the behavior of Cesium in the Hudson is a complex phenomenon, as discussed below.

The NYU Study (Ref. 2) shows that Cesium concentrations in fish are regulated at a relatively constant value independent of the concentration of Cesium in water, and the bioaccumulation factors are thus inversely proportional to the water concentration of Cesium. This explains the lower bioaccumulation factor for Cesium reported by numerous investigators for salt water fish as opposed to fresh water fish because of the higher stable Cesium content of sea water. The NYU Report states that water at Indian Point has a dissolved Cesium concentration which is much higher than would be expected from simple mixing between sea water and fresh water and postulates that these higher concentrations result from leaching of Cesium from bottom sediment by saline water.

Use of the bioaccumulation factors of Regulatory Guide 1.109 for a fresh water site will thus substantially overestimate fish ingestion doses because no account is taken of the phenomena just discussed. However, radio-cesium concentrations in fish may still be estimated through the use of a bioaccumulation factor, provided that this factor is determined from the body of water of interest. This factor has been estimated (Ref. 12, page 33) to be about 224 for the flesh of indigenous fish caught in the Indian Point area. In contrast, the Cesium fresh water bioaccumulation factor presented by Regulatory Guide 1.109 for fish is 2000.

Fish ingestion doses would therefore be overestimated by a factor of 13 if the Regulatory Guide values were used.

Similarly for invertebrates, the site specific bioaccumulation factor of 224 is used. This is larger than the value of 25 given in Reg Guide 1.109 for salt water invertebrates.

A second conservatism in the NRC model concerns the location at which the concentrations in the river of the discharged Cesium are evaluated. Use of this model implies that these fish have grown directly in such a location prior to being caught, which is unrealistic and adds about a factor of five in conservation. This conservatism remains in the calculation, thus the use of the NYU (Ref. 12) bioaccumulation factor is justifiable.

2.6.2 No bioaccumulation factor for Silver is listed in Rev. 1 of Regulatory Guide 1.109, Table A-1. The values of 2.3 and 5000 for fish and invertebrates were obtained from ORNL-4992 (sponsored by ERDA 660, Ref. 25) and are included in the ODCM in the interests of increased accuracy since Ag-110m is a potential component of IPEC liquid releases.

2.6.3 International Atomic Energy Agency Report No. 57 provides data more recent than that presented in Regulatory Guide 1.109 for niobium bioaccumulation factors. The factor in the Regulatory Guide appears to be substantially over-conservative and, therefore, the more recent IAEA information is incorporated into the dose calculation methodology for liquid releases of radio-niobium. The values from Table XVII of IAEA No. 57 are 300 and 100 for freshwater fish and marine invertebrates respectively and are incorporated into this ODCM.

2.6.4 Antimony isotopes are not listed in Reg. Guide 1.109. As for Niobium above, IAEA Report No. 57 was used to provide bioaccumulation factors for the Antimony isotopes in Table 2-1. Dose factors were calculated for Antimony as per Reference 13.

2.6.5 Te-123m dose factors are not listed in Reg. Guide 1.109. Since this isotope is identified from potentially failed secondary startup sources and previously identified at IPEC, ingestion dose factors were derived from ICRP 30 and calculated per Ref 34.

2.6.6 In summary, with the exception of the bioaccumulation and dose factors discussed above, all remaining factors applied at IPEC are defined in Reg Guide 1.109 for a combination of fresh water fish and salt water invertebrates.

Table 2 - 1

Site Related Adult Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.82E-01	2.82E-01	2.82E-01	2.82E-01	2.82E-01	2.82E-01
BE-7	3.29E-01	7.45E-01	3.69E-01	0.00E+00	7.83E-01	0.00E+00	1.28E+02
NA-24	4.08E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02
P-32	4.96E+07	3.08E+06	1.92E+06	0.00E+00	0.00E+00	0.00E+00	5.57E+06
CR-51	0.00E+00	0.00E+00	4.31E+00	2.58E+00	9.50E-01	5.72E+00	1.08E+03
MN-54	0.00E+00	5.43E+03	1.04E+03	0.00E+00	1.61E+03	0.00E+00	1.66E+04
MN-56	0.00E+00	1.37E+02	2.42E+01	0.00E+00	1.73E+02	0.00E+00	4.36E+03
FE-55	3.21E+04	2.21E+04	5.16E+03	0.00E+00	0.00E+00	1.24E+04	1.27E+04
FE-59	5.06E+04	1.19E+05	4.56E+04	0.00E+00	0.00E+00	3.32E+04	3.96E+05
CO-58	0.00E+00	5.15E+02	1.15E+03	0.00E+00	0.00E+00	0.00E+00	1.04E+04
CO-60	0.00E+00	1.48E+03	3.26E+03	0.00E+00	0.00E+00	0.00E+00	2.78E+04
NI-63	4.97E+04	3.45E+03	1.67E+03	0.00E+00	0.00E+00	0.00E+00	7.19E+02
NI-65	2.02E+02	2.62E+01	1.20E+01	0.00E+00	0.00E+00	0.00E+00	6.65E+02
CU-64	0.00E+00	9.08E+01	4.26E+01	0.00E+00	2.29E+02	0.00E+00	7.74E+03
ZN-65	1.61E+05	5.13E+05	2.32E+05	0.00E+00	3.43E+05	0.00E+00	3.23E+05
ZN-69	3.43E+02	6.57E+02	4.57E+01	0.00E+00	4.27E+02	0.00E+00	9.87E+01
BR-83	0.00E+00	0.00E+00	4.05E+01	0.00E+00	0.00E+00	0.00E+00	5.84E+01
BR-84	0.00E+00	0.00E+00	5.25E+01	0.00E+00	0.00E+00	0.00E+00	4.13E-04
BR-85	0.00E+00	0.00E+00	2.16E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	1.01E+05	4.72E+04	0.00E+00	0.00E+00	0.00E+00	2.00E+04
RB-88	0.00E+00	2.91E+02	1.54E+02	0.00E+00	0.00E+00	0.00E+00	4.02E-09
RB-89	0.00E+00	1.93E+02	1.35E+02	0.00E+00	0.00E+00	0.00E+00	1.12E-11
SR-89	2.57E+04	0.00E+00	7.37E+02	0.00E+00	0.00E+00	0.00E+00	4.12E+03
SR-90	6.32E+05	0.00E+00	1.55E+05	0.00E+00	0.00E+00	0.00E+00	1.82E+04
SR-91	4.72E+02	0.00E+00	1.91E+01	0.00E+00	0.00E+00	0.00E+00	2.25E+03
SR-92	1.79E+02	0.00E+00	7.75E+00	0.00E+00	0.00E+00	0.00E+00	3.55E+03
Y-90	6.07E+00	0.00E+00	1.63E-01	0.00E+00	0.00E+00	0.00E+00	6.43E+04
Y-91M	5.73E-02	0.00E+00	2.22E-03	0.00E+00	0.00E+00	0.00E+00	1.68E-01
Y-91	8.89E+01	0.00E+00	2.38E+00	0.00E+00	0.00E+00	0.00E+00	4.89E+04
Y-92	5.33E-01	0.00E+00	1.56E-02	0.00E+00	0.00E+00	0.00E+00	9.33E+03
Y-93	1.69E+00	0.00E+00	4.67E-02	0.00E+00	0.00E+00	0.00E+00	5.36E+04
ZR-95	1.63E+00	5.22E-01	3.54E-01	0.00E+00	8.20E-01	0.00E+00	1.66E+03
ZR-97	9.00E-02	1.82E-02	8.30E-03	0.00E+00	2.74E-02	0.00E+00	5.63E+03
NB-95	4.83E+00	2.69E+00	1.44E+00	0.00E+00	2.65E+00	0.00E+00	1.63E+04
MO-99	0.00E+00	1.28E+02	2.43E+01	0.00E+00	2.90E+02	0.00E+00	2.97E+02
TC-99M	1.59E-02	4.50E-02	5.73E-01	0.00E+00	6.84E-01	2.21E-02	2.66E+01
TC-101	1.64E-02	2.36E-02	2.32E-01	0.00E+00	4.25E-01	1.21E-02	7.09E-14
RU-103	1.10E+02	0.00E+00	4.74E+01	0.00E+00	4.20E+02	0.00E+00	1.28E+04
RU-105	9.16E+00	0.00E+00	3.62E+00	0.00E+00	1.18E+02	0.00E+00	5.60E+03
RU-106	1.64E+03	0.00E+00	2.07E+02	0.00E+00	3.16E+03	0.00E+00	1.06E+05
AG-110M	4.58E+02	4.23E+02	2.51E+02	0.00E+00	8.32E+02	0.00E+00	1.73E+05
SB-122	3.47E+01	7.99E-01	1.20E+01	5.38E-01	0.00E+00	2.08E+01	1.32E+04
SB-124	4.86E+02	9.20E+00	1.91E+02	1.18E+00	0.00E+00	3.79E+02	1.38E+04
SB-125	3.11E+02	3.47E+00	7.40E+01	3.16E-01	0.00E+00	2.40E+02	3.42E+03

Table 2 - 1

Site Related Adult Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
TE-125M	2.72E+03	9.87E+02	3.65E+02	8.19E+02	1.11E+04	0.00E+00	1.09E+04
TE-127M	6.88E+03	2.46E+03	8.38E+02	1.76E+03	2.79E+04	0.00E+00	2.31E+04
TE-127	1.12E+02	4.01E+01	2.42E+01	8.28E+01	4.55E+02	0.00E+00	8.82E+03
TE-129M	1.17E+04	4.36E+03	1.85E+03	4.01E+03	4.88E+04	0.00E+00	5.88E+04
TE-129	3.19E+01	1.20E+01	7.77E+00	2.45E+01	1.34E+02	0.00E+00	2.41E+01
TE-131M	1.76E+03	8.60E+02	7.16E+02	1.36E+03	8.71E+03	0.00E+00	8.53E+04
TE-131	2.00E+01	8.36E+00	6.32E+00	1.65E+01	8.77E+01	0.00E+00	2.83E+00
TE-132	2.56E+03	1.66E+03	1.55E+03	1.83E+03	1.60E+04	0.00E+00	7.83E+04
I-130	4.88E+01	1.44E+02	5.68E+01	1.22E+04	2.24E+02	0.00E+00	1.24E+02
I-131	2.68E+02	3.84E+02	2.20E+02	1.26E+05	6.58E+02	0.00E+00	1.01E+02
I-132	1.31E+01	3.50E+01	1.23E+01	1.23E+03	5.58E+01	0.00E+00	6.58E+00
I-133	9.16E+01	1.59E+02	4.86E+01	2.34E+04	2.78E+02	0.00E+00	1.43E+02
I-134	6.84E+00	1.86E+01	6.64E+00	3.22E+02	2.95E+01	0.00E+00	1.62E-02
I-135	2.86E+01	7.48E+01	2.76E+01	4.93E+03	1.20E+02	0.00E+00	8.45E+01
CS-134	4.14E+04	9.84E+04	8.04E+04	0.00E+00	3.18E+04	1.06E+04	1.72E+03
CS-136	4.33E+03	1.71E+04	1.23E+04	0.00E+00	9.51E+03	1.30E+03	1.94E+03
CS-137	5.30E+04	7.25E+04	4.75E+04	0.00E+00	2.46E+04	8.18E+03	1.40E+03
CS-138	3.67E+01	7.25E+01	3.59E+01	0.00E+00	5.33E+01	5.26E+00	3.09E-04
BA-139	6.47E+00	4.61E-03	1.89E-01	0.00E+00	4.31E-03	2.61E-03	1.15E+01
BA-140	1.35E+03	1.70E+00	8.87E+01	0.00E+00	5.78E-01	9.73E-01	2.79E+03
BA-141	3.14E+00	2.37E-03	1.06E-01	0.00E+00	2.21E-03	1.35E-03	1.48E-09
BA-142	1.42E+00	1.46E-03	8.93E-02	0.00E+00	1.23E-03	8.27E-04	2.00E-18
LA-140	1.58E+00	7.95E-01	2.10E-01	0.00E+00	0.00E+00	0.00E+00	5.83E+04
LA-142	8.07E-02	3.67E-02	9.15E-03	0.00E+00	0.00E+00	0.00E+00	2.68E+02
CE-141	3.23E+00	2.18E+00	2.48E-01	0.00E+00	1.01E+00	0.00E+00	8.35E+03
CE-143	5.69E-01	4.21E+02	4.66E-02	0.00E+00	1.85E-01	0.00E+00	1.57E+04
CE-144	1.68E+02	7.04E+01	9.04E+00	0.00E+00	4.17E+01	0.00E+00	5.69E+04
PR-143	5.80E+00	2.33E+00	2.88E-01	0.00E+00	1.34E+00	0.00E+00	2.54E+04
PR-144	1.90E-02	7.88E-03	9.65E-04	0.00E+00	4.45E-03	0.00E+00	2.73E-09
ND-147	3.97E+00	4.59E+00	2.74E-01	0.00E+00	2.68E+00	0.00E+00	2.20E+04
W-187	2.98E+02	2.49E+02	8.71E+01	0.00E+00	0.00E+00	0.00E+00	8.16E+04
NP-239	3.53E-02	3.47E-03	1.91E-03	0.00E+00	1.08E-02	0.00E+00	7.12E+02
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	1.21E+02	2.01E+02	0.00E+00	0.00E+00	0.00E+00	3.07E+03
SR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-97	4.05E-02	1.02E-02	3.74E-03	0.00E+00	1.20E-02	0.00E+00	3.78E+01
CD-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SN-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-134	3.29E+01	2.15E+01	1.32E+01	2.88E+01	2.08E+02	0.00E+00	3.65E-02
CE-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2 - 2

Site Related Teen Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.17E-01	2.17E-01	2.17E-01	2.17E-01	2.17E-01	2.17E-01
BE-7	3.58E-01	8.02E-01	4.01E-01	0.00E+00	8.50E-01	0.00E+00	9.76E+01
NA-24	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02	4.20E+02
P-32	5.40E+07	3.35E+06	2.09E+06	0.00E+00	0.00E+00	0.00E+00	4.54E+06
CR-51	0.00E+00	0.00E+00	4.44E+00	2.47E+00	9.73E-01	6.34E+00	7.46E+02
MN-54	0.00E+00	5.33E+03	1.06E+03	0.00E+00	1.59E+03	0.00E+00	1.09E+04
MN-56	0.00E+00	1.43E+02	2.54E+01	0.00E+00	1.81E+02	0.00E+00	9.40E+03
FE-55	3.35E+04	2.37E+04	5.54E+03	0.00E+00	0.00E+00	1.51E+04	1.03E+04
FE-59	5.20E+04	1.21E+05	4.69E+04	0.00E+00	0.00E+00	3.83E+04	2.87E+05
CO-58	0.00E+00	5.10E+02	1.18E+03	0.00E+00	0.00E+00	0.00E+00	7.04E+03
CO-60	0.00E+00	1.48E+03	3.32E+03	0.00E+00	0.00E+00	0.00E+00	1.92E+04
NI-63	5.15E+04	3.64E+03	1.75E+03	0.00E+00	0.00E+00	0.00E+00	5.79E+02
NI-65	2.18E+02	2.79E+01	1.27E+01	0.00E+00	0.00E+00	0.00E+00	1.51E+03
CU-64	0.00E+00	9.53E+01	4.48E+01	0.00E+00	2.41E+02	0.00E+00	7.39E+03
ZN-65	1.46E+05	5.07E+05	2.36E+05	0.00E+00	3.24E+05	0.00E+00	2.15E+05
ZN-69	3.73E+02	7.10E+02	4.97E+01	0.00E+00	4.64E+02	0.00E+00	1.31E+03
BR-83	0.00E+00	0.00E+00	4.41E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	5.55E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-85	0.00E+00	0.00E+00	2.34E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	1.09E+05	5.12E+04	0.00E+00	0.00E+00	0.00E+00	1.61E+04
RB-88	0.00E+00	3.12E+02	1.66E+02	0.00E+00	0.00E+00	0.00E+00	2.67E-05
RB-89	0.00E+00	2.01E+02	1.42E+02	0.00E+00	0.00E+00	0.00E+00	3.09E-07
SR-89	2.79E+04	0.00E+00	8.00E+02	0.00E+00	0.00E+00	0.00E+00	3.33E+03
SR-90	5.27E+05	0.00E+00	1.30E+05	0.00E+00	0.00E+00	0.00E+00	1.48E+04
SR-91	5.12E+02	0.00E+00	2.04E+01	0.00E+00	0.00E+00	0.00E+00	2.32E+03
SR-92	1.94E+02	0.00E+00	8.25E+00	0.00E+00	0.00E+00	0.00E+00	4.93E+03
Y-90	6.57E+00	0.00E+00	1.77E-01	0.00E+00	0.00E+00	0.00E+00	5.42E+04
Y-91M	6.18E-02	0.00E+00	2.36E-03	0.00E+00	0.00E+00	0.00E+00	2.92E+00
Y-91	9.64E+01	0.00E+00	2.58E+00	0.00E+00	0.00E+00	0.00E+00	3.95E+04
Y-92	5.80E-01	0.00E+00	1.68E-02	0.00E+00	0.00E+00	0.00E+00	1.59E+04
Y-93	1.84E+00	0.00E+00	5.03E-02	0.00E+00	0.00E+00	0.00E+00	5.61E+04
ZR-95	1.68E+00	5.29E-01	3.64E-01	0.00E+00	7.78E-01	0.00E+00	1.22E+03
ZR-97	9.65E-02	1.91E-02	8.80E-03	0.00E+00	2.90E-02	0.00E+00	5.17E+03
NB-95	4.86E+00	2.70E+00	1.48E+00	0.00E+00	2.61E+00	0.00E+00	1.15E+04
MO-99	0.00E+00	1.36E+02	2.60E+01	0.00E+00	3.12E+02	0.00E+00	2.44E+02
TC-99M	1.63E-02	4.55E-02	5.89E-01	0.00E+00	6.77E-01	2.52E-02	2.98E+01
TC-101	1.77E-02	2.51E-02	2.47E-01	0.00E+00	4.55E-01	1.53E-02	4.30E-09
RU-103	1.15E+02	0.00E+00	4.93E+01	0.00E+00	4.06E+02	0.00E+00	9.63E+03
RU-105	9.85E+00	0.00E+00	3.82E+00	0.00E+00	1.24E+02	0.00E+00	7.96E+03
RU-106	1.77E+03	0.00E+00	2.23E+02	0.00E+00	3.42E+03	0.00E+00	8.50E+04
AG-110M	4.45E+02	4.22E+02	2.56E+02	0.00E+00	8.04E+02	0.00E+00	1.18E+05
SB-122	4.35E+01	8.47E-01	1.27E+01	5.53E-01	0.00E+00	2.72E+01	9.13E+03
SB-124	5.09E+02	9.40E+00	1.99E+02	1.16E+00	0.00E+00	4.45E+02	1.03E+04
SB-125	3.27E+02	3.58E+00	7.64E+01	3.11E-01	0.00E+00	2.85E+02	2.53E+03

Table 2 - 2

Site Related Teen Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
TE-125M	2.96E+03	1.07E+03	3.96E+02	8.28E+02	0.00E+00	0.00E+00	8.75E+03
TE-127M	7.48E+03	2.65E+03	8.90E+02	1.78E+03	3.03E+04	0.00E+00	1.87E+04
TE-127	1.22E+02	4.33E+01	2.63E+01	8.44E+01	4.95E+02	0.00E+00	9.44E+03
TE-129M	1.26E+04	4.68E+03	2.00E+03	4.07E+03	5.28E+04	0.00E+00	4.74E+04
TE-129	3.47E+01	1.29E+01	8.44E+00	2.48E+01	1.46E+02	0.00E+00	1.90E+02
TE-131M	1.89E+03	9.06E+02	7.55E+02	1.36E+03	9.44E+03	0.00E+00	7.27E+04
TE-131	2.16E+01	8.90E+00	6.75E+00	1.66E+01	9.44E+01	0.00E+00	1.77E+00
TE-132	2.70E+03	1.71E+03	1.61E+03	1.80E+03	1.64E+04	0.00E+00	5.42E+04
I-130	5.06E+01	1.46E+02	5.84E+01	1.19E+04	2.25E+02	0.00E+00	1.12E+02
I-131	2.87E+02	4.02E+02	2.16E+02	1.17E+05	6.92E+02	0.00E+00	7.95E+01
I-132	1.37E+01	3.58E+01	1.29E+01	1.21E+03	5.64E+01	0.00E+00	1.56E+01
I-133	9.87E+01	1.67E+02	5.11E+01	2.34E+04	2.94E+02	0.00E+00	1.27E+02
I-134	7.17E+00	1.90E+01	6.82E+00	3.17E+02	2.99E+01	0.00E+00	2.50E-01
I-135	2.99E+01	7.71E+01	2.86E+01	4.96E+03	1.22E+02	0.00E+00	8.54E+01
CS-134	4.24E+04	9.97E+04	4.63E+04	0.00E+00	3.17E+04	1.21E+04	1.24E+03
CS-136	4.35E+03	1.71E+04	1.15E+04	0.00E+00	9.32E+03	1.47E+03	1.38E+03
CS-137	5.67E+04	7.54E+04	2.63E+04	0.00E+00	2.57E+04	9.97E+03	1.07E+03
CS-138	3.93E+01	7.54E+01	3.77E+01	0.00E+00	5.57E+01	6.48E+00	3.42E-02
BA-139	7.05E+00	4.96E-03	2.05E-01	0.00E+00	4.67E-03	3.42E-03	6.28E+01
BA-140	1.44E+03	1.76E+00	9.28E+01	0.00E+00	5.98E-01	1.19E+00	2.22E+03
BA-141	3.40E+00	2.54E-03	1.14E-01	0.00E+00	2.36E-03	1.74E-03	7.25E-06
BA-142	1.52E+00	1.52E-03	9.33E-02	0.00E+00	1.28E-03	1.01E-03	4.65E-12
LA-140	1.67E+00	8.20E-01	2.18E-01	0.00E+00	0.00E+00	0.00E+00	4.71E+04
LA-142	8.58E-02	3.81E-02	9.49E-03	0.00E+00	0.00E+00	0.00E+00	1.16E+03
CE-141	3.49E+00	2.33E+00	2.67E-01	0.00E+00	1.10E+00	0.00E+00	6.66E+03
CE-143	6.16E-01	4.48E+02	5.01E-02	0.00E+00	2.01E-01	0.00E+00	1.35E+04
CE-144	1.82E+02	7.55E+01	9.80E+00	0.00E+00	4.51E+01	0.00E+00	4.59E+04
PR-143	6.28E+00	2.51E+00	3.13E-01	0.00E+00	1.46E+00	0.00E+00	2.07E+04
PR-144	2.06E-02	8.44E-03	1.05E-03	0.00E+00	4.84E-03	0.00E+00	2.27E-05
ND-147	4.50E+00	4.89E+00	2.93E-01	0.00E+00	2.87E+00	0.00E+00	1.76E+04
W-187	3.22E+02	2.62E+02	9.19E+01	0.00E+00	0.00E+00	0.00E+00	7.10E+04
NP-239	3.98E-02	3.75E-03	2.08E-03	0.00E+00	1.18E-02	0.00E+00	6.03E+02
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	1.25E+02	2.10E+02	0.00E+00	0.00E+00	0.00E+00	2.33E+03
SR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-97	4.36E-02	1.08E-02	3.95E-03	0.00E+00	1.27E-02	0.00E+00	2.58E+02
CD-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SN-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-134	3.46E+01	2.22E+01	2.32E+01	2.84E+01	2.12E+02	0.00E+00	1.28E+00
CE-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2 - 3

Site Related Child Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	1.81E-01	1.81E-01	1.81E-01	1.81E-01	1.81E-01	1.81E-01
BE-7	4.77E-01	8.08E-01	5.33E-01	0.00E+00	7.96E-01	0.00E+00	4.52E+01
NA-24	4.57E+02	4.57E+02	4.57E+02	4.57E+02	4.57E+02	4.57E+02	4.57E+02
P-32	6.98E+07	3.27E+06	2.69E+06	0.00E+00	0.00E+00	0.00E+00	1.93E+06
CR-51	0.00E+00	0.00E+00	4.86E+00	2.70E+00	7.37E-01	4.92E+00	2.58E+02
MN-54	0.00E+00	4.20E+03	1.12E+03	0.00E+00	1.18E+03	0.00E+00	3.53E+03
MN-56	0.00E+00	1.31E+02	2.96E+01	0.00E+00	1.59E+02	0.00E+00	1.90E+04
FE-55	4.55E+04	2.42E+04	7.48E+03	0.00E+00	0.00E+00	1.37E+04	4.47E+03
FE-59	6.53E+04	1.06E+05	5.27E+04	0.00E+00	0.00E+00	3.07E+04	1.10E+05
CO-58	0.00E+00	4.20E+02	1.29E+03	0.00E+00	0.00E+00	0.00E+00	2.45E+03
CO-60	0.00E+00	1.23E+03	3.64E+03	0.00E+00	0.00E+00	0.00E+00	6.84E+03
NI-63	6.85E+04	3.67E+03	2.33E+03	0.00E+00	0.00E+00	0.00E+00	2.47E+02
NI-65	2.83E+02	2.66E+01	1.55E+01	0.00E+00	0.00E+00	0.00E+00	3.26E+03
CU-64	0.00E+00	9.05E+01	5.47E+01	0.00E+00	2.19E+02	0.00E+00	4.25E+03
ZN-65	1.55E+05	4.12E+05	2.56E+05	0.00E+00	2.59E+05	0.00E+00	7.23E+04
ZN-69	4.94E+02	7.14E+02	6.60E+01	0.00E+00	4.33E+02	0.00E+00	4.50E+04
BR-83	0.00E+00	0.00E+00	5.67E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-84	0.00E+00	0.00E+00	6.56E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BR-85	0.00E+00	0.00E+00	3.02E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RB-86	0.00E+00	1.06E+05	6.50E+04	0.00E+00	0.00E+00	0.00E+00	6.80E+03
RB-88	0.00E+00	3.00E+02	2.08E+02	0.00E+00	0.00E+00	0.00E+00	1.47E+01
RB-89	0.00E+00	1.85E+02	1.64E+02	0.00E+00	0.00E+00	0.00E+00	1.61E+00
SR-89	3.63E+04	0.00E+00	1.04E+03	0.00E+00	0.00E+00	0.00E+00	1.41E+03
SR-90	4.68E+05	0.00E+00	1.19E+05	0.00E+00	0.00E+00	0.00E+00	6.30E+03
SR-91	6.60E+02	0.00E+00	2.49E+01	0.00E+00	0.00E+00	0.00E+00	1.46E+03
SR-92	2.48E+02	0.00E+00	9.96E+00	0.00E+00	0.00E+00	0.00E+00	4.70E+03
Y-90	8.79E+00	0.00E+00	2.35E-01	0.00E+00	0.00E+00	0.00E+00	2.50E+04
Y-91M	8.17E-02	0.00E+00	2.97E-03	0.00E+00	0.00E+00	0.00E+00	1.60E+02
Y-91	1.29E+02	0.00E+00	3.44E+00	0.00E+00	0.00E+00	0.00E+00	1.71E+04
Y-92	7.70E-01	0.00E+00	2.20E-02	0.00E+00	0.00E+00	0.00E+00	2.22E+04
Y-93	2.44E+00	0.00E+00	6.69E-02	0.00E+00	0.00E+00	0.00E+00	3.63E+04
ZR-95	2.10E+00	4.62E-01	4.11E-01	0.00E+00	6.62E-01	0.00E+00	4.82E+02
ZR-97	1.27E-01	1.83E-02	1.08E-02	0.00E+00	2.63E-02	0.00E+00	2.77E+03
NB-95	5.75E+00	2.24E+00	1.60E+00	0.00E+00	2.10E+00	0.00E+00	4.14E+03
MO-99	0.00E+00	1.31E+02	3.23E+01	0.00E+00	2.79E+02	0.00E+00	1.08E+02
TC-99M	1.99E-02	3.89E-02	6.46E-01	0.00E+00	5.66E-01	1.98E-02	2.22E+01
TC-101	2.30E-02	2.41E-02	3.06E-01	0.00E+00	4.11E-01	1.27E-02	7.66E-02
RU-103	1.48E+02	0.00E+00	5.67E+01	0.00E+00	3.72E+02	0.00E+00	3.82E+03
RU-105	1.30E+01	0.00E+00	4.73E+00	0.00E+00	1.15E+02	0.00E+00	8.50E+03
RU-106	2.36E+03	0.00E+00	2.95E+02	0.00E+00	3.19E+03	0.00E+00	3.68E+04
AG-110M	5.24E+02	3.54E+02	2.83E+02	0.00E+00	6.59E+02	0.00E+00	4.21E+04
SB-122	5.80E+01	8.56E-01	1.70E+01	7.43E-01	0.00E+00	2.36E+01	4.46E+03
SB-124	6.55E+02	8.50E+00	2.29E+02	1.44E+00	0.00E+00	3.63E+02	4.09E+03
SB-125	4.22E+02	3.25E+00	8.85E+01	3.91E-01	0.00E+00	2.35E+02	1.01E+03

Table 2 - 3

Site Related Child Ingestion Dose Commitment Factors
(Freshwater Fish and Saltwater Invertebrate Consumption)

(AiT)
mR/hr per uCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
TE-125M	3.81E+03	1.03E+03	5.08E+02	1.07E+03	0.00E+00	0.00E+00	3.68E+03
TE-127M	9.67E+03	2.60E+03	1.15E+03	2.31E+03	2.76E+04	0.00E+00	7.83E+03
TE-127	1.58E+02	4.25E+01	3.38E+01	1.09E+02	4.48E+02	0.00E+00	6.15E+03
TE-129M	1.63E+04	4.55E+03	2.53E+03	5.25E+03	4.78E+04	0.00E+00	1.99E+04
TE-129	4.48E+01	1.25E+01	1.06E+01	3.20E+01	1.31E+02	0.00E+00	2.79E+03
TE-131M	2.41E+03	8.33E+02	8.86E+02	1.71E+03	8.06E+03	0.00E+00	3.38E+04
TE-131	2.78E+01	8.46E+00	8.26E+00	2.12E+01	8.40E+01	0.00E+00	1.46E+02
TE-132	3.38E+03	1.50E+03	1.81E+03	2.18E+03	1.39E+04	0.00E+00	1.51E+04
I-130	6.28E+01	1.27E+02	6.54E+01	1.40E+04	1.90E+02	0.00E+00	5.94E+01
I-131	3.70E+02	3.72E+02	2.12E+02	1.23E+05	6.11E+02	0.00E+00	3.31E+01
I-132	1.72E+01	3.16E+01	1.45E+01	1.47E+03	4.84E+01	0.00E+00	3.72E+01
I-133	1.27E+02	1.58E+02	5.96E+01	2.93E+04	2.63E+02	0.00E+00	6.35E+01
I-134	9.02E+00	1.67E+01	7.70E+00	3.85E+02	2.56E+01	0.00E+00	1.11E+01
I-135	3.77E+01	6.78E+01	3.21E+01	6.00E+03	1.04E+02	0.00E+00	5.16E+01
CS-134	5.15E+04	8.44E+04	1.78E+04	0.00E+00	2.62E+04	9.39E+03	4.55E+02
CS-136	5.17E+03	1.42E+04	9.19E+03	0.00E+00	7.56E+03	1.13E+03	4.99E+02
CS-137	7.19E+04	6.88E+04	1.02E+04	0.00E+00	2.24E+04	8.07E+03	4.31E+02
CS-138	5.01E+01	6.97E+01	4.42E+01	0.00E+00	4.90E+01	5.28E+00	3.21E+01
BA-139	9.34E+00	4.99E-03	2.71E-01	0.00E+00	4.35E-03	2.93E-03	5.39E+02
BA-140	1.87E+03	1.64E+00	1.09E+02	0.00E+00	5.35E-01	9.79E-01	9.50E+02
BA-141	4.51E+00	2.53E-03	1.47E-01	0.00E+00	2.19E-03	1.48E-02	2.57E+00
BA-142	1.97E+00	1.42E-03	1.10E-01	0.00E+00	1.15E-03	8.35E-04	2.57E-02
LA-140	2.16E+00	7.55E-01	2.54E-01	0.00E+00	0.00E+00	0.00E+00	2.10E+04
LA-142	1.12E-01	3.57E-02	1.12E-02	0.00E+00	0.00E+00	0.00E+00	7.08E+03
CE-141	4.65E+00	2.32E+00	3.45E-01	0.00E+00	1.02E+00	0.00E+00	2.90E+03
CE-143	8.19E-01	4.44E+02	6.44E-02	0.00E+00	1.86E-01	0.00E+00	6.51E+03
CE-144	2.44E+02	7.64E+01	1.30E+01	0.00E+00	4.23E+01	0.00E+00	1.99E+04
PR-143	8.40E+00	2.52E+00	4.17E-01	0.00E+00	1.37E+00	0.00E+00	9.06E+03
PR-144	2.76E-02	8.53E-03	1.39E-03	0.00E+00	4.51E-03	0.00E+00	1.84E+01
ND-147	5.96E+00	4.83E+00	3.74E-01	0.00E+00	2.65E+00	0.00E+00	7.65E+03
W-187	4.08E+02	2.42E+02	1.08E+02	0.00E+00	0.00E+00	0.00E+00	3.40E+04
NP-239	5.15E-02	3.70E-03	2.60E-03	0.00E+00	1.07E-02	0.00E+00	2.74E+02
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	1.15E+02	2.33E+02	0.00E+00	0.00E+00	0.00E+00	9.43E+02
SR-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NB-97	5.55E-02	1.00E-02	4.68E-03	0.00E+00	1.11E-02	0.00E+00	3.09E+03
CD-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SN-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TE-134	4.31E+01	1.94E+01	2.59E+01	3.41E+01	1.80E+02	0.00E+00	1.97E+02
CE-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2-4

Bio-Accumulation Factors for Liquid Effluent Isotopes
(pCi/kg per pCi/liter)

ISOTOPE	Freshwater Fish BFi	Saltwater Invertebrates BIi	ISOTOPE	Freshwater Fish BFi	Saltwater Invertebrates BIi
H-3	9.000E-01	9.300E-01	TE-125M	4.000E+02	1.000E+02
BE-7	2.000E+00	2.000E+02	TE-127M	4.000E+02	1.000E+02
NA-24	1.000E+02	1.900E-01	TE-127	4.000E+02	1.000E+02
P-32	1.000E+05	3.000E+04	TE-129M	4.000E+02	1.000E+02
CR-51	2.000E+02	2.000E+03	TE-129	4.000E+02	1.000E+02
MN-54	4.000E+02	4.000E+02	TE-131M	4.000E+02	1.000E+02
MN-56	4.000E+02	4.000E+02	TE-131	4.000E+02	1.000E+02
FE-55	1.000E+02	2.000E+04	TE-132	4.000E+02	1.000E+02
FE-59	1.000E+02	2.000E+04	I-130	1.500E+01	5.000E+01
CO-58	5.000E+01	1.000E+03	I-131	1.500E+01	5.000E+01
CO-60	5.000E+01	1.000E+03	I-132	1.500E+01	5.000E+01
NI-63	1.000E+02	2.500E+02	I-133	1.500E+01	5.000E+01
NI-65	1.000E+02	2.500E+02	I-134	1.500E+01	5.000E+01
CU-64	5.000E+01	1.700E+03	I-135	1.500E+01	5.000E+01
ZN-65	2.000E+03	5.000E+04	CS-134	2.240E+02	2.240E+02
ZN-69	2.000E+03	5.000E+04	CS-136	2.240E+02	2.240E+02
BR-83	4.200E+02	3.100E+00	CS-137	2.240E+02	2.240E+02
BR-84	4.200E+02	3.100E+00	CS-138	2.240E+02	2.240E+02
BR-85	4.200E+02	3.100E+00	BA-139	4.000E+00	1.000E+02
RB-86	2.000E+03	1.700E+01	BA-140	4.000E+00	1.000E+02
RB-88	2.000E+03	1.700E+01	BA-141	4.000E+00	1.000E+02
RB-89	2.000E+03	1.700E+01	BA-142	4.000E+00	1.000E+02
SR-89	3.000E+01	2.000E+01	LA-140	2.500E+01	1.000E+03
SR-90	3.000E+01	2.000E+01	LA-142	2.500E+01	1.000E+03
SR-91	3.000E+01	2.000E+01	CE-141	1.000E+00	6.000E+02
SR-92	3.000E+01	2.000E+01	CE-143	1.000E+00	6.000E+02
Y-90	2.500E+01	1.000E+03	CE-144	1.000E+00	6.000E+02
Y-91M	2.500E+01	1.000E+03	PR-143	2.500E+01	1.000E+03
Y-91	2.500E+01	1.000E+03	PR-144	2.500E+01	1.000E+03
Y-92	2.500E+01	1.000E+03	ND-147	2.500E+01	1.000E+03
Y-93	2.500E+01	1.000E+03	W-187	1.200E+03	3.000E+01
ZR-95	3.300E+00	8.000E+01	NP-239	1.000E+01	1.000E+01
ZR-97	3.300E+00	8.000E+01	K-40	0.000E+00	0.000E+00
NB-95	3.000E+02	1.000E+02	CO-57	5.000E+01	1.000E+03
MO-99	1.000E+01	1.000E+01	SR-85	0.000E+00	0.000E+00
TC-99M	1.500E+01	5.000E+01	Y-88	0.000E+00	0.000E+00
TC-101	1.500E+01	5.000E+01	NB-94	3.000E+02	1.000E+02
RU-103	1.000E+01	1.000E+03	NB-97	3.000E+02	1.000E+02
RU-105	1.000E+01	1.000E+03	CD-109	0.000E+00	0.000E+00
RU-106	1.000E+01	1.000E+03	SN-113	0.000E+00	0.000E+00
AG-110M	2.300E+00	5.000E+03	BA-133	0.000E+00	0.000E+00
SB-122	1.000E+00	3.000E+02	TE-134	4.000E+02	1.000E+02
SB-124	1.000E+00	3.000E+02	CE-139	0.000E+00	0.000E+00
SB-125	1.000E+00	3.000E+02	HG-203	0.000E+00	0.000E+00

Bio-Accumulation Factors and DFi's for Noble Gases = 0

3.0 GASEOUS EFFLUENTS

3.1 Gaseous Effluent Releases - General Information

3.1.1 A completed and properly authorized Airborne Radioactive Waste Release Permit shall be issued prior to the release of airborne activity from the waste gas holding system, containment purge, or any other batch release.

3.1.2 Since Indian Point is a two unit site, the derived instantaneous μCi/sec limits for each unit, (Section 3.2) were derived from an actual site limit (Appendix I). The time-average limits are "per reactor", and applicable to each unit.

3.1.3 During Modes 4 through 6, there is no flowpath for a release from the Condenser Air Ejector. During these intervals, when there is no actual release pathway, the monthly grab sample described in RECS D3.2.1 is not required.

3.1.4 During normal plant operation (without a primary to secondary leak), almost all gaseous releases are through the main Plant Vent. A negligible amount may be identified in other pathways (see Appendix C).

In the event of extended operation with a primary to secondary leak, low level releases are expected from both the blowdown flash tank vent and condenser air ejector. However, the limits on steam generator leakage are much more restrictive than those for effluent releases. Therefore, allocation of portions of the allowable release rate to these various release points during routine operation is not warranted.

If, on the other hand, the instantaneous release rate is being considered for the Plant Vent, then ALL release points should be considered when establishing alarm setpoints, per ODCM Part II, Section 1.

3.1.5 For releases that are expected to continue for periods over two days, a new release permit will normally be issued each day.

A containment purge permit may be closed, with the release reclassified as continuous building ventilation, when activity in containment is sufficiently reduced to that level which, if released for 31-days, would remain BELOW the dose projection limits.

However, when plant conditions change, such that releases to containment are likely, a new permit should be evaluated.

3.1.6 Assurance that the combined gaseous releases from Units 2 and 3 do not exceed limits of Section 3.2.1 is provided by administrative controls for both units. These controls include apportionment of the 10CFR20 limitations and back-calculating radiation monitor setpoints accordingly. These calculations are discussed in Appendix I.

3.1.7 By mutual agreement with units 2 and 3 Shift Supervisors, one unit can reduce or eliminate discharges for a period of time to allow the other unit to use the full site permissible discharge rate, or a specific portion thereof, for unique releases that may require the site limit for release rate. To better control these evolutions, written agreement to the apportionment is generally kept with each unit's CRS and included on applicable permits for the duration.

3.1.8 Conservative release rate limitations have been established to ensure compliance with 10CFR20, and to aid in controlling time average dose limits. The annual average release rate limit (Appendix I) shall normally be used for calculating limitations on discharge. If this limitation is unduly restrictive, other release rates may be allowed, per Appendix I, and summarized below:

Release Rate (μCi/sec)	Permission Required
Quarterly Average	Site Operations Manager / designee
Default Instantaneous	General Manager, Plant Operations / designee
ODCM Instantaneous	GMPO and Chemistry Superintendent / designee

As described in Appendix I, the ODCM instantaneous limit provides a maximum release rate with an actual or suspected isotopic mixture, back-calculated from the actual 10CFR20 limit (500 mrem/yr for the site). The calculations for the use of this limit should be verified within the Chemistry department. The default interval in which to determine the proximity to this limit (uCi/sec or mrem/yr) is one hour or less.

3.1.9 Containment Pressure Reliefs

Containment pressure reliefs occur frequently enough to be considered continuous releases. Grab samples of containment atmosphere are obtained periodically to ensure the use of accurate mixtures in effluent calculations. The containment noble gas monitors (R-42 for Unit 2 and R-12 for Unit 3) are used in conjuction with expected flow rates to determine a release rate. The effluent noble gas monitor in the plant vent is also used to verify total unit release rate remains below the current authorized limit.

3.1.10 Composite Particulate Samples

Continuous building ventilation exhaust points are sampled continuously for Iodine and Particulate. Media is replaced weekly, with composite filters prepared for vendor lab analyses monthly.

3.1.11 Flow rate measurement for the Continuous Building Ventilation systems is typically obtained from the installed process monitor or nearby instrument. When the process flow rate instrument is OOS, estimates are performed every 4 hours per the RECS, to allow appropriate quantification of continuous airborne effluent. The estimates are typically performed by summing the exhaust flow rates (or design flow rate) from any operable fans. Unit 3's PV flow may be estimated from a backup instrument.

Unit 3's Admin Bldg does NOT have a flow rate instrument (design flow of 12500 cfm is used). The process flow rate monitor surveillance requirements specified in the RECS are not applicable for the Unit 3 Admin Building.

3.1.12 Gas Storage Tank Activity Limits

The quantity of radioactivity in each gas storage tank is limited to 50,000 Ci of noble gas, Xenon-133 equivalent, per RECS D3.2.6. The source of this requirement is NUREG 0133 (Section 5.6.1) for both units. However, the parameters used in the given equation are applied differently at each unit, as defined in the FSARs and summarized in the following discussion:

Unit 2:

$$Q_{133} = \frac{(500 mrem) * 3.15E+7 \ \sec/yr}{(1E6 \mu Ci/Ci)(294 mrem - m^3/\mu Ci - yr)(1.81E-3 \ \sec/m^3)} = \underline{\mathbf{29{,}761\ Ci}}$$

Where;

294 mrem-m^3/μCi-yr = the Xe-133 WB dose factor, RG 1.109, table B-1 (K).
1.81E-3 sec/m^3 = Design Basis Accident X/Q from Indian Point 2 FSAR

An actual curie limit is calculated by substituting the actual mixture K_{eff} into the equation above. For example, the K_{eff} for the accident mix computed using Table 14.2-5 of the FSAR is 476 mrem-m^3/μCi-yr. Thus, the actual activity limit (for an expected mixture of radionuclides, not just Xe-133) is:

$$Q_{133} = \frac{(500 mrem) * 3.15E+7 \ \sec/yr}{(1E6 \mu Ci/Ci)(476 mrem - m^3/\mu Ci - yr)(1.81E-3 \ \sec/m^3)} = \underline{\mathbf{18{,}300\ Ci}}$$

Similar calculations could be performed with actual K_{eff} and X/Q data.

As demonstrated above, the setpoints calculated from NUREG 0133 modeling assume Xe-133 equivalent and no tank interconnections (29,761 Ci of Xe-133 equivalent or 18,300 Ci for an expected accident mixture).

However, the tanks are, in fact, generally interconnected, requiring a more conservative approach. The unit 2 FSAR (14.2.3) has established a specific gas decay tank limit of **6,000 Ci** each. This value is based on the original RECS required 29,761 curies of Xe-133 equivalent, divided into 4 large and all 6 small gas decay tanks. Given the actual atmospheric volume of the tanks (525 ft^3 for each large and 40 ft^3 for each small), the total volume is approximately 4.5 tanks:

$$\frac{29{,}761}{4.5} = \underline{\mathbf{6{,}000\ Ci}} \text{ Xe-133 Equivalent}$$

The RECS required gas storage tank radiation monitor (R-50), is therefore set to alarm at 6,000 curies. Warn setpoints are established by procedure, usually with consideration for measured tank contents and anticipated release rate.

In the event R-50 becomes inoperable, but a depressurized sample can be taken, the quantity limits can still be verified. Compliance with the appropriate curie limit in a tank is assured if the following inequality holds:

$$[A]_m < \frac{14.7\,(Q)}{(14.7 + P)V} \quad \text{or} \quad [A]_{eq} < \frac{14.7\,(Q133)}{(14.7 + P)V}$$

Where:

$[A]_m \equiv$ total measured depressurized sample concentration (μCi/cc)

$[A]_{eq} \equiv$ Xe-133 equivalent measured depressurized sample concentration (μCi/cc)

V $\equiv$ tank volume (cc) P $\equiv$ tank pressure (psig)

Q $\equiv$ activity limit for selected mix (μCi) Q133 $\equiv$ dose equivalent Xe133 limit(μCi)

Unit 3:

$$\text{Qit} = \frac{(500 mrem) * \ 3.15E+7 \ \sec/yr}{(1E6 \mu Ci/Ci)(294 mrem - m^3/\mu Ci - yr)(1.03E-3 \ \sec/m^3)} = \underline{\mathbf{50{,}000\ Ci}}$$

Where;

Ki = 294 mrem-m^3/μCi-yr, Xe-133 equivalent Table B-1 (RG 1.109)
X/Q = 1.03 x 10^{-3} sec/m^3, Indian Point 3 FSAR

This limit assumes 100% Xe-133 as per NUREG 0133. Utilizing the Ki from an expected mixture during RCS degasification (787 mrem-m^3 per uCi-yr), the gas tank conservative administrative limit should becomes:

$$\text{Qit} = \frac{(500\text{mrem}) * \ 3.15\text{E}+7 \ \text{sec/yr}}{(1\text{E}6\mu\text{Ci/Ci})(787\text{mrem} - \text{m}^3/\mu\text{Ci} - \text{yr})(1.03\text{E}-3 \ \text{sec/m}^3)} = \underline{\mathbf{19{,}400\ Ci}}$$

There are two methods available to ensure that the activity in the gas storage tank is within the conservative administrative limit:

$$\frac{1.94\text{E}+4 * 1\text{E}6\mu\text{Ci/Ci}}{525\,\text{ft}^3 * \left(\dfrac{164.7\text{psia}}{14.7\text{psia}}\right) * 2.83\text{E}4\,\text{cc/ft}^3} = 1.17\text{E}+2\ \mu\text{Ci/cc}$$

1. The total gaseous activity will normally be limited to less than 117 μCi/cc. If this concentration limit is exceeded, then the contents of the tank will be monitored and actions taken to ensure the 19,400 curie per tank limit is not exceeded.

