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Prepared By	Date	Reviewed By	Date
M.A. Randles	5-30-91	[illegible]	6/4/91

APPROVALS

Title/Dept.	Signature	Date
NAD Manager / NED	[illegible]	6-4-91
ROC Chairman	Joseph G Wynne	8-1-91
Plant Manager	[illegible]	8/1/91

TITLE OF DOCUMENT SHOREHAM NUCLEAR POWER STA - UNIT 1 OFFSITE DOSE CALCULATION MANUAL

INFORMATION ONLY

OFFSITE DOSE CALCULATION MANUAL

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LONG ISLAND LIGHTING COMPANY

OFFSITE DOSE CALCULATION MANUAL

EFFECTIVE DATE - AUGUST 7, 1991

Revision 18

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

PART I THE RADIOLOGICAL EFFLUENT CONTROLS (REC)

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PART II CALCULATIONAL METHODOLOGY AND PARAMETERS FOR COMPLIANCE WITH THE RADIOLOGICAL EFFLUENT CONTROLS

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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)

Additional changes to the Radiological Effluent Controls (Part I, Section 3) of the ODCM have been made to reflect the isotopic inventory and the radiological effluent monitoring requirements appropriate to a defueled operating condition with fuel stored in the Spent Fuel Pool.

The Plant may not be returned to an operational state or fuel moved back into the reactor vessel without modifying this ODCM. Additional changes to this document may be required for decommissioning activities.

(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.

PART I
SECTION 2

RADIOLOGICAL EFFLUENT CONTROLS

SE^TION 1.0

DEFINITIONS

SECTION

1.0 DEFINITIONS

LIST OF TABLES

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 to be taken under designated conditions.

CHANNEL CALIBRATION

1.2 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

1.3 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

1.4 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.

DEFUELED MODE

1.5 The plant is in the DEFUELED MODE when all fuel has been removed from the reactor vessel and there is fuel in the spent fuel storage pool or in the new fuel storage vault.

FREQUENCY NOTATION

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

FUEL HANDLING OPERATIONS

1.7 FUEL HANDLING OPERATIONS shall be the movement of fuel over or within the Spent Fuel Pool. Suspension of FUEL HANDLING OPERATIONS shall not preclude completion of the movement of fuel to a safe conservative position.

MEMBER(S) OF THE PUBLIC

1.8 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)

1.9 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 Technical Specification Section 6.0 and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Semiannual Radioactive Effluent Release Reports required by Technical Specification Section 6.0.

OPERABLE - OPERABILITY

1.10 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).

REPORTABLE EVENT

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

SITE BOUNDARY

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

SOURCE CHECK

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

UNRESTRICTED AREA

1.14 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.

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TABLE 1.1

SURVEILLANCE FREQUENCY NOTATION

NOTATION	FREQUENCY
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).
N/A	Not applicable.
P	Completed prior to each release.

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PART 1
SECTION 3

RADIOLOGICAL EFFLUENT CONTROLS

SECTIONS 3.0 and 4.0

CONTROLS

D

SURVEILLANCE REQUIREMENTS

CONTROLS AND SURVEILLANCE REQUIREMENTS

LIST OF TABLES

CONTROLS

3.0.1 Compliance with the Controls contained in the succeeding Controls is required during the DEFUELED MODE specified therein; except that upon failure to meet the Controls the associated ACTION requirements shall be met.

3.0.2 Noncompliance with a Control shall exist when the requirements of the Control and 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 Commencement or continuation of FUEL HANDLING OPERATIONS shall not be made when the conditions for the Controls are not met and the associated ACTION requires suspension of FUEL HANDLING OPERATIONS if they are not met within a specified time interval. FUEL HANDLING OPERATIONS may be made in accordance with the ACTION requirements when conformance to them:

1. Permits continued FUEL HANDLING OPERATIONS for an unlimited period of time or,

2. Permits fuel to be moved to a safe, conservative position.

APPLICABILITY

SURVEILLANCE REQUIREMENTS

4.0.1 Surveillance Requirements shall be met during the DEFUELED MODE or other APPLICABILITY conditions specified for individual Controls.

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

4.0.3 Failure to perform a Surveillance Requirement within the allowed surveillance interval, defined by Specification 4.0.2 shall constitute noncompliance with the OPERABILITY requirements for a Control. The time limits of the ACTION requirements are applicable at the time it is identified that a Surveillance Requirement has not been performed. Surveillance Requirements do no have to be performed on inoperable equipment.

4.0.4 FUEL HANDLING OPERATIONS shall not occur or continue unless all Surveillance Requirement(s) associated with the Control have been performed within the applicable surveillance interval. This provision shall not prevent passage through or to conditions as required to comply with ACTION requirements.

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 or change the setpoint so it is acceptably conservative.

b. With the number of channels OPERABLE less than the Minimum Channels OPERABLE requirement of Table 3.3.7.10-1, take the ACTION shown in Table 3.3.7.10-1. Restore the instruments to OPERABLE status within 30 days and if unsuccessful explain in the next Semiannual Radiological Effluent Release Report why the inoperability was not corrected in a timely manner.

c. The provisions of Control 3.0.3 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 or service 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

INSTRUMENT	MINIMUM CHANNELS OPERABLE	ACTION
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 when service water is flowing through the respective RHR heat exchanger and the associated RHR subsystem is filled with water

TABLE 3.3.7.10-1 (Continued)

ACTION STATEMENTS

ACTION 110 - With the uumber of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue 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 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 5×10^{-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 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 5×10^{-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 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 INSTRUMENATATION SUREVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE				
a. Liquid Radwaste Effluent Line, 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

*Only when service water is flowing through the respective RHR heat exchanger and the associated RHR subsystem is filled with water.

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.

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: At all times.

ACTION:

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

b. With the number of channels OPERABLE less than the Minimum Channels OPERABLE requirement of Table 3.3.7.11-1, take the ACTION shown in Table 3.3.7.11-1. Restore the instrument to OPERABLE status within 30 days and, if unsuccessful, explain in the next Semiannual Radiological Effluent Release Report why the inoperability was not corrected in a timely manner.

c. The provisions of Controls 3.0.3 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 .7.11-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	ACTION
1. [No Longer in Use]		
2. [No Longer in Use]		
3. STATION VENTILATION EXHAUST MONITORING SYSTEM		
a. Noble Gas Activity Monitor, RE-42	1	120
b. [No Longer in Use]		
c. Particulate Sampler	1	122
d. Effluent System Flow Rate Monitor	1	123
e. Sampler Flow Rate Monitor	1	123
4. [No Longer in Use]		

TABLE 3.3.7.11-1 (Continued)

TABLE NOTATIONS

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 provided grab samples are taken at least once per 12 hours and these samples are analyzed for radioactivity within 24 hours.

ACTION 121 - [No Longer in Use]

ACTION 122 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided samples are continuously collected starting within 8 hours of discovery, 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 provided the flow rate is estimated at least once per 12 hours.

ACTION 124 - [No Longer in Use]

TABLE .7.11-1

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. [No Longer in Use]				
2. [No Longer in Use]				
3. STATION VENTILATION EXHAUST MONITORING SYSTEM				
a. Noble Gas Activity Monitor, RE-42	D	M	R(2)	Q(1)
b. [No Longer in Use]				
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. [No Longer in Use]				

TABLE 4.3.7.11-1 (Continued)

TABLE NOTATIONS

(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) [No Longer in Use]

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) 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) (uCi/mL)[a]
A. Batch Waste Release Tanks and Sumps[b]	P Each Batch	P Each Batch	Principal Gamma Emitters[c]	$5x10^{-7}$
1. Discharge Waste Sample Tanks	P* One Batch/M	M*	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
2. Recovery Sample Tanks	P* Each Batch	M* Composite[d]	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
3. Yard Piping Drain Sump	P* Each Batch	Q** Composite[d]	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$
B. Continuous Releases[e]	M# Grab Sample[f]	M# Grab Sample[f]	Principal Gamma Emitters[c]	$5x10^{-7}$
1. RHR Heat Exchanger Service Water Outlet			Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
2. Reactor Building Salt Water Drain Tank			H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	Q## Grab Sample[f]	Q## Grab Sample[f]	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$

* If batch is released during the month.
** If batch is released during the quarter.
\# If flow is released during the month.
\## If flow is released during the quarter.

TABLE NOTATION

[a]The 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 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 posteriori (after the fact) limit for a particular measurement.

[b]A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated, and then thoroughly mixed by a method described in the ODCM to assure representative sampling.

TABLE NOTATIONS (Continued)

[c]The principal gamma emitters for which the LLD specification applies include the following radionuclides: Mn-54, Co-60, Zn-65, Cs-134 and Cs-137. Ce-144 shall also be measured, but with an LLD of 5×10^{-6} uCi/ml. 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.

[d]A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen that is representative of the liquids released.

[e]A continous release is the discharge of liquid wastes of a nondiscrete volume, e.g., from a volume of a system that has an input flow during the continuous release.

