



LONG ISLAND LIGHTING COMPANY

SHOREHAM NUCLEAR POWER STATION
P. O. BOX 618, NORTH COUNTRY ROAD • WADING RIVER, N.Y. 11792

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VICE PRESIDENT - OFFICE OF CORPORATE SERVICES
AND
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SNRC-1788

MAR 1 1991

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Semiannual Radioactive Effluent Release Report
Shoreham Nuclear Power Station
Docket No. 50-322

Ref: (1) Facility Operating License NPF-82 (Shoreham).
(2) SNRC-1747 dated August 23, 1990 to U.S. Nuclear
Regulatory Commission from John D. Leonard, Jr.;
subject: Semiannual Radioactive Effluent Release
Report.

Gentlemen:

Enclosed is a copy of our Semiannual Radioactive Effluent Release Report covering the third and fourth calendar quarters of 1990. This report is in conformance with Technical Specification 6.9.1.7 and is consistent with Sections 6.9.1.7 and 6.15.1 of Part I of the Offsite Dose Calculation Manual (ODCM), as revised, and Sections 9.3.1 and 9.4 of the Process Control Program (PCP), as revised, and was prepared in accordance with these documents. This report includes information for each type of solid waste shipped offsite during the period and changes made during the period to the ODCM.

On June 25, 1990 the NRC issued Amendment No. 5 to the Shoreham Nuclear Power Station (SNPS) Operating License (reference 1). This amendment, among other things, made changes to the Administrative Controls section (Section 6) of the Technical Specifications, relocated existing procedural details involving radioactive effluent monitoring instrumentation, equipment requirements, and control of radioactive liquid and gaseous effluents, and radiological monitoring and reporting details from the SNPS Technical Specifications to the ODCM. Additionally, the amendment relocated the requirements for radioactive solid waste from the Technical Specifications to the PCP and added record retention requirements for changes to the ODCM and PCP. In

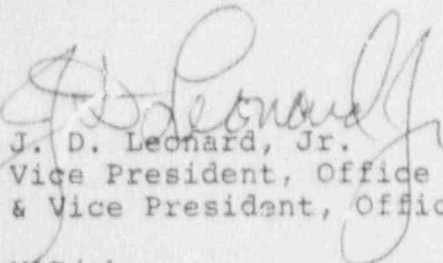
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SNRC-1747 (reference 2), we identified that these changes were only recently made effective and, therefore, committed to reporting these changes in the next Semiannual Radioactive Effluent Release Report. With the inclusion of revision 16 of the ODCM in this current report, this commitment has been fulfilled.

If you require additional information, please contact this office.

Very truly yours,



J. D. Leonard, Jr.
Vice President, Office of Corporate Services
& Vice President, Office of Nuclear

MAP/ab

cc: S. Brown
T. T. Martin
B. Norris

SEMIANNUAL RADIOACTIVE EFFLUENT
RELEASE REPORT

3rd and 4th Quarters of 1990
1990 Meteorological Summary and Offsite Dose Assessment

Facility: Shoreham Nuclear Power Station, Unit 1

Licensee: Long Island Lighting Company, Inc.

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INTRODUCTION

This Semiannual Radioactive Effluent Release Report, submitted in accordance with Technical Specification 6.9.1.7, Offsite Dose Calculation Manual (ODCM) 6.9.1.7 and 6.15.1, and Process Control Program (PCP) 9.4, covers the period from July 1, 1990 through December 31, 1990. Meteorological data summaries for the whole of 1990 are included as is an assessment of offsite doses due to liquid and gaseous effluents for the whole year. By contractual agreement with New York State, the Long Island Lighting Company (LILCO) will transfer the Shoreham Nuclear Power Station to the Long Island Power Authority. LILCO cannot operate the plant in the interim. In order to ready the plant for decommissioning and to protect plant systems, the fuel was transferred to the spent fuel pool in August 1989, and plant layup activities began. Prior to defueling, the plant was in a cold shutdown condition for almost two years.

A. SUPPLEMENTAL INFORMATION

1. Regulatory Limits

Shoreham's effluent regulatory limits are defined in Facility Operating License NPF-82, Shoreham Nuclear Power Station, Appendix A, Technical Specifications.

- a) Limits for gaseous effluents and noble gases are covered by Technical Specification 6.8.4 and ODCM Controls 3.11.2.1 and 3.11.2.2.
- b&c) Iodines and particulates with half-lives greater than 8 days in gaseous effluents are addressed in Technical Specification 6.8.4 and ODCM Control 3.11.2.3.
- d) Liquid effluent limits are described in Technical Specification 6.8.4 and ODCM Controls 3.11.1.1 and 3.11.1.2.
- e) In addition, with Shoreham's sampling and analysis program the following typical minimum detectable activities (MDA's) were achieved. These MDA's are less than the required lower limits of detection (LLD's):

Liquid:

Ce-141	3.06 E-8	uCi/ml
Co-58	2.84 E-8	uCi/ml
Cs-137	2.49 E-8	uCi/ml
Mn-54	2.49 E-8	uCi/ml
Mo-99	1.66 E-8	uCi/ml
Zn-65	6.50 E-8	uCi/ml

Gaseous:

Cs-137	5.65 E-14	uCi/cc
I-131	8.71 E-14	uCi/cc
I-133	7.29 E-13	uCi/cc
Mn-54	5.50 E-14	uCi/cc
Xe-133	1.33 E-08	uCi/cc
Zn-65	1.41 E-13	uCi/cc

2. Maximum Permissible Concentrations

a-d) Maximum permissible liquid effluent concentrations (MPC's) are those specified in 10 CFR 20, Appendix B, Table II, Column 2. If an isotope is listed with values for SOLUBLE and INSOLUBLE states, the more conservative value is utilized. For gaseous effluents, MPC's were not used. Direct calculations of dose were utilized to satisfy the dose rate limitations of Technical Specification 6.8.4 and ODCM Control 3.11.2.1.

3. Average Energy

No isotopes above minimum detectable activities were measured in gaseous effluents. Therefore, there is no reportable average energy for this time period.

4. Measurements and Approximations of Total Radioactivity

a-d) Samples were collected in the manner and with the frequency prescribed in Technical Specifications Surveillance Requirement 6.8.4 and ODCM Controls 4.11.1.1.1 and 4.11.2.1.2. Samples were analyzed in accordance with ODCM Controls Tables 4.11.1.1.1-1 and 4.11.2.1.2-1 regarding both type of analysis and level of sensitivity. Most samples were analyzed by gamma spectroscopy with a Germanium detector. A liquid scintillation counter was used to analyze for H-3 and Fe-55 while Sr-89, -90 analyses were done by proportional counter. Samples analyzed for iron and strontium underwent a chemical separation prior to counting. Approved sample collection and analysis procedures were followed.

Analytical results are examined to ensure that the minimum sensitivity levels required by ODCM lower limits of detection (LLD's) have been met. Any identifiable peaks above background are quantified.

The methods above were used for batch releases. The same methods were used for continuous discharges, but were combined with gross activity measurements on process streams and total flow for these streams.

No estimate of percent total error is provided in Table 1A and Table 2A because all values for gaseous and liquid effluents were determined to be less than required LLD's.

5. Batch Releases

a) Liquid	3rd quarter	4th Quarter
1. Number of batches	1.50 E+1	2.60 E+1
2. Total Time (minutes)	2.31 E+3	4.14 E+3
3. Maximum Time (minutes)	1.77 E+2	1.83 E+2
4. Average Time (minutes)	4 E+2	1.59 E+2
5. Minimum Time (minutes)	50 E+1	1.30 E+2
6. Average Flow (gpm) (Dilution)	1.43 E+5	7.02 E+4

b) Gaseous - None

6. Abnormal Releases

a) Liquid - None

b) Gaseous - None

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B - GASEOUS EFFLUENTS

3rd and 4th Quarters of 1990

All samples of gaseous effluents were analyzed and determined to be at or below minimum detectable activities (MDA's) for all radionuclides listed in Shoreham's ODCM. These MDA's were below the lower limits of detection required in ODCM Controls Table 4.11.2.1.2-1. In addition, no other radionuclides were identified. Therefore, no entries were made in Tables 1A, 1B or 1C that follow.

Composite sample results for the third and fourth quarters of this reporting period are all at or below MDA's. Similar results for the second quarter, which were not included in the last Semiannual Report because of unavailability then, are in and showing levels at or below MDA's.

TABLE 1A

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT 1990

GASEOUS EFFLUENTS—SUMMATION OF ALL RELEASES

	Unit	Quarter	Quarter	Est. Total Error, %
	1	3	4	

A. Fission & activation gases

1. Total release	Ci	. E	. E	. E
2. Average release rate for period	$\mu\text{Ci}/\text{sec}$	. E	. E	
3. Percent of Technical specification limit	%	. E	. E	

B. Iodines

1. Total iodine-131	Ci	. E	. E	. E
2. Average release rate for period	$\mu\text{Ci}/\text{sec}$	. E	. E	
3. Percent of technical specification limit	%	. E	. E	

C. Particulates

1. Particulates with half-lives >8 days	Ci	. E	. E	. E
2. Average release rate for period	$\mu\text{Ci}/\text{sec}$	. E	. E	
3. Percent of technical specification limit	%	. E	. E	
4. Gross alpha radioactivity	Ci	. E	. E	

D. Tritium

1. Total release	Ci	. E	. E	. E
2. Average release rate for period	$\mu\text{Ci}/\text{sec}$	. E	. E	
3. Percent of technical specification limit	%	. E	. E	

TABLE 1B

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT 1990
GASEOUS EFFLUENTS--ELEVATED RELEASE

Nuclides Released	Unit 1	CONTINUOUS MODE		BATCH MODE	
		Quarter 3	Quarter 4	Quarter 3	Quarter 4
1. Fission gases					
krypton-85	Ci	. E	. E	. E	. E
krypton-85m	Ci	. E	. E	. E	. E
krypton-87	Ci	. E	. E	. E	. E
krypton-88	Ci	. E	. E	. E	. E
xenon-133	Ci	. E	. E	. E	. E
xenon-135	Ci	. E	. E	. E	. E
xenon-135m	Ci	. E	. E	. E	. E
xenon-138	Ci	. E	. E	. E	. E
Others (specify)	Ci	. E	. E	. E	. E
	Ci	. E	. E	. E	. E
	Ci	. E	. E	. E	. E
unidentified	Ci	. E	. E	. E	. E
Total for period	Ci	. E	. E	. E	. E

2. Iodines

iodine-131	Ci	. E	. E	. E	. E
iodine-133	Ci	. E	. E	. E	. E
iodine-135	Ci	. E	. E	. E	. E
Total for period	Ci	. E	. E	. E	. E

3. Particulates

strontium-89	Ci	. E	. E	. E	. E
strontium-90	Ci	. E	. E	. E	. E
cesium-134	Ci	. E	. E	. E	. E
cesium-137	Ci	. E	. E	. E	. E
barium-lanthanum-140	Ci	. E	. E	. E	. E
Others (specify)	Ci	. E	. E	. E	. E
	Ci	. E	. E	. E	. E
	Ci	. E	. E	. E	. E
unidentified	Ci	. E	. E	. E	. E

TABLE 1C

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT 1990

GASEOUS EFFLUENTS—GROUND-LEVEL RELEASES

Nuclides Released	Unit	CONTINUOUS MODE		BATCH MODE	
		Quarter 3	Quarter 4	Quarter 3	Quarter 4

1. Fission gases

krypton-85	Ci	. E	. E	. E	. E
krypton-85m	Ci	. E	. E	. E	. E
krypton-87	Ci	. E	. E	. E	. E
krypton-86	Ci	. E	. E	. E	. E
xenon-133	Ci	. E	. E	. E	. E
xenon-135	Ci	. E	. E	. E	. E
xenon-135m	Ci	. E	. E	. E	. E
xenon-138	Ci	. E	. E	. E	. E
Others (specify)	Ci	. E	. E	. E	. E
	Ci	. E	. E	. E	. E
	Ci	. E	. E	. E	. E
unidentified	Ci	. E	. E	. E	. E
Total for period	Ci	. E	. E	. E	. E

2. Iodines

iodine-131	Ci	. E	. E	. E	. E
iodine-133	Ci	. E	. E	. E	. E
iodine-135	Ci	. E	. E	. E	. E
Total for period	Ci	. E	. E	. E	. E

3. Particulates

strontium-89	Ci	. E	. E	. E	. E
strontium-90	Ci	. E	. E	. E	. E
cesium-134	Ci	. E	. E	. E	. E
cesium-137	Ci	. E	. E	. E	. E
barium-lanthanum-140	Ci	. E	. E	. E	. E
Others (specify)	Ci	. E	. E	. E	. E
	Ci	. E	. E	. E	. E
	Ci	. E	. E	. E	. E
unidentified	Ci	. E	. E	. E	. E

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C - LIQUID EFFLUENT

3rd and 4th Quarters of 1990

All samples of liquid effluents were analyzed and determined to be at or below minimum detectable activities (MDA's) for all radionuclides listed in the ODCM.

These MDA's were below the LLD's required in ODCM Controls Table 4.11.1.1.1-1. In addition, no other radionuclides were identified. Therefore, no entries were made in Tables 2A and 2B that follow.

Composite sample results for the third and fourth quarters of this reporting period are all at or below MDA's. Results for the second quarter, which were not included in the last Semiannual Report because of unavailability then, also are at or below the MDA's.

TABLE 2A

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT 1990

LIQUID EFFLUENTS—SUMMATION OF ALL RELEASES

Unit 1	Quarter 3	Quarter 4	Est. Total Error, %
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A. Fission and activation products

1. Total release (not including tritium, gases, alpha)	Ci	. E	. E	. E
2. Average diluted concentration during period	$\mu\text{Ci/ml}$	. E	. E	
3. Percent of applicable limit	%	. E	. E	

B. Tritium

1. Total release	Ci	. E	. E	. E
2. Average diluted concentration during period	$\mu\text{Ci/ml}$	. E	. E	
3. Percent of applicable limit	%	. E	. E	

C. Dissolved and entrained gases

1. Total release	Ci	. E	. E	. E
2. Average diluted concentration during period	$\mu\text{Ci/ml}$	. E	. E	
3. Percent of applicable limit	%	. E	. E	

D. Gross alpha radioactivity

1. Total release	Ci	. E	. E	. E
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E. Volume of waste released (prior to dilution)	liters	. E	. E	. E
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F. Volume of dilution water used during period	liters	. E	. E	. E
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TABLE 2B

EFFLUENT AND WASTE DISPOSAL SEMI-ANNUAL REPORT 1990

LIQUID EFFLUENTS

Nuclides Released	Unit	CONTINUOUS MODE		BATCH MODE	
		Quarter 3	Quarter 4	Quarter 3	Quarter 4
strontium-89	Ci	. E	. E	. E	. E
strontium-90	Ci	. E	. E	. E	. E
cesium-134	Ci	. E	. E	. E	. E
cesium-137	Ci	. E	. E	. E	. E
iodine-131	Ci	. E	. E	. E	. E
cobalt-58	Ci	. E	. E	. E	. E
cobalt-60	Ci	. E	. E	. E	. E
iron-59	Ci	. E	. E	. E	. E
zinc-65	Ci	. E	. E	. E	. E
manganese-54	Ci	. E	. E	. E	. E
chromium-51	Ci	. E	. E	. E	. E
zirconium-niobium-95	Ci	. E	. E	. E	. E
molybdenum-99	Ci	. E	. E	. E	. E
technetium-99m	Ci	. E	. E	. E	. E
barium-lanthanum-140	Ci	. E	. E	. E	. E
cerium-141	Ci	. E	. E	. E	. E
Other (specify)	Ci	. E	. E	. E	. E
	Ci	. E	. E	. E	. E
	Ci	. E	. E	. E	. E
	Ci	. E	. E	. E	. E
	Ci	. E	. E	. E	. E
unidentified	Ci	. E	. E	. E	. E
Total for period (above)	Ci	. E	. E	. E	. E
xenon-133	Ci	. E	. E	. E	. E
xenon-135	Ci	. E	. E	. E	. E

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D - SOLID WASTE

3rd and 4th Quarters of 1990

Table 3 provides information on shipments of solid waste for the third and fourth quarters of 1990. These shipments consisted of dewatered Class A Resins, Class A Dry Active Waste (DAW), and Class A Irradiated Components. There were no irradiated fuel shipments. The resins were shipped in 158.1 ft³ DOT Spec 7A High Integrity Containers (HIC's), approved by the South Carolina Department of Health and Environmental Conservation. DAW was shipped in 55 gallon drums and the Irradiated Components were shipped in a lead-lined B-25 box in a special box cask.

TABLE 3

*** REGULATORY GUIDE 1.21 REPORT ***
 SOLID WASTE SHIPPED OFFSITE FOR DISPOSAL
 ** DURING PERIOD FROM 7/1/90 to 12/31/90**

WASTE STREAM: Resins, Filters, & Evaporator Bottoms

<u>WASTE CLASS</u>	<u>CUBIC METERS</u>	<u>CURIES</u>	<u>% ERROR (CI)</u>
A	17.9	3.23E-03	±25%

** ESTIMATES OF MAJOR NUCLIDES BY WASTE CLASS & STREAM **
 WASTE STREAM: Resins, Filters & Evaporator Bottoms with .0% CUTOFF

<u>WASTE CLASS</u>	<u>NUCLIDE</u>	<u>ABUNDANCE</u>	<u>CURIES</u>
A	Co-60	25.144%	8.11E-04
	Fe-55	21.932%	7.57E-04
	Cr-51	18.134%	5.85E-04
	Co-58	13.443%	4.34E-04
	Zn-65	4.167%	1.34E-04
	Ag-110m	3.336%	1.08E-04
	Pu-241	3.333%	1.08E-04
	H-3	3.255%	1.05E-04
	Mn-54	2.759%	8.90E-05
	Fe-59	1.682%	5.42E-05
	Ce-144	1.059%	3.42E-05
	Ni-63	.990%	3.19E-05
	Cs-137	.341%	1.10E-05
	Nb-95	.148%	4.77E-06
	Sb-124	.127%	4.09E-06
	Co-57	.102%	3.28E-06
	Ce-141	.023%	7.49E-07
	Ni-59	.018%	5.69E-07
	Sr-90	.007%	2.31E-07
	Nb-94	.000%	1.18E-08
	C-14	.000%	4.51E-09
	U-242	.000%	0.00E+00
	I-129	.000%	0.00E+00
	Tc-99	.000%	0.00E+00

TABLE 3 (Cont'd)

*** REGULATORY GUIDE 1.21 REPORT ***
 SOLID WASTE SHIPPED OFFSITE FOR DISPOSAL
 ** DURING PERIOD FROM 7/1/90 to 12/31/90**

WASTE STREAM: Dry Active Waste

<u>WASTE CLASS</u>	<u>CUBIC METERS</u>	<u>CURIES</u>	<u>% ERROR (CI)</u>
A	6.4	8.01E-02	±25%

** ESTIMATES OF MAJOR NUCLIDES BY WASTE CLASS & STREAM **
 WASTE STREAM: Dry Active Waste with .0% CUTOFF

<u>WASTE CLASS</u>	<u>NUCLIDE</u>	<u>ABUNDANCE</u>	<u>CURIES</u>
A	Mn-54	23.893%	1.91E-02
	Co-60	22.855%	1.83E-02
	Fe-55	18.640%	1.49E-02
	Cr-51	15.398%	1.23E-02
	Co-58	10.941%	8.77E-03
	Zn-65	3.764%	3.02E-03
	Ag-110M	3.069%	2.46E-03
	Fe-59	1.311%	1.05E-03
	Ni-63	.060%	4.80E-05
	H-3	.045%	3.62E-05
	Sb-124	.008%	6.48E-06
	Co-57	.007%	5.24E-06
	Zr-95	.005%	4.28E-06
	Cs-137	.003%	2.10E-06
	Ni-59	.001%	9.16E-07
	Ce-141	.000%	1.52E-07
	C-14	.000%	1.13E-07
	Am-241	.000%	5.00E-08
	Sr-90	.000%	3.66E-08
	Nb-94	.000%	1.85E-08
Ce-144	.000%	1.52E-08	
Cm-242	.000%	0.00E+00	
Pu-241	.000%	0.00E+00	
I-129	.000%	0.00E+00	
TC-99	.000%	0.00E+00	

TABLE 3 (Cont'd)

*** REGULATORY GUIDE 1.21 REPORT ***
 SOLID WASTE SHIPPED OFFSITE FOR DISPOSAL
 ** DURING PERIOD FROM 7/1/90 to 12/31/90**

WASTE STREAM: Irradiated Components

<u>WASTE CLASS</u>	<u>CUBIC METERS</u>	<u>CURIES</u>	<u>% ERROR (CI)</u>
A	2.8	8.19E-01	±25%

** ESTIMATES OF MAJOR NUCLIDES BY WASTE CLASS & STREAM **
 WASTE STREAM: Irradiated Components with .0% CUTOFF

<u>WASTE CLASS</u>	<u>NUCLIDE</u>	<u>ABUNDANCE</u>	<u>CURIES</u>
A	FE-55	66.426%	5.44E-01
	Co-60	29.428%	2.41E-01
	Ni-63	2.235%	1.83E-02
	Mn-54	1.893%	1.55E-02
	Ni-59	.015%	1.26E-04
	C-14	.003%	2.76E-05
	Nb-94	.000%	2.60E-07
	Pu-241	.000%	6.78E-08
	Pu239/40	.000%	4.62E-08
	Pu-238	.000%	2.92E-08
	Tc-99	.000%	2.53E-10
	Np-237	.000%	1.49E-10
	Cm-242	.000%	3.52E-11
	Am-241	.000%	2.60E-12
	Cr-51	.000%	1.37E-12
	Cm243/44	.000%	4.29E-14
	Pu-242	.000%	1.59E-14
	Am-243	.000%	6.50E-15
	Cs-137	.000%	0.00E+00
	I-129	.000%	0.00E+00
	Sr-90	.000%	0.00E+00
	H-3	.000%	0.00E+00

** SOLID WASTE DISPOSITION SUMMARY**

<u>NUMBER OF SHIPMENTS</u>	<u>MODE OF TRANSPORTATION</u>	<u>DESTINATION</u>
2	Truck	Barnwell
0	Truck	Richland
0	Truck	Beatty
0	Truck	Other

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E - RADIOLOGICAL IMPACT ON MAN

1990

During 1990, there were no radioactive isotopes identified within the limits of detection in any of the liquid or gaseous streams discharged. Therefore, dose calculations were not performed.

Direct radiation (as measured on quarterly TLD's) made no contribution to offsite doses based on a comparison of 1990 dose rates with 1984 (preoperational) dose rates. The highest dose measured in 1990 was 5.0 mrem/standard month (30.4 days) at indicator location 6A1 compared to the 1984 dose at the same maximum location of 5.1 mrem/standard month. Similarly, the 1990 average for all indicator locations was 3.6 mrem/standard month compared to a 1984 value of 3.9 mrem/standard month.

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F - METEOROLOGICAL DATA

1990

Tables of cumulative joint frequency distribution of wind speed, wind direction, and atmospheric stability are given by quarter for release heights of 33 feet and 150 feet. The joint frequency distributions reflect all data that was determined to be valid by a meteorological consultant and are given in the tables that follow.

Some of the 33-foot level wind speed data was recovered from strip charts at the offsite tower. The offsite tower data are considered representative of the site and this tower was used for the collection of the original licensing meteorological data base, which has been reviewed and accepted by the NRC. Although the calibration and maintenance of the strip chart recorders at the offsite tower is not included in the Plant's Surveillance Program, they are maintained by LLCO's Environmental Engineering Department (ENVED), in accordance with ENVED's procedures. A quarterly calibration and maintenance program for the meteorological instruments, including these recorders, is in effect and performed by TRC Environmental Consultants.

The percent recovery for joint wind speed, wind direction and delta temperature was 93% for the year.

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: A
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	1	0	0	0	1
NNE	0	0	1	1	0	0	2
NE	0	0	0	7	0	0	7
ENE	0	0	0	2	0	0	2
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	1	0	0	1
S	0	0	1	5	0	0	6
SSW	0	0	0	4	0	0	4
SW	0	0	0	1	0	0	1
WSW	0	0	0	0	0	0	0
W	0	0	2	2	0	0	4
WSW	0	0	0	9	5	0	14
WNW	0	0	1	11	0	0	12
WNW	0	0	2	6	2	0	10

VARIABLE
 TOTAL 64
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: B
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	2	0	0	2
NNE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	1	1	0	0	2
SSE	0	0	1	0	0	0	1
S	0	0	1	0	0	0	1
SSH	0	0	1	0	0	0	1
SH	0	0	1	0	0	0	1
SSH	0	0	0	0	0	0	0
W	0	0	0	1	0	0	1
WNW	0	0	1	5	3	0	9
W	0	0	2	4	0	0	6
WNW	0	0	1	2	0	0	3

VARIABLE
 TOTAL 27
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: C
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	0	0	0	0	0
NNE	0	0	2	0	0	0	2
NE	0	0	2	0	0	0	2
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	2	0	0	0	2
SSE	0	0	1	0	0	0	1
S	0	0	0	0	1	0	1
SSH	0	0	4	3	0	0	7
SH	0	0	1	0	0	0	1
HSH	0	0	1	0	0	0	1
H	0	0	1	1	1	0	3
HNN	0	0	2	1	2	0	5
NN	0	0	3	1	0	0	4
NHN	0	0	2	1	0	0	3

TOTAL 32
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: D
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	1	14	15	7	1	0	38
NNE	1	9	5	1	1	0	17
NE	0	3	6	0	0	0	9
ENE	0	3	5	1	0	0	9
E	0	3	4	4	0	0	11
ESE	0	2	4	0	0	0	6
SE	0	5	4	1	0	0	10
SSE	0	4	5	0	0	0	9
S	0	9	16	14	1	0	40
SSH	0	10	27	29	9	0	75
SH	2	5	15	0	0	0	22
HSH	0	5	11	2	0	0	18
H	0	5	16	20	1	0	42
HNH	0	13	39	17	7	0	76
NH	1	10	10	7	3	2	33
NNH	1	12	7	6	4	1	31
VARIABLE							

TOTAL 446
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: E
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	5	4	9	9	7	0	34
NNE	1	19	18	7	10	1	56
NE	4	19	8	1	9	0	36
ENE	7	17	8	15	0	0	47
E	1	13	13	1	0	0	28
ESE	5	10	9	0	0	0	24
SE	3	8	10	3	1	0	25
SSE	1	7	5	0	0	0	13
S	5	34	76	31	1	0	147
SSW	3	28	84	51	4	0	170
SW	4	34	29	2	0	0	69
WSW	4	16	23	1	0	0	44
W	3	9	45	21	0	0	78
WNW	2	8	35	34	29	13	121
WW	4	14	18	19	21	10	86
WNW	2	10	15	23	16	4	70

VARIABLE
 TOTAL 1048
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: F
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	2	5	0	1	0	0	8
NNE	0	3	1	0	0	0	4
NE	2	5	4	0	0	0	11
ENE	2	7	6	0	0	0	15
E	1	2	0	0	0	0	3
ESE	2	3	0	0	0	0	5
SE	2	3	1	0	0	0	6
SSE	3	20	0	0	0	0	23
S	4	24	12	1	0	0	41
SSW	3	14	16	0	0	0	33
SW	1	16	11	0	0	0	28
WSW	3	7	2	0	0	0	12
W	3	5	2	0	0	0	10
WNW	1	5	6	1	0	0	14
NW	3	3	2	0	0	0	8
NNW	1	1	3	0	0	0	5
VARIABLE							

TOTAL 226
 PERIODS OF CALM (HOURS): 1

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: G
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	2	0	0	0	0	2
NNE	0	1	0	0	0	0	1
NE	0	0	2	0	0	0	2
ENE	1	0	1	0	0	0	2
E	0	1	0	0	0	0	1
ESE	0	1	0	0	0	0	1
SE	1	0	0	0	0	0	1
SSE	4	13	2	0	0	0	19
S	3	13	11	0	0	0	27
SSW	7	22	3	0	0	0	32
SW	1	13	0	0	0	0	14
WSW	3	3	0	0	0	0	6
W	0	0	0	0	0	0	0
WNW	2	2	0	0	0	0	4
NW	0	1	0	0	0	0	1
NNW	0	1	0	0	0	0	1
VARIABLE							

TOTAL 114
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/90 TO 6/30/90
 STABILITY CLASS: A
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	5	1	0	0	6
NNE	0	0	2	0	0	0	2
NE	0	0	4	0	0	0	4
ENE	0	0	2	0	0	0	2
E	0	0	2	0	0	0	2
ESE	0	0	1	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	0	1	4	0	0	5
S	0	0	4	10	0	0	14
SSW	0	0	8	6	0	0	14
SW	0	0	2	0	0	0	2
WSW	0	0	1	0	0	0	1
W	0	0	1	2	0	0	3
WNW	0	0	0	11	0	0	11
NW	0	0	3	0	0	0	3
NNW	0	0	2	0	0	0	2
VARIABLE							
TOTAL	72						
PERIODS (IF CALM (HOURS):			0				

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/90 TO 6/30/90
 STABILITY CLASS: B
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	1	0	0	0	1
NNE	0	1	1	0	0	0	2
NE	0	0	3	0	0	0	3
NNE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	2	0	0	0	2
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	6	1	2	0	9
SSH	0	0	2	4	1	0	7
SW	0	2	0	0	0	0	2
WSW	0	0	0	0	0	0	0
W	0	0	1	1	0	0	2
WSW	0	0	9	10	0	0	19
WNW	0	0	3	1	0	0	4
WNW	0	0	1	0	0	0	1

TOTAL 52
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/70 TO 6/30/90
 STABILITY CLASS: C
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	1	4	0	0	0	5
N/E	0	2	2	0	0	0	4
NE	0	0	0	0	0	0	0
E/NE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
E/SE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
S/SE	0	1	2	0	0	0	3
S	0	0	4	3	1	0	8
S/SW	0	0	6	9	0	0	15
SW	0	1	0	0	0	0	1
W/SW	0	0	0	1	0	0	1
W	0	0	3	0	0	0	3
W/NW	0	0	10	8	0	0	18
NW	0	0	17	0	0	0	17
N/NW	0	0	0	0	0	0	0
VARIABLE							
TOTAL	75						
PERIODS OF CALM (HOURS):				0			

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/90 TO 6/30/90
 STABILITY CLASS: 0
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	1	25	8	1	0	0	35
NNE	0	25	8	4	0	0	37
NE	0	17	4	10	0	0	31
NNE	0	2	1	4	0	0	7
E	0	1	7	1	0	0	9
ESE	1	1	1	0	0	0	3
SE	0	4	4	1	0	0	11
SSE	0	13	29	4	1	0	47
S	1	35	42	26	5	0	109
SSW	2	16	19	21	10	0	68
SW	3	4	8	1	0	0	16
WSW	0	3	11	1	0	0	15
W	0	4	12	8	0	0	24
WNW	1	18	57	19	0	0	95
W	0	29	35	5	0	0	69
WNW	0	35	19	0	0	0	54
VARIABLE							

TOTAL 630
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/90 TO 6/30/90
 STABILITY CLASS: E
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	3	11	19	11	2	2	48
NNE	8	20	11	17	4	0	60
NE	10	35	21	15	4	0	85
ENE	0	17	26	18	0	0	61
E	3	7	5	1	0	0	16
ESE	2	12	5	2	0	0	21
SE	2	16	4	1	0	0	23
SSE	3	35	22	6	1	0	67
S	8	83	111	43	6	1	252
SSW	11	48	23	30	4	5	121
SW	9	20	14	0	0	0	43
WSW	8	12	7	2	0	0	29
W	4	23	12	3	0	0	42
WNW	12	20	11	13	0	0	56
WW	2	30	14	11	11	0	69
WNW	6	11	11	16	7	5	56
VARIABLE							

TOTAL 1049
 PERIODS OF CALM (HOURS): 1

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/90 TO 6/30/90
 STABILITY CLASS: F
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-11	13-18	19-24	>24	
N	2	0	4	0	0	0	6
NNE	0	0	0	0	0	0	0
NE	1	0	0	0	0	0	1
ENE	1	1	0	0	0	0	2
E	1	0	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	1	1	0	1	0	0	3
SSE	4	4	3	0	0	0	11
S	9	24	20	1	0	0	54
SSW	4	12	2	0	0	0	18
SW	11	20	3	0	0	0	34
WSW	5	6	0	0	0	0	11
W	5	5	0	0	0	0	11
WNW	6	4	2	0	0	0	13
W	3	1	4	0	0	0	9
WNW	4	6	1	1	0	0	12
VARIABLE							

TOTAL 186
 PERIODS OF CALM (HOURS): 3

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/90 TO 6/30/90
 STABILITY CLASS: G
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	2	0	0	0	0	0	2
SSE	1	5	2	0	0	0	8
S	2	14	1	0	0	0	17
SSW	8	20	1	0	0	0	29
SW	2	12	2	0	0	0	17
WSW	9	2	0	0	0	0	12
W	2	1	0	0	0	0	3
WNW	2	0	0	0	0	0	2
WV	1	1	0	0	0	0	2
WNW	0	0	0	0	0	0	0
VARIABLE							

TOTAL 92
 PERIODS OF CALM (HOURS): 2

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: A
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	0	4	0	0	4
NNE	0	9	1	1	0	0	11
NE	0	6	18	2	0	0	26
ENE	0	2	2	0	0	0	4
E	0	0	0	0	0	0	0
ESE	0	2	0	0	0	0	2
SE	1	2	0	0	0	0	3
SSE	0	2	8	0	0	0	10
S	0	3	11	2	0	2	18
SSW	0	0	4	1	0	1	6
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WW	0	0	1	0	0	0	1
WN	4	1	1	2	0	0	8
WNW	0	2	1	0	0	0	3

VARIABLE
 TOTAL 96
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: B
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	0	1	0	0	1
NNE	0	3	0	0	0	0	3
NE	0	1	6	1	0	0	8
ENE	0	0	0	0	0	0	0
E	0	3	0	0	0	0	3
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	2	0	0	0	2
S	1	2	4	1	0	0	8
SSW	0	2	3	1	1	1	8
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	3	0	0	0	3
NW	0	1	2	1	0	0	4
NNW	0	1	3	0	0	0	4
VARIABLE							

TOTAL 45
 PERIODS OF CALM (HOURS): 1

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: C
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	4	1	0	0	0	5
NNE	0	3	1	0	0	0	4
NE	1	4	3	0	0	0	8
ENE	0	4	0	0	0	0	4
E	1	1	0	0	0	0	2
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	1	3	0	0	0	4
S	0	4	5	1	0	0	10
SSH	0	1	2	0	0	0	3
SH	0	3	0	0	0	0	3
HSH	0	0	1	0	0	0	1
H	1	0	0	0	0	0	1
HSH	0	0	4	1	0	0	5
HH	1	4	3	1	0	0	9
HSH	0	3	2	0	0	0	5
VARIABLE							

TOTAL 64
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: D
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	2	23	2	0	0	0	27
NNE	9	15	5	4	0	0	33
NE	3	19	17	3	1	0	43
ENE	2	13	5	1	0	0	21
E	4	0	0	0	0	0	4
ESE	1	4	0	0	0	0	5
SE	4	5	2	0	0	0	11
SEF	0	20	13	0	0	0	33
S	3	19	32	2	1	1	58
SSH	1	19	16	3	0	3	42
SH	1	10	0	0	0	0	11
WSH	1	5	3	0	0	0	9
W	1	12	7	0	0	0	20
WSW	3	29	29	4	2	0	68
WV	5	49	10	1	0	0	65
WSW VARIABLE	13	59	2	4	0	0	78

TOTAL 528
 PERIODS OF CALM (HOURS): 1

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: E
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	5	11	8	8	1	0	34
NNE	9	18	17	12	3	0	59
NE	14	37	49	34	2	0	136
ENE	20	25	30	2	0	0	78
E	10	6	1	0	0	0	18
ESE	23	9	0	0	0	0	32
SE	15	16	1	0	0	0	33
SSE	14	48	18	0	0	0	81
S	9	99	54	6	2	1	171
SSW	8	23	20	1	0	1	54
SW	4	7	2	0	0	0	14
WSW	11	11	0	0	0	0	23
W	5	22	6	1	0	0	35
WNW	7	28	5	2	1	0	44
NW	10	18	25	7	0	0	62
WNW	6	23	15	11	1	0	56

IRIABLE

TOTAL 936
 PERIODS OF CALM (HOURS): 17

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: F
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	4	1	0	0	0	6
NNE	0	1	0	0	0	0	3
NE	1	0	0	0	0	0	1
ENE	2	1	0	0	0	0	3
E	2	0	0	0	0	0	2
ESE	3	0	0	0	0	0	4
SE	3	1	0	0	0	0	7
SSE	10	5	0	0	0	0	16
S	10	60	4	0	0	0	74
SSW	8	24	11	0	0	0	46
SW	12	14	1	0	0	0	31
WSW	7	1	1	0	0	0	10
W	6	1	1	0	0	0	9
WNW	3	7	0	0	0	0	13
NW	1	6	1	1	0	0	10
NNW	2	4	2	0	0	0	9
VARIABLE							

TOTAL 244
 PERIODS OF CALM (HOURS): 22

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: G
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-16	19-24	>24	
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	1	0	0	0	0	0	1
E	0	0	0	0	0	0	0
ESE	1	0	0	0	0	0	1
SE	7	3	0	0	0	0	11
SSE	5	15	0	0	0	0	20
S	19	34	0	0	0	0	53
SSW	29	55	4	0	0	0	90
SW	21	8	0	0	0	0	30
WSW	11	1	1	0	0	0	16
W	2	0	0	0	0	0	3
WNW	1	0	0	0	0	0	3
WN	0	0	0	0	0	0	1
WNW	0	0	0	0	0	0	0
VARIABLE							

TOTAL 229
 PERIODS OF CALM (HOURS): 11

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/31/90
 STABILITY CLASS: A
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	2	1	0	0	0	3
NNE	0	1	4	0	0	0	5
NE	0	7	1	0	0	0	8
NNE	0	2	1	0	0	0	3
E	0	1	1	0	0	0	2
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	5	0	0	0	0	5
S	0	1	0	0	0	0	1
SSW	0	9	0	0	0	0	9
SW	0	0	0	0	0	0	0
WSW	0	1	0	0	0	0	1
W	0	2	1	0	0	0	3
WSW	0	5	5	0	0	0	10
W	0	7	13	5	0	0	25
WSW	0	3	8	13	0	0	24
VARIABLE							

TOTAL 95
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/31/90
 STABILITY CLASS: B
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	1	0	0	0	1
NNE	0	0	1	0	0	0	1
NE	0	1	0	0	0	0	1
NNE	0	0	0	0	0	0	0
E	0	0	1	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	1	0	0	0	0	1
S	0	2	3	0	0	0	5
SSW	0	1	1	2	0	0	4
SW	0	0	0	0	0	0	0
WSW	0	2	0	0	0	0	2
W	0	0	0	0	0	0	0
WNW	0	2	5	4	0	0	11
NW	0	1	2	1	0	0	4
NWN	0	3	0	6	0	0	9
VARIABLE							
TOTAL	40						
PERIODS OF CALM (HOURS):				0			

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/31/90
 STABILITY CLASS: C
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
H	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	1	0	0	0	0	1
S	0	5	1	0	0	0	6
SSW	0	2	6	0	0	0	8
SW	0	0	2	0	0	0	2
WSW	1	0	2	0	0	0	3
W	0	1	0	0	0	0	1
WNW	0	1	1	4	2	0	8
NW	0	4	2	2	0	0	8
NNW	0	1	4	2	0	0	7
VARIABLE							

TOTAL 45
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/31/90
 STABILITY CLASS: 0
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	2	3	4	1	13	0	23
NNE	3	6	3	16	9	0	37
NE	0	5	5	4	0	0	14
NNE	0	2	2	1	0	0	5
E	2	11	3	0	0	0	16
ESE	4	4	0	0	0	0	8
SE	2	3	3	0	0	0	8
SSE	0	6	5	2	1	0	14
S	3	20	14	7	0	0	44
SSW	2	14	21	0	0	0	37
SW	2	5	9	0	0	0	16
WSW	2	4	6	0	0	0	12
W	3	6	13	3	0	0	25
WNW	6	15	19	26	9	0	75
NW	3	6	10	15	2	0	36
NNW	1	5	7	29	7	5	54
VARIABLE							

TOTAL 424
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/31/90
 STABILITY CLASS: E
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	3	22	10	2	0	38
NNE	0	2	19	6	2	0	29
NE	1	0	1	5	0	0	7
ENE	3	6	0	0	0	0	9
E	13	13	1	0	0	0	27
ESE	11	14	10	5	0	0	40
SE	7	22	7	4	0	0	40
SSE	8	28	15	3	1	0	55
S	11	91	39	10	0	0	151
SSW	10	54	38	16	0	0	118
SW	13	27	9	2	0	0	51
WSW	5	14	10	1	0	0	31
W	4	14	20	8	0	0	46
WNW	9	16	23	51	19	0	113
WW	2	10	27	38	11	0	69
WNW	0	3	26	66	22	1	119
VARIABLE							

TOTAL 963
 PERIODS OF CALM (HOURS): 4

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/31/90
 STABILITY CLASS: F
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-5	6-7	8-12	13-18	19-24	>24	
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	1	0	0	0	0	0	1
ENE	2	0	0	0	0	0	2
E	1	0	0	0	0	0	1
ESE	13	0	0	0	0	0	13
SE	6	1	0	0	0	0	7
SSE	6	8	0	0	0	0	14
S	13	29	4	0	0	0	46
SSW	9	16	1	2	0	0	28
SW	13	14	2	0	0	0	29
WSW	3	3	0	0	0	0	6
W	1	2	0	0	0	0	3
WNW	0	1	0	0	0	0	1
WW	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
VARIABLE							

TOTAL 161
 PERIODS OF CALM (HOURS): 10

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/31/90
 STABILITY CLASS: G
 ELEVATION: 33

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	2	0	0	0	0	0	2
SE	3	0	0	0	0	0	3
SSE	11	14	0	0	0	0	25
S	24	24	0	0	0	0	48
SSW	33	47	0	0	0	0	80
SW	15	14	0	0	0	0	31
WSW	4	1	0	0	0	0	5
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
WW	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
VARIABLE							

TOTAL 198
 PERIODS OF CALM (HOURS): 6

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: A
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	2	3	0	0	5
NNE	0	0	1	1	0	0	2
NE	0	0	0	0	0	0	0
ENE	0	0	4	4	0	0	8
E	0	0	0	1	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	2	0	0	2
SSW	0	0	0	8	1	0	9
SW	0	0	0	0	0	0	0
WSW	0	0	0	2	0	0	2
W	0	0	0	3	1	0	4
WNW	0	0	0	7	3	0	10
W	0	0	3	6	1	0	10
WNW	0	0	2	9	1	0	12
VARIABLE							

TOTAL 65
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: B
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	0	1	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	1	1	0	0	2
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	1	2	0	0	3
S	0	0	0	0	0	0	0
SSH	0	0	0	1	0	0	1
SH	0	0	0	1	0	0	1
HSH	0	0	1	0	0	0	1
N	0	0	0	1	1	0	2
NBN	0	0	1	4	0	0	5
NH	0	0	2	2	3	0	7
NBN	0	0	2	1	1	0	4

VARIABLE
 TOTAL 27
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: C
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	0	0	0	0	0
NNE	0	1	2	0	0	0	3
NL	0	0	0	0	0	0	0
ENE	0	0	1	1	0	0	2
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	3	0	0	0	3
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	1	2	1	1	5
SW	0	0	1	1	1	0	3
WSW	0	0	0	3	0	0	3
W	0	0	1	0	1	0	2
WSW	0	0	1	0	1	0	2
WNW	0	0	4	1	2	0	7
WNW	0	0	1	1	0	0	2
VARIABLE							

TOTAL 32
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: D
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	17	8	6	0	0	31
NNE	1	14	8	4	2	0	29
NE	2	4	0	0	0	0	6
ENE	0	6	9	1	0	0	16
E	1	2	6	1	1	0	11
ESE	0	1	4	3	4	0	12
SE	1	4	5	0	0	0	10
SSE	0	2	2	1	0	0	5
S	0	3	5	1	0	0	9
SSW	0	4	20	34	11	10	79
SW	0	2	12	17	10	0	41
WSW	0	3	10	6	0	0	19
W	0	3	12	19	6	0	40
WNW	0	8	35	18	17	0	78
NW	1	11	12	3	9	0	36
NNW	1	4	3	11	4	3	26
VARIABLE							

TOTAL 448
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECOND: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: E
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	1	11	15	21	8	0	56
NNE	2	4	19	16	8	0	49
NE	2	2	16	5	3	0	28
ENE	0	12	22	5	3	0	42
E	3	8	21	20	4	0	56
ESE	1	12	15	3	0	0	31
SE	1	8	12	1	0	0	22
SSE	0	4	6	7	1	0	18
S	0	6	5	7	0	0	18
SSW	0	3	45	75	36	3	162
SW	0	6	22	90	19	2	139
WSW	0	11	36	28	1	0	76
W	0	6	18	42	2	0	68
WNW	4	7	18	37	39	8	113
NW	2	9	19	30	24	8	92
NNW	0	5	22	26	21	6	80

VARIABLE

TOTAL 1050
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: F
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	3	5	1	0	0	9
NNE	0	1	0	0	0	0	1
NE	0	1	7	0	0	0	8
ENE	1	3	11	1	0	0	16
E	0	4	6	5	0	0	15
ESE	0	3	1	0	0	0	4
SE	0	7	1	0	0	0	8
SSE	0	4	6	0	0	0	10
S	0	4	13	4	0	0	21
SSW	0	0	16	7	0	0	23
SW	0	6	8	16	0	0	30
WSW	0	2	13	18	1	0	34
W	1	4	9	2	0	0	16
WNW	0	3	6	2	0	0	11
WW	0	4	3	5	0	0	12
WNW	1	2	4	1	0	0	8
VARIABLE							

TOTAL 226
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 1/ 1/90 TO 3/31/90
 STABILITY CLASS: G
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	3	0	0	0	0	3
NNE	0	1	0	0	0	0	1
NE	0	1	1	0	0	0	2
ENE	0	1	4	0	0	0	5
E	0	1	1	0	0	0	2
ESE	0	1	1	0	0	0	2
SE	0	1	0	0	0	0	1
SSE	0	5	6	2	0	0	13
S	1	2	5	4	0	0	12
SSW	0	3	4	7	0	0	14
SW	0	4	9	8	0	0	21
WSW	0	2	10	5	0	0	17
W	1	6	1	0	0	0	7
WNW	3	6	2	0	0	0	11
NW	0	0	2	0	0	0	2
NNW	0	0	0	0	0	0	0
VARIABLE							

TOTAL 114
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/90 TO 6/30/90
 STABILITY CLASS: A
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	3	2	0	0	5
NNE	0	0	3	1	0	0	4
NE	0	1	1	0	0	0	2
ENE	0	0	3	0	0	0	3
E	0	0	1	2	0	0	3
ESE	0	0	1	0	0	0	1
SE	0	0	1	0	0	0	1
SSE	0	0	1	1	0	0	2
S	0	0	0	8	0	0	8
SSW	0	0	2	14	3	0	19
SW	0	0	0	5	1	0	6
WSW	0	0	1	0	0	0	1
W	0	0	1	1	0	0	2
WNW	0	0	1	12	0	0	13
WW	0	0	0	1	0	0	1
WNW	0	0	0	1	0	0	1
VARIABLE							

TOTAL 72
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/90 TO 6/30/90
 STABILITY CLASS: B
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	0	0	0	0	0
NNE	0	0	1	0	0	0	1
NE	0	4	6	0	0	0	5
ENE	0	1	0	0	0	0	2
E	0	0	0	0	0	0	0
ESE	0	0	2	0	0	0	2
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	1	0	0	1
SSW	0	0	2	9	4	0	15
SW	0	0	1	0	0	0	1
WSW	0	0	1	0	0	0	1
W	0	0	0	0	0	0	0
WNW	0	0	5	14	2	0	21
WW	0	0	3	1	0	0	4
WNW	0	0	1	0	0	0	1
VARIABLE							

TOTAL 52
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/90 TO 6/30/90
 STABILITY CLASS: C
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	24	
N	0	0	2	0	0	0	2
NNE	0	0	2	1	0	0	3
NE	0	4	1	0	0	0	5
NNE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	1	0	0	0	1
SSE	0	0	0	0	0	0	0
S	0	0	1	1	0	0	2
SSW	0	0	5	12	3	0	20
SW	0	0	1	2	1	0	4
WSW	0	0	0	0	0	0	0
W	0	0	1	4	1	0	6
WSW	0	0	15	8	1	0	24
WNW	0	0	9	0	0	0	9
WNW	0	0	0	1	0	0	1
VARIABLE							

TOTAL 77
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/90 TO 6/30/90
 STABILITY CLASS: D
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	15	9	1	0	0	25
NNE	0	14	6	4	1	0	25
NE	0	22	5	0	0	0	27
NNE	0	9	13	11	3	0	36
E	0	3	3	4	0	0	10
ESE	1	1	1	2	0	0	5
SE	0	4	2	0	0	0	6
SSE	0	6	19	4	0	0	29
S	0	5	29	6	1	1	42
SSW	0	6	54	38	30	3	131
SW	0	4	17	14	2	1	38
WSW	0	3	10	6	3	0	22
W	0	3	8	16	7	0	34
WSW	0	18	40	34	5	0	97
W	0	29	30	5	2	0	66
WSW	0	22	18	2	0	0	42
VARIABLE							

TOTAL 635
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/90 TO 6/30/90
 STABILITY CLASS: E
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	5	12	21	3	2	43
NNE	2	8	21	13	4	0	48
NE	1	19	19	17	7	0	63
ENE	4	19	36	31	12	0	102
E	1	6	11	13	1	0	32
ESE	0	9	14	2	0	0	25
SE	1	13	5	0	0	0	19
SSE	0	15	27	10	2	1	55
S	0	15	51	20	3	2	91
SSW	3	8	79	114	36	7	247
SW	1	9	32	29	3	1	75
WSW	1	10	12	10	1	0	34
W	0	8	24	9	1	0	42
WSW	0	8	31	12	3	0	54
WNW	1	7	19	18	8	0	53
WNW	1	12	20	26	12	0	71
VARIABLE							