2. The waste gas line monitor (R-20) reads in μCi/cc. It allows for control of waste gas tank curie content by limiting the input concentration to 117 μCi/cc, thereby limiting the curies to 19,400.

Large gas decay tanks on fill and CVCS tanks (which are indicative of the gas mixture in or from the reuse system) are continuously monitored for H_2 and O_2 through in-line instrumentation. With either in-line instrument out of service, a grab sample of the tank on receipt shall be taken daily, unless in degassing operation, when the periodicity is every four hours.Other primary system tank cover gases can be manually directed through these instruments for individual samples.

Gas releases may also occur from the gas space atop liquid holdup tanks. The basis for assuring these tanks comply with the curie limits for noble gas is Technical Specification 3.4.16, which limits Reactor Coolant to ≤ 1 μCi/gm Dose Equivalent Iodine-131. Using the assumptions discussed in each unit's FSAR, the potential total curies of noble gas in the liquid holdup tanks is limited to less than the conservative limit for the Gas Storage Tanks.

3.1.13 The activity released via the blowdown flash tank vent is determined by obtaining the steam generator blowdown activity (tritium, noble gas, and iodine), partitioned per Regulatory Guide 1.42 "Interim Licensing Policy On As Low As Practicable for Gaseous Radioiodine Releases from Light Water Cooled Nuclear Power Reactors" (from NUREG 0472, Rev3, DRAFT 6, TABLE 3.3-13), or Reference 4, "An Evaluation to Demonstrate the Compliance of the Indian Point Reactors with the Design Objectives of 10CFR50, Appendix I".

3.1.14 Carbon 14 is released at a rate of 9.6 curies per GW(e)/yr based upon studies performed by the New York State Department of Health at Indian Point 3. This is released in a gaseous form, the primary dose from which is in the CO_2 form. While quantifiable based on the GW(e) per year, C-14 is exempt from the dose limits specified in the RECS. Nonetheless, doses resulting from these releases are calculated in accordance with the methodology in Reg. Guide 1.109 and listed in the Radiological Impact on Man section of the Annual Radioactive Effluent Release Report. The airborne effluent dose calculation from C-14 emissions is performed using the fraction of carbon 14 released in the CO_2 form (26%).

3.1.15 The Unit 3 Liquid Waste Monitor Tanks have an airborne release pathway. The original plant design limited the gases through this pathway by reducing the entrained gases to less than 2E-3 μCi/ml. The removal of the CVCS gas stripper under modification 86-3-122 CVCS requires the quantification of these gases when the entrained gaseous activity in the Monitor Tank inlet exceeds 2E-3 μCi/ml. No action is required if the inlet noble gas concentration is less than 2E-3 μCi/ml. This gas release will be quantified by calculating the difference (in μCi's) between the gaseous activity added to the tank and the gaseous activity present in the effluent release sample. This difference will be quantified as an airborne ground level batch release, using a specifically determined ground level dispersion constant (Section 3.5.3).

A separate release permit evaluating this release is not required prior to release. Calculation of this rate of release is not required, however the time average dose contribution shall be calculated and controlled per Sections 3.3 and 3.4 of the ODCM. Section 3.6 provides additional detail relative to the finite cloud correction assumptions for this pathway.

Unit 2's Waste Distillate Storage Tanks are vented inside the Unit 1 facility, so there is no similar airborne release pathway from these tanks.

3.1.16 Evaluations of previous gas decay tank and containment purge releases have been performed. These evaluations indicate that these "Short Term Releases" (less than 500 hours per year and less than 150 hours per quarter) are sufficiently random to utilize the long term meteorological dispersion factor (NUREG 0133, Section 3.3, Page 8). The short-term correction factor, will only be used when non-random releases are to be made an a routine basis.

3.1.17 Airborne releases from the Steam Generator Safety or Atmospheric Dump Valves can occur during a Primary to Secondary leak. Tritium, Noble Gas, and Iodine effluent doses are determined using a source term activity (Main Steam or Steam Generator Blowdown), an Iodine partition factor (per Section 3.1.13), and a release rate, determined from Engineering Design Calculation 187 (Steam Generator Atmospherics), or design flowrate (from Steam Generator Safeties) at specific pressures in the Steam Generator.

3.1.18 Other release pathways resulting from Primary to Secondary leakage include the steam driven auxiliary feed pump vent, the gland seal exhaust vent, the air ejector vent, and the Feed Water heater flash tank vent. Offsite doses from these or other abnormal airborne release points are calculated by obtaining the release rate (from system descriptions and/or steam tables corrected for system pressure, as applicable) and source term activity (eg. Main Steam , Reactor Coolant, or best estimate) for Tritium, Noble Gas, and Iodine, partitioned as per Section 3.1.13.

3.1.19 The Unit 3 Monitor Tank vents, both unit Condenser Air Ejector, and the Gland Seal Exhaust points are ground level releases. Unless otherwise designated, other release points are considered mixed mode, per Section 3.6.

3.2 Gaseous Effluent Dose Calculation Requirements

3.2.1 RECS D3.2.1 requires that the dose rate due to radioactive materials released in gaseous effluents from the site at or beyond the site boundary shall be limited to:

a) For noble gases: Less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin; and

b) For Iodine 131, H-3, and radioactive materials in particulate form with half lives greater than 8 days: Less than or equal to 1500 mrem/yr to any organ.

These are SITE limits and normally apportioned appropriately between the units to simplify assurance of compliance with the RECS. The methodologies for performing these calculations are discussed in Sections 3.3.1 and 3.3.2, respectively.

3.2.2 RECS Section D3.2.2 requires that the air dose due to noble gas released in gaseous effluents from each reactor unit at or beyond the site boundary shall be limited to:

a) During any calendar quarter: Less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation.

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

The methodology for calculating these doses is discussed in Section 3.3.3.

3.2.3 RECS Section D3.2.3 requires that the dose to a member of the general public from Iodine 131, Tritium, and radionuclides in particulate form (half-lives > 8 days) in gaseous effluents released from each reactor unit shall be limited to:

a) Less than or equal to 7.5 mrem to any organ during a calendar quarter

b) Less than or equal to 15 mrem to any organ during a calendar year.

Cumulative dose contributions for the current calendar quarter and current calendar year shall be determined at least once every 31 days.

The methodology for calculating these doses is discussed in Section 3.3.4.

If either of the air dose or iodine/particulate dose cumulative limits is exceeded by a factor of two or more, then a cumulative dose evaluation is required from all contributions of direct radiation at the site boundary per RECS D3.4.1.

3.2.4 RECS D3.2.4 requires that for each reactor unit, the appropriate portions of the gaseous radwaste treatment system shall be used to reduce radioactive effluents in gaseous waste prior to their discharge when projected gaseous effluent air dose at the site boundary when averaged over 31 days, would exceed 0.2 mrad for gamma radiation or 0.4 mrad for beta radiation.

RECS D3.2.4 requires that for each reactor unit, the appropriate portions of the The appropriate portions of the ventilation exhaust treatment system shall be used to reduce radioactive materials in gaseous releases when the projected doses averaged over 31 days, would exceed 0.3 mrem to any organ (at nearest residence). Dose due to gaseous releases from the site shall be calculated at least once every 31 days.

These doses are projected based on the dose methodology discussed in Section 3.3.3 (noble gas) and 3.3.4 (iodine). The average of previous months' doses is used to project future dose as follows:

$$\begin{bmatrix} \text{Dose} \\ \text{Projection} \end{bmatrix} = \frac{\text{Current Month Dose} + \text{Previous months' Dose}}{\text{number of months used}} \pm \begin{bmatrix} \textit{major} \\ \textit{planned} \\ \textit{evolutions} \end{bmatrix}$$

The term for planned evolutions is routinely determined from previous similar evolutions, such as releases associated with plant shutdown.

3.3 Dose Methodology (Computer Calculation)

3.3.1 Instantaneous Dose Rates - Noble Gas Releases

When the instantaneous limit applies, the process radiation monitor response or release rate can be averaged over a one-hour time interval.

3.3.1.1 The equations developed in this section are used to meet the calculational requirements of paragraph 3.2.1. The magnitude of this pathway is the same for all age groups so there is no critical group. The site release rate is split to 50% per each unit, in terms of uCi/sec. Converted to actual mrem/yr dose rate, Unit 2's portion is 44.6%, with Unit 3 being allocated 55.4% (Unit 3 is slightly closer to the site boundary where dose rates are calculated).

Each unit has different dispersion factors due to their relative positions to the critical sector of the unrestricted area boundary. The conversion from dose rate to Ci/sec was determined with the use of a model which incorporates a finite cloud exposure correction. The methodology is discussed in Section 3.6.

A calculation showing the relationship between Ci/sec and dose rates from Units 2 and 3 is shown in Appendix I. The equations for calculating the dose rate limitations are obtained from NUREG 0133 (Ref. 1, Section 5.2.1). Utilizing the above assumptions, these equations reduce to the following which are to be summed for each nuclide, i. (Note that these are default unit portions of a site release rate limit. The entire site limit can be applied to any one site, when required, per Section 3.1 and Appendix I).

$$\sum_i \left[(Ki)*\left(\overline{X}/Q\right)*\left(\dot{Q}i\right)\right] \leq \text{unit specific mrem/yr whole body limit}$$

$$\sum_i \left[(Li+1.1Mi)*\left(\overline{X}/Q\right)*\left(\dot{Q}i\right)\right] \leq \text{unit specific skin limit, mrem/yr}$$

Where:

Ki = The total body dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$ (unit-specific finite cloud correction included, per Table 3-4).

Li = The skin dose factor due to beta emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$, per Table 3-5.

Mi = The air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$ (unit-specific finite cloud correction included, per Table 3-6).

Ni = The air dose factor due to beta emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$, per Table 3-7.

$\dot{Q}i$ = The release rate of radionuclides, i, in gaseous effluent for all release points in $\mu Ci/sec$.

(X/Q) = For all vent releases, the highest calculated annual averaged relative concentration at the critical receptor (at a unit-specific distance and direction, in sec/m^3, as shown on Page 1 of Appendix I).

The Ki, Li, Mi, and Ni factors were obtained from Table B-1 of Regulatory Guide 1.109 and are included in this document as Tables 3-4, 3-5, 3-6, and 3-7 respectively. The gamma dose factgors (Ki and Mi) have a unit-specific finite cloud correction factor included, as discussed in Sections 3.5 and 3.6.

Unit specific dose rate limits, as stated in Appendix I are as follows:

Unit 2: mrem/yr whole body = 234, skin limit = 1194 mrem/yr
Unit 3: mrem/yr whole body = 266, skin limit = 1806 mrem/yr

3.3.1.2 These equations can also be expressed in the following manner:

$(\overline{K})\,(\dot{Q}t)\,(\overline{X/Q})$ = mrem/yr dose to whole body

$(\overline{L}+1.1\overline{M})\,(\overline{X/Q})\,(\dot{Q}t)$ = mrem/yr dose to skin

Where:

$\dot{Q}$ t = The release rate of all noble gases summed together in µCi/sec, i.e., the sum of all $\dot{Q}$ i.

$$\overline{K} = (1/\dot{Q}t)\sum_{i=1}^{n} (\dot{Q}i)(Ki)$$

$$\overline{L} = (1/\dot{Q}t)\sum_{i=1}^{n} (\dot{Q}i)(Li)$$

$$\overline{M} = (1/\dot{Q}t)\sum_{i=1}^{n} (\dot{Q}i)(Mi)$$

$$\overline{N} = (1/\dot{Q}t)\sum_{i=1}^{n} (\dot{Q}i)\,Ni)$$

The values of $\overline{K}$, $\overline{L}$, $\overline{M}$, and $\overline{N}$ are listed in Table 3-8 for the unrestricted area boundary, for both units.

3.3.2 Instantaneous Dose Rates - I-131, Part w/>8 day t½ , and H-3

The equation developed in this section is used to meet the calculational requirements of RECS D3.2.1. The critical organ is considered to be the child thyroid as stated in the RECS bases (BD3.2.1). Different dispersion factors are applied to the critical sector of the unrestricted area boundary for units 2 and 3. Therefore, while 50% of the site release limit (in Ci/sec) is applied to each unit, 32.8% of the limit is applied to Unit 2 and 67.2% to Unit 3 (per Appendix I). The equation for calculating the dose rate limitation is abbreviated from that shown in NUREG 0133 (Ref. 1, Section 5.2.1, Pg. 25) in that ground plane and milk pathways are not considered for this dose rate determination, due to insignificant contribution compared to the inhalation pathway.

Utilizing the above assumptions, the dose rate equation reduces to the following:

$\sum_{i} (Pi * (X/Q) * \dot{Q}i)$ must be less than the unit-specific mrem/yr limit

Where:

Unit-specific limits are 497 mrem/yr for Unit 2 and 1003 mrem/yr for Unit 3.

Pi = The dose parameter for radionuclides other than noble gases for the inhalation pathway in mrem/yr per µCi/m^3. These parameters (per Section 3.3.2.1) are calculated separately for each isotope, age group, and organ.

$\dot{Q}$i = The release rate of radionuclide 131 and particulates, i, in gaseous effluents for all release points in μCi/sec.

X/Q = The unit-specific annual average dispersion parameter for the inhalation pathway at the controlling location due to all vent releases, per Section 3.5 and Appendix I.

3.3.2.1 Calculation of Pi(in): Inhalation Dose Factor

Pi (inhalation) = K' (BR) DFAi (mrem/yr per $\mu Ci/m^3$)

Where:

K' = A constant of conversion, 10^6 pCi/μCi

BR = The breathing rate of each age group as per 3.3.4.5.a (Table E-5 of Reg. Guide 1.109).

DFAi = The inhalation dose factor for each age group, organ, and nuclide, in mrem/pCi. These values are taken from Reg Guide 1.109, Table E-7 through E-9 and are reproduced in Tables 3-1a through 3-1d.

3.3.3 Time Average Dose - Noble Gas Release

3.3.3.1 The equations in this section are used to meet the calculational requirements of RECS D3.2.2. All noble gas releases at IPEC are assumed to be mixed mode unless indicated otherwise. Because the limits are in measured air dose (mrad), the magnitude of a measured effect is the same for all age groups. Dispersion parameters are discussed in Section 3.5.

3.3.3.2 Equations for calculating the air dose limitations are obtained from NUREG 0133 (Ref. 1, Section 5.3). The doses are evaluated at the unrestricted area boundary in the worst meteorological sector (a unit-specific location identified in Appendix I). These equations reduce to the following:

$$gamma\ \ air\ \ mrad = 3.17E-8*\sum_i \mathrm{Mi}\,[(\mathrm{X/Q})\,(\tilde{\mathrm{Q}}\mathrm{i}) + (\mathrm{x/q})\,(\tilde{\mathrm{q}}\mathrm{i}) + (\mathrm{x/q_{mt}})\,(\tilde{\mathrm{q}}\mathrm{i}_{\mathrm{mt}})]$$

$$beta\ \ air\ \ mrad = 3.17E-8*\sum_i \mathrm{Ni}\,[(\mathrm{X/Q})\,(\tilde{\mathrm{Q}}\mathrm{i}) + (\mathrm{x/q})\,(\tilde{\mathrm{q}}\mathrm{i}) + (\mathrm{x/q_{mt}})\,(\tilde{\mathrm{q}}\mathrm{i}_{\mathrm{mt}})]$$

Where:

Air dose limits are as follows:

	Any Calendar Quarter	Any Calendar Year
Gamma Air	*5 mrad*	*10 mrad*
Beta Air	*10 mrad*	*20 mrad*

(X/Q) =The highest calculated annual average relative concentration for the unrestricted area boundary at the controlling sector for long term releases (greater than 500 hrs/yr or 150 hrs/qtr or as noted in 3.1.16), per Appendix I.

(x/q) = The relative concentration for the unrestricted area boundary for short term releases (equal to or less than 500 hrs/yr or 150 hrs/qtr and not random as defined in NUREG 0133, Section 3.3). This value is calculated as per Section 3.5.

(x/q_{mt})=The relative concentration for the unrestricted area boundary for ground level releases from Unit 3 Monitor Tanks at the critical receptor, in sec/m^3, per Section 3.5.3.

Mi = The weighted air dose factor due to gamma emission for each identified noble gas radionuclide in mrad/yr per μCi/m^3. This factor is unit-specific, per Table 3-6.

Ni = The weighted air dose factor due to beta emissions for each identified noble gas radionuclide in mrad/yr per μCi/m^3.

$\tilde{q}i_{mt}$ = The total releases of noble gas radionuclides in Monitor Tank vents in μCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

$\tilde{q}i$ = The total release of noble gas radionuclides in gaseous effluents, i, for short term releases (equal to or less than 500 hrs/yr or 150 hrs/qtr and not random as defined in NUREG 0133, Section 3.3) from all vents, in μCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

$\tilde{Q}i$ = The total release of noble gas radionuclides in gaseous effluents, i, for long term releases (greater than 500 hrs/yr or 150 hrs/qtr or as noted in 3.1.16) from all vents in μCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

3.17 E-8 = The inverse of the number of seconds in a year.

The air dose factors Mi and Ni were obtained from Table B-1 of Regulatory Guide 1.109 and are listed in Table 3-6 and 3-7 respectively. The M air dose factors are finite cloud corrected and therefore unit-specific.

3.3.4 Time Averaged Dose - Radioiodine 131, Part w/t½ >8 days, and Tritium

3.3.4.1 The equations in this section are used to meet the calculational requirements of RECS D3.2.3.

3.3.4.2 The pathways considered in this analysis are as follows:

Pathway	*Receptor*
Inhalation, Ground Plane, Vegetative Ingestion	Primary, Nearest Resident, per App I
Inhalation, Ground Plane, Vegatative, Cow-Milk Ingestion	Secondary Receptor at 5 mile, applied per the annual Land Use Census

The land use census identifies a high degree of commercial, industrial, and residential land usage in the area, and as such, the meat ingestion pathway is not considered. Doses from the cow-milk pathway are included only if the applicable annual census has defined the pathway applicable. The methodology in nonetheless included here.

3.3.4.3 The equations for calculating the dose limitations are obtained from NUREG 0133 (Ref. 1, Section 5.3). These equations reduce to the following :

$$(3.17\,E\text{-}08)^* \sum_i (Ri\,(W\,\tilde{Q}i \;+\; w\,\tilde{q}i) \;<\; 7.5 \text{ mrem} \quad \text{in a calendar quarter}$$

$$(3.17\,E\text{-}08)^* \sum_i (Ri\,(W\,\tilde{Q}i \;+\; w\,\tilde{q}i) \;<\; 15 \text{ mrem} \quad \text{in a calendar year}$$

Where:

$\tilde{Q}i$ = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for long term releases as defined in Section 3.1.16, in μCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

$\tilde{q}i$ = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for short term releases as defined in Section 3.1.16, in μCi. Releases shall be cumulative over the calendar quarter or year, as appropriate.

W = The dispersion or deposition parameter (based on meteorological data defined in Section 3.5) for estimating the dose to an individual at the applicable receptor for long term releases as defined in Section 3.1.16 and Appendix I.

w = The vent dispersion or deposition parameter for estimating the dose to an individual at the applicable receptor for short term releases as calculated as in Section 3.5 and defined in Section 3.1.16 and Appendix I.

3.17 E-08 = The inverse number of seconds in a year.

Ri = The dose factor for each identified pathway, organ, and radionuclide, i, in m^2 ·mrem/yr per μCi/sec or mrem/yr per μCi/m^3. These dose factors are determined as described in Sections 3.3.4.5a-d.

3.3.4.4 Utilizing the assumptions contained in Section 3.3.4.3, these equations for the nearest resident and the 5-mile cow secondary receptor reduce to the following:

$$DN=(3.17E\text{-}8)\sum_i [Ri(I)*[Wn(in)\tilde{Q}i+wn(in)\tilde{q}i]+(Ri(G)+ Ri(V))*[Wn(dep)\tilde{Q}i+wn(dep)\tilde{q}i]]$$

$$DS=(3.17E\text{-}8)\sum_i [Ri(I)*[Ws(in)\tilde{Q}i+ws(in)\tilde{q}i]+(Ri(G)+Ri(c)+Ri(V))*[Ws(dep)\tilde{Q}i+ws(dep)\tilde{q}i]]$$

Where:

DN = total dose at the nearest residence, in mrem

DS = total dose at the 5-mile cow secondary receptor, in mrem.

Wn(in) = The highest calculated annual average dispersion parameter for the inhalation pathway for the nearest residence in the unrestricted area, as defined in Appendix I.

wn(in) = The dispersion parameter Wn(in), corrected for short term releases, as defined in Appendix I.

Wn(dep)= The highest calculated annual average deposition parameter for the nearest residence in the unrestricted area, as defined in Appendix I, for all isotopes except Tritium, which uses the X/Q value instead (Wn(in)).

wn(dep)= The deposition parameter Wn(dep), corrected for short term releases, as defined in Appendix I.

Ws(in) = The highest calculated annual average dispersion parameter for the inhalation pathway at the 5-mile cow secondary receptor per Appendix I.

ws(in) = The dispersion parameter Ws(in), at the 5-mile cow secondary receptor, corrected for short term releases, as defined in Appendix I.

Ws(dep)= The highest calculated annual average deposition parameter for the 5-mile cow secondary receptor, as defined in Appendix I, for all isotopes except Tritium, which uses the X/Q value instead (Ws(in)).

ws(dep)= The deposition parameter Ws(dep), at the 5-mile cow secondary receptor, corrected for short term releases, as defined in Appendix I.

$\tilde{Q}i$ = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for long term releases as defined earlier, (uCi).

$\tilde{q}i$ = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for short term releases as defined earlier (uCi).

Ri (I): Inhalation pathway factor for each radionuclide, i, defined in Section 3.3.4.5.

Ri (G): Ground plane pathway factor for each radionuclide, i, defined in Section 3.3.4.5.

Ri (V): Vegetation pathway factor for each radionuclide, i, defined in Section 3.3.4.5.

Ri (C): Cow-Milk pathway factor for each radionuclide, i, defined in Section 3.3.4.5.

3.3.4.5 Calculation of Dose Factors

3.3.4.5.a Calculation of Ri (I) (X/Q) Inhalation Pathway Factor

$$Ri\,(I)_{(X/Q)} = K'[(BR)\,a]\,[(DFAi)\,a](\text{mrem/yr per }\mu\text{Ci/m}^3)$$

Where:

K' = Constant of unit conversion, 10^6 pCi/uCi

(BR) a = Breathing rate of the receptor of age group (a) in m^3/yr. (from Regulatory Guide 1.109, Table E-5)

Infant = 1400 (m^3/yr) Child = 3700 (m^3/yr) Adult/Teen = 8000 (m^3/yr)

(DFAi) a = The maximum organ inhalation dose factor for the receptor of age group (a) for the i_{th} radionuclide, in mrem/pCi. The total body is considered as an organ in the selection of (DFAi)a.

Child and infant inhalation dose factors are generally more restrictive, however, doses from each age group are calculated separately. The (DFAi)a values are listed in Tables 3-1a through 3-1d. The Ri values for the inhalation pathway are listed in Table 3-10a through 3-10d.

3.3.4.5.b Calculation of Ri(G)(D/Q) Ground Plane Pathway Factor

$$Ri(G)_{(D/Q)} = \frac{K'K''(SF)(DFGi)(1-e^{(-kit)})}{Ki} = \frac{m^2 \cdot mrem/yr}{uCi/\sec}$$

Where:

K' = A constant of conversion, 10^6 pCi/μCi.

K" = A constant of conversion, 8760 hr/yr.

ki = Decay constant for the i_{th} radionuclide sec^{-1}.

t = The exposure time, 4.73×10^8 sec (15 years).

DFGi = The ground plane dose conversion factor for i_{th} radionuclide (mrem/hr per pCi/m^2).

SF = Shielding factor (dimensionless) = 0.7 (from Table E-15 of Regulatory Guide 1.109).

The values of DFGi were obtained from Table E-6 of Regulatory Guide 1.109 and are listed in Table 3-2. These values were used to calculate Ri(G), which is the same for all age groups and organs and is listed in Table 3-13.

3.3.4.5.c Calculation of Ri(V)(D/Q) - Vegetation Pathway Factor

For non-Tritium isotopes:

$$Ri(V)_{(D/Q)} = \frac{K'(r)}{Yv(ki+kw)} * (DFLi)a * [(UaL)fL * e^{(-kitL)} + (UaS)fg * e^{(-kith)}]$$

Where:

K' = Constant of conversion, 10^6 pCi/μCi

r = Dimensionless correction factor for Iodine and Particulate from Table E-15 of Reg Guide 1.109: 0.2 for particulates, 1.0 for radioiodine

$DFLi_a$ = Reg Guide 1.109 dose factor for each nuclide, in mrem/pCi, for each age group.

UaL = Consumption rate of fresh leafy vegetation by the receptor in age group (a) in kg/yr.

ki = Decay constant for the radionuclide, in sec^{-1}

UaS = Consumption rate of non-leafy vegetables by the receptor in age group (a) in kg/yr.

fL = The fraction of the annual intake of leafy vegetation grown locally.

fg = The fraction of the annual intake of non-leafy vegetation grown locally.

kw = Decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73E-7 sec^{-1} (corresponding to a 14 day half-life).

tL = The average time between harvest of leafy vegetation and its consumption, in seconds.

th = The average time between harvest of stored vegetation and its consumption, in seconds.

Yv = The vegetation area density in kg/m^2.

The concentration of Tritium in vegetation is based on the airborne concentration rather than the deposition. Therefore, the Ri(V) is based on X/Q:

$(RiV)_{(X/Q)}$ = K'K"[(UaL)fL+(UaS)fg](DFLi)a (0.75)(0.5/H) (mrem/yr per $\mu Ci/m^3$)

Where:

K" = A constant of unit conversion, 1000 gm/kg

H = Absolute humidity of the atmosphere in gm/m^3. This value may be considered as 8 gm/m^3 (NUREG 0133, pg 27) in lieu of site specific information.

0.75 = The fraction of total feed that is water

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

DFLia for each age group is given in Tables 3-3a through 3-3d and Ri(V) values are listed in Table 3-11a through 3-11c.

Ri(V) Parameters Are From The Following Sources:

PARAMETER	VALUE	Reg Guide 1.109 Table
r (dimensionless)	1.0 for iodines & 0.2 for part.	E-15
(DFLi) a (mrem/pCi)	Each radionuclide	E-11 to E-14
UaL (kg/yr) - infant	0	E-5
- child	26	E-5
- teen	42	E-5
- adult	64	E-5
UaS (kg/yr) - infant	0	E-5
- child	520	E-5
- teen	630	E-5
- adult	520	E-5
fL (dimensionless)	1.0	E-15
fg (dimensionless)	0.76	E-15
tL (seconds)	8.6E4 (1 day)	E-15
th (seconds)	5.18E6 (60 days)	E-15
Yv (kg/m^2)	2.0	E-15

3.3.4.5.d Calculation of Ri(c)(D/Q) - Grass-Cow-Milk Pathway Factor

(applied only as required by the Land Use Census)

$$\mathrm{Ri(c)\,(D/Q)} = \frac{K(QF)(Uap)(Fm)(r)(DFLi)a}{ki + kw} * \left\langle [\frac{fpfs}{Yp} + \frac{1 - fpfs}{Ys}] * e^{(-kith)} \right\rangle * e^{(-kitf)} * e^{(-kitf)}$$

Where:

K' = Constant of conversion, 10^6 pCi/μCi

QF = Cow's consumption rate in kg/day (wet weight)

Uap= Receptor's milk consumption rate for age (a) in liters/yr.

Yp = Agricultural productivity by unit area of pasture grass in kg/m^2.

Ys = Agricultural productivity by unit area of stored feed in kg/m^2.

Fm = Stable element transfer coefficients in days/liters, Table 2-2.

r = Fraction of deposited activity retained on cow's feed grass.

(DFLi)a= The maximum organ ingestion dose for the radionuclide, I, for the receptor in age group (a) in mrem/pCi. Values are from Tables E-11 through E-14 of Regulatory Guide 1.109 and are listed in Tables 3-3a through 3-3d.

ki = Decay constant for the radionuclide in sec^{-1}.

kw = Decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73E-7 sec^{-1} (corresponding to a 14 day half-life).

tf = The transport time from pasture, to cow, to milk, to receptor in sec.

th = The transport time from pasture, to harvest, to cow, to milk, to receptor, in sec.

fp = Fraction of the year that the cow is on pasture.

fs = Fraction of the cow feed that is pasture grass while the cow is on pasture.

Note: The values of Ri (c) are listed in Table 3-12a-d.

The concentration of Tritium in milk is based on the airborne concentration rather than the deposition. Therefore, the Ri (c) is based on X/Q:

Ri (c) (X/Q) = K'K" (Fm) (QF) (Uap) (DFLi) a 0.75 (0.5/H) (mrem/yr per μCi/m^3)

Where:

K" = A constant of unit conversion, 10^3 m/kg;

H = Absolute humidity of the atmosphere in gm/m^3;

0.75 = The fraction of total feed that is water;

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

Other parameters and values are given above. The value of H may be considered as 8 grams/meter^3 (NUREG 0133, PAGE 27) in lieu of site specific information.

Ri(c) Parameters Are Taken From The Following Sources:

PARAMETER	VALUE	TABLE R.G. 1.109
r (dimensionless)	1.0 for radioiodine	E-15
	0.2 for particulates	E-15
Fm (days/liter)	Each stable element	E-1
Uap (liters/year) - infant	330	E-5
- child	330	E-5
- teen	400	E-5
- adult	310	E-5
(Dfli) a (mrem/pCi)	Each radionuclide	E-11 to E-14
Yp (kg/m^2)	0.7	E-15
Ys (kg/m^2)	2.0	E-15
tf (seconds)	1.73E5 (2 days)	E-15
th (seconds)	7.78E6 (90 days)	E-15
Qf (kg/day)	50	E-15
fs	Assumed to be unity	
fp	Assumed to be unity	

Stable Element Transfer data is listed in Table 3-2 (Reg Guide 1.109, Table E-1). The (DFLi)a values for 4 age groups are given in Tables 3-3a through 3-3d.

3.4 Backup Simplified Dose Methodology

The dose calculation procedures described in this section are provided for use as a backup whenever the primary computer methodology cannot be followed.

3.4.1 Instantaneous Dose Rates - Noble Gas Releases

Note: While true instantaneous rates and limits generally apply, a one hour average can be chosen as the defining interval for determining process radiation monitor response or release rate determinations.

3.4.1.1 This section describes the alternative calculational methods to meet the requirements of Section 3.2.1 and the calculational results per Section 3.3.1.

3.4.1.2 To determine an acceptable noble gas instantaneous release rate in μCi/sec, a standard isotopic mixture of noble gas is assumed. This isotopic mixture was measured for a mixture of isotopes typical of reactor coolant with exposed fuel. This requirement is evaluated at the worst sector of the unrestricted area boundary. Based on this isotopic mixture, standard weighted values of K, L, M, and N is determined using the technique presented in paragraph 3.3.1.2, and the Ki, Li, Mi, and Ni values from Tables 3-4 through 3-7. The data and results of this calculation are shown in Table 3-8.

3.4.1.3 Utilizing the equations from Paragraph 3.3.1.2 and the values from Table 3-8, conservative IPEC maximum (site) release limits for all noble gases in μCi/sec are calculated in Appendix I, page 2.

The resulting calculations establish a default instantaneous noble gas release rate limit of **140,000** μCi/sec for the site, split equally between the units for conservativism. While both Units 2 and 3 originally apply the instantaneous limit at 70,000 μCi/sec, any one unit can use up to nearly 100% of the site limit, should it become necessary.

Generally, as these limits begin to apply, actual sample data is used to determine the true instantaneous limit associated with 10CFR20 requirements, for both whole body and skin dose rate, as shown in Appendix I.

3.4.1.4 For individual release rate determinations, alternate computer codes and/or a procedurally driven hand calculation template serve as back up methodologies should the primary computer method be inoperable. These methods comply with calculations in Section 3.3.

3.4.2 Instantaneous Dose Rates-I-131, Particulates w/t½ >8 days, & H-3

3.4.2.1 This section describes the alternative calculational method to meet the requirements of Section 3.2.1. The purposes of this method is to provide backup calculational techniques, both computer aided and hand calculated, which approximate section 3.3.2.

3.4.2.2 To determine an acceptable iodine and particulate release rate, it is assumed that the limit on these releases shall be met if

a) the total noble gas concentration in the VC is at least a factor of 20,000 more than the concentration of radioiodine and long lived particulates, or

b) VC iodines and long lived particulates are less than 1E-7 μCi/cc.

Both these conditions have historically been the case, assuring that noble gas activity continues to be more limiting.

3.4.2.3 Backup instantaneous dose rate calculations can be performed with an alternate computer code or by formatted hand calculations which are identical to section 3.3.2.

3.4.3 <u>Time Averaged Dose - Noble Gas Releases</u>

3.4.3.1 This section describes alternative methods of meeting the requirements of Paragraphs 3.2.2 and 3.2.4, and the alternative methods of implementing the calculation techniques presented in Section 3.3.3.

3.4.3.2 The values of $\overline{Ki}$, $\overline{Li}$, $\overline{Mi}$, and $\overline{Ni}$ for either unit's Plant Vent (PV) mixed mode releases, and the potential Unit 3 Monitor Tank (MT) ground plane releases are determined for each release using the dispersion parameter for the site boundary in the worst sector. The calculations are as follows:

$$PV\overline{Ki} = (Ki)*(X/Q)PV \quad \text{and} \quad MTKi = (\overline{Ki})*(X/Q)MT$$

$$PV\overline{Li} = (Li)*(X/Q)PV \quad \text{and} \quad MTLi = (\overline{Li})*(X/Q)MT$$

$$PV\overline{Mi} = (Mi)*(X/Q)PV \quad \text{and} \quad MTMi = (\overline{Mi})*(X/Q)MT$$

$$PV\overline{Ni} = (Ni)*(X/Q)MT \quad \text{and} \quad MTNi = (\overline{Ni})*(X/Q)MT$$

<u>Where:</u>

Ki = The total body dose factor due to gamma emissions for each identified noble gas radionuclide in mrem/yr per $\mu Ci/m^3$ (unit-specific finite cloud correction used).

Li = The skin dose factor due to beta emissions for each identified noble gas radionuclide in mrem/yr per $\mu Ci/m^3$.

Mi = The air dose factor due to gamma emissions for each identified noble gas radionuclide in mrem/yr per $\mu Ci/m^3$ (unit-specific finite cloud correction used).

Ni = The air dose factor due to beta emissions for each identified noble gas radionuclide in mrad/yr per $\mu Ci/m^3$.

(X/Q)PV = The highest calculated annual average dispersion parameter for the noble gas pathway at the unrestricted area boundary, applicable to plant vent mixed mode releases, per Appendix I.

(X/Q)MT = The highest calculated annual average X/Q for ground level monitor tank noble gas release pathway, 5.00E-5 sec/m^3.

3.4.3.3 Determine weighted average dose factors as follows:

All values of Ki, Li, Mi, and Ni are shown in Table 3-4 through 3-7 for the unrestricted area boundary.

Each of the following expressions is summed over all the nuclides:

PV Kt = $\sum[Ki*(Ci/Ct)]$

PV Lt = $\sum[Li*(Ci/Ct)]$

PV Mt = $\sum[Mi*(Ci/Ct)]$

PV Nt = $\sum[Ni*(Ci/Ct)]$

For the monitor tank pathway, MTKt, MTLt, MTMt, and MTNt are calculated in the same way as for plant vent (PV) releases above, except that Ci and Ct apply to gaseous activity for the monitor tank vent pathway.

Where:

Ci = Concentration of isotope i (μCi/cc) in analysis, t (for either PV or MT pathway)

Ct = Concentration of all noble gas isotopes (μCi/cc) for a specific analysis, *t*, (for either the PV or MT pathway)

These calculations can be performed by hand (via formatted procedure) or by using approved alternate computer codes to compute all or part of the dose calculation.

3.4.3.4 Resultant doses are compared with limits as per 3.3.3. The sum of all releases in a calendar quarter or calendar year should be compared to the limits of Section 3.2.2 and 3.2.4 as appropriate for gamma air dose and beta air dose.

3.4.4 Time Averaged Dose-Iodine 131 and Particulates w/t½ days& H-3

3.4.4.1 This section describes the alternate methods of meeting the requirements of Paragraphs 3.2.3 and 3.2.4 and of implementing the calculational techniques presented in Section 3.3.4.

3.4.4.2 If the primary computer method is inoperable, dose calculations can be performed by 1) an alternate computer code which complies with Section 3.3.4, using all identified Iodine and Particulate isotopes; or 2) hand calculations (via a formalized departmental procedure) which comply with Section 3.3.4.

3.4.4.3 Quarterly and annual Iodine, Particulate, and Tritium dose contributions are summed and compared to limits described in Section 3.2.3.

3.5 Calculation of Meteorological Dispersion Factors

3.5.1 For the purpose of these calculations, the site boundary was taken to be the unrestricted area boundary. The distances to the site boundary and nearest residents are shown in Table 3-9 for each of the 16 major compass sectors. Site boundary distances at IPEC are measured from the applicable unit's Plant Vent, while distances to the nearest resident in each of these sectors is measured from a common point, the Unit 1 superheater stack.

In the sectors where the Hudson River forms the site or exclusion area boundary, the near shore is assumed as the boundary of the "unrestricted area", because, in general, IPEC does not attempt to control population on the river. Potential confusion regarding the near or far shore for this application is effectively removed per the definition of "unrestricted area" in NUREG 0133 (Ref. 1, Section 2.2, Page 6). This section states that these criteria do "not include areas over water bodies" and the river is therefore not applicable for evaluating the maximum unrestricted area boundary concentrations.

3.5.2 The atmospheric transport and diffusion model used in the evaluation of dispersion and deposition factors is the sector-average straight-line model in Regulatory Guide 1.111 (Ref. 15) for mixed-mode releases with plume-rise effects, downwash, and building-wake correction.

The analyses were carried out using the AEOLUS-3 computer code (Ref. 16) and are documented in detail in Ref. 17. Hourly meteorological data was collected from 1981 through 1990, and updated with data from 1992 to 2002, in accordance with the accuracy requirements of Safety (Draft Regulatory) Guide 1.23 (Ref. 18). The data recovery index for these periods was in excess of 99%.

Comparison of the new meteorological data (1992 to 2002) with previous data (1981 to 1990) continues to show little difference in the overall dispersion conditions at the site. In the analyses, wind-speed coefficients in Regulatory Guide 1.111 were used to extrapolate the measured wind speeds to the height of the main vent (on top of the primary containment). Also, the regulatory plume entrainment model was used to determine plume partitioning between ground-level and elevated releases, and no credit was taken for decay and depletion in transit.

Recirculation effects were accounted for by confining in-valley flows within the valley out to a distance of 10 miles (up or down the valley) and allowing a portion of them to return to the site without additional dilution.

3.5.3 To meet the calculational requirements of Paragraphs 3.2.1, 3.2.2, and 3.2.4 the annual average dispersion factors are calculated approximately once every ten years, for each compass sector at the site unrestricted area boundary. The most restrictive meteorological dispersion and deposition factors determined from this accumulation of data is currently presented in Attachment I.

The distances to the site boundary and nearest resident in each sector were determined from the land use census and global positioning technology, and are listed in Table 3-9.

For the monitor tank release pathway, ground level dispersion values (X/Q) were assessed using the methodology discussed in Section 3.5.2. The most restrictive X/Q was determined to be in the SW sector at 350m with a value of 5.00E-5 sec/m^3 (concentration X/Q per Ref. 21). This value is specific only to the Unit 3 Monitor Tank pathway for noble gas dose at the site boundary.

3.5.4 To meet the calculational requirements of Paragraph 3.2.3 (Iodines and Particulates), the annual average deposition and dispersion parameters were calculated for the nearest residents in each of the compass sectors. Because no real dairy exists within 5 miles of the power plant, a hypothetical grass-cow-milk pathway and its dispersion and deposition factors are included, but turned on or off according to the applicable annual Land Use Census. Dispersion and deposition parameters for these locations were calculated using the models and data described in Sec. 3.5.2, and are represented as:

Wn(in) = The highest calculated annual average dispersion parameters for the inhalation pathway for the nearest residence in the unrestricted area, per Attachment I.

Wn(dep)= The highest calculated annual average deposition parameters for the ground plane and vegetation pathways for the nearest residence in the unrestricted area, per Attachment I. For Tritium in the vegetation pathway, Wn(in) is used.

Ws(in) = The highest calculated annual average dispersion parameters for the inhalation pathway at the 5-mile cow secondary receptor, per Attachment I.

Ws(dep)= The highest calculated annual average deposition parameters for the cow-milk, vegetation, and ground plane pathways at the 5-mile secondary receptor, per Attachment I. For Tritium at this location, Ws(in) is used.

NOTE: For the monitor tank pathway, iodines and particulates are effectively removed by demineralization, therefore deposition parameters for this pathway are not applicable.

3.5.5 To meet the calculational requirements of Paragraphs 3.2.2, 3.2.3 and 3.2.4, and the calculation methodologies described in Sections 3.3.4 and 3.3.3, short term release dispersion and deposition factors may need to be calculated.

Short term release dispersion and deposition factors are determined from the long term annual average parameters and a method presented by Sagendorf in NUREG 0324 (Ref. 5) as recommended by NUREG 0133 (Ref. 1, Section 3.3, Page 8). This method makes use of a factor (F), developed for a particular compass sector and distance, which is simply multiplied by the annual average dispersion or deposition parameter for the same sector and distance to develop the corresponding short-term parameter.

This factor is defined as: $F = [NTOTAL/8760]^m$

Where:

F = The non-dimensional correction factor used to convert annual average dispersion or deposition factors to short term dispersion or deposition factors.

NTOTAL = The total duration of a short-term release (or releases) in hours, during a chosen reporting period.

m = $$\frac{\log(ANMX / F15MX)}{\log(8760)}$$

8760 = The total number of hours in a year.

ANMX = The calculated historical average dispersion (sec/m^3) or deposition (m^{-2}) factor for the compass sector and distance of interest.

F15MX = The short term dispersion (sec/m^3) or deposition (m^{-2}) factor for the compass sector and distance of interest. This is the 15th percentile value such that worse weather conditions can only exist 15% of the time and better conditions 85% of the time.

The atmospheric transport and diffusion model used in the evaluation of short-term dispersion and deposition parameters (F15MX) is the Gaussian plume-centerline model in Regulatory Guide 1.145 (Ref. 19), adapted for mixed-mode releases with plume-rise effects, downwash, building-wake correction and plume meander considerations.

As was the case with the annual average parameters, the analyses were carried out using the AEOLUS-3 computer code (Ref. 16) and the most recent 10-year hourly meteorological data. They are documented in detail in Reference 17.

Note that in line with the guidance in NUREG-0133, Sec. 5.3.1, page 29, short-term releases (equal to or less than 500 hours per year) are considered to be cumulative over the calendar quarter or year, as appropriate. However, from Sec. 3.1.16 of the ODCM Part II, and in line with Sec. 3.3, page 8 of NUREG-0133, gas-decay tank releases and containment purges have been determined to be sufficiently random so as to permit use of the long-term dispersion and deposition parameters for assessment of their radiological impact.

3.5.6 The short term 15th percentile dispersion or deposition factor for use in the equation of the preceding paragraphs and the simplified F factor equation for mixed-mode releases to critical locations of each IPEC unit are as follows:

a) Site Boundary Noble Gas:

		Unit 2	Unit 3
F15MX	=	7.724E-5 sec/m^3	1.590E-4 sec/m^3
ANMX	=	2.219E-6 sec/m^3	4.470E-6 sec/m^3

$$m = \frac{\log(ANMX / F15MX)}{\log(8760)} = -0.391 \qquad -0.393$$

F = **[NTOTAL/8760]$^{-0.391}$** **[NTOTAL/8760]$^{-0.393}$**

b) Nearest Residence Inhalation:

		Unit 2	Unit 3
F15MX	=	4.992E-5 sec/m^3	4.888E-5 sec/m^3
ANMX	=	1.030E-6 sec/m^3	1.016E-6 sec/m^3

$$m = \frac{\log(ANMX / F15MX)}{\log(8760)} = -0.428 \qquad -0.427$$

F = **[NTOTAL/8760]$^{-0.428}$** **[NTOTAL/8760]$^{-0.427}$**

c) Nearest Residence Deposition:

		Unit 2	Unit 3
F15MX	=	3.995E-7 m^{-2}	4.019E-7 m^{-2}
ANMX	=	7.517E-9 m^{-2}	7.451E-9 m^{-2}

$$m = \frac{\log(ANMX / F15MX)}{\log(8760)} = -0.438 \qquad -0.439$$

F = **[NTOTAL/8760]$^{-0.438}$** **[NTOTAL/8760]$^{-0.439}$**

d) 5-mile Inhalation:

		Same for both Units 2 and 3
F15MX	=	6.192E-6 sec/m^3
ANMX	=	7.223E-7 sec/m^3

$$m = \frac{\log(\mathrm{ANMX/F15MX})}{\log(8760)} = -0.237$$

$$\mathbf{F = [NTOTAL/8760]^{-0.237}}$$

e) 5-mile Deposition:

		Same for both Units 2 and 3
F15MX	=	9.501E-9 m^{-2}
ANMX	=	1.350E-9 m^{-2}

$$m = \frac{\log(\mathrm{ANMX/F15MX})}{\log(8760)} = -0.215$$

$$\mathbf{F = [NTOTAL/8760]^{-0.215}}$$

f) *The slopes ("m") for ground level short term correction factors can be calculated in* a similar fashion, from ground level data found in Reference 17. For example:

	Unit 2	Unit 3
Site Boundary Noble Gas:	-0.390	-0.397
Nearest Resident Inhalation:	-0.427	-0.427
Nearest Resident Deposition:	-0.455	-0.455
5-mile Inhalation:	-0.235	-0.235
5-mile Deposition:	-0.212	-0.212

3.6 Justification for and Use of Finite Cloud Assumption for Assessing Site Boundary Dose

Two models are available for the computation of doses from external gamma radiation:

a) The semi-infinite cloud model, which is conservatively applicable only for ground-level releases assumes ground level airborne concentrations are the same throughout a cloud that is large in extent relative to the photon path lengths in air.

b) The finite-cloud model, which takes into consideration the actual plume dimensions and the elevation above the receptor.