[f]If the alarm setpoint of the effluent monitor, as determined by the method presented in the ODCM, is exceeded, the frequency of sampling shall be increased to daily until the alarm condition no longer exists. Frequency of analysis shall be increased to daily for principal gamma emitters and on incident composite for H-3, gross alpha, Sr-89, Sr-90 and Fe-55 prepared and analyzed.

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) 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 Section 6.0, 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 Control 3.0.3 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.

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) 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 Section 6.0, 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 Control 3.0.3 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.

3.11.1.4 (Not Used)

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) 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 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 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]	M Particulate Sample	Principal Gamma Emitters[b]	1×10^{-11}
	Continuous[e]	M Particulate Sample	Gross Alpha	1×10^{-11}
	Continuous[e]	Q Composite Particulate Sample	Sr-89, Sr-90	1×10^{-11}
	Continous[e]	Noble Gas Monitor	Noble Gases Gross Beta or Gamma	1×10^{-6}
	M Grab Sample	M	Principal Gamma Emitters[b]	1×10^{-4}
	M[d] Grab Sample	M	H-3	1×10^{-6}
B. [No Longer in Use]				

TABLE 4.11.2.1.2-1 (Continued)

TABLE NOTATION

[a]The LLD is defined, for purposes of these Controls as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

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

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 <u>a priori</u> (before the fact) limit representing the capability of the measurement system and not as <u>a posteriori</u> (after the fact) limit for a particular measurement.

TABLE 4.11.2.1.2-1 (Continued)

TABLE NOTATIONS (Continued)

[b]The principal gamma emitters for which the LLD specification applies include the following radionuclides: Mn-54, Co-60, Zn-65, Cs-134, Cs-137 and Ce-144 in 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.

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

[d]Tritium grab samples shall also 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, until stable tritium release levels (5 consecutive samples) can be demonstrated.

[e]The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Controls 3.11.2.1 and 3.11.2.3.

[f] Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing, or after removal from sampler. 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.

[g] [No Longer in Use]

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) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 5 mrads for gamma radiation and less than or equal to 10 mrads for beta radiation and,

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

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 Section 6.0, 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 Control 3.0.3 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 - TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM

CONTROLS

3.11.2.3 The dose to a MEMBER OF THE PUBLIC from 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) 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 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 Section 6.0, 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 Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.3 Cumulative dose contributions for the current calendar quarter and current calendar year for 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.

GASEOUS RADWASTE TREATMENT SYSTEM

CONTROLS

3.11.2.4 [No Longer in Use]

SURVEILLANCE REQUIREMENTS

4.11.2.4 [No Longer in Use]

CONTROLS

3.11.2.5 [No Longer in Use]

SURVEILLANCE REQUIREMENTS

4.11.2.5.1 [No Longer in Use]

4.11.2.5.2 [No Longer in Use]

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).

CONTAINMENT PURGING AND VENTING

CONTROLS

3.11.2.8 [No Longer in Use]

SURVEILLANCE REQUIREMENTS

4.11.2.8.1 [No Longer in Use]

4.11.2.8.2 [No Longer in Use]

4.11.2.8.3 [No Longer in Use]

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RADIOACTIVE EFFLUENTS

3/4.11.3 [No Longer in Use]

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 unranium fuel cycle sources shall be lim'ted 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 Section 6.0, 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 Control 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.4.1 Cumulati.. 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.

3/4.12.1 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:

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

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.

CONTROLS (Continued)

ACTION: (Continued)

c. With 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 than 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 Control 3.0.3 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 : .1-1

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
1. DIRECT RADIATION[b]	18 routine monitoring stations, DR1-DR16, DR30-DR31 either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: a. A ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY, DR1-DR16; b. The remaining two stations, DR-30 and DR31 serve as control locations.	Quarterly	Gamma dose quarterly.

TABLE 3.1 -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			
Gross Beta and Gamma Isotopics	Samples from 5 locations, A1-A5: 3 samples, A1-A3* from close to the 3 SITE BOUNDARY locations, in different sectors, of the highest calculated annual average groundlevel D/Q. 1 sample, A4, from the vicinity of a community having the highest calculated annual average groundlevel D/Q. 1 sample, A5, from a control location as for example 15-30 km distant and in the least prevalent wind direction.[c]	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	Particulate Sampler: Gross beta radioactivity analysis following filter change;[d] Gamma isotopic analysis[e] of composite (by location) quarterly.
3. WATERBORNE			
a. Surface[h] (Long Island Sound)	1 sample control, Wa1 1 sample discharge, Wa2 or Wa3	Grab sample semiannually.	Gamma isotopic analysis[e] and tritium analysis semiannually.
b. Not Used			
c. Sediment from 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 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 (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. Not Used			
b. Fish and Invertebrates	1 sample of each commercially and recreationally important species in vicinity of plant discharge area, Ib1-Ib2.	Sample in season or semiannually if they are not seasonal.	Gamma isotopic analysis[e] on edible portions.
	1 sample of same species in areas not influenced by plant discharge, Ib3.		
c. FOOD PRODUCTS	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, Ic1 - Ic2.	At time of harvest.[i]	Gamma isotopic[e] analysis.
	1 sample of each of the similar broad leaf vegetation grown 15-30 km distant in the least prevalent wind direction, Ic3.	At time of harvest.[i]	Gamma isotopic[e] analysis.

TABLE 3.12.1-1 (Continued)

TABLE NOTATIONS

[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 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).

[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 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.

[c]The purpose of this sample is to obtain background information. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites that provide valid background data may be substituted.

[d]Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

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

TABLE 3.12.1-1 (Continued)

TABLE NOTATIONS (Continued)

[f] Not Used

[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 continously, sampling shall be monthly. Attention shall be paid to including samples of tuberous and root food products.

TABL 12.1-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

ANALYSIS	WATER (pCi/L)	AIRBORNE PARICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	FOOD PRODUCTS (pCi/kg, wet)
H-3	30,000			
Mn-54	1,000		30,000	
Co-60	300		10,000	
Zn-65	300		20,000	
Cs-134	30	10	1,000	1,000
Cs-137	50	20	2,000	2,000

TABLE [illegible].12.1-1

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS[a] [b]

LOWER LIMIT OF DETECTION (LLD)[c]

ANALYSIS	WATER (pCi/L)	AIRBORNE PARTICULATE OR GAS (pCi/m^3)	FISH (pCi/kg, wet)	FOOD PRODUCTS (pCi/kg, wet)	SEDIMENTS (pCi/kg, dry)
Gross Beta	4	0.01			
H-3	3000				
Mn-54	15		130		
Co-60	15		130		
Zn-65	30		260		
Cs-134	15	0.05	130	60	150
Cs-137	18	0.06	150	80	180

TABLE 4.12.1-1 (Continued)

TABLE NOTATIONS

[a]This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report pursuant to Control 6.9.1.6.

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

[c]The LLD is defined, for 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 NOTATIONS (Continued)

It should be recognized that the LLD is defined as an a prior (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 interferring 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.

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 m^2 (500 ft^2) 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 m^2 (500 ft^2) 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 Control 3.0.3 are not applicable.

SURVEILLANCE 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.

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 Control 3.0.3 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 ODCM

PART 1
SECTION 4

RADIOLOGICAL EFFLUENT

CONTROLS

BASES FOR

SECTIONS 3.0 AND 4.0

CONTROLS

AND

SURVEILLANCE REQUIREMENTS

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.

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).

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

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 substanially 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

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 - 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 P leases 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 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 [No Longer in Use]

3/4.11.2.5 [No Longer in Use]

3/4.11.2.8 [No Longer in Use]

3/4.11.4 TOTAL DOSE

This Contol 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.

3/4.12.1 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 station decontamination. 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 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

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 CONTROLS

SECTION 5.0

DESIGN FEATURES

DESIGN FEATURES

SECTION PAGE

5.1 SITE

LIST OF FIGURES

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.