TOTAL 1054
 PERIODS OF CALM (HOURS): 9

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/90 TO 6/30/90
 STABILITY CLASS: F
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	2	3	1	0	0	6
NNE	0	0	0	3	0	0	3
NE	0	3	0	0	0	0	3
ENE	0	5	1	0	0	0	6
E	0	0	0	0	0	0	0
ESE	0	1	0	0	0	0	1
SE	0	3	2	0	0	0	5
SSE	0	3	5	1	0	0	9
S	0	2	10	9	0	0	21
SSW	0	3	12	11	0	0	26
SW	0	2	16	7	0	0	25
WSW	1	4	12	7	0	0	24
W	0	2	16	1	0	0	19
WSW	1	3	13	0	0	0	17
NW	0	2	6	2	0	0	10
WNW	1	1	5	3	1	0	11
VARIABLE							

TOTAL 186
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 4/ 1/90 TO 6/30/90
 STABILITY CLASS: G
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	0	0	0	0	0
NNE	0	1	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	1	0	0	0	0	1
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	2	0	0	0	0	2
SSE	0	3	0	2	0	0	5
S	0	2	2	1	0	0	5
SSW	0	5	10	1	0	0	16
SW	0	0	9	1	0	0	10
WSW	0	5	15	6	0	0	26
W	0	3	10	2	0	0	15
WSW	0	4	4	0	0	0	8
WNW	0	1	0	0	0	0	1
NWN	0	1	0	0	0	0	1
VARIABLE							

TOTAL 92
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: A
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	1	0	1	4	0	0	6
NNE	0	0	3	1	0	0	4
NE	0	5	8	2	0	0	15
ENE	0	4	12	6	0	0	22
E	0	0	2	0	0	0	2
ESE	0	0	1	0	0	0	1
SE	0	2	1	0	0	0	3
SSE	0	0	1	4	0	0	5
S	0	0	7	5	0	0	12
SSW	0	0	6	7	0	0	13
SW	0	0	0	4	0	0	4
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	2	0	1	0	0	3
NW	1	0	1	2	0	0	4
N	0	1	0	3	0	0	4
VARIABLE							

TOTAL 98
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: B
 ELEVATION: 15'

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	2	0	0	0	0	2
NNE	1	1	0	1	0	0	3
NE	0	1	3	0	1	0	5
ENE	0	0	2	2	0	0	4
E	0	0	1	0	0	0	1
ESE	0	1	1	0	0	0	2
SE	0	0	0	0	0	0	0
SSE	0	0	2	0	0	0	2
S	0	1	2	3	0	0	6
SSW	0	1	3	4	0	0	8
SW	0	0	1	1	1	0	3
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	3	0	0	3
WW	0	0	3	0	0	0	3
WNW	0	1	1	2	0	0	4
VARIABLE							

TOTAL 46
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: C
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	1	1	0	0	0	2
NNE	1	4	3	0	0	0	8
NE	1	4	1	0	0	0	6
ENE	0	2	6	1	0	0	9
E	0	1	0	0	0	0	1
ESE	0	1	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	0	2	1	0	0	3
S	0	1	1	3	0	0	5
SSH	0	0	3	3	0	0	6
SW	0	0	5	1	0	0	6
WSW	0	0	1	0	0	0	1
W	0	0	1	1	0	0	2
WNW	0	1	4	0	0	0	5
NW	0	3	3	1	0	0	7
NNW	1	2	1	1	0	0	5
VARIABLE							

TOTAL 67
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: D
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	8	34	5	1	0	0	48
NNE	1	26	4	4	0	0	35
NE	2	14	9	2	1	0	28
ENE	2	13	25	7	1	0	48
E	1	4	2	1	2	0	10
ESE	0	1	3	0	0	0	4
SE	1	4	1	0	0	0	6
SSE	0	7	19	3	0	0	29
S	0	4	16	10	0	0	30
SSH	0	5	22	23	0	0	50
SW	0	5	18	11	0	0	34
WSW	1	5	10	1	0	0	17
W	1	4	17	12	0	0	34
WNW	2	10	38	25	0	0	75
NW	1	43	6	3	0	0	53
NNW	1	42	1	4	0	0	48
VARIABLE							

TOTAL 549
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: E
 ELEVATION: 156

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	1	12	21	7	3	0	44
NNE	2	12	20	16	9	0	59
NE	3	16	27	17	16	0	79
ENE	1	22	36	51	18	0	128
E	2	14	13	9	3	0	41
ESE	2	17	2	0	0	0	21
SE	3	29	1	0	0	0	33
SSE	0	13	33	12	0	0	58
S	0	9	46	20	0	0	75
SSW	0	5	65	49	0	0	119
SW	0	7	33	31	1	0	72
WSW	0	7	9	3	0	0	19
W	0	4	33	3	0	0	40
WNW	3	6	29	10	0	0	48
NW	4	10	17	17	2	0	50
NNW	1	9	17	24	3	0	54
VARIABLE							

TOTAL 940
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: F
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	2	5	7	0	0	0	14
NNE	0	3	4	0	0	0	7
NE	0	2	0	0	0	0	2
ENE	0	1	0	0	0	0	1
E	1	7	1	0	0	0	9
ESE	0	1	0	0	0	0	1
SE	1	2	0	0	0	0	3
SSE	1	2	5	0	0	0	8
S	0	0	10	2	0	0	12
SSH	0	2	29	16	0	0	47
SH	0	1	16	29	0	0	46
HSH	1	1	16	9	0	0	27
H	1	4	10	0	1	0	16
HNH	1	2	13	1	0	0	17
NH	1	8	9	0	0	0	18
NNH	1	6	3	2	0	0	12
VARIABLE							

TOTAL 240
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 7/ 1/90 TO 9/30/90
 STABILITY CLASS: G
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	2	1	0	0	0	0	3
NNE	2	0	1	0	0	0	3
NE	1	5	0	0	0	0	6
ENE	1	2	0	0	0	0	3
E	1	1	0	0	0	0	2
ESE	0	2	3	0	0	0	5
SE	2	4	3	0	0	0	9
SSE	0	2	8	1	0	0	11
S	0	6	14	4	0	0	24
SSW	0	3	15	6	0	0	24
SW	0	7	24	11	0	0	42
WSW	0	8	17	7	0	0	32
W	1	6	13	1	0	0	21
WWN	0	10	3	0	0	0	13
NW	1	8	0	0	0	0	9
NNW	1	7	0	0	0	0	8
VARIABLE							

TOTAL 215
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/31/90
 STABILITY CLASS: A
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	2	1	0	0	3
NNE	0	1	3	0	0	0	4
NNE	0	0	4	0	1	0	5
ENE	0	0	4	1	0	0	5
E	0	0	2	1	0	0	3
ESE	0	0	0	1	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	0	3	0	0	0	3
S	0	0	2	0	0	0	2
SSW	0	0	1	0	0	0	1
SH	0	0	4	5	0	0	9
HSH	0	0	3	0	0	0	3
H	0	0	1	3	0	0	4
HSH	0	0	9	0	0	0	9
HN	0	2	8	14	0	0	24
HSH	0	1	7	15	1	0	24

VARIABLE

TOTAL 100
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/7 1/90
 STABILITY CLASS: B
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	3	2	0	0	5
NNE	0	0	0	0	0	0	0
NE	0	0	1	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	1	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	1	0	0	0	1
SSW	0	1	2	1	0	0	4
SW	0	1	2	1	2	0	6
WSW	0	0	3	0	0	0	3
W	0	0	1	0	0	0	1
WNW	0	0	1	1	4	2	8
W	0	1	5	2	0	0	8
WNW	0	1	0	2	2	0	5

VARIABLE

TOTAL 43
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/31/90
 STABILITY CLASS: C
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	0	1	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	1	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	1	0	0	0	1
SSW	0	0	7	1	0	0	8
SW	0	0	3	4	2	0	9
WSW	0	0	0	2	0	0	2
W	0	0	2	1	1	0	4
WNW	0	0	2	0	1	5	8
WW	0	2	0	4	0	0	6
WNW	0	1	3	1	3	0	8
VARIABLE							

TOTAL 48
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/31/90
 STABILITY CLASS: D
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	1	4	3	5	12	23	48
NNE	0	6	0	1	6	13	26
NE	0	6	4	8	4	0	22
ENE	1	0	1	2	0	0	4
E	0	0	4	4	0	0	8
ESE	1	2	1	8	0	0	12
SE	0	7	2	0	0	0	9
SSE	0	1	1	6	0	0	8
S	0	1	9	1	2	2	15
SSW	0	6	10	30	6	1	53
SW	0	3	9	16	2	0	30
WSW	0	0	5	12	2	0	19
W	1	4	8	11	9	1	34
WNW	1	5	13	6	15	14	54
W	2	8	5	7	14	6	42
WNW	1	6	5	16	16	2	46
VARIABLE							

TOTAL 430
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/31/90
 STABILITY CLASS: E
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	2	5	47	18	3	75
NP/E	0	0	12	11	2	3	28
NE	0	0	4	4	1	0	9
E/NE	0	0	6	0	1	0	7
E	0	11	12	4	0	0	27
ESE	0	2	8	3	5	0	18
SE	0	10	16	11	6	0	43
SSE	0	7	26	14	2	1	50
S	0	4	14	13	3	4	38
SSW	0	6	49	72	15	7	150
SW	0	7	25	69	7	1	109
WSW	0	6	30	28	5	0	69
W	0	6	7	25	4	1	46
WSW	0	2	10	21	30	21	84
W	1	4	17	34	42	19	117
WSW	0	3	12	39	50	5	109
VARIABLE							

TOTAL 979
 PERIODS OF CALM (HOURS): 1

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/31/90
 STABILITY CLASS: F
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	0	0	0	0	0	0
NNE	0	1	1	0	0	0	2
NE	0	0	0	0	0	0	0
NNE	0	3	2	0	0	0	5
E	0	2	2	0	0	0	4
ESE	0	1	5	0	0	0	6
SE	0	6	5	0	0	0	11
SSE	0	1	1	1	0	0	3
S	0	0	8	7	0	0	15
SSH	0	8	11	8	2	0	29
SH	0	4	13	17	0	0	34
HSH	1	3	21	20	0	0	45
H	0	0	8	1	0	0	9
HSH	0	1	4	0	0	0	5
NH	0	1	2	0	0	0	3
NHW	2	1	0	0	0	0	3
VARIABLE							

TOTAL 174
 PERIODS OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 10/ 1/90 TO 12/31/90
 STABILITY CLASS: G
 ELEVATION: 150

WIND DIRECTION	WIND SPEED (MPH)						TOTALS
	1-3	4-7	8-12	13-18	19-24	>24	
N	0	1	1	0	0	0	2
NNE	1	2	0	0	0	0	3
NE	1	1	0	0	0	0	2
ENE	1	0	0	0	0	0	1
E	0	1	0	0	0	0	1
ESE	0	3	3	0	0	0	6
SE	0	2	1	0	0	0	3
SSE	1	3	4	0	0	0	8
S	1	7	11	9	0	0	28
SSW	0	10	11	14	0	0	35
SW	2	7	22	19	0	0	50
WSW	1	7	17	23	0	0	48
W	1	2	8	1	0	0	12
WSW	0	2	0	0	0	0	2
NW	0	3	1	0	0	0	4
NWN	1	0	0	0	0	0	1

VARIABLE

TOTAL 206
 PERIODS OF CALM (HOURS): 0

SEMIANNUAL RADIOACTIVE EFFLUENT
RELEASE REPORT

G - ODCM REVISIONS, REMP NON-COMPLIANCES AND
MAJOR CHANGES TO RADIOACTIVE WASTE TREATMENT SYSTEMS

According to Technical Specification 6.14.c and ODCM Control 6.9.1.7, the Semiannual Radioactive Effluent Release Report shall include any changes to the Offsite Dose Calculation Manual (ODCM) made during the reporting period.

A. Changes to the ODCM:

There was a single revision to the ODCM, Rev. 16, that was made during this reporting period.

In this revision, the ODCM was brought into compliance with the recommendations of NRC Generic Letter 89-01, which recommended that procedural details of the Radiological Effluent Technical Specifications not associated with solid radioactive wastes be relocated to the ODCM.

Portions of the Definitions and Administrative Controls Sections of the Technical Specifications (TS) have been relocated to the ODCM, and some words of these sections of TS have been changed. All the changes are made to provide conformance with the recommendations of Generic Letter 89-01.⁽¹⁾

Revision 16 to the ODCM was approved by the Review of Operations Committee on July 26, 1990 and became effective on July 30, 1990. A copy of this revision is attached to this Semiannual Effluent Release Report.

Action Statement c of ODCM Control 3.12.1 and a and b of ODCM Control 3.12.2 require certain items of REMP noncompliance to be reported in the Semiannual Radioactive Effluent Release Report.

B. There were no such REMP noncompliances during this reporting period.

Technical Specification 6.15 and PCP 9.3.1 and 9.4.4 state that the Semiannual Radioactive Effluent Release Report shall include major changes to radioactive waste treatment systems.

C. There were no major changes to radioactive waste treatment systems during this reporting period.

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

SEMIANNUAL RADIOACTIVE EFFLUENT
RELEASE REPORT

H - MISCELLANEOUS SPECIAL REPORTS

3rd and 4th Quarters of 1990

The ODCM requires ground water samples to be obtained quarterly from one or two sources Wb1, Wb2. The required samples from Wb1 were obtained, however the sampler at Wb2 were unavailable. To fulfill the requirements of ODCM location Wb2, the ODCM provides one waterborne sample location (13S2). On September 19, 1990 and December 6, 1990, the well at 13S2 was found dry and location 2A3 was substituted. This location, at a residence 0.3 miles NNE of the site, is not listed in ODCM Table 5-4, Radiological Environmental Monitoring Program Waterborne Monitoring Stations, but the sample provided meets ODCM Controls Table 3.12.1-1 requirements for Wb2.

Submitted with SNRC-1788

OFFSITE DOSE CALCULATION MANUAL, REV. 16

SHOREHAM NUCLEAR POWER STATION



Document No. 4170002
Eff. Date 7/12/90 Rev. No. 16

Prepared By	Date	Reviewed By	Date
<i>A. Saif</i>	7/12/90	<i>Arnold Beer</i>	7/12/90

APPROVALS

Title Dept.	Signature	Date
<i>Acting Manager NAD/NEO</i>	<i>R. P. Pappas</i>	<i>7-12-90</i>
<i>ROC CHAIRMAN/SNPS</i>	<i>Arnold Beer</i>	<i>7-26-90</i>
<i>Plant Mgr/SNPS</i>	<i>J. J. Calow</i>	<i>7/26/90</i>

TITLE OF DOCUMENT

SHOREHAM NUCLEAR POWER STATION - UNIT 1
OFFSITE DOSE CALCULATION MANUAL

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OFFSITE DOSE CALCULATION MANUAL

Revision 16 - July 1990

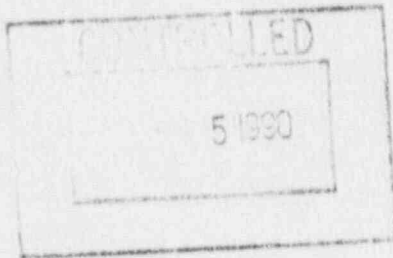
Insertion Instructions

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OFFSITE DJSE CALCULATION MANUAL

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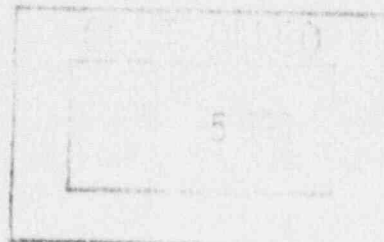
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LONG ISLAND LIGHTING COMPANY

OFFSITE DOSE CALCULATION MANUAL

Revision 16 - July 1990

SNPS-1 ODCM

PLEASE NOTE

Revision 1 - August 1983 of the LILCO, SNPS-1, Offsite Dose Calculation Manual has been totally revised from the Original - March 1983 Submittal - Therefore, Revision 1 - August 1983 has no change bars.

CHANGE BARS have been used in subsequent revisions to locate a change (additions, deletions, and/or modifications) in engineering, design, methodology, etc.

CHANGE BARS are not used for Errata (i.e., typos, format changes).

CHANGE BARS are not used in Part I Revision 16 since this material is entirely new to the ODCM. They are also not used to indicate changed page numbers in Part II Revision 16 since all page numbers have had a II, appended to them. In addition, Part II changes are not labelled Revision 16 at the page bottom if the only change is a page number appendage.

DO NOT REMOVE - KEEP IN YOUR ODCM

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PART I THE RADIOLOGICAL EFFLUENT CONTROLS (REC)

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PART I
SECTION 1

INTRODUCTION

Procedural details of the Radiological Effluent Technical Specifications not associated with solid radioactive wastes which were previously located in the Station Technical Specifications (TS) have been relocated to the ODCM. Portions of the Definitions and Administrative Controls Section of the TS are also being relocated to the ODCM, and some changes to the words of these sections of TS are being made. All the changes are made to provide conformance with the requirements of Generic Letter 89-01.⁽¹⁾

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

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PART I
SECTION 2

RADIOLOGICAL EFFLUENT
CONTROLS

SECTION 1.0

DEFINITIONS

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DEFINITIONS

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1.0 DEFINITIONS

The defined terms appear in capitalized type and shall be applicable throughout these Controls.

ACTION

- 1.1 ACTION shall be that part of a Control which prescribes remedial measures required under designated conditions.

CHANNEL CALIBRATION

- 1.4 A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds with the necessary range and accuracy to known values of the parameter which the channel monitors. The CHANNEL CALIBRATION shall encompass the entire channel including the sensor and alarm and/or trip functions, and shall include CHANNEL FUNCTIONAL TEST. The CHANNEL CALIBRATION may be performed by any series of sequential, overlapping or total channel steps such that the entire channel is calibrated.

CHANNEL CHECK

- 1.5 A CHANNEL CHECK shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter.

CHANNEL FUNCTIONAL TEST

- 1.6 A CHANNEL FUNCTIONAL TEST shall be:

- a. Analog channels - the injection of a simulated signal into the channel as close to the sensor as practicable to verify OPERABILITY including alarm and/or trip functions and channel failure trips.
- b. Bistable channels - the injection of a simulated signal into the sensor to verify OPERABILITY including alarm and/or trip functions.

The CHANNEL FUNCTIONAL TEST may be performed by any series of sequential, overlapping or total channel steps such that the entire channel is tested.

DOSE EQUIVALENT I-131

- 1.9 DOSE EQUIVALENT I-131 shall be that concentration of I-131, microcuries per gram, which alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134, and I-135 actually present. The thyroid dose conversion factors used for this calculation shall be those listed in Table III of TID-14844, "Calculation of Distance Factors for Power and Test Reactor Sites."

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FREQUENCY NOTATION

- 1.15 The FREQUENCY NOTATION specified for the performance of Surveillance Requirements shall correspond to the intervals defined in Table 1.1.

GASEOUS RADWASTE TREATMENT SYSTEM

- 1.16 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

- 1.23 MEMBER(S) OF THE PUBLIC shall include all persons who are not occupationally associated with the plant. This category does not include employees of the utility, its contractors or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational or other purposes not associated with the plant.

OFFSITE DOSE CALCULATION MANUAL (ODCM)

- 1.25 The OFFSITE DOSE CALCULATION MANUAL (ODCM) shall contain the methodology and parameters used in the calculation of offsite doses resulting from radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring Alarm/Trip Setpoints, and in the conduct of the Environmental Radiological Monitoring Program. The ODCM shall also contain (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs required by Section 5.8.4 and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Semiannual Radioactive Effluent Release Reports required by Specifications 6.9.1.6 and 6.9.1.7.

OPERABLE - OPERABILITY

- 1.26 A system, subsystem, train, component or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified function(s) and when all necessary attendant instrumentation, controls, electrical power, cooling or seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component or device to perform its function(s) are also capable of performing their related support function(s).

OPERATIONAL CONDITION - CONDITION

- 1.27 An OPERATIONAL CONDITION, i.e., CONDITION, shall be any one inclusive combination of mode switch position and average reactor coolant temperature as specified in Table 1.2.

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PURGE - PURGING

1.32 PURGE or PURGING shall be 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.

RATED THERMAL POWER

1.33 RATED THERMAL POWER shall be a total reactor core heat transfer rate to the reactor coolant of 2436 MWt.

REPORTABLE EVENT

1.35 A REPORTABLE EVENT shall be any of those conditions specified in Section 50.73 to 10 CFR Part 50.

SITE BOUNDARY

1.39 The SITE BOUNDARY shall be that line beyond which the land is neither owned, nor leased, nor otherwise controlled by the licensee.

SOURCE CHECK

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

THERMAL POWER

1.43 THERMAL POWER shall be the total reactor core heat transfer rate to the reactor coolant.

UNRESTRICTED AREA

1.46 An UNRESTRICTED AREA shall be any area at or beyond the SITE BOUNDARY access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, or any area within the SITE BOUNDARY used for residential quarters or for industrial, commercial, institutional, and/or recreational purposes.

VENTILATION EXHAUST TREATMENT SYSTEM

1.47 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

DEFINITIONS

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 (e.g. RBSYS) are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

VENTING

1.48 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 during VENTING. Vent, used in system names, does not imply a VENTING process.

DEFINITIONS

TABLE 1.1
SURVEILLANCE FREQUENCY NOTATION

<u>NOTATION</u>	<u>FREQUENCY</u>
S	At least once per 12 hours.
D	At least once per 24 hours.
W	At least once per 7 days.
M	At least once per 31 days.
Q	At least once per 92 days.
SA	At least once per 184 days.
A	At least once per 366 days.
R	At least once per 18 months (550 days).
S/U	Prior to each reactor startup.
N/A	Not applicable.
P	Completed prior to each release.

DEFINITIONS

TABLE 1.2
OPERATIONAL CONDITIONS

<u>CONDITION</u>	<u>MODE SWITCH POSITION</u>	<u>AVERAGE REACTOR COOLANT TEMPERATURE</u>
1. POWER OPERATION	Run	Any temperature
2. STARTUP	Startup/Hot Standby	Any temperature
3. HOT SHUTDOWN	Shutdown#***	>200°F
4. COLD SHUTDOWN	Shutdown# ##***	≤200°F
5. REFUELING	Shutdown or Refuel** #	≤140°F

#The reactor mode switch may be placed in the Run or Startup/Hot Standby position to test the switch interlock functions provided that the control rods are verified to remain fully inserted by a second licensed operator or other technically qualified member of the unit technical staff.

##The reactor mode switch may be placed in the Refuel position while a single control rod drive is being removed from the reactor pressure vessel per Specification 3.9.10.1 of the Technical Specifications.

*Fuel in the reactor vessel with the vessel head closure bolts less than fully tensioned or with the head removed .

**See Special Test Exceptions 3.10.1 and 3.10.3 of the Technical Specifications.

***The reactor mode switch may be placed in the Refuel position while a single control rod is being recoupled provided that the one-rod-out interlock is OPERABLE.

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PART 1
SECTION 3

RADIOLOGICAL EFFLUENT
CONTROLS

SECTIONS 3.0 and 4.0
CONTROLS

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CONTROLS AND SURVEILLANCE REQUIREMENTS

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3/4.0 APPLICABILITY

CONTROLS

3.0.1 Compliance with the Controls contained in the succeeding controls is required during the OPERATIONAL CONDITIONS or other conditions specified therein; except that upon failure to meet the Controls for Operation, the associated ACTION requirements shall be met.

3.0.2 Noncompliance with a Control shall exist when the requirements of the Control associated ACTION requirements are not met within the specified time intervals. If the Control is restored prior to expiration of the specified time intervals, completion of the ACTION requirements is not required.

3.0.3 When a Control is not met, except as provided in the associated ACTION requirements, within one hour action shall be initiated to place the unit in an OPERATIONAL CONDITION in which the Specification does not apply by placing it, as applicable, in:

1. At least STARTUP within the next 6 hours,
2. At least HOT SHUTDOWN within the following 6 hours, and
3. At least COLD SHUTDOWN within the subsequent 24 hours.

Where corrective measures are completed that permit operation under the ACTION requirements, the ACTION may be taken in accordance with the specified time limits as measured from the time of failure to meet the Control. Exceptions to these requirements are stated in the individual Controls.

This Control is not applicable in OPERATIONAL CONDITION 4 or 5.

3.0.4 Entry into an OPERATIONAL CONDITION or other specified condition shall not be made unless the conditions for the Control are met without reliance on provisions contained in the ACTION requirements. This provision shall not prevent passage through or to OPERATIONAL CONDITIONS as required to comply with ACTION requirements. Exceptions to these requirements are stated in the individual Controls.

APPLICABILITY

SURVEILLANCE REQUIREMENTS

4.0.1 Surveillance Requirements shall be met during the OPERATIONAL CONDITIONS or other conditions specified for individual Controls unless otherwise stated in an individual Surveillance Requirement.

4.0.2 Each Surveillance Requirement shall be performed within the specified time interval with:

- a. A maximum allowable extension not to exceed 25% of the surveillance interval, but
- h. The combined time interval for any 3 consecutive surveillance intervals shall not exceed 3.25 times the specified surveillance interval.

4.0.3 Failure to perform a Surveillance Requirement within the specified time interval shall constitute a failure to meet the OPERABILITY requirements for a Control. Exceptions to these requirements are stated in the individual Controls. Surveillance Requirements do not have to be performed on inoperable equipment.

4.0.4 Entry into an OPERATIONAL CONDITION or other specified applicable condition shall not be made unless the Surveillance Requirement(s) associated with the Controls have been performed within the applicable surveillance interval or as otherwise specified.

INSTRUMENTATION

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

3.3.7.10 The radioactive liquid effluent monitoring instrumentation channels shown in Table 3.3.7.10-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Control 3.11.1.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the Offsite Dose Calculation Manual (ODCM).

APPLICABILITY: At all times.

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.
- b. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 3.3.7.10-1. Restore the inoperable instrumentation to OPERABLE status within the time specified in the ACTION or explain in the next Semiannual Radioactive Effluent Release Report why this inoperability was not corrected within the time specified.
- c. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.3.7.10.1 Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4.3.7.10-1.

4.3.7.10.2 At least once per 4 hours at least one circulating water pump shall be determined to be operating and providing dilution to the discharge structure whenever dilution is required to meet the site radioactive effluent concentration limits of Control 3.11.1.1.

TABLE 3.3.7.10-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

1.	GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE		
	a. Liquid Radwaste Effluent Line, RE-13	1	110
2.	GROSS RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OF RELEASE		
	a. RHR Heat Exchanger Service Water Outlet, RE-23A, RE-23B	1*	111
	b. Reactor Building Salt Water Drain Tank Outlet, RE-79	1	112
3.	FLOW RATE MEASUREMENT DEVICE		
	a. Liquid Radwaste Effluent Line	1	113

* The detector associated with the operating RHR subsystem shall be OPERABLE

TABLE 3.3.7.10-1 (Continued)

ACTION STATEMENTS

- ACTION 110 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 14 days provided that prior to initiating a release:
- a. At least two independent samples are analyzed in accordance with Controls 4.11.1.1.1 and 4.11.1.1.2, and
 - b. At least two technically qualified members of the Station Staff independently verify the release rate calculations and discharge line valving;
- Otherwise, suspend release of radioactive effluents via this pathway.
- ACTION 111 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, for the detector(s) associated with operating RHR loop(s) effluent releases via the(se) pathway(s) may continue for up to 30 days provided that, at least once per 12 hours, grab samples are collected and analyzed for radioactivity at a lower limit of detection of at least 10^{-7} microcurie/mL.
- ACTION 112 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided that, at least once per 12 hours, grab samples are collected and analyzed for radioactivity at a lower limit of detection of at least 10^{-7} microcurie/mL.
- ACTION 113 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided that, flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves generated in place may be used to estimate flow.

TABLE 4.3.7.10-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SUREVEILLANCE REQUIREMENTS

<u>INSTRUMENT</u>	<u>CHANNEL CHECK</u>	<u>SOURCE CHECK</u>	<u>CHANNEL CALIBRATION</u>	<u>CHANNEL FUNCTIONAL TEST</u>
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE				
a. Liquid Radwaste Effluent Line, RE-13	D(4)	P	R(3)	Q(1)
2. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM BUT NOT PROVIDING AUTOMATIC TERMINATION OR RELEASE				
a. RHR Heat Exchanger Service Water Outlet, RE-23A, RE-23B	D	M	R(3)	Q(2)
b. Reactor Building Salt Water Drain Tank Outlet, RE-79	D	M	R(3)	Q(2)
3. FLOW RATE MEASUREMENT DEVICE				
a. Liquid Radwaste Effluent Line	D(4)	N.A	R	Q

TABLE 4.3.7.10-1 (Continued)

TABLE NOTATIONS

- (1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation and/or indication occur if any of the following conditions exists:
 1. Instrument indicates measured levels above the alarm/trip setpoint.
 2. Circuit failure.
 3. Instrument indicates a downscale failure.
 4. Instrument controls not set in operate mode.
- (2) The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation and/or indication occurs if any of the following conditions exists:
 1. Instrument indicates measured levels above the alarm/trip setpoint.
 2. Circuit failure.
 3. Instrument indicates a downscale failure.
 4. Instrument controls not set in operate mode.
- (3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.
- (4) CHANNEL CHECK shall consist of verifying indication during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days when batch releases are made.

INSTRUMENTATION

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

3.3.7.11 The radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.3.7.11-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Control 3.11.2.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the ODCM.

APPLICABILITY: As shown in Table 3.3.7.11-1

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.
- b. With less than minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 3.3.7.11-1. Restore the inoperable instrumentation to OPERABLE status within the time specified in the ACTION or explain in the next Semiannual Radioactive Effluent Release Report why this inoperability was not corrected within the time specified.
- c. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.3.7.11 Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4.3.7.11-1.

TABLE 3.3.7.11-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
1. MAIN CONDENSER OFFGAS TREATMENT SYSTEM EFFLUENT MONITORING SYSTEM			
a. Noble Gas Activity Monitors - Alarm, RE-65A, RE-65B	1#	**	120
2. (Not Used)			
3. STATION VENTILATION EXHAUST MONITORING SYSTEM			
a. Noble Gas Activity Monitor, RE-42	1	*	120
b. Iodine Sampler	1	*	122
c. Particulate Sampler	1	*	122
d. Effluent System Flow Rate Monitor	1	*	123
e. Sampler Flow Rate Monitor	1	*	123
4. CONDENSER AIR EJECTOR RADIOACTIVITY MONITOR PROVIDING ALARM (TERMINATION OF BYPASS FLOW IS MANUAL)			
a. Noble Gas Activity Monitors (prior to input to holdup system), RE-12A, RE-12B	1#	***	124

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TABLE 3.3.7.11-1 (Continued)

TABLE NOTATIONS

*At all times.

**During main condenser offgas treatment system operation.

***During operation of the main condenser steam jet air ejector(s).

†††Monitor connected to the operating offgas loop shall be OPERABLE.

ACTION STATEMENTS

ACTION 120 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided grab samples are taken at least once per 8 hours and these samples are analyzed for gross activity within 24 hours.

ACTION 121 - (Not Used)

ACTION 122 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided samples are continuously collected with auxiliary sampling equipment as required in Table 4.11.2.1.2-1.

ACTION 123 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided the flow rate is estimated at least once per 4 hours.

ACTION 124 - a. With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, the gases from the main condenser may be released to the environment for up to 72 hours provided:

1. The offgas system is not bypassed, and
2. The offgas delay treatment system effluent activity monitor is OPERABLE;

Otherwise, be in at least HOT SHUTDOWN within 12 hours.

b. With the number of channels OPERABLE equal to the Minimum Channels OPERABLE requirement and the release exceeding the setpoint, terminate the bypass flow manually within 1 hour.

TABLE 4.3.7.11-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

<u>INSTRUMENT</u>	<u>CHANNEL CHECK</u>	<u>SOURCE CHECK</u>	<u>CHANNEL CALIBRATION</u>	<u>CHANNEL FUNCTIONAL TEST</u>	<u>MODES IN WHICH SURVEILLANCE REQUIRED</u>
1. MAIN CONDENSER OFFGAS TREATMENT SYSTEM EFFLUENT MONITORING SY.					
a. Noble Gas Activity Monitor Alarm, RE-65A, RE-65B	D	M	R(2)	Q(1)	**
2. (NOT USED)					
3. STATION VENTILATION EXHAUST MONITORING SYSTEM					
a. Noble Gas Activity Monitor, RE-42	D	M	R(2)	Q(1)	*
b. Iodine Sampler	W	N/A	N/A	N/A	*
c. Particulate Sampler	W	N/A	N/A	N/A	*
d. Effluent System Flow Rate Monitor	D	N/A	Q	N/A	*
e. Sampler Flow Rate Monitor	D	N/A	Q	N/A	*
4. CONDENSER AIR EJECTOR RADIOACTIVITY MONITOR PROVIDING ALARM (TERMINATION OF BYPASS FLOW IS MANUAL)					
a. Noble Gas Activity Monitors (prior to input to holdup system), RE-12A, RE-12B	D	M	R(2)	Q(1)	***

I-3.13

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TABLE 4.3.7.11-1 (Continued)

TABLE NOTATIONS

*At all times.

**During main condenser offgas treatment system operation.

***During operation of the main condenser steam jet air ejector(s).

- (1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation and/or indication occurs if any of the following conditions exists:
 1. Instrument indicates measured levels above the alarm setpoint.
 2. Circuit failure.
 3. Instrument indicates a downscale failure.
 4. Instrument controls not set in operate mode.

- (2) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.

- (3) (Not Used)

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.1 LIQUID EFFLUENTS

CONCENTRATION

CONTROLS

3.11.1.1 The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Figure 5.1.3-1) shall be limited to the concentrations specified in 10 CFR Part 20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} microcurie/mL total activity.

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 the above limits.

SURVEILLANCE REQUIREMENTS

4.11.1.1.1 Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program of Table 4.11.1.1.1-1.

4.11.1.1.2 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 3.11.1.1.

TABLE 4.11.1.1.1-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) ($\mu\text{Ci/mL}$) ^a
A. Batch Waste Release Tanks and Sumps ^b	P Each Batch	P Each Batch	Principal Gamma Emitters ^c	5×10^{-7}
1. Discharge Waste Sample Tanks			I-131	1×10^{-6}
2. Recovery Sample Tanks	P* One Batch/M	M*	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
	P Each Batch	Composite ^d	H-3	1×10^{-5}
			Gross Alpha	1×10^{-7}
5. Yard Pipe and Drain Sump	P Each Batch	Q Composite ^d	Sr-89, Sr-90	5×10^{-8}
			Fe-55	1×10^{-6}
B. Continuous Releases ^e	D Grab Sample	W Composite ^d	Principal Gamma Emitters ^c	5×10^{-7}
1. RHR Heat Exchanger Service Water Outlet			I-131	1×10^{-6}
	M Grab Sample	M	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
2. Reactor Building Salt Water Drain Tank	D Grab Sample	M Composite ^d	H-3	1×10^{-5}
			Gross Alpha	1×10^{-7}
	D Grab Sample	Q Composite ^d	Sr-89, Sr-90	5×10^{-8}
			Fe-55	1×10^{-6}

* If batch is released during the month.

TABLE 4.11.1.1.1-1 (Continued)

TABLE NOTATION

^aThe LLD is defined, for purposes of the 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 >5% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{4.66 s_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

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

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate, as counts per minute,

E is the counting efficiency, as counts per disintegration,

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

2.22×10^6 is the number of disintegrations per minute per microcurie,

Y is the fractional radiochemical yield, when applicable,

λ is the radioactive decay constant for the particular radionuclide, and

Δt for plant effluents is the elapsed time between the midpoint of sample collection and the time of counting.

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

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of the measurement system and not as a posteriori (after the fact) limit for a particular measurement.

^bA 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 a method described in the ODCM to assure representative sampling.

TABLE 4.11.1.1-1 (Continued)

TABLE NOTATIONS (Continued)

^cThe principal gamma emitters for which the LLD specification applies include the following radionuclides: Mn-54, Fe-59, Co-58, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Semiannual Radioactive Effluent Release Report pursuant to Control 6.9.1.7.

^dA 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.

^eA 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.

RADIOACTIVE EFFLUENTS

DOSE

CONTROL

3.11.1.2 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 (see Figure 5.1.3-1) shall be limited:

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

APPLICABILITY: At all times.

ACTION:

- a. With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, 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.
- b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.1.2 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 31 days.

RADIOACTIVE EFFLUENTS

LIQUID RADWASTE TREATMENT SYSTEM

CONTROLS

3.11.1.3 The liquid radwaste treatment system shall be OPERABLE and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses due to the liquid effluent, from each reactor unit to UNRESTRICTED AREAS (see Figure 5.1.3-1) would exceed 0.06 mrem to the total body or 0.2 mrem to any organs in a 31-day period.

APPLICABILITY: At all times.

ACTION:

- a. With radioactive liquid waste being discharged without treatment and in excess of the above limits and any portion of the liquid radwaste treatment system not in operation, prepare and submit to the Commission within 30 days pursuant to Technical Specification 6.9.2 a Special Report that includes the following information:
 1. 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.
- b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.1.3.1 Doses due to liquid releases to UNRESTRICTED AREAS shall be projected at least once per 31 days, in accordance with the methodology and parameters in the ODCM.

4.11.1.3.2 The installed liquid radwaste treatment system shall be demonstrated OPERABLE by meeting Controls 3.11.1.1 and 3.11.1.2.

RADIOACTIVE EFFLUENTS

3.11.1.4 (Not Used)

RADIOACTIVE EFFLUENTS

3/4 11.2 GASEOUS EFFLUENTS

DOSE RATE

CONTROLS

3.11.2.1 The dose rate to areas at and beyond the SITE BOUNDARY due to radioactive materials released in gaseous effluents from the site (see Figure 5.1.3-1) shall be limited to the following:

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

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).

SURVEILLANCE REQUIREMENTS

4.11.2.1.1 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.

4.11.2.1.2 The dose rate due to iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents shall be determined to be within the 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 4.11.2.1.2-1.

TABLE 4.11.2.1.2-1

RADIOACTIVE GASEOUS WASTE MONITORING, SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (uCi/mL) ^a
A. Station Ventilation Exhaust	Continuous ^e	W ^f Charcoal Sample	I-131	1×10^{-12}
	Continuous ^e	W ^f Particulate Sample	Principal Gamma Emitters ^b	1×10^{-11}
	Continuous ^e	M Composite Particulate Sample	Gross Alpha	1×10^{-11}
	Continuous ^e	Q Composite Particulate Sample	Sr-89, Sr-90	1×10^{-11}
	Continuous ^e	Noble Gas Monitor	Noble Gases Gross Beta or Gamma	1×10^{-6}
	M ^c Grab Sample	M ^c	Principal Gamma Emitters ^b	1×10^{-4}
	M ^{c,d} Grab Sample	M ^c	H-3	1×10^{-6}
B. Containment Atmosphere	M ^{c,g} Grab Sample	M ^{c,g}	Principal Gamma Emitters ^b	1×10^{-4}
			H-3	1×10^{-6}

TABLE 4.11.2.1.2-1 (Continued)

TABLE NOTATION

^aThe 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.

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

$$LLD = \frac{4.66 s_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

Where:

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

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate, as counts per minute,

E is the counting efficiency, as counts per disintegration,

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

2.22×10^6 is the number of disintegrations per minute per microcurie,

Y is the fractional radiochemical yield, when applicable,

λ is the radioactive decay constant for the particular radionuclide, and

Δt for plant effluents is the elapsed time between the midpoint of sample collection and the time of counting.

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

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of the measurement system and not as a a posteriori (after the fact) limit for a particular measurement.

TABLE 4.11.2.1.2-1 (Continued)

TABLE NOTATIONS (Continued)

^bThe principal gamma emitters for which the LLD specification applies include the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 in noble gas releases and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, I-133, Cs-134, Cs-137, Ce-141 and Ce-144 in iodine and particulate releases. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Semiannual Radioactive Effluent Release Report pursuant to Control 6.9.1.7.

^cSampling and analysis shall also be performed following shutdown, startup, or a THERMAL POWER change exceeding 15% of RATED THERMAL POWER within 1-hour period.

^dTritium 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.

^eThe 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 3.11.2.1, 3.11.2.2, and 3.11.2.3.

^fSamples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing, or after removal from sampler. Sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup or THERMAL POWER change exceeding 15% of RATED THERMAL POWER in 1 hour and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement does not apply if (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the reactor coolant has not increased by more than a factor of 3; and (2) the noble gas monitor shows that effluent activity has not increased by more than a factor of 3.

^gSampling and analysis shall also be performed prior to VENTING or PURGING of the containment drywell and suppression chamber if the purge lines bypassing the Containment Purge Filtration System are utilized or if the Containment Drywell Filter Train Exhaust Radiation Monitor is inoperable.

RADIOACTIVE EFFLUENTS

DOSE - NOBLE GASES

CONTROLS

3.11.2.2 The air dose due to noble gases released in gaseous effluents, from each reactor unit, to areas at and beyond the SITE BOUNDARY (see Figure 5.1.3-1) shall be limited to the following:

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

APPLICABILITY: At all times.

ACTION:

- a. With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.
- b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

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

RADIOACTIVE EFFLUENTS

DOSE - IODINE-131, IODINE-133, TRITIUM, AND RADIONUCLIDES IN PARTICULATE FORM

CONTROLS

3.11.2.3 The dose to a MEMBER OF THE PUBLIC from iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, from each reactor unit, to areas at and beyond the SITE BOUNDARY (see Figure 5.1.3-1) shall be limited to the following:

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

APPLICABILITY: At all times.

ACTION:

- a. With the calculated dose from the release of iodine-131, iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, 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.
- b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

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

RADIOACTIVE EFFLUENTS

GASEOUS RADWASTE TREATMENT SYSTEM

CONTROLS

3.11.2.4 The GASEOUS RADWASTE TREATMENT SYSTEM shall be OPERABLE and in operation.

APPLICABILITY: Whenever the main condenser steam jet air ejector (evacuation) system is in operation.

ACTION:

- a. With the GASEOUS RADWASTE TREATMENT SYSTEM inoperable for more than 30 days, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report which includes the following information:
 1. Identification of the inoperable equipment or subsystems and the reason for 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.
- b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.4 The GASEOUS RADWASTE TREATMENT SYSTEM shall be demonstrated OPERABLE by verifying proper operation by checking relevant instrumentation at least once per 12 hours when the main condenser steam jet air ejector (evacuation) system is in operation.

RADIOACTIVE EFFLUENTS

VENTILATION EXHAUST TREATMENT SYSTEM

CONTROLS

3.11.2.5 The appropriate portions of the VENTILATION EXHAUST TREATMENT SYSTEM shall be OPERABLE and 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 (see Figure 5.1.3-1) when averaged over 31 days would exceed 0.3 mrem to any organ in a 31-day period.

APPLICABILITY: At all times.

ACTION:

- a. With the VENTILATION EXHAUST TREATMENT SYSTEM inoperable for more than 31 days, or with gaseous waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that includes the following information:
 1. Identification of the 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 descriptions of action(s) taken to prevent a recurrence.
- b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.5.1 Doses due to gaseous releases from each reactor unit to areas at and beyond the SITE BOUNDARY shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM.

4.11.2.5.2 The VENTILATION EXHAUST TREATMENT SYSTEM shall be demonstrated OPERABLE by operating the VENTILATION EXHAUST TREATMENT SYSTEM equipment for at least 15 minutes, at least once per 92 days unless the appropriate system has been utilized to process radioactive gaseous effluents during the previous 92 days.

RADIOACTIVE EFFLUENTS

EXPLOSIVE GAS MIXTURE

LIMITING CONDITION FOR OPERATION

3.11.2.6 (Not Used).

RADIOACTIVE EFFLUENTS

MAIN CONDENSER

LIMITING CONDITION FOR OPERATION

3.11.2.7 (Not Used).

RADIOACTIVE EFFLUENTS

CONTAINMENT PURGING AND VENTING

CONTROLS

3.11.2.8 VENTING or PURGING of the containment drywell and suppression chamber shall be through:

- a. The OPERABLE primary containment purge filter, or,
- b. The purge lines bypassing the primary containment purge filter. The station ventilation exhaust monitor (VE-42) shall be OPERABLE in this mode of operation.

APPLICABILITY: Whenever the drywell is vented or purged.

ACTION:

- a. With the requirements of the above specification not satisfied, suspend all VENTING and PURGING of the drywell.
- b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.8.1 The containment drywell shall be determined to be aligned for VENTING or PURGING through the primary containment purge system within 4 hours prior to start of and at least once per 12 hours during VENTING or PURGING of the drywell.

4.11.2.8.2 The containment drywell shall be analyzed per Table 4.11.2.1.2 of Specification 3.11.2.1 within 8 hours prior to start of and at least once per 12 hours during VENTING or PURGING of the drywell if the containment purge filter is bypassed or if the Containment Filter Train Exhaust Radiation Monitor is inoperable.

4.11.2.8.3 The primary containment purge system shall be demonstrated OPERABLE:

- a. At least once per 31 days by initiating, from the control room, flow through the HEPA filters and charcoal adsorbers and verifying that the system operates for at least 15 minutes unless the system has been utilized to process gaseous effluents during the previous 31 days.

RADIOACTIVE EFFLUENTS

SURVEILLANCE REQUIREMENTS (Continued)

- b. At least once per 18 months or (1) after any structural maintenance on the HEPA filter or charcoal adsorber housings, or (2) following painting, fire, or chemical release in any ventilation zone communicating with the system by:
1. Verifying that with the system operating at a flow rate of 1200 cfm \pm 10% and exhausting through the HEPA filters and charcoal adsorbers, the total bypass flow of the system to the facility vent, including leakage through the subsystem bypass valve, is less than or equal to 1% when the system is tested by admitting cold DOP at the system intake.
 2. Verifying that the system satisfies the in-place testing acceptance criteria and uses the test procedures of Regulatory Positions C.5.a, C.5.c, and C.5.d of Regulatory Guide 1.52, Revision 2, March 1978, at a system flow rate of 1200 cfm \pm 10%.
 3. Verifying within 31 days after removal that a laboratory analysis of a representative carbon sample obtained in accordance with Regulatory Position C.6.b of Regulatory Guide 1.52, Revision 2, March 1978, meets the laboratory testing criteria of Regulatory Position C.6.a of Regulatory Guide 1.52, Revision 2, March 1978.
 4. Verifying a system flow rate of 1200 cfm \pm 10% during subsystem operation when tested in accordance with ANSI N510-1975.
- c. After every 720 hours of charcoal adsorber operation by verifying within 31 days after removal that a laboratory analysis of a representative carbon sample obtained in accordance with Regulatory Position C.6.b of Regulatory Guide 1.52, Revision 2, March 1978, meets the laboratory testing criteria of Regulatory Position C.6.a of Regulatory Guide 1.52, Revision 2, March 1978.
- d. At least once per 18 months by:
1. Verifying that the pressure drop across the combined HEPA filters and charcoal adsorber banks is less than 5.5 inches water gauge while operating the filter train at a flow rate of 1200 cfm \pm 10%.
 2. Verifying that the filter train starts and isolation dampers open on manual initiation from the control room.
- e. After each complete or partial replacement of a HEPA filter bank by verifying that the HEPA filter banks remove greater than or equal to 99.00% of the DOP when they are tested in-place in accordance with ANSI N510-1975 while operating the system at a flow rate of 1200 cfm \pm 10%.

RADIOACTIVE EFFLUENTS

SURVEILLANCE REQUIREMENTS (Continued)

- f. After each complete or partial replacement of a charcoal adsorber bank by verifying that the charcoal adsorbers remove greater than 99.00% of a halogenated hydrocarbon refrigerant test gas when they are tested in-place in accordance with ANSI N510-1975 while operating the system at a flow rate of 1200 cfm \pm 10%.

RADIOACTIVE EFFLUENTS

3/4.11.3 Not Used

RADIOACTIVE EFFLUENTS

3/4.11.4 TOTAL DOSE

CONTROLS

3.11.4 The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 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 the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Controls 3.11.1.2a., 3.11.1.2b., 3.11.2.2a., 3.11.2.2b., 3.11.2.3a., or 3.11.2.3b., calculations should be made including direct radiation contributions from the reactor units and from outside storage tanks to determine whether the above limits of Control 3.11.4 have been exceeded. If such is the case, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, 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 20.405c, shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits, and if the release condition resulting in violation of 40 CFR Part 190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR Part 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.
- b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.4.1 Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with Controls 4.11.1.2, 4.11.2.2, and 4.11.2.3, and in accordance with the methodology and parameters in the ODCM.

4.11.4.2 Cumulative dose contributions from direct radiation from the reactor units and from radwaste storage tanks shall be determined in accordance with the methodology and parameters in the ODCM. This requirement is applicable only under conditions set forth in Control 3.11.4a.

3/4.12 RADIOACTIVE ENVIRONMENTAL MONITORING

3/4.12.1 MONITORING PROGRAM

CONTROLS

3.12.1 The radiological environmental monitoring program shall be conducted as specified in Table 3.12.1-1.

APPLICABILITY: At all times.

ACTION:

- a. With the radiological environmental program not being conducted as specified in Table 3.12.101, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report required by Control 6.9.1.6, 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 3.12.1-2 when averaged over any calendar quarter, prepare and submit to the Commission, within 30 days, pursuant to Technical Specification 6.9.2, 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 3.11.1.2, 3.11.2.2, and 3.11.2.3. When more than one of the radionuclides in Table 3.12.1-2 are detected in the sampling medium, this report shall be submitted if:

$$\frac{\text{concentration (1)}}{\text{reporting level (1)}} + \frac{\text{concentration (2)}}{\text{reporting level (2)}} + \dots \geq 1.0$$

When radionuclides other than those in Table 3.12.1-2 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 3.11.1.2, 3.11.2.2, and 3.11.2.3. 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.

*The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.