The semi-infinite cloud model (which is normally used in a variety of applications because of its simplicity) has two drawbacks:

1. It could be overly conservative for receptors close to the release point (particularly for ground-level releases under stable conditions with limited plume dispersion) due to the basis that the high concentration at the receptor is assumed to exist everywhere, and;

2. It is not suitable for elevated releases since gamma radiation emanating from the radioactive cloud could still reach a receptor on the ground even though the plume is still aloft (the concentration at ground level is equal to zero).

For practical applications, it is possible to define isotope-dependent finite-cloud correction factors to express the difference in external radiation exposures between a finite cloud (which may be either at ground level or elevated) and a semi-finite cloud. Physically, when such a correction factor is applied to the calculated ground-level concentration resulting from a given plume, it will define the equivalent concentration in a semi-infinite cloud which would yield the same external exposure as the finite cloud. Such a correction factor is a function of both the airborne radionuclide energy and of plume dispersion under the prevailing conditions. At distant receptors, where the plume dimensions reach limiting conditions, such correction factors reduce to unity.

The AEOLUS-3 code (which was used for the determination of the annual average dispersion and deposition parameters listed in Section 3.5), also has the capability of providing a basis for computation of isotope-specific finite-cloud correction factors based on the models in "Meteorology and Atomic Energy" (Ref. 20, Sec. 7.5.2). The code was used (along with the mixed-mode release option and the 10-year hourly meteorological data base) for the determination of the correction factors as would be applicable at the IPEC site boundary. Note that the correction factors can be viewed as adjustment factors to the dose conversion factors in Regulatory Guide 1.109 (Ref. 3) for immersion in semi-infinite clouds. The nuclide specific correction factors and adjusted dose factors are presented in Tables 3-4 and 3-6 for the IPEC site boundary.

For the Unit 3 Monitor Tank pathway (ground release concentration X/Q), use of the finite cloud corrected data presented in tables 3-4 and 3-6 will provide a conservative result. The conservativism is due to the indicated correction factors for the mixed mode case yielding larger correction factors per nuclide. However, in the event that a ground level specific finite cloud correction factor is desired (which will yield lower calculated doses) the Xe-133 gamma X/Q value may be used as described in Reference 21.

Table 3-1a

ADULT INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06
P-32	1.65E-04	9.64E-06	6.26E-06	0.00E+00	0.00E+00	0.00E+00	1.08E-05
Cr-51	0.00E+00	0.00E+00	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
Mn-54	0.00E+00	4.95E-06	7.87E-07	0.00E+00	1.23E-06	1.75E-04	9.67E-06
Mn-56	0.00E+00	1.55E-10	2.29E-11	0.00E+00	1.63E-10	1.18E-06	2.53E-06
Fe-55	3.07E-06	2.12E-06	4.93E-07	0.00E+00	0.00E+00	9.01E-06	7.54E-07
Fe-59	1.47E-06	3.47E-06	1.32E-06	0.00E+00	0.00E+00	1.27E-04	2.35E-05
Co-58	0.00E+00	1.98E-07	2.59E-07	0.00E+00	0.00E+00	1.16E-04	1.33E-05
Co-60	0.00E+00	1.44E-06	1.85E-06	0.00E+00	0.00E+00	7.46E-04	3.56E-05
Ni-63	5.40E-05	3.93E-06	1.81E-06	0.00E+00	0.00E+00	2.23E-05	1.67E-06
Ni-65	1.92E-10	2.62E-11	1.14E-11	0.00E+00	0.00E+00	7.00E-07	1.54E-06
Cu-64	0.00E+00	1.83E-10	7.69E-11	0.00E+00	5.78E-10	8.48E-07	6.12E-06
Zn-65	4.05E-06	1.29E-05	5.82E-06	0.00E+00	8.62E-06	1.08E-04	6.68E-06
Zn-69	4.23E-12	8.14E-12	5.65E-13	0.00E+00	5.27E-12	1.15E-07	2.04E-09
Br-83	0.00E+00	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.90E-08
Br-84	0.00E+00	0.00E+00	3.91E-08	0.00E+00	0.00E+00	0.00E+00	2.05E-13
Br-85	0.00E+00	0.00E+00	1.60E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.69E-05	7.37E-06	0.00E+00	0.00E+00	0.00E+00	2.08E-06
Rb-88	0.00E+00	4.84E-08	2.41E-08	0.00E+00	0.00E+00	0.00E+00	4.18E-19
Rb-89	0.00E+00	3.20E-08	2.12E-08	0.00E+00	0.00E+00	0.00E+00	1.16E-21
Sr-89	3.80E-05	0.00E+00	1.09E-06	0.00E+00	0.00E+00	1.75E-04	4.37E-05
Sr-90	1.24E-02	0.00E+00	7.62E-04	0.00E+00	0.00E+00	1.20E-03	9.02E-05
Sr-91	7.74E-09	0.00E+00	3.13E-10	0.00E+00	0.00E+00	4.56E-06	2.39E-05
Sr-92	8.43E-10	0.00E+00	3.64E-11	0.00E+00	0.00E+00	2.06E-06	5.38E-06
Y-90	2.61E-07	0.00E+00	7.01E-09	0.00E+00	0.00E+00	2.12E-05	6.32E-05
Y-91m	3.26E-11	0.00E+00	1.27E-12	0.00E+00	0.00E+00	2.40E-07	1.66E-10
Y-91	5.78E-05	0.00E+00	1.55E-06	0.00E+00	0.00E+00	2.13E-04	4.81E-05
Y-92	1.29E-09	0.00E+00	3.77E-11	0.00E+00	0.00E+00	1.96E-06	9.19E-06
Y-93	1.18E-08	0.00E+00	3.26E-10	0.00E+00	0.00E+00	6.06E-06	5.27E-05
Zr-95	1.34E-05	4.30E-06	2.91E-06	0.00E+00	6.77E-06	2.21E-04	1.88E-05
Zr-97	1.21E-08	2.45E-09	1.13E-09	0.00E+00	3.71E-09	9.84E-06	6.54E-05
Nb-95	1.76E-06	9.77E-07	5.26E-07	0.00E+00	9.67E-07	6.31E-05	1.30E-05
Mo-99	0.00E+00	1.51E-08	2.87E-09	0.00E+00	3.64E-08	1.14E-05	3.10E-05
Tc-99m	1.29E-13	3.64E-13	4.63E-12	0.00E+00	5.52E-12	9.55E-08	5.20E-07
Tc-101	5.22E-15	7.52E-15	7.38E-14	0.00E+00	1.35E-13	4.99E-08	1.36E-21
Ru-103	1.91E-07	0.00E+00	8.23E-08	0.00E+00	7.29E-07	6.31E-05	1.38E-05
Ru-105	9.88E-11	0.00E+00	3.89E-11	0.00E+00	1.27E-10	1.37E-06	6.02E-06
Ru-106	8.64E-06	0.00E+00	1.09E-06	0.00E+00	1.67E-05	1.17E-03	1.14E-04
Ag-110m	1.35E-06	1.25E-06	7.43E-07	0.00E+00	2.46E-06	5.79E-04	3.78E-05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	3.90E-06	7.36E-08	1.55E-06	9.44E-09	0.00E+00	3.10E-04	5.08E-05
Sb-125	6.67E-06	7.44E-08	1.58E-06	6.75E-09	0.00E+00	2.18E-04	1.26E-05

Table 3-1a

ADULT INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	4.27E-07	1.98E-07	5.84E-08	1.31E-07	1.55E-06	3.92E-05	8.83E-06
Te-127m	1.58E-06	7.21E-07	1.96E-07	4.11E-07	5.72E-06	1.20E-04	1.87E-05
Te-127	1.75E-10	8.03E-11	3.87E-11	1.32E-10	6.37E-10	8.14E-07	7.17E-06
Te-129m	1.22E-06	5.84E-07	1.98E-07	4.30E-07	4.57E-06	1.45E-04	4.79E-05
Te-129	6.22E-12	2.99E-12	1.55E-12	4.87E-12	2.34E-11	2.42E-07	1.96E-08
Te-131m	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05
Te-131	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09
Te-132	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05
I-130	5.72E-07	1.68E-06	6.60E-07	1.42E-04	2.61E-06	0.00E+00	9.61E-07
I-131	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	0.00E+00	7.85E-07
I-132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	0.00E+00	5.08E-08
I-133	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	0.00E+00	1.11E-06
I-134	8.05E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	0.00E+00	1.26E-10
I-135	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	0.00E+00	6.56E-07
Cs-134	4.66E-05	1.06E-04	9.10E-05	0.00E+00	3.59E-05	1.22E-05	1.30E-06
Cs-136	4.88E-06	1.83E-05	1.38E-05	0.00E+00	1.07E-05	1.50E-06	1.46E-06
Cs-137	5.98E-05	7.76E-05	5.35E-05	0.00E+00	2.78E-05	9.40E-06	1.05E-06
Cs-138	4.14E-08	7.76E-08	4.05E-08	0.00E+00	6.00E-08	6.07E-09	2.33E-13
Ba-139	1.17E-10	8.32E-14	3.42E-12	0.00E+00	7.78E-14	4.70E-07	1.12E-07
Ba-140	4.88E-06	6.13E-09	3.21E-07	0.00E+00	2.09E-09	1.59E-04	2.73E-05
Ba-141	1.25E-11	9.41E-15	4.20E-13	0.00E+00	8.75E-15	2.42E-07	1.45E-17
Ba-142	3.29E-12	3.38E-15	2.07E-13	0.00E+00	2.86E-15	1.49E-07	1.96E-26
La-140	4.30E-08	2.17E-08	5.73E-09	0.00E+00	0.00E+00	1.70E-05	5.73E-05
La-142	8.54E-11	3.88E-11	9.65E-12	0.00E+00	0.00E+00	7.91E-07	2.64E-07
Ce-141	2.49E-06	1.69E-06	1.91E-07	0.00E+00	7.83E-07	4.52E-05	1.50E-05
Ce-143	2.33E-08	1.72E-08	1.91E-09	0.00E+00	7.60E-09	9.97E-06	2.83E-05
Ce-144	4.29E-04	1.79E-04	2.30E-05	0.00E+00	1.06E-04	9.72E-04	1.02E-04
Pr-143	1.17E-06	4.69E-07	5.80E-08	0.00E+00	2.70E-07	3.51E-05	2.50E-05
Pr-144	3.76E-12	1.56E-12	1.91E-13	0.00E+00	8.81E-13	1.27E-07	2.69E-18
Nd-147	6.59E-07	7.62E-07	4.56E-08	0.00E+00	4.45E-07	2.76E-05	2.16E-05
W-187	1.06E-09	8.85E-10	3.10E-10	0.00E+00	0.00E+00	3.63E-06	1.94E-05
Np-239	2.87E-08	2.82E-09	1.55E-09	0.00E+00	8.75E-09	4.70E-06	1.49E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	8.65E-08	8.39E-08	0.00E+00	0.00E+00	4.62E-05	3.93E-06
Sr-85	4.00E-06	0.00E+00	9.70E-05	0.00E+00	0.00E+00	6.00E-05	7.60E-06
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.78E-11	7.03E-12	2.56E-12	0.00E+00	8.18E-12	3.00E-07	3.02E-08
Cd-109	0.00E+00	4.90E-05	1.60E-06	0.00E+00	4.70E-05	9.10E-05	8.20E-06
Sn-113	8.20E-06	2.70E-07	5.60E-07	1.70E-07	0.00E+00	1.20E-04	1.50E-06
Ba-133	9.50E-06	4.20E-07	2.50E-06	0.00E+00	2.10E-09	1.90E-04	1.00E-05
Te-134	3.84E-12	3.22E-12	1.57E-12	3.44E-12	2.18E-11	4.34E-07	2.97E-11
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-1b

TEEN INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06	1.72E-06
P-32	2.36E-04	1.37E-05	8.95E-06	0.00E+00	0.00E+00	0.00E+00	1.16E-05
Cr-51	0.00E+00	0.00E+00	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
Mn-54	0.00E+00	6.39E-06	1.05E-06	0.00E+00	1.59E-06	2.48E-04	8.35E-06
Mn-56	0.00E+00	2.12E-10	3.15E-11	0.00E+00	2.24E-10	1.90E-06	7.18E-06
Fe-55	4.18E-06	2.98E-06	6.93E-07	0.00E+00	0.00E+00	1.55E-05	7.99E-07
Fe-59	1.99E-06	4.62E-06	1.79E-06	0.00E+00	0.00E+00	1.91E-04	2.23E-05
Co-58	0.00E+00	2.59E-07	3.47E-07	0.00E+00	0.00E+00	1.68E-04	1.19E-05
Co-60	0.00E+00	1.89E-06	2.48E-06	0.00E+00	0.00E+00	1.09E-03	3.24E-05
Ni-63	7.25E-05	5.43E-06	2.47E-06	0.00E+00	0.00E+00	3.84E-05	1.77E-06
Ni-65	2.73E-10	3.66E-11	1.59E-11	0.00E+00	0.00E+00	1.17E-06	4.59E-06
Cu-64	0.00E+00	2.54E-10	1.06E-10	0.00E+00	8.01E-10	1.39E-06	7.68E-06
Zn-65	4.82E-06	1.67E-05	7.80E-06	0.00E+00	1.08E-05	1.55E-04	5.83E-06
Zn-69	6.04E-12	1.15E-11	8.07E-13	0.00E+00	7.53E-12	1.98E-07	3.56E-08
Br-83	0.00E+00	0.00E+00	4.30E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	5.41E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.29E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.38E-05	1.05E-05	0.00E+00	0.00E+00	0.00E+00	2.21E-06
Rb-88	0.00E+00	6.82E-08	3.40E-08	0.00E+00	0.00E+00	0.00E+00	3.65E-15
Rb-89	0.00E+00	4.40E-08	2.91E-08	0.00E+00	0.00E+00	0.00E+00	4.22E-17
Sr-89	5.43E-05	0.00E+00	1.56E-06	0.00E+00	0.00E+00	3.02E-04	4.64E-05
Sr-90	1.35E-02	0.00E+00	8.35E-04	0.00E+00	0.00E+00	2.06E-03	9.56E-05
Sr-91	1.10E-08	0.00E+00	4.39E-10	0.00E+00	0.00E+00	7.59E-06	3.24E-05
Sr-92	1.19E-09	0.00E+00	5.08E-11	0.00E+00	0.00E+00	3.43E-06	1.49E-05
Y-90	3.73E-07	0.00E+00	1.00E-08	0.00E+00	0.00E+00	3.66E-05	6.99E-05
Y-91m	4.63E-11	0.00E+00	1.77E-12	0.00E+00	0.00E+00	4.00E-07	3.77E-09
Y-91	8.26E-05	0.00E+00	2.21E-06	0.00E+00	0.00E+00	3.67E-04	5.11E-05
Y-92	1.84E-09	0.00E+00	5.36E-11	0.00E+00	0.00E+00	3.35E-06	2.06E-05
Y-93	1.69E-08	0.00E+00	4.65E-10	0.00E+00	0.00E+00	1.04E-05	7.24E-05
Zr-95	1.82E-05	5.73E-06	3.94E-06	0.00E+00	8.42E-06	3.36E-04	1.86E-05
Zr-97	1.72E-08	3.40E-09	1.57E-09	0.00E+00	5.15E-09	1.62E-05	7.88E-05
Nb-95	2.32E-06	1.29E-06	7.08E-07	0.00E+00	1.25E-06	9.39E-05	1.21E-05
Mo-99	0.00E+00	2.11E-08	4.03E-09	0.00E+00	5.14E-08	1.92E-05	3.36E-05
Tc-99m	1.73E-13	4.83E-13	6.24E-12	0.00E+00	7.20E-12	1.44E-07	7.66E-07
Tc-101	7.40E-15	1.05E-14	1.03E-13	0.00E+00	1.90E-13	8.34E-08	1.09E-16
Ru-103	2.63E-07	0.00E+00	1.12E-07	0.00E+00	9.29E-07	9.79E-05	1.36E-05
Ru-105	1.40E-10	0.00E+00	5.42E-11	0.00E+00	1.76E-10	2.27E-06	1.13E-05
Ru-106	1.23E-05	0.00E+00	1.55E-06	0.00E+00	2.38E-05	2.01E-03	1.20E-04
Ag-110m	1.73E-06	1.64E-06	9.99E-07	0.00E+00	3.13E-06	8.44E-04	3.41E-05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	5.38E-06	9.92E-08	2.10E-06	1.22E-08	0.00E+00	4.81E-04	4.98E-05
Sb-125	9.23E-06	1.01E-07	2.15E-06	8.80E-09	0.00E+00	3.42E-04	1.24E-05

Table 3-1b

TEEN INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	6.10E-07	2.80E-07	8.34E-08	1.75E-07	0.00E+00	6.70E-05	9.38E-06
Te-127m	2.25E-06	1.02E-06	2.73E-07	5.48E-07	8.17E-06	2.07E-04	1.99E-05
Te-127	2.51E-10	1.14E-10	5.52E-11	1.77E-10	9.10E-10	1.40E-06	1.01E-05
Te-129m	1.74E-06	8.23E-07	2.81E-07	5.72E-07	6.49E-06	2.47E-04	5.06E-05
Te-129	8.87E-12	4.22E-12	2.20E-12	6.48E-12	3.32E-11	4.12E-07	2.02E-07
Te-131m	1.23E-08	7.51E-09	5.03E-09	9.06E-09	5.49E-08	2.97E-05	7.76E-05
Te-131	1.97E-12	1.04E-12	6.30E-13	1.55E-12	7.72E-12	2.92E-07	1.89E-09
Te-132	4.50E-08	3.63E-08	2.74E-08	3.07E-08	2.44E-07	5.61E-05	5.79E-05
I-130	7.80E-07	2.24E-06	8.96E-07	1.86E-04	3.44E-06	0.00E+00	1.14E-06
I-131	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	0.00E+00	8.11E-07
I-132	1.99E-07	5.47E-07	1.97E-07	1.89E-05	8.65E-07	0.00E+00	1.59E-07
I-133	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	0.00E+00	1.29E-06
I-134	1.11E-07	2.90E-07	1.05E-07	4.94E-06	4.58E-07	0.00E+00	2.55E-09
I-135	4.62E-07	1.18E-06	4.36E-07	7.76E-05	1.86E-06	0.00E+00	8.69E-07
Cs-134	6.28E-05	1.41E-04	6.86E-05	0.00E+00	4.69E-05	1.83E-05	1.22E-06
Cs-136	6.44E-06	2.42E-05	1.71E-05	0.00E+00	1.38E-05	2.22E-06	1.36E-06
Cs-137	8.38E-05	1.06E-04	3.89E-05	0.00E+00	3.80E-05	1.51E-05	1.06E-06
Cs-138	5.82E-08	1.07E-07	5.58E-08	0.00E+00	8.28E-08	9.84E-09	3.38E-11
Ba-139	1.67E-10	1.18E-13	4.87E-12	0.00E+00	1.11E-13	8.08E-07	8.06E-07
Ba-140	6.84E-06	8.38E-09	4.40E-07	0.00E+00	2.85E-09	2.54E-04	2.86E-05
Ba-141	1.78E-11	1.32E-14	5.93E-13	0.00E+00	1.23E-14	4.11E-07	9.33E-14
Ba-142	4.62E-12	4.63E-15	2.84E-13	0.00E+00	3.92E-15	2.39E-07	5.99E-20
La-140	5.99E-08	2.95E-08	7.82E-09	0.00E+00	0.00E+00	2.68E-05	6.09E-05
La-142	1.20E-10	5.31E-11	1.32E-11	0.00E+00	0.00E+00	1.27E-06	1.50E-06
Ce-141	3.55E-06	2.37E-06	2.71E-07	0.00E+00	1.11E-06	7.67E-05	1.58E-05
Ce-143	3.32E-08	2.42E-08	2.70E-09	0.00E+00	1.08E-08	1.63E-05	3.19E-05
Ce-144	6.11E-04	2.53E-04	3.28E-05	0.00E+00	1.51E-04	1.67E-03	1.08E-04
Pr-143	1.67E-06	6.64E-07	8.28E-08	0.00E+00	3.86E-07	6.04E-05	2.67E-05
Pr-144	5.37E-12	2.20E-12	2.72E-13	0.00E+00	1.26E-12	2.19E-07	2.94E-14
Nd-147	9.83E-07	1.07E-06	6.41E-08	0.00E+00	6.28E-07	4.65E-05	2.28E-05
W-187	1.50E-09	1.22E-09	4.29E-10	0.00E+00	0.00E+00	5.92E-06	2.21E-05
Np-239	4.23E-08	3.99E-09	2.21E-09	0.00E+00	1.25E-08	8.11E-06	1.65E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.18E-07	1.15E-07	0.00E+00	0.00E+00	7.33E-05	3.93E-06
Sr-85	5.00E-06	0.00E+00	1.30E-06	0.00E+00	0.00E+00	8.80E-05	6.90E-06
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	3.93E-11	9.72E-12	3.55E-12	0.00E+00	1.14E-11	4.91E-07	2.71E-07
Cd-109	0.00E+00	1.00E-04	3.40E-06	0.00E+00	6.70E-05	1.60E-04	8.60E-06
Sn-113	1.50E-05	4.70E-07	9.70E-07	2.90E-07	0.00E+00	2.00E-04	1.50E-06
Ba-133	4.70E-05	8.00E-07	3.30E-06	0.00E+00	2.80E-09	2.90E-04	9.70E-06
Te-134	5.31E-12	4.35E-12	3.64E-12	4.46E-12	2.91E-11	6.75E-07	1.37E-09
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-1c

CHILD INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P-32	7.04E-04	3.09E-05	2.67E-05	0.00E+00	0.00E+00	0.00E+00	1.14E-05
Cr-51	0.00E+00	0.00E+00	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
Mn-54	0.00E+00	1.16E-05	2.57E-06	0.00E+00	2.71E-06	4.26E-04	6.19E-06
Mn-56	0.00E+00	4.48E-10	8.43E-11	0.00E+00	4.52E-10	3.55E-06	3.33E-05
Fe-55	1.28E-05	6.80E-06	2.10E-06	0.00E+00	0.00E+00	3.00E-05	7.75E-07
Fe-59	5.59E-06	9.04E-06	4.51E-06	0.00E+00	0.00E+00	3.43E-04	1.91E-05
Co-58	0.00E+00	4.79E-07	8.55E-07	0.00E+00	0.00E+00	2.99E-04	9.29E-06
Co-60	0.00E+00	3.55E-06	6.12E-06	0.00E+00	0.00E+00	1.91E-03	2.60E-05
Ni-63	2.22E-04	1.25E-05	7.56E-06	0.00E+00	0.00E+00	7.43E-05	1.71E-06
Ni-65	8.08E-10	7.99E-11	4.44E-11	0.00E+00	0.00E+00	2.21E-06	2.27E-05
Cu-64	0.00E+00	5.39E-10	2.90E-10	0.00E+00	1.63E-09	2.59E-06	9.92E-06
Zn-65	1.15E-05	3.06E-05	1.90E-05	0.00E+00	1.93E-05	2.69E-04	4.41E-06
Zn-69	1.81E-11	2.61E-11	2.41E-12	0.00E+00	1.58E-11	3.84E-07	2.75E-06
Br-83	0.00E+00	0.00E+00	1.28E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.48E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	6.84E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	5.36E-05	3.09E-05	0.00E+00	0.00E+00	0.00E+00	2.16E-06
Rb-88	0.00E+00	1.52E-07	9.90E-08	0.00E+00	0.00E+00	0.00E+00	4.66E-09
Rb-89	0.00E+00	9.33E-08	7.83E-08	0.00E+00	0.00E+00	0.00E+00	5.11E-10
Sr-89	1.62E-04	0.00E+00	4.66E-06	0.00E+00	0.00E+00	5.83E-04	4.52E-05
Sr-90	2.73E-02	0.00E+00	1.74E-03	0.00E+00	0.00E+00	3.99E-03	9.28E-05
Sr-91	3.28E-08	0.00E+00	1.24E-09	0.00E+00	0.00E+00	1.44E-05	4.70E-05
Sr-92	3.54E-09	0.00E+00	1.42E-10	0.00E+00	0.00E+00	6.49E-06	6.55E-05
Y-90	1.11E-06	0.00E+00	2.99E-08	0.00E+00	0.00E+00	7.07E-05	7.24E-05
Y-91m	1.37E-10	0.00E+00	4.98E-12	0.00E+00	0.00E+00	7.60E-07	4.64E-07
Y-91	2.47E-04	0.00E+00	6.59E-06	0.00E+00	0.00E+00	7.10E-04	4.97E-05
Y-92	5.50E-09	0.00E+00	1.57E-10	0.00E+00	0.00E+00	6.46E-06	6.46E-05
Y-93	5.04E-08	0.00E+00	1.38E-09	0.00E+00	0.00E+00	2.01E-05	1.05E-04
Zr-95	5.13E-05	1.13E-05	1.00E-05	0.00E+00	1.61E-05	6.03E-04	1.65E-05
Zr-97	5.07E-08	7.34E-09	4.32E-09	0.00E+00	1.05E-08	3.06E-05	9.49E-05
Nb-95	6.35E-06	2.48E-06	1.77E-06	0.00E+00	2.33E-06	1.66E-04	1.00E-05
Mo-99	0.00E+00	4.66E-08	1.15E-08	0.00E+00	1.06E-07	3.66E-05	3.42E-05
Tc-99m	4.81E-13	9.41E-13	1.56E-11	0.00E+00	1.37E-11	2.57E-07	1.30E-06
Tc-101	2.19E-14	2.30E-14	2.91E-13	0.00E+00	3.92E-13	1.58E-07	4.41E-09
Ru-103	7.55E-07	0.00E+00	2.90E-07	0.00E+00	1.90E-06	1.79E-04	1.21E-05
Ru-105	4.13E-10	0.00E+00	1.50E-10	0.00E+00	3.63E-10	4.30E-06	2.69E-05
Ru-106	3.68E-05	0.00E+00	4.57E-06	0.00E+00	4.97E-05	3.87E-03	1.16E-04
Ag-110m	4.56E-06	3.08E-06	2.47E-06	0.00E+00	5.74E-06	1.48E-03	2.71E-05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	1.55E-05	2.00E-07	5.41E-06	3.41E-08	0.00E+00	8.76E-04	4.43E-05
Sb-125	2.66E-05	2.05E-07	5.59E-06	2.46E-08	0.00E+00	6.27E-04	1.09E-05

Table 3-1c

CHILD INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	1.82E-06	6.29E-07	2.47E-07	5.20E-07	0.00E+00	1.29E-04	9.13E-06
Te-127m	6.72E-06	2.31E-06	8.16E-07	1.64E-06	1.72E-05	4.00E-04	1.93E-05
Te-127	7.49E-10	2.57E-10	1.65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
Te-129m	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
Te-129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
Te-131m	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
Te-131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
Te-132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
I-130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	0.00E+00	1.38E-06
I-131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	0.00E+00	7.68E-07
I-132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	0.00E+00	8.65E-07
I-133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	0.00E+00	1.48E-06
I-134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	0.00E+00	2.58E-07
I-135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	0.00E+00	1.20E-06
Cs-134	1.76E-04	2.74E-04	6.07E-05	0.00E+00	8.93E-05	3.27E-05	1.04E-06
Cs-136	1.76E-05	4.62E-05	3.14E-05	0.00E+00	2.58E-05	3.93E-06	1.13E-06
Cs-137	2.45E-04	2.23E-04	3.47E-05	0.00E+00	7.63E-05	2.81E-05	9.78E-07
Cs-138	1.71E-07	2.27E-07	1.50E-07	0.00E+00	1.68E-07	1.84E-08	7.29E-08
Ba-139	4.98E-10	2.66E-13	1.45E-11	0.00E+00	2.33E-13	1.56E-06	1.56E-05
Ba-140	2.00E-05	1.75E-08	1.17E-06	0.00E+00	5.71E-09	4.71E-04	2.75E-05
Ba-141	5.29E-11	2.95E-14	1.72E-12	0.00E+00	2.56E-14	7.89E-07	7.44E-08
Ba-142	1.35E-11	9.73E-15	7.54E-13	0.00E+00	7.87E-15	4.44E-07	7.41E-10
La-140	1.74E-07	6.08E-08	2.04E-08	0.00E+00	0.00E+00	4.94E-05	6.10E-05
La-142	3.50E-10	1.11E-10	3.49E-11	0.00E+00	0.00E+00	2.35E-06	2.05E-05
Ce-141	1.06E-05	5.28E-06	7.83E-07	0.00E+00	2.31E-06	1.47E-04	1.53E-05
Ce-143	9.89E-08	5.37E-08	7.77E-09	0.00E+00	2.26E-08	3.12E-05	3.44E-05
Ce-144	1.83E-03	5.72E-04	9.77E-05	0.00E+00	3.17E-04	3.23E-03	1.05E-04
Pr-143	4.99E-06	1.50E-06	2.47E-07	0.00E+00	8.11E-07	1.17E-04	2.63E-05
Pr-144	1.61E-11	4.99E-12	8.10E-13	0.00E+00	2.64E-12	4.23E-07	5.32E-08
Nd-147	2.92E-06	2.36E-06	1.84E-07	0.00E+00	1.30E-06	8.87E-05	2.22E-05
W-187	4.41E-09	2.61E-09	1.17E-09	0.00E+00	0.00E+00	1.11E-05	2.46E-05
Np-239	1.26E-07	9.04E-09	6.35E-09	0.00E+00	2.63E-08	1.57E-05	1.73E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	2.44E-07	2.88E-07	0.00E+00	0.00E+00	1.37E-04	3.58E-06
Sr-85	1.20E-05	0.00E+00	3.20E-06	0.00E+00	0.00E+00	1.50E-04	5.50E-06
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	1.16E-10	2.08E-11	9.73E-12	0.00E+00	2.31E-11	9.24E-07	7.51E-06
Cd-109	0.00E+00	1.90E-04	8.00E-06	0.00E+00	1.70E-04	3.00E-04	8.10E-06
Sn-113	3.80E-05	8.90E-07	2.30E-06	7.10E-07	0.00E+00	3.60E-04	1.30E-06
Ba-133	1.10E-04	1.10E-06	1.00E-05	0.00E+00	5.40E-09	5.20E-04	8.30E-06
Te-134	1.53E-11	8.81E-12	9.40E-12	1.24E-11	5.71E-11	1.23E-06	4.87E-07
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-1d

INFANT INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P-32	1.45E-03	8.03E-05	5.53E-05	0.00E+00	0.00E+00	0.00E+00	1.15E-05
Cr-51	0.00E+00	0.00E+00	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
Mn-54	0.00E+00	1.81E-05	3.56E-06	0.00E+00	3.56E-06	7.14E-04	5.04E-06
Mn-56	0.00E+00	1.10E-09	1.58E-10	0.00E+00	7.86E-10	8.95E-06	5.12E-05
Fe-55	1.41E-05	8.39E-06	2.38E-06	0.00E+00	0.00E+00	6.21E-05	7.82E-07
Fe-59	9.69E-06	1.68E-05	6.77E-06	0.00E+00	0.00E+00	7.25E-04	1.77E-05
Co-58	0.00E+00	8.71E-07	1.30E-06	0.00E+00	0.00E+00	5.55E-04	7.95E-06
Co-60	0.00E+00	5.73E-06	8.41E-06	0.00E+00	0.00E+00	3.22E-03	2.28E-05
Ni-63	2.42E-04	1.46E-05	8.29E-06	0.00E+00	0.00E+00	1.49E-04	1.73E-06
Ni-65	1.71E-09	2.03E-10	8.79E-11	0.00E+00	0.00E+00	5.80E-06	3.58E-05
Cu-64	0.00E+00	1.34E-09	5.53E-10	0.00E+00	2.84E-09	6.64E-06	1.07E-05
Zn-65	1.38E-05	4.47E-05	2.22E-05	0.00E+00	2.32E-05	4.62E-04	3.67E-05
Zn-69	3.85E-11	6.91E-11	5.13E-12	0.00E+00	2.87E-11	1.05E-06	9.44E-06
Br-83	0.00E+00	0.00E+00	2.72E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	2.86E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.46E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.36E-04	6.30E-05	0.00E+00	0.00E+00	0.00E+00	2.17E-06
Rb-88	0.00E+00	3.98E-07	2.05E-07	0.00E+00	0.00E+00	0.00E+00	2.42E-07
Rb-89	0.00E+00	2.29E-07	1.47E-07	0.00E+00	0.00E+00	0.00E+00	4.87E-08
Sr-89	2.84E-04	0.00E+00	8.15E-06	0.00E+00	0.00E+00	1.45E-03	4.57E-05
Sr-90	2.92E-02	0.00E+00	1.85E-03	0.00E+00	0.00E+00	8.03E-03	9.36E-05
Sr-91	6.83E-08	0.00E+00	2.47E-09	0.00E+00	0.00E+00	3.76E-05	5.24E-05
Sr-92	7.50E-09	0.00E+00	2.79E-10	0.00E+00	0.00E+00	1.70E-05	1.00E-04
Y-90	2.35E-06	0.00E+00	6.30E-08	0.00E+00	0.00E+00	1.92E-04	7.43E-05
Y-91m	2.91E-10	0.00E+00	9.90E-12	0.00E+00	0.00E+00	1.99E-06	1.68E-06
Y-91	4.20E-04	0.00E+00	1.12E-05	0.00E+00	0.00E+00	1.75E-03	5.02E-05
Y-92	1.17E-08	0.00E+00	3.29E-10	0.00E+00	0.00E+00	1.75E-05	9.04E-05
Y-93	1.07E-07	0.00E+00	2.91E-09	0.00E+00	0.00E+00	5.46E-05	1.19E-04
Zr-95	8.24E-05	1.99E-05	1.45E-05	0.00E+00	2.22E-05	1.25E-03	1.55E-05
Zr-97	1.07E-07	1.83E-08	8.36E-09	0.00E+00	1.85E-08	7.88E-05	1.00E-04
Nb-95	1.12E-05	4.59E-06	2.70E-06	0.00E+00	3.37E-06	3.42E-04	9.05E-06
Mo-99	0.00E+00	1.18E-07	2.31E-08	0.00E+00	1.89E-07	9.63E-05	3.48E-05
Tc-99m	9.98E-13	2.06E-12	2.66E-11	0.00E+00	2.22E-11	5.79E-07	1.45E-06
Tc-101	4.65E-14	5.88E-14	5.80E-13	0.00E+00	6.99E-13	4.17E-07	6.03E-07
Ru-103	1.44E-06	0.00E+00	4.85E-07	0.00E+00	3.03E-06	3.94E-04	1.15E-05
Ru-105	8.74E-10	0.00E+00	2.93E-10	0.00E+00	6.42E-10	1.12E-05	3.46E-05
Ru-106	6.20E-05	0.00E+00	7.77E-06	0.00E+00	7.61E-05	8.26E-03	1.17E-04
Ag-110m	7.13E-06	5.16E-06	3.57E-06	0.00E+00	7.80E-06	2.62E-03	2.36E-05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	2.71E-05	3.97E-07	8.56E-06	7.18E-08	0.00E+00	1.89E-03	4.22E-05
Sb-125	3.69E-05	3.41E-07	7.78E-06	4.45E-08	0.00E+00	1.17E-03	1.05E-05

Table 3-1d

INFANT INHALATION DOSE FACTORS

(mrem per pCi inhaled)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	3.40E-06	1.42E-06	4.70E-07	1.16E-06	0.00E+00	3.19E-04	9.22E-06
Te-127m	1.19E-05	4.93E-06	1.48E-06	3.48E-06	2.68E-05	9.37E-04	1.95E-05
Te-127	1.59E-05	6.81E-10	3.49E-10	1.32E-09	3.47E-09	7.39E-06	1.74E-05
Te-129m	1.01E-05	4.35E-06	1.59E-06	3.91E-06	2.27E-05	1.20E-03	4.93E-05
Te-129	5.63E-11	2.48E-11	1.34E-11	4.82E-11	1.25E-10	2.14E-06	1.88E-05
Te-131m	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
Te-131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
Te-132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I-130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	0.00E+00	1.42E-06
I-131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	0.00E+00	7.56E-07
I-132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	0.00E+00	1.36E-06
I-133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	0.00E+00	1.54E-06
I-134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	0.00E+00	9.21E-07
I-135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	0.00E+00	1.31E-06
Cs-134	2.83E-04	5.02E-04	5.32E-05	0.00E+00	1.36E-04	5.69E-05	9.53E-07
Cs-136	3.45E-05	9.61E-05	3.78E-05	0.00E+00	4.03E-05	8.40E-06	1.02E-06
Cs-137	3.92E-04	4.37E-04	3.25E-05	0.00E+00	1.23E-04	5.09E-05	9.53E-07
Cs-138	3.61E-07	5.58E-07	2.84E-07	0.00E+00	2.93E-07	4.67E-08	6.26E-07
Ba-139	1.06E-09	7.03E-13	3.07E-11	0.00E+00	4.23E-13	4.25E-06	3.64E-05
Ba-140	4.00E-05	4.00E-08	2.07E-06	0.00E+00	9.59E-09	1.14E-03	2.74E-05
Ba-141	1.12E-10	7.70E-14	3.55E-12	0.00E+00	4.64E-14	2.12E-06	3.39E-06
Ba-142	2.84E-11	2.36E-14	1.40E-12	0.00E+00	1.36E-14	1.11E-06	4.95E-07
La-140	3.61E-07	1.43E-07	3.68E-08	0.00E+00	0.00E+00	1.20E-04	6.06E-05
La-142	7.36E-10	2.69E-10	6.46E-11	0.00E+00	0.00E+00	5.87E-06	4.25E-05
Ce-141	1.98E-05	1.19E-05	1.42E-06	0.00E+00	3.75E-06	3.69E-04	1.54E-05
Ce-143	2.09E-07	1.38E-07	1.58E-08	0.00E+00	4.03E-08	8.30E-05	3.55E-05
Ce-144	2.28E-03	8.65E-04	1.26E-04	0.00E+00	3.84E-04	7.03E-03	1.06E-04
Pr-143	1.00E-05	3.74E-06	4.99E-07	0.00E+00	1.41E-06	3.09E-04	2.66E-05
Pr-144	3.42E-11	1.32E-11	1.72E-12	0.00E+00	4.80E-12	1.15E-06	3.06E-06
Nd-147	5.67E-06	5.81E-06	3.57E-07	0.00E+00	2.25E-06	2.30E-04	2.23E-05
W-187	9.26E-09	6.44E-09	2.23E-09	0.00E+00	0.00E+00	2.83E-05	2.54E-05
Np-239	2.65E-07	2.37E-08	1.34E-08	0.00E+00	4.73E-08	4.25E-05	1.78E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	4.65E-07	4.58E-07	0.00E+00	0.00E+00	2.71E-04	3.47E-06
Sr-85	2.70E-05	0.00E+00	5.40E-06	0.00E+00	0.00E+00	3.00E-04	4.80E-06
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.44E-10	5.21E-11	1.88E-11	0.00E+00	4.07E-11	2.37E-06	1.92E-05
Cd-109	0.00E+00	2.60E-04	1.00E-05	0.00E+00	2.00E-04	6.20E-04	8.00E-06
Sn-113	6.00E-05	1.60E-06	3.60E-06	1.30E-06	0.00E+00	7.80E-04	1.20E-06
Ba-133	1.90E-04	1.70E-06	1.30E-05	0.00E+00	8.90E-09	9.10E-04	7.70E-06
Te-134	3.18E-11	2.04E-11	1.68E-11	2.91E-11	9.59E-11	2.93E-06	2.53E-06
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-2

Total Body & Skin Ground Plane Dose Factors (mrem/hr per pCi/m^2)
with Isotope half-life and Stable Element Tranfer Data (Fm, cow)

Isotope	Halflife	unit	Fm	Ground Plane Dose Factors TotBody(DFg)	Skin(DFs)
H-3	12.350	Y	1.00E-02	0.00E+00	0.00E+00
Be-7	53.300	D	1.00E-04	0.00E+00	0.00E+00
Na-24	15.000	H	4.00E-02	2.50E-08	2.90E-08
P-32	14.290	D	2.50E-02	0.00E+00	0.00E+00
Cr-51	27.704	D	2.20E-03	2.20E-10	2.60E-10
Mn-54	312.500	D	2.50E-04	5.80E-09	6.80E-09
Mn-56	2.578	H	2.50E-04	1.10E-08	1.30E-08
Fe-55	2.700	Y	1.20E-03	0.00E+00	0.00E+00
Fe-59	44.529	D	1.20E-03	8.00E-09	9.40E-09
Co-58	70.800	D	1.00E-03	7.00E-09	8.20E-09
Co-60	5.271	Y	1.00E-03	1.70E-08	2.00E-08
Ni-63	96.000	Y	6.70E-03	0.00E+00	0.00E+00
Ni-65	2.520	H	6.70E-03	3.70E-09	4.30E-09
Cu-64	12.701	H	1.40E-02	1.50E-09	1.70E-09
Zn-65	243.900	D	3.90E-02	4.00E-09	4.60E-09
Zn-69	0.950	H	3.90E-02	0.00E+00	0.00E+00
Br-83	2.390	H	5.00E-02	6.40E-11	9.30E-11
Br-84	0.530	H	5.00E-02	1.20E-08	1.40E-08
Br-85	0.050	H	5.00E-02	0.00E+00	0.00E+00
Rb-86	18.660	D	3.00E-02	6.30E-10	7.20E-10
Rb-88	0.297	H	3.00E-02	3.50E-09	4.00E-09
Rb-89	0.253	H	3.00E-02	1.50E-08	1.80E-08
Sr-89	50.500	D	8.00E-04	5.60E-13	6.50E-13
Sr-90	29.120	Y	8.00E-04	0.00E+00	0.00E+00
Sr-91	9.500	H	8.00E-04	7.10E-09	8.30E-09
Sr-92	2.710	H	8.00E-04	9.00E-09	1.00E-08
Y-90	2.667	D	1.00E-05	2.20E-12	2.60E-12
Y-91m	0.829	H	1.00E-05	3.80E-09	4.40E-09
Y-91	58.510	D	1.00E-05	2.40E-11	2.70E-11
Y-92	3.540	H	1.00E-05	1.60E-09	1.90E-09
Y-93	10.100	H	1.00E-05	5.70E-10	7.80E-10
Zr-95	63.980	D	5.00E-06	5.00E-09	5.80E-09
Zr-97	16.900	H	5.00E-06	5.50E-09	6.40E-09
Nb-95	35.150	D	2.50E-03	5.10E-09	6.00E-09
Mo-99	2.750	D	7.50E-03	1.90E-09	2.20E-09
Tc-99m	6.020	H	2.50E-02	9.60E-10	1.10E-09
Tc-101	0.237	H	2.50E-02	2.70E-09	3.00E-09
Ru-103	39.280	D	1.00E-06	3.60E-09	4.20E-09
Ru-105	4.440	H	1.00E-06	4.50E-09	5.10E-09
Ru-106	368.200	D	1.00E-06	1.50E-09	1.80E-09
Ag-110m	249.900	D	5.00E-02	1.80E-08	2.10E-08
Sb-122	2.700	D	1.50E-03	0.00E+00	0.00E+00
Sb-124	60.200	D	1.50E-03	1.30E-08	1.50E-08
Sb-125	2.770	Y	1.50E-03	3.10E-09	3.50E-09

Table 3-2

Total Body & Skin Ground Plane Dose Factors (mrem/hr per pCi/m^2)
with Isotope half-life and Stable Element Tranfer Data (Fm, cow)

Isotope	Halflife	unit	Fm	Ground Plane Dose Factors TotBody(DFg)	Skin(DFs)
Te-125m	58.000	D	1.00E-03	3.50E-11	4.80E-11
Te-127m	109.000	D	1.00E-03	1.10E-12	1.30E-12
Te-127	9.350	H	1.00E-03	1.00E-11	1.10E-11
Te-129m	33.600	D	1.00E-03	7.70E-10	9.00E-10
Te-129	1.160	H	1.00E-03	7.10E-10	8.40E-10
Te-131m	30.000	H	1.00E-03	8.40E-09	9.90E-09
Te-131	0.417	H	1.00E-03	2.20E-09	2.60E-06
Te-132	3.258	D	1.00E-03	1.70E-09	2.00E-09
I-130	12.360	H	6.00E-03	1.40E-08	1.70E-08
I-131	8.040	D	6.00E-03	2.80E-09	3.40E-09
I-132	2.300	H	6.00E-03	1.70E-08	2.00E-08
I-133	20.800	H	6.00E-03	3.70E-09	4.50E-09
I-134	0.877	H	6.00E-03	1.60E-08	1.90E-08
I-135	6.610	H	6.00E-03	1.20E-08	1.40E-08
Cs-134	2.062	Y	1.20E-02	1.20E-08	1.40E-08
Cs-136	13.100	D	1.20E-02	1.50E-08	1.70E-08
Cs-137	30.000	Y	1.20E-02	4.20E-09	4.90E-09
Cs-138	0.537	H	1.20E-02	2.10E-08	2.40E-08
Ba-139	1.378	H	4.00E-04	2.40E-09	2.70E-09
Ba-140	12.740	D	4.00E-04	2.10E-09	2.40E-09
Ba-141	0.304	H	4.00E-04	4.30E-09	4.90E-09
Ba-142	0.177	H	4.00E-04	7.90E-09	9.00E-09
La-140	1.678	D	5.00E-06	1.50E-08	1.70E-08
La-142	1.542	H	5.00E-06	1.50E-08	1.80E-08
Ce-141	32.501	D	1.00E-04	5.50E-10	6.20E-10
Ce-143	33.000	H	1.00E-04	2.20E-09	2.50E-09
Ce-144	284.300	D	1.00E-04	3.20E-10	3.70E-10
Pr-143	13.560	D	5.00E-06	0.00E+00	0.00E+00
Pr-144	0.288	H	5.00E-06	2.00E-10	2.30E-10
Nd-147	10.980	D	5.00E-06	1.00E-09	1.20E-09
W-187	23.900	H	5.00E-04	3.10E-09	3.60E-09
Np-239	2.360	D	5.00E-06	9.50E-10	1.10E-09
K-40	1.28E+09	Y	1.00E-02	0.00E+00	0.00E+00
Co-57	270.900	D	1.00E-03	9.10E-10	1.00E-09
Sr-85	64.840	D	8.00E-04	0.00E+00	0.00E+00
Y-88	106.640	D	1.00E-05	0.00E+00	0.00E+00
Nb-94	2.03E+04	Y	2.50E-03	0.00E+00	0.00E+00
Nb-97	1.202	H	2.50E-03	4.60E-09	5.40E-09
Cd-109	1.271	Y	1.20E-04	0.00E+00	0.00E+00
Sn-113	115.100	D	2.50E-03	0.00E+00	0.00E+00
Ba-133	10.740	Y	4.00E-04	0.00E+00	0.00E+00
Te-134	0.697	H	1.00E-03	1.00E-09	1.20E-09
Ce-139	137.660	D	1.00E-04	0.00E+00	0.00E+00
Hg-203	46.600	D	3.80E-02	0.00E+00	0.00E+00