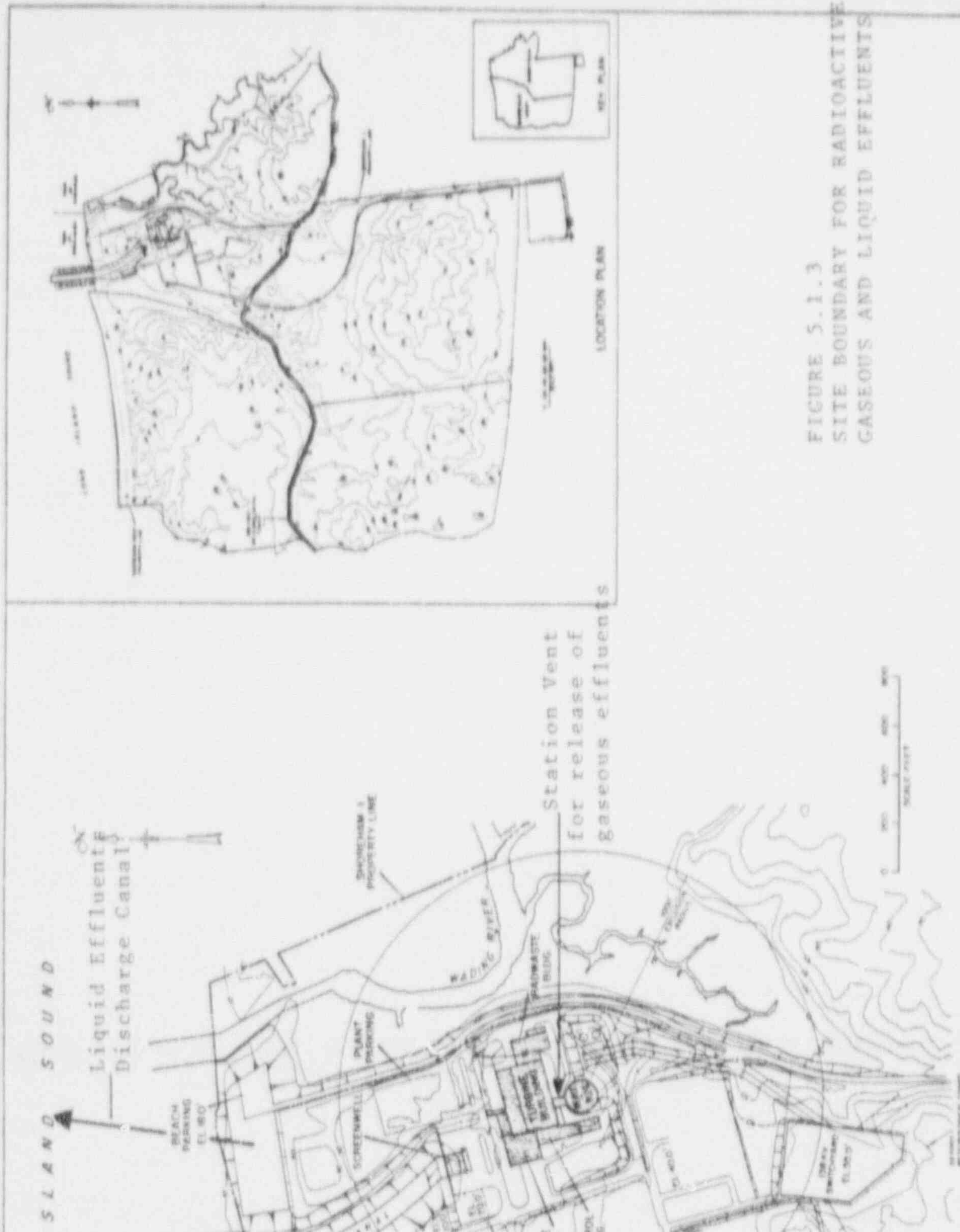

FIGURE 5.1.3
SITE BOUNDARY FOR RADIOACTIVE
GASEOUS AND LIQUID EFFLUENTS

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PART I
SECTION 6

RADIOLOGICAL EFFLUENT

CONTROLS

SECTION 6.0

ADMINISTRATIVE CONTROLS

ADMINISTRATIVE CONTROLS

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

6.8.1.3 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

6.8.1.4 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 therof.

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

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 40 CFR Part 190, Environmental Radiation Protection Standards for Nuclear Power Operation. Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in Regulatory Guide 1.109, Rev. 1, October 1977.

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.

6.13 OFFSITE DOSE CALCULATION MANUAL (ODCM)

See Technical Specification 6.13.

**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.

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.

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 1.109, 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.

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} µCi/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 one pump and circulates sea water at a rate of 143,500 gpm).

   b. The service water flow rate with the service water system composed of two reactor building service water pumps, each having a capacity of 8600 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} µCi/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 are released to the environment 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.

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 monthly grab 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 for batch releases. For continuous releases gross alpha and H-3 concentrations are determined by analysis of previous monthly grab sample.

Sr-89, Sr-90, Fe-55

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

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.

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:

$$\frac{C}{MPC} = \sum_{i=1}^{N} \frac{C_i}{MPC_i}$$

$$= \frac{C_a}{MPC_a} + \frac{C_b}{MPC_b} + \ldots\ldots + \frac{C_n}{MPC_n} + \frac{C_\alpha}{MPC_\alpha} + \frac{C_G}{MPC_G}$$

$$+ \frac{C_s}{MPC_s} + \frac{C_t}{MPC_t} + \frac{C_{Fe}}{MPC_{Fe}} \leq 1 \qquad (2.1.1)$$

where:

$C_a, C_b, \ldots\ldots C_n$ = Concentration of the individual gamma emitting radionuclides identified (µCi/ml)

C = The gross alpha concentration (µCi/ml)

C_G = The total concentration of dissolved or entrained noble gases (µCi/ml)

C_s = The Sr-89 and Sr-90 concentrations (µCi/ml)

C_t = The H-3 concentration (µCi/ml)

C_{Fe} = The Fe-55 concentration (µCi/ml)

MPC_i = MPC_a, MPC_b ....., MPC_n, MPC_α, MPC_G, MPC_s, MPC_t, MPC_{Fe}

= the maximum permissible concentration of the respective radioisotope i (µCi/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 (µCi/ml). For gross alpha, the MPC assumed will be 3.00E-08 (µCi/ml).

If the C/MPC calculated is greater 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_c (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_{HB}, etc. (defined in Section 2.1.1), and recalculate C/MPC using new C_i in Equation 2.1-1.

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

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

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:

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

where:

C_{Di} = concentration of radioisotope (i) (μCi/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) (μCi/ml)

C_{HiA} = RHR heat exchanger service water outlet concentration of radioisotope(i) (μCi/ml) from loop A.

C_{HiB} = RHR heat exchanger service water outlet concentration of radioisotope(i) (μCi/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/μCi/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.

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:

$$S_{79} \leq F^* \left[\sum_{i=1}^{N} C_{Si} E_i\right] \qquad \text{(cpm)}$$

where:

E_i = Gamma counting efficiency of RE-79 for radionuclide i (cpm/µCi/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.? 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:

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

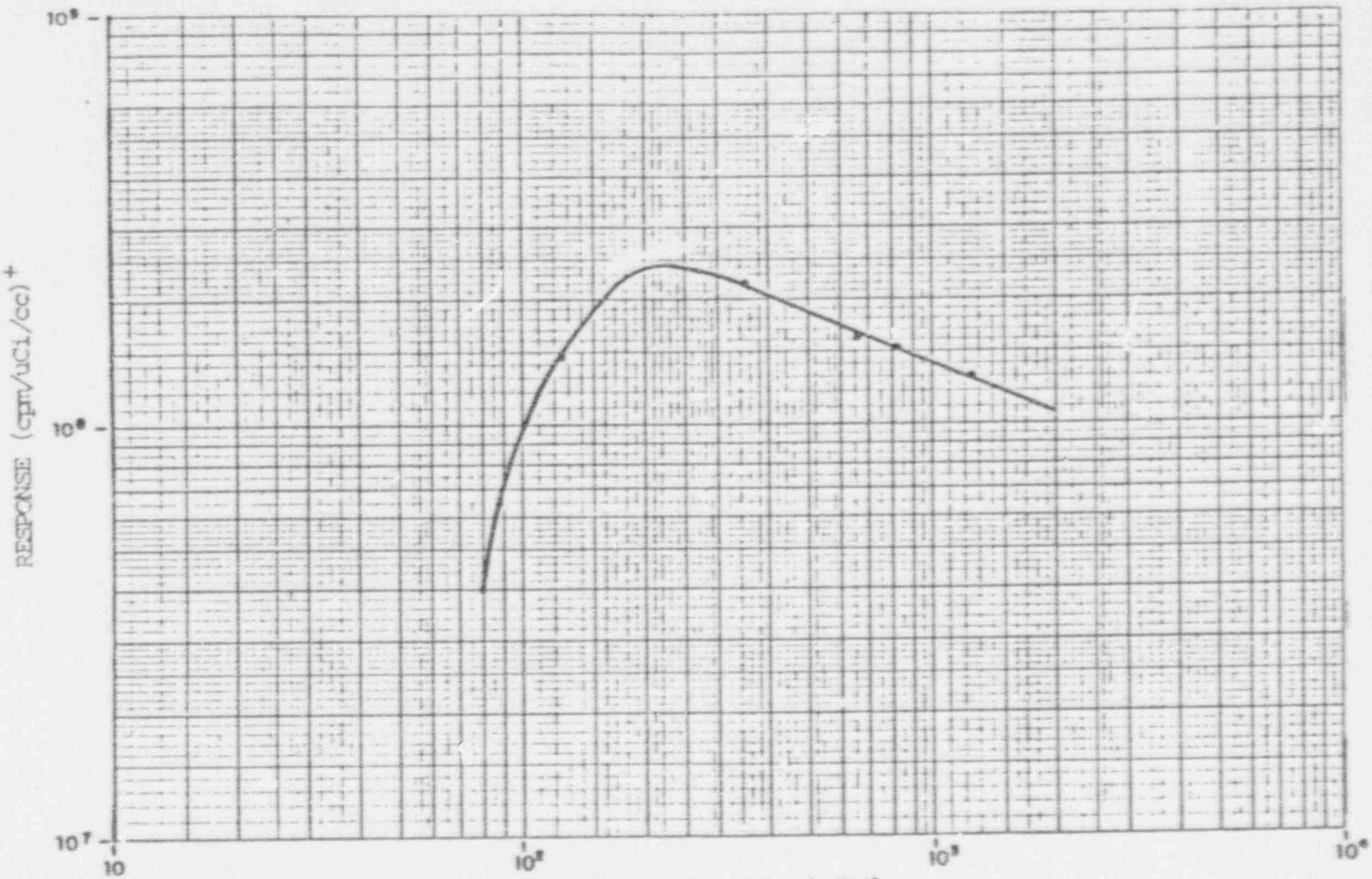
$$S_{23B} \leq F * [\sum_{i=1}^{N} C_{HiB} E_{iB}]$$

where:

E_{iA} = Gamma counting efficiency of RE-23A for radionuclide i (cpm/μCi/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/μCi/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.