RADIOLOGICAL ENVIRONMENTAL MONITORING

CONTROLS (Continued)

ACTION: (Continued)

- c. With milk or fresh leafy vegetable samples discontinued from one or more of the sample locations required by Table 3.12.1-1, 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. Pursuant to Control 6.9.1.7, identify the cause of the unavailability of samples and identify the new location(s) for obtaining replacement samples in the next Semiannual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).
- d. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.1 The radiological environmental samples shall be collected pursuant to Table 3.12.1-1 from the specific locations given in the table and figures in the ODCM, and shall be analyzed pursuant to the requirement of Table 3.12.1-1 and the detection capabilities required by 4.12.1-1.

TABLE 3.12.1-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM*

<u>EXPOSURE PATHWAY AND/OR SAMPLE</u>	<u>NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE COLLECTION^a</u>	<u>SAMPLING AND COLLECTION FREQUENCY</u>	<u>TYPE AND FREQUENCY OF ANALYSIS</u>
1. DIRECT RADIATION ^b	<p>36 routine monitoring stations, DR1-DR36, either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows:</p> <ol style="list-style-type: none"> 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-DR25; The balance of the stations, DR26-DR36, to be placed in special interest areas such as population centers, nearby residences, schools, and in 1 or 2 areas to serve as control stations. 	Quarterly	Gamma dose quarterly.

The number, media, frequency, and location of samples may vary from site to site. This table presents an acceptable minimum program for a site at which each entry is applicable. Local site characteristics must be examined to determine if pathways not covered by this table may significantly contribute to an individual's dose and should be included in the sampling program.

TABLE 3.12.1-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM*

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE COLLECTION ^a	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
2. AIRBORNE			
Radioiodine and Particulates	<p>Samples from 5 locations, A1-A5:</p> <p>3 samples, A1-A3* from close to the 3 SITE BOUNDARY locations, in different sectors, of the highest calculated annual average groundlevel D/Q.</p> <p>1 sample, A4, from the vicinity of a community having the highest calculated annual average groundlevel D/Q.</p> <p>1 sample, A5, from a control location as for example 15-30 km distant and in the least prevalent wind direction.^c</p>	<p>Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.</p>	<p>Radioiodine Cannister: I-131 analysis weekly.</p> <p>Particulate Sampler: Gross beta radioactivity analysis following filter change; Gamma isotopic analysis^e of composite (by location) quarterly.</p>
3. WATERBORNE			
a. Surface ^h (Long Island Sound)	<p>1 sample control, Wa1 1 sample on change, Wa2 or Wa3</p>	<p>Grab sample semiannually.</p>	<p>Gamma isotopic analysis^e and tritium analysis semiannually.</p>
b. Ground	<p>Samples from 1 or 2 sources, Wb1, Wb2, only if likely to be affected.^f</p>	<p>Quarterly.</p>	<p>Gamma isotopic^e and tritium analysis, quarterly.</p>
c. Sediment from shoreline	<p>1 sample from downstream area with existing or potential recreational value, Wd1.</p>	<p>Semiannually.</p>	<p>Gamma isotopic analysis^e semiannually.</p>

*The first and second highest D/Q sectors have radioiodine and particulate samples. The third highest D/Q sector at the SITE BOUNDARY is approximately 150 ft from the first highest sector.

TABLE 3.12.1-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM*

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE COLLECTION ^a	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
4. INGESTION			
a. Milk	<p>Samples from milking animals in location, Ia1, within 5 km distance having the highest dose potential. If there are none, then, 1 sample from milking animals in each of 3 areas, Ia1, between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per yr, or if there are none available within 8 km, then a location 8 to 17 km distant will be used.</p> <p>1 sample from milking animals at a control location, Ia2, 15-30 km distant, and not in a direction prevalently downwind from the Plant.</p>	<p>Semimonthly when animals are on pasture, monthly at other times.</p>	<p>Gamma isotopic^e and I-131 analysis semimonthly when animals are on pasture; monthly at other times.</p>
b. Fish and Invertebrates	<p>1 sample of each commercially and recreationally important species in vicinity of plant discharge area, Ib1-Ib2.</p> <p>1 sample of same species in areas not influenced by plant discharge, Ib3.</p>	<p>Sample in season or semiannually if they are not seasonal.</p>	<p>Gamma isotopic analysis^e on edible portions.</p>
c. FOOD PRODUCTS	<p>Samples of 3 different kinds of broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average ground-level D/Q, if milk sampling is not performed, Ic1 - Ic3.</p> <p>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 perform, Ic3.</p>	<p>At time of harvest.ⁱ</p> <p>At time of harvest.ⁱ</p>	<p>Gamma isotopic^e and I-131 analysis.</p> <p>Gamma isotopic^e and I-131 analysis.</p>

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TABLE 3.12.1-1 (Continued)

TABLE NOTATIONS

^aSpecific parameters of distance and direction sector from the centerline of one reactor, and additional description where pertinent, are provided for each and every sample location in Table 3.12.1-1 in a table and figure in the ODCM. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," 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 Controls 6.9.1.6. 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. Pursuant to Control 6.9.1.7, identify the cause of the unavailability of samples for that pathway and identify the new location(s) for obtaining replacement samples in the next Semiannual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

^bOne 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 thermoluminescent 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. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.

^cThe 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.

^dAirborne 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 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

^eGamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

TABLE 3.12.1-1 (Continued)

TABLE NOTATIONS (Continued)

^fGroundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

^gThe dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

^hThe "control" sample shall be taken at a distance beyond significant influence of the discharge. The "discharge" sample shall be taken in an area beyond but near the mixing zone.

ⁱIf harvest occurs more than once a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuberous and root food products.

TABLE 3.12.1-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

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	30,000				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	2	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200			300	

TABLE 4.12.1-1

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS^{a b}LOWER LIMIT OF DETECTION (LLD)^c

ANALYSIS	AIRBORNE PARTICULATE					
	WATER (pCi/L)	OR GAS (pCi/m ³)	FISH (pCi/kg, wet)	MILK (pCi/L)	FOOD PRODUCTS (pCi/kg, wet)	SEDIMENTS (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	3000					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-95	30					
Nb-95	15					
I-131	1 ^d	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140	60			60		
La-140	15			15		

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TABLE 4.12.1-1 (Continued)

TABLE NOTATIONS

^aThis 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 Control 6.9.1.6.

^bRequired detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.

^cThe LLD is defined, the 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.

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

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

Where:

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

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate, as counts per minute,

E is the counting efficiency (as counts per transformation),

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

2.22 is the number of transformations per minute per picocurie,

Y is the fractional radiochemical yield, when applicable,

λ is the radioactive decay constant for the particular radionuclide, and

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

Typical values of E, V, Y, and Δt shall be used in the calculations.

TABLE 4.12.1-1 (Continued)

TABLE NOTATIONS (Continued)

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, unavoidably 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 Control 6.9.1.6.

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

RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.2 LAND USE CENSUS

CONTROLS

3.12.2 A land use census shall be conducted and shall identify within a distance of 8 km (5 miles) the location of each of the 16 meteorological sectors of the nearest milk animal, the nearest residence, and the nearest garden of greater than 50 m² (500 ft²) producing broad leaf vegetation.* For elevated releases as defined in Regulatory Guide 1.111, Revision 1, July 1977, the land use census shall also identify within a distance of 8 km (5 miles) the locations in each of the 16 meteorological sectors of all milk animals and all gardens of greater than 50 m² (500 ft²) producing broad leaf vegetation.

APPLICABILITY: At all times.

ACTION:

- a. With a land use census identifying a location(s) which yields a calculated dose or dose commitment greater than the values currently being calculated in Control 4.11.2.3, identify the new location(s) in the next Semiannual Radioactive Effluent Release Report, pursuant to Control 6.9.1.7.
- b. With a land use census identifying a location(s) which yields a calculated dose or dose commitment (via the same exposure pathway) 20 percent greater than at a location from which samples are currently being obtained in accordance with Control 3.12.1, 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. Pursuant to Control 6.9.1.7, identify the new location(s) in the next Semiannual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).
- c. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SUREVEILLANCE REQUIREMENTS

4.12.2 The land use census shall be conducted during the growth season at least once per 12 months using that information that will provide the best results, such as by a door-to-door survey, aerial survey, or by consulting local agriculture authorities. The results of the land use census shall be included in the Annual Radiological Environmental Operating Report pursuant to Control 6.9.1.6.

*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. Specifications for broad leaf vegetation sampling in Table 3.12.1-1, item 4.c., shall be followed, including analysis of control samples.

RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

CONTROLS

3.12.3 Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program that has been approved by the Commission, that corresponds to samples required by Table 3.12.1-1.

APPLICABILITY: At all times.

ACTION:

- a. 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 Control 6.9.1.6.
- b. The provisions of Controls 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.3 The Interlaboratory Comparison Program shall be described in the ODCM. A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report pursuant to Control 6.9.1.6.

SNPS-1 ODDM

PART I
SECTION 4

RADIOLOGICAL EFFLUENT
CONTROLS

BASES FOR
SECTIONS 3.0 AND 4.0
CONTROLS
AND
SURVEILLANCE REQUIREMENTS

1.4-0

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NOTE

The BASES contained in succeeding pages summarize the reasons for the Controls in Sections 3.0 and 4.0, but in accordance with 10 CFR 50.36 are not part of these Controls.

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3/4.3.7 MONITORING INSTRUMENTATION

3/4.3.7.10 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

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

3/4.3.7.11 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

The radioactive gaseous effluent monitoring 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. This instrumentation also includes provisions for monitoring (and controlling) the concentrations of potentially explosive gas mixtures in the main condenser offgas treatment system. 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.

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.1 CONCENTRATION

This Control 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, Appendix B, Table II, Column 2. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposure within (1) the Section II.A design objectives of Appendix I, 10 CFR 20.106(e) 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 air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

This Control applies to the release of radioactive materials in liquid effluents from all reactor 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 HASL Procedures Manual, HASL-300 (revised annually), Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal-Chem. 40, 586-93 (1968), and Hartwell, J. K., Detection Limits for Radioanalytical Counting Techniques, Atlantic Richfield Hanford Company Report ARH-SA215 (June 1975).

3/4.11 RADIOACTIVE EFFLUENTS

BASES

3/4.11.1.2 DOSE

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 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." 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 radioactive materials in 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.

3/4.11.1.3 LIQUID RADWASTE TREATMENT SYSTEM

The OPERABILITY of the liquid radwaste treatment system ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment. 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 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.

3/4.11.2 GASEOUS EFFLUENTS

RADIOACTIVE EFFLUENTS BASES

3/4.11.2.1 DOSE RATE

This Control is provided to ensure that the dose at any time at and beyond the SITE BOUNDARY from gaseous effluents from all units on the site will be within the annual dose limits of 10 CFR Part 20 for unrestricted areas. The annual dose limits are the doses associated with the concentrations of 10 CFR Part 20, Appendix B, Table II, Column 1. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a MEMBER OF THE PUBLIC in an unrestricted area, either within or outside the SITE BOUNDARY, to annual average concentrations exceeding the limits specified in Appendix B, Table II of 10 CFR Part 20 (10 CFR 20.106(b)). For a MEMBER OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of the MEMBER OF THE PUBLIC will be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the SITE BOUNDARY. The specified release rate limits restrict, at all times, the corresponding gamma and beta 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 applies to the release of radioactive materials in gaseous effluents from all reactor units at the site.

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

3/4.11.2.2 DOSE - NOBLE GASES

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 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 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, October 1977 and Regulatory Guide 1.111, "Methods for estimating

DOSE - NOBLE GASES (Continued)

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 the SITE BOUNDARY are based upon the historical average atmospheric conditions.

3/4.11.2.3 DOSE - IODINE-131, IODINE-133, TRITIUM, AND RADIONUCLIDES IN PARTICULATE FORM

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 for 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 methods 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, iodine-133, radionuclides in particulate form and tritium are dependent on the existing radionuclide pathways to man, in the unrestricted area. The pathways which 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.

3/4.11.2.4 GASEOUS RADWASTE TREATMENT SYSTEM

This Control is provided to ensure the operation of the GASEOUS RADWASTE TREATMENT SYSTEM whenever the main condenser air ejector system is in operation. Implementation of this requirement provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." This Control implements the requirements of 10 CFR 50.36.a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives set forth in Sections II.B and II.D of Appendix I to 10 CFR Part 50 for gaseous effluents.

RADIOACTIVE EFFLUENTS

BASES

3/4.11.2.5 VENTILATION EXHAUST TREATMENT SYSTEM

The OPERABILITY of the VENTILATION EXHAUST TREATMENT SYSTEM ensures that the systems will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." This Control implements the requirements of 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.

3/4.11.2.8 CONTAINMENT PURGING AND VENTING

This Control provides reasonable assurance that releases from drywell purging and venting operations will not exceed the annual dose limits of 10 CFR Part 20 for UNRESTRICTED AREAS.

3/4.11.4 TOTAL DOSE

This Control is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20 by 46 FR 18525. The Control requires the preparation and submittal of a Special Report whenever the calculated doses from plant-generated radioactive effluents and direct radiation exceed 25 mrems to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems. For sites containing up to four 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 40 CFR Part 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR 190.11 and 10 CFR 20.405c, 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 Controls 3.11.1.1 and 3.11.2.1. 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.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

BASES

3/4.12.1 MONITORING PROGRAM

The radiological 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 individuals 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 modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. The initially specified monitoring program will be effective for at least the first 3 years of commercial operational experience. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 4.12-1 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.

Detailed discussion of the LLD, and other detection limits, can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93 (1968), and Hartwell, J. K., "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

Composite sampling and drinking water requirements are not applicable.

No public drinking water supplies could be affected by the plant's discharge since groundwater drainage is to the north into Long Island Sound (ER 2.5.3.2).

3/4.12.2 LAND USE CENSUS

This Control is provided to ensure that changes in the use of areas at or beyond the SITE BOUNDARY are identified and that modifications to the monitoring program are made if required by the results of this census. The best survey 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 500 square feet provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum

RADIOLOGICAL ENVIRONMENTAL MONITORING

BASES

3/4.12.2 LAND USE CENSUS (Continued)

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 used, (1) that 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/square meter.

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

The requirement for participation in an 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.

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PART I
SECTION 5

RADIOLOGICAL EFFLUENT
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SECTION 5.0
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5.0 DESIGN FEATURES

5.1 SITE

5.1.1 (Not Used)

5.1.2 (Not Used)

SITE BOUNDARY FOR RADIOACTIVE GASEOUS AND LIQUID EFFLUENTS

5.1.3 The SITE BOUNDARY for radioactive gaseous and liquid effluents shall be as shown in Figure 5.1.3-1.

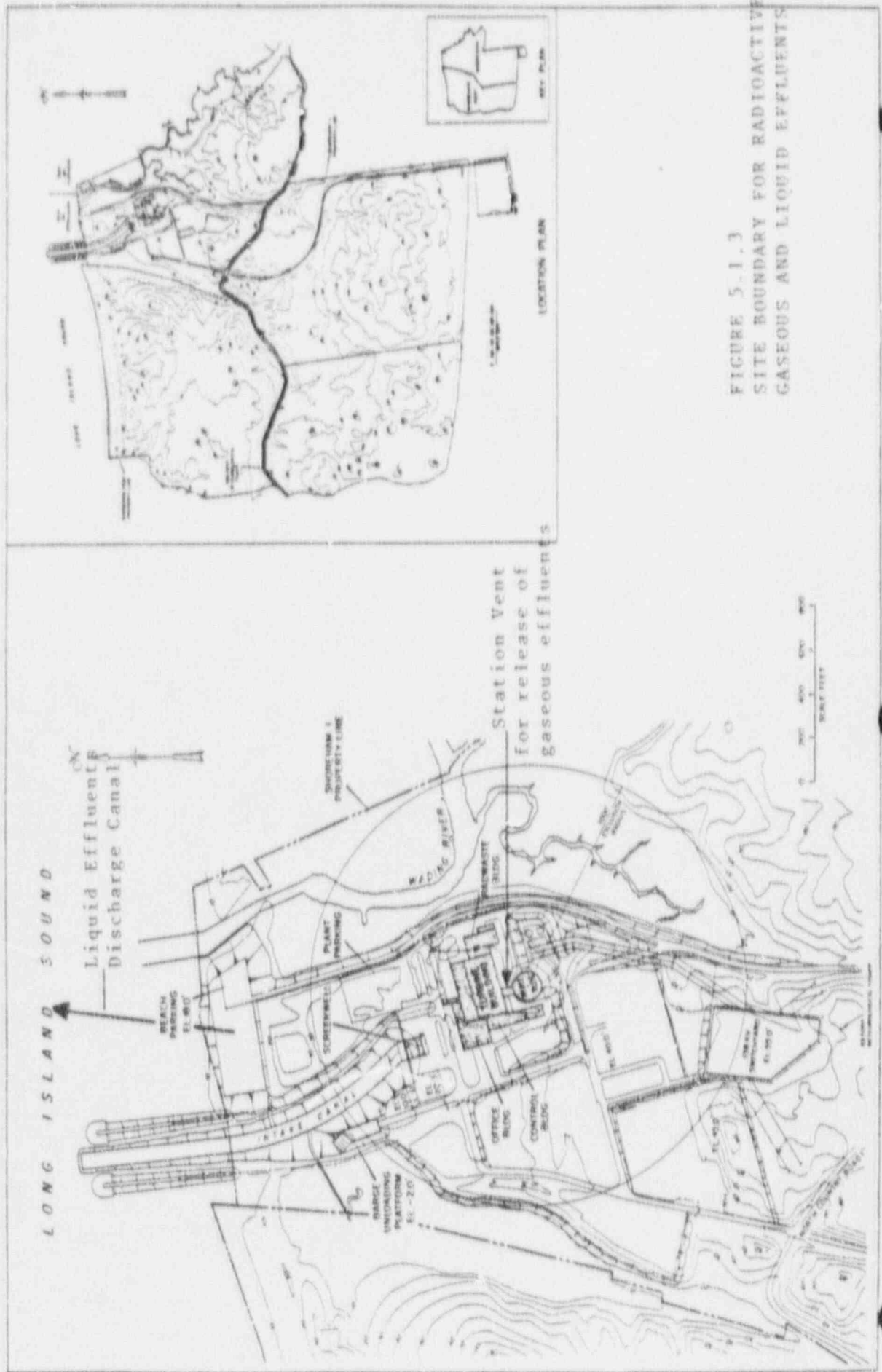


FIGURE 5.1.3
 SITE BOUNDARY FOR RADIOACTIVE
 GASEOUS AND LIQUID EFFLUENTS

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PART 1
SECTION 6

RADIOLOGICAL EFFLUENT
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SECTION 6.0
ADMINISTRATIVE CONTROLS

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ADMINISTRATIVE CONTROLS

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

6.9.1.6 Routine Annual Radiological Environmental Operating Reports covering the operation of the unit during the previous calendar year shall be submitted prior to May 1 of each year. The initial report shall be submitted prior to May 1 of the following year following initial criticality.

The Annual Radiological Environmental Operating Reports shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational surveillance reports and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of land use censuses required by Control 3.12.2.

The Annual Radiological Environmental Operating Reports shall include the results of analysis of all radiological environmental samples of all environmental radiation measurements taken during the period pursuant to the locations specified in the table 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.

The reports shall also include the following: a summary description of the radiological environmental monitoring program; at least two legible maps* covering all sampling locations keyed to a table giving distances and directions from the centerline of one reactor; the results of licensee participation in the Interlaboratory Comparison Program, required by Control 3.12.3; discussion of all deviations from the sampling schedule of Table 3.12-1; and discussion of all analyses in which the LLD required by Table 4.12-1 was not achievable.

SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

6.9.1.7 Routine Semiannual Radioactive Effluent Release Reports covering the operation of the unit during the previous 6 months of operation shall be submitted within 60 days after January 1 and July 1 of each year. The period of the first report shall begin with the date of initial criticality.

The Semiannual Radioactive Effluent Release Reports shall include 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.

*One map shall cover stations near the SITE BOUNDARY; a second shall include the more distant stations.

ADMINISTRATIVE CONTROLS

SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (Continued)

The Semiannual Radioactive Effluent Release Report to be submitted 60 days after January 1 of each year shall include 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 of wind speed, wind direction, atmospheric stability, and precipitation (if measured) on magnetic tape, or in the form of joint frequency distribution of windspeed, wind direction and atmospheric stability.** This same report shall include 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. This same report shall also include 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 5.1.3-1) 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. The meteorological conditions concurrent with the time of release of radioactive materials in gaseous effluents (as determined by sampling frequency and measurement) shall be used for determining the 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).

The Semiannual Radioactive Effluent Release Report to be submitted 60 days after January 1 of each year shall also include an assessment of radiation doses to nearby uranium fuel cycle sources (including doses from primary effluent pathways and direct radiation) for the previous calendar year to show conformance with 10 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.

The Semiannual Radioactive Effluent Release Reports shall include 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.

The Semiannual Radioactive Effluent Release Reports shall include any changes made during the reporting period to the OFFSITE DOSE CALCULATION MANUAL (ODCM), as well as listing of new locations for dose calculations and/or environmental monitoring identified by the land use census pursuant to Control 3.12.2.

6.14 OFFSITE DOSE CALCULATION MANUAL (ODCM)

See Technical Specification 6.14.

**In lieu of submission with the Semiannual Radioactive Effluent Release Report, the licensee has the option of retaining this summary of required meteorological data on file, in a file that shall be provided to the NRC upon request.

ADMINISTRATIVE CONTROLS

6.15 MAJOR CHANGES TO RADIOACTIVE LIQUID AND GASEOUS WASTE TREATMENT SYSTEMS

6.15.1 Licensee-initiated major changes to the radioactive waste treatment system (liquid and gaseous):

- a. Shall be reported to the Commission in the Semiannual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the Review of Operations Committee. The discussion of each change shall contain:
 1. A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR 50.59;
 2. Sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information;
 3. A detailed description of the equipment, components, and processes involved and the interfaces with other plant systems;
 4. An evaluation of the change which shows the predicted releases of radioactive materials in liquid and gaseous effluents that differ from those previously predicted in the license application and amendments thereto;
 5. An evaluation of the change which shows the expected maximum exposures to a MEMBER OF THE PUBLIC in the UNRESTRICTED AREAS and to the general population that differ from those previously estimated in the license application and amendments thereto;
 6. A comparison of the predicted releases of radioactive materials, in liquid and gaseous effluents, to the actual releases for the period prior to when the changes are to be made;
 7. An estimate of the exposure to plant operating personnel as a result of the change; and
 8. Documentation of the fact that the change was reviewed and found acceptable by the Review of Operations Committee.
- b. Shall become effective upon review and acceptance by the ROC.

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PART II

SECTION 1

INTRODUCTION

The purpose of this manual is to show the calculational methodology and parameters used to comply with the Radiological Effluent Controls (REC, Part I) of the ODCM.

Section 2 establishes methods to calculate the Liquid Effluent Monitor set point and the Gaseous Effluent Monitor set points in order to comply with REC Sections 3.11.1.1 and 3.11.2.1, respectively.

Section 3 establishes dose calculational methods for liquid and gaseous effluents. The liquid effluents dose calculation methods are used to show compliance with REC Sections 3.11.1.2 and 3.11.1.3. For liquid pathways, the dilution factor of 8.85 used in Section 3.1 is a calculated value based on a submerged, multiport diffuser with a port discharge velocity of 12 fps, a 300 ft radius mixing zone, and 4 circulating water pumps discharging. If only service water pumps are discharging, the dilution factor is one (1.0).

The gaseous effluent dose calculation methods are used to show compliance with REC Sections 3.11.2.1, 3.11.2.2, and 3.11.2.3. The atmospheric dispersion and deposition factors used in calculation methods were calculated based on onsite meteorological data for the 2-year period of October 1, 1973 through September 30, 1975.

Regulatory Guide 1.119, Rev. 1 (October 1977), Methodology and Parameters, with the exception of the dilution factor of 8.85, when circulating water flow exists, were used in Method 2 (the Backup Method) dose rate and dose conversion factors.

Tables 3.5-10, 3.5-12 and 3.5-13 are incorporated only for future use if there is a change in the land use census which requires considering any combination of cow's milk and meat pathways.

Section 4 identifies the receptor locations which represent critical pathway locations, water dilution, atmospheric dispersion, and deposition factors used in calculation Method 2. Table 4-1 summarizes the above factors for the gaseous effluent pathways.

Section 5 indicates locations at which environmental sampling may be conducted.

Section 6 addresses the Interlaboratory Comparison Program.

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PART II
SECTION 2

SET POINTS

2.1 LIQUID EFFLUENT MONITOR SET POINTS (Compliance with Section 3.11.1.1 of the Radiological Effluent Controls (REC, Part 1 of the ODCM).

The radionuclide concentrations released via liquid effluents to unrestricted areas shall be limited to the concentrations specified in 10CFR20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the total concentration shall be limited to 2×10^{-4} Ci/ml.

The set points of the effluent monitors are dependent on circulating or service water as follows:

1. a. With the circulating water system (a once-through system) in use, the circulating water flow rate (the circulating water system is composed of four pumps and circulates sea water at a rate of 574,000 gpm).
b. The service water flow rate, if the circulating water system is not in use but service water is in use. (The service water system is composed of four reactor building service water pumps, each having a capacity of 8600 gpm and three turbine building service water pumps each having a capacity of 8000 gpm.)
2. Flow rates of effluents from tanks and/or from the RHR heat exchanger service water outlet, and/or yard piping drain sump.
3. Individual concentrations of gamma emitters (other than dissolved or entrained noble gases) and Sr-89, Sr-90, Fe-55, and H-3; and the total concentration of dissolved or entrained noble gases and gross concentration of the alpha emitters in the liquids to be discharged.
4. Maximum allowable concentration of 2×10^{-4} μ Ci/ml for the total concentration of dissolved or entrained noble gases and maximum permissible concentrations (MPCs) of other gamma emitters, Sr-89, Sr-90, Fe-55, H-3, and alpha emitters in the effluents as specified in 10CFR20, Appendix B, Table II, Column 2 for an unrestricted area.

NOTE: Precautions should be taken to assure that the circulating water system flow rate or the service water system flow rate used in determining the set point remains constant during the period of discharge. If the circulating or service water flow rate during discharge becomes less than the flow rate that was used in calculating the discharge set point, the discharge must be terminated and a new set point calculated.

Service water via the RHR heat exchanger service water outlet will be released continuously to the environment when the RHR heat exchanger is in operation. Reactor building salt water drain tank contents may be released to the environment either as a batch process or continuously. The discharge waste sample tanks, recovery sample tanks, and yard piping drain sump contents will always be released to the environment as batch processes.

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For batch as well as continuous releases, the sampling and analysis program shall be in accordance with the minimum requirements of REC Table 4.11.1.1.1-1. Specifically, the analysis program will include the determination of gross alpha concentration of the alpha emitters. In addition, it will include isotopic analysis for determination of individual concentrations of principal gamma emitters, and the specific radionuclides, Sr-89, Sr-90, Fe-55, and H-3. It will also include the determination of total concentration of the dissolved and entrained noble gases (gamma emitters) in the liquids. The concentrations of individual gamma emitters are determined by gamma spectral analysis of 1) the batch sample prior to its release for the batch releases and 2) the weekly composite sample for continuous releases. For gross alpha and the specific radionuclides Sr-89, Sr-90, Fe-55, and H-3, if analysis cannot be performed prior to discharge, then the following concentrations are used in the monitor set point calculations:

Gross Alpha and H-3

Gross alpha concentration and H-3 concentrations as determined by analysis of the previous monthly composite sample.

Sr-89, Sr-90, Fe-55

Individual concentrations are determined by analysis of the previous quarterly composite sample for batch releases.

Representative Samples

Representative composite samples utilized in determining the concentrations of H-3, Sr-89, Sr-90, Fe-55, and the gross alpha concentration both for batch and continuous releases, and in determining the concentrations of gamma emitters (excluding dissolved and entrained noble gases) for continuous releases are obtained in accordance with the method stated for obtaining such samples in the REC Table 4.11.1.1.1-1.

The tank contents are recirculated prior to obtaining samples for analysis. The minimum recirculation time t_r shall be:

$$t_r = \frac{2v}{f_r}$$

where:

v = the volume of liquid in the tank to be sampled

f_r = the recirculation flow rate being used to mix the tank contents.

For the yard drain sump, the above methodology will be used unless it can be determined that there has been no condensate storage tank overflow events since the last batch release. Although designated a batch release, there may be times when non-contaminated yard drain runoff to the sump will occur during the discharge period. This input will not increase the discharge concentration.

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The above methodology will ensure that a representative sample will be obtained for batch releases.

Set Point Philosophy

The philosophy of the set points will be based on the sum of the ratios of isotopic concentrations to MPCs being less than 1 for discharges into unrestricted areas. Specifically:

$$\begin{aligned} \frac{C}{MPC} &= \sum_{i=1}^N \frac{C_i}{MPC_i} \\ &= \frac{C_a}{MPC_a} + \frac{C_b}{MPC_b} + \dots + \frac{C_n}{MPC_n} + \frac{C_\alpha}{MPC_\alpha} + \frac{C_G}{MPC_G} \\ &+ \frac{C_s}{MPC_s} + \frac{C_t}{MPC_t} + \frac{C_{Fe}}{MPC_{Fe}} \leq 1 \end{aligned} \quad (2.1.1)$$

where:

C_a, C_b, \dots, C_n = Concentration of the individual gamma emitting radionuclides identified ($\mu\text{Ci/ml}$)

C = The gross alpha concentration ($\mu\text{Ci/ml}$)

C_G = The total concentration of dissolved or entrained noble gases ($\mu\text{Ci/ml}$)

C_s = The Sr-89 and Sr-90 concentrations ($\mu\text{Ci/ml}$)

C_t = The H-3 concentration ($\mu\text{Ci/ml}$)

C_{Fe} = The Fe-55 concentration ($\mu\text{Ci/ml}$)

MPC_i = $MPC_a, MPC_b, \dots, MPC_n, MPC_\alpha, MPC_G, MPC_s, MPC_t, MPC_{Fe}$

= the maximum permissible concentration of the respective radioisotope i ($\mu\text{Ci/ml}$) from 10CFR20, Appendix B, Table II Column 2. For dissolved or entrained noble gases, the maximum allowable concentration (MPC_G) will be $2.00E-04$ ($\mu\text{Ci/ml}$). For gross alpha, the assumed will be $3.00E-08$ ($\mu\text{Ci/ml}$).

If the C/MPC calculated is less than 1, then no release is possible. The normalization factor (as defined in Section 2.1.1) must be greater than 1 to permit releases. To permit releases, this factor can be increased to a value greater than 1 by increasing dilution flow F (by running more circulating or service water pumps in the applicable discharge structure), and/or decreasing the effluent flow rates f_D, f_s, f_{HA}, f_{HR} , etc. (defined in Section 2.1.1), and recalculate C/MPC using new C_i in Equation 2.1-1.

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2.1.1 Radiation Effluent Monitor (RE-13) High/Trip Alarm Set Point for Discharge Waste Sample Tanks, Recovery Sample Tanks, or YARD Piping Drain Sump

The function of this monitor set point is to ensure that the sum of the ratios of the discharge concentrations to the MPCs of the corresponding radionuclides of the discharges monitored by this monitor and other liquid waste discharges, if any, does not exceed 1. If the monitor count rate is higher than the calculated set point, the radiation monitor will terminate the release.

A sample is taken from any of the following tanks or sump which is to be discharged along with any streams which are in the process of being discharged.

1. Discharge waste tanks
2. Recovery sample tanks
3. Yard piping drain sump
4. Reactor building salt water drain tank
5. Residual heat removal heat exchanger service water

Only one of the first three items above is discharged at any one time, which can be combined with releases from item 4 and/or 5.

Obtain the circulating or service water flow rate from the control room (see NOTE in Section 2.1).

Define Normalizing factor

$$F = \frac{[f_D + f_{HA} + f_{HB} + f_s + (F_c - f_{HA} - f_{HB})]}{N \sum_{i=1} \left[\frac{(C_{Di}f_D + C_{HiA}f_{HA} + C_{HiB}f_{HB} + C_{Si}f_s)}{MPC_i} \right]} * 0.8$$

An isotopic analysis of each sample is performed. This analysis includes isotopic analysis for gamma emitters; gross alpha emitters; total dissolved or entrained noble gases; and Sr-89, Sr-90, Fe-55, and H-3. This should be done for all monitors.

Then the set point (NOTE: the background (cpm), if it can be determined, is also added to the set point value. If, however, it cannot be determined, it is considered as zero) for detector RE-13 is calculated as:

$$S_{13} \leq F * \sum_{i=1}^N C_{Di} * E_i \quad (\text{cpm})$$

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where:

C_{Di} = concentration of radioisotope (i) ($\mu\text{Ci/ml}$) in any of the following tanks or sump that is to be discharged:

1. discharge waste tanks
2. recovery sample tanks
3. yard piping drain sump

f_D = Discharge flow rate (gpm) from any of the following tanks or sump that is to be discharged:

1. discharge waste tanks
2. recovery sample tanks
3. yard piping drain sump.

(Maximum design discharge flow rate = 150 gpm)

C_{Si} = Reactor building salt water drain tank concentration of radioisotope(i) ($\mu\text{Ci/ml}$)

C_{HiA} = RHR heat exchanger service water outlet concentration of radioisotope(i) ($\mu\text{Ci/ml}$) from loop A.

C_{HiB} = RHR heat exchanger service water outlet concentration of radioisotope(i) ($\mu\text{Ci/ml}$) from loop B.

f_S = Reactor building salt water drain tank discharge flow rate (gpm).
(Maximum design discharge flow rate = 100 gpm)

f_{HA} = RHR heat exchanger service water outlet discharge flow rate (gpm) from loop A (Maximum design discharge flow rate = 9340 gpm)

f_{HB} = RHR heat exchanger service water outlet discharge flow rate (gpm) from loop B (Maximum design discharge flow rate 9340 gpm)

F_C = Total circulating or service water flow rate (gpm) (this includes f_{HA} and f_{HB})

E_i = Gamma counting efficiency of RE-13 for radionuclide (i) (cpm/ $\mu\text{Ci/ml}$). Figure 2.1-1 shows the energy response. For non-gamma emitters, $E_i=0$.

0.8 = Safety factor

MPC_i is defined in Section 2.1. The above calculation is made for each batch to be released.

After each batch release, the high alarm set point should be reset as close to the background as practical to prevent spurious alarms and yet assure an alarm should an inadvertent release occur.

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2.1.2 Radiation Effluent Monitor (RE-79) High Alarm Set Point for Reactor Building Salt Water Drain Tank

The function of this monitor set point is to ensure that the sum of the ratios of the discharge concentrations to the MPCs of the corresponding radionuclides of the discharges monitored by this monitor and other liquid waste discharges, if any, does not exceed 1.

If the monitor count rate is higher than the calculated set point, the radiation monitor will alarm in the control room.

A sample will be taken from the reactor building salt water drain tank discharge, along with individual samples of any of the following streams which may be in the process of being discharged:

1. Discharge waste sample tanks
2. Recovery sample tanks
3. Yard piping drain sump
4. Residual heat removal heat exchanger service water

In the case of continuous release, samples will be taken as per requirement REC Table 4.11.1.1.1-1.

Obtain the circulating or service water flow rate from the control room (see NOTE in Section 2.1).

The set point for continuous or batch release (see NOTE in Section 2.1.1) will be calculated as follows:

$$S_{79} \leq F * \sum_{i=1}^N C_{S_i} E_i \quad (\text{cpm})$$

where:

E_i = Gamma counting efficiency of RE-79 for radionuclide i (cpm/ μ Ci/ml). Figure 2.1-2 shows the energy response. For non-gamma emitters, $E_i = 0$

All other parameters are as defined in Section 2.1.1.

When the tank operates in a batch mode, the above calculation is made for each batch to be released.

After each batch release or continuous release period, the high alarm set point should be reset as close to the background as practical to prevent spurious alarms and yet assure an alarm should an inadvertent release occur.

2.1.3 Residual Heat Removal Heat Exchanger Service Water Outlet Monitors (RE-23A, RE-23B) High Alarm Set Points

The function of this monitor set point is to ensure that the sum of the ratios of the discharge concentrations to the MPCs of the corresponding radionuclides of the discharges monitored by this monitor and other liquid waste discharges, if any, does not exceed 1. If the monitor count rate is higher than the calculated set point, the radiation monitor will alarm in the control room.

Monitors RE-23A and RE-23B are independent. Each is dedicated to monitor its respective RHR loop.

A sample will be taken from the RHR heat exchanger service water outlet (A and/or B), along with individual samples of any of the following streams which may be in the process of being discharged:

1. Discharge waste sample tanks
2. Recovery sample tanks
3. Yard piping drain sump
4. Reactor building salt water drain tank discharge

Obtain the circulating or service water flow rate from the control room (see NOTE in Section 2.1).

The set points for RE-23A and RE-23B are calculated as follows:

$$S_{23A} \leq F * \left[\sum_{i=1}^N C_{HiA} E_{iA} \right]$$

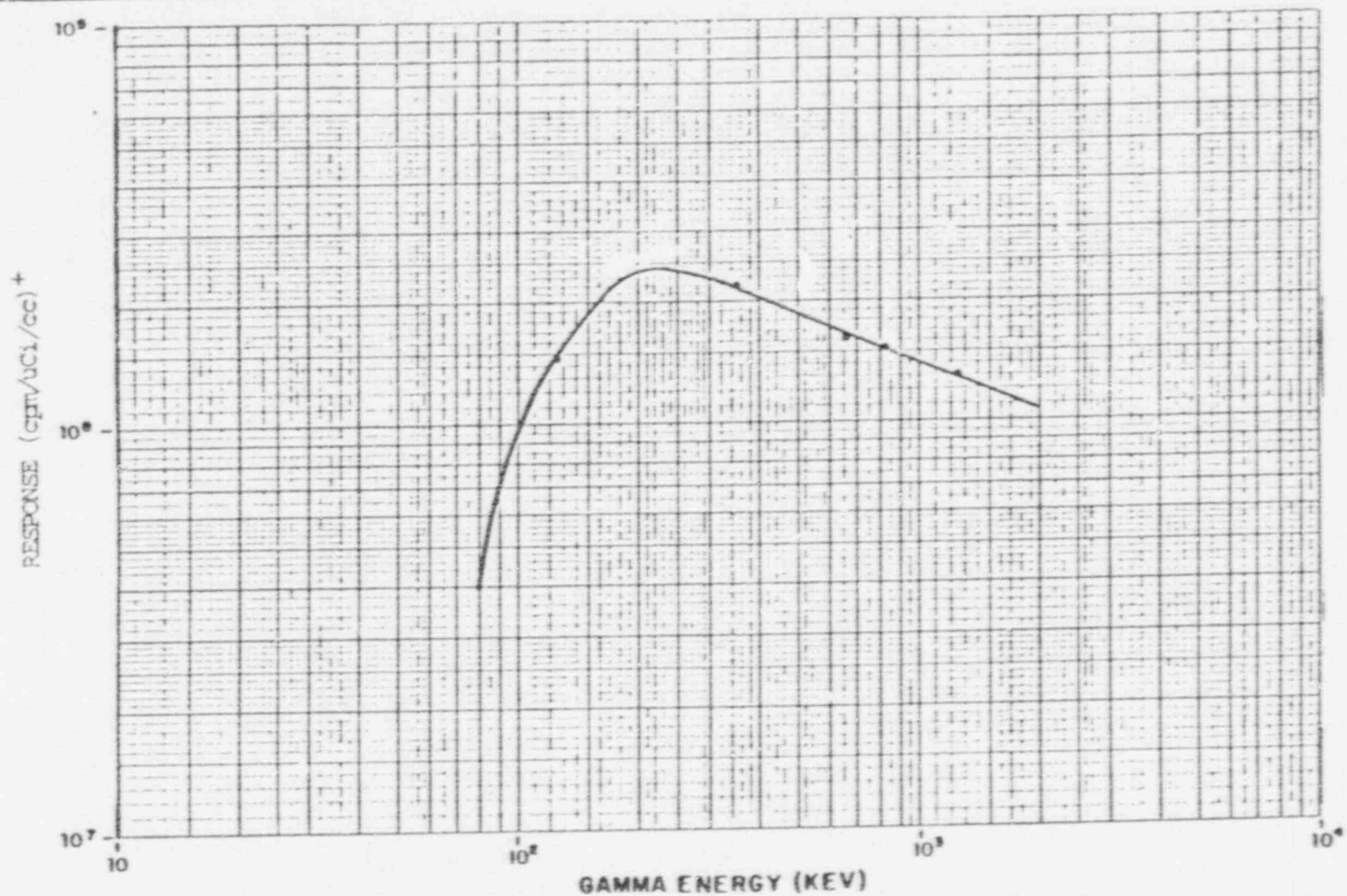
$$S_{23B} \leq F * \left[\sum_{i=1}^N C_{HiB} E_{iB} \right]$$

where:

E_{iA} = Gamma counting efficiency of RE-23A for radionuclide i (cpm/ μ Ci/ml). Figure 2.1-2 shows the gamma energy response. For non-gamma emitters, $E_{iA} = 0$

E_{iB} = Gamma counting efficiency of RE-23B for radionuclide i (cpm/ μ Ci/ml). Figure 2.1-2 shows the gamma energy response. For non-gamma emitters, $E_{iB} = 0$

All other parameters are as defined in Section 2.1.



SOURCE:

—●— C-RPD-482, Rev. 0

+ normalized to 1 photon/disintegration

FIGURE 2.1-1

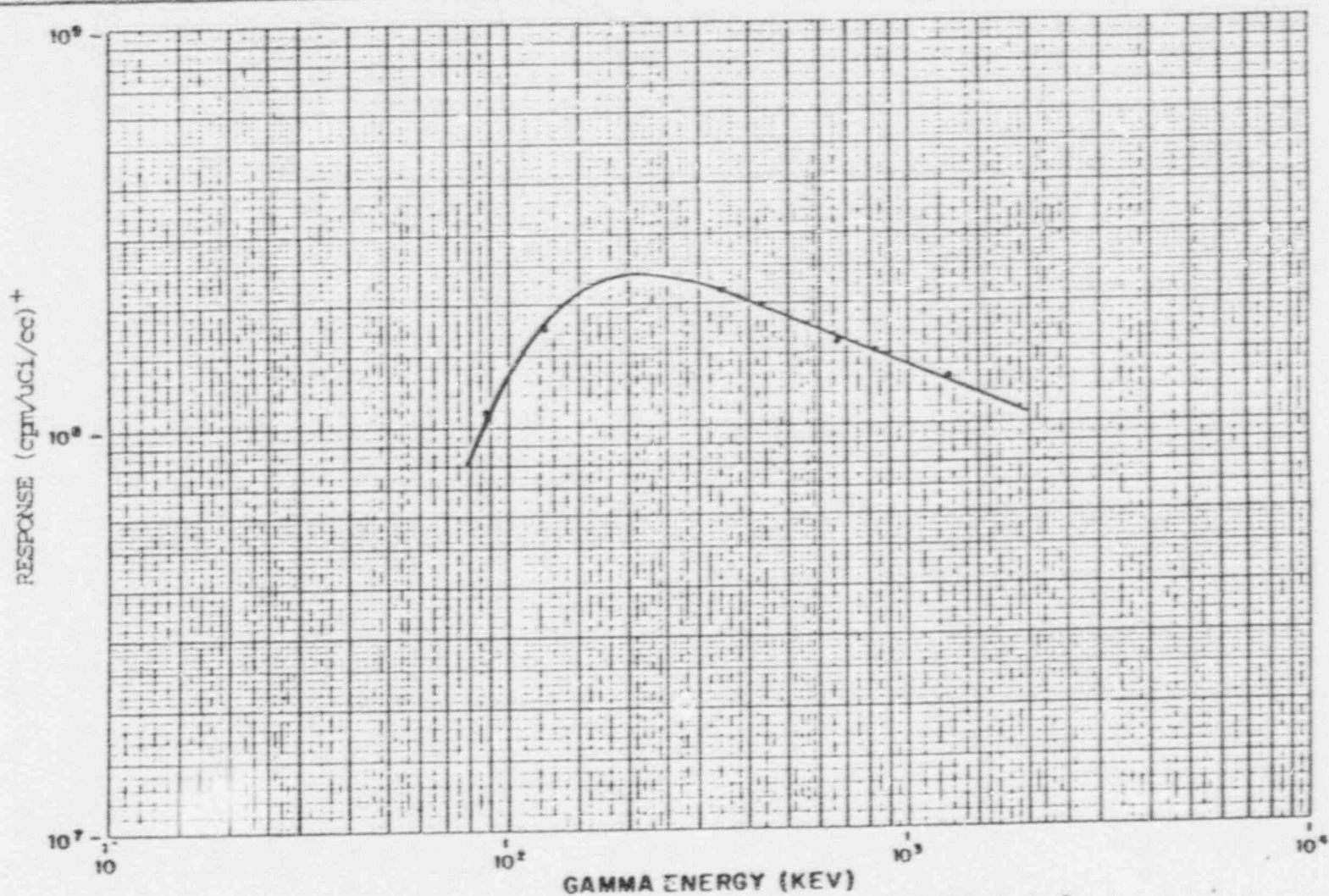
DETECTOR RE-13

RESPONSE VS. GAMMA ENERGY

SHOREHAM NUCLEAR POWER STATION-UNIT 1

OFFSITE DOSE CALCULATION MANUAL

Revision 14 - January 1989



SOURCE:

—●— C-RPD-490, Rev. 0

+ normalized to 1 photon/disintegration

FIGURE 2.1-2

DETECTORS RE-23A, RE-23B and RE-79
 RESPONSE VS. GAMMA ENERGY
 SHOREHAM NUCLEAR POWER STATION-UNIT 1
 OFFSITE DOSE CALCULATION MANUAL

Revision 14 - January 1989

2.2 GASEOUS EFFLUENT MONITOR SET POINTS (Compliance with Section 3.11.2.1 of the REC)

The high alarm set point for the Station Ventilation Exhaust Monitor (RE-42) is set in accordance with the dose rate limit for noble gases at the site boundary specified in Section 3.11.2.1 of the REC:

Less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin.

The set point for this monitor will be determined based on the lower of the two set points calculated for: 1) the total body dose rate and 2) the skin dose rate, calculated respectively in Sections 2.2.1 and 2.2.2.

The high alarm set points for the Main Condenser Offgas System Effluent Monitors (RE-65A, B) is based on the MPC limit specified in 10CFR20 Appendix B, Table II, Column 1 which is in conformance with the dose rate limits specified above. The high alarm set point for the Main Condenser Air Ejector Monitor (RE-12A, B) in normal operation is based on the REC limited total noble gas (beta and gamma) release rate at the main condenser air ejector, which is 244,000 $\mu\text{Ci}/\text{sec}$ at 30 minutes delay. The high alarm set point for the Main Condenser Air Ejector Effluent Monitors in the bypass mode (RE-12A, B in the bypass mode) are based on 25 percent of the limit specified above.

For all the above monitors, the initial set points are based on expected release rates (Ci/year) for radionuclides given in the Safety Evaluatic. Report (SER) for Shoreham (NUREG-420, April 1981, Table 11-2). An effective initial concentration, C_i (pCi/cc) for each radionuclide, i , is obtained from the release rate, Q_i (Ci/yr) for the radionuclide and the appropriate flow rate V (cc/sec) as follows:

$$C_i \text{ (pCi/cc)} = \frac{Q_i \text{ (Ci/yr)} * 10^{12} \left(\frac{\text{pCi}}{\text{Ci}}\right)}{3.15 * 10^7 \left(\frac{\text{sec}}{\text{yr}}\right)} * \frac{1}{V \left(\frac{\text{cc}}{\text{sec}}\right)}$$

When the mechanical vacuum pump is in operation, the release rate Q_{im} (Ci/yr) from mechanical vacuum pump exhaust will be used assuming that the mechanical vacuum pump operates for 100 hours or $3.6 * 10^5$ seconds per year. The effective initial concentration C_i (pCi/cc) for radionuclide, i , when the mechanical vacuum pump is in operation, is calculated as:

$$C_i \text{ (pCi/cc)} = \frac{Q_{im} \text{ (Ci/yr)} * 10^{12} \left(\frac{\text{pCi}}{\text{Ci}}\right)}{3.6 * 10^5 \left(\frac{\text{sec}}{\text{yr}}\right)} * \frac{1}{V \left(\frac{\text{cc}}{\text{sec}}\right)}$$

Once operation has begun, the concentration, C_i , for each radionuclide, will be obtained as the measured value from a grab sample.

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The methodology of multiplying the observed cpm by the calculated scale factor will be used to obtain the set point in the range where the detector response is linear with changes in nuclide concentration. In the non-linear region, appropriate correction as derived from Figures 2.2-2 or 2.2-4 will be made.

2.2.1 Gaseous Effluent Monitor High Alarm Set Point for Station Ventilation Exhaust Monitor (RE-42)

2.2.1.1 Gaseous Effluent Monitor High Alarm Set Point for Station Ventilation Exhaust Monitor (RE-42) Based on Noble Gases Total Body Dose Rate

1. During operation a gaseous sample from the monitor will be taken and analyzed for isotopic composition and concentration, C_i . Before startup, C_i will be calculated as noted in Section 2.2.
2. At the time of sampling, the net count rate (excluding background), CR (cpr), of the Station Ventilation Exhaust Noble Gas Radiation Monitor will be recorded. Before startup, the estimated CR is calculated as:

$$CR = 10^{-6} * \left(\sum_{i=1}^N C_i * E_i \right) \quad (\text{cpm})$$

where:

E_i = detector efficiency (cpm/ $\mu\text{Ci/cc}$) for RE-42 for radio-nuclide, i , as provided in Figure 2.2-1. The linearity response for RE-42 is shown in Figure 2.2-2.