Table 3-3a

ADULT INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07	1.05E-07
Be-7	2.77E-09	6.26E-09	3.10E-09	0.00E+00	6.58E-09	0.00E+00	1.08E-06
Na-24	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06	1.70E-06
P-32	1.93E-04	1.20E-05	7.46E-06	0.00E+00	0.00E+00	0.00E+00	2.17E-05
Cr-51	0.00E+00	0.00E+00	2.66E-09	1.59E-09	5.86E-10	3.53E-09	6.69E-07
Mn-54	0.00E+00	4.57E-06	8.72E-07	0.00E+00	1.36E-06	0.00E+00	1.40E-05
Mn-56	0.00E+00	1.15E-07	2.04E-08	0.00E+00	1.46E-07	0.00E+00	3.67E-06
Fe-55	2.75E-06	1.90E-06	4.43E-07	0.00E+00	0.00E+00	1.06E-06	1.09E-06
Fe-59	4.34E-06	1.02E-05	3.91E-06	0.00E+00	0.00E+00	2.85E-06	3.40E-05
Co-58	0.00E+00	7.45E-07	1.67E-06	0.00E+00	0.00E+00	0.00E+00	1.51E-05
Co-60	0.00E+00	2.14E-06	4.72E-06	0.00E+00	0.00E+00	0.00E+00	4.02E-05
Ni-63	1.30E-04	9.01E-06	4.36E-06	0.00E+00	0.00E+00	0.00E+00	1.88E-06
Ni-65	5.28E-07	6.86E-08	3.13E-08	0.00E+00	0.00E+00	0.00E+00	1.74E-06
Cu-64	0.00E+00	8.33E-08	3.91E-08	0.00E+00	2.10E-07	0.00E+00	7.10E-06
Zn-65	4.84E-06	1.54E-05	6.96E-06	0.00E+00	1.03E-05	0.00E+00	9.70E-06
Zn-69	1.03E-08	1.97E-08	1.37E-09	0.00E+00	1.28E-08	0.00E+00	2.96E-09
Br-83	0.00E+00	0.00E+00	4.02E-08	0.00E+00	0.00E+00	0.00E+00	5.79E-08
Br-84	0.00E+00	0.00E+00	5.21E-08	0.00E+00	0.00E+00	0.00E+00	4.09E-13
Br-85	0.00E+00	0.00E+00	2.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.11E-05	9.83E-06	0.00E+00	0.00E+00	0.00E+00	4.16E-06
Rb-88	0.00E+00	6.05E-08	3.21E-08	0.00E+00	0.00E+00	0.00E+00	8.36E-19
Rb-89	0.00E+00	4.01E-08	2.82E-08	0.00E+00	0.00E+00	0.00E+00	2.33E-21
Sr-89	3.08E-04	0.00E+00	8.84E-06	0.00E+00	0.00E+00	0.00E+00	4.94E-05
Sr-90	7.58E-03	0.00E+00	1.86E-03	0.00E+00	0.00E+00	0.00E+00	2.19E-04
Sr-91	5.67E-06	0.00E+00	2.29E-07	0.00E+00	0.00E+00	0.00E+00	2.70E-05
Sr-92	2.15E-06	0.00E+00	9.30E-08	0.00E+00	0.00E+00	0.00E+00	4.26E-05
Y-90	9.62E-09	0.00E+00	2.58E-10	0.00E+00	0.00E+00	0.00E+00	1.02E-04
Y-91m	9.09E-11	0.00E+00	3.52E-12	0.00E+00	0.00E+00	0.00E+00	2.67E-10
Y-91	1.41E-07	0.00E+00	3.77E-09	0.00E+00	0.00E+00	0.00E+00	7.76E-05
Y-92	8.45E-10	0.00E+00	2.47E-11	0.00E+00	0.00E+00	0.00E+00	1.48E-05
Y-93	2.68E-09	0.00E+00	7.40E-11	0.00E+00	0.00E+00	0.00E+00	8.50E-05
Zr-95	3.04E-08	9.75E-09	6.60E-09	0.00E+00	1.53E-08	0.00E+00	3.09E-05
Zr-97	1.68E-09	3.39E-10	1.55E-10	0.00E+00	5.12E-10	0.00E+00	1.05E-04
Nb-95	6.22E-09	3.46E-09	1.86E-09	0.00E+00	3.42E-09	0.00E+00	2.10E-05
Mo-99	0.00E+00	4.31E-06	8.20E-07	0.00E+00	9.76E-06	0.00E+00	9.99E-06
Tc-99m	2.47E-10	6.98E-10	8.89E-09	0.00E+00	1.06E-08	3.42E-10	4.13E-07
Tc-101	2.54E-10	3.66E-10	3.59E-09	0.00E+00	6.59E-09	1.87E-10	1.10E-21
Ru-103	1.85E-07	0.00E+00	7.97E-08	0.00E+00	7.06E-07	0.00E+00	2.16E-05
Ru-105	1.54E-08	0.00E+00	6.08E-09	0.00E+00	1.99E-07	0.00E+00	9.42E-06
Ru-106	2.75E-06	0.00E+00	3.48E-07	0.00E+00	5.31E-06	0.00E+00	1.78E-04
Ag-110m	1.60E-07	1.48E-07	8.79E-08	0.00E+00	2.91E-07	0.00E+00	6.04E-05
Sb-122	2.00E-07	4.60E-09	6.90E-08	3.10E-09	0.00E+00	1.20E-07	7.60E-05
Sb-124	2.80E-06	5.30E-08	1.10E-06	6.80E-09	0.00E+00	2.18E-06	7.95E-05
Sb-125	1.79E-06	2.00E-08	4.26E-07	1.82E-09	0.00E+00	1.38E-06	1.97E-05

Table 3-3a

ADULT INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	2.68E-06	9.71E-07	3.59E-07	8.06E-07	1.09E-05	0.00E+00	1.07E-05
Te-127m	6.77E-06	2.42E-06	8.25E-07	1.73E-06	2.75E-05	0.00E+00	2.27E-05
Te-127	1.10E-07	3.95E-08	2.38E-08	8.15E-08	4.48E-07	0.00E+00	8.68E-06
Te-129m	1.15E-05	4.29E-06	1.82E-06	3.95E-06	4.80E-05	0.00E+00	5.79E-05
Te-129	3.14E-08	1.18E-08	7.65E-09	2.41E-08	1.32E-07	0.00E+00	2.37E-08
Te-131m	1.73E-06	8.46E-07	7.05E-07	1.34E-06	8.57E-06	0.00E+00	8.40E-05
Te-131	1.97E-08	8.23E-09	6.22E-09	1.62E-08	8.63E-08	0.00E+00	2.79E-09
Te-132	2.52E-06	1.63E-06	1.53E-06	1.80E-06	1.57E-05	0.00E+00	7.71E-05
I-130	7.56E-07	2.23E-06	8.80E-07	1.89E-04	3.48E-06	0.00E+00	1.92E-06
I-131	4.16E-06	5.95E-06	3.41E-06	1.95E-03	1.02E-05	0.00E+00	1.57E-06
I-132	2.03E-07	5.43E-07	1.90E-07	1.90E-05	8.65E-07	0.00E+00	1.02E-07
I-133	1.42E-06	2.47E-06	7.53E-07	3.63E-04	4.31E-06	0.00E+00	2.22E-06
I-134	1.06E-07	2.88E-07	1.03E-07	4.99E-06	4.58E-07	0.00E+00	2.51E-10
I-135	4.43E-07	1.16E-06	4.28E-07	7.65E-05	1.86E-06	0.00E+00	1.31E-06
Cs-134	6.22E-05	1.48E-04	1.21E-04	0.00E+00	4.79E-05	1.59E-05	2.59E-06
Cs-136	6.51E-06	2.57E-05	1.85E-05	0.00E+00	1.43E-05	1.96E-06	2.92E-06
Cs-137	7.97E-05	1.09E-04	7.14E-05	0.00E+00	3.70E-05	1.23E-05	2.11E-06
Cs-138	5.52E-08	1.09E-07	5.40E-08	0.00E+00	8.01E-08	7.91E-09	4.65E-13
Ba-139	9.70E-08	6.91E-11	2.84E-09	0.00E+00	6.46E-11	3.92E-11	1.72E-07
Ba-140	2.03E-05	2.55E-08	1.33E-06	0.00E+00	8.67E-09	1.46E-08	4.18E-05
Ba-141	4.71E-08	3.56E-11	1.59E-09	0.00E+00	3.31E-11	2.02E-11	2.22E-17
Ba-142	2.13E-08	2.19E-11	1.34E-09	0.00E+00	1.85E-11	1.24E-11	3.00E-26
La-140	2.50E-09	1.26E-09	3.33E-10	0.00E+00	0.00E+00	0.00E+00	9.25E-05
La-142	1.28E-10	5.82E-11	1.45E-11	0.00E+00	0.00E+00	0.00E+00	4.25E-07
Ce-141	9.36E-09	6.33E-09	7.18E-10	0.00E+00	2.94E-09	0.00E+00	2.42E-05
Ce-143	1.65E-09	1.22E-06	1.35E-10	0.00E+00	5.37E-10	0.00E+00	4.56E-05
Ce-144	4.88E-07	2.04E-07	2.62E-08	0.00E+00	1.21E-07	0.00E+00	1.65E-04
Pr-143	9.20E-09	3.69E-09	4.56E-10	0.00E+00	2.13E-09	0.00E+00	4.03E-05
Pr-144	3.01E-11	1.25E-11	1.53E-12	0.00E+00	7.05E-12	0.00E+00	4.33E-18
Nd-147	6.29E-09	7.27E-09	4.35E-10	0.00E+00	4.25E-09	0.00E+00	3.49E-05
W-187	1.03E-07	8.61E-08	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.82E-05
Np-239	1.19E-09	1.17E-10	6.45E-11	0.00E+00	3.65E-10	0.00E+00	2.40E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.75E-07	2.91E-07	0.00E+00	0.00E+00	0.00E+00	4.44E-06
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	5.22E-11	1.32E-11	4.82E-12	0.00E+00	1.54E-11	0.00E+00	4.87E-08
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	3.24E-08	2.12E-08	1.30E-08	2.83E-08	2.05E-07	0.00E+00	3.59E-11
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-3b

TEEN INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07	1.06E-07
Be-7	3.96E-09	8.87E-09	4.43E-09	0.00E+00	9.40E-09	0.00E+00	1.08E-06
Na-24	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
P-32	2.76E-04	1.71E-05	1.07E-05	0.00E+00	0.00E+00	0.00E+00	2.32E-05
Cr-51	0.00E+00	0.00E+00	3.60E-09	2.00E-09	7.89E-10	5.14E-09	6.05E-07
Mn-54	0.00E+00	5.90E-06	1.17E-06	0.00E+00	1.76E-06	0.00E+00	1.21E-05
Mn-56	0.00E+00	1.58E-07	2.81E-08	0.00E+00	2.00E-07	0.00E+00	1.04E-05
Fe-55	3.78E-06	2.68E-06	6.25E-07	0.00E+00	0.00E+00	1.70E-06	1.16E-06
Fe-59	5.87E-06	1.37E-05	5.29E-06	0.00E+00	0.00E+00	4.32E-06	3.24E-05
Co-58	0.00E+00	9.72E-07	2.24E-06	0.00E+00	0.00E+00	0.00E+00	1.34E-05
Co-60	0.00E+00	2.81E-06	6.33E-06	0.00E+00	0.00E+00	0.00E+00	3.66E-05
Ni-63	1.77E-04	1.25E-05	6.00E-06	0.00E+00	0.00E+00	0.00E+00	1.99E-06
Ni-65	7.49E-07	9.57E-08	4.36E-08	0.00E+00	0.00E+00	0.00E+00	5.19E-06
Cu-64	0.00E+00	1.15E-07	5.41E-08	0.00E+00	2.91E-07	0.00E+00	8.92E-06
Zn-65	5.76E-06	2.00E-05	9.33E-06	0.00E+00	1.28E-05	0.00E+00	8.47E-06
Zn-69	1.47E-08	2.80E-08	1.96E-09	0.00E+00	1.83E-08	0.00E+00	5.16E-08
Br-83	0.00E+00	0.00E+00	5.74E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	7.22E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	3.05E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.98E-05	1.40E-05	0.00E+00	0.00E+00	0.00E+00	4.41E-06
Rb-88	0.00E+00	8.52E-08	4.54E-08	0.00E+00	0.00E+00	0.00E+00	7.30E-15
Rb-89	0.00E+00	5.50E-08	3.89E-08	0.00E+00	0.00E+00	0.00E+00	8.43E-17
Sr-89	4.40E-04	0.00E+00	1.26E-05	0.00E+00	0.00E+00	0.00E+00	5.24E-05
Sr-90	8.30E-03	0.00E+00	2.05E-03	0.00E+00	0.00E+00	0.00E+00	2.33E-04
Sr-91	8.07E-06	0.00E+00	3.21E-07	0.00E+00	0.00E+00	0.00E+00	3.66E-05
Sr-92	3.05E-06	0.00E+00	1.30E-07	0.00E+00	0.00E+00	0.00E+00	7.77E-05
Y-90	1.37E-08	0.00E+00	3.69E-10	0.00E+00	0.00E+00	0.00E+00	1.13E-04
Y-91m	1.29E-10	0.00E+00	4.93E-12	0.00E+00	0.00E+00	0.00E+00	6.09E-09
Y-91	2.01E-07	0.00E+00	5.39E-09	0.00E+00	0.00E+00	0.00E+00	8.24E-05
Y-92	1.21E-09	0.00E+00	3.50E-11	0.00E+00	0.00E+00	0.00E+00	3.32E-05
Y-93	3.83E-09	0.00E+00	1.05E-10	0.00E+00	0.00E+00	0.00E+00	1.17E-04
Zr-95	4.12E-08	1.30E-08	8.94E-09	0.00E+00	1.91E-08	0.00E+00	3.00E-05
Zr-97	2.37E-09	4.69E-10	2.16E-10	0.00E+00	7.11E-10	0.00E+00	1.27E-04
Nb-95	8.22E-09	4.56E-09	2.51E-09	0.00E+00	4.42E-09	0.00E+00	1.95E-05
Mo-99	0.00E+00	6.03E-06	1.15E-06	0.00E+00	1.38E-05	0.00E+00	1.08E-05
Tc-99m	3.32E-10	9.26E-10	1.20E-08	0.00E+00	1.38E-08	5.14E-10	6.08E-07
Tc-101	3.60E-10	5.12E-10	5.03E-09	0.00E+00	9.26E-09	3.12E-10	8.75E-17
Ru-103	2.55E-07	0.00E+00	1.09E-07	0.00E+00	8.99E-07	0.00E+00	2.13E-05
Ru-105	2.18E-08	0.00E+00	8.46E-09	0.00E+00	2.75E-07	0.00E+00	1.76E-05
Ru-106	3.92E-06	0.00E+00	4.94E-07	0.00E+00	7.56E-06	0.00E+00	1.88E-04
Ag-110m	2.05E-07	1.94E-07	1.18E-07	0.00E+00	3.70E-07	0.00E+00	5.45E-05
Sb-122	3.30E-07	6.42E-09	9.64E-08	4.19E-09	0.00E+00	2.06E-07	6.92E-05
Sb-124	3.86E-06	7.12E-08	1.51E-06	8.79E-09	0.00E+00	3.37E-06	7.81E-05
Sb-125	2.48E-06	2.71E-08	5.79E-07	2.36E-09	0.00E+00	2.16E-06	1.92E-05

Table 3-3b

TEEN INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	3.83E-06	1.38E-06	5.12E-07	1.07E-06	0.00E+00	0.00E+00	1.13E-05
Te-127m	9.67E-06	3.43E-06	1.15E-06	2.30E-06	3.92E-05	0.00E+00	2.41E-05
Te-127	1.58E-07	5.60E-08	3.40E-08	1.09E-07	6.40E-07	0.00E+00	1.22E-05
Te-129m	1.63E-05	6.05E-06	2.58E-06	5.26E-06	6.82E-05	0.00E+00	6.12E-05
Te-129	4.48E-08	1.67E-08	1.09E-08	3.20E-08	1.88E-07	0.00E+00	2.45E-07
Te-131m	2.44E-06	1.17E-06	9.76E-07	1.76E-06	1.22E-05	0.00E+00	9.39E-05
Te-131	2.79E-08	1.15E-08	8.72E-09	2.15E-08	1.22E-07	0.00E+00	2.29E-09
Te-132	3.49E-06	2.21E-06	2.08E-06	2.33E-06	2.12E-05	0.00E+00	7.00E-05
I-130	1.03E-06	2.98E-06	1.19E-06	2.43E-04	4.59E-06	0.00E+00	2.29E-06
I-131	5.85E-06	8.19E-06	4.40E-06	2.39E-03	1.41E-05	0.00E+00	1.62E-06
I-132	2.79E-07	7.30E-07	2.62E-07	2.46E-05	1.15E-06	0.00E+00	3.18E-07
I-133	2.01E-06	3.41E-06	1.04E-06	4.76E-04	5.98E-06	0.00E+00	2.58E-06
I-134	1.46E-07	3.87E-07	1.39E-07	6.45E-06	6.10E-07	0.00E+00	5.10E-09
I-135	6.10E-07	1.57E-06	5.82E-07	1.01E-04	2.48E-06	0.00E+00	1.74E-06
Cs-134	8.37E-05	1.97E-04	9.14E-05	0.00E+00	6.26E-05	2.39E-05	2.45E-06
Cs-136	8.59E-06	3.38E-05	2.27E-05	0.00E+00	1.84E-05	2.90E-06	2.72E-06
Cs-137	1.12E-04	1.49E-04	5.19E-05	0.00E+00	5.07E-05	1.97E-05	2.12E-06
Cs-138	7.76E-08	1.49E-07	7.45E-08	0.00E+00	1.10E-07	1.28E-08	6.76E-11
Ba-139	1.39E-07	9.78E-11	4.05E-09	0.00E+00	9.22E-11	6.74E-11	1.24E-06
Ba-140	2.84E-05	3.48E-08	1.83E-06	0.00E+00	1.18E-08	2.34E-08	4.38E-05
Ba-141	6.71E-08	5.01E-11	2.24E-09	0.00E+00	4.65E-11	3.43E-11	1.43E-13
Ba-142	2.99E-08	2.99E-11	1.84E-09	0.00E+00	2.53E-11	1.99E-11	9.18E-20
La-140	3.48E-09	1.71E-09	4.55E-10	0.00E+00	0.00E+00	0.00E+00	9.82E-05
La-142	1.79E-10	7.95E-11	1.98E-11	0.00E+00	0.00E+00	0.00E+00	2.42E-06
Ce-141	1.33E-08	8.88E-09	1.02E-09	0.00E+00	4.18E-09	0.00E+00	2.54E-05
Ce-143	2.35E-09	1.71E-06	1.91E-10	0.00E+00	7.67E-10	0.00E+00	5.14E-05
Ce-144	6.96E-07	2.88E-07	3.74E-08	0.00E+00	1.72E-07	0.00E+00	1.75E-04
Pr-143	1.31E-08	5.23E-09	6.52E-10	0.00E+00	3.04E-09	0.00E+00	4.31E-05
Pr-144	4.30E-11	1.76E-11	2.18E-12	0.00E+00	1.01E-11	0.00E+00	4.74E-14
Nd-147	9.38E-09	1.02E-08	6.11E-10	0.00E+00	5.99E-09	0.00E+00	3.68E-05
W-187	1.46E-07	1.19E-07	4.17E-08	0.00E+00	0.00E+00	0.00E+00	3.22E-05
Np-239	1.76E-09	1.66E-10	9.22E-11	0.00E+00	5.21E-10	0.00E+00	2.67E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	2.38E-07	3.99E-07	0.00E+00	0.00E+00	0.00E+00	4.44E-06
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	7.37E-11	1.83E-11	6.68E-12	0.00E+00	2.14E-11	0.00E+00	4.37E-07
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	4.47E-08	2.87E-08	3.00E-08	3.67E-08	2.74E-07	0.00E+00	1.66E-09
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-3c

CHILD INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
Be-7	1.18E-08	2.00E-08	1.32E-08	0.00E+00	1.97E-08	0.00E+00	1.12E-06
Na-24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P-32	8.25E-04	3.86E-05	3.18E-05	0.00E+00	0.00E+00	0.00E+00	2.28E-05
Cr-51	0.00E+00	0.00E+00	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
Mn-54	0.00E+00	1.07E-05	2.85E-06	0.00E+00	3.00E-06	0.00E+00	8.98E-06
Mn-56	0.00E+00	3.34E-07	7.54E-08	0.00E+00	4.04E-07	0.00E+00	4.84E-05
Fe-55	1.15E-05	6.10E-06	1.89E-06	0.00E+00	0.00E+00	3.45E-06	1.13E-06
Fe-59	1.65E-05	2.67E-05	1.33E-05	0.00E+00	0.00E+00	7.74E-06	2.78E-05
Co-58	0.00E+00	1.80E-06	5.51E-06	0.00E+00	0.00E+00	0.00E+00	1.05E-05
Co-60	0.00E+00	5.29E-06	1.56E-05	0.00E+00	0.00E+00	0.00E+00	2.93E-05
Ni-63	5.38E-04	2.88E-05	1.83E-05	0.00E+00	0.00E+00	0.00E+00	1.94E-06
Ni-65	2.22E-06	2.09E-07	1.22E-07	0.00E+00	0.00E+00	0.00E+00	2.56E-05
Cu-64	0.00E+00	2.45E-07	1.48E-07	0.00E+00	5.92E-07	0.00E+00	1.15E-05
Zn-65	1.37E-05	3.65E-05	2.27E-05	0.00E+00	2.30E-05	0.00E+00	6.41E-06
Zn-69	4.38E-08	6.33E-08	5.85E-09	0.00E+00	3.84E-08	0.00E+00	3.99E-06
Br-83	0.00E+00	0.00E+00	1.71E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.98E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	9.12E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	6.70E-05	4.12E-05	0.00E+00	0.00E+00	0.00E+00	4.31E-06
Rb-88	0.00E+00	1.90E-07	1.32E-07	0.00E+00	0.00E+00	0.00E+00	9.32E-09
Rb-89	0.00E+00	1.17E-07	1.04E-07	0.00E+00	0.00E+00	0.00E+00	1.02E-09
Sr-89	1.32E-03	0.00E+00	3.77E-05	0.00E+00	0.00E+00	0.00E+00	5.11E-05
Sr-90	1.70E-02	0.00E+00	4.31E-03	0.00E+00	0.00E+00	0.00E+00	2.29E-04
Sr-91	2.40E-05	0.00E+00	9.06E-07	0.00E+00	0.00E+00	0.00E+00	5.30E-05
Sr-92	9.03E-06	0.00E+00	3.62E-07	0.00E+00	0.00E+00	0.00E+00	1.71E-04
Y-90	4.11E-08	0.00E+00	1.10E-09	0.00E+00	0.00E+00	0.00E+00	1.17E-04
Y-91m	3.82E-10	0.00E+00	1.39E-11	0.00E+00	0.00E+00	0.00E+00	7.48E-07
Y-91	6.02E-07	0.00E+00	1.61E-08	0.00E+00	0.00E+00	0.00E+00	8.02E-05
Y-92	3.60E-09	0.00E+00	1.03E-10	0.00E+00	0.00E+00	0.00E+00	1.04E-04
Y-93	1.14E-08	0.00E+00	3.13E-10	0.00E+00	0.00E+00	0.00E+00	1.70E-04
Zr-95	1.16E-07	2.55E-08	2.27E-08	0.00E+00	3.65E-08	0.00E+00	2.66E-05
Zr-97	6.99E-09	1.01E-09	5.96E-10	0.00E+00	1.45E-09	0.00E+00	1.53E-04
Nb-95	2.25E-08	8.76E-09	6.26E-09	0.00E+00	8.23E-09	0.00E+00	1.62E-05
Mo-99	0.00E+00	1.33E-05	3.29E-06	0.00E+00	2.84E-05	0.00E+00	1.10E-05
Tc-99m	9.23E-10	1.81E-09	3.00E-08	0.00E+00	2.63E-08	9.19E-10	1.03E-06
Tc-101	1.07E-09	1.12E-09	1.42E-08	0.00E+00	1.91E-08	5.92E-10	3.56E-09
Ru-103	7.31E-07	0.00E+00	2.81E-07	0.00E+00	1.84E-06	0.00E+00	1.89E-05
Ru-105	6.45E-08	0.00E+00	2.34E-08	0.00E+00	5.67E-07	0.00E+00	4.21E-05
Ru-106	1.17E-05	0.00E+00	1.46E-06	0.00E+00	1.58E-05	0.00E+00	1.82E-04
Ag-110m	5.39E-07	3.64E-07	2.91E-07	0.00E+00	6.78E-07	0.00E+00	4.33E-05
Sb-122	9.83E-07	1.45E-08	2.88E-07	1.26E-08	0.00E+00	4.00E-07	7.56E-05
Sb-124	1.11E-05	1.44E-07	3.88E-06	2.44E-08	0.00E+00	6.15E-06	6.93E-05
Sb-125	7.15E-06	5.51E-08	1.50E-06	6.63E-09	0.00E+00	3.98E-06	1.71E-05

Table 3-3c

CHILD INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	1.14E-05	3.09E-06	1.52E-06	3.20E-06	0.00E+00	0.00E+00	1.10E-05
Te-127m	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	0.00E+00	2.34E-05
Te-127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	0.00E+00	1.84E-05
Te-129m	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	0.00E+00	5.94E-05
Te-129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	0.00E+00	8.34E-06
Te-131m	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	0.00E+00	1.01E-04
Te-131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	0.00E+00	4.36E-07
Te-132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	0.00E+00	4.50E-05
I-130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	0.00E+00	2.76E-06
I-131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	0.00E+00	1.54E-06
I-132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	0.00E+00	1.73E-06
I-133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	0.00E+00	2.95E-06
I-134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	0.00E+00	5.16E-07
I-135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	0.00E+00	2.40E-06
Cs-134	2.34E-04	3.84E-04	8.10E-05	0.00E+00	1.19E-04	4.27E-05	2.07E-06
Cs-136	2.35E-05	6.46E-05	4.18E-05	0.00E+00	3.44E-05	5.13E-06	2.27E-06
Cs-137	3.27E-04	3.13E-04	4.62E-05	0.00E+00	1.02E-04	3.67E-05	1.96E-06
Cs-138	2.28E-07	3.17E-07	2.01E-07	0.00E+00	2.23E-07	2.40E-08	1.46E-07
Ba-139	4.14E-07	2.21E-10	1.20E-08	0.00E+00	1.93E-10	1.30E-10	2.39E-05
Ba-140	8.31E-05	7.28E-08	4.85E-06	0.00E+00	2.37E-08	4.34E-08	4.21E-05
Ba-141	2.00E-07	1.12E-10	6.51E-09	0.00E+00	9.69E-11	6.58E-10	1.14E-07
Ba-142	8.74E-08	6.29E-11	4.88E-09	0.00E+00	5.09E-11	3.70E-11	1.14E-09
La-140	1.01E-08	3.53E-09	1.19E-09	0.00E+00	0.00E+00	0.00E+00	9.84E-05
La-142	5.24E-10	1.67E-10	5.23E-11	0.00E+00	0.00E+00	0.00E+00	3.31E-05
Ce-141	3.97E-08	1.98E-08	2.94E-09	0.00E+00	8.68E-09	0.00E+00	2.47E-05
Ce-143	6.99E-09	3.79E-06	5.49E-10	0.00E+00	1.59E-09	0.00E+00	5.55E-05
Ce-144	2.08E-06	6.52E-07	1.11E-07	0.00E+00	3.61E-07	0.00E+00	1.70E-04
Pr-143	3.93E-08	1.18E-08	1.95E-09	0.00E+00	6.39E-09	0.00E+00	4.24E-05
Pr-144	1.29E-10	3.99E-11	6.49E-12	0.00E+00	2.11E-11	0.00E+00	8.59E-08
Nd-147	2.79E-08	2.26E-08	1.75E-09	0.00E+00	1.24E-08	0.00E+00	3.58E-05
W-187	4.29E-07	2.54E-07	1.14E-07	0.00E+00	0.00E+00	0.00E+00	3.57E-05
Np-239	5.25E-09	3.77E-10	2.65E-10	0.00E+00	1.09E-09	0.00E+00	2.79E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	4.93E-07	9.98E-07	0.00E+00	0.00E+00	0.00E+00	4.04E-06
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.17E-10	3.92E-11	1.83E-11	0.00E+00	4.35E-11	0.00E+00	1.21E-05
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	1.29E-07	5.80E-08	7.74E-08	1.02E-07	5.37E-07	0.00E+00	5.89E-07
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-3d

INFANT INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
Be-7	2.26E-08	4.72E-08	2.51E-08	0.00E+00	3.34E-08	0.00E+00	1.11E-06
Na-24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P-32	1.70E-03	1.00E-04	6.59E-05	0.00E+00	0.00E+00	0.00E+00	2.30E-05
Cr-51	0.00E+00	0.00E+00	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
Mn-54	0.00E+00	1.99E-05	4.51E-06	0.00E+00	4.41E-06	0.00E+00	7.31E-06
Mn-56	0.00E+00	8.18E-07	1.41E-07	0.00E+00	7.03E-07	0.00E+00	7.43E-05
Fe-55	1.39E-05	8.98E-06	2.40E-06	0.00E+00	0.00E+00	4.39E-06	1.14E-06
Fe-59	3.08E-05	5.38E-05	2.12E-05	0.00E+00	0.00E+00	1.59E-05	2.57E-05
Co-58	0.00E+00	3.60E-06	8.98E-06	0.00E+00	0.00E+00	0.00E+00	8.97E-06
Co-60	0.00E+00	1.08E-05	2.55E-05	0.00E+00	0.00E+00	0.00E+00	2.57E-05
Ni-63	6.34E-04	3.92E-05	2.20E-05	0.00E+00	0.00E+00	0.00E+00	1.95E-06
Ni-65	4.70E-06	5.32E-07	2.42E-07	0.00E+00	0.00E+00	0.00E+00	4.05E-05
Cu-64	0.00E+00	6.09E-07	2.82E-07	0.00E+00	1.03E-06	0.00E+00	1.25E-05
Zn-65	1.84E-05	6.31E-05	2.91E-05	0.00E+00	3.06E-05	0.00E+00	5.33E-05
Zn-69	9.33E-08	1.68E-07	1.25E-08	0.00E+00	6.98E-08	0.00E+00	1.37E-05
Br-83	0.00E+00	0.00E+00	3.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	3.82E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.94E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.70E-04	8.40E-05	0.00E+00	0.00E+00	0.00E+00	4.35E-06
Rb-88	0.00E+00	4.98E-07	2.73E-07	0.00E+00	0.00E+00	0.00E+00	4.85E-07
Rb-89	0.00E+00	2.86E-07	1.97E-07	0.00E+00	0.00E+00	0.00E+00	9.74E-08
Sr-89	2.51E-03	0.00E+00	7.20E-05	0.00E+00	0.00E+00	0.00E+00	5.16E-05
Sr-90	1.85E-02	0.00E+00	4.71E-03	0.00E+00	0.00E+00	0.00E+00	2.31E-04
Sr-91	5.00E-05	0.00E+00	1.81E-06	0.00E+00	0.00E+00	0.00E+00	5.92E-05
Sr-92	1.92E-05	0.00E+00	7.13E-07	0.00E+00	0.00E+00	0.00E+00	2.07E-04
Y-90	8.69E-08	0.00E+00	2.33E-09	0.00E+00	0.00E+00	0.00E+00	1.20E-04
Y-91m	8.10E-10	0.00E+00	2.76E-11	0.00E+00	0.00E+00	0.00E+00	2.70E-06
Y-91	1.13E-06	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	8.10E-05
Y-92	7.65E-09	0.00E+00	2.15E-10	0.00E+00	0.00E+00	0.00E+00	1.46E-04
Y-93	2.43E-08	0.00E+00	6.62E-10	0.00E+00	0.00E+00	0.00E+00	1.92E-04
Zr-95	2.06E-07	5.02E-08	3.56E-08	0.00E+00	5.41E-08	0.00E+00	2.50E-05
Zr-97	1.48E-08	2.54E-09	1.16E-09	0.00E+00	2.56E-09	0.00E+00	1.62E-04
Nb-95	4.20E-08	1.73E-08	1.00E-08	0.00E+00	1.24E-08	0.00E+00	1.46E-05
Mo-99	0.00E+00	3.40E-05	6.63E-06	0.00E+00	5.08E-05	0.00E+00	1.12E-05
Tc-99m	1.92E-09	3.96E-09	5.10E-08	0.00E+00	4.26E-08	2.07E-09	1.15E-06
Tc-101	2.27E-09	2.86E-09	2.83E-08	0.00E+00	3.40E-08	1.56E-09	4.86E-07
Ru-103	1.48E-06	0.00E+00	4.95E-07	0.00E+00	3.08E-06	0.00E+00	1.80E-05
Ru-105	1.36E-07	0.00E+00	4.58E-08	0.00E+00	1.00E-06	0.00E+00	5.41E-05
Ru-106	2.41E-05	0.00E+00	3.01E-06	0.00E+00	2.85E-05	0.00E+00	1.83E-04
Ag-110m	9.96E-07	7.27E-07	4.81E-07	0.00E+00	1.04E-06	0.00E+00	3.77E-05
Sb-122	2.10E-06	3.85E-08	6.13E-07	3.14E-08	0.00E+00	1.09E-06	7.65E-05
Sb-124	2.14E-05	3.15E-07	6.63E-06	5.68E-08	0.00E+00	1.34E-05	6.60E-05
Sb-125	1.23E-05	1.19E-07	2.53E-06	1.54E-08	0.00E+00	7.72E-06	1.64E-05

Table 3-3d

INFANT INGESTION DOSE FACTORS

(mrem per pCi ingested)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	2.33E-05	7.79E-06	3.15E-06	7.84E-06	0.00E+00	0.00E+00	1.11E-05
Te-127m	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	0.00E+00	2.36E-05
Te-127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	0.00E+00	2.10E-05
Te-129m	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	0.00E+00	5.97E-05
Te-129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	0.00E+00	2.27E-05
Te-131m	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	0.00E+00	1.03E-04
Te-131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	0.00E+00	7.11E-06
Te-132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	0.00E+00	3.81E-05
I-130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	0.00E+00	2.83E-06
I-131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	0.00E+00	1.51E-06
I-132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	0.00E+00	2.73E-06
I-133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	0.00E+00	3.08E-06
I-134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	0.00E+00	1.84E-06
I-135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	0.00E+00	2.62E-06
Cs-134	3.77E-04	7.03E-04	7.10E-05	0.00E+00	1.81E-04	7.42E-05	1.91E-06
Cs-136	4.59E-05	1.35E-04	5.04E-05	0.00E+00	5.38E-05	1.10E-05	2.05E-06
Cs-137	5.22E-04	6.11E-04	4.33E-05	0.00E+00	1.64E-04	6.64E-05	1.91E-06
Cs-138	4.81E-07	7.82E-07	3.79E-07	0.00E+00	3.90E-07	6.09E-08	1.25E-06
Ba-139	8.81E-07	5.84E-10	2.55E-08	0.00E+00	3.51E-10	3.54E-10	5.58E-05
Ba-140	1.71E-04	1.71E-07	8.81E-06	0.00E+00	4.06E-08	1.05E-07	4.20E-05
Ba-141	4.25E-07	2.91E-10	1.34E-08	0.00E+00	1.75E-10	1.77E-10	5.19E-06
Ba-142	1.84E-07	1.53E-10	9.06E-09	0.00E+00	8.81E-11	9.26E-11	7.59E-07
La-140	2.11E-08	8.32E-09	2.14E-09	0.00E+00	0.00E+00	0.00E+00	9.77E-05
La-142	1.10E-09	4.04E-10	9.67E-11	0.00E+00	0.00E+00	0.00E+00	6.86E-05
Ce-141	7.87E-08	4.80E-08	5.65E-09	0.00E+00	1.48E-08	0.00E+00	2.48E-05
Ce-143	1.48E-08	9.82E-06	1.12E-09	0.00E+00	2.86E-09	0.00E+00	5.73E-05
Ce-144	2.98E-06	1.22E-06	1.67E-07	0.00E+00	4.93E-07	0.00E+00	1.71E-04
Pr-143	8.13E-08	3.04E-08	4.03E-09	0.00E+00	1.13E-08	0.00E+00	4.29E-05
Pr-144	2.74E-10	1.06E-10	1.38E-11	0.00E+00	3.84E-11	0.00E+00	4.93E-06
Nd-147	5.53E-08	5.68E-08	3.48E-09	0.00E+00	2.19E-08	0.00E+00	3.60E-05
W-187	9.03E-07	6.28E-07	2.17E-07	0.00E+00	0.00E+00	0.00E+00	3.69E-05
Np-239	1.11E-08	9.93E-10	5.61E-10	0.00E+00	1.98E-09	0.00E+00	2.87E-05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.15E-06	1.87E-06	0.00E+00	0.00E+00	0.00E+00	3.92E-06
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-4

Total Body Dose Factors

Ki

From Noble Gases (gamma)

	Gamma				Finite Cloud Correction Factor**				
Nuclide	TB factor *	x	(pCi/uCi)	x	Unit 2	Unit 3	=	U2 Ki ***	U3 Ki ***
Kr-83m	7.56E-08		1E+6		8.86E-01	5.78E-01		6.70E-02	4.37E-02
Kr-85m	1.17E-03		1E+6		7.49E-01	4.46E-01		8.76E+02	5.22E+02
Kr-85	1.61E-05		1E+6		6.73E-01	3.85E-01		1.08E+01	6.19E+00
Kr-87	5.92E-03		1E+6		5.68E-01	3.09E-01		3.36E+03	1.83E+03
Kr-88	1.47E-02		1E+6		5.40E-01	2.88E-01		7.93E+03	4.23E+03
Kr-89	1.66E-02		1E+6		5.60E-01	3.03E-01		9.30E+03	5.03E+03
Kr-90	1.56E-02		1E+6		5.97E-01	3.29E-01		9.31E+03	5.13E+03
Xe-131m	9.15E-05		1E+6		8.67E-01	5.62E-01		7.94E+01	5.14E+01
Xe-133m	2.51E-04		1E+6		8.17E-01	5.12E-01		2.05E+02	1.29E+02
Xe-133	2.94E-04		1E+6		8.86E-01	5.78E-01		2.60E+02	1.70E+02
Xe-135m	3.12E-03		1E+6		6.75E-01	3.87E-01		2.11E+03	1.21E+03
Xe-135	1.81E-03		1E+6		7.60E-01	4.55E-01		1.38E+03	8.24E+02
Xe-137	1.42E-03		1E+6		6.46E-01	3.65E-01		9.18E+02	5.18E+02
Xe-138	8.83E-03		1E+6		5.75E-01	3.14E-01		5.07E+03	2.77E+03
Ar-41	8.84E-03		1E+6		5.89E-01	3.21E-01		5.21E+03	2.84E+03

* From Reg Guide 1.109, Table B-1 (mrem/yr per pCi/m^3)

** The finite cloud correction factor is described in Section 3.6

*** Ki (mrem/yr per uCi/m^3)

Table 3-5

Skin Dose Factors

Li

From Noble Gases (beta)

Nucline	Beta Skin* Dose Factor	x	(pCi/uCi)	=	Li**
Kr-83m	0.00E+00		1E+6		0.00E+00
Kr-85m	1.46E-03		1E+6		1.46E+03
Kr-85	1.34E-03		1E+6		1.34E+03
Kr-87	9.73E-03		1E+6		9.73E+03
Kr-88	2.37E-03		1E+6		2.37E+03
Kr-89	1.01E-02		1E+6		1.01E+04
Kr-90	7.29E-03		1E+6		7.29E+03
Xe-131m	4.76E-04		1E+6		4.76E+02
Xe-133m	9.94E-04		1E+6		9.94E+02
Xe-133	3.06E-04		1E+6		3.06E+02
Xe-135m	7.11E-04		1E+6		7.11E+02
Xe-135	1.86E-03		1E+6		1.86E+03
Xe-137	1.22E-02		1E+6		1.22E+04
Xe-138	4.13E-03		1E+6		4.13E+03
Ar-41	2.69E-03		1E+6		2.69E+03

* From Reg Guide 1.109, Table B-1 (mrem/yr per pCi/m^3)

** Li (mrem/yr per uCi/m^3)

Table 3-6

Air Dose Factors

Mi

From Noble Gases (gamma)

	Gamma				Finite Cloud Correction Factor**				
Nuclide	factor *	x	(pCi/uCi)	x	Unit 2	Unit 3	=	U2 Mi ***	U3 Mi ***
Kr-83m	1.93E-05		1E+6		8.86E-01	5.78E-01		1.71E+01	1.12E+01
Kr-85m	1.23E-03		1E+6		7.49E-01	4.46E-01		9.21E+02	5.49E+02
Kr-85	1.72E-05		1E+6		6.73E-01	3.85E-01		1.16E+01	6.62E+00
Kr-87	6.17E-03		1E+6		5.68E-01	3.09E-01		3.50E+03	1.91E+03
Kr-88	1.52E-02		1E+6		5.40E-01	2.88E-01		8.20E+03	4.37E+03
Kr-89	1.73E-02		1E+6		5.60E-01	3.03E-01		9.69E+03	5.24E+03
Kr-90	1.63E-02		1E+6		5.97E-01	3.29E-01		9.73E+03	5.36E+03
Xe-131m	1.56E-04		1E+6		8.67E-01	5.62E-01		1.35E+02	8.77E+01
Xe-133m	3.27E-04		1E+6		8.17E-01	5.12E-01		2.67E+02	1.68E+02
Xe-133	3.53E-04		1E+6		8.86E-01	5.78E-01		3.13E+02	2.04E+02
Xe-135m	3.36E-03		1E+6		6.75E-01	3.87E-01		2.27E+03	1.30E+03
Xe-135	1.92E-03		1E+6		7.60E-01	4.55E-01		1.46E+03	8.74E+02
Xe-137	1.51E-03		1E+6		6.46E-01	3.65E-01		9.76E+02	5.51E+02
Xe-138	9.21E-03		1E+6		5.75E-01	3.14E-01		5.29E+03	2.89E+03
Ar-41	9.30E-03		1E+6		5.89E-01	3.21E-01		5.48E+03	2.99E+03

* From Reg Guide 1.109, Table B-1 (mrad/yr per pCi/m^3)

** The finite cloud correction factor is described in Section 3.6

*** Mi (mrad/yr per uCi/m^3)

Table 3-7

Air Dose Factors

Ni

From Noble Gases (beta)

Nucline	Beta * Factor	x (pCi/uCi)	=	Ni**
Kr-83m	2.88E-04	1E+6		2.88E+02
Kr-85m	1.97E-03	1E+6		1.97E+03
Kr-85	1.95E-03	1E+6		1.95E+03
Kr-87	1.03E-02	1E+6		1.03E+04
Kr-88	2.93E-03	1E+6		2.93E+03
Kr-89	1.06E-02	1E+6		1.06E+04
Kr-90	7.83E-03	1E+6		7.83E+03
Xe-131m	1.11E-03	1E+6		1.11E+03
Xe-133m	1.48E-03	1E+6		1.48E+03
Xe-133	1.05E-03	1E+6		1.05E+03
Xe-135m	7.39E-04	1E+6		7.39E+02
Xe-135	2.46E-03	1E+6		2.46E+03
Xe-137	1.27E-02	1E+6		1.27E+04
Xe-138	4.75E-03	1E+6		4.75E+03
Ar-41	3.28E-03	1E+6		3.28E+03

* From Reg Guide 1.109, Table B-1 (mrad/yr per pCi/m^3)

** Ni (mrad/yr per uCi/m^3)

Table 3 – 8

NOBLE GAS DOSE FACTORS

For Instantaneous and Time Average Mixtures at the Site Boundary, Units 2 and 3

Radionuclide	Instantaneous Mix (%)	Time Average Mix (%)
Kr-85m	3.09	
Kr-85	0	18.98
Kr-87	2.80	
Kr-88	5.22	
Xe-131m	0	0.162
Xe-133m	1.39	0.485
Xe-133	56.8	78.1
Xe-135m	1.34	
Xe-135	19.2	2.21
Xe-138	2.81	
Ar-41	7.43	
Total	100	100

Unit 2 effective instantaneous dose factors	Unit 3 effective instantaneous dose factors	Units	Unit 2 effective average dose factors	Unit 3 effective average dose factors
$\overline{K}$ = 1507	$\overline{K}$ = 849	mrem/yr per uCi/m^3	$\overline{K}$ = 237	$\overline{K}$ = 153
$\overline{L}$ = 1310	$\overline{L}$ = 1310	mrem/yr per uCi/m^3	$\overline{L}$ = 540	$\overline{L}$ = 540
$\overline{M}$ = 1601	$\overline{M}$ = 905	mrad/yr per uCi/m^3	$\overline{M}$ = 281	$\overline{M}$ = 181
$\overline{N}$ = 1977	$\overline{N}$ = 1977	mrad/yr per uCi/m^3	$\overline{N}$ = 1254	$\overline{N}$ = 1254

Instantaneous Mixture Basis:
This mix defines the shared-site noble gas limits between the two units, and is used for administrative guidelines for instantaneous releases based on an RCS noble gas mix at 1.6 yrs into a 24-month cycle, with two failed fuel rods, per Reference 30. These mixtures provide conservative application for calculating setpoints per 10CFR20, in terms of uCi/sec before an actual sample of the release is available, per Appendix I.