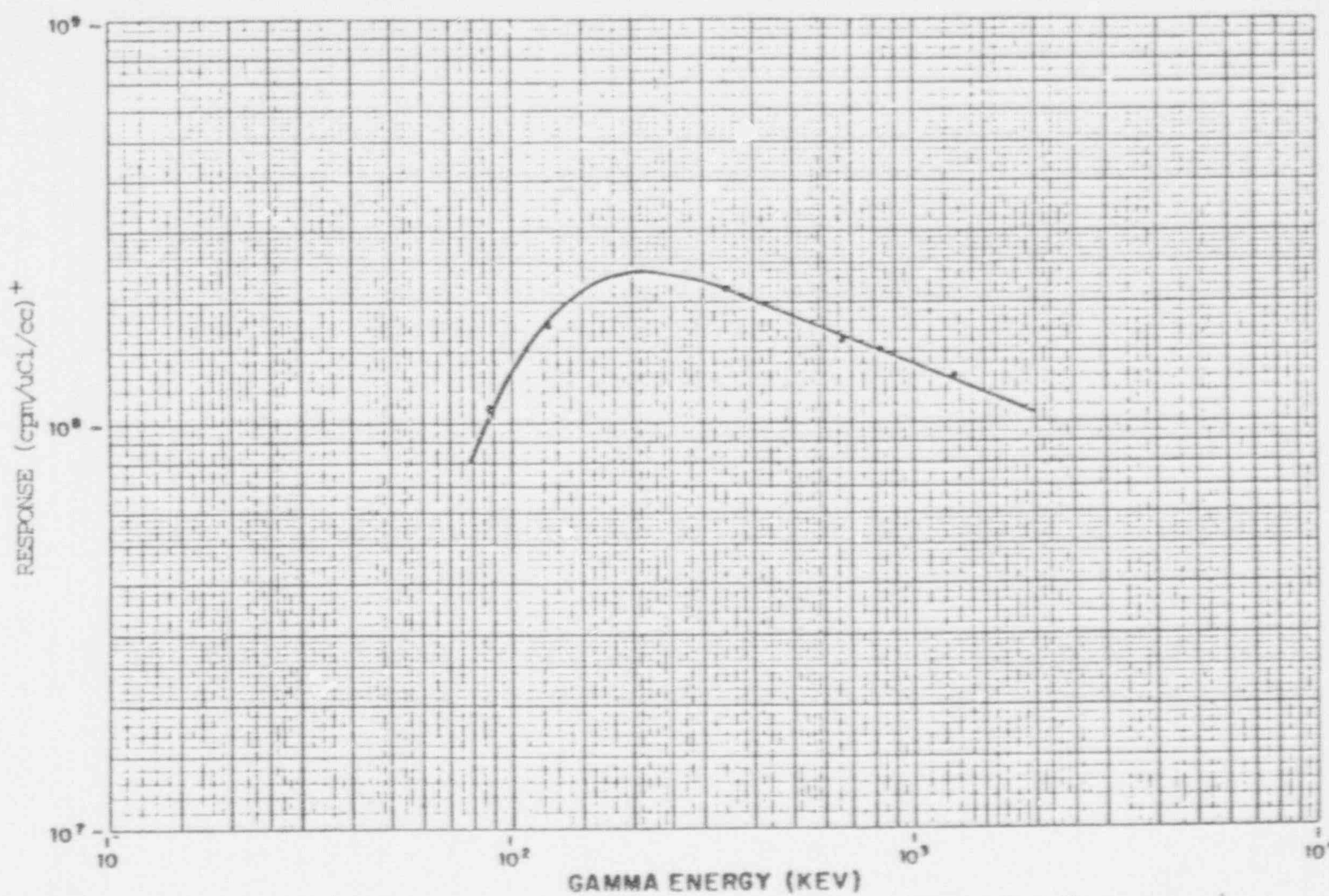
SOURCE:

C-RPD-482, Rev. 0

+ normalized to 1 photon/disintegration

FIGURE 2.1-1

DETECTOR RE-13
RESPONSE VS. GAMMA ENERGY



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

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 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 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. The net count rate (excluding background), CR (cpm), of the Station Ventilation Exhaust Noble Gas Radiation Monitor is given by:

$$CR = 10^{-6} * C(Kr\text{-}85)*E(Kr\text{-}85) \quad \text{(cpm)}$$

where:

E(Kr-85) = detector efficiency (cpm/ Ci/cc) for RE-42 for Kr-85 as provided in Figure 2.2-1. The linearity response for RE-42 is shown in Figure 2.2-2.

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

$$DR(Kr\text{-}85) = \chi/Q * V * DFB\ (Kr\text{-}85) * C\ (Kr\text{-}85) \quad \text{(mrem/yr)}$$

where:

DR(Kr-85) = predicted dose rate for (Kr-85) (mrem/yr),

X/Q = annual average X/Q (sec/m³) at 366 meters NNE due to releases via the station ventilation exhaust point (6.6E-07 sec/m³),

DFB(Kr-85) = total body dose rate conversion factor (mrem/yr/pCi/m³), from Table 2.2-1,

C(Kr-85) = isotope release concentration (pCi/cc) "sampling not required",

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

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

$$F_B = 500 / DR(Kr\text{-}85)$$

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

$$S^B_{42} \leq 0.8 * F_B * CR = \frac{0.8 * 500 * E(Kr\text{-}85)}{X/Q * V * DFB(Kr\text{-}85)} \quad \text{(cpm)}$$

where:

S^B_{42} = 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.

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

1. The net count rate (excluding background), CR (cpm), of the station ventilation exhaust noble gas radiation monitor is given as noted in Section 2.2.1.

2. The noble gases beta and gamma skin dose rate is given the following equation:

$$DR(Kr\text{-}85) = X/Q * V * K_{sim}(Kr\text{-}85) * C(Kr\text{-}85) \quad \text{(mrem/yr)}$$

where:

DR(Kr-85) = predicted dose rate for Kr-85 (mrem/yr), X/Q = annual average X/Q (sec/m³) at 366 meters NNE due to releases via the station ventilation exhaust point, (6.6E-07 sec/m³),

$K_{sim}(Kr\text{-}85)$ = skin dose rate conversion factor (mrem/yr/pCi/m³), from Table 2.2-1,

C(Kr-85) = isotope release concentration (pCi/cc) sampling not required,

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

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

$$F_S = 3000 / DR(Kr\text{-}85)$$

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

$$S_{42}^{S} \leq 0.8 * F_S * CR = \frac{0.8 * 3000 * E(Kr\text{-}85)}{X/Q * V * K_{sim}(Kr\text{-}85)} \quad \text{(cpm)}$$

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.

TABLE 2.2-1

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

Radio-nuclide	β-Air(1) $(DF\beta_i)$	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^{γ})	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