3. The noble gas total body dose rate is calculated using the following equation:

$$\sum_i DR_i = \chi/Q * V * \left(\sum_i DFB_i * C_i \right) \quad (\text{mrem/yr})$$

where:

DR_i = predicted dose rate based on gas sample for isotope i (mrem/yr),

χ/Q = annual average χ/Q (sec/ m^3) at 366 meters NNE due to releases via the station ventilation exhaust point ($6.6\text{E}-07$ sec/ m^3),

DFB_i = total body dose rate conversion factor (mrem/yr/ pCi/m^3), from Table 2.2-1,

C_i = sampled isotope release concentration (pCi/cc),

V = station ventilation exhaust rate (cc/sec). (Maximum exhaust rate = $1.73\text{E}+08$ cc/sec ($3.66\text{E}+05$ cfm).)

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- The isotopic release activity concentration is normalized to a total body dose rate of 500 mrem/yr by multiplying by the following normalizing factor:

$$F_B = 500 / \sum_i DR_i$$

- From the above, the set point (see NOTE in Section 2.1.1) based on total body dose rate can be calculated as follows:

$$S_{42}^B \leq 0.8 * F_B * CR \quad (\text{cpm})$$

where:

- S_{42}^B = high alarm set point that results in a total body dose rate of less than 500 mrem/yr,
- F_B = normalization factor (unitless),
- CR = station ventilation exhaust noble gas radiation monitor count rate (cpm), and
- 0.8 = safety factor.

The above procedure and format will be used to calculate the set point for RE-42 when the mechanical vacuum pump is in operation or during containment purge. Under these conditions, the short term atmospheric dispersion factor at 366 meters NNE ($3.60E-06 \text{ sec/m}^3$) shall be used instead of the annual average value.

2.2.1.2 Gaseous Effluent Monitor High Alarm Set Point for Station Ventilation Exhaust Monitor (RE-42) Based on Noble Gases Skin Dose Rate

- During operation a gaseous sample from the monitor will be taken and analyzed for isotopic composition and concentration, C_i . Before startup, C_i will be calculated as noted in Section 2.2.
- At the time of sampling, the net count rate (excluding background), CR (cpm), of the station ventilation exhaust noble gas radiation monitor will be recorded. Before startup, CR is calculated as noted in Section 2.2.1.
- The noble gases beta and gamma skin dose rate is calculated using the following equation:

$$\sum_i DR_i = X/Q * V * 8 \left(\sum_i K_{s,i} * C_i \right) \quad (\text{mrem/yr})$$

where:

- DR_i = predicted dose rate based on gas sample for isotope i (mrem/yr),

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- X/Q = annual average X/Q (sec/m^3) at 366 meters NNE due to releases via the station ventilation exhaust point, ($6.6\text{E}-07 \text{ sec}/\text{m}^3$),
- K_{sim} = skin dose rate conversion factor ($\text{mrem}/\text{yr}/\text{pCi}/\text{m}^3$), from Table 2.2-1,
- C_i = sampled isotope release concentration (pCi/cc),
- V = station ventilation exhaust rate (cc/sec). (Maximum exhaust rate = $1.73\text{E}+08 \text{ cc}/\text{sec}$ ($3.66\text{E}+05 \text{ cfm}$).)

4. The isotopic release activity concentration is normalized to a skin dose rate of 3000 mrem/yr by multiplying by the following normalizing factor:

$$F_S = 3000 / \sum_i DR_i$$

5. From the above, the alarm set point (see NOTE in Section 2.1.1), based on skin dose rate, can be calculated as follows:

$$S_{42}^S \leq 0.8 * F_S * CR \quad (\text{cpm})$$

where:

- S_{42}^S = high alarm set point that results in a skin dose rate of less than 3000 mrem/yr (cpm),
- F_S = normalization factor (unitless),
- CR = station ventilation exhaust noble gas radiation monitor count rate (cpm), and
- 0.8 = safety factor.

The above procedure and format will be used to calculate the set point for RE-42 when the mechanical vacuum pump is in operation or during containment purge. Under these conditions, the short term atmospheric dispersion factor at 366 meters NNE ($3.60\text{E}-06 \text{ sec}/\text{m}^3$) shall be used instead of the annual average value.

2.2.2 Main Condenser Offgas System Effluent Monitors (RE-65A,B) High Alarm Set Point

The Main Condenser Offgas System Effluent Monitor has two chambers (65A, 65B) in series. Each chamber constitutes a separate independent output channel containing a detector composed of 3 GM tubes whose output is summed. The monitor set point will be based on a release rate which results in 0.1 MPC at the site boundary. The set point calculated shall be divided by a factor of 3 to account for the case when only one GM tube per chamber is functional.

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1. During operation, a gaseous sample from the monitor will be taken and analyzed for isotopic composition and concentration, C_i . Before startup, C_i will be calculated as noted in Section 2.2.
2. At the time of sampling, the net count rate (excluding background), CR (cpm), of the monitor will be recorded. Before startup, the estimated count rate CR (cpm) due to concentration, C_i , is calculated as:

$$CR = 10^{-6} * \left(\sum_{i=1}^N C_i * E_i \right) \quad (\text{cpm})$$

where:

E_i = detector efficiency (cpm/ μ Ci/cc) for RE-65A,B for radio-nuclide, i , as provided in Figure 2.2-3. The generic linearity response for RE-65A,B is shown in Figure 2.2-4

3. The sum of the ratios of the released isotopic concentrations to MPC is normalized to 0.1 at the site boundary by multiplying by the following factor:

$$F = \frac{0.1}{\left(\sum_{i=1}^N \frac{C_i}{MPC_i} \right) * V * X/Q * 3.0}$$

where:

V = Main condenser offgas system ventilation flow rate (m^3/sec) (Maximum flow rate = $1.18E-02 m^3/\text{sec}$ (25 cfm).)

X/Q = annual average meteorological dispersion factor at 366 meters NNE ($6.6E-07 \text{ sec}/m^3$) due to releases via the station ventilation exhaust point.

3.0 = Safety factor in case of 2 out of 3 GM tube failures.

4. From the above, the high alarm set point for RE-65A,B (see NOTE in Section 2.1.1) is calculated as follows:

$$S_{65} \leq 0.8 * F * CR \quad (\text{cpm})$$

2.2.3 Main Condenser Air Ejector Monitors (RE-12A,B) High Alarm Set Point for Non-Bypass Mode Operation (Normal Operation)

The Main Condenser Air Ejector Monitor System has two detectors looking at one chamber. The alarm will be set off by a signal from either detector.

2.2.3.1 Initial Set Point for RE-12A,B Non-bypass Mode Operation

1. Decay the t=0 GE noble gas spectrum for off-gas system release rate prior to treatment (GE document 22A2703B Rev. 3, Table V) for 201 seconds. Scale it to the Shoreham REC (3.11.2.7) limit of 244,000 $\mu\text{Ci}/\text{sec}$ at 30 minutes decay by multiplying by 2.44. Divide it by the desuperheater condenser exhaust maximum flow rate ($4.8\text{E}+04$ cc/sec) to obtain the limiting concentrations C_i ($\mu\text{Ci}/\text{cc}$) of each radioisotope i .
2. Using the isotopic concentrations, C_i ($\mu\text{Ci}/\text{cc}$), defined above and the effective gamma energy per disintegration, $E_{i\ell}$ (MeV/dis) calculate the specific gamma activity, $A_{i\ell}$ (MeV/cc-sec), for the i -th isotope in each of the following gamma ray energy bins: 0-0.4, 0.4-0.8, 0.8-1.3, 1.3-1.7, 1.7-2.2, 2.2-2.5, and 2.5-3.5 (MeV). Thus:

$$A_{i\ell} = K * E_{i\ell} * C_i$$

where $E_{i\ell}$ is the total gamma energy (MeV) emitted per disintegration of the i -th isotope by gamma rays belonging to the ℓ -th energy bin defined above. The factor $K = 3.7 \times 10^4$ (dis/sec/ μCi) is introduced for unit conversion.

The total specific gamma activity, A_ℓ (MeV/cc-sec), for each gamma energy bin, ℓ , is calculated by summing the specific gamma activity, $A_{i\ell}$, for bin ℓ , over all isotopes.

$$A_\ell = \sum_{i=1}^N A_{i\ell}$$

3. Using the response curve for RE-12A,B given in Figure 2.2-5, calculate the dose rate. The generic linearity response curve for RE-12A,B is shown in Figure 2.2-6.

$$\text{DR} = \sum_{\ell=1}^7 \text{CF}_\ell * A_\ell \quad (\text{mrem/hr})$$

where:

CF_ℓ is the efficiency ($\frac{\text{mrem/hr}}{\text{MeV}}$) at the ℓ -th energy group
(MeV) MeV/cc-sec

4. The high alarm set point (see NOTE in Section 2.1.1, but note the background unit is in mrem/hr) for RE-12A,B in the non-bypass mode will be:

$$S_{12} \leq 0.8 * \text{DR} \quad (\text{mrem/hr})$$

2.2.3.2 Subsequent Adjustments of Set Points for RE-12A,B in Non-Bypass Mode Operation

1. During operation, a gaseous sample from the monitor will be taken and analyzed for noble gases isotopic composition and concentration, C_i , ($\mu\text{Ci/cc}$). The concentrations should be corrected for elapsed decay time between sampling and measurement. In addition, computed concentrations should be obtained for short lived isotopes. Before startup, C_i will be calculated as noted in Section 2.2.
2. At the time of sampling, the net dose rate reading (excluding background) of the monitor will be recorded, DR (mrem/hr).
3. The isotopic release activity concentrations, C_i , are summed and multiplied by the desuperheater condenser exhaust flow rate, V (cc/sec)* to obtain the noble gas release rate in $\mu\text{Ci/sec}$.
4. The release rate in step 3 is normalized to the REC Section 3.11.2.7 release limit of $2.44\text{E}+05$ $\mu\text{Ci/sec}$ at $t=30$ minutes as follows:

$$F = \frac{2.44\text{E}+05}{(\sum C_i) * V}$$

5. From above, the high alarm set point (see NOTE in Section 2.1.1, but note the background is in mrem/hr) based on a release rate of $2.44\text{E}+05$ $\mu\text{Ci/sec}$ at $t=30$ minutes can be calculated as follows:

$$S_{12} \leq 0.8 * F * DR \quad (\text{mrem/hr})$$

2.2.4 Main Condenser Air Ejector Monitor (RE-12A,B) High Alarm Set Point for Bypass Mode Operation

2.2.4.1 Initial Set Point for RE-12A,B in Bypass Mode Operation

1. Same as steps 1, 2, and 3 in Section 2.2.3.1. However, set the desuperheater condenser exhaust maximum flow rate to $5.3\text{E}+05$ cc/sec.
2. The offsite total body dose rate D_T corresponding to the above concentration is calculated as:

$$D_T = 10^{+6} * X/Q * V * (\sum_i \text{DFB}_i * C_i)$$

and the beta and gamma skin dose rate is calculated as:

$$D_S = 10^{+6} * X/Q * V * (\sum_i K_{sim} * C_i)$$

*Note: If flow rate increases, the setpoint must be recalculated. If the flow rate decreases, recalculation of setpoint is optional.

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where:

- D_T = predicted total body dose rate (mrem/yr)
- D_S = predicted beta and gamma skin dose rate (mrem/yr)
- X/Q = annual average atmospheric dispersion factor at 366 meters NNE ($6.6E-07$ sec/m³) due to releases via the station ventilation exhaust point
- V = desuperheater condenser maximum exhaust flow rate (cc/sec)
= $5.3E+05$ cc/sec
- DFB_i = total body dose rate conversion factor ($\frac{\text{mrem/yr}}{\text{pCi/m}^3}$) from Table 2.2-1
- K_{sim} = skin dose rate conversion factor ($\frac{\text{mrem/yr}}{\text{pCi/m}^3}$) from Table 2.2-1

3. The normalizing factor F is chosen to be the smaller of the two (to comply with 25 percent of the REC (3.11.2.1) dose rate limit):

$$F_T = \frac{125 \text{ mrem/yr}}{D_T}$$

$$F_S = \frac{750 \text{ mrem/yr}}{D_S}$$

F = the smaller of F_T or F_S (unitless)

4. The high alarm set point (see NOTE in Section 2.1.1, but note the background is in mrem/hr) RE-12A,B in bypass mode is set at:

$$S_{12} \leq 0.8 * F * DR \quad (\text{mrem/hr})$$

2.2.4.2 Subsequent Adjustments of Set Points for RE-12A,B in Bypass Mode Operation

1. A gaseous sample from the monitor will be taken and analyzed for isotopic composition and concentration, C_i ($\mu\text{Ci/cc}$)
2. At the time of sampling, the net dose rate reading, DR (mrem/hr), of the monitor will be recorded.
3. Follow procedures 2, 3, and 4 of Section 2.2.4.1 to get the high alarm set point for RE-12A,B in bypass mode.

TABLE 2.2-1

DOSE FACTORS FOR EXPOSURE TO A SEMI-INFINITE CLOUD OF NOBLE GASES

Radio-nuclide	β -Air ⁽¹⁾ (DFB _i)	β -Skin ⁽²⁾ (DFS _i)	γ -Air ⁽¹⁾ (DF _i ^{γ})	γ -Body ⁽²⁾ (DFB _i)	K_{Si} ⁽⁴⁾ Skin Dose ⁽²⁾	K_{Sim} ⁽⁵⁾ Skin Dose ⁽²⁾
Kr-83m	2.88E-04 ⁽³⁾	---	1.93E-05	7.56E-08	1.5E-05	2.1E-05
Kr-85m	1.97E-03	1.46E-03	1.23E-03	1.17E-03	2.4E-03	2.8E-03
Kr-85	1.95E-03	1.34E-03	1.72E-05	1.61E-05	1.4E-03	1.4E-03
Kr-87	1.03E-02	9.73E-03	6.17E-03	5.92E-03	1.5E-02	1.7E-02
Kr-88	2.93E-03	2.37E-03	1.52E-02	1.47E-02	1.4E-02	1.9E-02
Kr-89	1.06E-02	1.01E-02	1.73E-02	1.66E-02	2.4E-02	2.9E-02
Kr-90	7.83E-03	7.29E-03	1.63E-02	1.56E-02	2.0E-02	2.5E-02
Xe-131m	1.11E-03	4.76E-04	1.56E-04	9.15E-05	6.0E-04	6.5E-04
Xe-133m	1.48E-03	9.94E-04	3.27E-04	2.51E-04	1.2E-03	1.4E-03
Xe-133	1.05E-03	3.06E-04	3.53E-04	2.94E-04	5.8E-04	7.0E-04
Xe-135m	7.39E-04	7.11E-04	3.36E-03	3.12E-03	3.3E-03	4.4E-03
Xe-135	2.46E-03	1.86E-03	1.92E-03	1.81E-03	3.4E-03	4.0E-03
Xe-137	1.27E-02	1.22E-02	1.51E-03	1.42E-03	1.3E-02	1.4E-02

TABLE 2.2-1 (CONT'D)

Radio-nuclide	β -Air ⁽¹⁾ (DFB _i)	β -Skin ⁽²⁾ (DFS _i)	γ -Air ⁽¹⁾ (DF _i ^Y)	γ -Body ⁽²⁾ (DFB _i)	K_{si} ⁽⁴⁾ Skin Dose ⁽²⁾	K_{sim} ⁽⁵⁾ Skin Dose ⁽²⁾
Xe-138	4.75E-03	4.13E-03	9.21E-03	8.83E-03	1.1E-02	1.4E-02
Ar-41	3.28E-03	2.69E-03	9.30E-03	8.84E-03	9.9E-03	1.3E-02

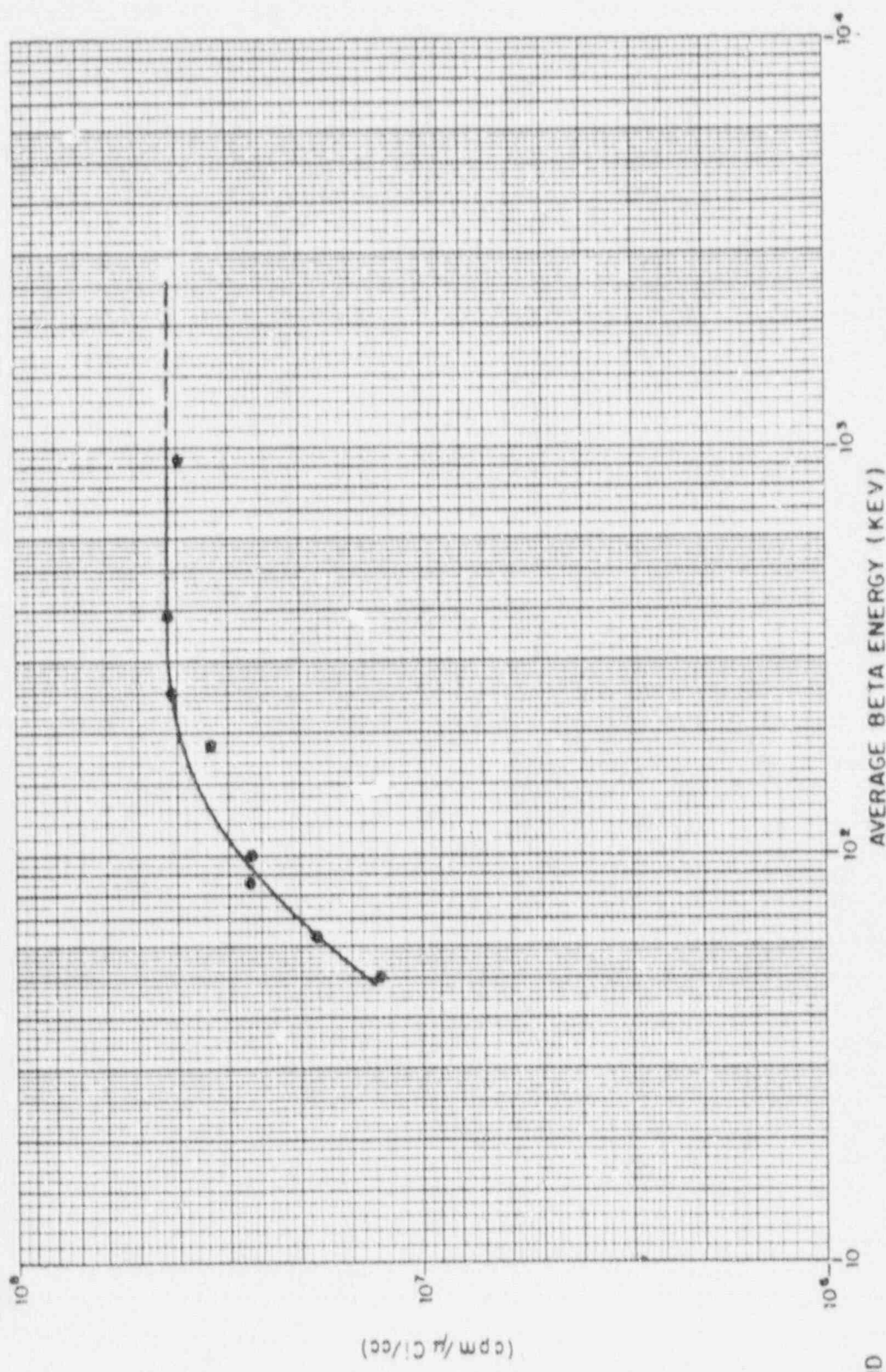
(1) $\frac{\text{mrad-m}^3}{\text{pCi-yr}}$

(2) $\frac{\text{mrem-m}^3}{\text{pCi-yr}}$

(3) $2.88\text{E-}04 = 2.88 * 10^{-4}$

(4) $K_{si} = (0.7 * 1.11 * DF_i^Y) + DFS_i$ |

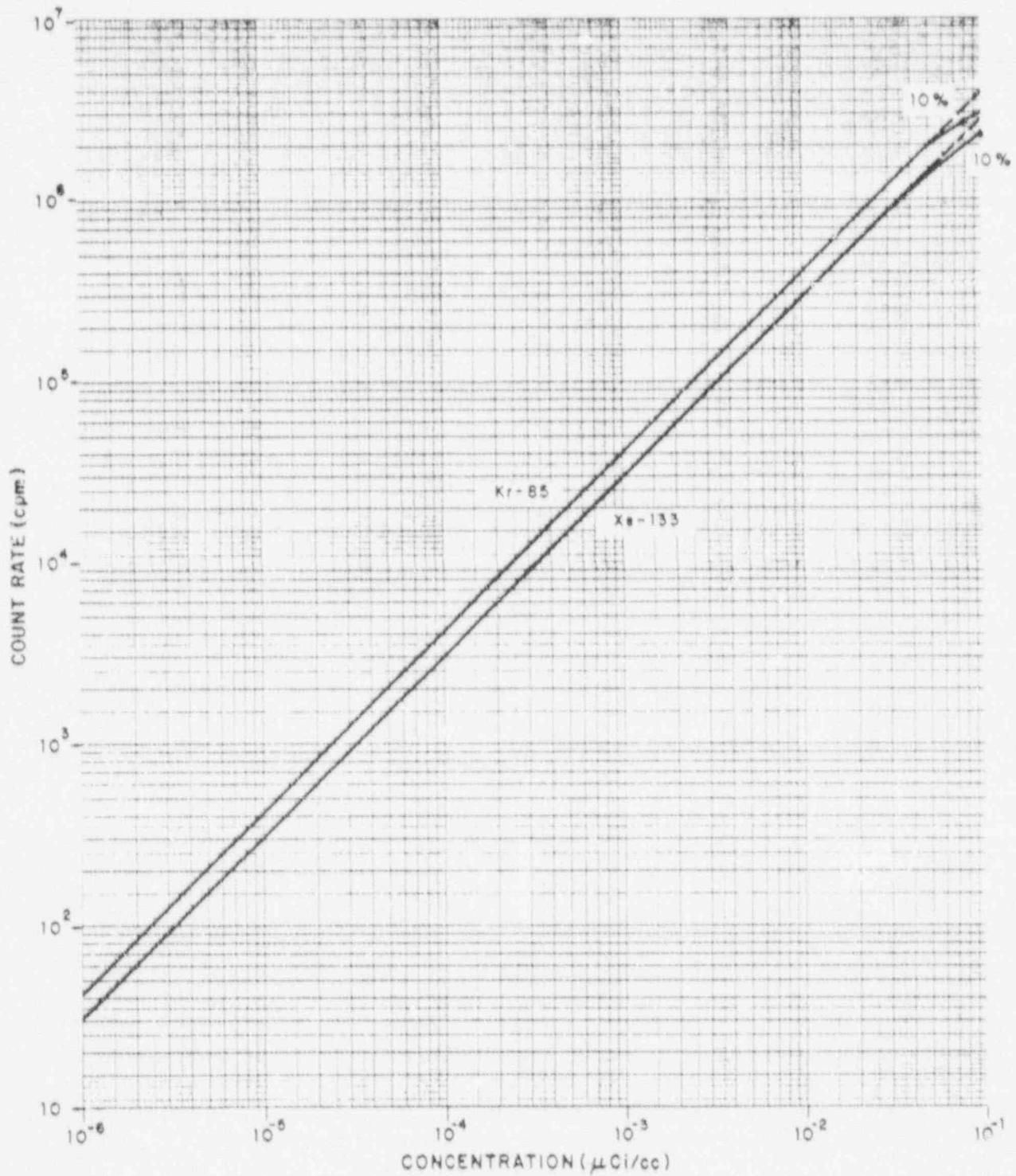
(5) $K_{sim} = (1.11 * DF_i^Y) + DFS_i$ |



LEGEND

- CALIBRATED DATA
- EXTRAPOLATED CURVE BASED ON PREMISE THAT FOR BETA ENERGIES GREATER THAN 1 MEV THE FRACTIONAL LOSS OF BETAS THROUGH SCATTERING OR ABSORPTION IN AIR AND DETECTOR WINDOW IS NEGLIGIBLE.

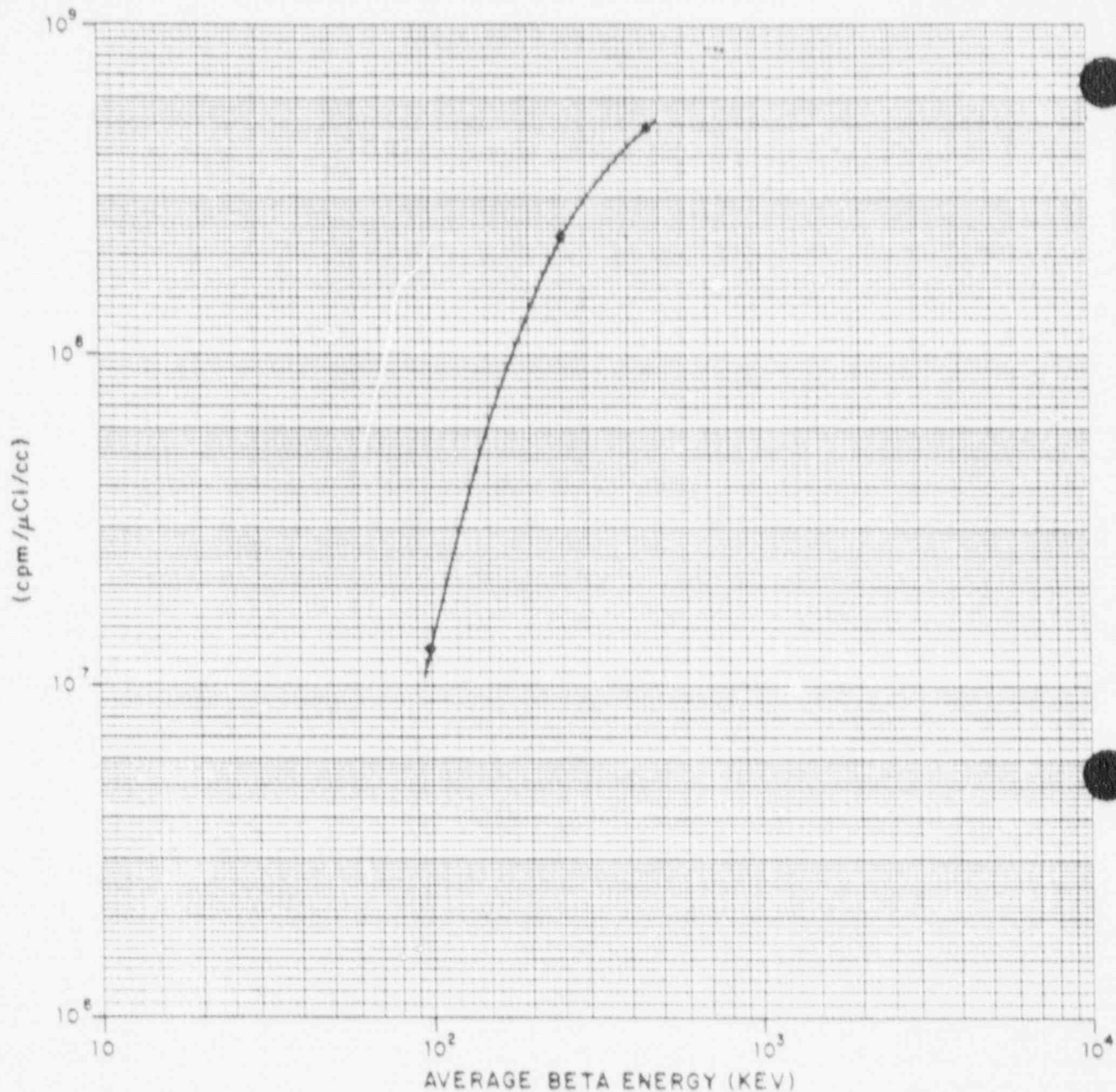
FIGURE 2.2-1
DETECTOR RE-42
EFFICIENCY VS. AVERAGE BETA ENERGY
 SHOREHAM NUCLEAR POWER STATION - UNIT 1
 ORFSITE DOSE CALCULATION MANUAL



SOURCE:
 LILCO LETTER FILE No. 221.9
 LIL-21157

--- IDEAL CURVE
 —◆— CALIBRATION CURVE
 (DATA CONSISTENT WITH
 FIGURE 2.2-1)

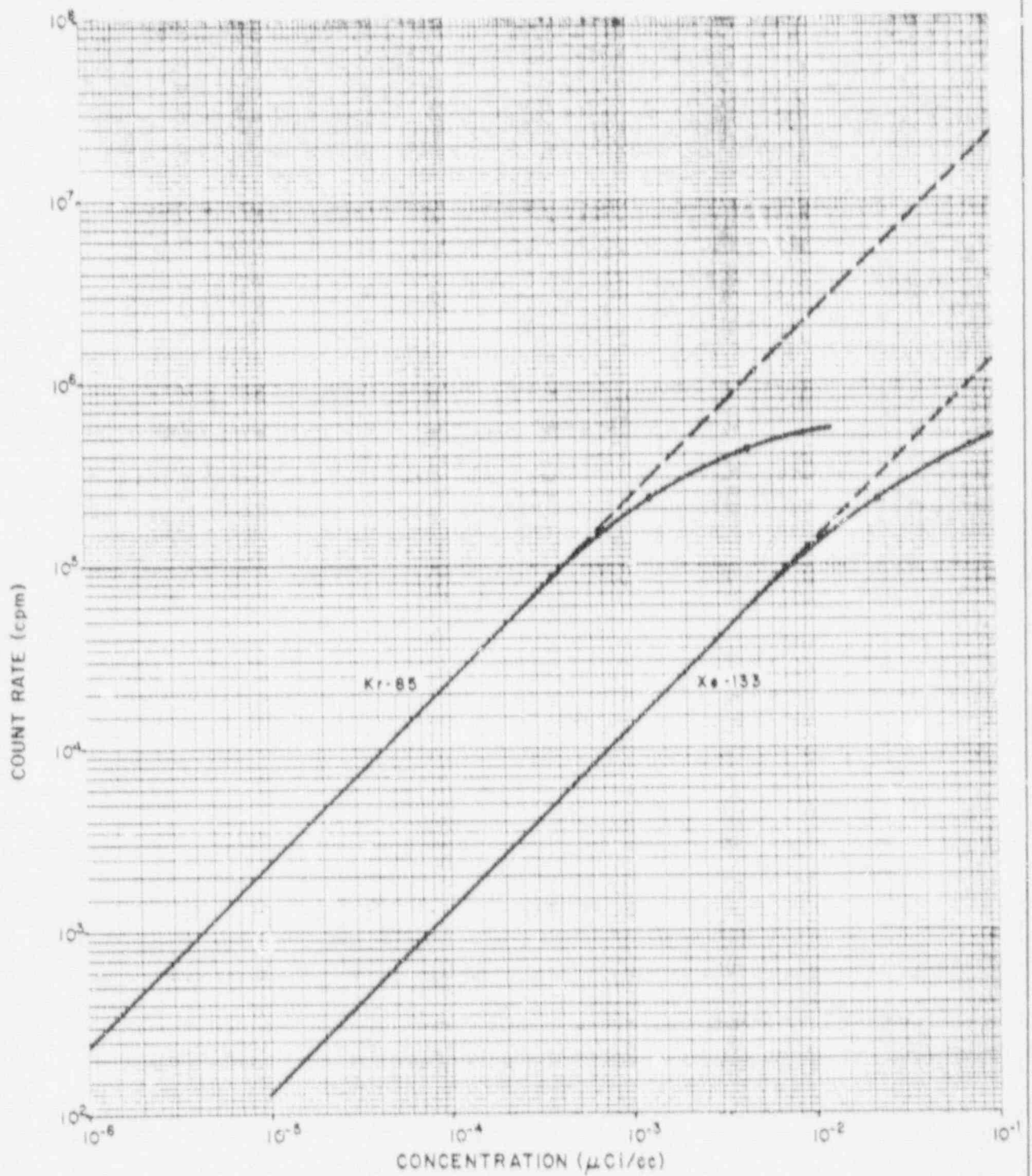
FIGURE 2.2-2
 LINEARITY RESPONSE CURVE FOR
 DETECTOR RE-42
 SHOREHAM NUCLEAR POWER STATION-UNIT 1
 OFFSITE DOSE CALCULATION MANUAL



SOURCE:
 GE MEMO (Pederson) - PROCESS RADIATION
 SAMPLING SENSITIVITIES. JUNE 26, 1977
 (REV. 1)

—●— GENERIC CALIBRATION
 CURVE

FIGURE 2.2-3
 DETECTORS RE-65A, B
 GENERIC EFFICIENCY VS. AVERAGE
 BETA ENERGY
 SHOREHAM NUCLEAR POWER STATION-UNIT 1
 OFFSITE DOSE CALCULATION MANUAL



SOURCE:
 LILCO DOCUMENT No. CS.630.005
 - - - - - IDEAL CURVE
 ———— GENERIC CALIBRATION
 CURVE

FIGURE 2.2-4
 GENERIC LINEARITY RESPONSE CURVE
 FOR DETECTORS RE-65A, B
 SHOREHAM NUCLEAR POWER STATION-UNIT 1
 OFFSITE DOSE CALCULATION MANUAL

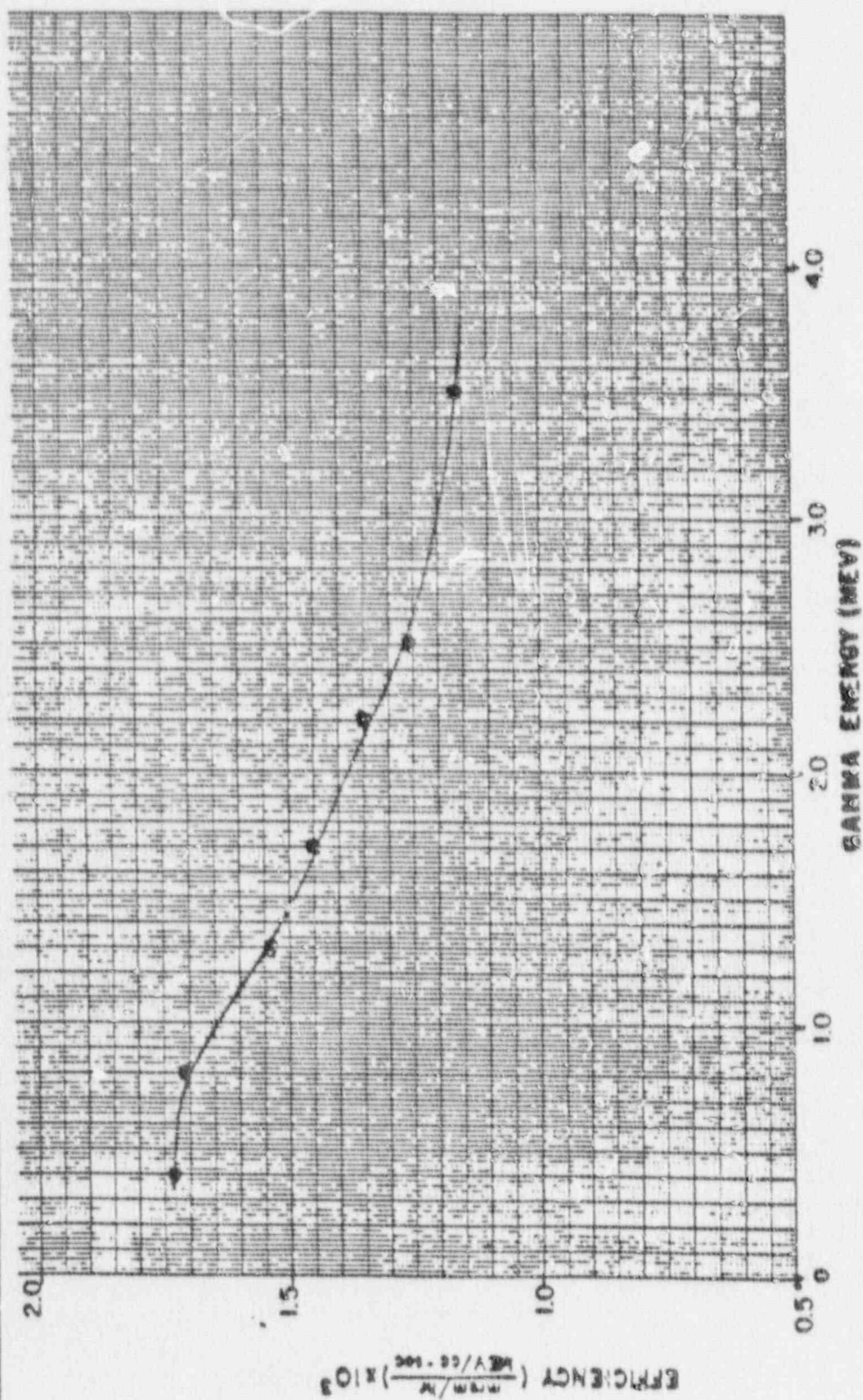
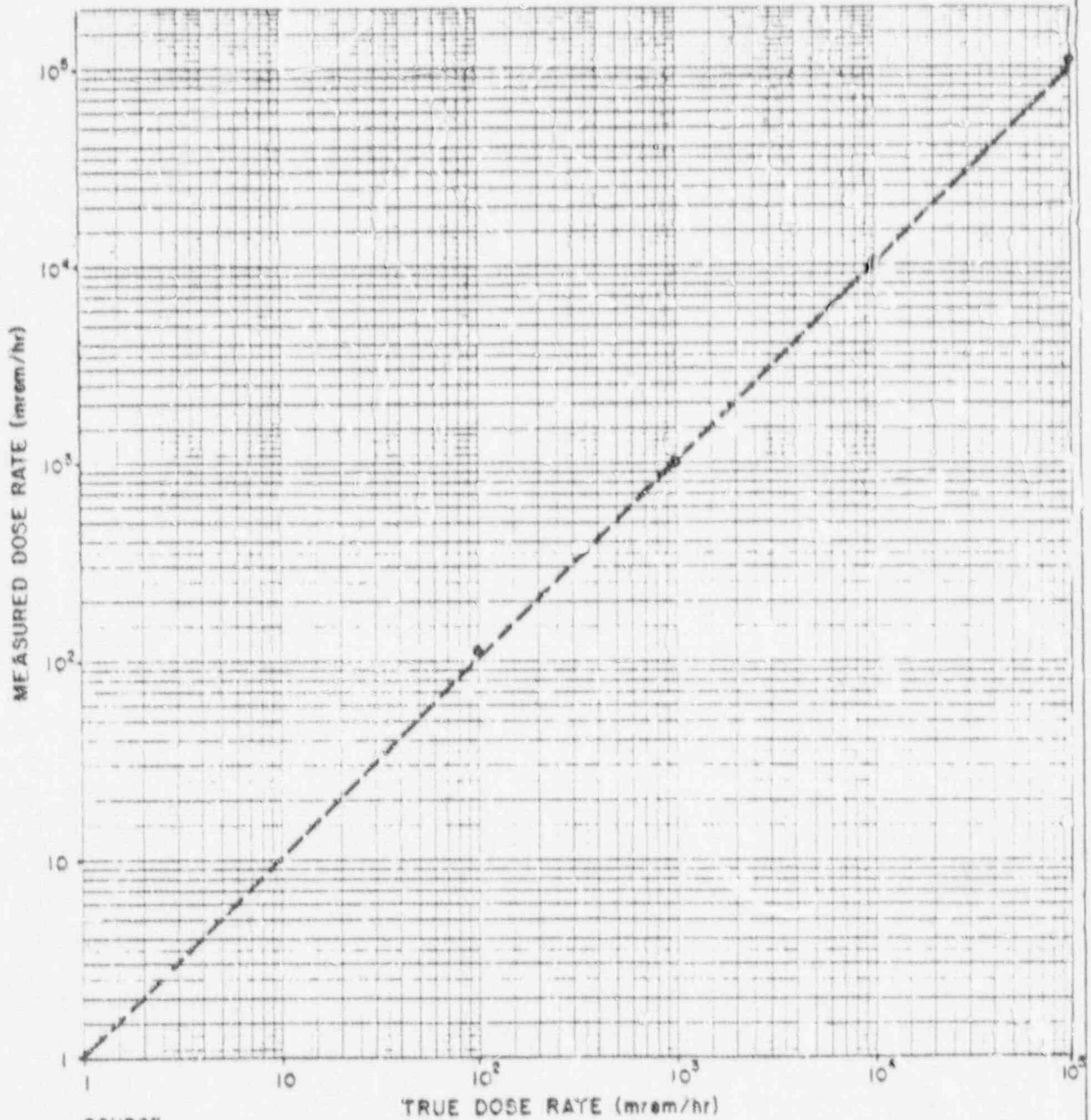


FIGURE 2.2-5
 DETECTOR'S RE-12A, B
 EFFICIENCY VS. GAMMA ENERGY
 SHOREHAM NUCLEAR POWER STATION-UNIT 1
 OFFSITE DOSE CALCULATION MANUAL

SOURCES:
 1. MED CALCULATION C-RPD-155 REV 1

* GAMMA ENERGY BINS (CP)

REVISION 7 OCT. 1985



SOURCE:
 EBERLINE INST. CORP — CALIBRATION OF EBERLINE EXTERNAL PROBE DATA
 CALIBRATION DATE, 02/22/85
 --- IDEAL CURVE
 • ACTUAL DATA

FIGURE 2.2-6
 GENERIC LINEARITY CURVE
 FOR DETECTORS RE-12A,B
 SHOREHAM NUCLEAR POWER STATION-UNIT 1
 OFFSITE DOSE CALCULATION MANUAL

DOSE CALCULATION METHODS

This section presents the calculational specifics required to demonstrate compliance with the following Radiological Effluent Controls (REC, Part I of the ODCM) sections:

- 3.11.1.2 - Liquid Effluent Dose Calculation
- 3.11.1.3 - Operation of Liquid Radwaste Treatment System
- 3.11.2.1 - Gaseous Effluent Dose Rate
- 3.11.2.2 - Noble Gas Air Dose
- 3.11.2.3 - Gaseous Effluent Dose From Radioiodines, Tritium, and Radionuclides In Particulate Form
- 3.11.2.5 - Operation of Ventilation Exhaust Treatment System

Calculation methods are based on the equation and calculational methods described in 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."

Two methods are provided for each analysis. The first method is the method used by the computerized radiation monitoring system. Method 2 is a backup hand calculational method to be used only if the computer is not functional.

The Semi-Annual Effluent Release Report is produced and the land use census is evaluated using NRC codes which implement Regulatory Guide 1.109.

3.1 LIQUID EFFLUENT, DOSE CALCULATION

To comply with Section 3.11.1.2 of the REC, the liquid effluents released to unrestricted areas shall be limited:

1. During any calendar quarter to less than or equal to 1.5 mrem to the total body and to less than or equal to 5 mrem to any organ.
2. During any calendar year to less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

The site boundary for liquid effluents is shown in Figure 3.1-1. The liquid radwaste system model is shown in Figure 3.1-2.

3.1.1 Method 1: (Computerized Method)

The equations which follow are used by the computer software to calculate the offsite doses due to release of liquid radwaste. For this dose calculation the actual concentration to be discharged by isotope, the total volume of liquid to be discharged, and the number of circulating water pumps running, supplied by the operator, shall be used.

The software computes the isotopic releases by multiplying the lab measurements by the volume of the liquid to be released:

$$Q_i = 3.785 \times 10^{-3} \cdot q_i$$

where:

Q_i = total inventory of isotope i in the liquid to be released (Ci)

q_i = concentration of isotope i in the liquid to be discharged (as measured in laboratory) ($\mu\text{Ci/cc}$)

V = volume of liquid to be discharged (gallons)

$$3.785 \times 10^{-3} = [(Ci/\mu Ci) (cc/gal)]$$

The dose equations which follow are from Regulatory Guide 1.109, with minor modifications. They are employed for the computation of dose from any single batch discharge (continuous discharges are handled as batch discharges in the computerized method). Weekly and quarterly cumulative doses are also calculated and stored in data files for reporting.

(a) Organ Dose Due to Ingestion of Salt Water Fish

$$R_{ja}^{\text{ing fish}} = 0.389 U_{ap}^{\text{fis}} (1/K_1) \sum_{\text{part+I}} Q_i B_{ip}^{\text{fis}} DFI_{ija} e^{-24\lambda_i} \quad i \text{ for circ. water}$$

$$R_{ja}^{\text{ing fish}} = 57.4/(K_2 + 0.930 K_3) U_{ap}^{\text{fis}} \sum_{\text{part+I}} Q_i B_{ip}^{\text{fis}} DFI_{ija} e^{-24\lambda_i} \quad i \text{ for service water}$$

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where:

$R_{ja}^{ing fish}$ = dose to organ j of individual in age group a due to ingestion of fish contaminated with particulates and radioiodines (mrem) (Ref. Reg. Guide 1.109, with the following special values:

- F (flow rate of liquid effluent) is represented by product $K_m * F_{pump,m}$ [ft³/sec], where K_m is the number of pumps of system m operating and $F_{pump,m}$ is the flow rate per unit pump. For the circulating water system, m=1; for the reactor building service water system, m=2; for the turbine building service water system, m=3
- $F_{pump,1} = 1.435 \times 10^5$ [gpm] = 319.7 [ft³/sec]
- $F_{pump,2} = 8,600$ [gpm] = 19.16 [ft³/sec]
- $F_{pump,3} = 8,000$ [gpm] = 17.82 [ft³/sec]
- M_{mix} (mixing ratio at the point of exposure) = 0.113 = (1/8.85) if circulating water is in use; = 1.0 if service water is in use.
- D_{aipj} (dose factor) = DFI_{ija} (see below)
- t_{aipj} (transit time required for nuclides to reach the point of exposure) = 24 [hr] (see pg 1.109-12 of the Regulatory Guide)

U_{fis} = fish consumption rate by individual in age group a [kg/yr] (from Table E-5 of the Guide, for maximum individual)

K_m = number of pumps of system m operating

Q_i = total activity of isotope i released [Ci], from above
= Bioaccumulation factor for saltwater fish [(pCi/kg)/(pCi/liter)] (from Table A-1 of the Guide)

DFI_{ija} = dose conversion factor for nuclide i to organ j of individual in age group a due to ingestion [mrem/pCi ingested] (from Tables E-11 through E-14 of the Guide)

λ_i = radionuclide decay constant [hr⁻¹] (from Table 3.1-1)

0.389 = $1100 M_{p,pump,1} / F_{pump,1} = 1100 \times 0.113 / 319.7$ [(pCi/l)/(Ci/yr)] for circ water

57.4 = $1100 / F_{pump,2} = 1100 / 19.16$ [(pCi/l)/(Ci/yr)] for reactor building service water

0.930 = $F_{pump,3} / F_{pump,2}$

part+I = 68 particulates and 5 iodines in the summation sign

(b) Organ Dose Due to Ingestion of Salt Water Invertebrate

$$R_{ja}^{ing inv} = 0.389 U_{ap}^{inv} (1/K_1) \sum_{part+I} Q_i R_{ip}^{inv} DFI_{ija} e^{-24\lambda_i} \text{ for circ. water}$$

$$R_{ja}^{ing inv} = 57.4 / (K_2 + 0.930 K_3) U_{ap}^{inv} \sum_{part+I} Q_i R_{ip}^{inv} DFI_{ija} e^{-24\lambda_i} \text{ for service water}$$

where:

- $R_{ja}^{ing\ inv}$ = dose to organ j of individual in age group a due to the ingestion of saltwater invertebrate contaminated with radioactive particulates and iodines [mrem] (Ref.: Reg. Guide 1.109 Eq. A-3 with the special values identified in the fish-ingestion equation above)
- B_{ip}^{inv} = Bioaccumulation factor for saltwater invertebrate [(pCi/kg)/(pCi/liter)] (from Table A-1 of the Guide)
- U_{ap}^{inv} = invertebrate consumption rate by individual in age group a [kg/yr] (from Table E-5 of the Guide, for maximum individual)

(c) Total Body Dose From Shoreline Deposits

$$R_{wb,a}^{shore} = 0.561 U_{ap}^{shore} (1/K_1) \sum_{part+I} Q_i DFG_{i1} \left(\frac{1-e^{-t_b \lambda_i}}{\lambda_i} \right) \text{ for circ. water}$$

$$= 82.9/(K_2 + 0.930 K_3) U_{ap}^{shore} \sum_{part+I} Q_i DFG_{i1} \left(\frac{1-e^{-t_b \lambda_i}}{\lambda_i} \right) \text{ service water}$$

where:

- $R_{wb,a}^{shore}$ = total body dose to individual in age group a from shoreline deposits [mrem] (Ref.: Reg. Guide 1.109 Eq. A-7 with the following special values:
 - ° F (flow rate of liquid effluent) is represented by the product $K_m * F_{pump,m}$ [ft³/sec], where K_m is the number of operating pumps of system m and $F_{pump,m}$ is the flow rate per unit pump
 - For the circulating water system, m=1; for the reactor building service water system, m=2; for the turbine building service water system, m=3
 - ° $F_{pump,1} = 1.435 \times 10^5$ [gpm] = 319.7 [ft³/sec]
 - ° $F_{pump,2} = 8,600$ [gpm] = 19.16 [ft³/sec]
 - ° $F_{pump,3} = 8,000$ [gpm] = 17.82 [ft³/sec]
 - ° M_p (mixing ratio) = 0.113 if circ. water is in use
= 1.0 if service water is in use
 - ° W (shore-width factor that describes the geometry of the exposure) = 0.5 for ocean site (from Table A-2 of the guide)
 - ° t_b (transit time from source to shoreline) = 0 (see Reg. Guide pg 1.109-69, for Eq. A-7)
 - ° T_i (radionuclide half life, days) = $0.693/(24 \lambda_i)$ where $0.693 = \log_e 2$ and λ_i is the decay constant in [hr⁻¹]
 - ° $D_{aipj} = DFG_{i1}$ (see below)
- = shoreline exposure time for individual in age group a [hr/yr] (from Table E-5 of the Guide, for maximum individual)

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- K_m = number of pumps of system m operating
 Q_i = total activity of isotope i released [Ci], from above
 DFG_{11} = total body conversion factor for standing on contaminated ground (shore) [(mrem/hr)/(pCi/m²)] (from Table E-6 of the guide)
 t_b = time period over which accumulation is evaluated (15 years, or 1.4×10^5 hours)
 0.561 = $110,000 M_p W (T_1 \lambda_1) / F_{pump,1} [(pCi/l)/(Ci/yr)]$
 = $110,000 \times 0.113 \times 0.5 \times (0.693/24) / 319.7$ for circ. water
 82.9 = $110,000 W (T_1 \lambda_1) F_{pump,2} [(pCi/l)/(Ci/yr)]$
 = $110,000 \times 0.5 \times (0.693/24) / 19.16$ for reactor building service water
 0.930 = $F_{pump,3} / F_{pump,2}$
 part+1 = 68 particulates and 5 iodines in the summation sign

(d) Skin Dose From Shoreline Deposits

$$\begin{aligned}
 R^{shore} &= 0.561 U_{ap}^{shore} (1/K_1) \sum_{part+1} Q_i DFG_{12} \left(\frac{1-e^{-t_b \lambda_i}}{\lambda_i} \right) \text{ for circ. water} \\
 &= 82.9 / (K_2 + 0.930 K_3) U_{ap}^{shore} \sum_{part+1} Q_i DFG_{12} \left(\frac{1-e^{-t_b \lambda_i}}{\lambda_i} \right) \\
 &\quad \text{for service water}
 \end{aligned}$$

where:

$R_{skin,a}^{shore}$ = skin dose to individual in age group a from shoreline deposits [mrem]; (Ref.: Reg. Guide 1.109 Eq. A-7 with the special values listed for the total body dose)

DFG_{12} = skin dose conversion factor for standing on contaminated ground (shore) [(mrem/hr)/(pCi/m²)] (from Table E-6 of the Guide)

Other parameters are as defined earlier for the total body dose from shoreline deposits.