Time Averaged Release Mixture Basis:
This mix defines the routine (time-averaged) releases from either unit. It was derived from average noble-gas releases from year 2000-2003 at IPEC units 2 and 3 per Reference 30. They are used in conjunction with calculations to determine representative quarterly and annual time averaged release rates in curies per second for administrative purposes only, per Appendix I.

TABLE 3 – 9

LOCATIONS OF SITE BOUNDARY AND NEAREST RESIDENCE

Sector by compass point	Distance to Site Boundary from Unit 2 Plant Vent, in meters	Distance to Site Boundary from Unit 3 Plant Vent, in meters	Distance to nearest residence, from Unit 1 superheater, in meters
N	**RIVER**	**RIVER**	**1788.1**
NNE	**RIVER**	**RIVER**	**3111.3**
NE	**550**	**744**	**1907.3**
ENE	**600**	**775**	**1478.2**
E	**662**	**785**	**1370.9**
ESE	**569**	**622**	**715.2**
SE	**553**	**564**	**1168.2**
SSE	**569**	**551**	**1239.7**
S	**700**	**566**	**1132.5**
SSW	**755**	**480**	**1573.5**
SW	**544**	**350**	**3015.9**
WSW	**RIVER**	**RIVER**	**2169.6**
W	**RIVER**	**RIVER**	**1918.7**
WNW	**RIVER**	**RIVER**	**1752.4**
NW	**RIVER**	**RIVER**	**1692.7**
NNW	**RIVER**	**RIVER**	**1609.3**

Distances to the Site Boundary are unit-specific and measured from the applicable unit's Plant Vent release point. Distances to the Nearest Residence are measured from the Unit 1 Superheater Stack for both Units 2 and 3, per Reference 31.

Table 3-10a

ADULT INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04
P-32	1.32E+06	7.71E+04	5.01E+04	0.00E+00	0.00E+00	0.00E+00	8.64E+04
Cr-51	0.00E+00	0.00E+00	1.00E+02	5.95E+01	2.28E+01	1.44E+04	3.32E+03
Mn-54	0.00E+00	3.96E+04	6.30E+03	0.00E+00	9.84E+03	1.40E+06	7.74E+04
Mn-56	0.00E+00	1.24E+00	1.83E-01	0.00E+00	1.30E+00	9.44E+03	2.02E+04
Fe-55	2.46E+04	1.70E+04	3.94E+03	0.00E+00	0.00E+00	7.21E+04	6.03E+03
Fe-59	1.18E+04	2.78E+04	1.06E+04	0.00E+00	0.00E+00	1.02E+06	1.88E+05
Co-58	0.00E+00	1.58E+03	2.07E+03	0.00E+00	0.00E+00	9.28E+05	1.06E+05
Co-60	0.00E+00	1.15E+04	1.48E+04	0.00E+00	0.00E+00	5.97E+06	2.85E+05
Ni-63	4.32E+05	3.14E+04	1.45E+04	0.00E+00	0.00E+00	1.78E+05	1.34E+04
Ni-65	1.54E+00	2.10E-01	9.12E-02	0.00E+00	0.00E+00	5.60E+03	1.23E+04
Cu-64	0.00E+00	1.46E+00	6.15E-01	0.00E+00	4.62E+00	6.78E+03	4.90E+04
Zn-65	3.24E+04	1.03E+05	4.66E+04	0.00E+00	6.90E+04	8.64E+05	5.34E+04
Zn-69	3.38E-02	6.51E-02	4.52E-03	0.00E+00	4.22E-02	9.20E+02	1.63E+01
Br-83	0.00E+00	0.00E+00	2.41E+02	0.00E+00	0.00E+00	0.00E+00	2.32E+02
Br-84	0.00E+00	0.00E+00	3.13E+02	0.00E+00	0.00E+00	0.00E+00	1.64E-03
Br-85	0.00E+00	0.00E+00	1.28E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.35E+05	5.90E+04	0.00E+00	0.00E+00	0.00E+00	1.66E+04
Rb-88	0.00E+00	3.87E+02	1.93E+02	0.00E+00	0.00E+00	0.00E+00	3.34E-09
Rb-89	0.00E+00	2.56E+02	1.70E+02	0.00E+00	0.00E+00	0.00E+00	9.28E-12
Sr-89	3.04E+05	0.00E+00	8.72E+03	0.00E+00	0.00E+00	1.40E+06	3.50E+05
Sr-90	9.92E+07	0.00E+00	6.10E+06	0.00E+00	0.00E+00	9.60E+06	7.22E+05
Sr-91	6.19E+01	0.00E+00	2.50E+00	0.00E+00	0.00E+00	3.65E+04	1.91E+05
Sr-92	6.74E+00	0.00E+00	2.91E-01	0.00E+00	0.00E+00	1.65E+04	4.30E+04
Y-90	2.09E+03	0.00E+00	5.61E+01	0.00E+00	0.00E+00	1.70E+05	5.06E+05
Y-91m	2.61E-01	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.92E+03	1.33E+00
Y-91	4.62E+05	0.00E+00	1.24E+04	0.00E+00	0.00E+00	1.70E+06	3.85E+05
Y-92	1.03E+01	0.00E+00	3.02E-01	0.00E+00	0.00E+00	1.57E+04	7.35E+04
Y-93	9.44E+01	0.00E+00	2.61E+00	0.00E+00	0.00E+00	4.85E+04	4.22E+05
Zr-95	1.07E+05	3.44E+04	2.33E+04	0.00E+00	5.42E+04	1.77E+06	1.50E+05
Zr-97	9.68E+01	1.96E+01	9.04E+00	0.00E+00	2.97E+01	7.87E+04	5.23E+05
Nb-95	1.41E+04	7.82E+03	4.21E+03	0.00E+00	7.74E+03	5.05E+05	1.04E+05
Mo-99	0.00E+00	1.21E+02	2.30E+01	0.00E+00	2.91E+02	9.12E+04	2.48E+05
Tc-99m	1.03E-03	2.91E-03	3.70E-02	0.00E+00	4.42E-02	7.64E+02	4.16E+03
Tc-101	4.18E-05	6.02E-05	5.90E-04	0.00E+00	1.08E-03	3.99E+02	1.09E-11
Ru-103	1.53E+03	0.00E+00	6.58E+02	0.00E+00	5.83E+03	5.05E+05	1.10E+05
Ru-105	7.90E-01	0.00E+00	3.11E-01	0.00E+00	1.02E+00	1.10E+04	4.82E+04
Ru-106	6.91E+04	0.00E+00	8.72E+03	0.00E+00	1.34E+05	9.36E+06	9.12E+05
Ag-110m	1.08E+04	1.00E+04	5.94E+03	0.00E+00	1.97E+04	4.63E+06	3.02E+05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	3.12E+04	5.89E+02	1.24E+04	7.55E+01	0.00E+00	2.48E+06	4.06E+05
Sb-125	5.34E+04	5.95E+02	1.26E+04	5.40E+01	0.00E+00	1.74E+06	1.01E+05

Table 3-10a

ADULT INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	3.42E+03	1.58E+03	4.67E+02	1.05E+03	1.24E+04	3.14E+05	7.06E+04
Te-127m	1.26E+04	5.77E+03	1.57E+03	3.29E+03	4.58E+04	9.60E+05	1.50E+05
Te-127	1.40E+00	6.42E-01	3.10E-01	1.06E+00	5.10E+00	6.51E+03	5.74E+04
Te-129m	9.76E+03	4.67E+03	1.58E+03	3.44E+03	3.66E+04	1.16E+06	3.83E+05
Te-129	4.98E-02	2.39E-02	1.24E-02	3.90E-02	1.87E-01	1.94E+03	1.57E+02
Te-131m	6.99E+01	4.36E+01	2.90E+01	5.50E+01	3.09E+02	1.46E+05	5.56E+05
Te-131	1.11E-02	5.95E-03	3.59E-03	9.36E-03	4.37E-02	1.39E+03	1.84E+01
Te-132	2.60E+02	2.15E+02	1.62E+02	1.90E+02	1.46E+03	2.88E+05	5.10E+05
I-130	4.58E+03	1.34E+04	5.28E+03	1.14E+06	2.09E+04	0.00E+00	7.69E+03
I-131	2.52E+04	3.58E+04	2.05E+04	1.19E+07	6.13E+04	0.00E+00	6.28E+03
I-132	1.16E+03	3.26E+03	1.16E+03	1.14E+05	5.18E+03	0.00E+00	4.06E+02
I-133	8.64E+03	1.48E+04	4.52E+03	2.15E+06	2.58E+04	0.00E+00	8.88E+03
I-134	6.44E+02	1.73E+03	6.15E+02	2.98E+04	2.75E+03	0.00E+00	1.01E+00
I-135	2.68E+03	6.98E+03	2.57E+03	4.48E+05	1.11E+04	0.00E+00	5.25E+03
Cs-134	3.73E+05	8.48E+05	7.28E+05	0.00E+00	2.87E+05	9.76E+04	1.04E+04
Cs-136	3.90E+04	1.46E+05	1.10E+05	0.00E+00	8.56E+04	1.20E+04	1.17E+04
Cs-137	4.78E+05	6.21E+05	4.28E+05	0.00E+00	2.22E+05	7.52E+04	8.40E+03
Cs-138	3.31E+02	6.21E+02	3.24E+02	0.00E+00	4.80E+02	4.86E+01	1.86E-03
Ba-139	9.36E-01	6.66E-04	2.74E-02	0.00E+00	6.22E-04	3.76E+03	8.96E+02
Ba-140	3.90E+04	4.90E+01	2.57E+03	0.00E+00	1.67E+01	1.27E+06	2.18E+05
Ba-141	1.00E-01	7.53E-05	3.36E-03	0.00E+00	7.00E-05	1.94E+03	1.16E-07
Ba-142	2.63E-02	2.70E-05	1.66E-03	0.00E+00	2.29E-05	1.19E+03	1.57E-16
La-140	3.44E+02	1.74E+02	4.58E+01	0.00E+00	0.00E+00	1.36E+05	4.58E+05
La-142	6.83E-01	3.10E-01	7.72E-02	0.00E+00	0.00E+00	6.33E+03	2.11E+03
Ce-141	1.99E+04	1.35E+04	1.53E+03	0.00E+00	6.26E+03	3.62E+05	1.20E+05
Ce-143	1.86E+02	1.38E+02	1.53E+01	0.00E+00	6.08E+01	7.98E+04	2.26E+05
Ce-144	3.43E+06	1.43E+06	1.84E+05	0.00E+00	8.48E+05	7.78E+06	8.16E+05
Pr-143	9.36E+03	3.75E+03	4.64E+02	0.00E+00	2.16E+03	2.81E+05	2.00E+05
Pr-144	3.01E-02	1.25E-02	1.53E-03	0.00E+00	7.05E-03	1.02E+03	2.15E-08
Nd-147	5.27E+03	6.10E+03	3.65E+02	0.00E+00	3.56E+03	2.21E+05	1.73E+05
W-187	8.48E+00	7.08E+00	2.48E+00	0.00E+00	0.00E+00	2.90E+04	1.55E+05
Np-239	2.30E+02	2.26E+01	1.24E+01	0.00E+00	7.00E+01	3.76E+04	1.19E+05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	6.92E+02	6.71E+02	0.00E+00	0.00E+00	3.70E+05	3.14E+04
Sr-85	3.20E+04	0.00E+00	7.76E+05	0.00E+00	0.00E+00	4.80E+05	6.08E+04
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.22E-01	5.62E-02	2.05E-02	0.00E+00	6.54E-02	2.40E+03	2.42E+02
Cd-109	0.00E+00	3.92E+05	1.28E+04	0.00E+00	3.76E+05	7.28E+05	6.56E+04
Sn-113	6.56E+04	2.16E+03	4.48E+03	1.36E+03	0.00E+00	9.60E+05	1.20E+04
Ba-133	7.60E+04	3.36E+03	2.00E+04	0.00E+00	1.68E+01	1.52E+06	8.00E+04
Te-134	3.07E-02	2.58E-02	1.26E-02	2.75E-02	1.74E-01	3.47E+03	2.38E-01
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-10b

TEEN INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04	1.38E+04
P-32	1.89E+06	1.10E+05	7.16E+04	0.00E+00	0.00E+00	0.00E+00	9.28E+04
Cr-51	0.00E+00	0.00E+00	1.35E+02	7.50E+01	3.07E+01	2.10E+04	3.00E+03
Mn-54	0.00E+00	5.11E+04	8.40E+03	0.00E+00	1.27E+04	1.98E+06	6.68E+04
Mn-56	0.00E+00	1.70E+00	2.52E-01	0.00E+00	1.79E+00	1.52E+04	5.74E+04
Fe-55	3.34E+04	2.38E+04	5.54E+03	0.00E+00	0.00E+00	1.24E+05	6.39E+03
Fe-59	1.59E+04	3.70E+04	1.43E+04	0.00E+00	0.00E+00	1.53E+06	1.78E+05
Co-58	0.00E+00	2.07E+03	2.78E+03	0.00E+00	0.00E+00	1.34E+06	9.52E+04
Co-60	0.00E+00	1.51E+04	1.98E+04	0.00E+00	0.00E+00	8.72E+06	2.59E+05
Ni-63	5.80E+05	4.34E+04	1.98E+04	0.00E+00	0.00E+00	3.07E+05	1.42E+04
Ni-65	2.18E+00	2.93E-01	1.27E-01	0.00E+00	0.00E+00	9.36E+03	3.67E+04
Cu-64	0.00E+00	2.03E+00	8.48E-01	0.00E+00	6.41E+00	1.11E+04	6.14E+04
Zn-65	3.86E+04	1.34E+05	6.24E+04	0.00E+00	8.64E+04	1.24E+06	4.66E+04
Zn-69	4.83E-02	9.20E-02	6.46E-03	0.00E+00	6.02E-02	1.58E+03	2.85E+02
Br-83	0.00E+00	0.00E+00	3.44E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.33E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	1.83E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.90E+05	8.40E+04	0.00E+00	0.00E+00	0.00E+00	1.77E+04
Rb-88	0.00E+00	5.46E+02	2.72E+02	0.00E+00	0.00E+00	0.00E+00	2.92E-05
Rb-89	0.00E+00	3.52E+02	2.33E+02	0.00E+00	0.00E+00	0.00E+00	3.38E-07
Sr-89	4.34E+05	0.00E+00	1.25E+04	0.00E+00	0.00E+00	2.42E+06	3.71E+05
Sr-90	1.08E+08	0.00E+00	6.68E+06	0.00E+00	0.00E+00	1.65E+07	7.65E+05
Sr-91	8.80E+01	0.00E+00	3.51E+00	0.00E+00	0.00E+00	6.07E+04	2.59E+05
Sr-92	9.52E+00	0.00E+00	4.06E-01	0.00E+00	0.00E+00	2.74E+04	1.19E+05
Y-90	2.98E+03	0.00E+00	8.00E+01	0.00E+00	0.00E+00	2.93E+05	5.59E+05
Y-91m	3.70E-01	0.00E+00	1.42E-02	0.00E+00	0.00E+00	3.20E+03	3.02E+01
Y-91	6.61E+05	0.00E+00	1.77E+04	0.00E+00	0.00E+00	2.94E+06	4.09E+05
Y-92	1.47E+01	0.00E+00	4.29E-01	0.00E+00	0.00E+00	2.68E+04	1.65E+05
Y-93	1.35E+02	0.00E+00	3.72E+00	0.00E+00	0.00E+00	8.32E+04	5.79E+05
Zr-95	1.46E+05	4.58E+04	3.15E+04	0.00E+00	6.74E+04	2.69E+06	1.49E+05
Zr-97	1.38E+02	2.72E+01	1.26E+01	0.00E+00	4.12E+01	1.30E+05	6.30E+05
Nb-95	1.86E+04	1.03E+04	5.66E+03	0.00E+00	1.00E+04	7.51E+05	9.68E+04
Mo-99	0.00E+00	1.69E+02	3.22E+01	0.00E+00	4.11E+02	1.54E+05	2.69E+05
Tc-99m	1.38E-03	3.86E-03	4.99E-02	0.00E+00	5.76E-02	1.15E+03	6.13E+03
Tc-101	5.92E-05	8.40E-05	8.24E-04	0.00E+00	1.52E-03	6.67E+02	8.72E-07
Ru-103	2.10E+03	0.00E+00	8.96E+02	0.00E+00	7.43E+03	7.83E+05	1.09E+05
Ru-105	1.12E+00	0.00E+00	4.34E-01	0.00E+00	1.41E+00	1.82E+04	9.04E+04
Ru-106	9.84E+04	0.00E+00	1.24E+04	0.00E+00	1.90E+05	1.61E+07	9.60E+05
Ag-110m	1.38E+04	1.31E+04	7.99E+03	0.00E+00	2.50E+04	6.75E+06	2.73E+05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	4.30E+04	7.94E+02	1.68E+04	9.76E+01	0.00E+00	3.85E+06	3.98E+05
Sb-125	7.38E+04	8.08E+02	1.72E+04	7.04E+01	0.00E+00	2.74E+06	9.92E+04

Table 3-10b

TEEN INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	4.88E+03	2.24E+03	6.67E+02	1.40E+03	0.00E+00	5.36E+05	7.50E+04
Te-127m	1.80E+04	8.16E+03	2.18E+03	4.38E+03	6.54E+04	1.66E+06	1.59E+05
Te-127	2.01E+00	9.12E-01	4.42E-01	1.42E+00	7.28E+00	1.12E+04	8.08E+04
Te-129m	1.39E+04	6.58E+03	2.25E+03	4.58E+03	5.19E+04	1.98E+06	4.05E+05
Te-129	7.10E-02	3.38E-02	1.76E-02	5.18E-02	2.66E-01	3.30E+03	1.62E+03
Te-131m	9.84E+01	6.01E+01	4.02E+01	7.25E+01	4.39E+02	2.38E+05	6.21E+05
Te-131	1.58E-02	8.32E-03	5.04E-03	1.24E-02	6.18E-02	2.34E+03	1.51E+01
Te-132	3.60E+02	2.90E+02	2.19E+02	2.46E+02	1.95E+03	4.49E+05	4.63E+05
I-130	6.24E+03	1.79E+04	7.17E+03	1.49E+06	2.75E+04	0.00E+00	9.12E+03
I-131	3.54E+04	4.91E+04	2.64E+04	1.46E+07	8.40E+04	0.00E+00	6.49E+03
I-132	1.59E+03	4.38E+03	1.58E+03	1.51E+05	6.92E+03	0.00E+00	1.27E+03
I-133	1.22E+04	2.05E+04	6.22E+03	2.92E+06	3.59E+04	0.00E+00	1.03E+04
I-134	8.88E+02	2.32E+03	8.40E+02	3.95E+04	3.66E+03	0.00E+00	2.04E+01
I-135	3.70E+03	9.44E+03	3.49E+03	6.21E+05	1.49E+04	0.00E+00	6.95E+03
Cs-134	5.02E+05	1.13E+06	5.49E+05	0.00E+00	3.75E+05	1.46E+05	9.76E+03
Cs-136	5.15E+04	1.94E+05	1.37E+05	0.00E+00	1.10E+05	1.78E+04	1.09E+04
Cs-137	6.70E+05	8.48E+05	3.11E+05	0.00E+00	3.04E+05	1.21E+05	8.48E+03
Cs-138	4.66E+02	8.56E+02	4.46E+02	0.00E+00	6.62E+02	7.87E+01	2.70E-01
Ba-139	1.34E+00	9.44E-04	3.90E-02	0.00E+00	8.88E-04	6.46E+03	6.45E+03
Ba-140	5.47E+04	6.70E+01	3.52E+03	0.00E+00	2.28E+01	2.03E+06	2.29E+05
Ba-141	1.42E-01	1.06E-04	4.74E-03	0.00E+00	9.84E-05	3.29E+03	7.46E-04
Ba-142	3.70E-02	3.70E-05	2.27E-03	0.00E+00	3.14E-05	1.91E+03	4.79E-10
La-140	4.79E+02	2.36E+02	6.26E+01	0.00E+00	0.00E+00	2.14E+05	4.87E+05
La-142	9.60E-01	4.25E-01	1.06E-01	0.00E+00	0.00E+00	1.02E+04	1.20E+04
Ce-141	2.84E+04	1.90E+04	2.17E+03	0.00E+00	8.88E+03	6.14E+05	1.26E+05
Ce-143	2.66E+02	1.94E+02	2.16E+01	0.00E+00	8.64E+01	1.30E+05	2.55E+05
Ce-144	4.89E+06	2.02E+06	2.62E+05	0.00E+00	1.21E+06	1.34E+07	8.64E+05
Pr-143	1.34E+04	5.31E+03	6.62E+02	0.00E+00	3.09E+03	4.83E+05	2.14E+05
Pr-144	4.30E-02	1.76E-02	2.18E-03	0.00E+00	1.01E-02	1.75E+03	2.35E-04
Nd-147	7.86E+03	8.56E+03	5.13E+02	0.00E+00	5.02E+03	3.72E+05	1.82E+05
W-187	1.20E+01	9.76E+00	3.43E+00	0.00E+00	0.00E+00	4.74E+04	1.77E+05
Np-239	3.38E+02	3.19E+01	1.77E+01	0.00E+00	1.00E+02	6.49E+04	1.32E+05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	9.44E+02	9.20E+02	0.00E+00	0.00E+00	5.86E+05	3.14E+04
Sr-85	4.00E+04	0.00E+00	1.04E+04	0.00E+00	0.00E+00	7.04E+05	5.52E+04
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	3.14E-01	7.78E-02	2.84E-02	0.00E+00	9.12E-02	3.93E+03	2.17E+03
Cd-109	0.00E+00	8.00E+05	2.72E+04	0.00E+00	5.36E+05	1.28E+06	6.88E+04
Sn-113	1.20E+05	3.76E+03	7.76E+03	2.32E+03	0.00E+00	1.60E+06	1.20E+04
Ba-133	3.76E+05	6.40E+03	2.64E+04	0.00E+00	2.24E+01	2.32E+06	7.76E+04
Te-134	4.25E-02	3.48E-02	2.91E-02	3.57E-02	2.33E-01	5.40E+03	1.10E+01
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-10c

CHILD INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04
P-32	2.60E+06	1.14E+05	9.88E+04	0.00E+00	0.00E+00	0.00E+00	4.22E+04
Cr-51	0.00E+00	0.00E+00	1.54E+02	8.55E+01	2.43E+01	1.70E+04	1.08E+03
Mn-54	0.00E+00	4.29E+04	9.51E+03	0.00E+00	1.00E+04	1.58E+06	2.29E+04
Mn-56	0.00E+00	1.66E+00	3.12E-01	0.00E+00	1.67E+00	1.31E+04	1.23E+05
Fe-55	4.74E+04	2.52E+04	7.77E+03	0.00E+00	0.00E+00	1.11E+05	2.87E+03
Fe-59	2.07E+04	3.34E+04	1.67E+04	0.00E+00	0.00E+00	1.27E+06	7.07E+04
Co-58	0.00E+00	1.77E+03	3.16E+03	0.00E+00	0.00E+00	1.11E+06	3.44E+04
Co-60	0.00E+00	1.31E+04	2.26E+04	0.00E+00	0.00E+00	7.07E+06	9.62E+04
Ni-63	8.21E+05	4.63E+04	2.80E+04	0.00E+00	0.00E+00	2.75E+05	6.33E+03
Ni-65	2.99E+00	2.96E-01	1.64E-01	0.00E+00	0.00E+00	8.18E+03	8.40E+04
Cu-64	0.00E+00	1.99E+00	1.07E+00	0.00E+00	6.03E+00	9.58E+03	3.67E+04
Zn-65	4.26E+04	1.13E+05	7.03E+04	0.00E+00	7.14E+04	9.95E+05	1.63E+04
Zn-69	6.70E-02	9.66E-02	8.92E-03	0.00E+00	5.85E-02	1.42E+03	1.02E+04
Br-83	0.00E+00	0.00E+00	4.74E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	5.48E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.53E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.98E+05	1.14E+05	0.00E+00	0.00E+00	0.00E+00	7.99E+03
Rb-88	0.00E+00	5.62E+02	3.66E+02	0.00E+00	0.00E+00	0.00E+00	1.72E+01
Rb-89	0.00E+00	3.45E+02	2.90E+02	0.00E+00	0.00E+00	0.00E+00	1.89E+00
Sr-89	5.99E+05	0.00E+00	1.72E+04	0.00E+00	0.00E+00	2.16E+06	1.67E+05
Sr-90	1.01E+08	0.00E+00	6.44E+06	0.00E+00	0.00E+00	1.48E+07	3.43E+05
Sr-91	1.21E+02	0.00E+00	4.59E+00	0.00E+00	0.00E+00	5.33E+04	1.74E+05
Sr-92	1.31E+01	0.00E+00	5.25E-01	0.00E+00	0.00E+00	2.40E+04	2.42E+05
Y-90	4.11E+03	0.00E+00	1.11E+02	0.00E+00	0.00E+00	2.62E+05	2.68E+05
Y-91m	5.07E-01	0.00E+00	1.84E-02	0.00E+00	0.00E+00	2.81E+03	1.72E+03
Y-91	9.14E+05	0.00E+00	2.44E+04	0.00E+00	0.00E+00	2.63E+06	1.84E+05
Y-92	2.04E+01	0.00E+00	5.81E-01	0.00E+00	0.00E+00	2.39E+04	2.39E+05
Y-93	1.86E+02	0.00E+00	5.11E+00	0.00E+00	0.00E+00	7.44E+04	3.89E+05
Zr-95	1.90E+05	4.18E+04	3.70E+04	0.00E+00	5.96E+04	2.23E+06	6.11E+04
Zr-97	1.88E+02	2.72E+01	1.60E+01	0.00E+00	3.88E+01	1.13E+05	3.51E+05
Nb-95	2.35E+04	9.18E+03	6.55E+03	0.00E+00	8.62E+03	6.14E+05	3.70E+04
Mo-99	0.00E+00	1.72E+02	4.25E+01	0.00E+00	3.92E+02	1.35E+05	1.27E+05
Tc-99m	1.78E-03	3.48E-03	5.77E-02	0.00E+00	5.07E-02	9.51E+02	4.81E+03
Tc-101	8.10E-05	8.51E-05	1.08E-03	0.00E+00	1.45E-03	5.85E+02	1.63E+01
Ru-103	2.79E+03	0.00E+00	1.07E+03	0.00E+00	7.03E+03	6.62E+05	4.48E+04
Ru-105	1.53E+00	0.00E+00	5.55E-01	0.00E+00	1.34E+00	1.59E+04	9.95E+04
Ru-106	1.36E+05	0.00E+00	1.69E+04	0.00E+00	1.84E+05	1.43E+07	4.29E+05
Ag-110m	1.69E+04	1.14E+04	9.14E+03	0.00E+00	2.12E+04	5.48E+06	1.00E+05
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	5.74E+04	7.40E+02	2.00E+04	1.26E+02	0.00E+00	3.24E+06	1.64E+05
Sb-125	9.84E+04	7.59E+02	2.07E+04	9.10E+01	0.00E+00	2.32E+06	4.03E+04

Table 3-10c

CHILD INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	6.73E+03	2.33E+03	9.14E+02	1.92E+03	0.00E+00	4.77E+05	3.38E+04
Te-127m	2.49E+04	8.55E+03	3.02E+03	6.07E+03	6.36E+04	1.48E+06	7.14E+04
Te-127	2.77E+00	9.51E-01	6.10E-01	1.96E+00	7.07E+00	1.00E+04	5.62E+04
Te-129m	1.92E+04	6.85E+03	3.04E+03	6.33E+03	5.03E+04	1.76E+06	1.82E+05
Te-129	9.77E-02	3.50E-02	2.38E-02	7.14E-02	2.57E-01	2.93E+03	2.55E+04
Te-131m	1.34E+02	5.92E+01	5.07E+01	9.77E+01	4.00E+02	2.06E+05	3.08E+05
Te-131	2.17E-02	8.44E-03	6.59E-03	1.70E-02	5.88E-02	2.05E+03	1.33E+03
Te-132	4.81E+02	2.72E+02	2.63E+02	3.17E+02	1.77E+03	3.77E+05	1.38E+05
I-130	8.18E+03	1.64E+04	8.44E+03	1.85E+06	2.45E+04	0.00E+00	5.11E+03
I-131	4.81E+04	4.81E+04	2.73E+04	1.62E+07	7.88E+04	0.00E+00	2.84E+03
I-132	2.12E+03	4.07E+03	1.88E+03	1.94E+05	6.25E+03	0.00E+00	3.20E+03
I-133	1.66E+04	2.03E+04	7.70E+03	3.85E+06	3.38E+04	0.00E+00	5.48E+03
I-134	1.17E+03	2.16E+03	9.95E+02	5.07E+04	3.30E+03	0.00E+00	9.55E+02
I-135	4.92E+03	8.73E+03	4.14E+03	7.92E+05	1.34E+04	0.00E+00	4.44E+03
Cs-134	6.51E+05	1.01E+06	2.25E+05	0.00E+00	3.30E+05	1.21E+05	3.85E+03
Cs-136	6.51E+04	1.71E+05	1.16E+05	0.00E+00	9.55E+04	1.45E+04	4.18E+03
Cs-137	9.07E+05	8.25E+05	1.28E+05	0.00E+00	2.82E+05	1.04E+05	3.62E+03
Cs-138	6.33E+02	8.40E+02	5.55E+02	0.00E+00	6.22E+02	6.81E+01	2.70E+02
Ba-139	1.84E+00	9.84E-04	5.36E-02	0.00E+00	8.62E-04	5.77E+03	5.77E+04
Ba-140	7.40E+04	6.48E+01	4.33E+03	0.00E+00	2.11E+01	1.74E+06	1.02E+05
Ba-141	1.96E-01	1.09E-04	6.36E-03	0.00E+00	9.47E-05	2.92E+03	2.75E+02
Ba-142	4.99E-02	3.60E-05	2.79E-03	0.00E+00	2.91E-05	1.64E+03	2.74E+00
La-140	6.44E+02	2.25E+02	7.55E+01	0.00E+00	0.00E+00	1.83E+05	2.26E+05
La-142	1.29E+00	4.11E-01	1.29E-01	0.00E+00	0.00E+00	8.70E+03	7.59E+04
Ce-141	3.92E+04	1.95E+04	2.90E+03	0.00E+00	8.55E+03	5.44E+05	5.66E+04
Ce-143	3.66E+02	1.99E+02	2.87E+01	0.00E+00	8.36E+01	1.15E+05	1.27E+05
Ce-144	6.77E+06	2.12E+06	3.61E+05	0.00E+00	1.17E+06	1.20E+07	3.89E+05
Pr-143	1.85E+04	5.55E+03	9.14E+02	0.00E+00	3.00E+03	4.33E+05	9.73E+04
Pr-144	5.96E-02	1.85E-02	3.00E-03	0.00E+00	9.77E-03	1.57E+03	1.97E+02
Nd-147	1.08E+04	8.73E+03	6.81E+02	0.00E+00	4.81E+03	3.28E+05	8.21E+04
W-187	1.63E+01	9.66E+00	4.33E+00	0.00E+00	0.00E+00	4.11E+04	9.10E+04
Np-239	4.66E+02	3.34E+01	2.35E+01	0.00E+00	9.73E+01	5.81E+04	6.40E+04
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	9.03E+02	1.07E+03	0.00E+00	0.00E+00	5.07E+05	1.32E+04
Sr-85	4.44E+04	0.00E+00	1.18E+04	0.00E+00	0.00E+00	5.55E+05	2.04E+04
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	4.29E-01	7.70E-02	3.60E-02	0.00E+00	8.55E-02	3.42E+03	2.78E+04
Cd-109	0.00E+00	7.03E+05	2.96E+04	0.00E+00	6.29E+05	1.11E+06	3.00E+04
Sn-113	1.41E+05	3.29E+03	8.51E+03	2.63E+03	0.00E+00	1.33E+06	4.81E+03
Ba-133	4.07E+05	4.07E+03	3.70E+04	0.00E+00	2.00E+01	1.92E+06	3.07E+04
Te-134	5.66E-02	3.26E-02	3.48E-02	4.59E-02	2.11E-01	4.55E+03	1.80E+03
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-10d

INFANT INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02
Be-7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04	1.06E+04
P-32	2.03E+06	1.12E+05	7.74E+04	0.00E+00	0.00E+00	0.00E+00	1.61E+04
Cr-51	0.00E+00	0.00E+00	8.95E+01	5.75E+01	1.32E+01	1.28E+04	3.57E+02
Mn-54	0.00E+00	2.53E+04	4.98E+03	0.00E+00	4.98E+03	1.00E+06	7.06E+03
Mn-56	0.00E+00	1.54E+00	2.21E-01	0.00E+00	1.10E+00	1.25E+04	7.17E+04
Fe-55	1.97E+04	1.17E+04	3.33E+03	0.00E+00	0.00E+00	8.69E+04	1.09E+03
Fe-59	1.36E+04	2.35E+04	9.48E+03	0.00E+00	0.00E+00	1.02E+06	2.48E+04
Co-58	0.00E+00	1.22E+03	1.82E+03	0.00E+00	0.00E+00	7.77E+05	1.11E+04
Co-60	0.00E+00	8.02E+03	1.18E+04	0.00E+00	0.00E+00	4.51E+06	3.19E+04
Ni-63	3.39E+05	2.04E+04	1.16E+04	0.00E+00	0.00E+00	2.09E+05	2.42E+03
Ni-65	2.39E+00	2.84E-01	1.23E-01	0.00E+00	0.00E+00	8.12E+03	5.01E+04
Cu-64	0.00E+00	1.88E+00	7.74E-01	0.00E+00	3.98E+00	9.30E+03	1.50E+04
Zn-65	1.93E+04	6.26E+04	3.11E+04	0.00E+00	3.25E+04	6.47E+05	5.14E+04
Zn-69	5.39E-02	9.67E-02	7.18E-03	0.00E+00	4.02E-02	1.47E+03	1.32E+04
Br-83	0.00E+00	0.00E+00	3.81E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	4.00E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	2.04E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	1.90E+05	8.82E+04	0.00E+00	0.00E+00	0.00E+00	3.04E+03
Rb-88	0.00E+00	5.57E+02	2.87E+02	0.00E+00	0.00E+00	0.00E+00	3.39E+02
Rb-89	0.00E+00	3.21E+02	2.06E+02	0.00E+00	0.00E+00	0.00E+00	6.82E+01
Sr-89	3.98E+05	0.00E+00	1.14E+04	0.00E+00	0.00E+00	2.03E+06	6.40E+04
Sr-90	4.09E+07	0.00E+00	2.59E+06	0.00E+00	0.00E+00	1.12E+07	1.31E+05
Sr-91	9.56E+01	0.00E+00	3.46E+00	0.00E+00	0.00E+00	5.26E+04	7.34E+04
Sr-92	1.05E+01	0.00E+00	3.91E-01	0.00E+00	0.00E+00	2.38E+04	1.40E+05
Y-90	3.29E+03	0.00E+00	8.82E+01	0.00E+00	0.00E+00	2.69E+05	1.04E+05
Y-91m	4.07E-01	0.00E+00	1.39E-02	0.00E+00	0.00E+00	2.79E+03	2.35E+03
Y-91	5.88E+05	0.00E+00	1.57E+04	0.00E+00	0.00E+00	2.45E+06	7.03E+04
Y-92	1.64E+01	0.00E+00	4.61E-01	0.00E+00	0.00E+00	2.45E+04	1.27E+05
Y-93	1.50E+02	0.00E+00	4.07E+00	0.00E+00	0.00E+00	7.64E+04	1.67E+05
Zr-95	1.15E+05	2.79E+04	2.03E+04	0.00E+00	3.11E+04	1.75E+06	2.17E+04
Zr-97	1.50E+02	2.56E+01	1.17E+01	0.00E+00	2.59E+01	1.10E+05	1.40E+05
Nb-95	1.57E+04	6.43E+03	3.78E+03	0.00E+00	4.72E+03	4.79E+05	1.27E+04
Mo-99	0.00E+00	1.65E+02	3.23E+01	0.00E+00	2.65E+02	1.35E+05	4.87E+04
Tc-99m	1.40E-03	2.88E-03	3.72E-02	0.00E+00	3.11E-02	8.11E+02	2.03E+03
Tc-101	6.51E-05	8.23E-05	8.12E-04	0.00E+00	9.79E-04	5.84E+02	8.44E+02
Ru-103	2.02E+03	0.00E+00	6.79E+02	0.00E+00	4.24E+03	5.52E+05	1.61E+04
Ru-105	1.22E+00	0.00E+00	4.10E-01	0.00E+00	8.99E-01	1.57E+04	4.84E+04
Ru-106	8.68E+04	0.00E+00	1.09E+04	0.00E+00	1.07E+05	1.16E+07	1.64E+05
Ag-110m	9.98E+03	7.22E+03	5.00E+03	0.00E+00	1.09E+04	3.67E+06	3.30E+04
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-124	3.79E+04	5.56E+02	1.20E+04	1.01E+02	0.00E+00	2.65E+06	5.91E+04
Sb-125	5.17E+04	4.77E+02	1.09E+04	6.23E+01	0.00E+00	1.64E+06	1.47E+04

Table 3-10d

INFANT INHALATION Ri(I) (mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	4.76E+03	1.99E+03	6.58E+02	1.62E+03	0.00E+00	4.47E+05	1.29E+04
Te-127m	1.67E+04	6.90E+03	2.07E+03	4.87E+03	3.75E+04	1.31E+06	2.73E+04
Te-127	2.23E+04	9.53E-01	4.89E-01	1.85E+00	4.86E+00	1.03E+04	2.44E+04
Te-129m	1.41E+04	6.09E+03	2.23E+03	5.47E+03	3.18E+04	1.68E+06	6.90E+04
Te-129	7.88E-02	3.47E-02	1.88E-02	6.75E-02	1.75E-01	3.00E+03	2.63E+04
Te-131m	1.07E+02	5.50E+01	3.63E+01	8.93E+01	2.65E+02	1.99E+05	1.19E+05
Te-131	1.74E-02	8.22E-03	5.00E-03	1.58E-02	3.99E-02	2.06E+03	8.22E+03
Te-132	3.72E+02	2.37E+02	1.76E+02	2.79E+02	1.03E+03	3.40E+05	4.41E+04
I-130	6.36E+03	1.39E+04	5.57E+03	1.60E+06	1.53E+04	0.00E+00	1.99E+03
I-131	3.79E+04	4.44E+04	1.96E+04	1.48E+07	5.18E+04	0.00E+00	1.06E+03
I-132	1.69E+03	3.54E+03	1.26E+03	1.69E+05	3.95E+03	0.00E+00	1.90E+03
I-133	1.32E+04	1.92E+04	5.60E+03	3.56E+06	2.24E+04	0.00E+00	2.16E+03
I-134	9.21E+02	1.88E+03	6.65E+02	4.45E+04	2.09E+03	0.00E+00	1.29E+03
I-135	3.86E+03	7.60E+03	2.77E+03	6.96E+05	8.47E+03	0.00E+00	1.83E+03
Cs-134	3.96E+05	7.03E+05	7.45E+04	0.00E+00	1.90E+05	7.97E+04	1.33E+03
Cs-136	4.83E+04	1.35E+05	5.29E+04	0.00E+00	5.64E+04	1.18E+04	1.43E+03
Cs-137	5.49E+05	6.12E+05	4.55E+04	0.00E+00	1.72E+05	7.13E+04	1.33E+03
Cs-138	5.05E+02	7.81E+02	3.98E+02	0.00E+00	4.10E+02	6.54E+01	8.76E+02
Ba-139	1.48E+00	9.84E-04	4.30E-02	0.00E+00	5.92E-04	5.95E+03	5.10E+04
Ba-140	5.60E+04	5.60E+01	2.90E+03	0.00E+00	1.34E+01	1.60E+06	3.84E+04
Ba-141	1.57E-01	1.08E-04	4.97E-03	0.00E+00	6.50E-05	2.97E+03	4.75E+03
Ba-142	3.98E-02	3.30E-05	1.96E-03	0.00E+00	1.90E-05	1.55E+03	6.93E+02
La-140	5.05E+02	2.00E+02	5.15E+01	0.00E+00	0.00E+00	1.68E+05	8.48E+04
La-142	1.03E+00	3.77E-01	9.04E-02	0.00E+00	0.00E+00	8.22E+03	5.95E+04
Ce-141	2.77E+04	1.67E+04	1.99E+03	0.00E+00	5.25E+03	5.17E+05	2.16E+04
Ce-143	2.93E+02	1.93E+02	2.21E+01	0.00E+00	5.64E+01	1.16E+05	4.97E+04
Ce-144	3.19E+06	1.21E+06	1.76E+05	0.00E+00	5.38E+05	9.84E+06	1.48E+05
Pr-143	1.40E+04	5.24E+03	6.99E+02	0.00E+00	1.97E+03	4.33E+05	3.72E+04
Pr-144	4.79E-02	1.85E-02	2.41E-03	0.00E+00	6.72E-03	1.61E+03	4.28E+03
Nd-147	7.94E+03	8.13E+03	5.00E+02	0.00E+00	3.15E+03	3.22E+05	3.12E+04
W-187	1.30E+01	9.02E+00	3.12E+00	0.00E+00	0.00E+00	3.96E+04	3.56E+04
Np-239	3.71E+02	3.32E+01	1.88E+01	0.00E+00	6.62E+01	5.95E+04	2.49E+04
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	6.51E+02	6.41E+02	0.00E+00	0.00E+00	3.79E+05	4.86E+03
Sr-85	3.78E+04	0.00E+00	7.56E+03	0.00E+00	0.00E+00	4.20E+05	6.72E+03
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	3.42E-01	7.29E-02	2.63E-02	0.00E+00	5.70E-02	3.32E+03	2.69E+04
Cd-109	0.00E+00	3.64E+05	1.40E+04	0.00E+00	2.80E+05	8.68E+05	1.12E+04
Sn-113	8.40E+04	2.24E+03	5.04E+03	1.82E+03	0.00E+00	1.09E+06	1.68E+03
Ba-133	2.66E+05	2.38E+03	1.82E+04	0.00E+00	1.25E+01	1.27E+06	1.08E+04
Te-134	4.45E-02	2.86E-02	2.35E-02	4.07E-02	1.34E-01	4.10E+03	3.54E+03
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-11a

ADULT INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03
Be-7	9.36E+04	2.11E+05	1.05E+05	0.00E+00	2.22E+05	0.00E+00	3.65E+07
Na-24	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05	2.69E+05
P-32	1.40E+09	8.73E+07	5.43E+07	0.00E+00	0.00E+00	0.00E+00	1.58E+08
Cr-51	0.00E+00	0.00E+00	4.64E+04	2.78E+04	1.02E+04	6.16E+04	1.17E+07
Mn-54	0.00E+00	3.13E+08	5.97E+07	0.00E+00	9.31E+07	0.00E+00	9.58E+08
Mn-56	0.00E+00	1.59E+01	2.82E+00	0.00E+00	2.02E+01	0.00E+00	5.07E+02
Fe-55	2.10E+08	1.45E+08	3.38E+07	0.00E+00	0.00E+00	8.08E+07	8.31E+07
Fe-59	1.26E+08	2.96E+08	1.13E+08	0.00E+00	0.00E+00	8.27E+07	9.86E+08
Co-58	0.00E+00	3.07E+07	6.89E+07	0.00E+00	0.00E+00	0.00E+00	6.23E+08
Co-60	0.00E+00	1.67E+08	3.69E+08	0.00E+00	0.00E+00	0.00E+00	3.14E+09
Ni-63	1.04E+10	7.21E+08	3.49E+08	0.00E+00	0.00E+00	0.00E+00	1.50E+08
Ni-65	6.15E+01	7.99E+00	3.64E+00	0.00E+00	0.00E+00	0.00E+00	2.03E+02
Cu-64	0.00E+00	9.20E+03	4.32E+03	0.00E+00	2.32E+04	0.00E+00	7.84E+05
Zn-65	3.17E+08	1.01E+09	4.56E+08	0.00E+00	6.75E+08	0.00E+00	6.36E+08
Zn-69	8.73E-06	1.67E-05	1.16E-06	0.00E+00	1.09E-05	0.00E+00	2.51E-06
Br-83	0.00E+00	0.00E+00	3.11E+00	0.00E+00	0.00E+00	0.00E+00	4.47E+00
Br-84	0.00E+00	0.00E+00	2.48E-11	0.00E+00	0.00E+00	0.00E+00	1.94E-16
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.19E+08	1.02E+08	0.00E+00	0.00E+00	0.00E+00	4.33E+07
Rb-88	0.00E+00	3.43E-22	1.82E-22	0.00E+00	0.00E+00	0.00E+00	4.74E-33
Rb-89	0.00E+00	1.39E-26	9.74E-27	0.00E+00	0.00E+00	0.00E+00	8.05E-40
Sr-89	9.96E+09	0.00E+00	2.86E+08	0.00E+00	0.00E+00	0.00E+00	1.60E+09
Sr-90	6.05E+11	0.00E+00	1.48E+11	0.00E+00	0.00E+00	0.00E+00	1.75E+10
Sr-91	3.05E+05	0.00E+00	1.23E+04	0.00E+00	0.00E+00	0.00E+00	1.45E+06
Sr-92	4.27E+02	0.00E+00	1.85E+01	0.00E+00	0.00E+00	0.00E+00	8.45E+03
Y-90	1.33E+04	0.00E+00	3.56E+02	0.00E+00	0.00E+00	0.00E+00	1.41E+08
Y-91m	5.22E-09	0.00E+00	2.02E-10	0.00E+00	0.00E+00	0.00E+00	1.53E-08
Y-91	5.11E+06	0.00E+00	1.37E+05	0.00E+00	0.00E+00	0.00E+00	2.81E+09
Y-92	9.15E-01	0.00E+00	2.68E-02	0.00E+00	0.00E+00	0.00E+00	1.60E+04
Y-93	1.70E+02	0.00E+00	4.68E+00	0.00E+00	0.00E+00	0.00E+00	5.38E+06
Zr-95	1.17E+06	3.77E+05	2.55E+05	0.00E+00	5.91E+05	0.00E+00	1.19E+09
Zr-97	3.37E+02	6.81E+01	3.11E+01	0.00E+00	1.03E+02	0.00E+00	2.11E+07
Nb-95	1.43E+05	7.94E+04	4.27E+04	0.00E+00	7.85E+04	0.00E+00	4.82E+08
Mo-99	0.00E+00	6.15E+06	1.17E+06	0.00E+00	1.39E+07	0.00E+00	1.43E+07
Tc-99m	3.10E+00	8.77E+00	1.12E+02	0.00E+00	1.33E+02	4.30E+00	5.19E+03
Tc-101	8.22E-31	1.18E-30	1.16E-29	0.00E+00	2.13E-29	6.05E-31	3.56E-42
Ru-103	4.76E+06	0.00E+00	2.05E+06	0.00E+00	1.82E+07	0.00E+00	5.56E+08
Ru-105	5.39E+01	0.00E+00	2.13E+01	0.00E+00	6.96E+02	0.00E+00	3.29E+04
Ru-106	1.93E+08	0.00E+00	2.44E+07	0.00E+00	3.72E+08	0.00E+00	1.25E+10
Ag-110m	1.05E+07	9.75E+06	5.79E+06	0.00E+00	1.92E+07	0.00E+00	3.98E+09
Sb-122	2.80E+05	6.43E+03	9.65E+04	4.34E+03	0.00E+00	1.68E+05	1.06E+08
Sb-124	1.04E+08	1.96E+06	4.07E+07	2.52E+05	0.00E+00	8.07E+07	2.94E+09
Sb-125	1.37E+08	1.53E+06	3.25E+07	1.39E+05	0.00E+00	1.05E+08	1.50E+09