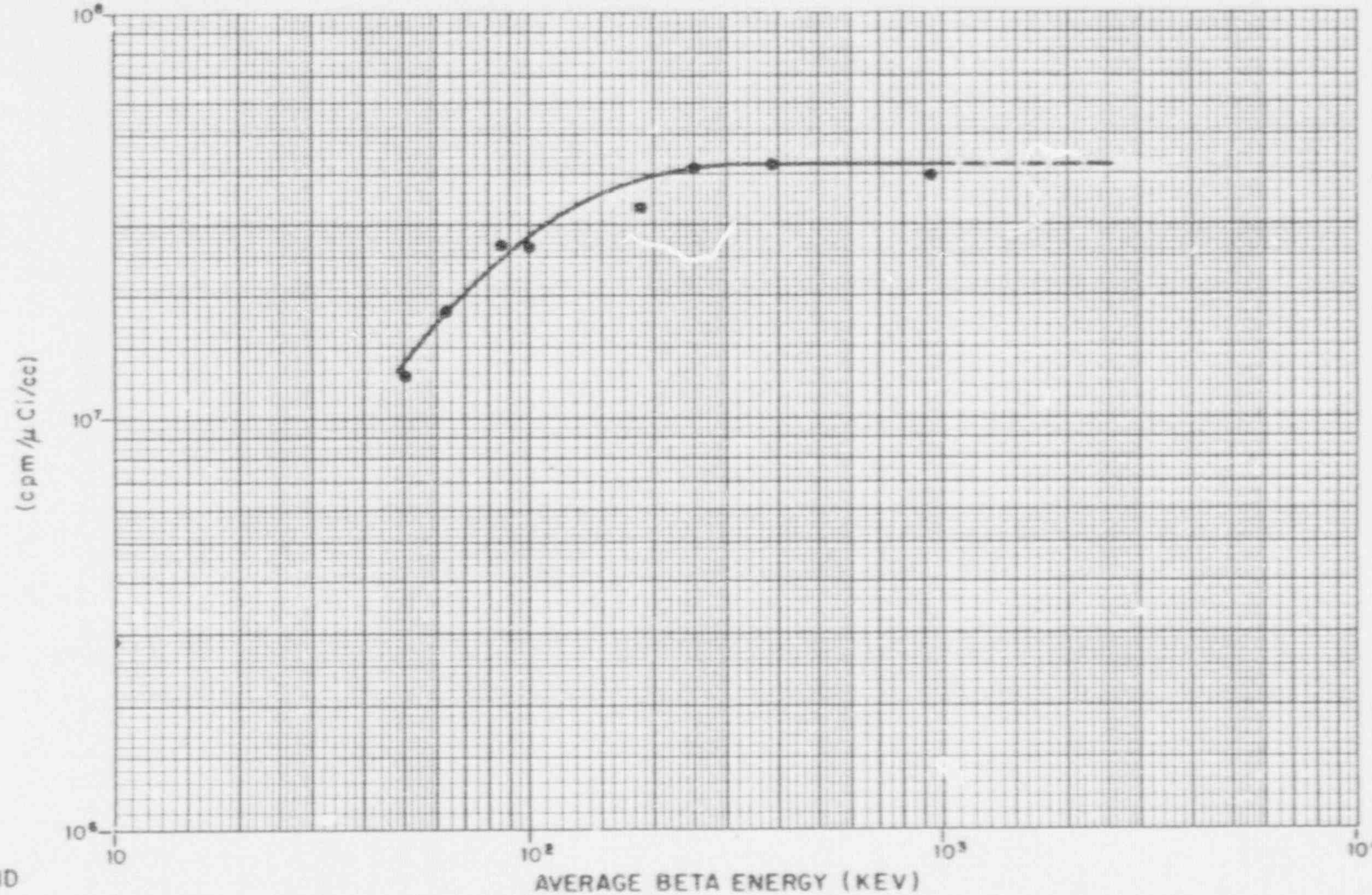
(1) $\frac{\text{mrad-m}^3}{\text{pCi-yr}}$

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

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

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

(5) $K_{sim} = (1.11 * DF_i^{\gamma}) + DFS_i$

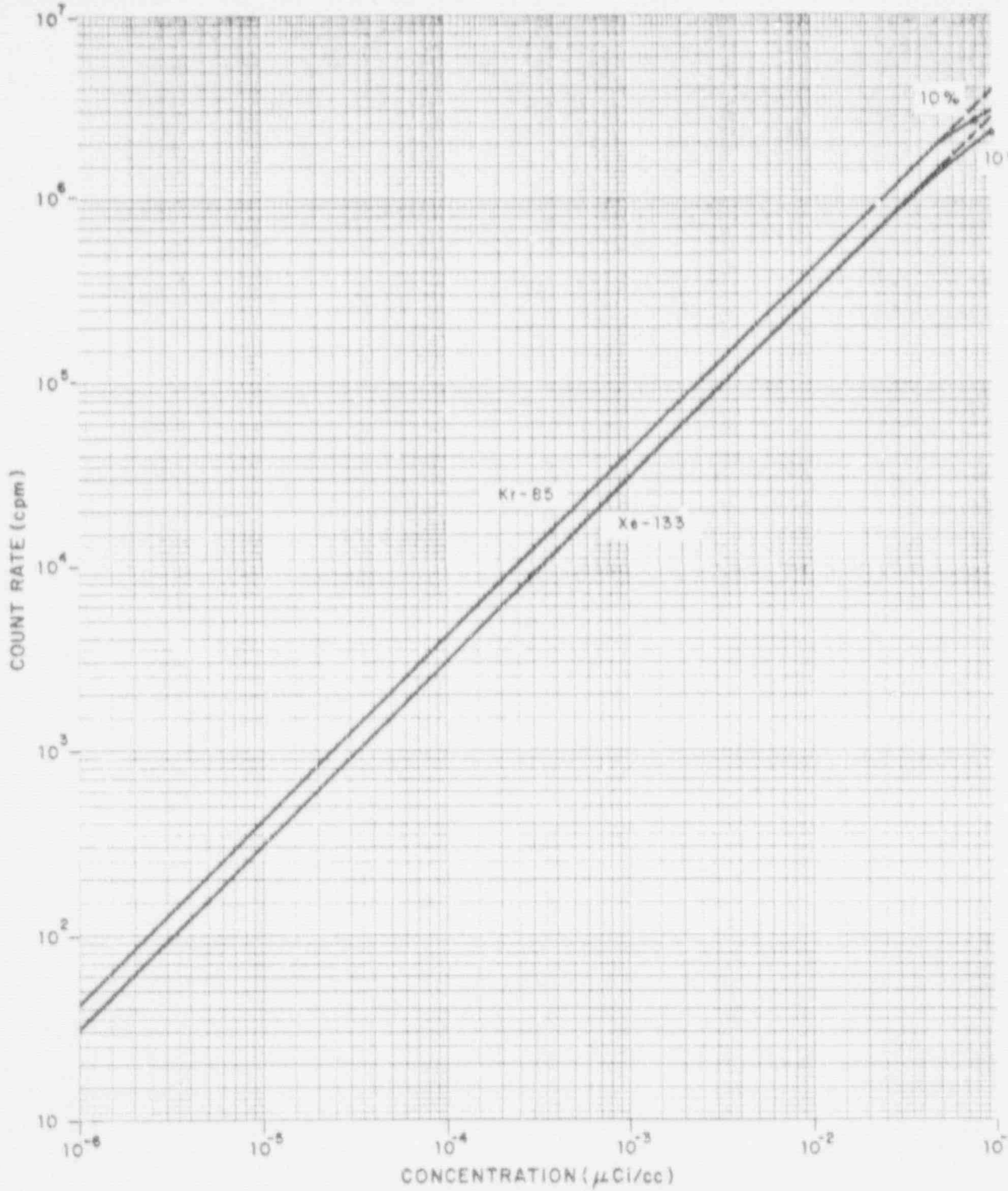


LEGEND

● 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
OFFSITE DOSE CALCULATION MANUAL



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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

PART II
SECTION 3

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

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 Part I Figure 5.1-3. The liquid radwaste system model is shown in Figure 3.1-1.

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:

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

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) (µCi/cc)

V = volume of liquid to be discharged (gallons)

3.785×10^{-3} = [(Ci/µCi) (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

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

$$R_{ja}^{ing\ fish} = 57.4/(K_2 + 0.930 \, K_3) \, U_{ap}^{fis} \sum_{part+I} Q_i \, b_{ip}^{fis} \, DFI_{ija} e^{-24 \lambda_i}$$

for service water

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
- $F_{pump,1}$ = 1.435x10⁵ [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 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_p (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 = $1100\ M_p/F_{pump,1}$ = 1100 x 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

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

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

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 x 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_p (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}^{e} (see below)

= shoreline exposure time for individual in age group a [hr/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

DFG_{i1} = 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 1.314×10^5 hours)

0.561 = $110{,}000\ M_p\ W\ (T_i \lambda_i)/\ F_{pump,1}$ [(pCi/ℓ)/(Ci/yr)]

= $110{,}000 \times 0.113 \times 0.5 \times (0.693/24)/\ 319.7$ for circ. water

82.9 = $110{,}000 W\ (T_i \lambda_i)\ F_{pump,2}$ [(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+I = 68 particulates and 5 iodines in the summation sign

(d) Skin Dose From Shoreline Deposits

$$R^{shore} = 0.561\ U_{ap}^{shore}\ (1/K_1) \sum_{part+I} Q_i\ DFG_{i2}\ \left(\frac{1-e^{-t_b \lambda_i}}{\lambda_i}\right) \text{ for circ. water}$$

$$= 82.9/(K_2 + 0.930\ K_3)\ U_{ap}^{shore} \sum_{part+I} Q_i\ DFG_{i2}\ \left(\frac{1-e^{-t_b \lambda_i}}{\lambda_i}\right)$$

for service water

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_{i2} = 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:

R_{ja} = $R_{ja}^{ing\ fish} + R_{ja}^{ing\ inv}$

$R_{wb,a}$ = $R_{wb,a}^{ing\ fish} + R_{wb,a}^{ing\ inv} + R_{wb,a}^{shore}$

$R_{skin,a}$ = $R_{skin,a}^{shore}$

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:

$$D_\tau = \sum_{i=1}^{N} [A_{i\tau} \sum_{\ell=1}^{M} \Delta t_\ell \; C_{i\ell} F_\ell] \qquad (3.1\text{-}1)$$

where:

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

$\sum_{\ell=1}^{M} \Delta t_\ell$ (mrem),

Δt_ℓ = the length of the ℓth release period over which $C_{i\ell}$ and F_ℓ are averaged for all liquid released (minutes),

$C_{i\ell}$ = the average concentration of radionuclide C_i in undiluted liquid effluent during release period Δt_ℓ from any liquid release (µCi/cc),

$A_{i\tau}$ = 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 µCi/cc), see Appendix A for derivation

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

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

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

$$D_{Total} = D_{\tau D} + D_{\tau R} + D_{\tau H} + D_{\tau S} + D_{\tau P}$$

where:

$D_{\tau D}$ = Dose contribution from discharge waste sample tanks as calculated in Equation 3.1-1

$D_{\tau R}$ = Dose contribution from recovery sample tanks as calculated in Equation 3.1-1

$D_{\tau H}$ = Dose contribution from RHR heat exchanger, service water as calculated in Equation 3.1-1

$D_{\tau S}$ = Dose contribution from reactor building salt water drain tank as calculated in Equation 3.1-1

$D_{\tau P}$ = 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.