(e) Total Doses

The individual dose components described in items (a), (b), (c), and (d) above are summed in the following way for the computation of total doses:

$$\begin{aligned}
 R_{ja} &= p_{ja}^{ing fish} + p_{ja}^{ing inv} \\
 R_{wb,a} &= p_{wb,a}^{ing fish} + p_{wb,a}^{ing inv} + R_{wb,a}^{shore} \\
 R_{skin,a} &= p_{skin,a}^{shore}
 \end{aligned}$$

where:

R_{ja} = total dose to organ j (exclusive of the total body) of individual in age group a due to the ingestion of fish and invertebrate (mrem)

$R_{wb,a}$ = total dose to the total body of individual in age group a due to the ingestion of fish and invertebrates, and direct radiation from shoreline deposits

and

$R_{skin,a}$ = total dose to the skin of an individual in age group a from shoreline deposits (mrem).

3.1.2 Method 2: (Backup Method)

The dose contributions for the total release period shall be calculated for all radionuclides identified in liquid effluents released to unrestricted areas using the following expression:

$$D_T = \sum_{j=1}^N [A_{jT} \sum_{l=1}^M \Delta t_l C_{j,l} F_l] \quad (3.1-1)$$

where:

D_T = the cumulative dose or dose commitment to the total body or an organ from the liquid effluents for the total release period

$$\sum_{l=1}^M \Delta t_l \quad (\text{mrem}),$$

Δt_l = the length of the l th release period over which $C_{j,l}$ and F_l are averaged for all liquid released (minutes),

$C_{j,l}$ = the average concentration of radionuclide C_j in undiluted liquid effluent during release period Δt_l from any liquid release ($\mu\text{Ci/cc}$),

A_{jT} = the site-related ingestion dose or dose commitment factor to the total body or any organ for each identified principal gamma and beta emitter listed in Table 3.1-2 (mrem/min per $\mu\text{Ci/cc}$), see Appendix A for derivation

F_l = Undiluted liquid effluent flow rate
 $\frac{F_c}{M_p}$

F_c = total circulating water flow rate with the number of circulating pumps in use

= total service water flow rate if the circulating water is not in use

M_p (Mixing factor) = 0.113 if circulating water is in use;
 = 1.0 if service water only is in use

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The total dose from liquid effluents from all discharges, D_{Total} , is:

$$D_{Total} = D_{TD} + D_{TR} + D_{TH} + D_{TS} + D_{TP}$$

where:

- D_{TD} = Dose contribution from discharge waste sample tanks as calculated in Equation 3.1-1
- D_{TR} = Dose contribution from recovery sample tanks as calculated in Equation 3.1-1
- D_{TH} = Dose contribution from RHR heat exchanger, service water as calculated in Equation 3.1-1
- D_{TS} = Dose contribution from reactor building salt water drain tank as calculated in Equation 3.1-1
- D_{TP} = Dose contribution from yard piping drain sump as calculated in Equation 3.1-1.

If the calculated total dose exceeds the limit specified in Section 3.1, consult REC Section 3.11.1.2.

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TABLE 3.1-1

DECAY CONSTANTS (1/hr)

<u>Radio-nuclide</u>	<u>Constant</u>	<u>Radio-nuclide</u>	<u>Constant</u>
H-3	6.408E-06	Ru-103	7.300E-04
C-14	1.379E-08	Ru-105	1.600E-01
Na-24	4.600E-02	Ru-106	7.800E-05
P-32	2.000E-03	Ag-110m	1.100E-04
Cr-51	1.044E-03	Te-125m	5.000E-04
Mn-54	9.252E-05	Te-127m	2.600E-04
Mn-56	2.700E-01	Te-127	7.400E-02
Fe-55	2.930E-05	Te-129m	8.600E-04
Fe-59	6.480E-04	Te-129	5.900E-01
Co-58	4.068E-04	Te-131m	2.300E-02
Co-60	1.501E-05	Te-131	1.700E+00
Ni-63	8.600E-07	Te-132	8.900E-03
Ni-65	2.700E-01	I-130	5.600E-02
Cu-64	5.400E-02	I-131	3.593E-03
Zn-65	1.184E-04	I-132	3.000E-01
Zn-69	7.296E-01	I-133	3.334E-02
Br-83	2.900E-01	I-134	7.900E-01
Br-84	1.300E+00	I-135	1.100E-01
Br-85	1.449E+01	Cs-134	3.852E-05
Rb-86	1.500E-03	Cs-136	2.203E-03
Rb-88	2.400E+00	Cs-137	2.635E-06
Rb-89	2.700E+00	Cs-138	1.300E+00
Sr-89	5.724E-04	Ba-139	5.000E-01
Sr-90	2.776E-06	Ba-140	2.257E-03
Sr-91	7.300E-02	Ba-141	2.300E+00
Sr-92	2.600E-01	Ba-142	3.900E+00
Y-90	1.100E-02	La-140	1.700E-02
Y-91m	8.300E-01	La-142	4.500E-01
Y-91	4.900E-04	Ce-141	8.892E-04
Y-92	2.00E-01	Ce-143	2.100E-02
Y-93	6.800E-02	Ce-144	1.019E-04
Zr-95	4.392E-04	Pr-143	2.100E-03
Zr-97	4.100E-02	Pr-144	2.400E+00
Nb-95	8.200E-04	Nd-147	2.600E-03
Mo-99	1.000E-02	W-187	2.900E-02
Tc-99m	1.200E-01	Np-239	1.200E-02
Tc-101	2.900E+00		

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TABLE 3.1-2

ADULT DOSE RATE CONVERSION FACTORS⁽¹⁾, A_{it}
 FOR (FISH AND INVERTEBRATE) INGESTION PATHWAY
 (mrem/min per Ci/cc)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-Li.I
H-3	(1)	4.6E-03	4.6E-03	4.6E-03	4.6E-03	4.6E-03	4.6E-03
C-14	2.4E+02	4.7E+01	4.7E+01	4.7E+01	4.7E+01	4.7E+01	4.7E+01
F-18	1.2E-05	-	1.4E-06	-	-	-	3.7E-07
NA-24	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03
P-32	2.6E+05	1.6E+04	1.0E+04	-	-	-	3.0E+04
CR-51	-	-	9.0E-02	5.3E-02	2.0E-02	1.2E-01	2.2E+01
MN-54	-	1.2E+02	2.2E+01	-	3.4E+01	-	3.5E+02
MN-56	-	4.6E-03	8.1E-04	-	5.9E-03	-	1.4E-01
FE-55	8.3E+02	5.8E+02	1.4E+02	-	-	3.2E+02	3.3E+02
FE-59	1.3E+03	3.1E-03	1.2E+03	-	-	8.6E+02	1.0E+04
CO-58	-	9.8E-00	2.2E+01	-	-	-	2.0E+02
CO-60	-	2.8E+01	6.3E+01	-	-	-	5.4E+02
NI-63	8.1E+02	5.6E+01	2.7E+01	-	-	-	1.2E+01
NI-65	4.8E-03	6.2E-04	2.9E-04	-	-	-	1.6E-02
CU-64	-	9.6E-01	4.5E-01	-	2.4E+00	-	8.2E+01
ZN-65	2.7E+03	8.4E+03	3.8E+03	-	5.6E+03	-	5.3E+03
ZN-69M	1.7E+00	3.3E+00	2.2E-01	-	2.1E+00	-	4.9E-01
BR-83	-	-	1.1E-06	-	-	-	1.6E-06
BR-84	-	-	2.7E-17	-	-	-	-
RB-86	-	9.8E+00	4.6E+00	-	-	-	1.9E+00
SR-89	8.1E+01	-	2.3E+00	-	-	-	1.3E+01
SR-90	2.0E+03	-	5.0E+02	-	-	-	5.8E+01
SR-91	2.6E-01	-	1.0E-02	-	-	-	1.2E+00
SR-92	1.2E-03	-	5.3E-05	-	-	-	2.4E-02
Y-90	7.6E-02	-	2.1E-03	-	-	-	8.2E+02
Y-91M	1.9E-12	-	7.2E-14	-	-	-	5.4E-12
Y-91	1.4E+00	-	3.9E-02	-	-	-	8.0E+02
Y-92	7.9E-05	-	2.3E-06	-	-	-	1.4E+00
Y-93	5.4E-03	-	1.5E-04	-	-	-	1.8E+02
ZR-95	2.6E-01	8.3E-02	5.6E-02	-	1.3E-01	-	2.6E+02

TABLE 3.1-2 (CONT'D)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
ZR-97	5.4E-03	1.1E-03	4.9E-04	-	1.6E-03	-	3.4E+02
NB-95	7.2E+00	4.0E+00	2.1E+00	-	4.0E+00	-	2.4E+04
MO-99	-	1.6E+00	3.1E-01	-	3.7E+00	-	3.8E+00
TC-99M	1.3E-05	3.8E-05	4.8E-04	-	5.7E-04	1.8E-05	2.2E-02
RU-103	1.7E+00	-	7.4E-01	-	6.6E+00	-	2.0E+02
RU-105	3.4E-03	-	1.3E-03	-	4.5E-02	-	2.1E+00
RU-106	2.6E+01	-	3.2E+00	-	5.1E+01	-	1.7E+03
AG-110M	2.6E+01	2.4E+01	1.4E+01	-	4.7E+01	-	9.7E+03
SB-124	4.5E+00	8.5E-02	1.8E+00	1.1E-02	-	3.5E+00	1.2E+02
TE-125M	3.5E+00	1.3E+03	4.7E-01	1.0E+00	1.4E+01	-	1.4E+01
TE-127M	8.9E+00	3.1E+00	1.1E+00	2.3E+00	3.7E+01	-	3.0E+01
TE-127	2.5E-02	8.9E-03	5.4E-03	1.8E-02	1.0E-01	-	2.0E+00
TE-129M	1.5E+01	5.6E+00	2.4E+00	5.1E+00	6.2E+01	-	7.5E+01
TE-129	2.7E-08	1.0E-08	6.5E-09	2.1E-08	1.1E-07	-	2.0E-08
TE-131M	1.3E+00	6.4E-01	5.4E-01	1.0E+00	6.5E+00	-	6.4E+01
TE-131	1.3E-19	5.4E-20	4.1E-20	1.1E-19	5.7E-19	-	1.9E-20
TE-132	2.7E+00	1.7E+00	1.7E+00	2.0E+00	1.7E+01	-	8.2E+01
I-130	1.7E-01	5.0E-01	2.0E-01	4.2E+01	7.9E-01	-	4.4E-01
I-131	3.3E+00	4.7E+00	2.7E+00	1.5E+03	8.1E+00	-	1.2E+00
I-132	1.2E-04	3.3E-04	1.1E-04	1.1E-02	5.7E-04	-	6.1E-05
I-133	5.5E-01	9.6E-01	2.9E-01	1.4E+02	1.7E+00	-	8.6E-01
I-134	5.1E-10	1.4E-09	4.9E-10	2.4E-08	2.2E-09	-	1.2E-12
I-135	3.1E-02	8.1E-02	3.0E-02	5.3E+00	1.3E-01	-	9.0E-02
CS-134	1.1E+02	2.7E+02	2.2E+02	-	8.6E+01	2.9E+01	4.7E+00
CS-136	1.1E+01	4.4E+01	3.2E+01	-	2.4E+01	3.3E+00	5.0E+00
CS-137	1.5E+02	2.0E+02	1.3E+02	-	6.7E+01	2.2E+01	3.8E+00
CS-138	3.6E-15	7.0E-15	3.4E-15	-	5.2E-15	5.2E-16	3.0E-20
BA-139	8.1E-07	5.8E-10	2.4E-08	-	5.4E-10	3.3E-10	1.4E-06
BA-140	2.6E+01	3.2E-02	1.7E+00	-	1.1E-02	1.8E-02	5.3E+01
LA-140	1.7E-02	8.6E-03	2.3E-03	-	-	-	6.3E+02
LA-142	2.7E-08	1.2E-08	3.1E-09	-	-	-	8.9E-05
CE-141	5.5E-02	3.7E-02	4.2E-03	-	1.7E-02	-	1.4E+02
CE-143	6.0E-03	4.4E+00	4.9E-04	-	1.9E-03	-	1.6E+02
CE-144	2.9E+00	1.2E+00	1.6E-01	-	7.3E-01	-	9.9E+02
PR-143	9.1E-02	3.6E-02	4.5E-03	-	2.1E-02	-	4.0E+02

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TABLE 3.1-2 (CONT'D)

<u>Nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
ND-147	6.1E-02	7.1E-02	4.2E-03	-	4.1E-02	-	3.4E+02
W-187	7.5E-02	6.3E-02	2.2E-02	-	-	-	2.1E+01
NP-239	4.3E-04	4.2E-05	2.3E-05	-	1.3E-04	-	8.7E+00

(1) The dash (-) indicates insufficient data or that the dose factor is $<1.0E-20$.

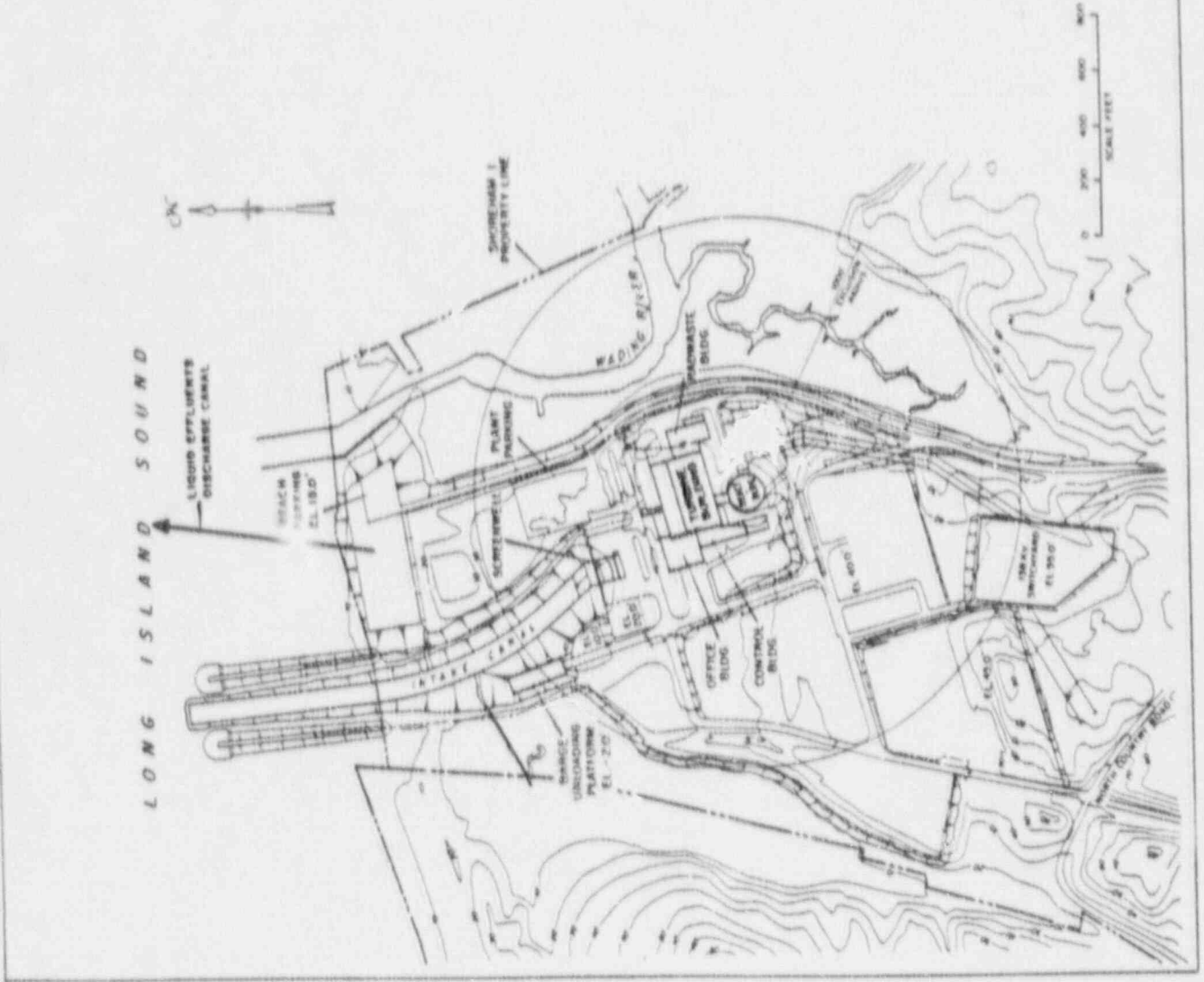
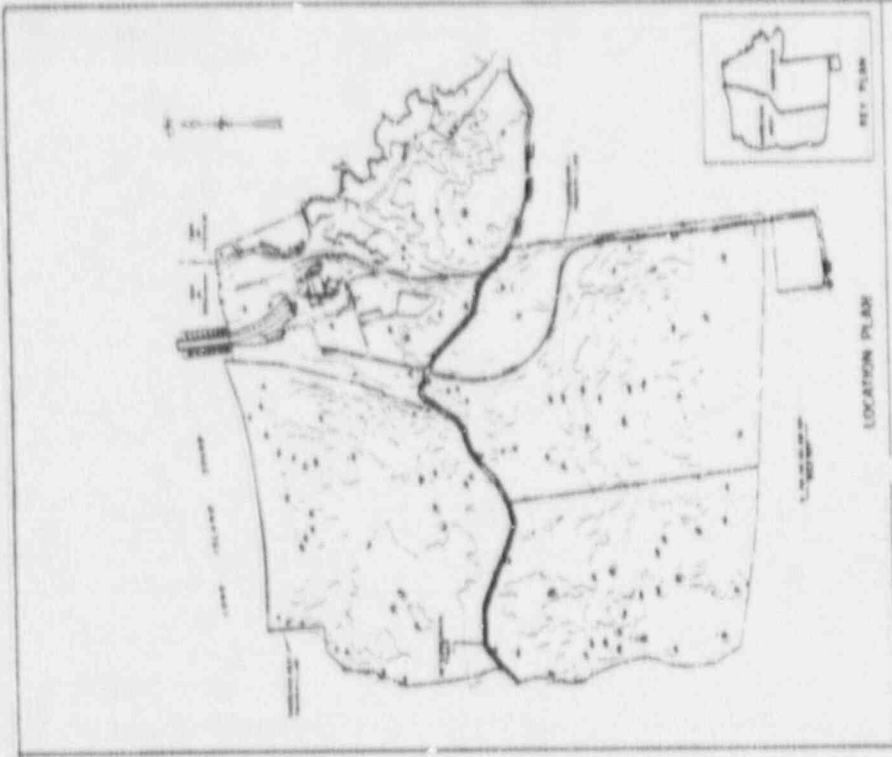


FIGURE 3.1-1
 SITE BOUNDARY FOR LIQUID
 EFFLUENTS
 SHOREHAM NUCLEAR POWER STATION-UNIT 1
 OFFSITE DOSE CALCULATION MANUAL

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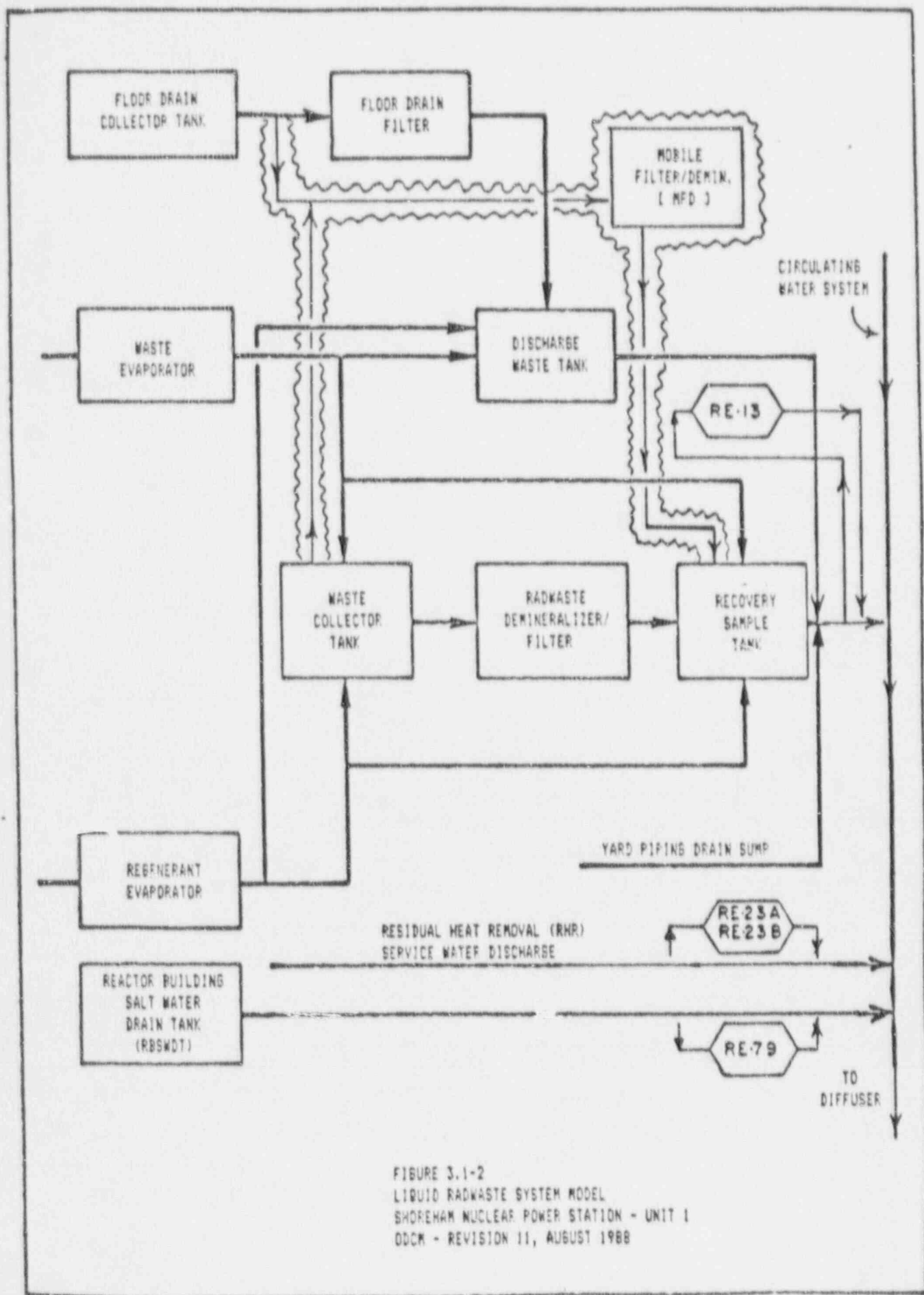


FIGURE 3.1-2
 LIQUID RADWASTE SYSTEM MODEL
 SHOREHAM NUCLEAR POWER STATION - UNIT 1
 ODCM - REVISION 11, AUGUST 1988

3.2 OPERATION OF LIQUID WASTE TREATMENT SUBSYSTEMS

The dose projection analysis will be performed using the methodology described in Section 3.1 with the exception that the calculated doses will be compared with the limits specified in REC Section 3.11.1.3.

The liquid radwaste treatment system shall be OPERABLE and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses due to the liquid effluent to UNRESTRICTED AREAS would exceed 0.06 mrem to the total body or 0.2 mrem to any organs in a 31-day period.

A model of the liquid radwaste treatment subsystems is shown on Figure 3.1-2. Although the RHR Service Water Discharge, RBSWD, and yard piping drain sump systems are not part of the radwaste treatment subsystems, they are included in Figure 3.1-2 because they represent locations of potentially radioactive discharges.

3.3 DOSE RATE DUE TO GASEOUS EFFLUENTS

To comply with Section 3.11.2.1 of REC, the dose rate at any time in the unrestricted area for noble gas dose and for organ dose due to radioactive materials in gaseous effluents released via the station ventilation exhaust duct shall be limited to the following values:

1. 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
2. For I-131, I-133, tritium, and for all radionuclides in particulate form with half lives greater than 8 days: Less than or equal to 1500 mrem/yr to any organ.

The gaseous effluent model is shown in Figure 3.3-1.

3.3.1 Method 1: (Computerized Method)3.3.1.1 Release Rate Estimation

Dose rate estimation is performed every 15 minutes by making use of the atmospheric dispersion calculation made every hour from meteorological data taken every minute (see Section 4), and of the following equation for the release rate (Ci/hr):

$$Q_i = F' f_i$$

where:

$$F' = 4 k \sum_{j=1}^{15} F_s(j) \dot{C}_{ng}(j) \Delta t$$

$$f_i = 10^{-6} q_i(\tau) / \dot{C}_{ng}(\tau)$$

$$k = 2.832 \times 10^4 \text{ (cc/ft}^3\text{)}$$

$$F_s(j) = \text{vent flow during time interval } j \text{ (cfm)}$$

$$\dot{C}_{ng}(j) = \text{noble gas effluent monitor count rate during time interval } j \text{ (cpm)}$$

$$t = \text{time interval (=1 minute)}$$

$$q_i = \text{concentration of isotope } i \text{ in the effluent as measured in the lab at time } \tau \text{ (}\mu\text{Ci/cc)}$$

$$F' = \text{15-minute average of the flow and count rate product (for dose rate estimation every 15 minutes) assumed to apply for a 60-minute interval [(cc/hr) (cpm)]}$$

$$4 \times 15 = \text{number of } t \text{ intervals per hour (1/hr)}$$

3.3.1.2 Total Body Dose Rate

$$D_{wb} = D_{wb}^{cloud} + D_{wb}^{inh} + D_{wb}^{ground}$$

where:

$$D_{wb}^{cloud} = (X/Q)_{\gamma}^{sa} F' 2.22 \times 10^4 \sum_{nobl} f_i DFB_i$$

$$D_{wb}^{inh} = (X/Q)_{\gamma}^{sa} F' 3.17 \times 10^4 R_{ad} \sum_{part+I} f_i DFA_{ij,ad}$$

$$D_{wb}^{ground} = (D/Q) F' 7 \times 10^{11} \sum_{part+I} f_i DFG_{i1} [1 - e^{-t_b \lambda_i}] / \lambda_i$$

$$D_{wb}^{cloud} = \text{total body dose due to direct radiation from the radioactive cloud [mrem/hr] (Ref.: Reg. Guide 1.109 Eq. B-8; also similar to Eq. B-6 if one makes use of the gamma (X/Q) and the DFB}_i \text{ instead of DF}_i \text{ dose conversion}$$

$$D_{wb}^{inh} = \text{total body dose (j = total body) due to inhalation [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-3 and C-4, for an adult)}$$

$$D_{wb}^{ground} = \text{total body dose due to particulate and iodine radioactivity depositing on the ground [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-1 and C-2 with the product 8760 [hr/yr] (1/\lambda_i) [yr] replaced by (1/\lambda_i) [hr] and parameter \delta_i(r,\theta) represented by the (D/Q)).}$$

$$DFB_i = \text{gamma dose to body conversion factor [(mrem/yr)/(pCi/m^3)] (from Table B-1 of the guide)}$$

$$DFA_{ij,ad} = \text{dose conversion factor for nuclide i to organ j of an adult individual [mrem/pCi inhaled] (from Tables E-7 through E-10 of Reg. Guide 1.109)}$$

$$DFG_{i1} = \text{total body conversion factor for standing on contaminated ground [(mrem/hr)/(pCi/m^2)] (from Table E-6 of Reg. Guide 1.109)}$$

$$(X/Q)_{\gamma}^{sa} = \text{concentration dispersion factor (sector-average model) for the period of release (site boundary only) (sec/m^3)}$$

$$(X/Q)_{\gamma}^{sa} = \text{gamma (X/Q) (finite cloud sector-average model) for the period of release (site boundary only) (sec/m^3)}$$

$$(D/Q) = \text{particulate deposition rate (site boundary only) (1/m^2)}$$

$$F' f_i = Q_i \text{ (Ci/hr) (as defined in Section 3.3.1.1)}$$

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- R_{ad} = adult breathing rate (m^3/yr) (from Table E-5 of the Guide)
- λ_i = radionuclide decay constant (hr^{-1})
- t_b = time period over which the accumulation is evaluated, which is 15 years (1.314×10^5 hours) (Reg. Guide pg 1.109-24)
- 3.17×10^4 = $10^{12}/(8760 \times 3600)$ [(pCi/Ci) (yr/sec)]
- 2.2×10^4 = $3.17 \times 10^4 \times 0.7$, where 0.7 is the shielding factor which accounts for the dose reduction due to the shielding effects of residential structures during occupancy (Ref.: Reg. Guide 1.107 Table E-15)
- 7×10^{11} = $10^{12} \times 0.7$, where 0.7 is the shielding factor and 10^{12} is the number of pCi per Ci (see Eqs. C-1 and C-2 of the guide)
- part+I = 68 particulates and 5 iodines in the summation sign

3.3.1.3 Skin Dose Rate

$$D_{skin} = D_{skin}^{cloud} + D_{skin}^{ground}$$

where:

- $$D_{skin}^{cloud} = 1.11 \times 0.7 (X/Q)_{\gamma}^{sa} F' 3.17 \times 10^4 \sum_{nobles} f_i DF_i^{\gamma} + (X/Q)_{\beta}^{sa} F' 3.17 \times 10^4 \sum_{nobles} f_i DFS_i$$
- $$D_{skin}^{ground} = (D/Q) F' 7 \times 10^{11} \sum_{part+I} f_i DFG_{i2} [1 - e^{-t_b \lambda_i}]/\lambda_i$$
- D_{skin}^{cloud} = skin dose due to direct gamma radiation from the radioactive cloud (first component of the equation with finite cloud modeling) and beta radiation (second component, semi-infinite cloud immersion) [mrem/hr] (Ref.: Reg. Guide 1.109 Eq. B-9; also similar to Eq. B-7 if one makes use of the gamma (X/Q))
- D_{skin}^{ground} = skin dose due to particulate and iodine radioactivity depositing on the ground [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-1 and C-2 with the product 8760 [hr/yr] ($1/\lambda_i$) [yr] replaced by ($1/\lambda_i$) [hr] and parameter δ_i (r, θ) represented by the (D/Q))
- DF_i^{γ} = gamma dose to air conversion factor [(mrad/yr)/(pCi/m³)] (from Table B-1 of the Guide)
- DFS_i = beta dose to skin conversion factor [(mrem/yr)/(pCi/m³)] (from Table B-1 of the Guide)

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DFG_{12} = skin dose conversion factor for standing on contaminated ground [(mrem/hr)/(pCi/m²)] (from Table E-6 of Reg. Guide 1.109)

1.11 = average ratio of tissue to air energy absorption coefficient (from Reg. Guide 1.109, pg 1.109-6)

0.7 = shielding dose-reduction factor (see pg 1.109-68 of the Guide)

λ_i = radionuclide decay constant [hr⁻¹]

3.3.1.4 Organ Dose Rate (I-131, I-133, Tritium and Particulate Release)

$$D_{ja}^{inh} = (\lambda/Q^{sa} F' 3.17 \times 10^4 R_a) \sum_{i=1}^n f_i DFA_{ija}$$

where:

D_{ja}^{inh} = dose to organ j of individual in age group a due to inhalation of airborne radioactivity [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-3 and C-4.)

DFA_{ija} = dose conversion factor for nuclide i to organ j of individual in age group a [mrem/pCi inhaled] (from Tables E-7 through E-10 of the Guide)

R_a = breathing rate of individual in age group a [m³/yr] (from Table E-5 of Reg. Guide 1.109, for the maximum individuals)

The analysis is limited to the computation of the thyroid dose to a child at the site boundary in the downwind sector for the period of the release (i.e., j = thyroid, a = child).

3.3.2 Method 2: (Backup Method)3.3.2.1 Noble Gas Total Body Dose Rate

$$\begin{aligned}
 DT_s = & 0.7 * X/Q_1 * \sum_i [DFB_i * (C_{i1} * V_1 - C_{i2} * V_2 - C_{i3} * V_3)] \\
 & + 0.7 * V_2 * X/Q_2 * \sum_i [DFB_i * C_{i2}] \\
 & + 0.7 * V_3 * X/Q_3 * \sum_i [DFB_i * C_{i3}] \quad (\text{mrem/yr})
 \end{aligned}$$

During periods of no intermittent releases such as no main condenser air removal pump operation and no containment drywell purge the above formula reduces to the following:

$$DT_s = 0.7 * V_1 * X/Q_1 * \sum_i [DFB_i * C_{i1}] \quad (\text{mrem/yr})$$

If main condenser air removal is performed by the mechanical vacuum pump and the sampling is performed at the Station Vent, the following equation should be used:

$$DT_s = 0.7 * V_1 * X/Q_2 * \sum_i [DFB_i * C_{i1}] \quad (\text{mrem/yr})$$

where:

- DT_s = total body dose rate from all radionuclides releases (mrem/yr),
- DFB_i = the total body dose rate factor due to gamma emissions for each identified noble gas radionuclide (mrem/yr per pCi/m³) (Table 2.2-1),
- C_{i1} = the station ventilation exhaust duct release concentration of radionuclide, i , (pCi/cc) (from the isotopic analyses performed on the gaseous sample taken from the station ventilation exhaust monitor),
- C_{i2} = the air removal pump ventilation exhaust duct release concentration of radionuclide, i , (pCi/cc) (from the isotopic analyses performed on the gaseous sample taken from the air removal pump discharge monitor),
- C_{i3} = the containment drywell purge ventilation exhaust concentration of radionuclide, i , (pCi/cc) obtained from a sample taken during a filtered release or from the containment drywell atmosphere monitor with the purge lines bypassing the primary containment purge filter (The concentration is obtained from the isotopic analyses performed on the gaseous sample taken.),

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- V_1 = 1.73E+08 cc/sec (3.66E+05 cfm), station ventilation exhaust duct ventilation exhaust flow rate,
- V_2 = 5.70E+05 cc/sec (1200 cfm), air removal pump exhaust duct ventilation exhaust flow rate,
- V_3 = 5.70E+05 cc/sec (1200 cfm), containment drywell purge ventilation exhaust flow rate,
- X/Q_1 = long term dispersion factor due to release via the station ventilation exhaust point; refer to Table 4-1, cells A1 and A3,
- X/Q_2 = short term dispersion factor due to air removal pump release via the station ventilation exhaust point; refer to Table 4-1, cells A1 and A5,
- X/Q_3 = short term dispersion factor due to containment drywell purge via the station ventilation exhaust point; refer to Table 4-1, cells A1 and A7,
- 0.70 = shielding factor that accounts for dose reduction due to shielding from residential structures.

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3.3.2.2 Noble Gas Skin Dose Rate

$$DS_s = V_1 * X/Q_1 * \sum_i [K_{si} * (C_{i1} * V_1 - C_{i2} * V_2 - C_{i3} * V_3)] + V_2 * (X/Q_2 * \sum_i [K_{si} * C_{i2}]) + V_3 * X/Q_3 * \sum_i [K_{si} * C_{i3}] \quad (\text{mrem/yr})$$

During periods of no intermittent releases such as no main condenser air removal pump operation and no containment drywell purge the above formula reduces to the following:

$$DS_s = V_1 * X/Q_1 * \sum_i [K_{si} * C_{i1}] \quad (\text{mrem/yr})$$

If main condenser air removal is performed by the mechanical vacuum pump and the sampling is performed at the Station Vent, the following equation should be used:

$$DS_s = V_1 * X/Q_2 * \sum_i [K_{si} * C_{i1}] \quad (\text{mrem/yr})$$

where:

DS_s = skin dose rate from all radionuclides released (mrem/yr),

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- K_{si} = the skin dose factor due to beta and gamma emissions for each identified noble gas radionuclide (mrem/yr per pCi/m³) from Table 2.2-1,
- C_{i1} = the station ventilation exhaust duct release concentration of radionuclide, i, (pCi/cc) (from isotopic analyses performed on the gaseous sample taken from the station ventilation exhaust monitor),
- C_{i2} = the air removal pump ventilation exhaust duct release concentration of radionuclide, i, (pCi/cc) (from the isotopic analyses performed on the gaseous sample taken from the air removal pump discharge monitor),
- C_{i3} = the containment drywell purge ventilation exhaust concentration of radionuclide, i, (pCi/cc) obtained from a sample taken during a filtered release or from the containment drywell atmosphere monitor with the purge lines bypassing the primary containment purge filter (The concentration is obtained from the isotopic analyses performed on the gaseous sample taken.),
- V_1 = 1.73E+08 cc/sec (3.66E+05 cfm), station ventilation exhaust duct ventilation exhaust flow rate,
- V_2 = 5.70E+05 cc/sec (1200 cfm), air removal pump exhaust duct ventilation exhaust flow rate,
- V_3 = 5.70E+05 cc/sec (1200 cfm), containment drywell purge ventilation exhaust flow rate,
- X/Q_1 = long term dispersion factor due to release via the station ventilation exhaust point; refer to Table 4-1, cells A1 and A3,
- X/Q_2 = short term dispersion factor due to air removal pump release via the station ventilation exhaust point; refer to Table 4-1, cells A1 and A5,
- X/Q_3 = short term dispersion factor due to containment drywell purge via the station ventilation exhaust point; refer to Table 4-1, cells A1 and A7.

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3.3.2.3 Organ Dose Rate (Particulate Releases)

$$D_{sj} = \sum_i [10^6 * R_a * P_{ij} * X/Q_1 * (C_{i1} V_1 - C_{i2} V_2 - C_{i3} V_3)] + V_2 * \sum_i [10^6 * R_a * P_{ij} * X/Q_2 * C_{i2}] + V_3 * \sum_i [10^6 * R_a * P_{ij} * X/Q_3 * C_{i3}] \quad (\text{mrem/yr})$$

During periods of no intermittent releases, such as no main condenser air removal pump operation and no containment drywell purge, the above formula reduces to the following:

$$D_{sj} = V_1 * \sum_i 10^6 * R_A * P_{ij} * X/Q_1 * C_{i1} \quad (\text{mrem/yr})$$

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If main condenser air removal is performed by the mechanical vacuum pump and the sampling is performed at the Station Vent, the following equation should be used:

$$D_{sj} = 10^6 * V_1 * R_a * X/Q_2 * \sum_i [P_{ij} * C_{i1}] \quad (\text{mrem/yr})$$

where:

D_{sj} = total dose rate to organ, j, mrem/yr.

P_{ij} = the inhalation dose conversion factor, for radionuclides other than noble gases, i, and organ, j, in mrem per pCi from Table 3.5-3.

The dose factor P_{ij} is based on the critical individual organ for the Child group, which is most restrictive. Inhalation dose factors for other age groups are given in Tables 3.5-1, 3.5-2, and 3.5-4.

R_a = inhalation rate (m^3/yr), from Table 3.5-5.

C_{i1} = the station ventilation exhaust duct release concentration of radionuclide, i, ($\mu\text{Ci}/\text{cc}$) (from the isotopic analyses performed on the filter paper and charcoal cartridge taken from the station ventilation exhaust monitor),

C_{i2} = the air removal pump ventilation exhaust duct release concentration of radionuclide, i, ($\mu\text{Ci}/\text{cc}$) (from the isotopic analyses performed on the iodine and particulate filters taken from the air removal pump discharge monitor),

C_{i3} = the containment drywell purge ventilation exhaust concentration of radionuclide, i, ($\mu\text{Ci}/\text{cc}$) obtained from the iodine and particulate filters during a filtered release or from the containment drywell atmosphere monitor with the purge lines bypassing the primary containment purge filter (The concentration is obtained from the isotopic analyses performed on the iodine and particulate filters.),

V_1 = $1.70\text{E}+08$ cc/sec ($3.60\text{E}+05$ cfm), station ventilation exhaust duct ventilation exhaust flow rate,

V_2 = $5.70\text{E}+05$ cc/sec (1200 cfm), air removal pump exhaust duct ventilation exhaust flow rate,

V_3 = $5.70\text{E}+05$ cc/sec (1200 cfm), containment drywell purge ventilation exhaust flow rate,

X/Q_1 = long term dispersion factor due to releases via the station ventilation exhaust point; refer to Table 4-1, cells A2 and A4,

X/Q_2 = short term dispersion factor due to condenser air removal pump release via the station ventilation exhaust point; refer to Table 4-1, cells A2 and A6,

X/Q_3 = short term dispersion factor due to containment drywell purge via the station ventilation exhaust point; refer to Table 4-1, cells A2 and A8.

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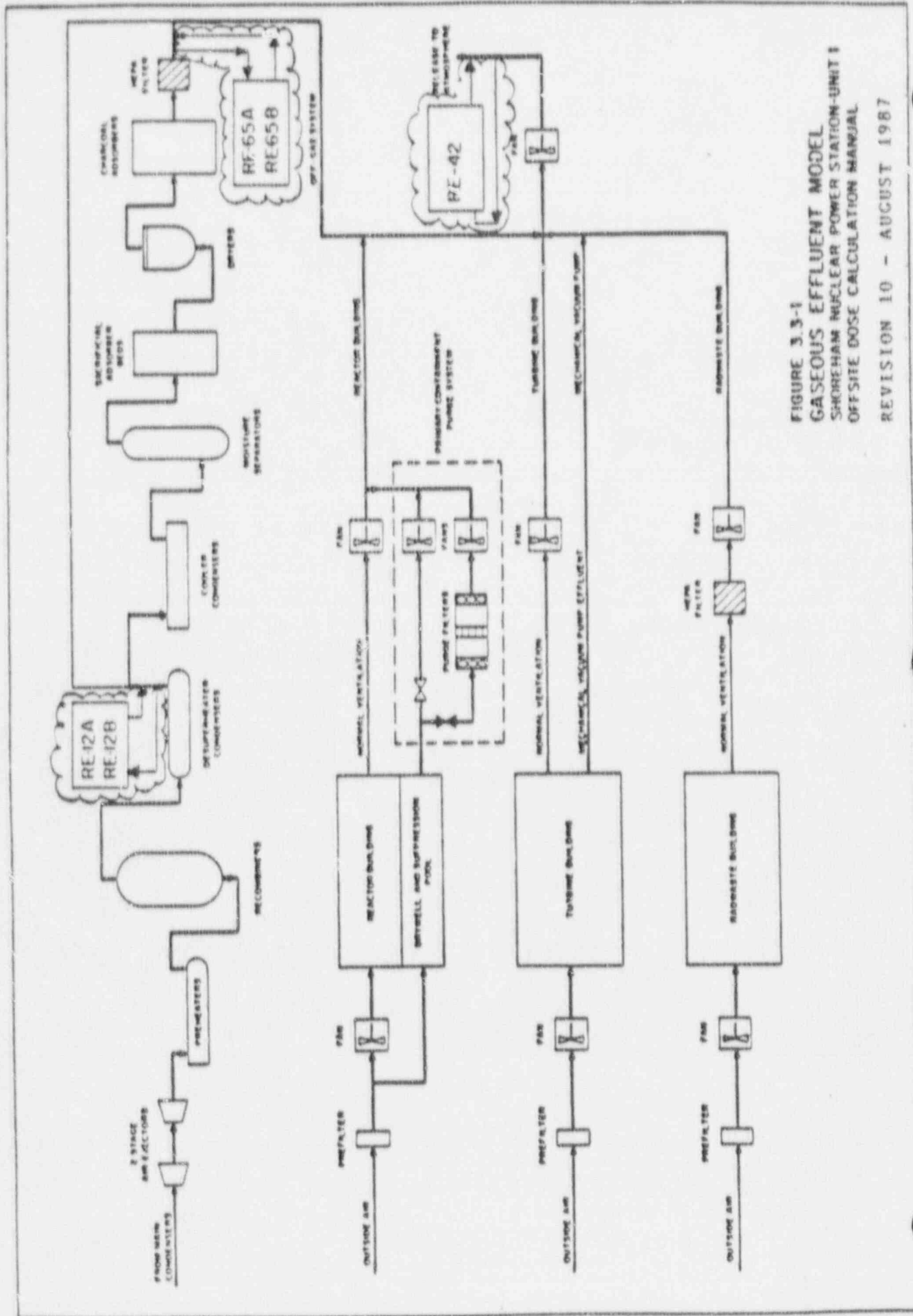


FIGURE 3.3-1
 GASEOUS EFFLUENT MODEL
 SHREHAM NUCLEAR POWER STATION-UNIT 1
 OFFSITE DOSE CALCULATION MANUAL
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3.4 GASEOUS EFFLUENTS NOBLE GAS AIR DOSE

To comply with Section 3.11.2.2 of the REC, the air dose in unrestricted area location due to releases via the station ventilation exhaust point shall be limited to the following:

1. 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.
2. 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.

3.4.1 Method 1: (Computerized Method)

Cumulative doses are calculated by making use of hourly dose rate equations presented in the following subsections.

3.4.1.1 Release Estimation

Dose estimation is performed every hour by making use of the atmospheric dispersion calculation made every hour from meteorological data taken every minute (see Section 4), and of the following equation for the release rate (Ci/hr):

$$Q_i = F' f_i$$

where:

$$F' = k \sum_{j=1}^{60} F_s(j) \dot{C}_{ng}(j) \Delta t$$

$$f_i = 10^{-6} q_i(\tau) / \dot{C}_{ng}(\tau)$$

$$k = 2.832 \times 10^4 \text{ (cc/ft}^3\text{)}$$

$$F_s(j) = \text{vent flow rate during interval } j \text{ (cfm)}$$

$$\dot{C}_{ng}(j) = \text{noble gas effluent monitor count rate during interval } j \text{ (cpm)}$$

$$\Delta t = \text{time interval (= 1 minute)}$$

$$q_i = \text{concentration of isotope } i \text{ in the effluent as measured in the lab at time } \tau \text{ (}\mu\text{Ci/cc)}$$

$$F' = \text{60-minute average of the flow and count-rate product [(cc/hr) (cpm)]}$$

$$60 = \text{number of } \Delta t \text{ intervals per hour (1/hr)}$$

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3.4.1.2 Noble Gas Gamma Air Dose

$$D_{\gamma,air} = (X/Q)_{\gamma}^{sa} F' 3.17 \times 10^4 \sum_{\text{nobles}} f_i DF_i^{\gamma}$$

where

$D_{\gamma,air}$ = gamma dose to air at the site boundary in the downwind sector during the period of release (mrad/hr) (Ref.: Reg. Guide 1.109, Eqs. B-4 and B-5, and also Eq. B-1 with the substitution of $(X/Q)_{\gamma}$)

$(X/Q)_{\gamma}^{sa}$ = finite-cloud sector-average 'gamma' dilution factor at the downwind site-boundary [sec/m^3]

DF_i^{γ} = gamma dose to air conversion factor (from Table B-1 of Reg. Guide 1.109) [$(\text{mrad}/\text{yr})/(\text{pCi}/\text{m}^3)$]

$F'f_i$ = Q_i (Ci/hr) (see Section 3.4.1.1)

3.4.1.3 Noble Gas Beta Air Dose

$$D_{\beta,air} = (X/Q)^{sa} F' 3.17 \times 10^4 \sum_{\text{nobles}} f_i DF_i^{\beta}$$

where

$D_{\beta,air}$ = beta dose to air at the site boundary in the downwind sector during the period of release [mrad/hr] (Ref.: Reg. Guide 1.109, Eqs. B-4 and B-5)

DF_i^{β} = beta dose to air conversion factor (from Table B-1 of Reg. Guide 1.109) [$(\text{mrad}/\text{yr})/(\text{pCi}/\text{m}^3)$]

$F'f_i$ = Q_i (Ci/hr) (see Section 3.4.1.1)

$(X/Q)^{sa}$ = sector-average concentration dilution factor at the site boundary during the period of release [sec/m^3]

3.4.2 Method 2: (Backup Method)3.4.2.1 Noble Gas Gamma Air Dose

The general equation is:

$$D_{Gs} = 3.17E-08 \sum_i \frac{x/Q_i}{V_i} [M_i * (C_{i1} V_1 t_1 - C_{i2} V_2 t_2 - C_{i3} V_3 t_3)] \\ + 3.17E-08 * V_2 * t_2 * \sum_i \frac{x/Q_2}{V_i} [M_i * C_{i2}] \\ + 3.17E-08 * V_3 * t_3 * \sum_i \frac{x/Q_3}{V_i} [M_i * C_{i3}] \quad (\text{mrad})$$

During periods of no intermittent releases, such as no main condenser air removal pump operation and no containment drywell purge, the above formula reduces to the following:

$$D_{Gs} = 3.17E-08 * V_1 * t_1 * \sum_i \frac{x/Q_1}{V_i} [M_i * C_{i1}] \quad (\text{mrad})$$

If main condenser air removal is performed by the mechanical vacuum pump and the sampling is performed at the Station Vent, the following equation should be used:

$$D_{Gs} = 3.17E-08 * V_1 * t_2 * \sum_i \frac{x/Q_2}{V_i} [M_i * C_{i1}] \quad (\text{mrad})$$

where:

- D_G = the total gamma air dose from the releases (mrad),
- $3.17E-08$ = the inverse of number of seconds in a year,
- M_i = the air dose factor due to gamma emissions for each identified noble gas radionuclide (mrad/yr per $\mu\text{Ci}/\text{m}^3$) from Table 3.4-1,
- t_1 = $7.88E+06$ sec for quarterly dose calculation,
= $3.15E+07$ sec for yearly dose calculation
- t_2 = release period (sec) for condenser air removal pump
- t_3 = release period (sec) for containment drywell purge exhaust
- C_{i1} = the station ventilation exhaust duct release concentration of radionuclide, i, ($\mu\text{Ci}/\text{cc}$) (from the isotopic analyses performed on the gaseous sample taken from the station ventilation exhaust monitor),
- C_{i2} = the air removal pump ventilation exhaust duct release concentration of radionuclide, i, ($\mu\text{Ci}/\text{cc}$) (from the isotopic analyses performed on the gaseous sample taken from the air removal pump discharge monitor),

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- C_{13} = the containment drywell purge ventilation exhaust concentration of radionuclide, i , ($\mu\text{Ci/cc}$) obtained from a sample taken during a filtered release or from the containment drywell atmosphere monitor with the purge lines bypassing the primary containment purge filter (The concentration is obtained from the isotopic analyses performed on the gaseous sample taken.),
- V_1 = $1.73\text{E}+08$ cc/sec ($3.66\text{E}+05$ cfm), station ventilation exhaust duct ventilation exhaust flow rate,
- V_2 = $5.70\text{E}+05$ cc/sec (1200 cfm), air removal pump exhaust duct ventilation exhaust flow rate,
- V_3 = $5.70\text{E}+05$ cc/sec (1200 cfm), containment drywell purge ventilation exhaust flow rate,
- X/Q_1 = long term dispersion factor due to release via the station ventilation exhaust point; refer to Table 4-1, cells B1 and B3,
- X/Q_2 = short term dispersion factor due to condenser air removal pump release via the station ventilation exhaust point; refer to Table 4-1, cells B1 and B5,
- X/Q_3 = short term dispersion factor due to containment drywell purge release via the station ventilation exhaust release point; refer to Table 4-1, cells B1 and B7.