Table 3-11a

ADULT INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	9.66E+07	3.50E+07	1.29E+07	2.90E+07	3.93E+08	0.00E+00	3.86E+08
Te-127m	3.49E+08	1.25E+08	4.26E+07	8.92E+07	1.42E+09	0.00E+00	1.17E+09
Te-127	5.66E+03	2.03E+03	1.22E+03	4.19E+03	2.31E+04	0.00E+00	4.47E+05
Te-129m	2.51E+08	9.38E+07	3.98E+07	8.63E+07	1.05E+09	0.00E+00	1.27E+09
Te-129	7.62E-04	2.87E-04	1.86E-04	5.85E-04	3.20E-03	0.00E+00	5.75E-04
Te-131m	9.12E+05	4.46E+05	3.72E+05	7.06E+05	4.52E+06	0.00E+00	4.43E+07
Te-131	1.50E-15	6.27E-16	4.74E-16	1.23E-15	6.57E-15	0.00E+00	2.13E-16
Te-132	4.30E+06	2.78E+06	2.61E+06	3.07E+06	2.68E+07	0.00E+00	1.32E+08
I-130	3.92E+05	1.16E+06	4.57E+05	9.81E+07	1.81E+06	0.00E+00	9.96E+05
I-131	8.08E+07	1.16E+08	6.62E+07	3.79E+10	1.98E+08	0.00E+00	3.05E+07
I-132	5.76E+01	1.54E+02	5.39E+01	5.39E+03	2.45E+02	0.00E+00	2.89E+01
I-133	2.09E+06	3.63E+06	1.11E+06	5.33E+08	6.33E+06	0.00E+00	3.26E+06
I-134	9.65E-05	2.62E-04	9.38E-05	4.54E-03	4.17E-04	0.00E+00	2.29E-07
I-135	3.90E+04	1.02E+05	3.77E+04	6.73E+06	1.64E+05	0.00E+00	1.15E+05
Cs-134	4.67E+09	1.11E+10	9.08E+09	0.00E+00	3.59E+09	1.19E+09	1.94E+08
Cs-136	4.24E+07	1.68E+08	1.21E+08	0.00E+00	9.32E+07	1.28E+07	1.90E+07
Cs-137	6.36E+09	8.70E+09	5.70E+09	0.00E+00	2.95E+09	9.81E+08	1.68E+08
Cs-138	3.91E-11	7.73E-11	3.83E-11	0.00E+00	5.68E-11	5.61E-12	3.30E-16
Ba-139	2.68E-02	1.91E-05	7.86E-04	0.00E+00	1.79E-05	1.08E-05	4.76E-02
Ba-140	1.28E+08	1.61E+05	8.38E+06	0.00E+00	5.46E+04	9.20E+04	2.63E+08
Ba-141	1.15E-21	8.70E-25	3.89E-23	0.00E+00	8.09E-25	4.94E-25	5.43E-31
Ba-142	2.46E-39	2.53E-42	1.55E-40	0.00E+00	2.14E-42	1.43E-42	0.00E+00
La-140	1.98E+03	9.98E+02	2.64E+02	0.00E+00	0.00E+00	0.00E+00	7.33E+07
La-142	1.41E-04	6.43E-05	1.60E-05	0.00E+00	0.00E+00	0.00E+00	4.69E-01
Ce-141	1.97E+05	1.33E+05	1.51E+04	0.00E+00	6.19E+04	0.00E+00	5.10E+08
Ce-143	9.98E+02	7.38E+05	8.16E+01	0.00E+00	3.25E+02	0.00E+00	2.76E+07
Ce-144	3.29E+07	1.38E+07	1.77E+06	0.00E+00	8.16E+06	0.00E+00	1.11E+10
Pr-143	6.26E+04	2.51E+04	3.10E+03	0.00E+00	1.45E+04	0.00E+00	2.74E+08
Pr-144	3.09E-26	1.28E-26	1.57E-27	0.00E+00	7.23E-27	0.00E+00	4.44E-33
Nd-147	3.33E+04	3.85E+04	2.31E+03	0.00E+00	2.25E+04	0.00E+00	1.85E+08
W-187	3.82E+04	3.19E+04	1.12E+04	0.00E+00	0.00E+00	0.00E+00	1.05E+07
Np-239	1.43E+03	1.41E+02	7.76E+01	0.00E+00	4.39E+02	0.00E+00	2.89E+07
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.17E+07	1.95E+07	0.00E+00	0.00E+00	0.00E+00	2.97E+08
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.15E-06	5.45E-07	1.99E-07	0.00E+00	6.35E-07	0.00E+00	2.01E-03
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	3.56E-08	2.33E-08	1.43E-08	3.11E-08	2.25E-07	0.00E+00	3.95E-11
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-11b

TEEN INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03
Be-7	1.43E+05	3.20E+05	1.60E+05	0.00E+00	3.39E+05	0.00E+00	3.90E+07
Na-24	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05
P-32	1.61E+09	9.97E+07	6.24E+07	0.00E+00	0.00E+00	0.00E+00	1.35E+08
Cr-51	0.00E+00	0.00E+00	6.17E+04	3.43E+04	1.35E+04	8.81E+04	1.04E+07
Mn-54	0.00E+00	4.54E+08	9.01E+07	0.00E+00	1.36E+08	0.00E+00	9.32E+08
Mn-56	0.00E+00	1.43E+01	2.55E+00	0.00E+00	1.81E+01	0.00E+00	9.44E+02
Fe-55	3.26E+08	2.31E+08	5.39E+07	0.00E+00	0.00E+00	1.47E+08	1.00E+08
Fe-59	1.79E+08	4.18E+08	1.61E+08	0.00E+00	0.00E+00	1.32E+08	9.88E+08
Co-58	0.00E+00	4.36E+07	1.00E+08	0.00E+00	0.00E+00	0.00E+00	6.01E+08
Co-60	0.00E+00	2.49E+08	5.60E+08	0.00E+00	0.00E+00	0.00E+00	3.24E+09
Ni-63	1.61E+10	1.13E+09	5.45E+08	0.00E+00	0.00E+00	0.00E+00	1.81E+08
Ni-65	5.72E+01	7.31E+00	3.33E+00	0.00E+00	0.00E+00	0.00E+00	3.97E+02
Cu-64	0.00E+00	8.34E+03	3.92E+03	0.00E+00	2.11E+04	0.00E+00	6.47E+05
Zn-65	4.24E+08	1.47E+09	6.86E+08	0.00E+00	9.42E+08	0.00E+00	6.23E+08
Zn-69	8.18E-06	1.56E-05	1.09E-06	0.00E+00	1.02E-05	0.00E+00	2.87E-05
Br-83	0.00E+00	0.00E+00	2.91E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	2.25E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.74E+08	1.29E+08	0.00E+00	0.00E+00	0.00E+00	4.05E+07
Rb-88	0.00E+00	3.17E-22	1.69E-22	0.00E+00	0.00E+00	0.00E+00	2.71E-29
Rb-89	0.00E+00	1.25E-26	8.82E-27	0.00E+00	0.00E+00	0.00E+00	1.91E-35
Sr-89	1.51E+10	0.00E+00	4.33E+08	0.00E+00	0.00E+00	0.00E+00	1.80E+09
Sr-90	7.51E+11	0.00E+00	1.85E+11	0.00E+00	0.00E+00	0.00E+00	2.11E+10
Sr-91	2.85E+05	0.00E+00	1.13E+04	0.00E+00	0.00E+00	0.00E+00	1.29E+06
Sr-92	3.97E+02	0.00E+00	1.69E+01	0.00E+00	0.00E+00	0.00E+00	1.01E+04
Y-90	1.24E+04	0.00E+00	3.34E+02	0.00E+00	0.00E+00	0.00E+00	1.02E+08
Y-91m	4.86E-09	0.00E+00	1.86E-10	0.00E+00	0.00E+00	0.00E+00	2.29E-07
Y-91	7.84E+06	0.00E+00	2.10E+05	0.00E+00	0.00E+00	0.00E+00	3.21E+09
Y-92	8.60E-01	0.00E+00	2.49E-02	0.00E+00	0.00E+00	0.00E+00	2.36E+04
Y-93	1.59E+02	0.00E+00	4.36E+00	0.00E+00	0.00E+00	0.00E+00	4.86E+06
Zr-95	1.72E+06	5.43E+05	3.73E+05	0.00E+00	7.98E+05	0.00E+00	1.25E+09
Zr-97	3.12E+02	6.18E+01	2.85E+01	0.00E+00	9.37E+01	0.00E+00	1.67E+07
Nb-95	1.93E+05	1.07E+05	5.89E+04	0.00E+00	1.04E+05	0.00E+00	4.57E+08
Mo-99	0.00E+00	5.65E+06	1.08E+06	0.00E+00	1.29E+07	0.00E+00	1.01E+07
Tc-99m	2.74E+00	7.63E+00	9.89E+01	0.00E+00	1.14E+02	4.24E+00	5.01E+03
Tc-101	7.64E-31	1.09E-30	1.07E-29	0.00E+00	1.97E-29	6.62E-31	1.86E-37
Ru-103	6.81E+06	0.00E+00	2.91E+06	0.00E+00	2.40E+07	0.00E+00	5.69E+08
Ru-105	5.00E+01	0.00E+00	1.94E+01	0.00E+00	6.31E+02	0.00E+00	4.04E+04
Ru-106	3.10E+08	0.00E+00	3.90E+07	0.00E+00	5.97E+08	0.00E+00	1.48E+10
Ag-110m	1.52E+07	1.43E+07	8.72E+06	0.00E+00	2.74E+07	0.00E+00	4.03E+09
Sb-122	3.03E+05	5.89E+03	8.85E+04	3.85E+03	0.00E+00	1.89E+05	6.35E+07
Sb-124	1.54E+08	2.84E+06	6.02E+07	3.50E+05	0.00E+00	1.34E+08	3.11E+09
Sb-125	2.14E+08	2.34E+06	5.00E+07	2.04E+05	0.00E+00	1.86E+08	1.66E+09

Table 3-11b

TEEN INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	1.48E+08	5.34E+07	1.98E+07	4.14E+07	0.00E+00	0.00E+00	4.37E+08
Te-127m	5.51E+08	1.96E+08	6.56E+07	1.31E+08	2.24E+09	0.00E+00	1.37E+09
Te-127	5.34E+03	1.89E+03	1.15E+03	3.68E+03	2.16E+04	0.00E+00	4.12E+05
Te-129m	3.62E+08	1.34E+08	5.73E+07	1.17E+08	1.51E+09	0.00E+00	1.36E+09
Te-129	7.14E-04	2.66E-04	1.74E-04	5.10E-04	3.00E-03	0.00E+00	3.90E-03
Te-131m	8.44E+05	4.05E+05	3.38E+05	6.09E+05	4.22E+06	0.00E+00	3.25E+07
Te-131	1.39E-15	5.75E-16	4.36E-16	1.07E-15	6.10E-15	0.00E+00	1.14E-16
Te-132	3.91E+06	2.47E+06	2.33E+06	2.61E+06	2.37E+07	0.00E+00	7.84E+07
I-130	3.51E+05	1.01E+06	4.05E+05	8.28E+07	1.56E+06	0.00E+00	7.80E+05
I-131	7.69E+07	1.08E+08	5.78E+07	3.14E+10	1.85E+08	0.00E+00	2.13E+07
I-132	5.19E+01	1.36E+02	4.88E+01	4.58E+03	2.14E+02	0.00E+00	5.92E+01
I-133	1.94E+06	3.29E+06	1.00E+06	4.59E+08	5.76E+06	0.00E+00	2.49E+06
I-134	8.73E-05	2.31E-04	8.31E-05	3.85E-03	3.65E-04	0.00E+00	3.05E-06
I-135	3.52E+04	9.07E+04	3.36E+04	5.83E+06	1.43E+05	0.00E+00	1.00E+05
Cs-134	7.10E+09	1.67E+10	7.75E+09	0.00E+00	5.31E+09	2.03E+09	2.08E+08
Cs-136	4.34E+07	1.71E+08	1.15E+08	0.00E+00	9.30E+07	1.47E+07	1.37E+07
Cs-137	1.01E+10	1.35E+10	4.69E+09	0.00E+00	4.59E+09	1.78E+09	1.92E+08
Cs-138	3.61E-11	6.93E-11	3.47E-11	0.00E+00	5.12E-11	5.96E-12	3.15E-14
Ba-139	2.52E-02	1.78E-05	7.35E-04	0.00E+00	1.67E-05	1.22E-05	2.25E-01
Ba-140	1.37E+08	1.68E+05	8.85E+06	0.00E+00	5.70E+04	1.13E+05	2.12E+08
Ba-141	1.08E-21	8.04E-25	3.59E-23	0.00E+00	7.46E-25	5.50E-25	2.29E-27
Ba-142	2.27E-39	2.27E-42	1.40E-40	0.00E+00	1.92E-42	1.51E-42	0.00E+00
La-140	1.81E+03	8.89E+02	2.37E+02	0.00E+00	0.00E+00	0.00E+00	5.11E+07
La-142	1.30E-04	5.76E-05	1.43E-05	0.00E+00	0.00E+00	0.00E+00	1.75E+00
Ce-141	2.83E+05	1.89E+05	2.17E+04	0.00E+00	8.89E+04	0.00E+00	5.40E+08
Ce-143	9.33E+02	6.79E+05	7.58E+01	0.00E+00	3.04E+02	0.00E+00	2.04E+07
Ce-144	5.27E+07	2.18E+07	2.83E+06	0.00E+00	1.30E+07	0.00E+00	1.33E+10
Pr-143	7.00E+04	2.80E+04	3.49E+03	0.00E+00	1.63E+04	0.00E+00	2.30E+08
Pr-144	2.89E-26	1.18E-26	1.47E-27	0.00E+00	6.80E-27	0.00E+00	3.19E-29
Nd-147	3.62E+04	3.94E+04	2.36E+03	0.00E+00	2.31E+04	0.00E+00	1.42E+08
W-187	3.55E+04	2.90E+04	1.02E+04	0.00E+00	0.00E+00	0.00E+00	7.84E+06
Np-239	1.39E+03	1.31E+02	7.28E+01	0.00E+00	4.11E+02	0.00E+00	2.11E+07
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.79E+07	3.00E+07	0.00E+00	0.00E+00	0.00E+00	3.33E+08
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	2.00E-06	4.95E-07	1.81E-07	0.00E+00	5.79E-07	0.00E+00	1.18E-02
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	3.23E-08	2.07E-08	2.17E-08	2.65E-08	1.98E-07	0.00E+00	1.20E-09
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-11c

CHILD INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	4.01E+03	4.01E+03	4.01E+03	4.01E+03	4.01E+03	4.01E+03
Be-7	3.37E+05	5.72E+05	3.77E+05	0.00E+00	5.63E+05	0.00E+00	3.20E+07
Na-24	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05	3.73E+05
P-32	3.37E+09	1.58E+08	1.30E+08	0.00E+00	0.00E+00	0.00E+00	9.31E+07
Cr-51	0.00E+00	0.00E+00	1.17E+05	6.50E+04	1.78E+04	1.19E+05	6.21E+06
Mn-54	0.00E+00	6.65E+08	1.77E+08	0.00E+00	1.86E+08	0.00E+00	5.58E+08
Mn-56	0.00E+00	1.88E+01	4.24E+00	0.00E+00	2.27E+01	0.00E+00	2.72E+03
Fe-55	8.01E+08	4.25E+08	1.32E+08	0.00E+00	0.00E+00	2.40E+08	7.87E+07
Fe-59	3.97E+08	6.42E+08	3.20E+08	0.00E+00	0.00E+00	1.86E+08	6.68E+08
Co-58	0.00E+00	6.44E+07	1.97E+08	0.00E+00	0.00E+00	0.00E+00	3.76E+08
Co-60	0.00E+00	3.78E+08	1.12E+09	0.00E+00	0.00E+00	0.00E+00	2.10E+09
Ni-63	3.95E+10	2.11E+09	1.34E+09	0.00E+00	0.00E+00	0.00E+00	1.42E+08
Ni-65	1.05E+02	9.89E+00	5.77E+00	0.00E+00	0.00E+00	0.00E+00	1.21E+03
Cu-64	0.00E+00	1.10E+04	6.64E+03	0.00E+00	2.66E+04	0.00E+00	5.16E+05
Zn-65	8.12E+08	2.16E+09	1.35E+09	0.00E+00	1.36E+09	0.00E+00	3.80E+08
Zn-69	1.51E-05	2.18E-05	2.02E-06	0.00E+00	1.32E-05	0.00E+00	1.37E-03
Br-83	0.00E+00	0.00E+00	5.37E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	3.82E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.52E+08	2.78E+08	0.00E+00	0.00E+00	0.00E+00	2.91E+07
Rb-88	0.00E+00	4.37E-22	3.04E-22	0.00E+00	0.00E+00	0.00E+00	2.15E-23
Rb-89	0.00E+00	1.64E-26	1.46E-26	0.00E+00	0.00E+00	0.00E+00	1.43E-28
Sr-89	3.59E+10	0.00E+00	1.03E+09	0.00E+00	0.00E+00	0.00E+00	1.39E+09
Sr-90	1.24E+12	0.00E+00	3.15E+11	0.00E+00	0.00E+00	0.00E+00	1.67E+10
Sr-91	5.24E+05	0.00E+00	1.98E+04	0.00E+00	0.00E+00	0.00E+00	1.16E+06
Sr-92	7.28E+02	0.00E+00	2.92E+01	0.00E+00	0.00E+00	0.00E+00	1.38E+04
Y-90	2.30E+04	0.00E+00	6.17E+02	0.00E+00	0.00E+00	0.00E+00	6.56E+07
Y-91m	8.91E-09	0.00E+00	3.24E-10	0.00E+00	0.00E+00	0.00E+00	1.74E-05
Y-91	1.86E+07	0.00E+00	4.99E+05	0.00E+00	0.00E+00	0.00E+00	2.48E+09
Y-92	1.58E+00	0.00E+00	4.53E-02	0.00E+00	0.00E+00	0.00E+00	4.58E+04
Y-93	2.93E+02	0.00E+00	8.04E+00	0.00E+00	0.00E+00	0.00E+00	4.37E+06
Zr-95	3.86E+06	8.48E+05	7.55E+05	0.00E+00	1.21E+06	0.00E+00	8.84E+08
Zr-97	5.70E+02	8.24E+01	4.86E+01	0.00E+00	1.18E+02	0.00E+00	1.25E+07
Nb-95	4.12E+05	1.60E+05	1.15E+05	0.00E+00	1.51E+05	0.00E+00	2.97E+08
Mo-99	0.00E+00	7.71E+06	1.91E+06	0.00E+00	1.65E+07	0.00E+00	6.38E+06
Tc-99m	4.71E+00	9.24E+00	1.53E+02	0.00E+00	1.34E+02	4.69E+00	5.26E+03
Tc-101	1.41E-30	1.47E-30	1.87E-29	0.00E+00	2.51E-29	7.78E-31	4.68E-30
Ru-103	1.53E+07	0.00E+00	5.88E+06	0.00E+00	3.85E+07	0.00E+00	3.96E+08
Ru-105	9.16E+01	0.00E+00	3.32E+01	0.00E+00	8.05E+02	0.00E+00	5.98E+04
Ru-106	7.45E+08	0.00E+00	9.30E+07	0.00E+00	1.01E+09	0.00E+00	1.16E+10
Ag-110m	3.21E+07	2.17E+07	1.73E+07	0.00E+00	4.04E+07	0.00E+00	2.58E+09
Sb-122	5.58E+05	8.24E+03	1.64E+05	7.16E+03	0.00E+00	2.27E+05	4.30E+07
Sb-124	3.52E+08	4.56E+06	1.23E+08	7.73E+05	0.00E+00	1.95E+08	2.20E+09
Sb-125	4.99E+08	3.84E+06	1.05E+08	4.63E+05	0.00E+00	2.78E+08	1.19E+09

Table 3-11c

CHILD INGESTION (Leafy Vegetable) Ri(V)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	3.51E+08	9.50E+07	4.67E+07	9.84E+07	0.00E+00	0.00E+00	3.38E+08
Te-127m	1.32E+09	3.56E+08	1.57E+08	3.16E+08	3.77E+09	0.00E+00	1.07E+09
Te-127	9.85E+03	2.65E+03	2.11E+03	6.81E+03	2.80E+04	0.00E+00	3.85E+05
Te-129m	8.41E+08	2.35E+08	1.31E+08	2.71E+08	2.47E+09	0.00E+00	1.03E+09
Te-129	1.32E-03	3.69E-04	3.14E-04	9.43E-04	3.87E-03	0.00E+00	8.23E-02
Te-131m	1.54E+06	5.33E+05	5.68E+05	1.10E+06	5.16E+06	0.00E+00	2.16E+07
Te-131	2.57E-15	7.83E-16	7.64E-16	1.97E-15	7.77E-15	0.00E+00	1.35E-14
Te-132	7.00E+06	3.10E+06	3.74E+06	4.51E+06	2.88E+07	0.00E+00	3.12E+07
I-130	6.16E+05	1.24E+06	6.41E+05	1.37E+08	1.86E+06	0.00E+00	5.82E+05
I-131	1.43E+08	1.44E+08	8.17E+07	4.75E+10	2.36E+08	0.00E+00	1.28E+07
I-132	9.22E+01	1.69E+02	7.79E+01	7.86E+03	2.59E+02	0.00E+00	1.99E+02
I-133	3.53E+06	4.37E+06	1.65E+06	8.11E+08	7.28E+06	0.00E+00	1.76E+06
I-134	1.55E-04	2.88E-04	1.32E-04	6.62E-03	4.40E-04	0.00E+00	1.91E-04
I-135	6.26E+04	1.13E+05	5.33E+04	9.97E+06	1.73E+05	0.00E+00	8.58E+04
Cs-134	1.60E+10	2.63E+10	5.55E+09	0.00E+00	8.15E+09	2.93E+09	1.42E+08
Cs-136	8.17E+07	2.25E+08	1.45E+08	0.00E+00	1.20E+08	1.78E+07	7.90E+06
Cs-137	2.39E+10	2.29E+10	3.38E+09	0.00E+00	7.46E+09	2.68E+09	1.43E+08
Cs-138	6.57E-11	9.13E-11	5.79E-11	0.00E+00	6.43E-11	6.91E-12	4.21E-11
Ba-139	4.65E-02	2.48E-05	1.35E-03	0.00E+00	2.17E-05	1.46E-05	2.69E+00
Ba-140	2.75E+08	2.41E+05	1.60E+07	0.00E+00	7.84E+04	1.44E+05	1.39E+08
Ba-141	1.99E-21	1.11E-24	6.47E-23	0.00E+00	9.62E-25	6.53E-24	1.13E-21
Ba-142	4.11E-39	2.96E-42	2.29E-40	0.00E+00	2.39E-42	1.74E-42	5.36E-41
La-140	3.25E+03	1.14E+03	3.83E+02	0.00E+00	0.00E+00	0.00E+00	3.17E+07
La-142	2.35E-04	7.49E-05	2.35E-05	0.00E+00	0.00E+00	0.00E+00	1.48E+01
Ce-141	6.56E+05	3.27E+05	4.86E+04	0.00E+00	1.43E+05	0.00E+00	4.08E+08
Ce-143	1.72E+03	9.31E+05	1.35E+02	0.00E+00	3.91E+02	0.00E+00	1.36E+07
Ce-144	1.27E+08	3.98E+07	6.78E+06	0.00E+00	2.21E+07	0.00E+00	1.04E+10
Pr-143	1.46E+05	4.37E+04	7.23E+03	0.00E+00	2.37E+04	0.00E+00	1.57E+08
Pr-144	5.37E-26	1.66E-26	2.70E-27	0.00E+00	8.79E-27	0.00E+00	3.58E-23
Nd-147	7.15E+04	5.79E+04	4.48E+03	0.00E+00	3.18E+04	0.00E+00	9.17E+07
W-187	6.47E+04	3.83E+04	1.72E+04	0.00E+00	0.00E+00	0.00E+00	5.38E+06
Np-239	2.57E+03	1.84E+02	1.29E+02	0.00E+00	5.33E+02	0.00E+00	1.36E+07
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	2.99E+07	6.04E+07	0.00E+00	0.00E+00	0.00E+00	2.45E+08
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	3.64E-06	6.57E-07	3.07E-07	0.00E+00	7.29E-07	0.00E+00	2.03E-01
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	5.76E-08	2.59E-08	3.46E-08	4.56E-08	2.40E-07	0.00E+00	2.63E-07
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-12a

ADULT GRASS/COW/MILK PATHWAY Ri(C)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	7.63E+02	7.63E+02	7.63E+02	7.63E+02	7.63E+02	7.63E+02
Be-7	1.65E+03	3.73E+03	1.85E+03	0.00E+00	3.92E+03	0.00E+00	6.44E+05
Na-24	2.44E+06	2.44E+06	2.44E+06	2.44E+06	2.44E+06	2.44E+06	2.44E+06
P-32	1.71E+10	1.06E+09	6.61E+08	0.00E+00	0.00E+00	0.00E+00	1.92E+09
Cr-51	0.00E+00	0.00E+00	2.86E+04	1.71E+04	6.30E+03	3.79E+04	7.19E+06
Mn-54	0.00E+00	8.41E+06	1.61E+06	0.00E+00	2.50E+06	0.00E+00	2.58E+07
Mn-56	0.00E+00	4.15E-03	7.36E-04	0.00E+00	5.27E-03	0.00E+00	1.32E-01
Fe-55	2.51E+07	1.74E+07	4.05E+06	0.00E+00	0.00E+00	9.68E+06	9.95E+06
Fe-59	2.97E+07	6.98E+07	2.67E+07	0.00E+00	0.00E+00	1.95E+07	2.33E+08
Co-58	0.00E+00	4.71E+06	1.06E+07	0.00E+00	0.00E+00	0.00E+00	9.55E+07
Co-60	0.00E+00	1.64E+07	3.62E+07	0.00E+00	0.00E+00	0.00E+00	3.08E+08
Ni-63	6.73E+09	4.66E+08	2.26E+08	0.00E+00	0.00E+00	0.00E+00	9.73E+07
Ni-65	3.70E-01	4.81E-02	2.19E-02	0.00E+00	0.00E+00	0.00E+00	1.22E+00
Cu-64	0.00E+00	2.38E+04	1.12E+04	0.00E+00	6.01E+04	0.00E+00	2.03E+06
Zn-65	1.37E+09	4.36E+09	1.97E+09	0.00E+00	2.92E+09	0.00E+00	2.75E+09
Zn-69	5.18E-12	9.91E-12	6.89E-13	0.00E+00	6.44E-12	0.00E+00	1.49E-12
Br-83	0.00E+00	0.00E+00	9.72E-02	0.00E+00	0.00E+00	0.00E+00	1.40E-01
Br-84	0.00E+00	0.00E+00	1.61E-23	0.00E+00	0.00E+00	0.00E+00	1.26E-28
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.59E+09	1.21E+09	0.00E+00	0.00E+00	0.00E+00	5.12E+08
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.45E+09	0.00E+00	4.16E+07	0.00E+00	0.00E+00	0.00E+00	2.33E+08
Sr-90	4.68E+10	0.00E+00	1.15E+10	0.00E+00	0.00E+00	0.00E+00	1.35E+09
Sr-91	2.89E+04	0.00E+00	1.17E+03	0.00E+00	0.00E+00	0.00E+00	1.38E+05
Sr-92	4.88E-01	0.00E+00	2.11E-02	0.00E+00	0.00E+00	0.00E+00	9.68E+00
Y-90	7.07E+01	0.00E+00	1.90E+00	0.00E+00	0.00E+00	0.00E+00	7.49E+05
Y-91m	5.98E-20	0.00E+00	2.32E-21	0.00E+00	0.00E+00	0.00E+00	1.76E-19
Y-91	8.59E+03	0.00E+00	2.30E+02	0.00E+00	0.00E+00	0.00E+00	4.73E+06
Y-92	5.58E-05	0.00E+00	1.63E-06	0.00E+00	0.00E+00	0.00E+00	9.77E-01
Y-93	2.23E-01	0.00E+00	6.17E-03	0.00E+00	0.00E+00	0.00E+00	7.08E+03
Zr-95	9.43E+02	3.02E+02	2.05E+02	0.00E+00	4.75E+02	0.00E+00	9.59E+05
Zr-97	4.33E-01	8.74E-02	4.00E-02	0.00E+00	1.32E-01	0.00E+00	2.71E+04
Nb-95	8.26E+04	4.60E+04	2.47E+04	0.00E+00	4.54E+04	0.00E+00	2.79E+08
Mo-99	0.00E+00	2.48E+07	4.71E+06	0.00E+00	5.61E+07	0.00E+00	5.74E+07
Tc-99m	3.32E+00	9.38E+00	1.20E+02	0.00E+00	1.43E+02	4.60E+00	5.55E+03
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.02E+03	0.00E+00	4.38E+02	0.00E+00	3.88E+03	0.00E+00	1.19E+05
Ru-105	8.57E-04	0.00E+00	3.38E-04	0.00E+00	1.11E-02	0.00E+00	5.24E-01
Ru-106	2.04E+04	0.00E+00	2.58E+03	0.00E+00	3.94E+04	0.00E+00	1.32E+06
Ag-110m	5.82E+07	5.39E+07	3.20E+07	0.00E+00	1.06E+08	0.00E+00	2.20E+10
Sb-122	2.24E+05	5.16E+03	7.73E+04	3.47E+03	0.00E+00	1.35E+05	8.52E+07
Sb-124	2.57E+07	4.87E+05	1.01E+07	6.25E+04	0.00E+00	2.00E+07	7.31E+08
Sb-125	2.04E+07	2.28E+05	4.86E+06	2.08E+04	0.00E+00	1.58E+07	2.25E+08

Table 3-12a

ADULT GRASS/COW/MILK PATHWAY Ri(C)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	1.63E+07	5.90E+06	2.18E+06	4.90E+06	6.63E+07	0.00E+00	6.50E+07
Te-127m	4.58E+07	1.64E+07	5.58E+06	1.17E+07	1.86E+08	0.00E+00	1.54E+08
Te-127	6.53E+02	2.34E+02	1.41E+02	4.84E+02	2.66E+03	0.00E+00	5.15E+04
Te-129m	6.02E+07	2.25E+07	9.53E+06	2.07E+07	2.51E+08	0.00E+00	3.03E+08
Te-129	2.82E-10	1.06E-10	6.88E-11	2.17E-10	1.19E-09	0.00E+00	2.13E-10
Te-131m	3.61E+05	1.77E+05	1.47E+05	2.80E+05	1.79E+06	0.00E+00	1.75E+07
Te-131	3.60E-33	1.51E-33	1.14E-33	2.96E-33	1.58E-32	0.00E+00	5.10E-34
Te-132	2.40E+06	1.55E+06	1.46E+06	1.72E+06	1.50E+07	0.00E+00	7.35E+07
I-130	4.20E+05	1.24E+06	4.89E+05	1.05E+08	1.93E+06	0.00E+00	1.07E+06
I-131	2.96E+08	4.23E+08	2.43E+08	1.39E+11	7.26E+08	0.00E+00	1.12E+08
I-132	1.64E-01	4.39E-01	1.54E-01	1.54E+01	7.00E-01	0.00E+00	8.25E-02
I-133	3.87E+06	6.73E+06	2.05E+06	9.89E+08	1.17E+07	0.00E+00	6.05E+06
I-134	2.02E-12	5.48E-12	1.96E-12	9.49E-11	8.71E-12	0.00E+00	4.77E-15
I-135	1.28E+04	3.36E+04	1.24E+04	2.22E+06	5.39E+04	0.00E+00	3.80E+04
Cs-134	5.65E+09	1.35E+10	1.10E+10	0.00E+00	4.35E+09	1.45E+09	2.35E+08
Cs-136	2.63E+08	1.04E+09	7.46E+08	0.00E+00	5.77E+08	7.90E+07	1.18E+08
Cs-137	7.38E+09	1.01E+10	6.61E+09	0.00E+00	3.43E+09	1.14E+09	1.95E+08
Cs-138	9.04E-24	1.79E-23	8.85E-24	0.00E+00	1.31E-23	1.30E-24	7.62E-29
Ba-139	3.92E-08	2.79E-11	1.15E-09	0.00E+00	2.61E-11	1.58E-11	6.94E-08
Ba-140	2.68E+07	3.37E+04	1.76E+06	0.00E+00	1.15E+04	1.93E+04	5.52E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	4.52E+00	2.28E+00	6.02E-01	0.00E+00	0.00E+00	0.00E+00	1.67E+05
La-142	9.34E-12	4.25E-12	1.06E-12	0.00E+00	0.00E+00	0.00E+00	3.10E-08
Ce-141	4.84E+03	3.28E+03	3.72E+02	0.00E+00	1.52E+03	0.00E+00	1.25E+07
Ce-143	4.16E+01	3.07E+04	3.40E+00	0.00E+00	1.35E+01	0.00E+00	1.15E+06
Ce-144	3.58E+05	1.50E+05	1.92E+04	0.00E+00	8.87E+04	0.00E+00	1.21E+08
Pr-143	1.58E+02	6.33E+01	7.83E+00	0.00E+00	3.66E+01	0.00E+00	6.92E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	9.42E+01	1.09E+02	6.51E+00	0.00E+00	6.36E+01	0.00E+00	5.22E+05
W-187	6.56E+03	5.48E+03	1.92E+03	0.00E+00	0.00E+00	0.00E+00	1.80E+06
Np-239	3.68E+00	3.62E-01	2.00E-01	0.00E+00	1.13E+00	0.00E+00	7.43E+04
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	1.28E+06	2.13E+06	0.00E+00	0.00E+00	0.00E+00	3.25E+07
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	3.29E-12	8.32E-13	3.04E-13	0.00E+00	9.71E-13	0.00E+00	3.07E-09
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	8.90E-19	5.83E-19	3.57E-19	7.78E-19	5.63E-18	0.00E+00	9.87E-22
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-12b

TEEN GRASS/COW/MILK PATHWAY Ri(C)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	9.94E+02	9.94E+02	9.94E+02	9.94E+02	9.94E+02	9.94E+02
Be-7	3.05E+03	6.83E+03	3.41E+03	0.00E+00	7.23E+03	0.00E+00	8.31E+05
Na-24	4.26E+06	4.26E+06	4.26E+06	4.26E+06	4.26E+06	4.26E+06	4.26E+06
P-32	3.15E+10	1.95E+09	1.22E+09	0.00E+00	0.00E+00	0.00E+00	2.65E+09
Cr-51	0.00E+00	0.00E+00	4.99E+04	2.77E+04	1.09E+04	7.13E+04	8.39E+06
Mn-54	0.00E+00	1.40E+07	2.78E+06	0.00E+00	4.18E+06	0.00E+00	2.87E+07
Mn-56	0.00E+00	7.36E-03	1.31E-03	0.00E+00	9.31E-03	0.00E+00	4.84E-01
Fe-55	4.45E+07	3.16E+07	7.36E+06	0.00E+00	0.00E+00	2.00E+07	1.37E+07
Fe-59	5.18E+07	1.21E+08	4.67E+07	0.00E+00	0.00E+00	3.81E+07	2.86E+08
Co-58	0.00E+00	7.94E+06	1.83E+07	0.00E+00	0.00E+00	0.00E+00	1.09E+08
Co-60	0.00E+00	2.78E+07	6.26E+07	0.00E+00	0.00E+00	0.00E+00	3.62E+08
Ni-63	1.18E+10	8.35E+08	4.01E+08	0.00E+00	0.00E+00	0.00E+00	1.33E+08
Ni-65	6.77E-01	8.65E-02	3.94E-02	0.00E+00	0.00E+00	0.00E+00	4.69E+00
Cu-64	0.00E+00	4.25E+04	2.00E+04	0.00E+00	1.07E+05	0.00E+00	3.29E+06
Zn-65	2.11E+09	7.31E+09	3.41E+09	0.00E+00	4.68E+09	0.00E+00	3.10E+09
Zn-69	9.55E-12	1.82E-11	1.27E-12	0.00E+00	1.19E-11	0.00E+00	3.35E-11
Br-83	0.00E+00	0.00E+00	1.79E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	2.88E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	4.73E+09	2.22E+09	0.00E+00	0.00E+00	0.00E+00	7.00E+08
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	2.67E+09	0.00E+00	7.66E+07	0.00E+00	0.00E+00	0.00E+00	3.18E+08
Sr-90	6.61E+10	0.00E+00	1.63E+10	0.00E+00	0.00E+00	0.00E+00	1.86E+09
Sr-91	5.31E+04	0.00E+00	2.11E+03	0.00E+00	0.00E+00	0.00E+00	2.41E+05
Sr-92	8.94E-01	0.00E+00	3.81E-02	0.00E+00	0.00E+00	0.00E+00	2.28E+01
Y-90	1.30E+02	0.00E+00	3.50E+00	0.00E+00	0.00E+00	0.00E+00	1.07E+06
Y-91m	1.10E-19	0.00E+00	4.19E-21	0.00E+00	0.00E+00	0.00E+00	5.17E-18
Y-91	1.58E+04	0.00E+00	4.24E+02	0.00E+00	0.00E+00	0.00E+00	6.48E+06
Y-92	1.03E-04	0.00E+00	2.98E-06	0.00E+00	0.00E+00	0.00E+00	2.83E+00
Y-93	4.12E-01	0.00E+00	1.13E-02	0.00E+00	0.00E+00	0.00E+00	1.26E+04
Zr-95	1.65E+03	5.20E+02	3.58E+02	0.00E+00	7.65E+02	0.00E+00	1.20E+06
Zr-97	7.88E-01	1.56E-01	7.19E-02	0.00E+00	2.37E-01	0.00E+00	4.22E+04
Nb-95	1.41E+05	7.82E+04	4.30E+04	0.00E+00	7.58E+04	0.00E+00	3.34E+08
Mo-99	0.00E+00	4.47E+07	8.52E+06	0.00E+00	1.02E+08	0.00E+00	8.01E+07
Tc-99m	5.76E+00	1.61E+01	2.08E+02	0.00E+00	2.39E+02	8.92E+00	1.05E+04
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	1.81E+03	0.00E+00	7.74E+02	0.00E+00	6.38E+03	0.00E+00	1.51E+05
Ru-105	1.56E-03	0.00E+00	6.07E-04	0.00E+00	1.97E-02	0.00E+00	1.26E+00
Ru-106	3.75E+04	0.00E+00	4.73E+03	0.00E+00	7.24E+04	0.00E+00	1.80E+06
Ag-110m	9.63E+07	9.11E+07	5.54E+07	0.00E+00	1.74E+08	0.00E+00	2.56E+10
Sb-122	4.77E+05	9.29E+03	1.39E+05	6.06E+03	0.00E+00	2.98E+05	1.00E+08
Sb-124	4.58E+07	8.44E+05	1.79E+07	1.04E+05	0.00E+00	4.00E+07	9.26E+08
Sb-125	3.65E+07	3.99E+05	8.53E+06	3.48E+04	0.00E+00	3.18E+07	2.83E+08

Table 3-12b

TEEN GRASS/COW/MILK PATHWAY Ri(C)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	3.00E+07	1.08E+07	4.02E+06	8.39E+06	0.00E+00	0.00E+00	8.86E+07
Te-127m	8.44E+07	2.99E+07	1.00E+07	2.01E+07	3.42E+08	0.00E+00	2.10E+08
Te-127	1.21E+03	4.29E+02	2.60E+02	8.35E+02	4.90E+03	0.00E+00	9.34E+04
Te-129m	1.10E+08	4.09E+07	1.74E+07	3.55E+07	4.61E+08	0.00E+00	4.13E+08
Te-129	5.20E-10	1.94E-10	1.26E-10	3.71E-10	2.18E-09	0.00E+00	2.84E-09
Te-131m	6.57E+05	3.15E+05	2.63E+05	4.74E+05	3.29E+06	0.00E+00	2.53E+07
Te-131	6.58E-33	2.71E-33	2.06E-33	5.07E-33	2.88E-32	0.00E+00	5.40E-34
Te-132	4.29E+06	2.72E+06	2.56E+06	2.87E+06	2.61E+07	0.00E+00	8.61E+07
I-130	7.38E+05	2.14E+06	8.53E+05	1.74E+08	3.29E+06	0.00E+00	1.64E+06
I-131	5.37E+08	7.52E+08	4.04E+08	2.19E+11	1.29E+09	0.00E+00	1.49E+08
I-132	2.91E-01	7.62E-01	2.74E-01	2.57E+01	1.20E+00	0.00E+00	3.32E-01
I-133	7.07E+06	1.20E+07	3.66E+06	1.67E+09	2.10E+07	0.00E+00	9.07E+06
I-134	3.58E-12	9.50E-12	3.41E-12	1.58E-10	1.50E-11	0.00E+00	1.25E-13
I-135	2.28E+04	5.87E+04	2.18E+04	3.78E+06	9.27E+04	0.00E+00	6.51E+04
Cs-134	9.82E+09	2.31E+10	1.07E+10	0.00E+00	7.34E+09	2.80E+09	2.87E+08
Cs-136	4.47E+08	1.76E+09	1.18E+09	0.00E+00	9.57E+08	1.51E+08	1.42E+08
Cs-137	1.34E+10	1.78E+10	6.20E+09	0.00E+00	6.06E+09	2.35E+09	2.53E+08
Cs-138	1.64E-23	3.15E-23	1.57E-23	0.00E+00	2.33E-23	2.71E-24	1.43E-26
Ba-139	7.24E-08	5.09E-11	2.11E-09	0.00E+00	4.80E-11	3.51E-11	6.46E-07
Ba-140	4.84E+07	5.93E+04	3.12E+06	0.00E+00	2.01E+04	3.99E+04	7.46E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	8.12E+00	3.99E+00	1.06E+00	0.00E+00	0.00E+00	0.00E+00	2.29E+05
La-142	1.69E-11	7.49E-12	1.86E-12	0.00E+00	0.00E+00	0.00E+00	2.28E-07
Ce-141	8.88E+03	5.93E+03	6.81E+02	0.00E+00	2.79E+03	0.00E+00	1.70E+07
Ce-143	7.64E+01	5.56E+04	6.21E+00	0.00E+00	2.49E+01	0.00E+00	1.67E+06
Ce-144	6.58E+05	2.72E+05	3.54E+04	0.00E+00	1.63E+05	0.00E+00	1.66E+08
Pr-143	2.90E+02	1.16E+02	1.44E+01	0.00E+00	6.73E+01	0.00E+00	9.54E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	1.81E+02	1.97E+02	1.18E+01	0.00E+00	1.16E+02	0.00E+00	7.11E+05
W-187	1.20E+04	9.78E+03	3.43E+03	0.00E+00	0.00E+00	0.00E+00	2.65E+06
Np-239	7.03E+00	6.63E-01	3.68E-01	0.00E+00	2.08E+00	0.00E+00	1.07E+05
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	2.25E+06	3.76E+06	0.00E+00	0.00E+00	0.00E+00	4.19E+07
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	5.99E-12	1.49E-12	5.43E-13	0.00E+00	1.74E-12	0.00E+00	3.55E-08
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	1.59E-18	1.02E-18	1.06E-18	1.30E-18	9.72E-18	0.00E+00	5.89E-20
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-12c