TABLE 3.1-1

DECAY CONSTANTS (1/hr)

Radio-nuclide	Constant	Radio-nuclide	Constant
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		

TABLE 3.1-2

ADULT DOSE RATE CONVERSION FACTORS[1], $A_{i\tau}$

FOR (FISH AND INVERTEBRATE) INGESTION PATHWAY
(mrem/min per Ci/cc)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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+00	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	5.2E-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

TABLE 3.1-2 (CONT'D)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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.

TABLE 4-1 (Cont'd.)

		A	B	C	D
Long Term Relative Deposition Factor for Station Ventilation Exhaust D/Q_1	9	N/A	N/A	5.16E-08 m^{-2} (3)	5.16E-08 m^{-2} (3)
	10	5.16E-08 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-6-120, Rev. 0, and NED calculation CC1#039215, Rev. 0.

TABLE 4-2

GENERAL SITE SPECIFIC DATA

PARAMETER	VALUE
Elevation of lower-level met. instruments	33 ft above ground level
Elevation of upper-level met. instruments	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	σ_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

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 3.12.1-1, (Page I.3-37), 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 5-1, 5-2, 5-3 and 5-4, 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 (REMP)
DIRECT RADIATION MONITORING STATIONS

Functional Designation (NUREG-0473)	Location Code (Shoreham REMP)	Location Description
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
DR30	12G1	Central Islip Substation, 19.9 mi. WSW
DR31	11G1	MacArthur Substation, 16.6 mi. SW

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL
MONITORING PROGRAM (REMP)
AIRBORNE MONITORING STATIONS

Functional Designation (NUREG-0473)	Location Code (Shoreham REMP)	Location Description
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

TABLE 5-3

RADIOLOGICAL ENVIRONMENTAL
MONITORING PROGRAM (REMP)
WATERBORNE MONITORING STATIONS

Functional Designation (NUREG-0473)	Location Code (Shoreham REMP)	Location Description
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
Wd1	2A4	Sediment, beach, 0.4 mi. NNE

TABLE 5-4

RADIOLOGICAL ENVIRONMENTAL
MONITORING PROGRAM (REMP)
INGESTION MONITORING STATIONS

Functional Designation (NUREG-0473)	Location Code (Shoreham REMP)	Location Description
Ia, Ia2	Not Used	
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 Farm, 1.8 Mi. ESE
Ic3	12H1 or 12H2	Food Products, Background Farm, 26 Mi. WSW Food Products, Background Farm, 32.1 Mi WSW

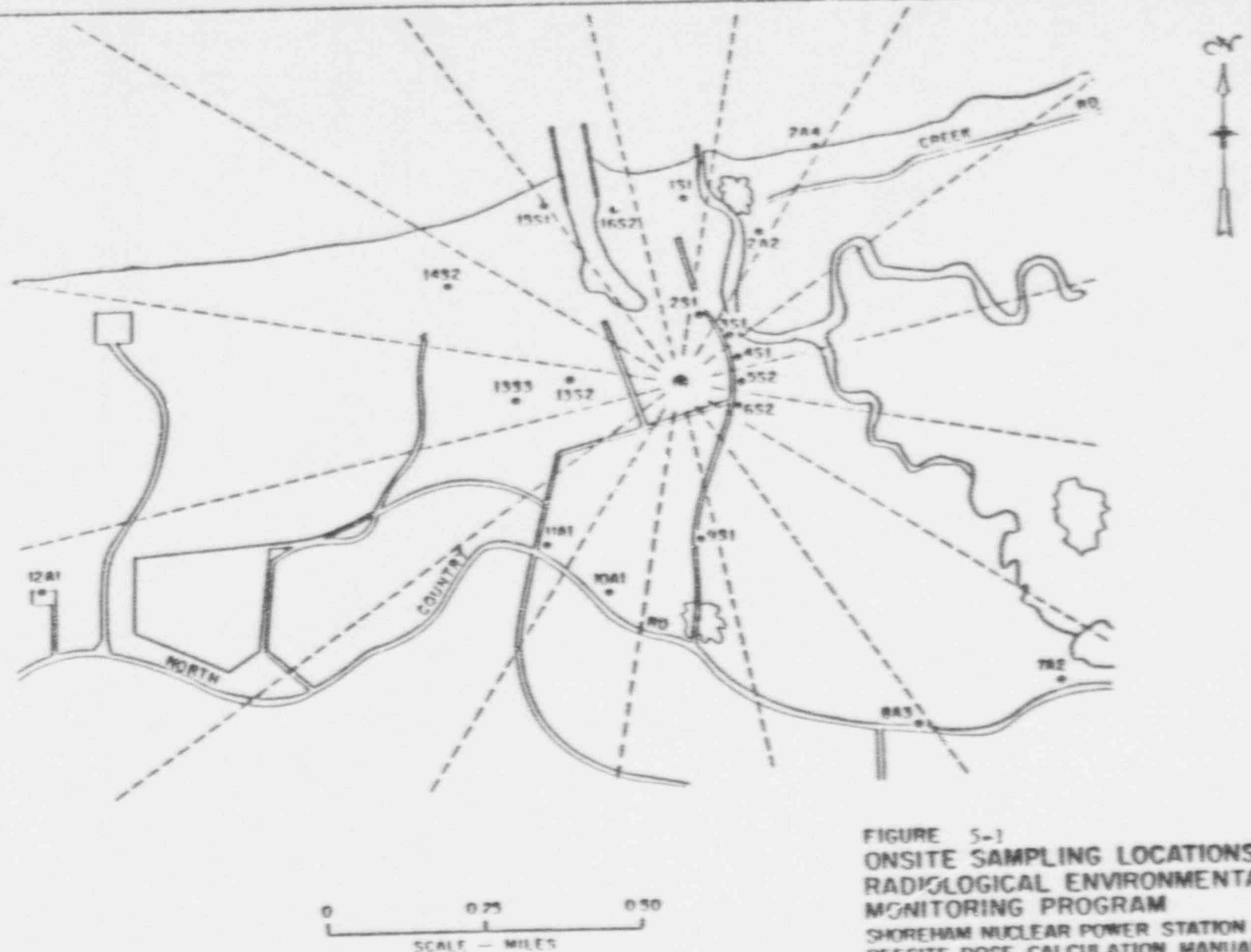

FIGURE 5-1
ONSITE SAMPLING LOCATIONS
RADIOLOGICAL ENVIRONMENTAL
MONITORING PROGRAM
SHOREHAM NUCLEAR POWER STATION - UNIT 1
OFFSITE DOSE CALCULATION MANUAL