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3.4.2.2 Noble Gas Beta Air Dose

The general equation is:

$$D_{B_s} = 3.17\text{E}-08 * X/Q_1 * \sum_i [N_i * (C_{i1} V_1 t_1 - C_{i2} V_2 t_2 - C_{i3} V_3 t_3)] \\ + 3.17\text{E}-08 * X/Q_2 * V_2 * t_2 * \sum_i [N_i * C_{i2}] \\ + 3.17\text{E}-08 * X/Q_3 * V_3 * t_3 * \sum_i [N_i * C_{i3}] \quad (\text{mrad})$$

During periods of no intermittent releases, such as no main condenser air removal pump operation and no containment drywell purge, the above formula reduces to the following:

$$D_{B_s} = 3.17\text{E}-08 * X/Q_1 * V_1 * t_1 * \sum_i [N_i * C_{i1}] \quad (\text{mrad})$$

If the main condenser air removal is performed by the mechanical vacuum pump and the sampling is performed at the Station Vent, the following equation should be used:

$$D_{B_s} = 3.17\text{E}-08 * V_1 * t_2 * X/Q_2 * \sum_i [N_i * C_{i1}] \quad (\text{mrad})$$

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where:

- D_B = beta air dose from all radionuclides released (mrad),
- N_i = the air dose factor due to beta emissions for each identified noble gas radionuclide (mrad/yr per $\mu\text{Ci}/\text{m}^3$) from Table 3.4-1,
- $.17\text{E}-08$ = the inverse of number of seconds in a year,
- t_1 = 7.88E+06 sec for quarterly dose calculation,
= 3.15E+07 sec for yearly dose calculation,
- t_2 = release period (sec) for condenser air removal pump,
- t_3 = release period (sec) for containment drywell purge exhaust,
- C_{i1} = the station ventilation exhaust duct release concentration of radionuclide, i, ($\mu\text{Ci}/\text{cc}$) (from the isotopic analysis performed on the gaseous sample taken from the station ventilation exhaust monitor),
- C_{i2} = the air removal pump ventilation exhaust duct release concentration of radionuclide, i, ($\mu\text{Ci}/\text{cc}$) (from the isotopic analyses performed on the gaseous sample taken from the air removal pump discharge monitor),
- C_{i3} = the containment drywell purge ventilation exhaust concentration of radionuclide, i, ($\mu\text{Ci}/\text{cc}$) obtained from a sample taken during a filtered release or from the containment drywell atmosphere monitor with the purge lines bypassing the primary containment purge filter (The concentration is obtained from the isotopic analyses performed on the gaseous sample taken.),
- V_1 = 1.73E+08 cc/sec (3.66E+05 cfm), station ventilation exhaust duct ventilation exhaust flow rate,
- V_2 = 5.70E+05 cc/sec (1200 cfm), air removal pump exhaust duct ventilation exhaust flow rate,
- V_3 = 5.70E+05 cc/sec (1200 cfm), containment drywell purge ventilation exhaust flow rate,
- X/Q_1 = long term dispersion factor due to release via the station ventilation exhaust point; refer to Table 4-1, cells B1 and B3,
- X/Q_2 = short term dispersion factor due to condenser air removal pump release via the station ventilation exhaust point; refer to Table 4-1, cells B1 and B5,
- X/Q_3 = short term dispersion factor due to containment drywell purge release via the station ventilation exhaust point; refer to Table 4-1, cells B1 and B7.

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TABLE 3.4-1

NOBLE GAS DOSE FACTORS

Isotope	Gamma Air Dose Factor	Beta Air Dose Factor
	M_1 (mrad/yr per $\mu\text{Ci}/\text{m}^3$)	N_1 (mrad/yr per $\mu\text{Ci}/\text{m}^3$)
Kr - 83m	1.9E+01	2.9E+02
Kr - 85m	1.2E+03	2.0E+03
Kr - 85	1.7E+01	2.0E+03
Kr - 87	6.2E+03	1.0E+04
Kr - 88	1.5E+04	2.9E+03
Kr - 89	1.7E+04	1.1E+04
Kr - 90	1.6E+04	7.8E+03
Rn - 131m	1.6E+02	1.1E+03
Xe - 133m	3.3E+02	1.5E+03
Xe - 133	3.5E+02	1.1E+03
Xe - 135m	3.4E+03	7.4E+02
Xe - 135	1.9E+03	2.5E+03
Xe - 137	1.5E+03	1.3E+02
Xe - 138	9.2E+03	4.8E+03
Ar - 41	1.3E+03	3.3E+03

3.5 GASEOUS EFFLUENTS, DOSE DUE TO RADIOIODINES AND RADIOACTIVE MATERIALS IN PARTICULATE FORM AND RADIONUCLIDES (other than Noble Gases) WITH HALF-LIVES GREATER THAN 8 DAYS

To comply with Section 3.11.2.3 of the Radiological Effluent Controls, the organ dose to maximum individual in unrestricted area due to radioiodines and particulates releases via the station ventilation exhaust point shall be limited to the following:

1. During any calendar quarter: Less than or equal to 7.5 mrem to any organ, and
2. During any calendar year: Less than or equal to 15 mrem to any organ.

3.5.1 Method 1: (Computerized Method)

Cumulative doses are calculated by making use of hourly dose rate equations presented in the following subsections.

3.5.1.1 Release Estimation

Dose estimation is performed every hour by making use of the atmospheric dispersion calculation made every hour from meteorological data taken every minute (see Section 4), and of the following equation for the release rate (Ci/hr):

$$Q_i = F' f_i$$

where:

$$F' = k \sum_{j=1}^{60} F_s(j) \dot{C}_{ng}(j) \Delta t$$

$$f_i = 10^{-6} q_i(\tau) / \dot{C}_{ng}(\tau)$$

$$k = 2.832 \times 10^4 \text{ (cc/ft}^3\text{)}$$

$$F_s(j) = \text{vent flow rate during interval } j \text{ (cfm)}$$

$$\dot{C}_{ng}(j) = \text{noble gas effluent monitor count rate during interval } j \text{ (cpm)}$$

$$\Delta t = \text{time interval (= 1 minute)}$$

$$q_i = \text{concentration of isotope } i \text{ in the effluent as measured in the lab at time } \tau \text{ (}\mu\text{Ci/cc)}$$

$$F' = \text{60-minute average of the flow and count-rate product [(cc/hr) (cpm)]}$$

$$60 = \text{number of } \Delta t \text{ intervals per hour (1/hr)}$$

3.5.1.2 Total Body Dose

$$D_{wb} = D_{wb}^{cloud} + D_{wb}^{inh} + D_{wb}^{ground}$$

where:

$$D_{wb}^{cloud} = (X/Q)_Y^{sa} F' 2.22 \times 10^4 \sum_{\text{nobles}} f_i DFB_i$$

$$D_{wb}^{inh} = (X/Q)_Y^{sa} F' 3.17 \times 10^4 R_{ad} \sum_{\text{part+I}} f_i DFA_{ij,ad}$$

$$D_{wb}^{ground} = (D/Q) F' 7 \times 10^{11} \sum_{\text{part+I}} F_i DFG_{i1} [1 - e^{-t_b \lambda_i}] / \lambda_i$$

$$D_{wb}^{cloud} = \text{total body dose due to direct radiation from the radioactive cloud [mrem/hr] (Ref.: Reg. Guide 1.109 Eq. 3-8; also similar to Eq. B-6 if one makes use of the gamma (X/Q) and the } DFB_i \text{ instead of dose conversion factor)}$$

$$D_{wb}^{inh} = \text{total body dose (j = total body) due to inhalation [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-3 and C-4, for an adult)}$$

$$D_{wb}^{ground} = \text{total body dose due to particulate and iodine radioactivity depositing on the ground [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-1 and C-2 with the product 8760 [hr/yr] (1/\lambda_i) [yr] replaced by [1/\lambda_i] [hr] and parameter } \delta_i(r,\theta) \text{ represented by the (D/Q))}$$

$$DFB_i = \text{gamma dose to body conversion factor [(mrem/yr)/(pCi/m^3)] (from Table B-1 of the Reg. Guide)}$$

$$DFA_{ij,ad} = \text{dose conversion factor for nuclide i to organ j of an adult individual [mrem/pCi inhaled] (from Table E-7 of Reg. Guide 1.109)}$$

$$DFG_{i1} = \text{total body conversion factor for standing on contaminated ground [(mrem/hr)/(pCi/m^2)] (from Table E-6 of Reg. Guide 1.109)}$$

$$(X/Q)_Y^{sa} = \text{concentration dispersion factor (sector-average model) for the period of release (site boundary only) (sec/m^3)}$$

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- $(\chi/Q)_Y^{sa}$ = gamma (χ/Q) (finite cloud sector-average model) for the period of release (site boundary only) (sec/m^3)
- (D/Q) = particulate deposition rate (site boundary only) ($1/\text{m}^2$)
- $F' f_i$ = Q_i (Ci/hr) (as defined in Section 3.5.1.1)
- R_{ad} = adult breathing rate (m^3/yr) (from Table E-5)
- λ_i = radionuclide decay constant ($1/\text{hr}$)
- t_b = time period over which the accumulation is evaluated, which is 15 years (1.314×10^5 hours) (Reg. Guide pg 1.109-24)
- 3.17×10^4 = $10^{12} / (8760 \times 3600)$ [(pCi/Ci) (yr/sec)]
- 2.22×10^4 = $3.17 \times 10^4 \times 0.7$, where 0.7 is the shielding factor which accounts for the dose reduction due to the shielding effects of residential structures during occupancy (Ref.: Reg. Guide 1.109 Table E-15)
- 7×10^{11} = $10^{12} \times 0.7$, where 0.7 is the shielding factor and 10^{12} is the number of pCi per Ci (see Eqs. C-1 and C-2 of the guide)
- part+I = 68 particulates and 5 iodines in the summation sign

Note that the total "total body" dose as computed above is used only for hourly assessment of plant operation within the specification limits. The reports prepared by the dose software include the total body dose due to inhalation as a separate parameter. Also note that the equation conservatively includes the dose due to the airborne noble gases, even though this section addresses only the iodines and particulates.

3.5.1.3 Skin Dose

$$D_{skin} = D_{skin}^{cloud} + D_{skin}^{ground}$$

where:

$$D_{skin}^{cloud} = 1.11 \times 0.7 (\chi/Q)_Y^{sa} F' 3.17 \times 10^4 \sum_{nobles} f_i DF_i^Y + (\chi/Q)_Y^{sa} F' 3.17 \times 10^4 \sum_{nobles} f_i DFS_i$$

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- $D_{\text{skin}}^{\text{ground}} = (D/Q) F' 7 \times 10^{11} \sum_{\text{part}+1} f_i DFG_{i2} [1 - e^{-t_b \lambda_i}] / \lambda_i$
- $D_{\text{skin}}^{\text{cloud}} =$ skin dose due to direct gamma radiation from the radioactive cloud (first component of the equation with finite cloud modeling) and beta radiation (second component, semi-infinite cloud immersion) [mrem/hr] (Ref.: Reg. Guide 1.109 Eq. B-9; also similar to Eq. B-7 if one makes use of the gamma (χ/Q))
- $D_{\text{skin}}^{\text{ground}} =$ skin dose due to particulate and iodine radioactivity depositing on the ground [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-1 and C-2 with the product $8760[\text{hr/yr}](1/\lambda_i)[\text{yr}]$ replaced by $(1/\lambda_i)[\text{hr}]$ and parameter δ_i (r, θ) represented by the (D/Q))
- $DF_i^{\gamma} =$ gamma dose to air conversion factor [(mrad/yr)/(pCi/m³)] (from Table B-1 of the Guide)
- $DFS_i =$ beta dose to skin conversion factor [(mrem/yr)/(pCi/m³)] (from Table B-1 of the Guide)
- $DFG_{i2} =$ skin dose conversion factor for standing on contaminated ground [(mrem/hr)/(pCi/m²)] (from Table E-6 of Reg. Guide 1.109)
- 1.11 = average ratio of tissue to air energy absorption coefficient (from Reg. Guide 1.109, pg 1.109-6)
- 0.7 = shielding dose-reduction factor (from Reg. Guide 1.109, pg 1.109-68)

and the remaining parameters are as defined above in Section 3.5.1.2.

Note that the total skin dose as described here includes the contribution of airborne noble gases, even though this section addresses only the iodines and particulates.

3.5.1.4 Organ Doses Due to Inhalation

$$D_{ja}^{inh} = (X/Q)^{sa} F' 3.17 \times 10^4 R_a \sum_{part+I} f_i DFA_{ija}$$

where:

$$D_{ja}^{inh} = \text{dose to organ } j \text{ of individual in age group } a \text{ due to inhalation of airborne radioactivity [mrem/hr] (Ref.: Reg. Guide 1.109 Eqs. C-3 and C-4)}$$

$$DFA_{ija} = \text{dose conversion factor for nuclide } i \text{ to organ } j \text{ of individual in age group } a \text{ [mrem/pCi inhaled] (from Tables E-7 through E-10 of the Guide)}$$

$$R_a = \text{breathing rate of individual in age group } a \text{ [m}^3\text{/yr] (from Table E-5 of Reg. Guide 1.109, for the maximum individuals)}$$

$$(X/Q)^{sa} = \text{concentration dispersion factor (Sector-Average model) for the period of release (nearest garden and nearest residence) [sec/m}^3\text{]}$$

3.5.1.5 Organ Dose Due to Ingestion of Leafy Vegetables

$$D_{ja}^{ing} = (D_{ja}^{ing})_{part} + (D_{ja}^{ing})_{iodines} + (D_{ja}^{ing})_{C14}$$

where:

$$(D_{ja}^{ing})_{part} = (D/Q) F' 1.1 \times 10^8 \sum_{part} U_a^L f_i DFI_{ija} \times \left[\frac{0.2}{2(\lambda_i + 0.0021)} + \frac{B_{iv}}{240\lambda_i} \right] e^{-24\lambda_i}$$

$$(D_{ja}^{ing})_{iodines} = (D/Q) F' 5.5 \times 10^7 \sum_{iodines} U_a^L f_i DFI_{ija} \times \left[\frac{1.0}{2(\lambda_i + 0.0021)} + \frac{B_{iv}}{240\lambda_i} \right] e^{-24\lambda_i}$$

$$(D_{ja}^{ing})_{C14} = (X/Q)^{sa} F' 5.5 \times 10^7 U_a^L f_{C14} DFI_{C14,ja}$$

$$(D_{ja}^{ing})_{H3} = (X/Q)^{sa} F' \left(\frac{1.2 \times 10^7}{H} \right) U_a^L f_{H3} DFI_{H3,ja}$$

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$(D_{ja}^{ing})_{part}$

= dose to organ j of individual in age group a due to ingestion of leafy vegetables contaminated with particulate radioactivity [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-5, C-6 and C-13 for leafy vegetables only, with the following:

- ° r (fraction of deposited activity retained on crops) = 0.2 (see pg 1.109-68 of the Guide)
- ° t_c (time period that crops are exposed to contamination during growing season) = [hrs]
- ° t_e (time period over which the accumulation is evaluated) = [hrs]
- ° t_d (time delay between harvest of vegetation or crops and ingestion) = 24 [hrs]
- ° Y_v (agricultural productivity) = 2 [kg/m²]
- ° P (soil effective surface density) = 240 [kg/m²]
- ° $\lambda_{Ei} = \lambda_i + 0.0021$ [hr⁻¹] (Ref.: Reg. Guide 1.109, pgs 1.109-4 and 1.109-69)
- ° $\delta_i(r, \theta) = (D/Q)$ [m⁻²]
- ° f_d (fraction of leafy vegetables growing in garden of interest) = 1.0

$(D_{ja}^{ing})_{iodines}$

= dose to organ j of individual in age group a due to ingestion of leafy vegetables contaminated with radioiodines [mrem/hr] (Ref.: Reg. Guide 1.109 Eqs. C-5, C-7 and C-13 for leafy vegetables only; similar to the organ dose due to particulate radioactivity given above but with r = 1.0 and different multiplying constant)

$(D_{ja}^{ing})_{C14}$

= dose to organ j of individual in age group a due to ingestion of leafy vegetables exposed to airborne Carbon-14 [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-8 and C-13 for leafy vegetables only, with p (the ratio of the total annual release time to the total annual time during which photosynthesis occurs) = 1)

$(D_{ja}^{ing})_{H3}$

= dose to organ j of individual in age group a due to ingestion of leafy vegetables exposed to airborne tritium [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-9 and C-13 for leafy vegetables only)

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- U_a^L = ingestion rate of leafy vegetables by individual in age group a (from Table E-5 of the Guide, maximum individual) [kg/yr]
- B_{iv} = concentration factor for uptake of radionuclide i from soil by edible parts of crops [(pCi/kg)(wet weight)/(pCi/kg) (dry soil)] (Ref.: Reg. Guide 1.109, Table E-1 and included on Table 3.5-6)
- DFI_{kja} = dose conversion factor for nuclide i to organ j of individual in age group a due to ingestion of contaminated food [mrem/pCi ingested] (from Tables E-11 through E-14 of the Guide)
- $DFI_{C14,ja}$ = DFI_{ija} for Carbon-14
- $DFI_{H3,ja}$ = DFI_{ija} for tritium
- F_{C14} = f_i for Carbon-14 (see Section 3.5.1.1 above)
- f_{H3} = f_i for tritium
- H = absolute humidity of the atmosphere at the location of interest [g/m³] (See Table 3.5-7)
- $(X/Q)^{sa}$ = concentration dispersion factor (Sector - Average model) for the period of release (nearest garden and nearest residence) [sec/m³]
- (D/Q) = particulate deposition rate (nearest garden and nearest residence) [1/m²]

3.5.1.6 Infant Thyroid Dose Due to Ingestion of Goat Milk and Inhalation

Infant thyroid dose equation:

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$$D_{thy,inf} = D_{thy,inf}^{inh} + D_{thy,inf}^{milk}$$

where:

$$D_{thy,inf}^{milk} = (D_{thy,inf}^{milk})_{part} + (D_{thy,inf}^{milk})_{iodines} \\ + (D_{thy,inf}^{milk})_{C14} + (D_{thy,inf}^{milk})_{H3}$$

$$D_{thy,inf}^{inh} = (X/Q)^{sa} F' 3.17 \times 10^4 R_{inf} \sum_{part+I} f_i DFA_{i,thy,inf}$$

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$$(D_{thy,inf}^{milk})_{part} = (D/Q) F' 1.1 \times 10^8 \text{ part } U_{inf}^m f_i DFI_{i,thy,inf} \\ \times 6 F_{mi} \left[\frac{0.2}{0.7[\lambda_i + 0.0021]} + \frac{B_{iv}}{240\lambda_i} \right] e^{-24\lambda_i}$$

$$(D_{thy,inf}^{milk})_{iodines} = (D/Q) F' 5.5 \times 10^7 \sum_{iodines} U_{inf}^m f_i DFI_{i,thy,inf} \\ \times 6 F_{mi} \left[\frac{1.0}{0.7(\lambda_i + 0.0021)} + \frac{B_{iv}}{240\lambda_i} \right] e^{-24\lambda_i}$$

$$(D_{thy,inf}^{milk})_{C14} = (X/Q)^{sa} F' 2.2 \times 10^7 U_{inf}^m f_{C14} DFI_{C14,thy,inf} \\ \times 6 f_{m,C14} \exp(-24\lambda_{C14})$$

$$(D_{thy,inf}^{milk})_{H3} = (X/Q)^{sa} F' \left[\frac{1.2 \times 10^7}{H} \right] U_{inf}^m f_{H3} DFI_{H3,thy,inf} \\ \times 6 F_{m,H3} \exp(-24\lambda_{H3})$$

$D_{thy,inf}^{inh}$ = infant thyroid dose due to inhalation of airborne radioactivity [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-3 and C-4)

$(D_{thy,inf}^{milk})_{part}$ = infant thyroid dose due to ingestion of milk contaminated with radioactive particulates [mrem/hr] (Reg. Guide Eqs. C-5, C-6, C-10, C-11 and C-13) for milk, with the following:

- ° r (fraction of deposited activity retained on crops) = 0.2 (see pg 1.109-68 of the Guide)
- ° t_c (time period that crops are exposed to contamination during growing season) = [hrs]
- ° t_b (time period over which accumulation is evaluated) = [hrs]
- ° t_h (time delay for ingestion of forage by animals) = t_h [hrs] (see pg 1.109-69 of Reg. Guide)
- ° Y_v (agricultural productivity, grass-animal-milk-man pathway) = 0.7 [kg/m²] (Reg Guide 1.109, Rev. 0)
- ° P (soil effective surface density) = 240 [kg/m²]

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- ° $\lambda_{Ei} = \lambda_i + 0.0021 \text{ [hr}^{-1}\text{]}$ (see pgs 1.109-4 and 1.109-69)
- ° $\delta_i(r, \theta) = (D/Q) \text{ [m}^{-2}\text{]}$
- ° t_f (average transport time of activity from the feed into the milk and to the receptor); data listed in Table 4-2 Rev. 12
- ° f_p (fraction of the year that animals graze on pasture based on survey data); data listed in Table 4-2 Rev. 12
- ° f_s (fraction of daily feed that is pasture grass when the animal grazes on pasture based on survey data); data listed in Table 4-2 Rev. 12

$(D_{thy,inf}^{milk})_{iodines}$ = infant thyroid dose due to ingestion of milk contaminated with radio-iodines [mrem/hr] (Ref.: Reg. Guide Eqs. C-5, C-7, C-10, C-11, and C-13 for milk; similar to the infant thyroid dose due to the ingestion of particulates given above, with the exception of a different multiplying factor and $r = 1.0$)

$(D_{thy,inf}^{milk})_{C14}$ = infant thyroid dose due to ingestion of milk contaminated with C14 [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-8, C-10, C-11 and C-13 for milk, with p (the ratio of the total annual release time to the total annual time during which photosynthesis occurs) = 1, and t_f , f_p , and f_s as given above for the particulates)

$(D_{thy,inf}^{milk})_{H3}$ = infant thyroid dose due to ingestion of milk contaminated with tritium [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-9, C-10, C-11, and C-13 for milk, with t_f , f_p , and f_s as given above for the particulates)

R_{inf} = infant breathing rate [m^3/yr] (from Table E-5 of the Guide, for maximum individual)

$DFA_{i,thy,inf}$ = dose conversion factor for nuclide i to the infant thyroid due to inhalation [mrem/pCi inhaled] (from Table E-10 of the Guide)

$DFI_{i,thy,inf}$ = dose conversion factor for nuclide i to the infant thyroid due to ingestion [mrem/pCi ingested] (from Table E-14 of the Guide)

$DFI_{C14,thy,inf}$ = $DFI_{i,thy,inf}$ for Carbon-14

$DFI_{H3,thy,inf}$ = $DFI_{i,thy,inf}$ for tritium

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- F_{C14} = f_i for Carbon-14 (see Section 3.5.1.1 above)
- F_{H3} = f_i for tritium
- U_{inf}^m = milk ingestion rate by infant [liters/yr] (Ref.: Reg. Guide 1.109, Table E-5, max ind.)
- F_{mi} = average fraction of the animal's daily intake of radionuclide i which appears in each liter of milk [days/liter] from Table E-2 of the Guide, with $F_m = F_{mi}$ for goat)
- B_{iv} = concentration factor for uptake of radionuclide i from soil by edible parts of crops [(pCi/kg) (wet weight) / (pCi/kg) (dry soil)] (from Table E-1 of the Guide and included on Table 3.5-6)
- H = absolute humidity of the atmosphere at the location of interest [g/m³] (See Table 3.5-7)
- δ = amount of feed consumed by a goat per day [kg/day] (from Table E-3 of the Guide, Q_F factor)
- $(X/Q)_{sa}$ = concentration dispersion factor (Sector - Average model) for the period of release (nearest goat location) [sec/m³]
- (D/Q) = particulate deposition rate (nearest goat location) [1/m²]

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3.5.2 Method 2: (Backup Method)

3.5.2.1 Organ Doses:

$$D_j = 3.17E-08 * \sum_i [(10^6 * R_a * P_{ij} * X/Q_1 + P_{oij} * D/Q_1) * (C_{i1} * V_1 * t_1 - C_{i2} * V_2 * t_2 - C_{i3} * V_3 * t_3)] + 3.17E-08 * V_2 * t_2 * \sum_i [(10^6 * R_a * P_{ij} * X/Q_2 + P_{oij} * D/Q_2) * C_{i2}] + 3.17E-08 * V_3 * t_3 * \sum_i [(10^6 * R_a * P_{ij} * X/Q_2 + P_{oij} * D/Q_3) * C_{i3}] \quad (\text{mrem})$$

(3.5.2-1)

During periods of no intermittent releases, such as no main condenser air removal pump operation and no containment drywell purge, the above formula reduces to the following:

$$D_j = 3.17E-08 * V_1 * t_1 * \sum_i [(10^6 * R_a * P_{ij} * X/Q_1 + P_{oij} * D/Q_1) * C_{i1}] \quad (\text{mrem})$$

(3.5.2-2)

If main condenser air removal is performed by the mechanical pump and the sampling is performed at the Station Vent, the following equation should be used:

$$D_j = 3.17 * 10^{-8} * V_1 * t_2 * \sum_i [(10^6 * R_a * P_{ij} * X/Q_2 + P_{oij} * D/Q_2) * C_{i1}] \quad (\text{mrem})$$

(3.5.2-3)

where:

D_j = total dose to organ j (mrem),

P_{ij} = the inhalation dose conversion factor for radionuclides, i, (other than noble gases), and organ j, (mrem per pCi inhaled) from Table 3.5-4.

P_{ij} values listed in Table 3.5-17 are the dose rate conversion factors for tritium and carbon-14 from ingestion of goat's milk.

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Note: For short term releases such as from condenser air removal pump or containment drywell purge P_{ij} for C^{-1} must be adjusted (see note in Table 3.5-17)

- R_a = inhalation rate (m^3/yr) from Table 3.5-5,
- P_{oij} = the dose conversion factor for radionuclides, other than noble gases, i , and organ j , for goat milk in $m^2(mrem/yr \text{ per } \mu Ci/sec)$ from Table 3.5-14.
- The dose factors P_{ij} , P_{oij} are based on the critical individual organ for the infant group, since this group is most restrictive.
- t_1 = 7.88E+06 sec for quarterly dose calculation
 = 3.15E+07 sec for yearly dose calculation,
- t_2 = release period (sec) for condenser air removal pump,
- t_3 = release period (sec) for containment drywell purge exhaust,
- C_{i1} = the station ventilation exhaust duct release concentration of radionuclide, i , ($\mu Ci/cc$) (from the isotopic analyses performed on the iodine and filter cartridge taken from the station ventilation exhaust monitor),
- C_{i2} = the air removal pump ventilation exhaust duct release concentration of radionuclide, i , ($\mu Ci/cc$) (from the isotopic analyses performed on the iodine and particulate filters taken from the air removal pump discharge monitor),
- C_{i3} = the containment drywell purge ventilation exhaust concentration of radionuclide, i , ($\mu Ci/cc$) obtained from the iodine and particulate filters during a filtered release or from the containment drywell atmosphere monitor with the purge lines bypassing the primary containment purge filter (The concentration is obtained from the isotopic analyses performed on the iodine and particulate filters.),
- V_1 = 1.73E+08 cc/sec (3.66E+05 cfm), station ventilation exhaust duct ventilation exhaust flow rate,
- V_2 = 5.70E+05 cc/sec (1200 cfm), air removal pump exhaust duct ventilation exhaust flow rate,
- V_3 = 5.70E+05 cc/sec (1200 cfm), containment drywell purge ventilation exhaust flow rate,
- X/Q_1 = long term dispersion factor due to releases via the station ventilation exhaust point; refer to Table 4-1, cells C1 and C3,
- X/Q_2 = short term dispersion factor due to condenser air removal pump release via the station ventilation exhaust point; refer to Table 4-1, cells C1 and C5.

X/Q_3 = short term dispersion factor due to containment drywell purge via the station ventilation exhaust point; refer to Table 4-1, cells C1 and C7,

D/Q_1 = long term deposition factor due to releases via the station ventilation exhaust point; refer to Table 4-1, cells C1 and C9,

D/Q_2 = short term deposition factor due to condenser air removal pump releases via the station ventilation exhaust point; refer to Table 4-1, cells C1 and C11,

D/Q_3 = short term deposition factor due to containment drywell purge exhaust via the station ventilation exhaust point; refer to Table 4-1, cells C1 and C13,

$3.17E-08$ = inverse of $3.15E+07$ sec/yr, and

NOTE:

If the land use census (see Table 3.5-8) changes, the critical location; i.e., the location where an individual would be exposed to the highest dose, must be reevaluated using Equation 3.5.2-1 for each of the following locations:

1. nearest residence,
2. nearest vegetable garden, and
3. nearest milk cow or goat.

P_{0ij} used in Equation 3.5.2-1 will include the values in Tables 3.5-10 through 3.5-14, if those pathways exist.

At each location, the following pathways must be considered and dose (dose rates) reevaluated if any actual pathway exists:

1. inhalation,
2. leafy vegetables (fresh),
3. stored vegetables,
4. goat's or cow's milk (if both exist choose the one resulting in the higher dose), and
5. deposition on ground.

Since a person will always be present, pathways 1 and 5 must always be evaluated.

Once the location of the critical individual is determined and found to be other than the one listed in Table 4-1 (cell C1), the values of X/Q and D/Q at the updated critical location must be used.

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TABLE 3.5-1

INHALATION DOSE FACTORS FOR ADULTS
(mrem per pCi inhaled)

Radio- nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07
C-14	2.27E-06	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07
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	No Data	No Data	No Data	1.08E-05
Cr-51	No Data	No Data	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07
Mn-54	No Data	4.95E-06	7.87E-07	No Data	1.23E-06	1.75E-04	9.67E-06
Mn-56	No Data	1.55E-10	2.29E-11	No Data	1.63E-10	1.18E-06	2.53E-06
Fe-55	3.07E-06	2.12E-06	4.93E-07	No Data	No Data	9.01E-06	7.54E-07
Fe-59	1.47E-06	3.47E-06	1.32E-06	No Data	No Data	1.27E-04	2.35E-05
Co-58	No Data	1.98E-07	2.59E-07	No Data	No Data	1.16E-04	1.33E-05
Co-60	No Data	1.44E-06	1.85E-06	No Data	No Data	7.46E-04	3.56E-05
Ni-63	5.40E-05	3.03E-06	1.87E-06	No Data	No Data	2.23E-05	1.67E-06
Ni-65	1.92E-10	2.62E-11	1.14E-11	No Data	No Data	7.00E-07	1.54E-06
Cu-64	No Data	1.83E-10	7.69E-11	No Data	5.78E-10	8.48E-07	6.12E-06
Zn-65	4.05E-06	1.29E-05	5.82E-06	No Data	8.62E-06	1.08E-04	6.68E-06
Zn-69	4.23E-12	8.14E-12	5.65E-13	No Data	5.27E-12	1.15E-07	2.04E-09
Br-83	No Data	No Data	3.01E-08	No Data	No Data	No Data	2.90E-08
Br-84	No Data	No Data	3.91E-08	No Data	No Data	No Data	2.05E-13
Br-85	No Data	No Data	1.60E-09	No Data	No Data	No Data	1.00E-24
Rb-86	No Data	1.69E-05	7.37E-06	No Data	No Data	No Data	2.08E-06
Rb-88	No Data	4.84E-08	2.41E-08	No Data	No Data	No Data	4.18E-19
Rb-89	No Data	3.20E-08	2.12E-08	No Data	No Data	No Data	1.16E-21
Sr-89	3.80E-05	No Data	1.09E-06	No Data	No Data	1.75E-04	4.37E-05
Sr-90	1.24E-02	No Data	7.62E-04	No Data	No Data	1.20E-03	9.02E-05
Sr-91	7.74E-09	No Data	3.13E-10	No Data	No Data	4.56E-06	2.39E-05
Sr-92	8.43E-10	No Data	3.64E-11	No Data	No Data	2.06E-06	5.38E-06
Y-90	2.61E-07	No Data	7.01E-09	No Data	No Data	2.12E-05	6.32E-05
Y-91m	3.26E-11	No Data	1.27E-12	No Data	No Data	2.40E-07	1.66E-10
Y-91	5.78E-05	No Data	1.55E-06	No Data	No Data	2.13E-04	4.81E-05
Y-92	1.29E-09	No Data	3.77E-11	No Data	No Data	1.96E-06	9.19E-06
Y-93	1.18E-05	No Data	3.26E-10	No Data	No Data	6.06E-06	5.27E-05

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TABLE 3.5-1 (CONT'D)

Radio-nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Zr-95	1.34E-05	4.30E-06	2.91E-06	No Data	6.77E-06	2.21E-04	1.88E-05
Zr-97	1.21E-08	2.45E-09	1.13E-09	No Data	3.71E-09	9.84E-06	6.54E-05
Nb-95	1.76E-06	9.77E-07	5.26E-07	No Data	9.67E-07	6.31E-05	1.30E-05
Mo-99	No Data	1.51E-08	2.87E-09	No Data	3.64E-08	1.14E-05	3.10E-05
Tc-99m	1.29E-13	3.64E-13	4.63E-12	No Data	5.52E-12	9.55E-08	5.20E-07
Tc-101	5.22E-15	7.52E-15	7.38E-14	No Data	1.35E-13	4.99E-08	1.36E-21
Ru-103	1.91E-07	No Data	8.23E-08	No Data	7.29E-07	6.31E-05	1.38E-05
Ru-105	9.88E-11	No Data	3.89E-11	No Data	1.27E-10	1.37E-06	6.02E-06
Ru-106	8.64E-06	No Data	1.09E-06	No Data	1.67E-05	1.17E-03	1.14E-04
Ag-110m	1.35E-06	1.25E-06	7.43E-07	No Data	2.46E-06	5.79E-04	3.78E-05
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	No Data	9.61E-07
I-131	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	No Data	7.85E-07
I-132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	No Data	5.08E-08
I-133	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	No Data	1.11E-06
I-134	8.05E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	No Data	1.26E-10
I-135	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	No Data	6.56E-07
Cs-134	4.66E-05	1.06E-04	3.10E-05	No Data	3.59E-05	1.22E-05	1.30E-06
Cs-136	4.88E-06	1.83E-05	1.38E-05	No Data	1.07E-05	1.50E-06	1.46E-06
Cs-137	5.98E-05	7.76E-05	5.35E-05	No Data	2.78E-05	9.40E-06	1.05E-06
Cs-138	4.14E-05	7.76E-08	4.05E-08	No Data	6.00E-08	6.07E-09	2.33E-13
Ba-139	1.17E-10	8.32E-14	3.42E-12	No Data	7.78E-14	4.70E-07	1.12E-07
Ba-140	4.88E-06	6.13E-09	3.21E-07	No Data	2.09E-09	1.59E-04	2.73E-05
Ba-141	1.25E-11	9.41E-15	4.20E-13	No Data	8.75E-15	2.42E-07	1.45E-17
Ba-142	3.29E-12	3.38E-15	2.07E-13	No Data	2.86E-15	1.49E-07	1.96E-26
La-140	4.30E-08	2.17E-08	5.73E-09	No Data	No Data	1.70E-05	5.73E-05
La-142	8.54E-11	3.88E-11	9.65E-12	No Data	No Data	7.91E-07	2.64E-07

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TABLE 3.5-1 (CONT'D)

<u>Radio-nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
Ce-141	2.49E-06	1.69E-06	1.91E-07	No Data	7.83E-07	4.52E-05	1.50E-05
Ce-143	2.33E-08	1.72E-08	1.91E-09	No Data	7.60E-09	9.97E-06	2.83E-05
Ce-144	4.29E-04	1.79E-04	2.30E-05	No Data	1.06E-04	9.72E-04	1.02E-04
Pr-143	1.17E-06	4.69E-07	5.80E-08	No Data	2.70E-07	3.51E-05	2.50E-05
Pr-144	3.76E-12	1.56E-12	1.91E-13	No Data	8.81E-13	1.27E-07	2.69E-18
Nd-147	6.59E-07	7.62E-07	4.56E-08	No Data	4.45E-07	2.76E-05	2.16E-05
W-187	1.06E-09	8.85E-10	3.10E-10	No Data	No Data	3.63E-06	1.94E-05
Np-239	2.87E-08	2.82E-09	1.55E-09	No Data	8.75E-09	4.70E-06	1.49E-05

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TABLE 3.5-2

INHALATION DOSE FACTORS FOR TEENAGER
(mrem per pCi inhaled)

Radio-nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07	1.59E-07
C-14	3.25E-06	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07	6.09E-07
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	No Data	No Data	No Data	1.16E-05
Cr-51	No Data	No Data	1.69E-08	9.37E-09	3.84E-09	2.62E-06	3.75E-07
Mn-54	No Data	6.39E-06	1.05E-06	No Data	1.59E-06	2.48E-04	8.35E-06
Mn-56	No Data	2.12E-10	3.15E-11	No Data	2.24E-10	1.90E-06	7.18E-06
Fe-55	4.18E-06	2.98E-06	6.93E-07	No Data	No Data	1.55E-05	7.99E-07
Fe-59	1.99E-06	4.62E-06	1.79E-06	No Data	No Data	1.91E-04	2.23E-05
Co-58	No Data	2.59E-07	3.47E-07	No Data	No Data	1.68E-04	1.19E-05
Co-60	No Data	1.89E-06	2.48E-06	No Data	No Data	1.09E-03	3.24E-05
Ni-63	7.25E-05	5.43E-06	2.47E-06	No Data	No Data	3.84E-05	1.77E-06
Ni-65	2.73E-10	3.66E-11	1.59E-11	No Data	No Data	1.17E-06	4.59E-06
Cu-64	No Data	2.54E-10	1.06E-10	No Data	8.01E-10	1.39E-06	7.68E-06
Zn-65	4.82E-06	1.67E-05	7.80E-06	No Data	1.08E-05	1.55E-04	5.83E-06
Zn-69	6.04E-12	1.15E-11	8.07E-13	No Data	7.53E-12	1.98E-07	3.56E-08
Br-83	No Data	No Data	4.30E-08	No Data	No Data	No Data	< 1.00E-24
Br-84	No Data	No Data	5.41E-08	No Data	No Data	No Data	< 1.00E-24
Br-85	No Data	No Data	2.29E-09	No Data	No Data	No Data	< 1.00E-24
Rb-86	No Data	2.38E-05	1.05E-05	No Data	No Data	No Data	2.21E-06
Rb-88	No Data	6.82E-08	3.40E-08	No Data	No Data	No Data	3.65E-15
Rb-89	No Data	4.40E-08	2.91E-08	No Data	No Data	No Data	4.22E-17
Sr-89	5.43E-05	No Data	1.56E-06	No Data	No Data	3.02E-04	4.64E-05
Sr-90	1.35E-02	No Data	8.35E-04	No Data	No Data	2.06E-03	9.56E-05
Sr-91	1.10E-08	No Data	4.39E-10	No Data	No Data	7.59E-06	3.24E-05
Sr-92	1.19E-09	No Data	5.08E-11	No Data	No Data	3.43E-06	1.49E-05
Y-90	3.73E-07	No Data	1.00E-08	No Data	No Data	3.66E-05	6.99E-05
Y-91m	4.63E-11	No Data	1.77E-12	No Data	No Data	4.00E-07	3.77E-09
Y-91	8.26E-05	No Data	2.21E-06	No Data	No Data	3.67E-04	5.11E-05
Y-92	1.84E-09	No Data	5.36E-11	No Data	No Data	3.35E-06	2.06E-05
Y-93	1.69E-08	No Data	4.65E-10	No Data	No Data	1.04E-05	7.24E-05

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TABLE 3.5-2 (CONT'D)

Radio-nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Zr-95	1.82E-05	5.73E-06	3.94E-06	No Data	8.42E-06	3.36E-04	1.86E-05
Zr-97	1.72E-08	3.40E-09	1.57E-09	No Data	5.15E-09	1.62E-05	7.88E-05
Nb-95	2.32E-06	1.29E-06	7.08E-07	No Data	1.25E-06	9.39E-05	1.21E-05
Mo-99	No Data	2.11E-08	4.08E-09	No Data	5.14E-08	1.92E-05	3.36E-05
Tc-99m	1.73E-13	4.83E-13	6.24E-12	No Data	7.20E-12	1.44E-07	7.66E-07
Tc-101	7.40E-15	1.05E-14	1.03E-13	No Data	1.90E-13	8.34E-08	1.09E-16
Ru-103	2.63E-07	No Data	1.12E-07	No Data	9.29E-07	9.79E-05	1.36E-05
Ru-105	1.40E-10	No Data	5.42E-11	No Data	1.76E-10	2.27E-06	1.13E-05
Ru-106	1.23E-05	No Data	1.55E-06	No Data	2.38E-05	2.01E-03	1.20E-04
Ag-110m	1.73E-06	1.64E-06	9.99E-07	No Data	3.13E-06	8.44E-04	3.41E-05
Te-125m	6.10E-07	2.80E-07	8.34E-08	1.75E-07	No Data	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	2.14E-07	5.61E-05	5.79E-05
I-130	7.80E-07	2.24E-06	8.96E-07	1.86E-04	3.44E-06	No Data	1.14E-06
I-131	4.43E-06	6.14E-06	3.30E-06	1.83E-03	1.05E-05	No Data	8.11E-07
I-132	1.99E-07	5.47E-07	1.97E-07	1.89E-05	8.65E-07	No Data	1.59E-07
I-133	1.52E-06	2.56E-06	7.78E-07	3.65E-04	4.49E-06	No Data	1.29E-06
I-134	1.11E-07	2.90E-07	1.05E-07	4.94E-06	4.58E-07	No Data	2.55E-09
I-135	4.62E-07	1.18E-06	4.36E-07	7.76E-05	1.86E-06	No Data	8.69E-07
Cs-134	6.28E-05	1.41E-04	6.86E-05	No Data	4.69E-05	1.83E-05	1.22E-06
Cs-136	6.44E-06	2.42E-05	1.71E-05	No Data	1.38E-05	2.22E-06	1.36E-06
Cs-137	8.38E-05	1.06E-04	3.89E-05	No Data	3.80E-05	1.51E-05	1.06E-06
Cs-138	5.82E-08	1.07E-07	5.58E-08	No Data	8.28E-08	9.84E-09	3.38E-11
Ba-139	1.67E-10	1.18E-13	4.87E-12	No Data	1.11E-13	8.08E-07	8.06E-07
Ba-140	6.84E-06	8.38E-09	4.40E-07	No Data	2.85E-09	2.54E-04	2.86E-05
Ba-141	1.78E-11	1.32E-14	5.93E-13	No Data	1.23E-14	4.11E-07	9.33E-14
Ba-142	4.62E-12	4.63E-15	2.84E-13	No Data	3.92E-15	2.39E-07	5.99E-20
La-140	5.99E-08	2.95E-08	7.82E-09	No Data	No Data	2.68E-05	6.09E-05
La-142	1.20E-10	5.31E-11	1.32E-11	No Data	No Data	1.27E-06	1.50E-06

SNPS-1 ODCM

TABLE 3.5-2 (CONT'D)

<u>Radio-nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
Ce-141	3.55E-06	2.37E-06	2.71E-07	No Data	1.11E-06	7.67E-05	1.58E-05
Ce-143	3.32E-08	2.42E-08	2.70E-09	No Data	1.08E-08	1.63E-05	3.19E-05
Ce-144	6.11E-04	2.53E-04	3.28E-05	No Data	1.51E-04	1.67E-03	1.08E-04
Pr-143	1.67E-06	6.64E-07	8.28E-08	No Data	3.86E-07	6.04E-05	2.67E-05
Pr-144	5.37E-12	2.20E-12	2.72E-13	No Data	1.26E-12	2.19E-07	2.94E-14
Nd-147	9.83E-07	1.07E-06	6.41E-08	No Data	6.28E-07	4.65E-05	2.28E-05
W-187	1.50E-09	1.22E-09	4.29E-10	No Data	No Data	5.92E-06	2.21E-05
Np-239	4.23E-08	3.99E-09	2.21E-09	No Data	1.25E-08	8.11E-06	1.65E-05

SNPS-1 ODCM

TABLE 3.5-3

 INHALATION DOSE FACTORS FOR CHILD
 (mrem per pCi inhaled)

Radio-nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
C-14	9.70E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06
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	No Data	No Data	No Data	1.14E-05
Cr-51	No Data	No Data	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
Mn-54	No Data	1.16E-05	2.57E-06	No Data	2.71E-06	4.26E-04	6.19E-06
Mn-56	No Data	4.48E-10	8.43E-11	No Data	4.52E-10	3.55E-06	3.33E-05
Fe-55	1.28E-05	6.80E-06	2.10E-06	No Data	No Data	3.00E-05	7.75E-07
Fe-59	5.59E-06	9.04E-06	4.51E-06	No Data	No Data	3.43E-04	1.91E-05
Co-58	No Data	4.79E-07	8.55E-07	No Data	No Data	2.99E-04	9.29E-06
Co-60	No Data	3.55E-06	6.12E-06	No Data	No Data	1.91E-03	2.60E-05
Ni-63	2.22E-04	1.25E-05	7.56E-06	No Data	No Data	7.43E-05	1.71E-06
Ni-65	8.08E-10	7.99E-11	4.44E-11	No Data	No Data	2.21E-06	2.27E-05
Cu-64	No Data	5.39E-10	2.90E-10	No Data	1.63E-09	2.59E-06	9.92E-06
Zn-65	1.15E-05	3.06E-05	1.90E-05	No Data	1.93E-05	2.69E-04	4.41E-06
Zn-67	1.81E-11	2.61E-11	2.41E-12	No Data	1.58E-11	3.84E-07	2.75E-06
Br-83	No Data	No Data	1.28E-07	No Data	No Data	No Data	<1.00E-24
Br-84	No Data	No Data	1.48E-07	No Data	No Data	No Data	<1.00E-24
Br-85	No Data	No Data	6.84E-09	No Data	No Data	No Data	<1.00E-24
Rb-86	No Data	5.36E-05	3.09E-05	No Data	No Data	No Data	2.16E-06
Rb-88	No Data	1.52E-07	9.90E-08	No Data	No Data	No Data	4.66E-09
Rb-89	No Data	9.33E-08	7.83E-08	No Data	No Data	No Data	5.11E-10
Sr-89	1.62E-04	No Data	4.66E-06	No Data	No Data	5.83E-04	4.52E-05
Sr-90	2.73E-02	No Data	1.74E-03	No Data	No Data	3.99E-03	9.28E-05
Sr-91	3.28E-08	No Data	1.24E-09	No Data	No Data	1.44E-05	4.70E-05
Sr-92	3.54E-09	No Data	1.42E-10	No Data	No Data	6.49E-06	6.55E-05
Y-90	1.11E-06	No Data	2.99E-08	No Data	No Data	7.07E-05	7.24E-05
Y-91m	1.37E-10	No Data	4.98E-12	No Data	No Data	7.60E-07	4.64E-07
Y-91	2.47E-04	No Data	6.59E-06	No Data	No Data	7.10E-04	4.97E-05
Y-92	5.50E-09	No Data	1.57E-10	No Data	No Data	6.46E-06	6.46E-05
Y-93	5.04E-08	No Data	1.38E-09	No Data	No Data	2.01E-05	1.05E-04

TABLE 3.5-3 (CONT'D)