CHILD GRASS/COW/MILK PATHWAY Ri(C)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03
Be-7	7.49E+03	1.27E+04	8.38E+03	0.00E+00	1.25E+04	0.00E+00	7.11E+05
Na-24	8.85E+06	8.85E+06	8.85E+06	8.85E+06	8.85E+06	8.85E+06	8.85E+06
P-32	7.78E+10	3.64E+09	3.00E+09	0.00E+00	0.00E+00	0.00E+00	2.15E+09
Cr-51	0.00E+00	0.00E+00	1.02E+05	5.65E+04	1.54E+04	1.03E+05	5.40E+06
Mn-54	0.00E+00	2.10E+07	5.59E+06	0.00E+00	5.88E+06	0.00E+00	1.76E+07
Mn-56	0.00E+00	1.28E-02	2.90E-03	0.00E+00	1.55E-02	0.00E+00	1.86E+00
Fe-55	1.12E+08	5.93E+07	1.84E+07	0.00E+00	0.00E+00	3.35E+07	1.10E+07
Fe-59	1.20E+08	1.94E+08	9.68E+07	0.00E+00	0.00E+00	5.64E+07	2.02E+08
Co-58	0.00E+00	1.21E+07	3.71E+07	0.00E+00	0.00E+00	0.00E+00	7.07E+07
Co-60	0.00E+00	4.32E+07	1.27E+08	0.00E+00	0.00E+00	0.00E+00	2.39E+08
Ni-63	2.96E+10	1.59E+09	1.01E+09	0.00E+00	0.00E+00	0.00E+00	1.07E+08
Ni-65	1.66E+00	1.56E-01	9.10E-02	0.00E+00	0.00E+00	0.00E+00	1.91E+01
Cu-64	0.00E+00	7.46E+04	4.51E+04	0.00E+00	1.80E+05	0.00E+00	3.50E+06
Zn-65	4.13E+09	1.10E+10	6.85E+09	0.00E+00	6.94E+09	0.00E+00	1.93E+09
Zn-69	2.35E-11	3.39E-11	3.13E-12	0.00E+00	2.06E-11	0.00E+00	2.14E-09
Br-83	0.00E+00	0.00E+00	4.40E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	6.51E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	8.77E+09	5.39E+09	0.00E+00	0.00E+00	0.00E+00	5.64E+08
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	6.62E+09	0.00E+00	1.89E+08	0.00E+00	0.00E+00	0.00E+00	2.56E+08
Sr-90	1.12E+11	0.00E+00	2.83E+10	0.00E+00	0.00E+00	0.00E+00	1.51E+09
Sr-91	1.30E+05	0.00E+00	4.92E+03	0.00E+00	0.00E+00	0.00E+00	2.88E+05
Sr-92	2.18E+00	0.00E+00	8.75E-02	0.00E+00	0.00E+00	0.00E+00	4.13E+01
Y-90	3.21E+02	0.00E+00	8.60E+00	0.00E+00	0.00E+00	0.00E+00	9.15E+05
Y-91m	2.68E-19	0.00E+00	9.74E-21	0.00E+00	0.00E+00	0.00E+00	5.24E-16
Y-91	3.90E+04	0.00E+00	1.04E+03	0.00E+00	0.00E+00	0.00E+00	5.20E+06
Y-92	2.53E-04	0.00E+00	7.24E-06	0.00E+00	0.00E+00	0.00E+00	7.31E+00
Y-93	1.01E+00	0.00E+00	2.78E-02	0.00E+00	0.00E+00	0.00E+00	1.51E+04
Zr-95	3.83E+03	8.42E+02	7.50E+02	0.00E+00	1.21E+03	0.00E+00	8.79E+05
Zr-97	1.92E+00	2.77E-01	1.64E-01	0.00E+00	3.98E-01	0.00E+00	4.20E+04
Nb-95	3.18E+05	1.24E+05	8.85E+04	0.00E+00	1.16E+05	0.00E+00	2.29E+08
Mo-99	0.00E+00	8.13E+07	2.01E+07	0.00E+00	1.74E+08	0.00E+00	6.73E+07
Tc-99m	1.32E+01	2.59E+01	4.29E+02	0.00E+00	3.76E+02	1.32E+01	1.47E+04
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	4.28E+03	0.00E+00	1.65E+03	0.00E+00	1.08E+04	0.00E+00	1.11E+05
Ru-105	3.82E-03	0.00E+00	1.39E-03	0.00E+00	3.36E-02	0.00E+00	2.49E+00
Ru-106	9.24E+04	0.00E+00	1.15E+04	0.00E+00	1.25E+05	0.00E+00	1.44E+06
Ag-110m	2.09E+08	1.41E+08	1.13E+08	0.00E+00	2.63E+08	0.00E+00	1.68E+10
Sb-122	1.17E+06	1.73E+04	3.44E+05	1.50E+04	0.00E+00	4.77E+05	9.02E+07
Sb-124	1.09E+08	1.41E+06	3.80E+07	2.39E+05	0.00E+00	6.02E+07	6.78E+08
Sb-125	8.69E+07	6.70E+05	1.82E+07	8.06E+04	0.00E+00	4.84E+07	2.08E+08

Table 3-12c

CHILD GRASS/COW/MILK PATHWAY Ri(C)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	7.38E+07	2.00E+07	9.84E+06	2.07E+07	0.00E+00	0.00E+00	7.12E+07
Te-127m	2.08E+08	5.60E+07	2.47E+07	4.97E+07	5.93E+08	0.00E+00	1.68E+08
Te-127	2.98E+03	8.02E+02	6.38E+02	2.06E+03	8.47E+03	0.00E+00	1.16E+05
Te-129m	2.71E+08	7.58E+07	4.21E+07	8.75E+07	7.97E+08	0.00E+00	3.31E+08
Te-129	1.28E-09	3.58E-10	3.04E-10	9.15E-10	3.75E-09	0.00E+00	7.98E-08
Te-131m	1.60E+06	5.53E+05	5.89E+05	1.14E+06	5.35E+06	0.00E+00	2.24E+07
Te-131	1.62E-32	4.93E-33	4.81E-33	1.24E-32	4.89E-32	0.00E+00	8.49E-32
Te-132	1.02E+07	4.53E+06	5.48E+06	6.60E+06	4.21E+07	0.00E+00	4.57E+07
I-130	1.73E+06	3.49E+06	1.80E+06	3.84E+08	5.22E+06	0.00E+00	1.63E+06
I-131	1.30E+09	1.31E+09	7.45E+08	4.33E+11	2.15E+09	0.00E+00	1.17E+08
I-132	6.89E-01	1.27E+00	5.82E-01	5.87E+01	1.94E+00	0.00E+00	1.49E+00
I-133	1.72E+07	2.12E+07	8.03E+06	3.94E+09	3.54E+07	0.00E+00	8.56E+06
I-134	8.48E-12	1.58E-11	7.25E-12	3.62E-10	2.41E-11	0.00E+00	1.04E-11
I-135	5.40E+04	9.72E+04	4.60E+04	8.61E+06	1.49E+05	0.00E+00	7.40E+04
Cs-134	2.26E+10	3.72E+10	7.84E+09	0.00E+00	1.15E+10	4.13E+09	2.00E+08
Cs-136	1.01E+09	2.77E+09	1.79E+09	0.00E+00	1.48E+09	2.20E+08	9.74E+07
Cs-137	3.22E+10	3.09E+10	4.55E+09	0.00E+00	1.01E+10	3.62E+09	1.93E+08
Cs-138	3.98E-23	5.53E-23	3.51E-23	0.00E+00	3.89E-23	4.19E-24	2.55E-23
Ba-139	1.78E-07	9.50E-11	5.16E-09	0.00E+00	8.29E-11	5.59E-11	1.03E-05
Ba-140	1.17E+08	1.02E+05	6.82E+06	0.00E+00	3.33E+04	6.10E+04	5.92E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	1.94E+01	6.80E+00	2.29E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+05
La-142	4.07E-11	1.30E-11	4.06E-12	0.00E+00	0.00E+00	0.00E+00	2.57E-06
Ce-141	2.19E+04	1.09E+04	1.62E+03	0.00E+00	4.78E+03	0.00E+00	1.36E+07
Ce-143	1.87E+02	1.02E+05	1.47E+01	0.00E+00	4.26E+01	0.00E+00	1.49E+06
Ce-144	1.62E+06	5.09E+05	8.66E+04	0.00E+00	2.82E+05	0.00E+00	1.33E+08
Pr-143	7.18E+02	2.16E+02	3.56E+01	0.00E+00	1.17E+02	0.00E+00	7.75E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	4.45E+02	3.60E+02	2.79E+01	0.00E+00	1.98E+02	0.00E+00	5.70E+05
W-187	2.91E+04	1.72E+04	7.73E+03	0.00E+00	0.00E+00	0.00E+00	2.42E+06
Np-239	1.73E+01	1.24E+00	8.73E-01	0.00E+00	3.59E+00	0.00E+00	9.19E+04
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	3.84E+06	7.77E+06	0.00E+00	0.00E+00	0.00E+00	3.14E+07
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	1.46E-11	2.63E-12	1.23E-12	0.00E+00	2.92E-12	0.00E+00	8.12E-07
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	3.77E-18	1.70E-18	2.26E-18	2.98E-18	1.57E-17	0.00E+00	1.72E-17
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-12d

INFANT GRASS/COW/MILK PATHWAY Ri(C)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
H-3	0.00E+00	2.38E+03	2.38E+03	2.38E+03	2.38E+03	2.38E+03	2.38E+03
Be-7	1.43E+04	3.00E+04	1.59E+04	0.00E+00	2.12E+04	0.00E+00	7.05E+05
Na-24	1.54E+07	1.54E+07	1.54E+07	1.54E+07	1.54E+07	1.54E+07	1.54E+07
P-32	1.60E+11	9.43E+09	6.21E+09	0.00E+00	0.00E+00	0.00E+00	2.17E+09
Cr-51	0.00E+00	0.00E+00	1.61E+05	1.05E+05	2.30E+04	2.05E+05	4.70E+06
Mn-54	0.00E+00	3.90E+07	8.84E+06	0.00E+00	8.64E+06	0.00E+00	1.43E+07
Mn-56	0.00E+00	3.14E-02	5.42E-03	0.00E+00	2.70E-02	0.00E+00	2.85E+00
Fe-55	1.35E+08	8.73E+07	2.33E+07	0.00E+00	0.00E+00	4.27E+07	1.11E+07
Fe-59	2.24E+08	3.92E+08	1.54E+08	0.00E+00	0.00E+00	1.16E+08	1.87E+08
Co-58	0.00E+00	2.42E+07	6.05E+07	0.00E+00	0.00E+00	0.00E+00	6.04E+07
Co-60	0.00E+00	8.82E+07	2.08E+08	0.00E+00	0.00E+00	0.00E+00	2.10E+08
Ni-63	3.49E+10	2.16E+09	1.21E+09	0.00E+00	0.00E+00	0.00E+00	1.07E+08
Ni-65	3.50E+00	3.97E-01	1.80E-01	0.00E+00	0.00E+00	0.00E+00	3.02E+01
Cu-64	0.00E+00	1.86E+05	8.59E+04	0.00E+00	3.14E+05	0.00E+00	3.81E+06
Zn-65	5.55E+09	1.90E+10	8.78E+09	0.00E+00	9.23E+09	0.00E+00	1.61E+10
Zn-69	5.00E-11	9.00E-11	6.70E-12	0.00E+00	3.74E-11	0.00E+00	7.34E-09
Br-83	0.00E+00	0.00E+00	9.34E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-84	0.00E+00	0.00E+00	1.26E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Br-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	0.00E+00	2.23E+10	1.10E+10	0.00E+00	0.00E+00	0.00E+00	5.69E+08
Rb-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.26E+10	0.00E+00	3.61E+08	0.00E+00	0.00E+00	0.00E+00	2.59E+08
Sr-90	1.22E+11	0.00E+00	3.10E+10	0.00E+00	0.00E+00	0.00E+00	1.52E+09
Sr-91	2.72E+05	0.00E+00	9.83E+03	0.00E+00	0.00E+00	0.00E+00	3.21E+05
Sr-92	4.64E+00	0.00E+00	1.72E-01	0.00E+00	0.00E+00	0.00E+00	5.00E+01
Y-90	6.80E+02	0.00E+00	1.82E+01	0.00E+00	0.00E+00	0.00E+00	9.39E+05
Y-91m	5.67E-19	0.00E+00	1.93E-20	0.00E+00	0.00E+00	0.00E+00	1.89E-15
Y-91	7.33E+04	0.00E+00	1.95E+03	0.00E+00	0.00E+00	0.00E+00	5.25E+06
Y-92	5.38E-04	0.00E+00	1.51E-05	0.00E+00	0.00E+00	0.00E+00	1.03E+01
Y-93	2.16E+00	0.00E+00	5.87E-02	0.00E+00	0.00E+00	0.00E+00	1.70E+04
Zr-95	6.80E+03	1.66E+03	1.18E+03	0.00E+00	1.79E+03	0.00E+00	8.26E+05
Zr-97	4.06E+00	6.97E-01	3.18E-01	0.00E+00	7.03E-01	0.00E+00	4.45E+04
Nb-95	5.94E+05	2.45E+05	1.41E+05	0.00E+00	1.75E+05	0.00E+00	2.06E+08
Mo-99	0.00E+00	2.08E+08	4.05E+07	0.00E+00	3.11E+08	0.00E+00	6.85E+07
Tc-99m	2.75E+01	5.67E+01	7.30E+02	0.00E+00	6.10E+02	2.96E+01	1.65E+04
Tc-101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	8.67E+03	0.00E+00	2.90E+03	0.00E+00	1.80E+04	0.00E+00	1.05E+05
Ru-105	8.05E-03	0.00E+00	2.71E-03	0.00E+00	5.92E-02	0.00E+00	3.20E+00
Ru-106	1.90E+05	0.00E+00	2.38E+04	0.00E+00	2.25E+05	0.00E+00	1.44E+06
Ag-110m	3.86E+08	2.82E+08	1.86E+08	0.00E+00	4.03E+08	0.00E+00	1.46E+10
Sb-122	2.51E+06	4.59E+04	7.31E+05	3.75E+04	0.00E+00	1.30E+06	9.13E+07
Sb-124	2.09E+08	3.08E+06	6.49E+07	5.56E+05	0.00E+00	1.31E+08	6.46E+08
Sb-125	1.50E+08	1.45E+06	3.08E+07	1.87E+05	0.00E+00	9.38E+07	1.99E+08

Table 3-12d

INFANT GRASS/COW/MILK PATHWAY Ri(C)

m^2 * mrem/yr per uCi/sec (H-3: mrem/yr per uCi/m^3)

Isotope	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GILLI
Te-125m	1.51E+08	5.04E+07	2.04E+07	5.07E+07	0.00E+00	0.00E+00	7.18E+07
Te-127m	4.21E+08	1.40E+08	5.10E+07	1.22E+08	1.04E+09	0.00E+00	1.70E+08
Te-127	6.32E+03	2.12E+03	1.36E+03	5.14E+03	1.54E+04	0.00E+00	1.33E+05
Te-129m	5.57E+08	1.91E+08	8.58E+07	2.14E+08	1.39E+09	0.00E+00	3.33E+08
Te-129	2.72E-09	9.37E-10	6.35E-10	2.28E-09	6.77E-09	0.00E+00	2.17E-07
Te-131m	3.38E+06	1.36E+06	1.12E+06	2.75E+06	9.35E+06	0.00E+00	2.29E+07
Te-131	3.43E-32	1.27E-32	9.62E-33	3.06E-32	8.76E-32	0.00E+00	1.38E-30
Te-132	2.11E+07	1.04E+07	9.75E+06	1.54E+07	6.53E+07	0.00E+00	3.87E+07
I-130	3.55E+06	7.81E+06	3.13E+06	8.75E+08	8.58E+06	0.00E+00	1.67E+06
I-131	2.72E+09	3.20E+09	1.41E+09	1.05E+12	3.74E+09	0.00E+00	1.14E+08
I-132	1.43E+00	2.90E+00	1.03E+00	1.36E+02	3.24E+00	0.00E+00	2.35E+00
I-133	3.63E+07	5.28E+07	1.55E+07	9.60E+09	6.21E+07	0.00E+00	8.93E+06
I-134	1.76E-11	3.60E-11	1.28E-11	8.40E-10	4.03E-11	0.00E+00	3.73E-11
I-135	1.12E+05	2.23E+05	8.14E+04	2.00E+07	2.49E+05	0.00E+00	8.08E+04
Cs-134	3.65E+10	6.80E+10	6.87E+09	0.00E+00	1.75E+10	7.18E+09	1.85E+08
Cs-136	1.97E+09	5.79E+09	2.16E+09	0.00E+00	2.31E+09	4.72E+08	8.80E+07
Cs-137	5.15E+10	6.02E+10	4.27E+09	0.00E+00	1.62E+10	6.55E+09	1.88E+08
Cs-138	8.39E-23	1.36E-22	6.61E-23	0.00E+00	6.80E-23	1.06E-23	2.18E-22
Ba-139	3.79E-07	2.51E-10	1.10E-08	0.00E+00	1.51E-10	1.52E-10	2.40E-05
Ba-140	2.40E+08	2.40E+05	1.24E+07	0.00E+00	5.71E+04	1.48E+05	5.91E+07
Ba-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	4.06E+01	1.60E+01	4.12E+00	0.00E+00	0.00E+00	0.00E+00	1.88E+05
La-142	8.55E-11	3.14E-11	7.51E-12	0.00E+00	0.00E+00	0.00E+00	5.33E-06
Ce-141	4.34E+04	2.64E+04	3.11E+03	0.00E+00	8.15E+03	0.00E+00	1.37E+07
Ce-143	3.97E+02	2.63E+05	3.00E+01	0.00E+00	7.67E+01	0.00E+00	1.54E+06
Ce-144	2.33E+06	9.52E+05	1.30E+05	0.00E+00	3.85E+05	0.00E+00	1.33E+08
Pr-143	1.49E+03	5.55E+02	7.36E+01	0.00E+00	2.06E+02	0.00E+00	7.84E+05
Pr-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-147	8.81E+02	9.05E+02	5.55E+01	0.00E+00	3.49E+02	0.00E+00	5.74E+05
W-187	6.12E+04	4.26E+04	1.47E+04	0.00E+00	0.00E+00	0.00E+00	2.50E+06
Np-239	3.66E+01	3.27E+00	1.85E+00	0.00E+00	6.53E+00	0.00E+00	9.46E+04
K-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-57	0.00E+00	8.95E+06	1.46E+07	0.00E+00	0.00E+00	0.00E+00	3.05E+07
Sr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-97	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cd-109	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ce-139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg-203	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-13

Total Body & Skin Ground Plane Dose Factors Ri(G) and Ri(S)

(m^2 * mrem/yr per uCi/sec)

Isotope	Decay Constant (sec^{-1})	Ri(G)	Ri(S)
H-3	1.780E-09	0.00E+00	0.00E+00
Be-7	1.505E-07	0.00E+00	0.00E+00
Na-24	1.284E-05	1.19E+07	1.39E+07
P-32	5.614E-07	0.00E+00	0.00E+00
Cr-51	2.896E-07	4.66E+06	5.51E+06
Mn-54	2.567E-08	1.39E+09	1.62E+09
Mn-56	7.467E-05	9.03E+05	1.07E+06
Fe-55	8.141E-09	0.00E+00	0.00E+00
Fe-59	1.802E-07	2.72E+08	3.20E+08
Co-58	1.133E-07	3.79E+08	4.44E+08
Co-60	4.170E-09	2.15E+10	2.53E+10
Ni-63	2.290E-10	0.00E+00	0.00E+00
Ni-65	7.641E-05	2.97E+05	3.45E+05
Cu-64	1.516E-05	6.07E+05	6.88E+05
Zn-65	3.289E-08	7.46E+08	8.58E+08
Zn-69	2.027E-04	0.00E+00	0.00E+00
Br-83	8.056E-05	4.87E+03	7.08E+03
Br-84	3.633E-04	2.03E+05	2.36E+05
Br-85	3.851E-03	0.00E+00	0.00E+00
Rb-86	4.299E-07	8.99E+06	1.03E+07
Rb-88	6.490E-04	3.31E+04	3.78E+04
Rb-89	7.600E-04	1.21E+05	1.45E+05
Sr-89	1.589E-07	2.16E+04	2.51E+04
Sr-90	7.548E-10	0.00E+00	0.00E+00
Sr-91	2.027E-05	2.15E+06	2.51E+06
Sr-92	7.105E-05	7.77E+05	8.63E+05
Y-90	3.008E-06	4.48E+03	5.30E+03
Y-91m	2.324E-04	1.00E+05	1.16E+05
Y-91	1.371E-07	1.07E+06	1.21E+06
Y-92	5.439E-05	1.80E+05	2.14E+05
Y-93	1.906E-05	1.83E+05	2.51E+05
Zr-95	1.254E-07	2.45E+08	2.84E+08
Zr-97	1.139E-05	2.96E+06	3.44E+06
Nb-95	2.282E-07	1.37E+08	1.61E+08
Mo-99	2.917E-06	3.99E+06	4.62E+06
Tc-99m	3.198E-05	1.84E+05	2.11E+05
Tc-101	8.136E-04	2.04E+04	2.26E+04
Ru-103	2.042E-07	1.08E+08	1.26E+08
Ru-105	4.337E-05	6.36E+05	7.21E+05
Ru-106	2.179E-08	4.22E+08	5.07E+08
Ag-110m	3.210E-08	3.44E+09	4.01E+09
Sb-122	2.971E-06	0.00E+00	0.00E+00
Sb-124	1.333E-07	5.98E+08	6.90E+08
Sb-125	7.935E-09	2.34E+09	2.64E+09

Table 3-13

Total Body & Skin Ground Plane Dose Factors Ri(G) and Ri(S)

(m^2 * mrem/yr per uCi/sec)

Isotope	Decay Constant (sec^{-1})	Ri(G)	Ri(S)
Te-125m	1.383E-07	1.55E+06	2.13E+06
Te-127m	7.360E-08	9.16E+04	1.08E+05
Te-127	2.059E-05	2.98E+03	3.28E+03
Te-129m	2.388E-07	1.98E+07	2.31E+07
Te-129	1.660E-04	2.62E+04	3.10E+04
Te-131m	6.418E-06	8.03E+06	9.46E+06
Te-131	4.621E-04	2.92E+04	3.45E+07
Te-132	2.462E-06	4.23E+06	4.98E+06
I-130	1.558E-05	5.51E+06	6.69E+06
I-131	9.978E-07	1.72E+07	2.09E+07
I-132	8.371E-05	1.25E+06	1.46E+06
I-133	9.257E-06	2.45E+06	2.98E+06
I-134	2.196E-04	4.47E+05	5.30E+05
I-135	2.913E-05	2.53E+06	2.95E+06
Cs-134	1.066E-08	6.86E+09	8.00E+09
Cs-136	6.124E-07	1.50E+08	1.70E+08
Cs-137	7.327E-10	1.03E+10	1.20E+10
Cs-138	3.588E-04	3.59E+05	4.10E+05
Ba-139	1.397E-04	1.05E+05	1.19E+05
Ba-140	6.297E-07	2.04E+07	2.34E+07
Ba-141	6.323E-04	4.17E+04	4.75E+04
Ba-142	1.090E-03	4.44E+04	5.06E+04
La-140	4.781E-06	1.92E+07	2.18E+07
La-142	1.249E-04	7.36E+05	8.84E+05
Ce-141	2.468E-07	1.37E+07	1.54E+07
Ce-143	5.835E-06	2.31E+06	2.63E+06
Ce-144	2.822E-08	6.95E+07	8.04E+07
Pr-143	5.916E-07	0.00E+00	0.00E+00
Pr-144	6.685E-04	1.83E+03	2.11E+03
Nd-147	7.306E-07	8.39E+06	1.01E+07
W-187	8.056E-06	2.36E+06	2.74E+06
Np-239	3.399E-06	1.71E+06	1.98E+06
K-40	1.717E-17	0.00E+00	0.00E+00
Co-57	2.961E-08	1.88E+08	2.07E+08
Sr-85	1.237E-07	0.00E+00	0.00E+00
Y-88	7.523E-08	0.00E+00	0.00E+00
Nb-94	1.083E-12	0.00E+00	0.00E+00
Nb-97	1.602E-04	1.76E+05	2.07E+05
Cd-109	1.729E-08	0.00E+00	0.00E+00
Sn-113	6.970E-08	0.00E+00	0.00E+00
Ba-133	2.047E-09	0.00E+00	0.00E+00
Te-134	2.764E-04	2.22E+04	2.66E+04
Ce-139	5.828E-08	0.00E+00	0.00E+00
Hg-203	1.722E-07	0.00E+00	0.00E+00

4.0 TOTAL DOSE DETERMINATIONS

4.1 40CFR190 Dose Evaluation

Per RECS D3.4, the direct radiation component for potential offsite dose is routinely determined and reported, along with doses from effluent. Radiological Support has determined bounding calculations (using References 26 through 29) as follows:

Direct Radiation Dose = VC + IRWSF + SGM + ISFSI + RMHAs

where;

VC	=	The Vapor Containment structures
IRWSF	=	The Interim Radioactive Waste Storage Facility
SGM	=	The Steam Generator Mausoleums (both units)
ISFSI	=	The Dry Cask Storage Facility, once active
RMHA	=	Radioactive Material Handling Areas, as posted, summed

Other structures or tanks are included as determined by Rad Support. The calculations in References 26 through 29 were performed in order to meet the requirements of the annual effluent report, and NRC Generic Letter 81-38, 11/10/1981, Storage of Low-Level Radioactive Wastes at Power Reactor Sites.

> "Offsite doses from onsite storage must be sufficiently low to account for other uranium fuel cycle sources (e.g., an additional dose of <1 mrem/year is not likely to cause the limits of 40 CFR 190 to be exceeded). On site dose limits will be controlled per 10CFR20..."

The IRWSF, SGM, and RMHAs fence line dose rates are limited by department procedures to keep dose rates at the SITE BOUNDARY fence < 1 mrem/yr based on calculations performed in References 26 through 29. These calculations contain realistic occupancy factors for the SITE BOUNDARY fence and the nearest neighbor.

ISFSI dose rate calculations and specification are bounded by a conservatively applied maximum annual dose of 17 mrem at the site boundary. This special bounding criteria ensure that combined offsite doses (effluent and direct shine) are in compliance with 40CFR190.

4.2 Doses From Liquid Releases

Doses to real individuals can be determined with the same (maximum individual) methodology described in the ODCM, but with more realistic assumptions with regard to dilution, diet, and occupenncy. Actual radionuclide concentrations in foodstuffs can be applied per the Radiological Environmental Monitoring Program (REMP), such that more accurate doses are determined from actual intakes, rather than models only.

4.3 Doses From Atmospheric Releases

Similarly, real individual methodology can be substituted for maximum individual modeling for airborne releases. Specific dose transfer factors can be used in lieu of weighted dose transfer factors. Information on the location and occupancy of real individuals, as well as more precise meteorological information and the consumption of foodstuffs, can be employed to re-calculate more accurate doses. The REMP can also provide actual concentrations to apply for a more accurate determination than modeling alone.

Data from the land use census can be used to either extend times from food production to consumption, or otherwise show that the exposure of the critical receptors is reduced.

Also, estimates of direct exposure through calculation may be supplanted by REMP results, since these are often more indicative of the true impact at specific locations. Default values used in NUREG-0133 and Reg Guide 1.109 methodology can be supplanted by more specific values if there has been sufficient science and pedigree involved in their determination.

4.4 Doses to MEMBERS OF THE PUBLIC Visiting the Site

Per the RECS Bases, and the discussion regarding gaseous effluent dose rate, visiting MEMBERS OF THE PUBLIC will receive negligible dose from plant effluents, as calculated per ODCM Part II, Sections 3.3.3 and 3.3.4, due the application of multiplicative occupancy factors. These factors are determined by comparing the expected hours on site to 8760 hours (the number of hours in a year, which is used in the calculations demonstrated in Sections 3.3.3 and 3.3.4). Examples of these calculations are as follows:

example 1: Several students visit the site for an 8-hour guided tour.
Their occupancy factor is: 8 / 8760 or **.0009**.

example 2: A man drives his wife to work and drops her off at the security gate each morning, with a total stay-time on site for 2 minutes per day. His occupancy factor is calculated as follows:

2 min/60 min per hour =.0333 hr ; 0.0333 / 8760 = **3.8E-6**

These factors, when multiplied by doses calculated per Sections 3.3.3 and 3.3.4, demonstrate that dose to these MEMBERS OF THE PUBLIC is negligible, despite any potential reduction in the atmospheric dispersion.

5.0 LOWER LIMIT OF DETECTION (LLD)

The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{\frac{2.71}{T_s} + 3.29 s_b * \sqrt{1 + (\frac{T_b}{T_s})}}{E * V * k * Y * e^{-\lambda t}}$$

where:

LLD =	The lower limit of detection as defined above (as picocurie per unit mass or volume)
T_s =	The sample counting time in minutes
s_b =	The standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)
T_b =	The background count time in minutes
E =	The counting efficiency (as counts per transformation)
V =	The sample size (in units of mass or volume)
k =	A constant for the number of transformations per minute per unit of activity (normally, 2.22E+6 dpm per μCi)
Y =	The fractional radiochemical yield (when applicable)
λ =	The radioactive decay constant for the particular radionuclide
t =	The elapsed time between midpoint of sample collection and time of counting
Note:	The above LLD formula accounts for differing background and sample count times. The Radiological Environmental Monitoring Program, REMP, uses an LLD formula that assumes equal background and sample count times, in accordance with the RECS. When the above LLD formula is more appropriate for the effluents program, it may be used.

The constants 2.71 and 3.29 and the general LLD equation were derived from the following two sources:

1) Currie, L.A. "Limits for Qualitative Detection of Quantitative Determination". (Anal. Chem. 40:586-593, 1968); and,

2) Mayer, Dauer "Application of Systematic Error Bounds to Detection Limits for Practical Counting". (HP Journal 65(1): 89-91, 1993)

The value of Sb used in the calculation of the LLD for a detection system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance. In calculating the LLD for a radionuclide determined by gamma ray spectrometry, the background shall include the typical contributions of other radionuclides normally present in the samples. Typical values of E, V, Y, and t shall be used in the calculation. The background count rate is calculated from the background counts that are determined to be within $\pm$ one FWHM (Full-Width-at-Half-Maximum) energy band about the energy of the gamma ray peak used for the quantitative analysis for that radionuclide.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement process and not as an a posteriori (after the fact) limit for a particular measurement.

To handle the a posteriori problem, a decision level must be defined, which has been identified as the Critical Level. Following an experimental observation, one must decide whether or not a real signal was, in fact, detected. This type of binary qualitative decision is subject to two kinds of error: deciding that the radioactive material is present when it is not (a: Type I error), and the converse, failing to decide that it is present when it is (b: Type II error). The maximum acceptable Type I error (a), together with the standard deviation, Snet, of the net signal when the net signal equals zero, establish the Critical Level, Lc, upon which decisions may be based.

Operationally, an observed signal, S, must exceed L_c to yield the decision, detected.

$$L_c = k_a s_b (1+T_b/T_s)^{0.5}$$

where:

k_a is related to the standardized normal distribution and corresponds to a probability level of 1-a. For instance, selection of a = 0.01 corresponds to a 99% confidence level that activity is present. When determining the Lc for different measurement processes, it is allowable to set a at less than or equal to 0.05 as long as the following condition is met:

To set a for L_c determination at less than 0.05, the equation for the LLD (which places a less than or equal to 0.05) should be employed to verify that the calculated LLD is less than or equal to the LLDs specified in the RECS. This calculation, if necessary, will be performed on a case by case basis.

REFERENCES

1. U.S. Nuclear Regulatory Commission, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants", USNRC Report NUREG-0133, Washington D.C. 20555, October 1978.

2. M.E. Wrenn and J. W. Lentsch, "The Fate of Gamma-Emitting Radionuclides Released into the Hudson River Estuary and an Evaluation of Their Environmental Significance", New York University Medical Center, Institute of Environmental Medicine, 1974.

3. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I, Revisions 1 and 0 (original draft for information only), USNRC Washington D.C. 20555, October 1977.

4. "An Evaluation to Demonstrate the Compliance of the Indian Point Reactors with the Design Objectives of 10CFR50, Appendix I", Consolidated Edison Company of New York, Inc. and Power Authority of the State of New York, February 1977.

5. U.S. Nuclear Regulatory Commission, "XOQDOQ Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations", USNRC Report NUREG-0324, Washington D.C. 10555, September 1977. (Later updated by NUREG CR 2919).

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18. USNRC Regulatory Guide 1.23, "Onsite Meteorological Programs," U.S. Nuclear Regulatory Commission (2/17/72) (Safety Guide 23 and and proposed revision 1 to the Reg Guide).

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APPENDIX A

SUMMARY of RADIOLOGICAL EFFLUENT CONTROLS (RECS)

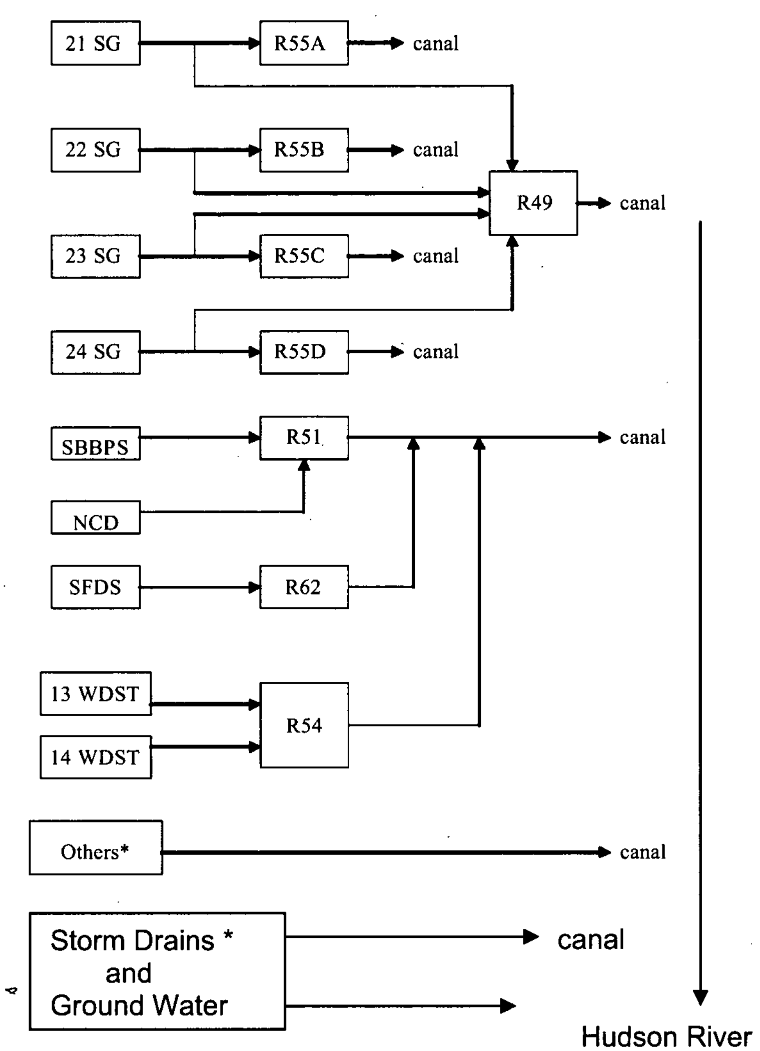
	LIQUID:	***AIRBORNE:***
Dose Rate	The diluted concentration of each isotope in UNRESTRICTED AREAS is limited to ten times the ECs of 10CFR20, defined as the Maximum Permissible Concentrations (MPCw) identified per Section D1.1. The diluted concentration of dissolved or entrained noble gases is limited to 2E-4 uCi/ml.	Dose rate is limited at or beyond the SITE BOUNDARY to: • 500 mrem/yr whole body, per site, for noble gases; • 3000 mrem/yr to the skin, per site, for noble gases; • 1500 mrem/yr to any organ, per site for iodine-131, tritium, or 8 day particulates.
Cumulative Dose	Dose commitment to any member of public in UNRESTRICTED AREAS is limited to: 1) In any calendar quarter, 1.5 mrem to the total body and 5 mrem to any organ. 2) In a calendar year, 3 mrem to the total body and 10 mrem to any organ.	Air Dose at the SITE BOUNDARY is limited to: 5 mrad per quarter and 10 mrad per year for noble gases, gamma air dose; 10 mrad per quarter and 20 mrad per year for noble gases, beta air dose. Maximum Individual Dose to a Member of the Public at the nearest resident is limited to 7.5 mrem per qtr and 15 mrem per yr for Iodine, H-3, & 8 day particulates to any organ.
Dose Projection	Projection of liquid effluent doses shall be computed at least every 31 days. If projected doses exceed: 0.06 mrem total body, or 0.2 mrem critical organ, clean-up treatment systems are required to be operational and applied to future releases.	Projection of airborne effluent doses shall be computed at least every 31 days. If projected doses exceed 0.2 mrad gamma air dose, 0.4 mrad beta air dose, or 0.3 mrem to any organ at the nearest residence, clean-up treatment systems are required to be operational.

TOTAL DOSE:

25 mrem/yr, all sources, whole body or any organ except thyroid,
75 mrem/yr, all sources, thyroid.

APPENDIX B
(Page 1 or 2)

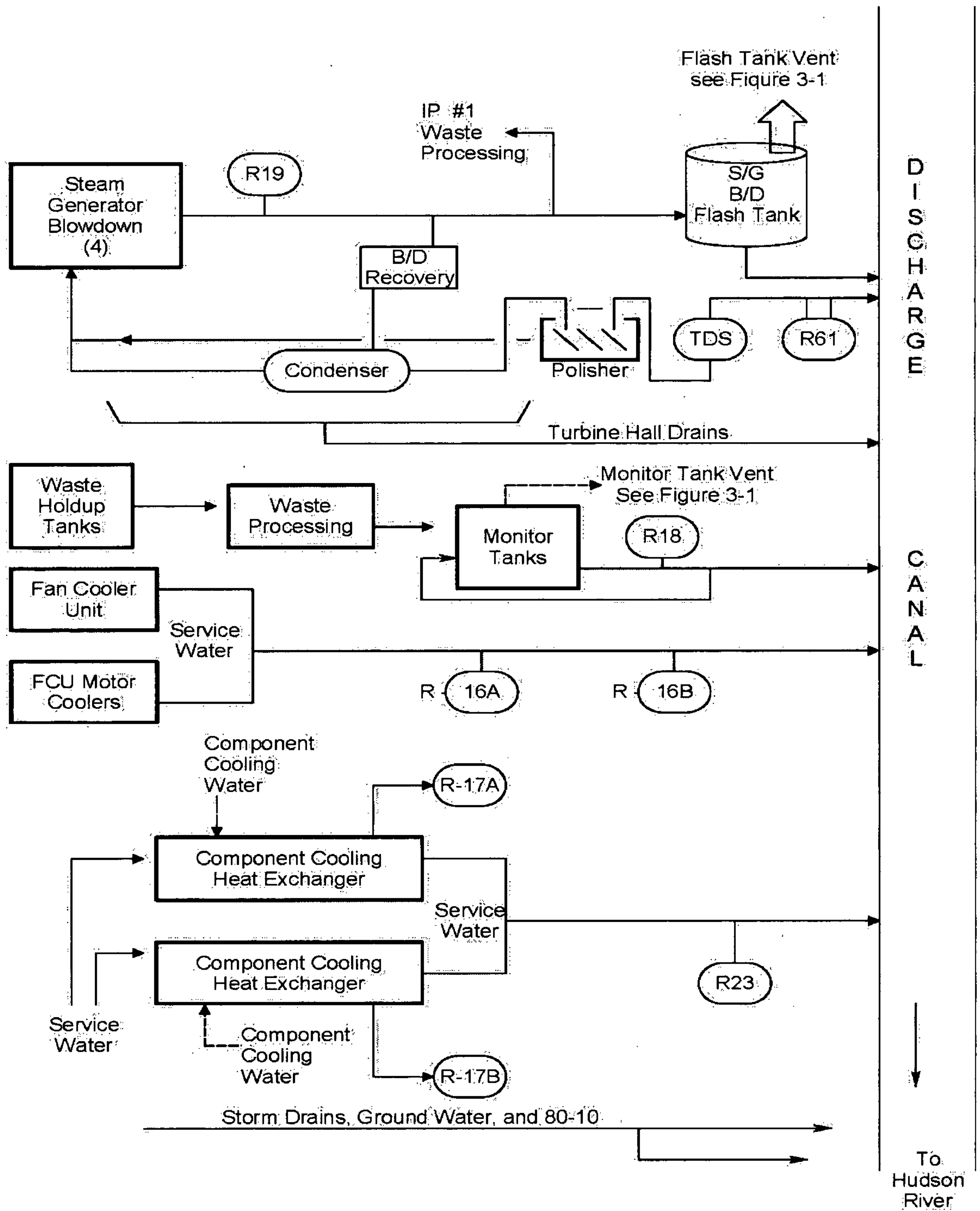
UNITS 1 and 2 LIQUID EFFLUENT SIMPLIFIED FLOW DIAGRAM



*e.g.: House Service Boilers Blowdown; Steam Condensate; Service Water Return; Utility Tunnel Sump (expectedly <LLD for gamma emitters in effluents). These and other systems are monitored per the IPEC 80-10 compliance program.

APPENDIX B
(Page 2 or 2)

UNIT 3 LIQUID EFFLUENT SIMPLIFIED FLOW DIAGRAM



APPENDIX C
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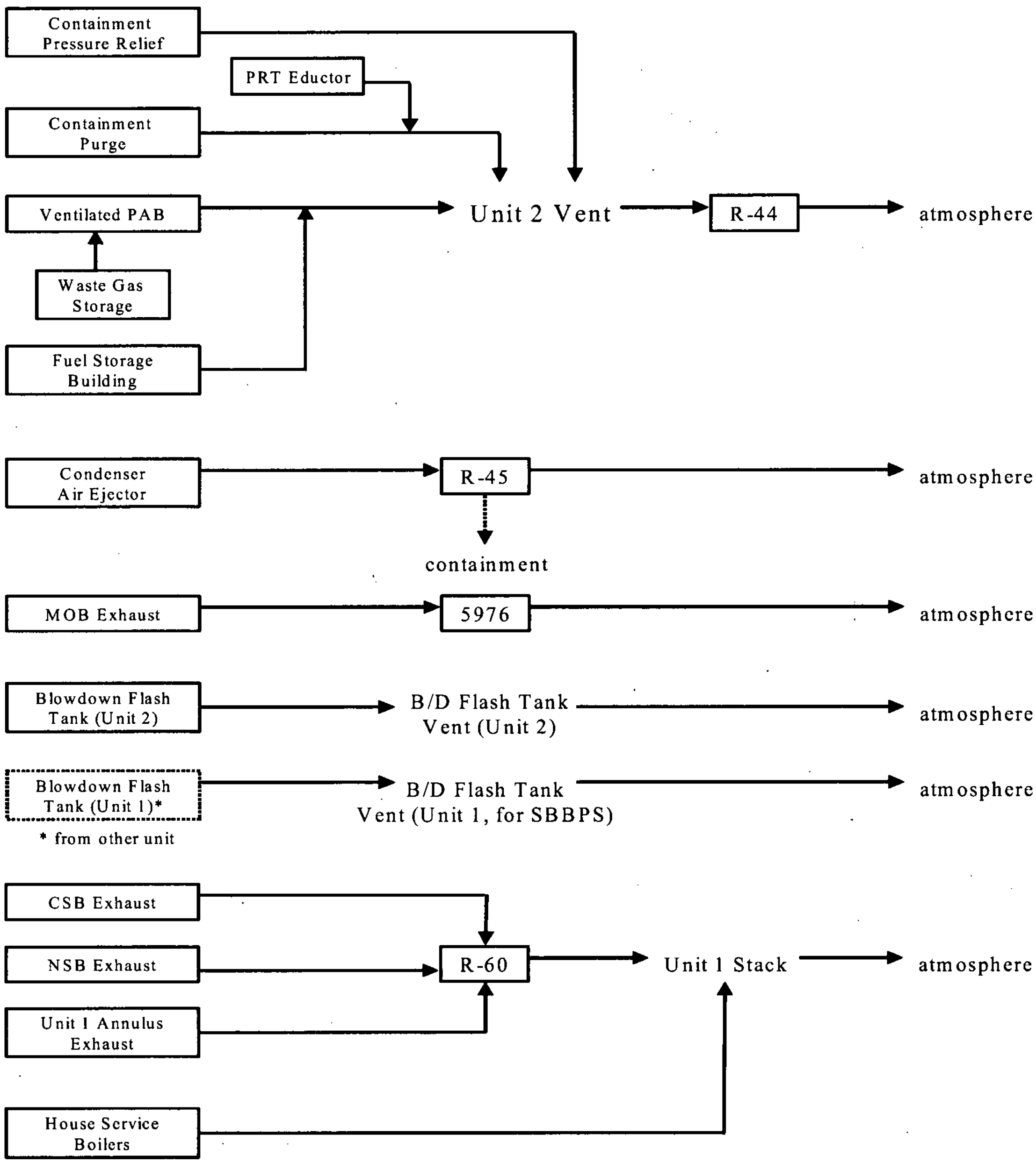
UNITS 1 and 2 GASEOUS EFFLUENT SIMPLIFIED FLOW DIAGRAM



APPENDIX C
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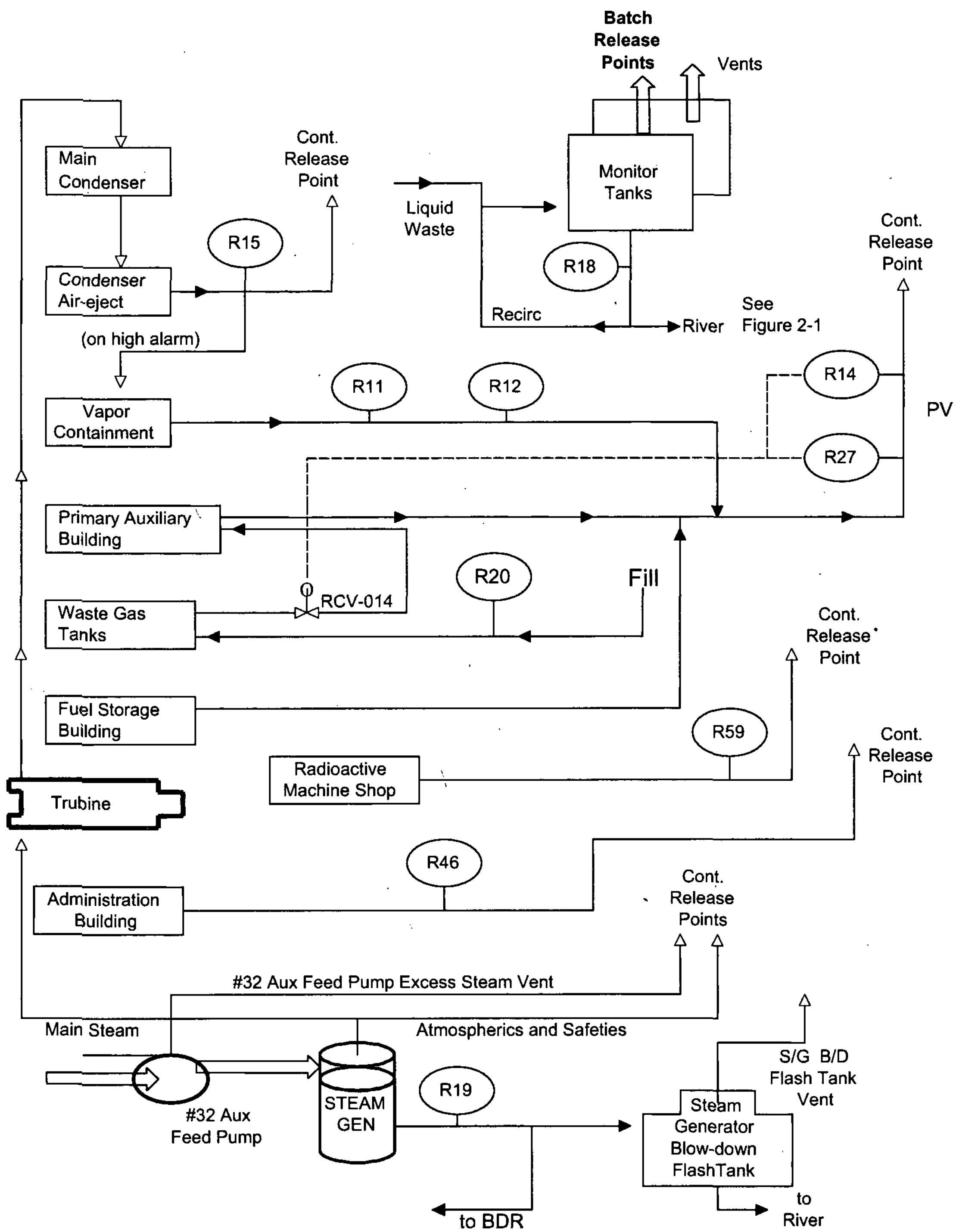
UNIT 3 GASEOUS EFFLUENT SIMPLIFIED FLOW DIAGRAM



APPENDIX D

STEAM PARTITION FACTOR CALCULATION (*f*)

The Steam Partition Factor f for the Unit 2 flash tank vent is given by:

$$f = \frac{{}^{h}BD - 180}{970}$$

For the secondary boiler blowdown purification system flash tank, the factor f is calculated by:

$$f = \frac{{}^{h}BD - 291}{895}$$

Where;

${}^{h}BD$ is the enthalpy of blowdown liquid, as taken from SOP 15.1, "Calorimetric Thermal Power Calculation," in BTU/lbm. A typical value = 500 BTU/lbm.