Revision 17 - May 1991

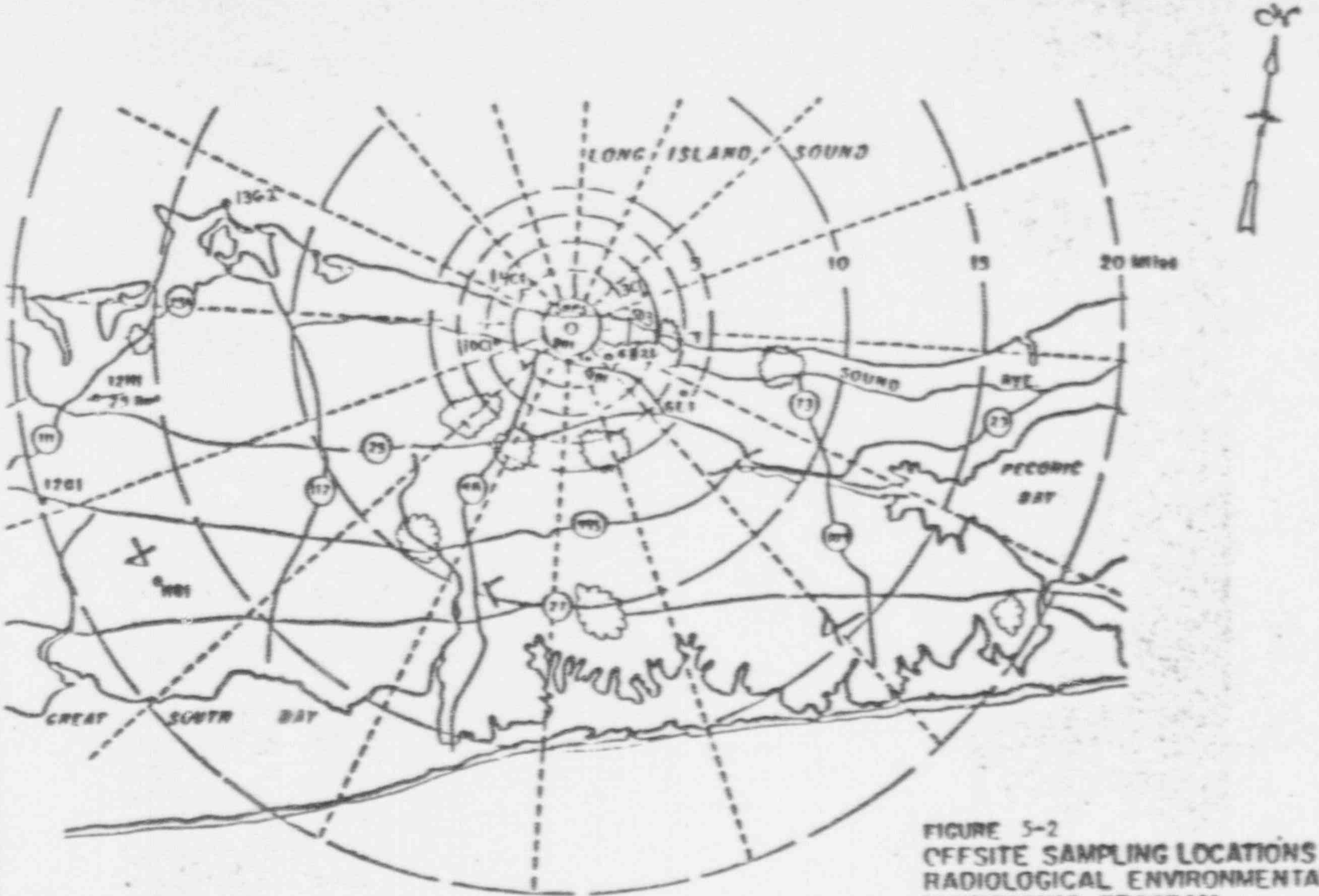

FIGURE 5-2
OFFSITE SAMPLING LOCATIONS
RADIOLOGICAL ENVIRONMENTAL
MONITORING PROGRAM
SHOREHAM NUCLEAR POWER STATION-UNIT I
OFFSITE DOSE CALCULATION MANUAL

Revision 17 - May 1991

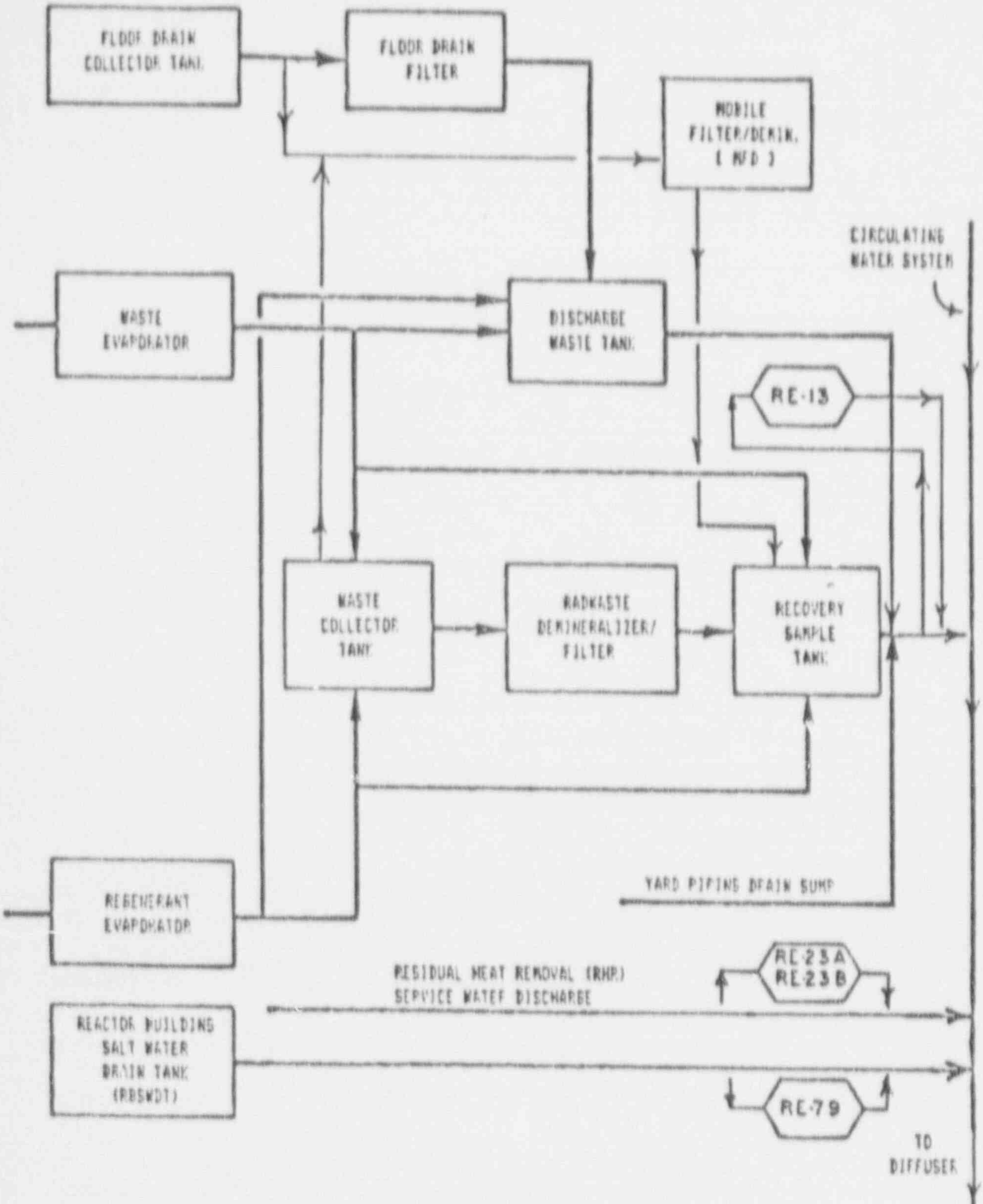

FIGURE 3.1-1

LIQUID RADWASTE SYSTEM MODEL

SHOREHAM NUCLEAR POWER STATION UNIT 1

OFFSITE DOSE CALCULATION MANUAL

REVISION 17, MAY 1991

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, RBSWDT, 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:

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

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

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

$F_s(j)$ = vent flow during time interval j (cfm)

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

t = time interval (=1 minute)

q_i = concentration of isotope i in the effluent as measured in the lab at time τ (μCi/cc)

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

4×15 = number of t 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:

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

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

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

D_{wb}^{cloud} = 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 (χ/Q) and the DFB_i instead of DF_i^{γ} dose conversion

D_{wb}^{inh} = 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} = 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 = gamma dose to body conversion factor [(mrem/yr)/(pCi/m³)] (from Table B-1 of the guide)

$DFA_{ij,ad}$ = 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} = total body conversion factor for standing on contaminated ground [(mrem/hr)/(pCi/m²)] (from Table E-6 of Reg. Guide 1.109)

$(\chi/Q)^{sa}$ = concentration dispersion factor (sector-average model) for the period of release (site boundary only) (sec/m³)

$(\chi/Q)_{\gamma}^{sa}$ = gamma (χ/Q) (finite cloud sector-average model) for the period of release (site boundary only) (sec/m³)

(D/Q) = particulate deposit' n rate (site boundary only) (1/m²)

$F'\ f_i$ = Q_i (Ci/hr) (as defi.ed in Section 3.3.1.1)

R_{ad} = adult breathing rate (m³/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 1.109 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

3.3.1.3 Skin Dose Rate

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

where:

$$D_{skin}^{cloud} = 1.11 \times 0.7\ (\chi/Q)_{\gamma}^{sa}\ F'\ 3.17 \times 10^4 \sum_{nobles} f_i\ DF_i^{\gamma} + (\chi/Q)^{sa}\ F'\ 3.17 \times 10^4 \sum_{nobles} f_i\ DFS_i$$

$$D_{skin}^{ground} = (D/Q)\ F'\ 7 \times 10^{11} \sum_{part+I} f_i\ DFG_{i2}\ [1 - e^{-t_b \lambda_i}]/\lambda_i$$

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 (χ/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)

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 (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)

$$D_{ja}^{inh} = (\chi/Q^{sa}\ F'\ 3.17 \times 10^4\ R_a) \sum_{part+I} f_i DFA_{ija}$$

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

The following equation should be used:

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

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),

V_1 = 1.73E+08 cc/sec (3.66E+05 cfm), station ventilation exhaust duct 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,

0.70 = shielding factor that accounts for dose reduction due to shielding from residential structures.