Radio-nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-ILLI
Zr-95	5.13E-05	1.13E-05	1.00E-05	No Data	1.61E-05	6.03E-04	1.65E-05
Zr-97	5.07E-08	7.34E-09	4.32E-09	No Data	1.05E-08	3.06E-05	9.49E-05
Nb-95	6.35E-06	2.48E-06	1.77E-06	No Data	2.33E-06	1.66E-04	1.00E-05
Mo-99	No Data	4.66E-08	1.15E-08	No Data	1.06E-07	3.66E-05	3.42E-05
Tc-99m	4.81E-13	9.41E-13	1.56E-11	No Data	1.37E-11	2.57E-07	1.30E-06
Tc-101	2.19E-14	2.30E-14	2.91E-13	No Data	3.92E-13	1.58E-07	4.41E-09
Ru-103	7.55E-07	No Data	2.90E-07	No Data	1.90E-06	1.79E-04	1.21E-05
Ru-105	4.13E-10	No Data	1.50E-10	No Data	3.63E-10	4.30E-06	2.69E-05
Ru-106	3.68E-05	No Data	4.57E-06	No Data	4.97E-05	3.87E-03	1.16E-04
Ag-110m	4.56E-06	3.08E-06	2.47E-06	No Data	5.74E-06	1.48E-03	2.71E-05
Te-125m	1.82E-06	6.29E-07	2.47E-07	5.20E-07	No Data	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	No Data	1.38E-06
I-131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	No Data	7.68E-07
I-132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-05	No Data	8.65E-07
I-133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	No Data	1.48E-06
I-134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	No Data	2.58E-07
I-135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	No Data	1.20E-06
Cs-134	1.76E-04	2.74E-04	6.07E-05	No Data	8.93E-05	3.27E-05	1.04E-06
Cs-136	1.76E-05	4.62E-05	3.14E-05	No Data	2.58E-05	3.93E-06	1.13E-06
Cs-137	2.45E-04	2.23E-04	3.47E-05	No Data	7.63E-05	2.81E-05	9.78E-07
Cs-138	1.71E-07	2.27E-07	1.50E-07	No Data	1.68E-07	1.84E-08	7.29E-08
Ba-139	4.98E-10	2.66E-13	1.45E-11	No Data	2.33E-13	1.56E-06	1.56E-05
Ba-140	2.00E-05	1.75E-08	1.17E-06	No Data	5.71E-09	4.71E-04	2.75E-05
Ba-141	5.29E-11	2.95E-14	1.72E-12	No Data	2.56E-14	7.89E-07	7.44E-08
Ba-142	1.35E-11	9.73E-15	7.54E-13	No Data	7.87E-15	4.44E-07	7.41E-10
La-140	1.74E-07	6.08E-08	2.04E-08	No Data	No Data	4.94E-05	6.10E-05
La-142	3.50E-10	1.11E-10	3.49E-11	No Data	No Data	2.35E-06	2.05E-05

SNPS-1 ODCM

TABLE 3.5-3 (CONT'D)

<u>Radio-nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
Ce-141	1.06E-05	5.28E-06	7.83E-07	No Data	2.31E-06	1.47E-04	1.53E-05
Ce-143	9.89E-08	5.37E-08	7.77E-09	No Data	2.26E-08	3.12E-05	3.44E-05
Ce-144	1.83E-03	5.72E-04	9.77E-05	No Data	3.17E-04	3.23E-03	1.05E-04
Pr-143	4.99E-06	1.50E-06	2.47E-07	No Data	8.11E-07	1.17E-04	2.63E-05
Pr-144	1.61E-11	4.99E-12	8.10E-13	No Data	2.64E-12	4.23E-07	5.32E-08
Nd-147	2.92E-06	2.36E-06	1.84E-07	No Data	1.30E-06	8.87E-05	2.22E-05
W-187	4.41E-09	2.61E-09	1.17E-09	No Data	No Data	1.11E-05	2.46E-05
Np-239	1.26E-07	9.04E-09	6.35E-09	No Data	2.63E-08	1.57E-05	1.73E-05

SNPS-1 ODCM

TABLE 3.5-4

 INHALATION DOSE FACTORS FOR INFANT
 (mrem per pCi inhaled)

Radio-nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07
C-14	1.89E-05	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06
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	No Data	No Data	No Data	1.15E-05
Cr-51	No Data	No Data	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
Mn-54	No Data	1.81E-05	3.56E-06	No Data	3.56E-06	7.14E-04	5.04E-06
Mn-56	No Data	1.10E-09	1.58E-10	No Data	7.86E-10	8.95E-06	5.12E-05
Fe-55	1.41E-05	8.39E-06	2.38E-06	No Data	No Data	6.21E-05	7.82E-07
Fe-59	9.69E-06	1.68E-05	6.77E-06	No Data	No Data	7.25E-04	1.77E-05
Co-58	No Data	8.71E-07	1.30E-06	No Data	No Data	5.55E-04	7.95E-06
Co-60	No Data	5.73E-06	8.41E-06	No Data	No Data	3.22E-03	2.28E-05
Ni-63	2.42E-04	1.46E-05	8.29E-06	No Data	No Data	1.49E-04	1.73E-06
Ni-65	1.71E-09	2.03E-10	8.79E-11	No Data	No Data	5.80E-06	3.58E-05
Cu-64	No Data	1.34E-09	5.53E-10	No Data	2.84E-09	6.64E-06	1.07E-05
Zn-65	1.38E-05	4.47E-05	2.22E-05	No Data	2.32E-05	4.62E-04	3.67E-05
Zn-69	3.85E-11	6.91E-11	5.13E-12	No Data	2.87E-11	1.05E-06	9.44E-06
Br-83	No Data	No Data	2.72E-07	No Data	No Data	No Data	<1.00E-24
Br-84	No Data	No Data	2.86E-07	No Data	No Data	No Data	<1.00E-24
Br-85	No Data	No Data	1.46E-08	No Data	No Data	No Data	<1.00E-24
Rb-86	No Data	1.36E-04	6.30E-05	No Data	No Data	No Data	2.17E-06
Rb-88	No Data	3.98E-07	2.05E-07	No Data	No Data	No Data	2.42E-07
Rb-89	No Data	2.29E-07	1.47E-07	No Data	No Data	No Data	4.87E-08
Sr-89	2.84E-04	No Data	8.15E-06	No Data	No Data	1.45E-03	4.57E-05
Sr-90	2.92E-02	No Data	1.85E-03	No Data	No Data	8.03E-03	9.36E-05
Sr-91	6.83E-08	No Data	2.47E-09	No Data	No Data	3.76E-05	5.24E-05
Sr-92	7.50E-09	No Data	2.79E-10	No Data	No Data	1.70E-05	1.90E-04
Y-90	2.35E-06	No Data	6.30E-08	No Data	No Data	1.92E-04	7.43E-05
Y-91m	2.91E-10	No Data	9.90E-12	No Data	No Data	1.99E-06	1.68E-06
Y-91	4.20E-04	No Data	1.12E-05	No Data	No Data	1.75E-03	5.02E-05
Y-92	1.17E-08	No Data	3.29E-10	No Data	No Data	1.75E-05	9.04E-05
Y-93	1.07E-07	No Data	2.91E-09	No Data	No Data	5.46E-05	1.19E-04

SNPS-1 ODCM

TABLE 3.5-4 (CONT'D)

Radio-nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Zr-95	8.24E-05	1.99E-05	1.45E-05	No Data	2.22E-05	1.25E-03	1.55E-05
Zr-97	1.07E-07	1.83E-08	8.36E-09	No Data	1.85E-08	7.88E-05	1.00E-04
Nb-95	1.12E-05	4.59E-06	2.70E-06	No Data	3.37E-06	3.42E-04	9.05E-06
Mo-99	No Data	1.18E-07	2.31E-08	No Data	1.89E-07	9.63E-05	3.48E-05
Tc-99m	9.98E-13	2.06E-12	2.66E-11	No Data	2.22E-11	5.79E-07	1.45E-06
Tc-101	4.65E-14	5.88E-14	5.80E-13	No Data	6.99E-13	4.17E-07	6.03E-07
Ru-103	1.44E-06	No Data	4.85E-07	No Data	3.03E-06	3.94E-04	1.15E-05
Ru-105	8.74E-10	No Data	2.93E-10	No Data	6.42E-10	1.12E-05	3.46E-05
Ru-106	6.20E-05	No Data	7.77E-06	No Data	7.61E-05	8.26E-03	1.17E-04
Ag-110m	7.13E-06	5.16E-06	3.57E-06	No Data	7.80E-06	2.62E-03	2.36E-05
Te-125m	3.40E-06	1.42E-06	4.70E-07	1.16E-06	No Data	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-09	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
T-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	No Data	1.42E-06
I-131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	No Data	7.56E-07
I-132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	No Data	1.36E-06
I-133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	No Data	1.54E-06
I-134	6.58E-07	1.34E-06	4.75E-07	3.1E-05	1.49E-06	No Data	9.21E-07
I-135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	No Data	1.31E-06
Cs-134	2.83E-04	5.02E-04	5.32E-05	No Data	1.36E-04	5.69E-05	9.53E-07
Cs-136	3.45E-05	9.61E-05	3.78E-05	No Data	4.03E-05	8.40E-06	1.02E-06
Cs-137	3.92E-04	4.37E-04	3.25E-05	No Data	1.23E-04	5.09E-05	9.53E-07
Cs-138	3.61E-07	5.58E-07	2.84E-07	No Data	2.93E-07	4.67E-08	6.26E-07
Ba-139	1.06E-09	7.03E-13	3.07E-11	No Data	4.23E-13	4.25E-06	3.64E-05
Ba-140	4.00E-05	4.00E-08	2.07E-06	No Data	9.59E-09	1.14E-03	2.74E-05
Ba-141	1.12E-10	7.70E-14	3.55E-12	No Data	4.64E-14	2.12E-06	3.39E-06
Ba-142	2.84E-11	2.36E-14	1.40E-12	No Data	1.36E-14	1.11E-06	4.95E-07
La-140	3.61E-07	1.43E-07	3.68E-08	No Data	No Data	1.20E-04	6.06E-05
La-142	7.36E-10	2.69E-10	6.46E-11	No Data	No Data	5.87E-06	4.25E-05

TABLE 3.5-4 (CONT'D)

<u>Radio-nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
Ce-141	1.98E-05	1.19E-05	1.42E-06	No Data	3.75E-06	3.59E-04	1.54E-05
Ce-143	2.09E-07	1.38E-07	1.58E-08	No Data	4.03E-08	8.30E-05	3.55E-05
Ce-144	2.28E-03	8.65E-04	1.26E-04	No Data	3.84E-04	7.03E-03	1.06E-04
Pr-143	1.00E-05	3.74E-06	4.99E-07	No Data	1.41E-06	3.09E-04	2.66E-05
Pr-144	3.42E-11	1.32E-11	1.72E-12	No Data	4.80E-12	1.15E-06	3.06E-06
Nd-147	5.67E-06	5.81E-06	3.57E-07	No Data	2.25E-06	2.30E-04	2.23E-05
W-187	9.26E-09	6.44E-09	2.23E-09	No Data	No Data	2.83E-05	2.54E-05
Np-239	2.65E-07	2.37E-08	1.34E-08	No Data	4.73E-08	4.25E-05	1.78E-05

TABLE 3.5-5

RECOMMENDED VALUES FOR U_{ap} TO BE USED FOR THE MAXIMUM EXPOSED
INDIVIDUAL IN LIEU OF SITE-SPECIFIC DATA

<u>Pathway</u>	<u>Infant</u>	<u>Child</u>	<u>Teen</u>	<u>Adult</u>
Fruits, vegetables & grain (kg/yr) ^{(1),(2)}	N/A ⁽⁷⁾	520	630	520
Leafy vegetables (kg/yr) ⁽¹⁾	N/A	26	42	64
Milk (L/yr) ⁽¹⁾	330	330	400	310
Meat & poultry (kg/yr) ⁽¹⁾	N/A	41	65	110
Fish (fresh or salt) (kg/yr) ⁽³⁾	N/A	6.9	16	21
Other seafood (kg/yr) ⁽¹⁾	N/A	1.7	3.9	5
Drinking water (L/yr) ⁽⁴⁾	330	510	510	730
Shoreline recreation (hr/yr) ⁽⁴⁾	N/A	14	67	12
Inhalation (m ³ /yr)	1400 ⁽⁵⁾	3700 ⁽⁶⁾	8000 ⁽⁶⁾	8000 ⁽⁵⁾

(1) Consumption rate obtained from Reference 19 for average individual and age prorated and maximized using techniques contained in Reference 10 of Regulatory Guide 1.109, Rev 1, Oct. 1977.

(2) Consists of the following (on a mass basis): 22% fruit, 54% vegetables (including leafy vegetables), and 24% grain.

TABLE 3.5-5 (CONT'D)

- (3) Consumption rate for adult obtained by averaging data from References 10 and 21-24 of Regulatory Guide 1.109, Rev. 1, Oct. 1977 and age-prorated using techniques contained in Reference 10.
- (4) Data obtained directly from Reference 10 of Regulatory Guide 1.109, Rev. 1, Oct. 1977.
- (5) Data obtained directly from Reference 20 of Regulatory Guide 1.109, Rev. 1, Oct. 1977.
- (6) Inhalation rate derived from data provided in Reference 20 of Regulatory Guide 1.109, Rev. 1, Oct. 1977.
- (7) N/A indicates not applicable.

TABLE 3.5-6

STABLE ELEMENT TRANSFER DATA(1)

Element	B Veg/Soil	F (Cow) Milk (d/l)	F Meat (d/kg)
H ⁽²⁾	4.8E+00	1.0E-02	1.2E-02
C ⁽²⁾	5.5E+00	1.2E-02	3.1E-02
Na	5.2E-02	4.0E-02 ⁽³⁾	3.0E-02
P	1.1E+00	2.5E-02	4.6E-02
Cr	2.5E-04	2.2E-03	2.4E-03
Mn	2.9E-02	2.5E-04	8.0E-04
Fe	6.6E-04	1.2E-03	4.0E-02
Co	9.4E-03	1.0E-03	1.3E-02
Ni	1.9E-02	6.7E-03	5.2E-02
Cu	1.2E-01	1.4E-02	8.0E-03
Zn	4.0E-01	3.9E-02	3.0E-02
Rb	1.3E-01	3.0E-02 ⁽³⁾	3.1E-02
Sr	1.7E-02	8.0E-04 ⁽³⁾	6.0E-04
Y	2.6E-03	1.0E-05	4.6E-03
Zr	1.7E-04	5.0E-06	3.4E-02
Nb	9.4E-03	2.5E-03	2.8E-01
Mo	1.2E-01	7.5E-03	8.0E-03
Tc	2.5E-01	2.5E-02	4.0E-01
Ru	5.0E-02	1.0E-06	4.0E-01
Rh	1.3E-01	1.0E-02	1.5E-03
Ag	1.5E-01	5.0E-02	1.7E-02
Te	1.3E-00	1.0E-03 ⁽⁴⁾	7.7E-02
I	2.0E-02	6.0E-03 ⁽³⁾	2.9E-03
Cs	1.0E-02	1.2E-02 ⁽³⁾	4.0E-03
Ba	5.0E-03	4.0E-04 ⁽³⁾	3.2E-03
La	2.5E-03	5.0E-06 ⁽³⁾	2.0E-04
Ce	2.5E-03	1.0E-04 ⁽³⁾	1.2E-03
Pr	2.5E-03	5.0E-06	4.7E-03
Nd	2.4E-03	5.0E-06	3.3E-03
W	1.8E-02	5.0E-04	1.3E-03
Np	2.5E-03	5.0E-06	2.0E-04 ⁽⁵⁾

- (1) Data presented in this table is from Reference 1 of Regulatory Guide 1.109, Rev. 1, Oct. 1977.
- (2) Meat and milk coefficients are based on specific activity considerations.
- (3) From Reference 15 of Regulatory Guide 1.109, Rev. 1, Oct. 1977.
- (4) See text (Regulatory Guide 1.109, Rev. 1, Oct. 1977).
- (5) From Reference 13 of Regulatory Guide 1.109, Rev. 1, Oct. 1977.

SNPS-1 ODCM

TABLE 3.5-7

HUMIDITY PARAMETERS AT RECEPTORS

Monthly Average Absolute Humidity (gm/m³)

January	3.06
February	3.09
March	3.83
April	5.71
May	8.19
June	12.62
July	15.53
August	14.52
September	11.68
October	8.11
November	5.37
December	3.73

TABLE 3.5-8

LOCATION OF NEAREST RESIDENCE, VEGETABLE GARDEN, SITE BOUNDARY, AND MILK ANIMAL BY SECTION

Sector	Nearest Site Boundary		Nearest Residence(+)		Nearest Vegetable Garden(+)		Nearest Milk Animal(++)	
	Distance* (Meters)	Elevation** (Meters)	Distance* (Meters)	Elevation** (Meters)	Distance* (Meters)	Elevation** (Meters)	Distance* (Meters)	Elevation** (Meters)
N	436	6.1	-	-	-	-	-	-
NNE	366	6.1	458	12.2	-	-	-	-
NE	332	6.1	584	12.2	-	-	-	-
ENE	311	6.1	1050	12.2	1895	32.0	-	-
E	346	6.1	1097	12.2	1212	17.4	-	-
ESE	457	6.1	889	12.2	1323	10.2	-	-
SE	1105	26.0	1007	19.8	1260	21.3	-	-
SSE	876	30.0	789	30.8	1920	51.4	-	-
S	610	25.9	1170	41.1	1837	57.9	-	-
SSW	457	22.0	1487	62.5	1496	62.5	-	-
SW	533	17.0	497	21.3	2046	45.7	***	***
WSW	457	15.0	1694	38.4	1867	53.3	-	-
W	360	6.1	1408	33.5	2273	40.2	3058	41.5 (Goats)
WNW	354	6.1	664	25.9	-	-	-	-
NW	419	6.1	-	-	-	-	-	-
NNW	436	6.1	-	-	-	-	-	-

Notes:

* Distances are given from the reactor centerline out to 8046 meters.

** Elevations given are meters above mean sea level - highest elevation between reactor and receptor point.

*** Milking goats are also located at 3062 meters from SNPS, at elevation 42.7 meters, in this section. However, per the Milk Animal Survey, these goats are on 100% indoor-stored, non-local commercial feed.

(+) Results of 1988 Land Use Survey.

(++) Results of 1989 Milk Animal Survey

TABLE 3.5-9

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CONTAMINATED GROUND, INGESTION OF LEAFY AND STORED VEGETABLES DOSE RATE CONVERSION FACTORS FOR CHILD
 m^2 (mrem/yr/ μ Ci/sec)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
N-13	4.0E+04	4.0E+04	4.0E+04	4.0E+04	4.0E+04	4.0E+04	4.0E+04
F-18	4.0E+05	4.0E+05	4.0E+05	4.0E+05	4.0E+05	4.0E+05	4.0E+05
NA-24	1.2E+07	1.2E+07	1.2E+07	1.2E+07	1.2E+07	1.2E+07	1.2E+07
P-32	3.6E+09	1.7E+08	1.4E+08	-(1)	-	-	9.9E+07
CR-51	4.9E+06	4.9E+06	5.0E+06	5.0E+06	4.9E+06	5.0E+06	1.1E+07
MN-54	1.3E+09	1.9E+09	1.5E+09	1.3E+09	1.5E+09	1.3E+09	1.8E+09
MN-56	9.0E+05	9.0E+05	9.0E+05	9.0E+05	9.0E+05	9.0E+05	9.0E+05
FE-55	7.3E+08	3.8E+08	1.2E+08	-	-	2.1E+08	7.1E+07
FE-59	6.5E+08	8.8E+08	5.8E+08	2.8E+08	2.8E+08	4.5E+08	9.1E+08
CO-58	3.8E+08	4.4E+08	5.6E+08	3.8E+08	3.8E+08	3.8E+08	7.3E+08
CO-60	2.3E+10	2.3E+10	2.4E+10	2.3E+10	2.3E+10	2.3E+10	2.5E+10
NI-63	4.6E+10	2.4E+09	1.6E+09	-	-	-	1.6E+08
NI-65	3.0E+05	3.0E+05	3.0E+05	3.0E+05	3.0E+05	3.0E+05	3.0E+05
CU-64	6.1E+05	6.2E+05	6.2E+05	6.1E+05	6.4E+05	6.1E+05	1.1E+06
ZN-65	1.8E+09	3.4E+09	2.5E+09	8.6E+08	2.5E+09	8.6E+08	1.3E+09
ZN-69M	1.3E+06	1.3E+06	1.3E+06	1.3E+06	1.3E+06	1.3E+06	1.5E+06
BR-83	4.9E+03	4.9E+03	4.9E+03	4.9E+03	4.9E+03	4.9E+03	4.9E+03
BR-84	2.0E+05	2.0E+05	2.0E+05	2.0E+05	2.0E+05	2.0E+05	2.0E+05
RB-86	9.0E+06	4.5E+08	2.8E+08	9.0E+06	9.0E+06	9.0E+06	3.7E+07
RB-88	3.3E+04	3.3E+04	3.3E+04	3.3E+04	3.3E+04	3.3E+04	3.3E+04
RB-89	1.2E+05	1.2E+05	1.2E+05	1.2E+05	1.2E+05	1.2E+05	1.2E+05
SR-89	3.3E+10	2.2E+04	9.5E+08	2.2E+04	2.2E+04	2.2E+04	1.3E+09
SR-90	1.4E+12	6.7E+06	3.4E+11	6.7E+06	6.7E+06	6.7E+06	1.8E+10
SR-91	3.8E+06	3.3E+06	3.3E+06	3.3E+06	3.3E+06	3.3E+06	4.4E+06
SR-92	9.5E+05	9.5E+05	9.5E+05	9.5E+05	9.5E+05	9.5E+05	9.6E+05
Y-90	2.7E+04	4.5E+03	5.1E+03	4.5E+03	4.5E+03	4.5E+03	6.3E+07
Y-91H ₂	1.0E+05	1.0E+05	1.0E+05	1.0E+05	1.0E+05	1.0E+05	1.0E+05
Y-91	1.8E+07	1.1E+06	1.6E+06	1.1E+06	1.1E+06	1.1E+06	2.3E+09
Y-92	1.8E+05	1.8E+05	1.8E+05	1.8E+05	1.8E+05	1.8E+05	1.9E+06
Y-93	1.8E+05	1.8E+05	1.8E+05	1.8E+05	1.8E+05	1.8E+05	4.5E+06
ZR-95	5.0E+08	5.0E+08	5.0E+08	5.0E+08	5.0E+08	5.0E+08	1.3E+09
ZR-97	5.3E+06	5.3E+06	5.3E+06	5.3E+06	5.3E+06	5.3E+06	1.7E+07

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TABLE 3.5-9 (CONT'D)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
NB-95	1.4E+08	1.4E+08	1.4E+08	1.4E+08	1.4E+08	1.4E+08	4.2E+08
MO-99	6.1E+06	1.4E+07	7.9E+06	6.1E+06	2.2E+07	6.1E+06	1.2E+07
TC-99M	1.8E+05	1.8E+05	1.8E+05	1.8E+05	1.8E+05	1.8E+05	1.9E+05
IC-101	2.0E+04	2.0E+04	2.0E+04	2.0E+04	2.0E+04	2.0E+04	2.0E+04
RU-103	1.2E+08	1.1E+08	1.2E+08	1.1E+08	1.5E+08	1.1E+08	4.9E+08
RU-105	7.3E+05	7.3E+05	7.3E+05	7.3E+05	7.3E+05	7.3E+05	7.9E+05
RU-106	1.1E+09	4.2E+08	5.1E+08	4.2E+08	1.4E+09	4.2E+08	1.1E+10
AG-110M	3.5E+09	3.5E+09	3.5E+09	3.5E+09	3.5E+09	3.5E+09	6.2E+09
SB-124	6.8E+08	6.0E+08	6.3E+08	6.0E+08	6.0E+08	6.6E+08	3.0E+09
TE-125M	4.2E+08	1.1E+08	5.7E+07	1.2E+08	1.6E+06	1.5E+06	4.1E+08
TE-127M	1.9E+09	4.9E+08	2.2E+08	4.4E+08	5.2E+09	9.2E+05	1.4E+09
TE-127	1.3E+04	5.7E+03	5.2E+03	9.9E+03	3.2E+04	3.0E+03	3.9E+05
TE-129M	9.7E03	2.9E+03	1.8E+08	3.3E+08	2.7E+09	3.8E+07	1.2E+09
TE-129	2.6E+04	2.6E+04	2.6E+04	2.6E+04	2.6E+04	2.6E+04	2.6E+04
TE-131M	1.4E+07	1.3E+07	1.3E+07	1.3E+07	1.7E+07	1.2E+07	3.4E+07
TE-131	6.6E+04	6.6E+04	6.6E+04	6.6E+04	6.6E+04	6.6E+04	6.6E+04
TE-132	5.4E+07	5.0E+07	5.1E+07	5.2E+07	7.6E+07	4.7E+07	7.9E+07
TE-132	3.1E+06	3.4E+06	3.1E+06	6.9E+07	3.7E+06	2.8E+06	3.1E+06
I-131	7.7E+07	7.8E+07	4.8E+07	2.3E+10	1.2E+08	8.6E+06	1.5E+07
I-132	6.2E+05	6.2E+05	6.2E+05	6.2E+05	6.2E+05	6.2E+05	6.2E+05
I-133	2.9E+06	3.3E+06	2.0E+06	3.9E+08	4.7E+06	1.2E+06	2.0E+06
I-134	2.2E+05	2.2E+05	2.2E+05	2.2E+05	2.2E+05	2.2E+05	2.2E+05
I-135	1.3E+06	1.4E+06	1.3E+06	6.0E+06	1.4E+06	1.3E+06	1.3E+06
CS-134	2.2E+10	3.1E+10	1.2E+10	6.9E+09	1.4E+10	9.6E+09	7.0E+09
CS-136	2.3E+08	3.5E+08	2.9E+08	1.5E+08	2.6E+08	1.7E+08	1.6E+08
CS-137	3.7E+10	3.6E+10	1.6E+10	1.3E+10	2.1E+10	1.6E+10	1.3E+10
CS-138	3.6E+05	3.6E+05	3.6E+05	3.6E+05	3.6E+05	3.6E+05	3.6E+05
BA-139	1.1E+05	1.1E+05	1.1E+05	1.1E+05	1.1E+05	1.1E+05	1.1E+05
BA-140	4.3E+08	1.7E+08	1.9E+08	1.7E+08	1.7E+08	1.7E+08	3.0E+08
BA-141	5.0E+04	5.0E+04	5.0E+04	5.0E+04	5.0E+04	5.0E+04	5.0E+04
BA-142	1.3E+05	1.3E+05	1.3E+05	1.3E+05	1.3E+05	1.3E+05	1.3E+05
LA-140	1.9E+07	1.9E+07	1.9E+07	1.9E+07	1.9E+07	1.9E+07	4.9E+07
LA-142	7.3E+05	7.3E+05	7.3E+05	7.3E+05	7.3E+05	7.3E+05	7.3E+05
CE-141	1.5E+07	1.4E+07	1.4E+07	1.4E+07	1.4E+07	1.4E+07	4.0E+08
CE-143	2.3E+06	3.2E+06	2.3E+06	2.3E+06	2.3E+06	2.3E+06	1.5E+07
CE-144	2.3E+08	1.5E+08	1.2E+08	1.1E+08	1.3E+08	1.1E+08	9.6E+09

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TABLE 3.5-9 (CONT'D)

<u>Nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
PR-143	1.4E+05	4.2E+04	6.2E+03	-	2.3E+04	-	1.5E+08
PR-144	1.8E+03	1.8E+03	1.8E+03	1.8E+03	1.8E+03	1.8E+03	1.8E+03
ND-147	8.5E+06	8.5E+06	8.4E+06	8.4E+06	8.4E+06	8.4E+06	9.5E+07
W-187	2.5E+06	2.4E+06	2.4E+06	2.4E+06	2.4E+06	2.4E+06	7.6E+06
NP-239	1.7E+06	1.7E+06	1.7E+06	1.7E+06	1.7E+06	1.7E+06	1.5E+07

(1) The dash (-) indicates insufficient data or that the dose factor is $<1.0E-20$.

TABLE 3.5-10

 P_{oij} CHILD INGESTION OF COW'S MILK DOSE RATE CONVERSION FACTORS
 $m^2(mrem/yr/\mu Ci/sec)$

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-ILLI
P-32	3.5E-03	-	3.9E-04	-	-	-	1.0E-04
Na-24	4.3E+06	4.3E+06	4.3E+06	4.3E+06	4.3E+06	4.3E+06	4.3E+06
P-32	3.7E+10	1.7E+09	1.4E+09	-	-	-	1.0E+09
CR-51	-(1)	-	4.6E+04	2.5E+04	7.0E+03	4.6E+04	2.4E+06
MN-54	-	1.1E+07	2.9E+06	-	3.0E+06	-	9.0E+06
MN-56	-	6.2E-03	1.4E-03	-	7.5E-03	-	9.0E-01
FE-55	5.8E+07	3.1E+07	9.5E+06	-	-	1.7E+07	5.7E+06
FE-59	5.4E+07	8.8E+07	4.4E+07	-	-	2.5E+07	9.1E+07
CO-58	-	5.6E+06	1.7E+07	-	-	-	3.3E+07
CO-60	-	2.3E+07	6.9E+07	-	-	-	1.3E+08
NI-63	1.8E+10	9.8E+08	6.2E+08	-	-	-	6.6E+07
NI-65	9.5E-01	8.9E-02	5.2E-02	-	-	-	1.1E+01
CU-64	-	3.7E+04	2.3E+04	-	9.1E+04	-	1.8E+06
ZN-65	2.4E+09	6.5E+09	4.1E+09	-	4.1E+09	-	1.1E+09
ZN-69M	2.5E+04	3.6E+04	3.3E+03	-	2.2E+04	-	2.2E+06
BR-83	-	-	2.3E-01	-	-	-	-
RB-86	-	4.0E+09	2.4E+09	-	-	-	2.5E+08
SR-89	3.0E+09	-	8.6E+07	-	-	-	1.2E+08
SR-90	6.6E+10	-	1.7E+10	-	-	-	8.9E+08
SR-91	6.2E+04	-	2.4E+03	-	-	-	1.4E+05
SR-92	1.1E+00	-	4.2E-02	-	-	-	2.0E+01
Y-90	1.5E+02	-	4.1E+00	-	-	-	4.4E+05
Y-91M	1.5E-19	-	-	-	-	-	2.9E-16
Y-91	1.8E+04	-	4.8E+02	-	-	-	2.4E+06
Y-92	1.2E-04	-	3.5E-06	-	-	-	1.4E+02
Y-93	5.1E-01	-	1.4E-02	-	-	-	7.6E+03
ZR-95	1.8E+03	3.9E+02	3.5E+02	-	5.6E+02	-	4.1E+05
ZR-97	9.0E-01	1.3E-01	7.7E-02	-	1.9E-01	-	2.0E+04

SNPS-1 ODCM

TABLE 3.5-10 (CONT'D)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
NB-95	1.4E+05	5.5E+04	3.9E+04	-	5.2E+04	-	1.0E+08
MO-99	-	3.9E+07	9.7E+06	-	8.4E+07	-	3.2E+07
TC-99M	6.5E+00	1.3E+01	2.1E+02	-	1.8E+02	6.4E+00	7.2E+03
RU-103	1.9E+03	-	7.4E+02	-	4.8E+03	-	5.0E+04
RU-105	1.9E-03	-	6.8E-04	-	1.6E-02	-	1.2E+00
RU-106	4.9E+04	-	6.1E+03	-	6.6E+04	-	7.6E+05
AG-110M	1.1E+08	7.6E+07	6.1E+07	-	1.4E+08	-	9.0E+09
SB-124	1.3E+07	2.4E+05	5.0E+06	3.0E+04	-	9.8E+06	3.6E+08
TE-125M	3.8E+07	1.0E+07	5.1E+06	1.1E+07	-	-	3.7E+07
TE-127M	1.3E+08	3.4E+07	1.5E+07	3.0E+07	3.6E+08	-	1.0E+08
TE-127	1.5E+03	4.0E+02	3.2E+02	1.0E+03	4.5E+03	-	5.8E+04
TE-129M	1.3E+08	3.6E+07	2.0E+07	4.2E+07	3.8E+08	-	1.6E+08
TE-129	7.8E-10	2.2E-10	1.8E-10	5.5E-10	2.3E-09	-	4.8E-08
TE-131M	7.9E+05	2.7E+05	2.9E+05	5.6E+05	2.6E+06	-	1.1E+07
TE-132	5.0E+06	2.2E+06	2.7E+06	3.2E+06	2.1E+07	-	2.2E+07
I-130	4.2E+05	8.6E+05	4.4E+05	9.4E+07	1.2E+06	-	4.0E+05
I-131	3.1E+08	3.1E+08	1.8E+08	1.0E+11	5.1E+08	-	2.7E+07
I-132	1.6E-01	2.8E-01	1.3E-01	1.3E+01	4.4E-01	-	3.4E-01
I-133	4.1E+06	5.1E+06	1.9E+06	9.5E+08	8.5E+06	-	2.1E+06
I-134	2.0E-12	3.7E-12	1.7E-12	8.5E-11	5.7E-12	-	2.5E-12
I-135	1.3E+04	2.3E+04	1.1E+04	2.1E+06	3.6E+04	-	1.8E+04
CS-134	1.2E+10	1.9E+10	4.1E+09	-	6.0E+09	2.2E+09	1.0E+08
CS-136	4.6E+08	1.3E+09	8.2E+08	-	6.7E+08	1.0E+08	4.4E+07
CS-137	1.8E+10	1.7E+10	2.6E+09	-	5.7E+09	2.0E+09	1.1E+08
BA-139	1.1E-07	5.7E-11	3.1E-09	-	5.0E-11	3.4E-11	6.2E-06
BA-140	5.4E+07	4.7E+04	3.1E+06	-	1.5E+04	2.8E+04	2.7E+07
LA-140	9.4E+00	3.3E+00	1.0E+00	-	-	-	9.1E+04
LA-142	2.0E-11	6.3E-12	2.0E-12	-	-	-	1.2E-06
CE-141	5.7E+03	4.8E+03	7.2E+02	-	2.1E+03	-	6.0E+06
CE-143	9.0E+01	4.9E+04	7.1E+00	-	2.1E+01	-	7.2E+05
CE-144	8.2E+05	2.6E+05	4.4E+04	-	1.4E+05	-	6.7E+07
PR-143	3.3E+02	9.8E+01	1.6E+01	-	5.3E+01	-	3.5E+05

SNPS-1 ODCM

TABLE 3.5-10 (CONT'D)

<u>Nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
ND-147	2.1E+02	1.7E+02	1.3E+01	-	9.1E+01	-	2.6E+05
W-187	1.4E+04	8.3E+03	3.7E+03	-	-	-	1.2E+06
NP-239	8.3E+00	6.0E-01	4.2E-01	-	1.7E+00	-	4.4E+04

(1) The dash (-) indicates insufficient data or that the dose factor is $<1.0E-20$.

TABLE 3.5-11

 P_{ij} CHILD INGESTION OF GOAT'S MILK DOSE RATE CONVERSION FACTORS
 m^2 (mrem/yr/ μ Ci/sec)

Nuclide	Bone	Liver	T. Body	thyroid	Kidney	Lung	GI-LLI
F-18	3.0E-04	-	3.3E-05	-	-	-	8.8E-06
NA-24	5.2E+05	5.2E+05	5.2E+05	5.2E+05	5.2E+05	5.2E+05	5.2E+05
P-32	4.4E+10	2.1E+09	1.7E+09	-	-	-	1.2E+09
CR-51	-(1)	-	5.5E+03	3.1E+03	8.3E+02	5.6E+03	2.9E+05
MN-54	-	1.3E+06	3.4E+05	-	3.6E+05	-	1.1E+06
MN-56	-	7.5E-04	1.7E-04	-	9.0E-04	-	1.1E-01
FE-55	7.5E+05	4.0E+05	1.2E+05	-	-	2.3E+05	7.4E+04
FE-59	7.0E+05	1.1E+06	5.7E+05	-	-	3.3E+05	1.2E+06
CO-58	-	6.8E+05	2.1E+06	-	-	-	3.9E+06
CO-60	-	2.8E+06	8.2E+06	-	-	-	1.5E+07
NI-63	2.2E+09	1.2E+08	7.4E+07	-	-	-	7.9E+06
NI-65	1.1E-01	1.1E-02	6.2E-03	-	-	-	1.3E+00
CU-64	-	4.2E+03	2.5E+03	-	1.0E+04	-	2.0E+05
ZN-65	2.9E+08	7.8E+08	4.9E+08	-	4.9E+08	-	1.4E+08
ZN-69M	3.0E+03	4.3E+03	3.9E+02	-	2.6E+03	-	2.7E+05
BR-83	-	-	2.8E-02	-	-	-	-
RB-86	-	4.7E+08	2.9E+08	-	-	-	3.1E+07
SR-89	6.3E+09	-	1.8E+08	-	-	-	2.4E+08
SR-90	1.4E+11	-	3.5E+10	-	-	-	1.9E+09
SR-91	1.3E+05	-	4.9E+03	-	-	-	2.9E+05
SR-92	2.2E+00	-	8.9E-02	-	-	-	4.2E+01
Y-90	1.9E+01	-	5.0E-01	-	-	-	5.3E+04
Y-91M	1.8E-20	-	-	-	-	-	3.4E-17
Y-91	2.1E+03	-	5.7E+01	-	-	-	2.9E+05
Y-92	1.5E-05	-	4.2E-07	-	-	-	1.7E+01
Y-93	6.1E-02	-	1.7E-03	-	-	-	9.1E+02
ZR-95	2.1E+02	4.7E+01	4.2E+01	-	6.7E+01	-	4.9E+04
ZR-97	1.1E-01	1.6E-02	9.2E-03	-	2.2E-02	-	2.4E+03

TABLE 3.5-11 (CONT'D)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
NB-95	1.7E+04	6.6E+03	4.7E+03	-	6.2E+03	-	1.2E+07
MO-99	-	4.7E+06	1.2E+06	-	1.0E+07	-	3.9E+06
TC-99M	8.1E-01	1.6E+00	2.6E+01	-	2.3E+01	8.0E-01	9.0E+02
RU-103	2.3E+02	-	8.9E+01	-	5.8E+02	-	6.0E+03
RU-105	2.2E-04	-	8.1E-05	-	2.0E-03	-	1.5E-01
RU-106	5.8E+03	-	7.3E+02	-	7.9E+03	-	9.1E+04
AG-110M	1.3E+07	9.1E+06	7.3E+06	-	1.7E+07	-	1.1E+09
SR-124	1.5E+06	2.9E+04	6.0E+05	3.7E+03	-	1.2E+06	4.3E+07
TE-125M	4.6E+06	1.2E+06	6.1E+05	1.3E+06	-	-	4.4E+06
TE-127M	1.5E+07	4.1E+06	1.8E+06	3.6E+06	4.3E+07	-	1.2E+07
TE-127	1.8E+02	4.8E+01	3.8E+01	1.2E+02	5.1E+02	-	7.0E+03
TE-129M	1.6E+07	4.4E+06	2.4E+06	5.0E+06	4.6E+07	-	1.9E+07
TE-129	9.3E-11	2.6E-11	2.2E-11	6.6E-11	2.7E-10	-	5.8E-09
TE-131M	9.4E+04	3.3E+04	3.5E+04	6.7E+04	3.2E+05	-	1.3E+06
TE-132	6.0E+05	2.7E+05	3.2E+05	3.9E+05	2.5E+06	-	2.7E+06
I-130	5.1E+05	1.0E+06	5.3E+05	1.1E+08	1.5E+06	-	4.8E+05
I-131	3.7E+08	3.7E+08	2.1E+08	1.2E+11	6.1E+08	-	3.3E+07
I-132	1.9E-01	3.4E-01	1.6E-01	1.6E+01	5.2E-01	-	4.0E-01
I-133	5.0E+06	6.1E+06	2.3E+06	1.1E+09	1.0E+07	-	2.5E+06
I-134	2.4E-12	4.4E-12	2.0E-12	1.0E-10	6.8E-12	-	3.0E-12
I-135	1.6E+04	2.8E+04	1.3E+04	2.5E+06	4.3E+04	-	2.1E+04
CS-134	3.6E+10	5.8E+10	1.2E+10	-	1.8E+10	6.5E+09	3.1E+08
CS-136	1.4E+09	3.8E+09	2.5E+09	-	2.0E+09	3.0E+08	1.3E+08
CS-137	5.5E+10	5.2E+10	7.7E+09	-	1.7E+10	6.1E+09	3.3E+08
BA-139	1.3E-08	6.8E-12	3.7E-10	-	6.0E-12	4.0E-12	7.4E-07
BA-140	6.4E+06	5.6E+03	3.8E+05	-	1.8E+03	3.4E+03	3.3E+06
LA-140	1.1E+00	3.9E-01	1.2E-01	-	-	-	1.1E+04
LA-142	2.4E-12	7.5E-13	2.4E-13	-	-	-	1.5E-07
CE-141	7.0E+03	3.5E+03	5.2E+02	-	1.5E+03	-	4.4E+06
CE-143	6.5E+01	3.5E+04	5.1E+00	-	1.5E+01	-	5.2E+05
CE-144	5.9E+05	1.8E+05	3.7E+04	-	1.0E+05	-	4.8E+07
PR-143	3.9E+01	1.2E+01	1.9E+00	-	6.4E+00	-	4.2E+04

TABLE 3.5-11 (CONT'D)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-111
ND-147	2.5E+01	2.0E+01	1.5E+00	-	1.1E+01	-	3.2E+04
W-187	1.7E+03	1.0E+03	4.5E+02	-	-	-	1.4E+05
NP-239	1.0E+00	7.2E-02	5.1E-02	-	2.1E-01	-	5.3E+03

(1) The dash (-) indicates insufficient data or that the dose factor is $< 1.0E-20$.

TABLE 3.5-12

P_{oij}
CHILD INGESTION OF MEAT ϕ_{ij} RATE CONVERSION FACTORS
 m^2 (mrem/yr/ μ Ci/sec)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-ILLI
NA-24	9.5E-04	9.5E-04	9.5E-04	9.5E-04	9.5E-04	9.5E-04	9.5E-04
P-32	3.5E+09	1.7E+08	1.4E+08	-	-	-	9.8E+07
CR-51	-(1)	-	4.0E+03	2.2E+03	6.1E+02	4.1E+03	2.1E+05
MN-54	-	4.1E+06	1.1E+06	-	1.1E+06	-	3.4E+06
FE-55	2.4E+08	1.3E+08	3.9E+07	-	-	7.1E+07	2.3E+07
FE-59	1.7E+08	2.8E+08	1.4E+08	-	-	8.0E+07	2.9E+08
CO-58	-	7.6E+06	2.3E+07	-	-	-	4.5E+07
CO-60	-	3.7E+07	1.1E+08	-	-	-	2.1E+09
NI-63	1.8E+09	9.6E+07	6.1E+07	-	-	-	6.5E+06
CU-64	-	2.0E-07	1.2E-07	-	4.7E-07	-	9.2E-06
ZN-65	2.2E+08	5.9E+08	3.7E+08	-	3.7E+08	-	1.0E+08
ZN-69M	1.0E-06	1.5E-06	1.4E-07	-	9.0E-07	-	9.3E-05
RB-86	-	2.6E+08	1.6E+08	-	-	-	1.7E+07
SR-89	2.2E+08	-	6.2E+06	-	-	-	8.5E+06
SR-90	6.2E+09	-	1.6E+09	-	-	-	8.3E+07
SR-91	1.1E-10	-	4.2E-12	-	-	-	2.5E-10
Y-90	8.3E+01	-	2.2E+06	-	-	-	2.4E+05
Y-91	8.2E+05	-	2.2E+04	-	-	-	1.1E+08
Y-93	5.1E-12	-	1.4E-13	-	-	-	7.6E-08
ZR-95	1.2E+06	2.7E+05	2.4E+05	-	3.9E+05	-	2.8E+08
ZR-97	1.3E-05	1.9E-06	1.1E-06	-	2.7E-06	-	2.8E-01

TABLE 3.5-12 (CONT'D)

<u>Nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
NB-95	1.4E+06	5.4E+05	3.8E+05	-	5.0E+05	-	9.9E+08
MO-99	-	5.6E+04	1.4E+04	-	1.2E+05	-	4.6E+04
TC-99M	-	-	1.1E-19	-	-	-	3.8E-18
RU-103	7.0E+07	-	2.7E+07	-	1.8E+08	-	1.8E+09
RU-106	2.3E+09	-	2.9E+08	-	3.2E+09	-	3.6E+10
AG-110M	4.5E+06	3.0E+06	2.4E+06	-	5.7E+06	-	3.6E+08
SB-124	3.4E+06	6.4E+04	1.3E+06	8.2E+03	-	2.6E+06	9.6E+07
TE-125M	3.0E+08	8.0E+07	3.9E+07	8.3E+07	-	-	2.9E+08
TE-127M	1.1E+09	2.9E+08	1.3E+08	2.6E+08	3.1E+09	-	8.7E+08
TE-127	2.0E-10	5.5E-11	4.4E-11	1.4E-10	5.8E-10	-	8.0E-09
TE-129M	8.6E+08	2.4E+08	1.3E+08	2.8E+08	2.5E+09	-	1.0E+09
TE-131M	3.5E+02	1.2E+02	1.3E+02	2.5E+02	.12E+03	-	4.9E+03
TL-132	1.0E+06	4.6E+05	5.5E+05	6.6E+05	4.2E+06	-	4.6E+06
I-130	8.7E-07	1.7E-06	9.0E-07	1.9E-04	2.6E-06	-	8.2E-07
I-131	3.9E+06	3.9E+06	2.2E+06	1.3E+09	6.4E+06	-	3.5E+05
I-133	1.4E-01	1.7E-01	6.6E-02	3.2E+01	2.9E-01	-	7.0E-02
I-135	1.6E-17	2.8E-17	1.3E-17	2.5E-15	4.3E-17	-	2.1E-17
CS-134	4.8E+08	7.9E+08	1.7E+08	-	2.5E+08	8.8E+07	4.3E+06
CS-136	7.3E+06	2.0E+07	1.3E+07	-	1.1E+07	1.6E+06	7.0E+05
CS-137	7.5E+08	7.2E+08	1.1E+08	-	2.4E+08	8.5E+07	4.5E+06
BA-139	-	-	-	-	-	-	-
BA-140	2.0E+07	1.8E+04	1.2E+06	-	5.7E+03	1.0E+04	1.0E+07
LA-140	2.8E-02	9.6E-03	3.0E-03	-	-	-	2.7E+02
CE-141	9.9E+03	4.9E+03	7.3E+02	-	2.2E+03	-	6.1E+06
CE-143	1.5E-02	8.4E+00	1.2E-03	-	3.5E-03	-	1.2E+02
CE-144	1.2E+06	3.7E+05	6.2E+04	-	2.0E+05	-	9.5E+07
PR-143	1.5E+04	4.6E+03	7.6E+02	-	2.5E+03	-	1.6E+07

TABLE 3.5-12 (CONT'D)

<u>Nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
ND-147	5.4E+03	4.4E+03	3.4E+02	-	2.4E+03	-	6.9E+06
W-187	1.6E-02	9.7E-03	4.4E-03	-	-	-	1.4E+00
NP-239	2.1E-01	1.5E-02	1.1E-02	-	4.4E-02	-	1.1E+03

(1) The dash (-) indicates insufficient data or that the dose factor is $<1.0E-20$.