180 or 291 is the enthalpy of condensed water in each flash tank, in BTU/lbm

970 or 895 is the enthalpy of associated with the latent heat of vaporization in each tank, in BTU/lbm

f = A multiplicative factor used to determine the curies of H-3 escaping the flash tank vent, as follows:

f * SGBD activity (uCi/ml) * SGBD flowrate (gpm) * 3785 ml/gal * min = uCi released from vent

(1-f) * SGBD activity (uCi/ml) * SGBD flowrate (gpm) * 3785 ml/gal * min = Liquid uCi released

APPENDIX E

ALLOWED DILUTED CONCENTRATION (ADC)

The Allowed Diluted Concentration (ADC) is derived and calculated as follows:

$$ADC = \frac{MPCWt * CG}{Total\ activity} \quad or \quad ADC = \frac{MPCWt * CG}{CG + CB} \quad or \quad ADC = \frac{MPCWt}{1 + {CB}/{CG}}$$

Where;

ADC = Allowed diluted concentration in μCi/ml

MPCWt = Maximum permissible concentration in water for all isotopes (beta & gamma), in uCi/ml, as defined in RECS D3.1.1, as follows:

$$MPCWt = \frac{\sum_i Ci}{\sum_i \left\langle {Ci}/{MPCWi} \right\rangle}$$

Where;

Ci and MPCWi = Concentration and MPCW for each isotope

CB = The concentration of the non gamma emitters, in μCi/cc

CG = The concentration of the gamma emitters in uCi/ml

Applications of ADC:

If simultaneous liquid radioactive discharges are being performed from one unit, dilution flows may need to be re-apportioned. This may be performed by allocation or by calculation. The required dilution flow is calculated as follows:

$$E = \frac{Dr * CG}{ADC}$$

where;

Dr = Current release discharge rate, gpm

E = Required dilution for current existing release(s), gpm

The permissible discharge rate is then calculated as follows:

$$D = \frac{ADC * B}{CG}$$

Where:

D = Permissible discharge rate in gal/min

B = Adjusted dilution flow (Available – E, above), in gpm

Note that when there are no other releases (E=0), B simply becomes the available dilution flow.

APPENDIX F

CONVERSION FACTORS FOR LIQUID EFFLUENT MONITORS

Monitor conversion factors are derived from circulating a representative sample (or NIST traceable fluid) through the monitor until a stable reading is obtained. The conversion factor is then determined by quantifying the uCi/cc (by gamma spectroscopy or known activity) and dividing this value by the net cpm displayed on the monitor.

Fluid may be recirculated within the monitoring system, or introduced into a closed loop, to provide elevated, stable readings on the monitor. This fluid should be representative of the expected nuclide mixture in the system, as the conversion factor is energy-dependent.

When the process fluid itself is of sufficient activity to provide this function, it is this fluid that is measured and applied to develop a typical conversion factor.

When the process fluid is usually free of contamination, NIST traceable fluid must be injected into the sample chamber to accomplish this task.

Once the sample chamber is providing a stable reading, an alequate of the fluid is measured by gamma spectroscopy to determine the average energy and the monitor's conversion factor.

Conversion Factors for effluent monitors are maintained by Chemistry and updated when standard mixtures change which would warrant an improved average energy representation.

If desired, a more robust method can be applied per Reference 43.

APPENDIX G
(Page 1 of 7)

ENVIRONMENTAL SAMPLING POINTS

SAMPLE DESIGNATION / STATION	LOCATION	DISTANCE
DR1/57	Roa Hook	2.0 mi – N
DR2/59	Old Pemart Avenue	1.8 mi – NNE
DR3/90	Charles Point	0.88 mi – NE
DR4/28	Lents Cove	0.45 mi – ENE
DR5/35	Broadway and Bleakley Avenue	0.37 mi – E
DR6/88	Reuter-Stokes Pole #6	0.32 mi – ESE
DR7/14	Water Meter House	0.3 mi – SE
DR8/03	Service Center Building	0.35 mi – SSE
DR9/34	South East Corner of Site	0.52 mi – S
DR10/05	NYU Tower	0.88 mi – SSW
DR11/53	White Beach	0.92 mi – SW
DR12/74	West Shore Drive - South	1.59 mi – WSW
DR13/76	West Shore Drive – North	1.21 mi – W
DR14/78	Rt. 9W, across from R/S #14	1.2 mi – WNW
DR15/80	Rt. 9W - South of Ayers Road	1.02 mi – NW
DR16/82	Ayers Road	1.01 mi – NNW
DR17/58	Rt. 9D – Garrison	5.41 mi – N
DR18/60	Gallows Hill Road and Sprout Brook Road	5.02 mi – NNE
DR19/62	West Brook Drive (near the Community Center)	5.03 mi – NE
DR20/64	Lincoln Road – Cortlandt (School Parking Lot)	4.6 mi – ENE
DR21/66	Croton Ave. – Cortlandt	4.87 mi – E
DR22/67	Colabaugh Pond Rd. – Cortlandt	4.5 mi – ESE
DR23/69	Mt. Airy & Windsor Road	4.97 mi – SE
DR24/92	Warren Rd. – Cortlandt	3.84 mi – SSE
DR25/71	Warren Ave. – Haverstraw	4.83 mi – S
DR26/72	Railroad Ave. & 9W Haverstraw	4.53 mi – SSW
DR27/73	Willow Grove Rd. & Captain Faldermeyer Drive	4.97 mi – SW
DR28/81	Palisades Parkway, Lake Welch Exit	4.96 mi – WSW
DR29/77	Palisades Parkway	4.15 mi – W
DR30/79	Anthony Wayne Park	4.57 mi – WNW
DR31/75	Palisades Parkway	4.65 mi – NW
DR32/83	Rt. 9W Fort Montgomery	4.82 mi – NNW
DR33/33	Hamilton Street (Substation)	2.88 mi – NE
DR34/38	Furnace Dock (Substation)	3.43 mi – SE
DR35/89	Highland Ave. & Sprout Brook Rd. (near Rock Cut)	2.89 mi – NNE
DR36/61	Lower South Street and Franklin Street	1.3 mi – NE
DR37/56	Verplanck – Broadway & 6th St.	1.25 mi – SSW
DR38/20	Cortlandt Yacht Club (aka Montrose Marina)	1.5 mi – S
DR39/29	Grassy Point	3.37 mi – SSW
DR40/23	*Roseton	20.7 mi – N
DR41/27	Croton Point	6.36 mi – SSE

* Control Station

APPENDIX G
(Page 2 of 7)

ENVIRONMENTAL SAMPLING POINTS

SAMPLE DESIGNATION/ STATION	LOCATION	DISTANCE
	Airborne	
A1/4	Algonquin Gas Line	0.28 mi – SW
A2/94	IPEC Training Center	0.39 mi – S
A3/95	Meteorological Tower	0.46 mi – SSW
A4/5	NYU Tower	0.88 mi – SSW
A5/23	*Roseton	20.7 mi – N
	Waterborne – Surface (Hudson River Water)	
Wa1/9	*Plant Inlet (Hudson River Intake)	0.16 mi – W
Wa2/10	Discharge Canal (Mixing Zone)	0.3 mi – WSW
	Waterborne – Drinking	
Wb1/7	Camp Field Reservoir	3.4 mi – NE
	Soil From Shoreline	
Wc1/53	White Beach	0.92 mi – SW
Wc2/50	*Manitou Inlet	4.48 mi – NNW

Exposure Pathway/Sample: Milk

There are no milch animals whose milk is used for human consumption within 8 km distance of Indian Point; therefore, no milk samples are taken.

Exposure Pathway/Sample: Ingestion-Fish and Invertebrates

The RECS designate two required sample locations labeled Ib1/25 and Ib2/23. The downstream Ib1 location and samples will be chosen where it is likely to be affected by plant discharge. Ib2 will be a location upstream that is not likely to be affected by plant discharge. The following species along with other commercially/recreationally important species are considered acceptable:

Striped Bass	Pumpkin Seed	American Eel
Bluegill Sunfish	White Catfish	Crabs
White Perch	Blueback Herring	

Exposure Pathway/Sample: Ingestion-Food Products (Broad Leaf Vegetation)

Ic1/95	Meteorological Tower	0.46 mi - SSW
Ic2/94	IPEC Training Center	0.39 mi - S
Ic3/23	*Roseton	20.7 mi - N

*Control Station

APPENDIX G
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ENVIRONMENTAL SAMPLING POINTS

SAMPLE DESIGNATION/ STATION	LOCATION	DISTANCE	SAMPLE TYPES
DR8/3	Service Center Building	0.35 mi – SSE	3
A1/4	Algonquin Gas Line	0.28 mi – SW	1,2
A4, DR10/5	NYU Tower	0.88 mi – SSW	1,2,3
Wb1/7	Camp Field Reservoir	3.4 mi – NE	6
**/8	Croton Reservoir	6.3 mi - SE	6
Wa1/9	*Plant Inlet (Hudson River Intake)	0.16 mi - W	7
Wa2/10	Discharge Canal (Mixing Zone)	0.3 mi - WSW	7,8
DR7/14	Water Meter House	0.3 mi – SE	3
**/17	Off Verplanck	1.5 mi – SSW	8,9,10
DR38/20	Cortlandt Yacht Club (AKA Montrose Marina)	1.5 mi – S	3
**/22	Lovett Power Plant	1.6 mi – WSW	1,2
Ib2,A5,DR40,Ic3/23	*Roseton	20.7 mi – N	1,2,3,4,5,11,12
Ib1/25	where available, downstream	N/A	12
DR41/27	Croton Point	6.36 mi – SSE	1,2,3
DR4/28	Lents Cove	0.45 mi - ENE	3,8,9,10
DR39/29	Grassy Point	3.37 mi – SSW	1,2,3
DR33/33	Hamilton Street (Substation)	2.88 mi – NE	3
DR9/34	South East Corner of Site	0.52 mi – S	3
DR5/35	Broadway & Bleakley Avenue	0.37 mi – E	3
DR34/38	Furnace Dock (Substation)	3.43 mi – SE	3
**/44	Peekskill Gas Holder Building	1.84 mi – NE	1,2,11
Wc2/50	*Manitou Inlet	4.48 mi – NNW	10
Wc1, DR11/53	White Beach	0.92 mi – SW	3,10
DR37/56	Verplanck – Broadway & 6th Street	1.25 mi - SSW	3
DR1/57	Roa Hook	2.0 mi – N	3
DR17/58	Rt. 9D Garrison	5.41 mi – N	3
DR2/59	Old Pemart Ave.	1.8 mi – NNE	3
DR18/60	Gallows Hill Road and Sprout Brook Road	5.02 mi – NNE	3
DR36/61	Lower South Street and Franklin Street	1.3 mi – NE	3
DR19/62	West Brook Drive (near the Community Center)	5.03 mi – NE	3
DR20/64	Lincoln Road – Cortlandt (School Parking Lot)	4.6 mi – ENE	3
DR21/66	Croton Ave. – Cortlandt	4.87 mi – E	3
DR22/67	Colabaugh Pond Rd. – Cortlandt	4.5 mi – ESE	3
DR23/69	Mt. Airy & Windsor Road	4.97 mi – SE	3

* Control Station

** Items are in excess of RECS requirements

APPENDIX G
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ENVIRONMENTAL SAMPLING POINTS

SAMPLE DESIGNATION/ STATION	LOCATION	DISTANCE	SAMPLE TYPES
DR25/71	Warren Avenue – Haverstraw	4.83 mi – S	3
DR26/72	Railroad Ave. & 9W – Haverstraw	4.53 mi – SSW	3
DR27/73	Willow Grove Rd. & Captain Faldermeyer Dr	4.97 mi – SW	3
DR12/74	West Shore Drive – South	1.59 mi – WSW	3
DR31/75	Palisades Parkway	4.65 mi – NW	3
DR13/76	West Shore Drive – North	1.21 mi – W	3
DR29/77	Palisades Parkway	4.15 mi – W	3
DR14/78	Rte. 9W, across from R/S #14	1.2 mi – WNW	3
DR30/79	Anthony Wayne Park	4.57 mi – WNW	3
DR15/80	Rte. 9W – South of Ayers Road	1.02 mi – NW	3
DR28/81	Palisades Parkway, Lake Welch Exit	4.96 mi – WSW	3
DR16/82	Ayers Road	1.01 mi – NNW	3
DR32/83	Rte. 9W – Fort Montgomery	4.82 mi – NNW	3
**/84	Cold Spring	10.88 mi – N	8,9,10
**/85	Quality Control		6
DR6/88	Reuter-Stokes Pole #6	0.32 mi – ESE	3
DR35/89	Highland Ave. & Sprout Brook Road (near rock cut)	2.89 mi – NNE	3
DR3/90	Charles Point	0.88 mi – NE	3
DR24/92	Warren Rd. – Cortlandt	3.84 mi – SSE	3
A2, Ic2/94	IPEC Training Center	0.39 mi – S	1,2,4,5
A3, Ic1/95	Meteorological Tower	0.46 mi - SSW	1,2,4,5
MW-40/104	Boundary Well #40	0.21 mi - SW	13
MW-51/105	Boundary Well #51	0.18 mi – SSW	13

** Items are in excess of RECS requirements

Sample types are:

1. Air particulates
2. Radioiodine
3. Direct gamma
4. Broadleaf vegetation
5. Soil
6. Drinking water
7. Hudson River (H.R.) water
8. H.R. bottom sediment-silt
9. H.R. aquatic vegetation
10. H.R. shoreline soil
11. Fallout
12. Fish and invertebrates
13. Ground Water Boundary Monitoring (see ODCM Part I, Figure D 4.1-1)

APPENDIX G
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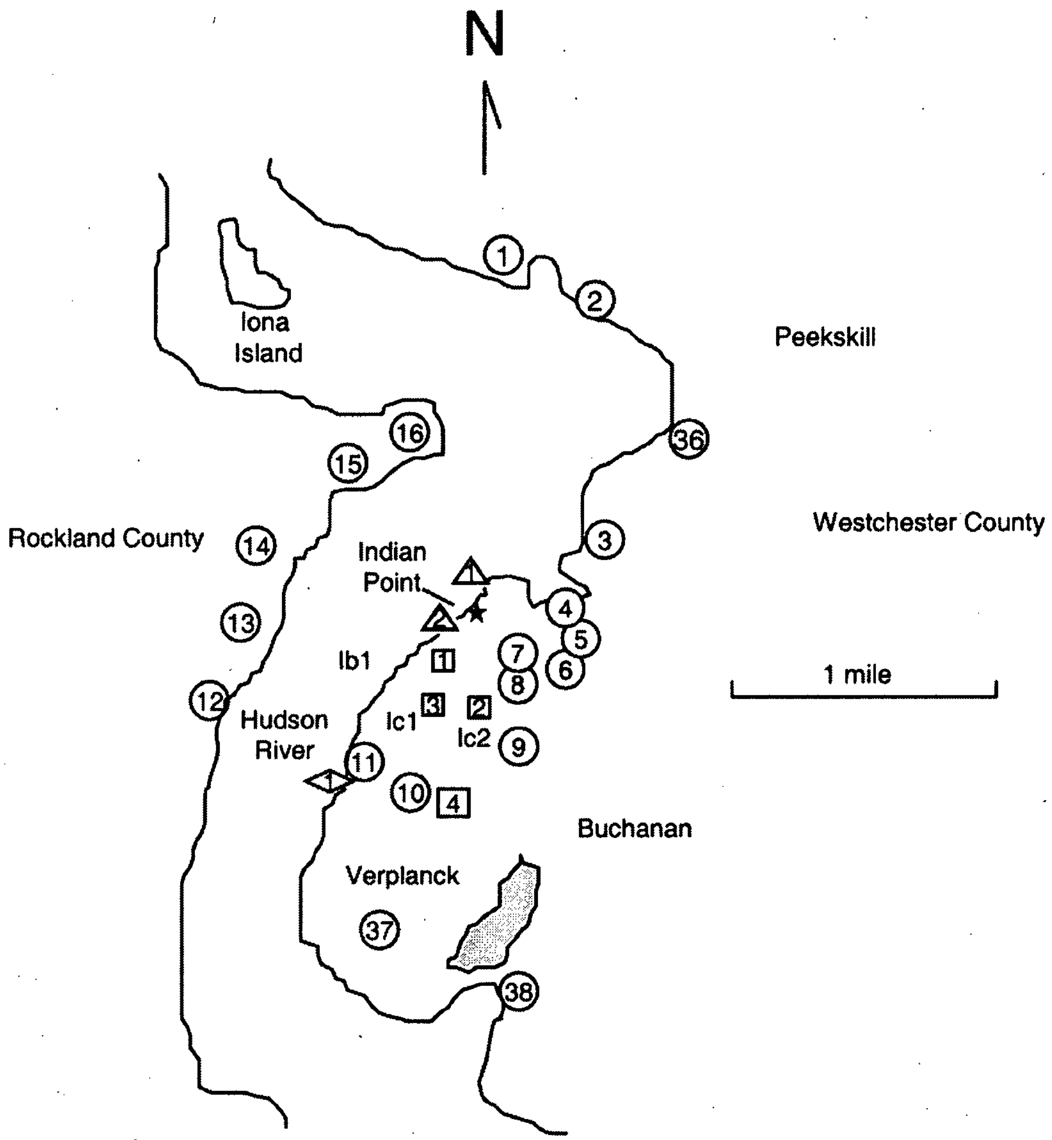
ENVIRONMENTAL SAMPLING POINTS

SAMPLING LOCATIONS
Within Two Miles of Indian Point



Key: Δ - Waterborne: Surface (HR) Wa#
○ - Direct Radiation Sample Location DR#
□ - Air Particulate & Radioiodine A#
◇ - HR Shoreline Sediment Wc#

Ic# - Broadleaf Vegetation
Ib1 - Fish and Invertebrates (where available downstream)

APPENDIX G
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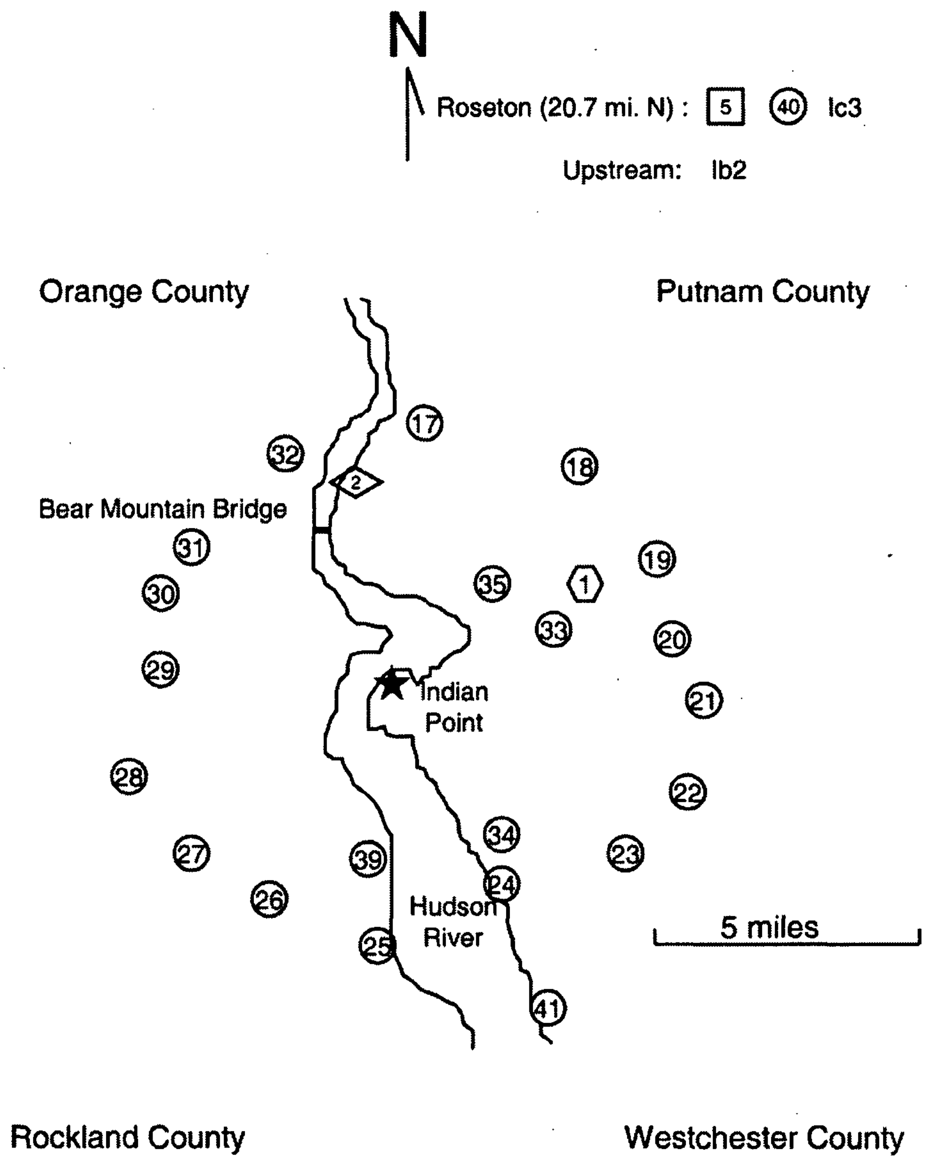
ENVIRONMENTAL SAMPLING POINTS

SAMPLING LOCATIONS
Within Ten Miles of Indian Point



Key:
- ○ - Direct Radiation Sample Location DR#
- □ - Air Particulate & Radioiodine A#
- ◇ - HR Shoreline Sediment Wc#
- ⬡ - Waterborne: Drinking Wb#

Ic3 - Broadleaf Vegetation
Ib2 - Fish and Invertebrates (where available upstream)

APPENDIX G
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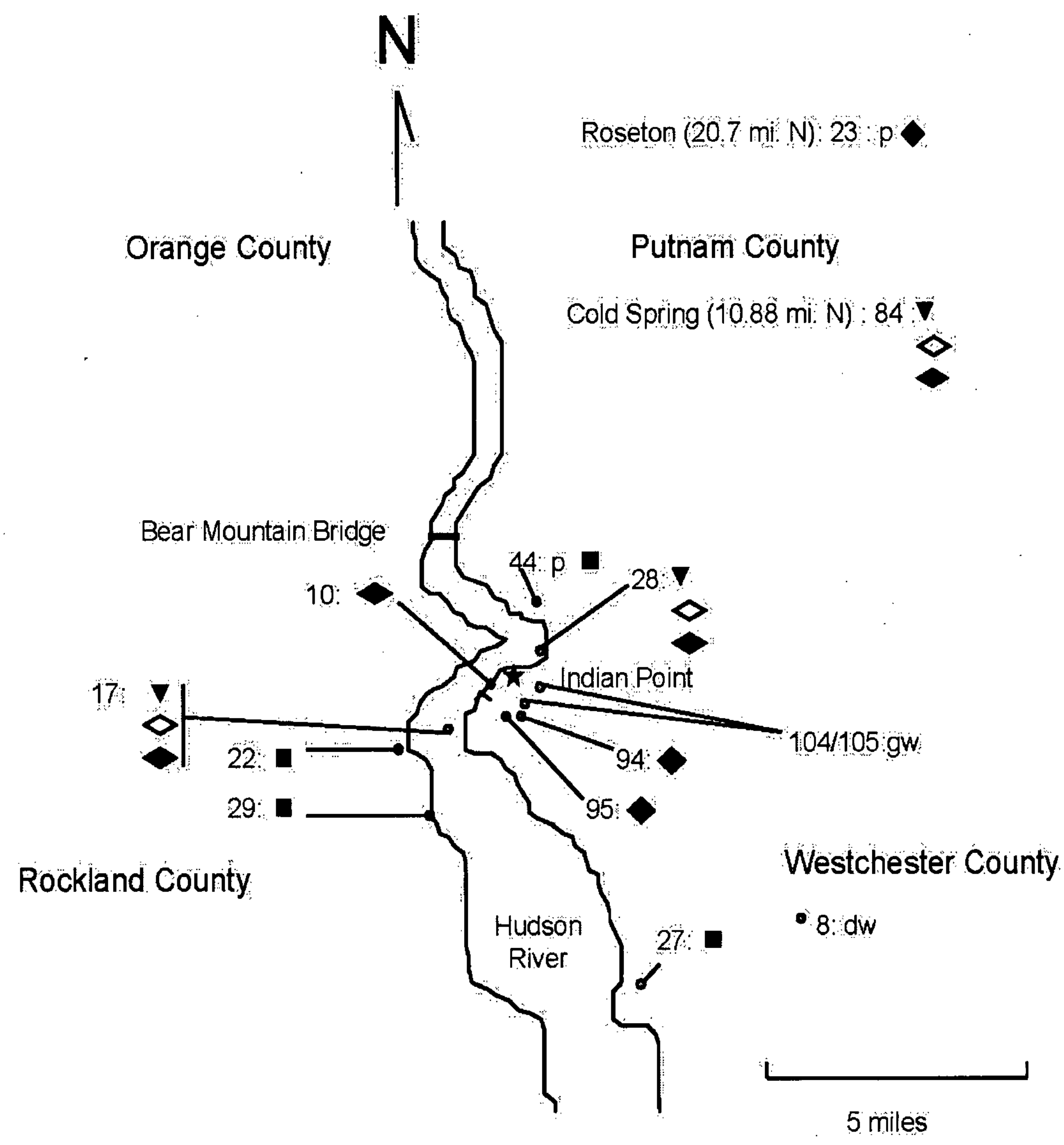
ENVIRONMENTAL SAMPLING POINTS

ADDITIONAL SAMPLING LOCATIONS



Key:
- ■ - Air Particulate & Radioiodine
- ▼ - Aquatic Vegetation
- HR Bottom Sediment
- p - Precipitation
- dw - Drinking Water
- HR Shoreline Sediment
- ◆ - Soil
- gw – Ground Water Boundary Monitoring (see detailed site map)

APPENDIX H

INTERLABORATORY COMPARISON PROGRAM

Laboratories used for analysis of samples to support the Radiological Environmental Monitoring Program (REMP) participate in an Interlaboratory Comparison Program or comparable program with an approved vendor (EPA, NIST, etc).

Samples of various media containing known activities of radionuclides are sent to participating laboratories for analyses. Results of the analyses are compared to the known values.

While laboratory results may be reported in terms of normalized deviations from a known value (generally $\pm$ 3 sigma), the results are evaluated for acceptance criteria using the NRC's standardized comparison requirements for agreement found in the site quality control procedures (as a function of resolution).

Annual results of the interlab participation, along with resolution and agreement criteria, are summarized in the Annual Environmental Operating Report.

APPENDIX I

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

Primary Assumptions:

- Units 2 and 3 effective dose factors (KLMN) are equivalent, except for unit-specific finite cloud correction factors, which represent different recirculation contribution, as required.
- For instantaneous release calculations, the default (initial) condition is for each unit to share (50-50) in the application of the site's 10CFR20 limit (converted to uCi/sec from mrem/yr).
- The following data represent long-term meteorological factors. Short term correction, if applicable, should be applied to these values, as discussed in Section 3.5, and Reference 17.

Unit 1 or 2 Release Points	Receptor	Site Boundary	Nearest Resident	5-miles Down Valley, Haverstraw
Primary Vent Releases	Concentration X/Q (sec/m^3)	2.219E-06 [SSW, 755 m]	1.030E-06 [SSW, 1574 m]	7.22E-07
	Deposition D/Q (m^{-2})	1.407E-08 [SSW, 755 m	7.517E-09 [S, 1133 m]	1.35E-09
Ground Level Releases	Concentration X/Q (sec/m^3)	2.873E-05 [SSW, 440 m]	5.158E-06 [SSW, 1374 m]	7.22E-07
	Deposition D/Q (m^{-2})	8.759E-08 [SSW, 440 m	1.878E-08 [S, 933 m]	1.35E-09

Unit 3 Release Point	Receptor	Site Boundary	Nearest Resident	5-miles Down Valley, Haverstraw
Primary Vent Releases	Concentration X/Q (sec/m^3)	4.473E-06 [SW, 350 m]	1.016E-06 [SSW, 1574 m]	7.22E-07
	Deposition D/Q (m^{-2})	2.599E-08 [SSW, 480 m]	7.451E-09 [S, 1133 m]	1.35E-09
Ground Level Releases	Concentration X/Q (sec/m^3)	6.980E-05 [SSW, 250 m]	5.158E-06 [SSW, 1374 m]	7.22E-07
	Deposition D/Q (m^{-2})	2.012E-07 [SSW, 250 m]	1.878E-08 [S, 933 m]	1.35E-09

APPENDIX I

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

Instantaneous Release Rates vs Dose Rates

Indian Point units 2 and 3 share a common site boundary limit of 500 mrem/yr. This 500 mrem/yr limit was divided between the units based upon a 50-50 split of the release rate in μCi/sec. Because each unit has its own X/Q and K-bar, equal μCi/sec discharges from each plant will result in different dose rates for each plant at the most restrictive site boundary location. In order to define the split of the 500 mrem/yr limit, IPEC units 2 and 3 must base the dose split on the mixture presented in Table 2-8.

Dose Split Between IP2 and IP3

A. Instantaneous Dose Rates and Calculation of Allowable Release Rate in uCi/sec:

i. Whole Body Dose Rate Calculations:

Given:

a) site limit is 500 mrem/yr

b) IP3 worst sector X/Q = 4.47E-6 sec/m^3

c) IP3 K-bar for instantaneous mixture = 849 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$

d) IP2 worst sector X/Q = 2.22E-6 sec/m^3

e) IP2 K-bar for instantaneous mixture = 1507 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$

f) $\dot{Q}$ = μCi/sec

> Note:
>
> Units 2 and 3 effective dose factors (KLMN) are equivalent, except for site-specific finite cloud correction, as defined in Table 2-8.

Solve for $\dot{Q}$:

$\dot{Q}$ [(X/Q$_3$) (K bar$_3$) + (X/Q$_2$) (K bar$_2$)] = 500 mrem/yr

$\dot{Q}$ [(4.47E-6) (849) + (2.22E-6) (1507)] = 500 mrem/yr

Therefore, without performing any specific calculations for an actual release, the default back-calculated instantaneous release rate ($\dot{Q}$) ***for either unit*** = **7.00E+4 μCi/sec.**

In other words, if both units were releasing at this rate, with the default instantaneous mixture identified in Table 2-8, IPEC would be releasing at 500 mrem/yr (the RECS and 10CFR20 release rate limit).

Since this value assumes ALL releases are included (per unit), a partitioning factor should be applied for each applicable release point when this limit is used. Should it become necessary to "borrow" from the other unit , isotopic mixtures from specific sample results should replace the dose factors used in this default calculation.

Without specific sample data, the default ***SITE*** release rate limit is then: **1.40E5 uCi/sec.**

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

ii. Skin Dose Rate Calculations:

Given:

a) site limit is 3,000 mrem/yr

b) IP3 worst sector X/Q = 4.47E-6 sec/m^3

c) IP3 (Li + 1.1 Mi) = 2306 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$

d) IP2 X/Q for SSW sector = 2.22E-6 sec/m^3

e) IP2 (Li + 1.1 Mi) = 3071 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$

f) $\dot{Q}$ = uCi/sec

Solve for $\dot{Q}$:

$\dot{Q}$ [$(X/Q)_3$ $(Li + 1.1\ Mi)_3$ + $(X/Q)_2$ $(Li + 1.1\ Mi)_2$] = 3,000 mrem/yr

$\dot{Q}$ [(4.47E-6) (2306) + (2.22E-6) (3071)] = 3,000 mrem/yr

$\dot{Q}$ = 1.75E+5 μCi/sec (less restrictive than Whole Body)

iii. Solve for WB dose rate commitments per site (with $\dot{Q}$ = 7.00E+4 uCi/sec)

Indian Point 2:

(7.00E+4 μCi/sec) (2.22E-6 sec/m^3) (1507 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$) = **234 mrem/yr**

Indian Point 3:

(7.00E+4 μCi/sec) (4.47E-6 sec/m^3) (849 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$) = **266 mrem/yr**

The less restrictive skin dose rate limit for each unit (information only):

Unit 2: (1.75E+5 uCi/sec) (2.22E-6 sec/m^3) (3071 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$) = 1194 mrem/yr

Unit 3: (1.75E+5 uCi/sec) (4.47E-6 sec/m^3) (2306 $\frac{mrem \bullet m^3}{\mu Ci \bullet yr}$) = 1806 mrem/yr

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

RELEASE RATE LIMITS FOR QUARTERLY AND ANNUAL AVERAGE NOBLE GAS RELEASES

	For a Calendar Quarter	For a Calendar Year
Gamma air dose	5 mrad limit	10 mrad limit
Beta air dose	10 mrad limit	20 mrad limit

I. Assumptions:

1. Doses are delivered to the air at the site boundary.
2. Finite cloud geometry is assumed for noble gas releases at site boundary.
3. X/Q for Unit 2 = 2.22E-6 sec/m^3, ($\dot{Q}$ = release rate uCi/sec)
4. X/Q for Unit 3 = 4.47E-6 sec/m^3, ($\dot{Q}$ = release rate uCi/sec)
5. Gamma and Beta air dose factors (M and N), Corrected for finite cloud geometry (as described on Table 2-8) are as follows:

Unit 2 effective average dose factors	Unit 3 effective average dose factors	Units
$\overline{M}$ = 281	$\overline{M}$ = 181	mrad/yr per uCi/m^3
$\overline{N}$ = 1254	$\overline{N}$ = 1254	mrad/yr per uCi/m^3

II. Calculation of Quarterly Release Rates:

a) for gamma dose: ($\dot{Q}$)*[(M)(X/Q)] less than or equal to 5 mrad/qtr

b) for beta dose: ($\dot{Q}$)*[(N)(X/Q)] less than or equal to 10 mrad/qtr

		unit 2	unit 3
gamma dose rate	$\dot{Q} = \dfrac{5 mrad/qtr}{(1/4 yr)(M)(X/Q)}$	= 3.21E+4 μCi/sec	2.47E+4 μCi/sec
beta dose rate	$\dot{Q} = \dfrac{10 mrad/qtr}{(1/4 yr)(N)(X/Q)}$	= 1.44E+4 μCi/sec	7.14E+3 μCi/sec

Based on the above analysis, the beta dose is limiting for time average doses. Therefore, the allowable quarterly average release rates are 1.44E+4 μCi/sec for unit 2 and 7.14E+3 μCi/sec for unit 3.

III. Calculation of Calendar Year Release Rate

Annual limits are one half of quarterly limits. Therefore, using Beta air dose as most limiting, the maximum annual average release rates are 7.20E+3 μCi/sec for unit 2 and 3.57E+3 μCi/sec for unit 3.

CALCULATION OF ALLOWABLE RELEASE RATES FOR INDIAN POINT UNITS 2 and 3

ALLOWABLE INSTANTANEOUS RELEASE RATE for I-131 & Particulates w/ T½ > 8 DAYS)

Given: Wv(in): X/Q at the Site Boundary for IP3 = 4.47E-6 sec/m^3

Wv(in): X/Q at the Site Boundary for IP2 = 2.22E-6 sec/m^3

$$PI(c) = 1.62\ E7\ \frac{mrem/yr}{\mu Ci/m^3}$$

Assumed Pathway: Child Inhalation at Unrestricted Area Boundary

Solve the following equation for $\dot{Q}$:

$$[(\dot{Q})PI(c)(Wv(in))\ \text{Unit 3}] + [(\dot{Q})PI(c)(Wv(in))\ \text{Unit 2}] = 1500\ \text{mrem/yr}$$

$$IP3:\ (\dot{Q})PI(c)(Wv(in))3 = \dot{Q} * 1.62E7\ \frac{mrem/yr}{\mu Ci/m^3} 4.47E\text{-}6\ s/m^3 = \dot{Q} * 72.4\ \frac{mrem/yr}{\mu Ci/\sec}$$

$$IP2:\ (\dot{Q})PI(c)(Wv(in))2 = \dot{Q} * 1.62E7\ \frac{mrem/yr}{\mu Ci/m^3} 2.22E\text{-}6\ s/m^3 = \dot{Q} * 36.0\ \frac{mrem/yr}{\mu Ci/\sec}$$

The sum equals : (108) ($\dot{Q}$) mrem/yr per uCi/sec

Limit is 1500 mrem/yr per site:

$$\text{Therefore:}\quad 108 * \dot{Q}\ \frac{mrem/yr}{\mu Ci/\sec} = 1500\ \text{mrem/yr}$$

$$\dot{Q} = 1.38E{+}1\ \mu Ci/sec \quad \text{(for each unit)}$$

$$\text{IP3 Dose Contribution:}\quad 1.38E{+}1\ \frac{\mu Ci}{\sec} * 1.62E7 \frac{mrem}{yr}\frac{m^3}{\mu Ci} * 4.47E-6 \frac{\sec}{m^3} = 1003\ \text{mrem/yr}$$

$$\text{IP2 Dose Contribution:}\quad 1.38E{+}1\ \frac{\mu Ci}{\sec} * 1.62E7 \frac{mrem}{yr}\frac{m^3}{\mu Ci} * 2.22E-6 \frac{\sec}{m^3} = 497\ \text{mrem/yr}$$

Sum = 1500 mrem/yr

(Approximately a 67 / 33 percent dose split for IP3 and IP2 respectively).

ALLOWABLE QUARTERLY and ANNUAL IODINE/PARTICULATE RELEASE RATES

DOSE LIMITS AT THE NEAREST RESIDENT

Dose factors for the child, thyroid (for Iodine 131) are used for this category as a conservative assumption since this nuclide has the highest thyroid dose factor of all iodines and particulates, and its most significant effect in on the child age group. The H-3 dose factor is about 4 orders of magnitude less significant and its contribution to the total dose is considered negligible.

The back-calculated release rate for Iodine and Particulate is as follows:

	Unit 2	Unit 3
X/Q (in sec/m^3 at the nearest resident)	1.03E-6	1.02E-6
D/Q (in m^{-2} at the nearest resident)	7.52E-9	7.45E-9

RI(c) = 1.62E+7 $\frac{mrem/yr}{\mu Ci/m^3}$, child thyroid inhalation dose factor for I-131 (for both units)

RG = 1.72E+7 m^2 $\frac{mrem/yr}{\mu Ci/\sec}$, ground plane dose factor for I-131 (for both units)

RV(c) = 4.75E+10 m^2 $\frac{mrem/yr}{\mu Ci/\sec}$, child thyroid vegetation dose factor for I-131 (for both units)

Calculating the allowable time average release rate by solving the following equation for $\dot{Q}$:

$\dot{Q}$ [(RIc)(X/Q) + (RG)(D/Q) + (RVc)(D/Q)] = limit in mrem/yr

	Unit 2	Unit 3
$\dot{Q}$ (RIc)(X/Q) in mrem/yr per uCi/sec =	16.7 * $\dot{Q}$	16.5 * $\dot{Q}$
$\dot{Q}$ (RG) (D/Q) in mrem/yr per uCi/sec =	0.129 * $\dot{Q}$	0.128 * $\dot{Q}$
$\dot{Q}$ (RVc)(D/Q) in mrem/yr per uCi/sec =	357 * $\dot{Q}$	354 * $\dot{Q}$
The sum for each unit (X * $\dot{Q}$) in mrem/yr per uCi/sec.	**374** * $\dot{Q}$	**371** * $\dot{Q}$

Quarterly time average limit is 7.5 mrem to any organ (or 30 mrem/yr). Solving for $\dot{Q}$ yields:

		(Quarterly Limit)	**(Annual Limit)**
(IP2)	$\dot{Q}$ * 374 $\frac{mrem/yr}{\mu Ci/\sec}$ = 30 mrem/yr;	8.02E-2 µCi/sec	4.01E-2 µCi/sec
(IP3)	$\dot{Q}$ * 371 $\frac{mrem/yr}{\mu Ci/\sec}$ = 30 mrem/yr;	8.10E-2 µCi/sec	4.05E-2 µCi/sec

(Annual limits are ½ quarterly limits, or 15 mrem to any organ/yr)

ALLOWABLE QUARTERLY and ANNUAL IODINE/PARTICULATE RELEASE RATES

DOSE LIMITS AT THE 5-MILE SECONDARY RECEPTOR (when applied)

Dose factors for the infant, thyroid (for Iodine 131) are used for this category as a conservative assumption since this nuclide has the highest thyroid dose factor of all iodines and particulates, and its most significant effect is on the infant age group at this location. When applied (as required by the applicable current Land Use Census), this pathway may be approximately four times more limiting than the Primary Receptor. The back-calculated release rate for Iodine and Particulate are as follows:

	Units 2 or 3
X/Q (in sec/m^3 at 5-miles down valley)	7.22E-7
D/Q (in m^{-2} at 5-miles down valley)	1.35E-9

RI(i) = 1.48E+7 $\frac{mrem/yr}{\mu Ci/m^3}$, infant thyroid inhalation dose factor for I-131 (for both units)

RG = 2.10E+7 m^2 $\frac{mrem/yr}{\mu Ci/\sec}$, ground plane dose factor for I-131 (for both units)

RC(i) = 1.05E+12 m^2 $\frac{mrem/yr}{\mu Ci/\sec}$, infant thyroid cow-milk dose factor for I-131 (for both units)

(there is no vegetative pathway for the infant)

Calculating the allowable time average release rate by solving the following equation for $\dot{Q}$:

$\dot{Q}$ [(RIi)(X/Q) + (RG)(D/Q) + (RCi)(D/Q)] = limit in mrem/yr

	Units 2 or 3
$\dot{Q}$ (RIi)(X/Q) in mrem/yr per uCi/sec =	10.7 * $\dot{Q}$
$\dot{Q}$ (RG) (D/Q) in mrem/yr per uCi/sec =	0.028 * $\dot{Q}$
$\dot{Q}$ (RCi)(D/Q) in mrem/yr per uCi/sec =	1412 * $\dot{Q}$

The sum for each unit (X * $\dot{Q}$) in mrem/yr per uCi/sec.	**1428** * $\dot{Q}$

Quarterly time average limit is 7.5 mrem to any organ (or 30 mrem/yr).

Solving for $\dot{Q}$ yields the following limits, at either unit:

	(Quarterly Limit)	**(Annual Limit)**
$\dot{Q}$ * 1428 $\frac{mrem/yr}{\mu Ci/\sec}$ = 30 mrem/yr;	2.10E-2 µCi/sec	1.05E-2 µCi/sec

(Annual limits are ½ quarterly limits, or 15 mrem to any organ/yr)

APPENDIX J

HYDROLOGICAL VERIFICATION OF GROUNDWATER FLOW RATES

Site hydrologists have verified the overall direction of groundwater flow at IPEC to be ultimately into the Hudson River. From this established understanding, two independent models are applied to determine groundwater flowrates from the site into the river, the precipitation mass balance and the Darcy's Law models. Either of these methods involves identification of specific zones over which the method is applied:

Zone 1	Area north of Unit 2, determined to have no impact on site effluents
Zone 2	Area along the Unit 2 riverfront
Zone 3	Area facing the river in front of Units 1 and 3, later split into Areas 3A (Unit 1) and 3B (Unit 3), to represent the groundwater flow from each unit.
Zone 4	Area south of Unit 3, determined to have no impact on site effluents.

Precipitation Mass Balance Method:

Measurements of the effected area, annual average rainfall, and infiltration rates (determined from USGS data) are used to compute a total mass to the river for each zone. This value is then adjusted for any known removal mechanism, such as evaporation, transpiration, runoff into storm drains (and any exfiltration back into groundwater), or footing drains. The resulting flow rates are then applied to the source term at the river front for each zone.

Source terms for this method are combined from all levels, and a 3rd quartile conservative assessment is generally assumed, where there is sufficient data to evaluate this statistical interpretation. Otherwise, a simple conservative average is used, or on rare occasions, a single positive value if all other values are negative. Doses are then calculated normally, in accordance with the ODCM and Reference 44.

Darcy's Law Method:

In this model, groundwater elevation contours and measurements of hydraulic conductivity are developed from the wells on site, recognizing that flow is perpendicular to the contours. This effort also provides knowledge of facility-specific flow paths. Darcy's Law is then applied to determine flow rate: $Q = k * i * A$ where Q, the ground water flow rate is a function of;

- k — the ease of which flow can be forced through the subsurface media, otherwise known as hydraulic conductivity;
- i — the pressure driving the flow, or the gradient (groundwater elevation change divided by the distance over which the change occurs);
- A — the cross-sectional area through which the flow occurs (length of groundwater or river interface times depth to bottom of contaminated groundwater flow).

Source terms for this method are more integrated than the mass balance method, and split into higher and lower elevations. At IPEC, this method is applied to verify the mass balance determinations, particularly to further integrate the area of the plume(s) in Areas 2 and 3A. In these key areas, dose calculations are integrated separately, as defined by individual well data, with source term quantification split into high and low elevations. As in the model above, doses are again calculated and summed in accordance with the ODCM and Reference 44.