TABLE 3.5-13

P_{oij}
INFANT INGESTION OF COW'S MILK DOSE RATE CONVERSION FACTORS
 m^2 (mrem/yr/ $\mu Ci/sec$)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
F-16	3.5E-03	-	3.9E-04	-	-	-	1.0E-04
NA-24	7.5E+06	7.5E+06	7.5E+06	7.5E+06	7.5E+06	7.5E+06	7.5E+06
P-32	7.6E+10	4.5E+09	2.9E+09	-	-	-	1.0E+09
CR-51	-(1)	-	7.3E+04	4.7E+04	1.0E+04	9.2E+04	2.1E+06
MN-54	-	2.0E+07	4.5E+06	-	4.4E+06	-	7.3E+06
MN-56	-	1.5E-02	2.6E-03	-	1.3E-02	-	1.4E+00
FE-55	7.0E+07	4.5E+07	1.2E+07	-	-	-	5.8E+06
FE-59	1.0E+08	1.8E+08	7.0E+07	-	-	2.2E+07	8.4E+07
CO-58	-	1.1E+07	2.8E+07	-	-	5.2E+07	2.8E+07
CO-60	-	4.8E+07	1.1E+08	-	-	-	1.1E+08
NI-63	2.1E+10	1.3E+09	7.5E+08	-	-	-	6.6E+07
NI-65	2.0E+00	2.3E-01	1.0E-01	-	-	-	1.7E+01
CU-64	-	9.3E+04	4.3E+04	-	1.6E+05	-	1.9E+06
ZN-65	3.3E+09	1.1E+10	5.2E+09	-	5.5E+09	-	9.5E+09
ZN-69M	5.2E+04	9.4E+04	7.0E+03	-	3.9E+04	-	7.7E+06
BR-83	-	-	4.9E-01	-	-	-	-
RB-86	-	1.0E+10	5.0E+09	-	-	-	2.6E+08
SR-89	5.7E+09	-	1.6E+08	-	-	-	1.2E+08
SR-90	7.2E+10	-	1.8E+10	-	-	-	9.0E+08
SR-91	1.3E+05	-	4.7E+03	-	-	-	1.5E+05
SR-92	2.2E+00	-	8.3E-02	-	-	-	2.4E+01
Y-90	3.3E+02	-	8.8E+00	-	-	-	4.5E+05
Y-91M	3.1E-19	-	1.1E-20	-	-	-	1.0E-15
Y-91	3.3E+04	-	8.9E+02	-	-	-	2.4E+06
Y-92	2.6E-04	-	7.3E-06	-	-	-	4.9E+00
Y-93	1.1E+00	-	2.9E-02	-	-	-	8.6E+03
ZR-95	3.1E+03	7.7E+02	5.4E+02	-	8.3E+02	-	3.8E+05

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TABLE 3.5-13 (CONT'D)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
ZR-97	1.9E+00	3.3E-01	1.5E-01	-	3.3E-01	-	2.1E+04
NB-95	2.6E+05	1.1E+05	6.3E+04	-	7.8E+04	-	9.2E+07
MO-99	-	1.0E+08	2.0E+07	-	1.5E+08	-	3.3E+07
TC-99M	1.3E+01	2.8E+01	3.6E+02	-	3.0E+02	1.5E+01	8.1E+03
RU-103	3.9E+03	-	1.3E+03	-	8.1E+03	-	4.7E+04
RU-105	3.9E-03	-	1.3E-03	-	2.9E-03	-	1.6E+00
RU-106	1.0E+05	-	1.3E+04	-	1.2E+05	-	7.6E+05
AG-110M	2.1E+08	1.5E+08	1.0E+08	-	2.2E+08	-	7.8E+09
SB-124	1.3E+07	2.4E+05	5.0E+06	3.0E+04	-	9.8E+06	3.6E+08
TE-125M	7.8E+07	2.6E+07	1.1E+07	2.6E+07	-	-	3.7E+07
TE-127M	2.5E+08	8.4E+07	3.1E+07	7.3E+07	6.3E+08	-	1.0E+08
TE-127	3.2E+03	1.1E+03	6.8E+02	2.6E+03	7.7E+03	-	6.7E+04
TE-129M	2.7E+08	9.2E+07	4.1E+07	1.0E+08	6.7E+08	-	1.6E+08
TE-129	1.6E-09	5.7E-10	3.8E-10	1.4E-09	4.1E-09	-	1.3E-07
TE-131M	1.7E+06	6.7E+05	5.5E+05	1.4E+06	4.6E+06	-	1.1E+07
TE-132	1.0E+07	5.1E+06	4.8E+06	7.5E+06	3.7E+07	-	1.9E+07
I-130	8.7E+05	1.9E+06	7.7E+05	2.2E+08	2.1E+06	-	4.1E+05
I-131	6.4E+08	7.5E+08	3.3E+08	2.5E+11	8.8E+08	-	2.7E+07
I-132	3.2E-01	6.5E-01	2.3E-01	3.1E+01	7.3E-01	-	5.3E-01
I-133	8.7E+06	1.3E+07	3.7E+06	2.3E+09	1.5E+07	-	2.2E+06
I-134	4.1E-12	8.5E-12	3.0E-12	2.0E-10	9.5E-12	-	8.8E-12
I-135	2.7E+04	5.4E+04	2.0E+04	4.8E+06	6.0E+04	-	1.9E+04
CS-134	1.9E+10	3.6E+10	3.6E+09	-	9.2E+09	3.8E+09	9.7E+07
CS-136	9.0E+08	2.6E+09	9.9E+08	-	1.1E+09	2.2E+08	4.0E+07
CS-137	2.9E+10	3.4E+10	2.4E+09	-	9.1E+09	3.7E+09	1.1E+08
BA-139	2.3E-07	1.5E-10	6.6E-09	-	9.1E-11	9.1E-11	1.4E-05
BA-140	1.1E+08	1.1E+05	5.7E+06	-	2.6E+04	6.8E+04	2.7E+07
LA-140	2.0E+01	7.7E+00	2.0E+00	-	-	-	9.1E+04
LA-142	4.1E-11	1.5E-11	3.6E-12	-	-	-	2.6E-06
CE-141	1.9E+04	1.2E+04	1.4E+03	-	3.6E+03	-	6.1E+06
CE-143	1.9E+02	1.3E+05	1.4E+01	-	3.7E+01	-	7.4E+05
CE-144	1.2E+06	4.8E+05	6.6E+04	-	1.9E+05	-	6.7E+07
PR-143	6.8E+02	2.5E+02	3.4E+01	-	9.4E+01	-	3.6E+05

TABLE 3.5-13 (CONT'D)

<u>Nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
ND-147	4.1E+02	4.2E+02	2.6E+01	-	1.6E+02	-	2.6E+05
W-187	2.9E+04	2.1E+04	7.1E+03	-	-	-	1.2E+06
NP-239	1.8E+01	1.6E+00	8.9E-01	-	3.1E+00	-	4.6E+04

(1) The dash (-) indicates insufficient data or that the dose factor is $<1.0E-20$.

TABLE 3.5-14

P_{eij}

INFANT INGESTION OF GOAT'S MILK DOSE RATE CONVERSION FACTORS
m² (mrem/yr/ μ Ci/sec)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
F-18	3.0E-04	-	3.3E-05	-	-	-	8.8E-06
NA-24	9.1E+05	9.1E+05	9.1E+05	9.1E+05	9.1E+05	9.1E+05	9.1E+05
P-32	9.1E+10	5.4E+09	3.5E+09	-	-	-	1.2E+09
CR-51	-(1)	-	8.7E+03	5.7E+03	1.2E+03	1.1E+04	2.5E+05
MN-54	-	2.4E+06	5.4E+05	-	5.3E+05	-	8.8E+05
MN-56	-	1.8E-03	3.1E-04	-	1.6E-03	-	1.7E-01
FE-55	9.1E+05	5.9E+05	1.6E+05	-	-	2.9E+05	7.5E+04
FE-59	1.3E+06	2.3E+06	9.1E+05	-	-	6.8E+05	1.1E+06
CO-58	-	1.4E+06	3.4E+06	-	-	-	3.4E+06
CO-60	-	5.7E+06	1.3E+07	-	-	-	1.4E+07
NI-63	2.6E+09	1.6E+08	8.9E+07	-	-	-	7.9E+06
NI-65	2.4E-01	2.7E-02	1.2E-02	-	-	-	2.1E+00
CU-64	-	1.0E+04	4.8E+03	-	1.8E+04	-	2.1E+05
ZN-65	3.9E+08	1.4E+09	6.2E+08	-	6.6E+08	-	1.1E+09
ZN-69M	6.3E+03	1.1E+04	8.4E+02	-	4.7E+03	-	9.2E+05
BR-83	-	-	5.8E-02	-	-	-	-
RB-86	-	1.2E+09	6.0E+08	-	-	-	3.1E+07
SR-89	1.2E+10	-	3.4E+08	-	-	-	2.5E+08
SR-90	1.5E+11	-	3.9E+10	-	-	-	1.9E+09
SR-91	2.7E+05	-	9.9E+03	-	-	-	3.2E+05
SR-92	4.7E+00	-	1.7E-01	-	-	-	5.1E+01
Y-90	3.9E+01	-	1.1E+00	-	-	-	5.4E+04
Y-91M	3.7E-20	-	-	-	-	-	1.2E-16
Y-91	4.0E+03	-	1.1E+02	-	-	-	2.9E+05
Y-92	3.1E-05	-	8.7E-07	-	-	-	5.9E-01
Y-93	1.3E-01	-	3.5E-03	-	-	-	1.0E+03
ZR-95	3.8E+02	9.2E+01	6.5E+01	-	9.9E+01	-	4.6E+04
ZR-97	2.3E-01	3.9E-02	1.8E-02	-	4.0E-02	-	2.5E+03

TABLE 3.5-14 (CONT'D)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
NB-95	3.2E+04	1.3E+04	7.5E+03	-	9.4E+03	-	1.1E+07
MO-99	-	1.2E+07	2.3E+06	-	1.8E+07	-	4.0E+06
TC-99M	1.7E+00	3.5E+00	4.5E+01	-	3.7E+01	1.8E+00	1.0E+03
RU-103	4.7E+02	-	1.6E+02	-	9.7E+02	-	5.7E+03
RU-105	4.7E-04	-	1.6E-04	-	3.5E-03	-	1.9E-01
RU-106	1.2E+04	-	1.5E+03	-	1.4E+04	-	9.1E+04
AG-110M	2.5E+07	1.8E+07	1.2E+07	-	2.6E+07	-	9.4E+08
SB-124	1.5E+06	2.9E+04	6.0E+05	3.7E+03	-	1.2E+06	4.3E+07
TE-125M	9.4E+06	3.1E+06	1.3E+06	3.2E+06	-	-	4.5E+06
TE-127M	3.0E+07	1.0E+07	3.7E+06	8.8E+06	7.5E+07	-	1.2E+07
TE-127	3.8E+02	1.3E+02	8.2E+01	3.1E+02	6.3E+02	-	8.0E+03
TE-129M	3.2E+07	1.1E+07	4.9E+06	1.2E+07	8.0E+07	-	1.9E+07
TE-129	2.0E-10	6.8E-11	4.6E-11	1.7E-10	4.9E-10	-	1.6E-08
TE-131M	2.0E+05	8.0E+04	6.6E+04	1.6E+05	5.5E+05	-	1.3E+06
TE-132	1.2E+06	6.1E+05	5.7E+05	9.1E+05	3.8E+06	-	2.3E+06
I-130	1.0E+06	2.3E+06	9.2E+05	2.6E+08	2.5E+06	-	4.9E+05
I-131	7.7E+08	9.0E+08	4.0E+08	3.0E+11	1.1E+09	-	3.2E+07
I-132	3.9E-01	7.8E-01	2.8E-01	3.7E+01	8.7E-01	-	6.3E-01
I-133	1.0E+07	1.5E+07	4.5E+06	2.8E+09	1.8E+07	-	2.6E+06
I-134	5.0E-12	1.0E-11	3.6E-12	2.4E-10	1.1E-11	-	1.1E-11
I-135	3.2E+04	6.4E+04	2.3E+04	5.8E+06	7.2E+04	-	2.3E+04
CS-134	5.7E+10	1.1E+11	1.1E+10	-	2.8E+10	1.1E+10	2.9E+08
CS-136	2.7E+09	7.9E+09	3.0E+09	-	3.2E+09	6.5E+08	1.2E+08
CS-137	8.7E+10	1.0E+11	7.2E+09	-	2.7E+10	1.1E+10	3.2E+08
BA-139	2.7E-08	1.8E-11	7.9E-10	-	1.1E-11	1.1E-11	1.7E-06
BA-140	1.3E+07	1.3E+04	6.8E+05	-	3.1E+03	8.1E+03	3.3E+06
LA-140	2.3E+00	9.3E-01	2.4E-01	-	-	-	1.1E+04
LA-142	5.0E-12	1.8E-12	4.4E-13	-	-	-	3.1E-07
CE-141	1.4E+04	8.5E+03	1.0E+03	-	2.6E+03	-	4.4E+06
CE-143	1.4E+02	9.1E+04	1.0E+01	-	2.7E+01	-	5.3E+05
CE-144	8.4E+05	3.5E+05	4.7E+04	-	1.4E+05	-	4.8E+07

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TABLE 3.5-14 (CONT'D)

<u>Nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
PR-143	8.1E+01	3.0E+01	4.0E+00	-	1.1E+01	-	4.3E+04
ND-147	4.9E+01	5.0E+01	3.1E+00	-	1.9E+01	-	3.2E+04
W-187	3.5E+03	2.5E+03	8.5E+02	-	-	-	1.4E+05
NP-239	2.1E+00	1.9E-01	1.1E-01	-	3.8E-01	-	5.5E+03

(1) The dash (-) indicates insufficient data or that the dose factor is $1.0E-20$.

TABLE 3.5-15

 P_{ij} CHILD INHALATION AND INGESTION OF LEAFY AND STORED VEGETABLES DOSE RATE CONVERSION FACTORS
(mrem per pCi)

<u>Nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
H-3	-	1.4E-6	1.4E-6	1.4E-6	1.4E-6	1.4E-6	1.4E-6
C-14*	9.6E-4	1.9E-4	1.9E-4	1.9E-4	1.9E-4	1.9E-4	1.9E-4

Note:

- * For short term releases such as from air removal pump or from containment drywell purge vent C-14 values should be multiplied by 2.

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TABLE 3.5-16

P_{ij}

CHILD INGESTION OF GOAT'S MILK DOSE RATE CONVERSION FACTORS
(mrem per pCi)

<u>Nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
H-3	-	8.6E-7	8.6E-7	8.6E-7	8.6E-7	8.6E-7	8.6E-7
C-14*	4.7E-4	8.9E-5	8.9E-5	8.9E-5	8.9E-5	8.9E-5	8.9E-5

*See Note in Table 3.5-15

TABLE 3.5-17

 P_{ij}

INFANT INGESTION OF GOAT'S MILK DOSE RATE CONVERSION FACTORS
(mrem per pCi)

<u>Nuclide</u>	<u>Bone</u>	<u>Liver</u>	<u>T. Body</u>	<u>Thyroid</u>	<u>Kidney</u>	<u>Lung</u>	<u>GI-LLI</u>
H-3	-	3.5E-12	3.5E-12	3.5E-12	3.5E-12	3.5E-12	3.5E-12
C-14*	2.4E-9	4.9E-10	4.9E-10	4.9E-10	4.9E-10	4.9E-10	4.9E-10

Note:

*For the short term releases such as from air removal pump or from containment drywell purge vent, C-14 values should be multiplied by 2.

3.6 OPERATION OF VENTILATION EXHAUST TREATMENT SYSTEM

The Ventilation Exhaust Treatment System (see Figure 3.6-1) shall be used to reduce radioactive materials in gaseous waste prior to their discharge as specified in REC Section 3.11.2.5. The dose analysis will be performed as described in Sections 3.5.1 or 3.5.2. If the calculated doses exceed the limits specified above consult REC Section 3.11.2.5.

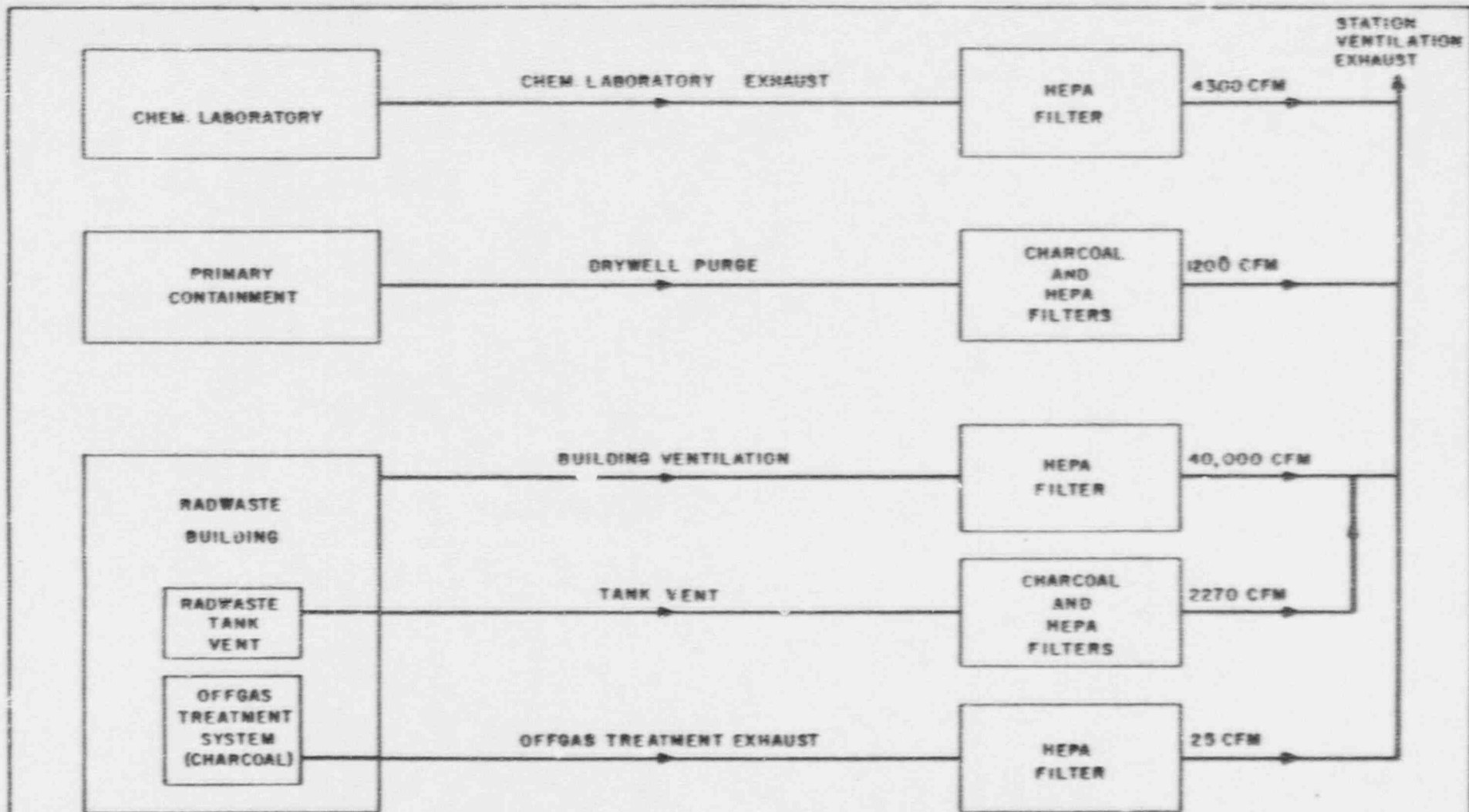


FIGURE 3.6-1
 VENTILATION EXHAUST
 TREATMENT SYSTEM
 SHOREHAM NUCLEAR POWER STATION - UNIT-1
 OFFSITE DOSE CALCULATION MANUAL

3.7 TOTAL DOSE FOR THE URANIUM FUEL CYCLE

To comply with Section 3.11.4 of the REC which implements 40CFR190, radiation doses shall be limited as follows:

The dose or dose commitment to a member of the public, due to releases of radioactivity and radiation, from uranium fuel cycle sources shall be limited to 25 mrem, or less, to the total body and/or any organ (except the thyroid, which shall be limited to 75 mrem, or less), over any 12 consecutive months.

3.7.1 Sources of Radiation and Radioactivity

The uranium fuel cycle is defined in 40CFR190 to include:

- a. operations of milling of uranium ore,
- b. chemical conversion of uranium,
- c. isotopic enrichment of uranium,
- d. fabrication of uranium fuel,
- e. generation of electricity by a nuclear power plant using uranium fuel, and
- f. reprocessing of spent uranium fuel.

The maximum individual doses due to each of the processing facilities for items a, b, c, d, and f above are required to be less than 10CFR20 limits. Therefore, the dose contribution to any person living in the Shoreham service area due to the above facilities, which are all more than 125 kilometers distance away, is expected to be negligible compared to 40CFR190 limits.

The only radiological source of concern will be due to item e above. The nearest nuclear power plant using uranium fuel is more than 75 kilometers away.

3.7.2 Radiological Impact of Generation of Electricity

The generation of electricity using a nuclear power plant results in radioactivity released in gaseous and liquid effluents. The dose rate assessment of these is done in Section 3.3. The radiological impact of direct radiation (including skyshine) from the plant can be determined by measurement. The direct radiation measuring devices (TLD systems) are provided by the Radiological Environmental Monitoring Program (REMP) and are listed in Tables 5-1 and 5-4.

Dose registered by the TLDs will be added to the doses calculated in Sections 3.1.1 (Dose From Liquid Effluent) and 3.5.1 (dose to maximum individual due to inhalation and ingestion from gaseous effluents) to determine the total body dose due to all sources of radiation in the uranium fuel cycle.

SECTION 4

METEOROLOGICAL AND HYDROLOGICAL PARAMETERS UTILIZED
IN THE CALCULATION OF DOSES

4.1 INTRODUCTION

This section specifies the liquid pathway dilution factor and the dispersion and deposition factors utilized for atmospheric releases. A description is given of the meteorological methodology and parameters utilized in the computerized method for atmospheric release. Critical locations for receptors and their respective dispersion and deposition factors are provided for the backup method for atmospheric releases.

For liquid effluent pathways a calculated dilution factor of 8.85 is used if circulation water is utilized. If service water is in use the dilution factor is one (1.0).

4.2 PARAMETERS AND METHODOLOGY USED IN THE COMPUTERIZED METHOD

4.2.1 Meteorological Data

Hourly average values (based upon 60 one-minute values) of temperature, wind speed, wind direction and temperature difference from the 33- and 150-ft levels of the Shoreham meteorological towers are used in the computerized method, to determine χ/Q and D/Q values at the locations given in Table 3.5.-8.

4.2.2 Long-Term χ/Q and D/Q Values

Sector-average atmospheric concentration dispersion factors $(\chi/Q)^{SA}$, gamma dispersion factors $(\chi/Q)^{SA}$ and relative deposition factors (D/Q) are calculated every hour using 60 one-minute meteorological data values obtained from the meteorological towers. The methodology utilized is described in the report "Shoreham Nuclear Power Station EMSP Software (Rev. B.1)" (Entech Engineering Inc., P104-R3, Section 2.0, July 1983, by J. N. Hamawi). General site specific data values that may be required for the calculation of dispersion parameters are given in Table 4-2.

The basic methodology used to obtain the $(\chi/Q)^{SA}$ and D/Q values is the straight-line trajectory model with Gaussian dispersion described in Regulatory Guide 1.111, Rev. 1. The list of selected options and variations from the Regulatory Guide is as follows:

- (a) Plume depletion due to dry and wet depositions, as well as to enroute radioactive decay is conservatively ignored.

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- (b) Plume recirculation is accounted for by making use of the conservative open-terrain recirculation correction factors in Revision 0 of Reg. Guide 1.111, which are also used in the XQDDQ computer code (NUREG/CR-2919, August 1982).
- (c) The atmospheric dispersion equations employed include terms to account for the plume eddy reflections between the ground and an inversion layer aloft. The reflection model was based on Turner's 'Workbook of Atmospheric Dispersion Estimates', (USEPA, Publication AP-26, 1970) and has the additional capability of predicting the entire range of effects from no reflection to the attainment of uniform vertical concentration resulting from multiple reflections.
- (d) According to Regulatory Guide 1.111, Rev. 1, effluents can be considered to be ground-level releases, elevated releases, or mixed-mode releases depending on (a) the elevation of the release point above grade relative to the height of adjacent buildings, and (b) the effluent exit velocity relative to the speed of the prevailing wind during the period of interest. At the Shoreham station, vent releases are assumed to be either at ground level or totally elevated. Conditions leading to a mixed mode release under Regulatory Guide 1.111, Rev. 1 criteria are conservatively assumed to result in a ground level release in the computerized method.
- (e) The wind speed at the release height is computed by subjecting the wind speed measured at the upper instrument level of the meteorological tower to the height-dependent wind speed relationship in the XQDDQ computer code (NUREG/CR-2919, August 1982); the same relationship is used to replace missing wind speed data at either the lower or upper instrument levels of the meteorological towers.
- (f) Sector-average $(\chi/Q)^{SA}$ values are not permitted to exceed the plume centerline values corresponding to the same atmospheric conditions, plume centerline values are computed using the equations in Regulatory Guide 1.145 Rev. 1 for non-meandering plumes, and the recirculation factor described in item (b) above.
- (g) Vertical plume standard deviations for Pasquill stability G($\sigma_z(G)$) are computed using the relationship between the stability classes F and G given in Reg. Guide 1.145. All σ_z values are limited to a maximum value of 1000 m.

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- (ii) Site specific, sector-and distance-dependent terrain heights are employed in connection with elevated releases. These terrain heights (as given in Table 3.5-8) represent the maximum heights between the release point and the locations where the concentrations are being calculated, in accordance with Regulatory Guide 1.111 Rev. 1.
- (1) Relative deposition factors (D/Q) are calculated using the relative deposition rates given in Regulatory Guide 1.111 Rev. 1 in graphical form; the height-dependent curves in the guide are used as follows:

<u>Calculated Effective Height Range (m)</u>	<u>Applicability Regulatory Guide 1.111 Rev. 1 Curve</u>
0 - 15	Ground-level releases
15 - 45	30-m releases
45 - 80	60-m releases
>80	100-m releases

In addition to the atmospheric dispersion factors, the computerized method also computes certain "effective gamma dispersion factors" $(X/Q)^{SA}$ which permit evaluation of external air and whole body doses from finite clouds of multi-energetic gamma sources. The basic definition of the X/Q^{SA} was derived by expressing the finite-cloud dose rate equations in Regulatory Guide 1.109 in a form identical to the standard dose rate equation for semi-infinite clouds. It includes the I function of Appendix F of Regulatory Guide 1.109, and for large plume standard deviations its numerical value reduces to that of the standard X/Q . The gamma spectrum is representative of the actual nuclide mix in the effluent. The finite cloud model is employed for both ground-level and elevated releases. Recirculation correction and inversion layer reflection are accounted for, and sector-average finite cloud values are not allowed to exceed corresponding plume center-line values computed in accordance with the three-dimensional Gaussian puff model described by Slade ('Meteorology and Atomic Energy 1968', USAEC TID-24190, 1968, Sec. 7-5.2.2).

4.3 PARAMETERS AND METHODOLOGY USED IN THE BACKUP METHOD

For gaseous effluent pathways, Table 4-1 lists the critical locations for receptors and their respective dispersion and deposition factors. The atmospheric dispersion and deposition factors were calculated utilizing Shoreham onsite meteorological data for the 2-year period of October 1, 1973 through September 30, 1975, Regulatory Guide 1.111 Rev. 0, March 1976, and Rev. 1, July 1977. Several X/Q values were obtained from the Final Environmental Statement, NUREG-0285, dated October 1977, docket No. 50-322 (See Table 4-1).

TABLE 4-1

CRITICAL RECEPTOR LOCATIONS FOR GASEOUS EFFLUENT CALCULATIONS

	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
Technical Specification Section	3.11.2.1	3.11.2.2	3.11.2.3	3.11.2.5
Sections in this Manual Limiting Criteria	3.3 Instantaneous Dose Rate to Whole Body and Skin due to Noble Gas and dose to any organ due to radionuclides other than Noble Gas	3.4 Quarterly and Annual Air Doses due to Gamma and Beta radiation	3.5 Quarterly and Annual Dose due to radionuclides other than Noble Gas	3.6 Dose to any organ due to radionuclides other than Noble Gas for 31-day period
Distance and Direction of Receptor from the Plant	1 Noble Gas: 366 meters, NNE 2 Organ: 3058 meters, W	457 meters, ESE	3058 meters, W	3058 meters, W
Description of Location	Location of Highest Dose Rate	Location of Highest Dose	Location of Highest Dose	Location of Highest Dose
Long Term (Annual Average) Atmospheric Dispersion Factor for Station Ventilation Exhaust λ/Q_1	3 $6.6E-07 \text{ sec/m}^3$ ⁽¹⁾ 4 $3.73E-08 \text{ sec/m}^3$ ⁽³⁾	$8.44E-07 \text{ sec/m}^3$ ⁽²⁾	$3.73E-08 \text{ sec/m}^3$ ⁽³⁾	$3.73E-08 \text{ sec/m}^3$ ⁽³⁾
Short Term Atmospheric Dispersion Factor for Air Removal Pump λ/Q_2	5 $3.6E-06 \text{ sec/m}^3$ ⁽¹⁾ 6 $1.79E-07 \text{ sec/m}^3$ ⁽³⁾	$1.83E-06 \text{ sec/m}^3$ ⁽²⁾	$1.79E-07 \text{ sec/m}^3$ ⁽³⁾	$1.79E-07 \text{ sec/m}^3$ ⁽³⁾
Short Term Atmospheric Dispersion Factor for Containment Drywell Purge λ/Q_3	7 $3.6E-06 \text{ sec/m}^3$ ⁽¹⁾ 8 $1.79E-07 \text{ sec/m}^3$ ⁽³⁾	$1.83E-06 \text{ sec/m}^3$ ⁽²⁾	$1.79E-07 \text{ sec/m}^3$ ⁽³⁾	$1.79E-07 \text{ sec/m}^3$ ⁽³⁾

TABLE 4-1 (Cont'd.)

		<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	Rev. 12
Long Term Relative Deposition Factor for Station Ventilation Exhaust D/Q ₁	9	N/A	N/A	4.10E-10 m ⁻² (3)	4.10E-10 m ⁻² (3)	
	10	4.10E-10 m ⁻² (3)				
Short Term Relative Deposition Factor for Air Removal Pump D/Q ₂	11	N/A	N/A	1.95E-09 m ⁻² (3)	1.95E-09 m ⁻² (3)	
	12	1.95E-09 m ⁻² (3)				
Short Term Relative Deposition Factor for Containment Drywell Purge D/Q ₃	13	N/A	N/A	1.95E-09 m ⁻² (3)	1.95E-09 m ⁻² (3)	
	14	1.95E-09 m ⁻² (3)				

- (1) Long Island Lighting Company, Shoreham Nuclear Station - Unit One, FINAL ENVIRONMENTAL STATEMENT, NUREG 0285, October 1977, Docket 50-322.
- (2) "Compliance With 10CFR50 Appendix I," Shoreham Nuclear Power Station - Unit One, Long Island Lighting Company, Docket 50-322, SNRC-119, July 30, 1976.
- (3) Based on Stone & Webster calculation 19.6A-6-118, Rev. 0, and NED calculation C-RPD-473, Rev. 0.

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TABLE 4-2

GENERAL SITE SPECIFIC DATA

<u>PARAMETER</u>	<u>VALUE</u>
Elevation of upper-level met. instruments (1)	33 ft above ground level
Elevation of upper-level met. instruments (2)	150 ft above ground level
Temperature sensor separation	117 feet
Release height for station vent	249 ft above MSL
Station grade elevation	20 ft above MSL
Reactor building height	65 m
Reactor building cross-sectional area	2600 m ²
Station vent equivalent diameter	2.664 m
Maximum effective plume height allowed	400 m
Height of inversion layer aloft	600 m
Maximum plume vertical standard deviation	$\sigma_z = 1000$ m
Fraction of the year that animals graze on pasture	$f_p = 1.0$
Fraction of daily feed that is pasture grass when the animal grazes on pasture	$f_s = 0.84$
Average transport time of activity from the feed into the milk and to the receptor	$t_f = 24$ hours

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- (1) Onsite 10 M meteorological tower
 (2) Offsite 400 ft meteorological tower

PART II
SECTION 5

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLING LOCATIONS

The purpose of this section is to identify those sampling locations from which the radiological environmental monitoring samples shall be collected pursuant to Radiological Effluent Controls 3/4-12 (Part I of the ODCM).

Table 5-1, based on NUREG 0473, defines an acceptable Radiological Environmental Monitoring Program by providing guidelines for the sampling locations according to pathways. It specifies the number, location and frequency of sample collection and the required analyses.

The Shoreham-specific implementation of the program is given in Tables 5-2, 5-3, 5-4 and 5-5, corresponding to the four pathways of direct, airborne, waterborne and ingestion doses. The corresponding onsite and offsite sampling locations are shown in Figures 5-1 and 5-2, respectively.

TABLE 5-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM*
(TYPICAL SAMPLING AND COLLECTION FREQUENCY)

<u>EXPOSURE PATHWAY AND/OR SAMPLE</u>	<u>NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATION^a</u>	<u>SAMPLING AND COLLECTION FREQUENCY</u>	<u>TYPE AND FREQUENCY OF ANALYSIS</u>
1. DIRECT RADIATION ^b	<p>36 routine monitoring stations, DR1-DR36, either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows:</p> <ul style="list-style-type: none"> a. An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY, DR1-DR16; b. An outer ring of stations, one in each meteorological sector in the 6- to 8-km range from the site, DR17-DR25; c. The balance of the stations, DR26-DR36, to be placed in special interest areas such as population centers, nearby residences, schools, and in 1 or 2 areas to serve as control stations. 	Quarterly.	Gamma dose quarterly.

*The number, media, frequency, and location of samples may vary from site to site. This table presents an acceptable minimum program for a site at which each entry is applicable. Local site characteristics must be examined to determine if pathways not covered by this table may significantly contribute to an individual's dose and should be included in the sampling program.

TABLE 5-1 (CONT'D)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATION ^a	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
2. AIRBORNE			
Radioiodine and Particulates	<p>Samples from 5 locations, A1-A5:</p> <p>3 samples, A1-A3* from close to the 3 SITE BOUNDARY locations, in different sectors, of the highest calculated annual average groundlevel D/Q.</p> <p>1 sample, A4, from the vicinity of a community having the highest calculated annual average groundlevel D/Q.</p> <p>1 sample, A5, from a control location, as for example 15-30 km distant and in the least prevalent wind direction. c</p>	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	<p>Radioiodine Canister: I-131 analysis weekly.</p> <p>Particulate Sampler: Gross beta radioactivity analysis following filter change; Gamma isotopic analysis^e of composite (by location) quarterly.</p>
3. WATERBORNE			
a. Surface ^h (Long Island Sound)	1 sample control, WA1 1 sample discharge, WA2 or WA3	Grab sample semi-annually.	Gamma isotopic analysis ^e and tritium analysis semiannually.
b. Ground	Samples from 1 or 2 sources, Wb1, f Wb2, only if likely to be affected.	Quarterly.	Gamma isotopic ^e and tritium analysis quarterly.
c. Sediment form shoreline	1 sample from downstream area with existing or potential recreational value, Wd1.	Semiannually.	Gamma isotopic analysis ^e semiannually.

*The first and second highest D/Q sectors have radioiodine and particulate samples. The third highest D/Q sector at the SITE BOUNDARY is approximately 150 ft from the first highest sector.

TABLE 5-1 (CONT'D)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATION ^a	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
4. INGESTION			
a. Milk	<p>Samples from milking animals in location, Ia1, within 5 km distance having the highest dose potential. If there are none, then, 1 sample from milking animals in each of 3 areas, Ia1, between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per yr, or if there are none available within 8 km, then a location 8 to 17 km distant will be used.⁹</p> <p>1 sample from milking animals at a control location, Ia2, 15-30 km distant, and not in the least prevalent wind directions.</p>	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.
b. Fish and Invertebrates	<p>1 sample of each commercially and recreationally important species in vicinity of plant discharge area, Ib1 - Ib2.</p> <p>1 sample of same species in areas not influenced by plant discharge, Ib3.</p>	Sample in season or semiannually if they are not seasonal.	Gamma isotopic analysis ^e on edible portions.
c. Food Products	<p>Samples of 3 different kinds of broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average ground-level D/Q, if milk sampling is not performed, Ic1 - Ic3.</p> <p>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.</p>	At time of harvest.	Gamma Isotopic ^e and I-131 analysis.
		At time of harvest.	Gamma Isotopic ^e and I-131 analysis.

TABLE 5-1 (CONT'D)

TABLE NOTATION

- a Specific parameters of distance and direction sector from the centerline of one reactor, and additional description where pertinent, are provided for each and every sample location in Table 3.12.1-1 in a table and figure in the ODCM. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," 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 REC 6.9.1.6. 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 REC 6.9.1.7, identify the cause of the unavailability of samples for that pathway and identify the new location(s) for obtaining replacement samples in the next Semi-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 thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.
- 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.

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TABLE 5-1 (CONT'D)

TABLE NOTATION

- 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 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on individual samples.
- e Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.
- f Groundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.
- g The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.
- h The "control" sample shall be taken at a distance beyond significant influence of the discharge. The "discharge" sample shall be taken in an area beyond but near the mixing zone.
- i If harvest occurs more than once a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuberous and root food products.

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TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL
MONITORING PROGRAM (REMP)
DIRECT RADIATION MONITORING STATIONS

<u>Functional Designation (NUREG-0473)</u>	<u>Location Code (Shoreham REMP)</u>	<u>Location Description</u>
DR1	1S1	Beach east of intake, 0.3 mi. N
DR2	2A2	West end of Creek Road, 0.2 mi. NNE
DR3	3S1	Site Boundary, 0.1 mi. NE
DR4	4S1	Site Boundary, 0.1 mi. ENE
DR5	5S2	Site Boundary, 0.1 mi. E
DR6	6S2	Site Boundary, 0.1 mi. ESE
DR7	7A2	North Country Road, 0.7 mi. SE
DR8	8A3	North Country Road, 0.6 mi. SSE
DR9	9S1	Service Road SNPS, 0.2 mi. S
DR10	10A1	North Country Road, 0.3 mi. SSW
DR11	11A1	Site Boundary, 0.3 mi. SW
DR12	12A1	Meteorological Tower, 0.9 mi, WSW
DR13	13S3	Site Boundary, 0.2 mi. W
DR14	14S2	St. Joseph's Villa, 0.4 mi. WNW
DR15	15S1	Beach west of intake, 0.3 mi. NW
DR16	16S2	Site Boundary 0.3 mi. NNW
DR17	6E2	Calverton, 4.5 mi. E
DR18	6E1	LILCO ROW, 4.8 mi. ESE
DR19	7E1	Calverton, 4.9 mi. SE
DR20	8E1	Calverton, 4.4 mi. SSE
DR21	9E1	Brookhaven National Laboratory, 5.0 mi. S
DR22	10E1	Ridge Substation, 4.0 mi. SSW
DR2	11E1	LILCO ROW, 4.7 mi. SW
DR24	12D1	North Shore Beach Substation, 3.7 mi. WSW
DR25	13E1	Sound Way Drive, 4.5 mi. W
DR26	5D1	Wildwood State Park, 3.4 mi. E
DR27	5F3	Dairy Farm, 7.8 mi. E
DR28	7B1	Overhill Road, 1.4 mi. SE
DR29	12G2	Flowerfield Substation, 15.4 mi. WSW
DR30	12G1	Central Islip Substation, 19.9 mi. WSW
DR31	11G1	MacArthur Substation, 16.6 mi. SW
DR32	8G1	Wading River Road, 10.1 mi. SSE
DR33	6G1	Hampton Bays Substation, 19.0 mi. ESE
DR34	6A1	Sound Road, 0.7 mi. ESE
DR35	2A3	Nearest Residence, 0.3 mi. NNE
DR36	9S2	East Gate SNPS, 0.3 mi. S

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TABLE 5-3

RADIOLOGICAL ENVIRONMENTAL
MONITORING PROGRAM (REMP)
(PARTICULATES AND RADIOIODINE)

<u>Functional Designation (NUREG-0473)</u>	<u>Location Code (Shoreham REMP)</u>	<u>Location Description</u>
A1	6S2	Site Boundary, 0.1 mi. ESE
A2	2A2	West end of Creek Road, 0.2 mi. NNE
A3	3S1	Site Boundary, 0.1 mi. NE
A4	7B1	Overhill Road, 1.4 mi. SE
A5	11G1	MacArthur Substation, 16.6 mi. SW

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TABLE 5-4

RADIOLOGICAL ENVIRONMENTAL
MONITORING PROGRAM (REMP)
WATERBORNE MONITORING STATIONS

<u>Functional Designation (NUREG-0473)</u>	<u>Location Code (Shoreham REMP)</u>	<u>Location Description</u>
WA1	13G2	Surface, background area, 13.2 mi. W
WA2	14C1	Surface, outfall area, 2.1 mi. WNW
WA3	3C1	Surface, outfall area, 2.9 mi. NE
Wb1	2S1	Potable Water, well on site, 0.1 mi. NNE
Wb2	13S2	Potable Water, well on site, 0.2 mi. W
Wd1	2A4	Sediment, beach, 0.4 mi. NNE

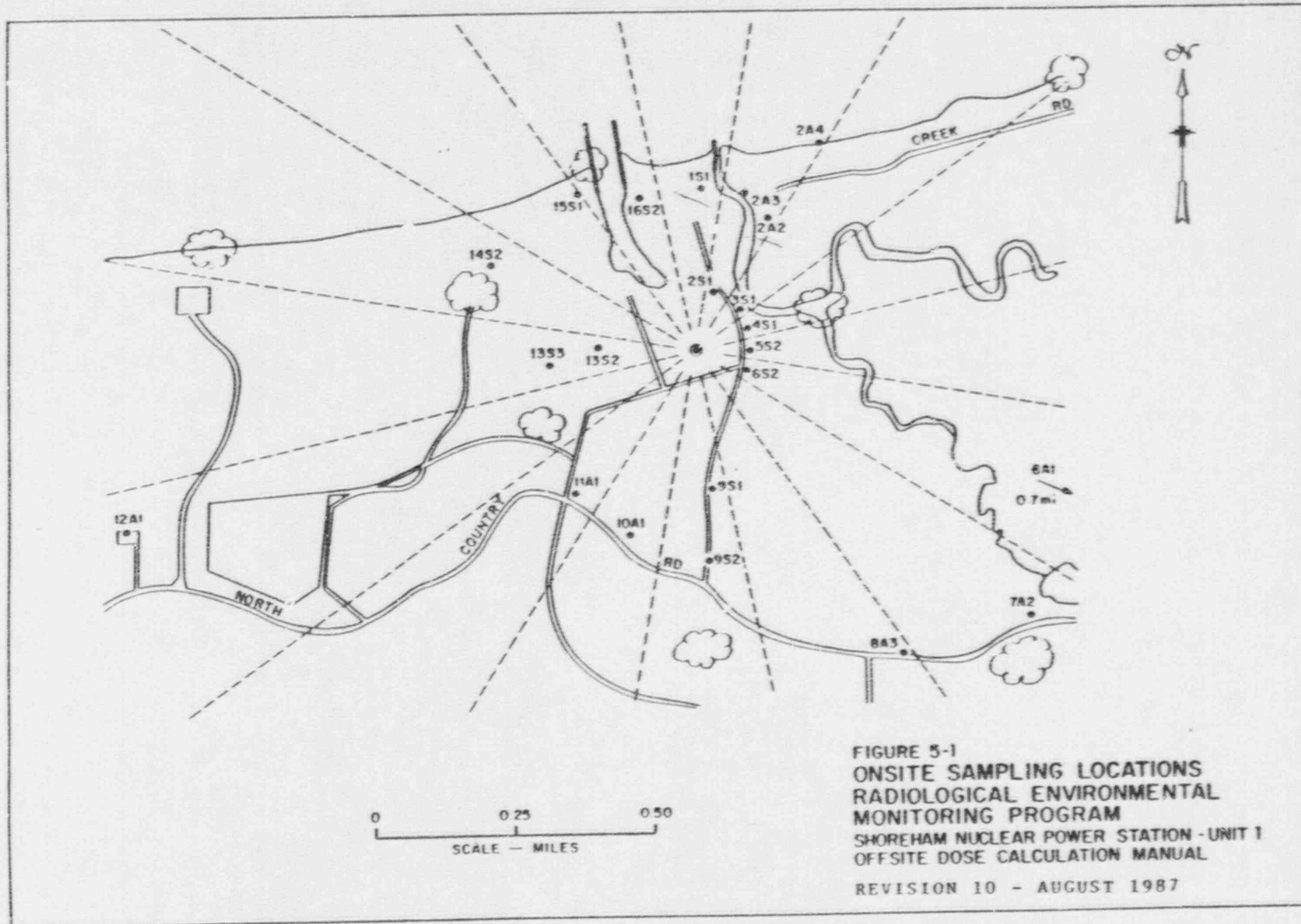
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TABLE 5-5

 RADIOLOGICAL ENVIRONMENTAL
 MONITORING PROGRAM (REMP)
 INGESTION MONITORING STATIONS

<u>Functional Designation (NUREG-0473)</u>	<u>Location Code (Shoreham REMP)</u>	<u>Location Description</u>
Ia	13B1	Milk, Goat Farm 1.90 Mi. W
Ia2*	10F1 8G2	Milk, Goat Farm, 9.2 Mi. SSW Dairy (Cow), 10.8 Mi. SSE
Ib1	3C1	Fish and Invertebrates, Outfall Area, 2.9 Mi. NE
Ib2	14C1	Fish and Invertebrates, Outfall Area 2.1 Mi. WNW
Ib3	13G2	Fish and Invertebrates, Background, 13.2 Mi. W
Ic1	8B1	Food Product, Local Farm, 1.2 Mi. SSE
Ic2	6B21	Food Product, Condzella's Farm, 1.8 Mi. ESE
Ic3	12H1	Food Products, Background Farm, 26 Mi. WSW

*Samples will be obtained from one of the locations listed as available. Priority will be given to the first of the two locations listed. If samples are unavailable from that location, substitution will be made from the second location listed.



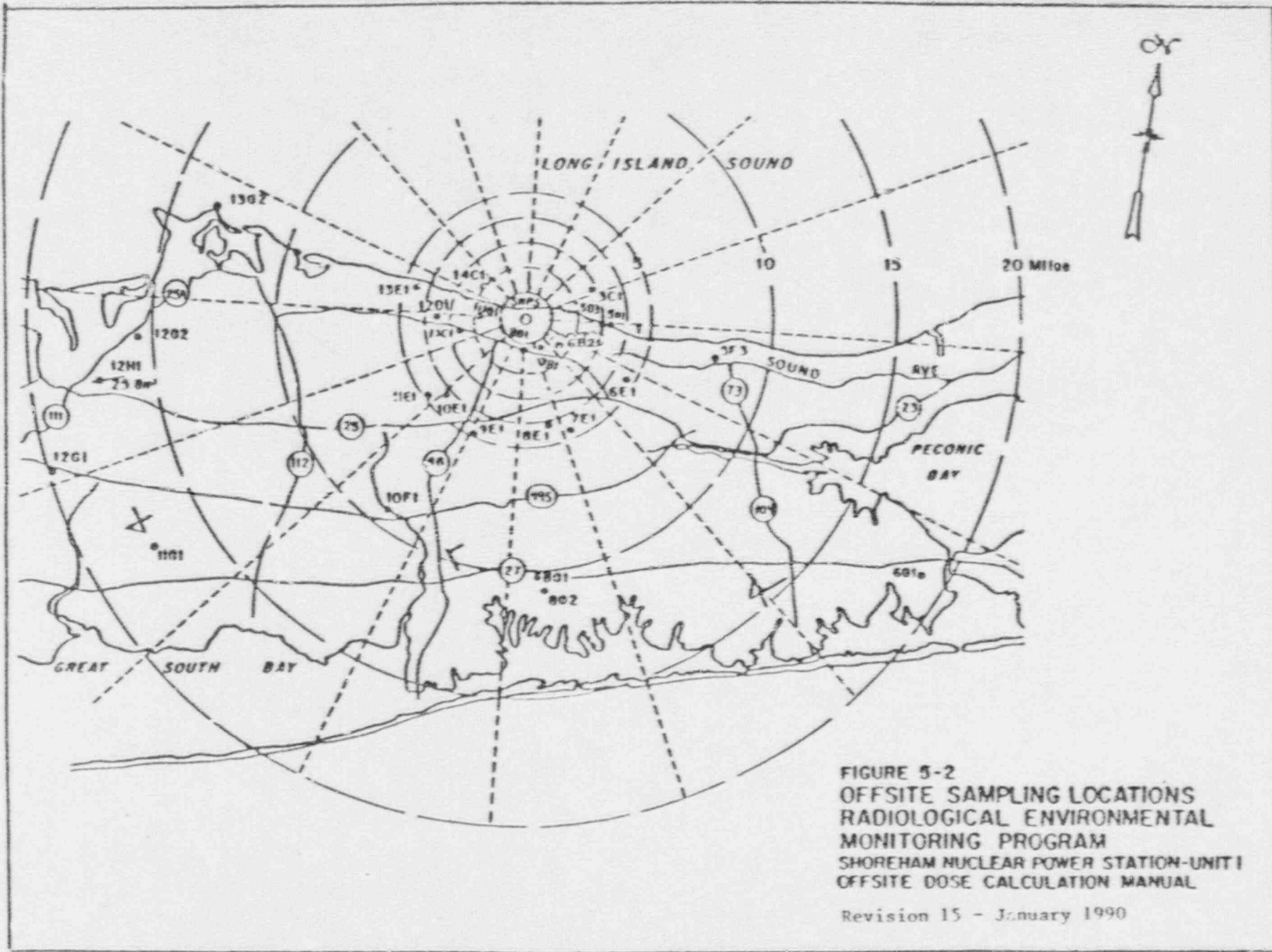


FIGURE 5-2
 OFFSITE SAMPLING LOCATIONS
 RADIOLOGICAL ENVIRONMENTAL
 MONITORING PROGRAM
 SHOREHAM NUCLEAR POWER STATION-UNIT 1
 OFFSITE DOSE CALCULATION MANUAL

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SECTION 6

INTERLABORATORY COMPARISON PROGRAM

The laboratory performing the radiological environmental analyses shall participate in an interlaboratory comparison program which has been approved by the NRC. Currently this program is the Environmental Protection Agency (EPA) environmental radioactivity laboratory intercomparison studies (cross-check) program. Our participation code is "CJ".

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APPENDIX A

DERIVATION OF A_i

A_i (mrem/min per Ci/cc) is the dose conversion factor for the combined fish plus seafood pathways due to a liquid radwaste system discharge.

The doses to an organ, due to ingestion of fish and seafood (contribution from shoreline deposit is considered insignificant) containing isotope, i , were calculated by a computer code based on Regulatory Guide 1.109, Rev. 1 methodology and default parameters.

The computer isotopic dose rates output were normalized to unit intake concentration with the following equation:

$$A_i = \frac{D_{Fi} + D_{Si}}{C_i/F}$$

where:

D_{Fi} = Calculated fish ingestion dose rate (mrem/min) to an organ, from isotope, i , (Ref. Reg. Guide 1.109, Eq. (A-3)) assuming a dilution factor of 8.85.

D_{Si} = Calculated seafood ingestion dose rate (mrem/min) to an organ, from isotope, i , (Ref. Reg. Guide 1.109, Eq. (A-3)) assuming a dilution factor of 8.85.

C_i = Discharge concentration of isotope, i (Ci/cc)

F = Near field dilution factor, 8.85 (unitless)

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APPENDIX B

DERIVATION OF P_{oij}

P_{oij} ($\frac{m^2 \cdot mrem/yr}{\mu Ci/sec}$) is the dose conversion factor due to combined effect of

ingestion of leafy vegetables, ingestion of stored vegetables, (fruits, vegetables, and grains), and contaminated ground pathways.

The dose delivered to organ, j, due to the combined effect of the 3 pathways were calculated for each radioisotope, i, using a computer code based on Regulatory Guide 1.109, Rev. 1 methodology and default parameters.

The computer isotopic dose rates output were normalized to unit isotopic release rate and deposition factor with the equation:

$$P_{oij} = \frac{D_{cij} + D_{Lij} + D_{sij}}{3.17 \cdot 10^{-2} * C_i * D/Q}$$

where:

- D_{cij} = Calculated contaminated ground dose to organ, j, from isotope, i,
- D_{Lij} = Calculated leafy vegetable ingestion dose to organ, j, from isotope, i,
- D_{sij} = Calculated sorted vegetables dose to organ, j, from isotope, i,
- C_i = Gaseous effluent release rate of isotope, i, (Ci/yr)
- D/Q = Deposition factor (m^{-2}) as used in calculation of D_{cij} , D_{Lij} , D_{sij} .
- $3.17 \cdot 10^{-2}$ = The number of years per second (3.17×10^{-8}) times the number of μCi per Ci (10^6).