3.3.2.2 Noble Gas Skin Dose Rate

The following equation should be used:

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

where:

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

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),

V_1 = 1.73E+08 cc/sec (3.66E+05 cfm), station ventilation exhaust duct ventilation exhaust flow rate,

X/Q_1 = long term dispersion factor due tc release via the station ventilation exhaust point; refer to Table 4-1, cells A1 and A3,

3.3.2.3 Organ Dose Rate (Particulate Releases)

The following equation should be used:

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

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, (uCi/cc) (from the isotopic analyses performed on the filter paper and charcoal cartridge taken from the station ventilation exhaust monitor),

V_1 = 1.70E+08 cc/sec (3.60E+05 cfm), station ventilation exhaust duct 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,

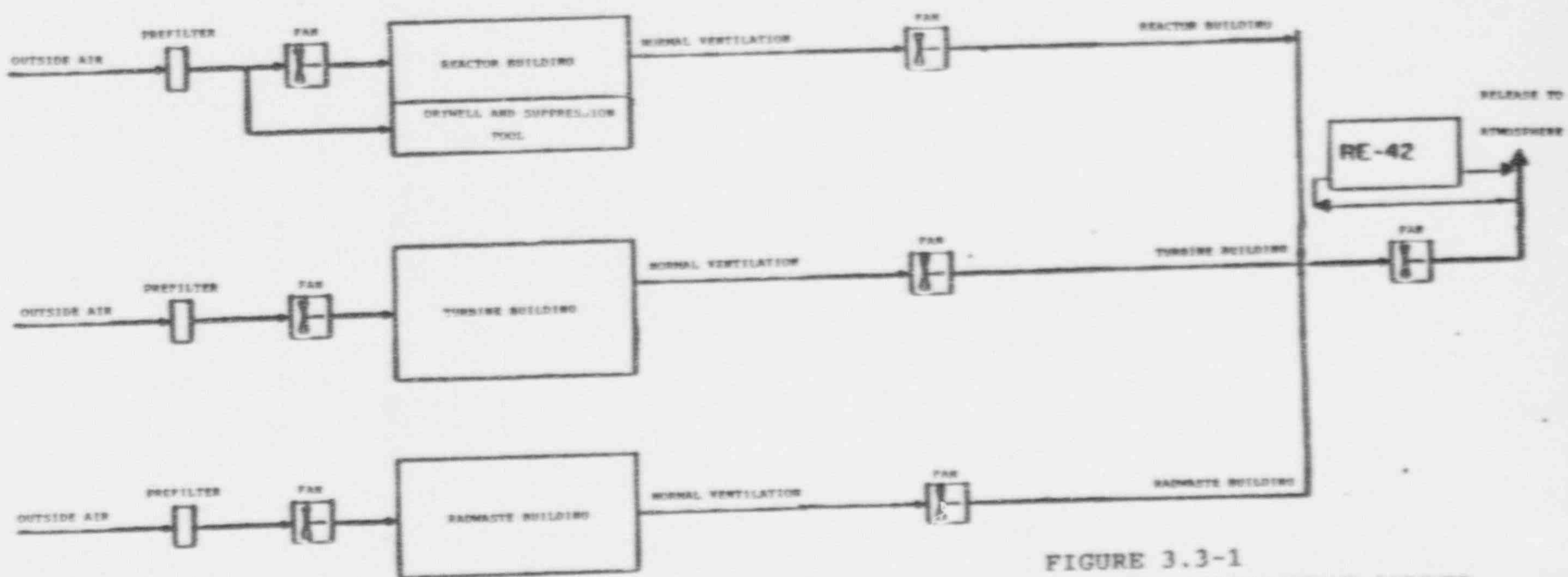

FIGURE 3.3-1
GASEOUS EFFLUENT MODEL
SHOREHAM NUCLEAR POWER STATION-UNIT 1
OFFSITE DOSE CALCULATION MANUAL
REVISION 17 - MAY 1991

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

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):

$$Qi = F' f_i$$

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 = 2.832×10^4 (cc/ft³)

$F_s(j)$ = vent flow rate during interval j (cfm)

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

Δt = time interval (= 1 minute)

q_i = concentration of isotope i in the effluent as measured in the lab at time τ (μCi/cc)

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

60 = number of Δt intervals per hour (1/hr)

3.4.1.2 Noble Gas Gamma Air Dose

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

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 $(\chi/Q)_{\gamma}$

$(\chi/Q)_{\gamma}^{sa}$ = finite-cloud sector-average 'gamma' dilution factor at the downwind site-boundary [sec/m³]

DF_i^{γ} = gamma dose to air conversion factor (from Table B-1 of Reg. Guide 1.109) [(mrad/yr)/(pCi/m³)]

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

3.4.1.3 Noble Gas Beta Air Dose

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

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) [(mrad/yr)/(pCi/m³)]

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

$(\chi/Q)^{sa}$ = sector-average concentration dilution factor at the site boundary during the period of release [sec/m³]

3.4.2 Method 2: (Backup Method)

3.4.2.1 Noble Gas Gamma Air Dose

The following equation should be used:

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

where:

D_{GS} = 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 Ci/m³) from Table 3.4-1,

t_1 = 7.88E+06 sec for quarterly dose calculation,
= 3.15E+07 sec for yearly dose calculation

C_{i1} = the station ventilation exhaust duct release concentration of radionuclide, i, (Ci/cc) (from the isotopic analyses performed on the gaseous sample taken from the station ventilation exhaust monitor),

V_1 = 1.73E+08 cc/sec (3.66E+05 cfm), station ventilation exhaust duct 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,

3.4.2.2 Noble Gas Beta Air Dose

The following equation should be used:

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

where:

D_{BS}	=	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 uCi/m³) from Table 3.4-1,
3.17E-08	=	the inverse o.' number of seconds in a year,
t_1	=	7.88E+06 sec for quarterly dose calculation,
	=	3.15E+07 sec for yearly dose calculation,
C_{i1}	=	the station ventilation exhaust duct release concentration of radionuclide, i, (uCi/cc) (from the isotopic analyses performed on the gaseous sample taken from the station ventilation exhaust monitor),
V_1	=	1.73E+08 cc/sec (3.66E+05 cfm), station ventilation exhaust duct 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,

TABLE 3.4-1

NOBLE GAS DOSE FACTORS

Isotope	Gamma Air Dose Factor M_i (mrad/yr per µCi/m³)	Beta Air Dose Factor N_i (mrad/yr per µCi/m³)
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
Xe - 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	9.3E+03	3.3E+03

3.5 GASEOUS EFFLUENTS, DOSE DUE TO 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 particulate 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 = 2.832×10^4 (cc/ft³)

$F_s(j)$ = vent flow rate during interval j (cfm)

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

Δt = time interval (= 1 minute)

q_i = concentration of isotope i in the effluent as measured in the lab at time τ (μCi/cc)

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

60 = number of Δt intervals per hour (1/hr)

3.5.1.2 Total Body Dose

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

where:

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

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

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

D_{wb}^{cloud} = 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 (χ/Q) and the DFB_i^{γ} instead of dose conversion factor)

D_{wb}^{inh} = 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} = 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 = gamma dose to body conversion factor [(mrem/yr)/(pCi/m³)] (from Table B-1 of the Reg. Guide)

$DFA_{ij,ad}$ = 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} = total body conversion factor for standing on contaminated ground [(mrem/hr)/(pCi/m²)] (from Table E-6 of Reg. Guide 1.109)

$(\chi/Q)^{sa}$ = concentration dispersion factor (sector-average model) for the period of release (site boundary only) (sec/m³)

$(\chi/Q)^{sa}_{\gamma}$	=	gamma (χ/Q) (finite cloud sector-average model) for the period of release (site boundary only) (sec/m³)
(D/Q)	=	particulate deposition rate (site boundary only) (1/m²)
$F' f_i$	=	Q_i (Ci/hr) (as defined in Section 3.5.1.1)
R_{ad}	=	adult breathing rate (m³/yr) (from Table E-5)
λ_i	=	radionuclide decay constant (1/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

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

where:

$$D^{cloud}_{skin} = 1.11 \times 0.7\,(\chi/Q)^{sa}_{\gamma}\,F'\,3.17 \times 10^4 \sum_{nobles} f_i\,DF^{\gamma}_i$$

$$+ (\chi/Q)^{sa}\,F'\,3.17 \times 10^4 \sum_{nobles} f_i\,DFS_i$$

$$D_{skin}^{ground} = (D/Q)\ F'\ 7 \times 10^{11} \sum_{part+I} f_i\ DFG_{i2}\ [1 - e^{-t_b \lambda_i}]/\lambda_i$$

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 (χ/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)

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

$$D_{ja}^{inh} = (\chi/Q)^{sa} F' \, 3.17 \times 10^{4} R_a \sum_{part+I} f_i \, DFA_{ija}$$

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)

$(\chi/Q)^{sa}$ = concentration dispersion factor (Sector-Average model) for the period of release (nearest garden and nearest residence) [sec/m³]

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:

$$(D_{ja}^{ing})_{part} = (D/Q) F' \, 1.1 \times 10^{8} \sum_{part} U_a^L f_i \, DFI_{ija} \times \left[\frac{0.2}{2(\lambda_i + 0.0021)} + \frac{B_{iv}}{240\lambda_i}\right] e^{-24\lambda_i}$$

$$(D_{ja}^{ing})_{iodines} = (D/Q) F' \, 5.5 \times 10^{7} \sum_{iodines} U_a^L f_i \, DFI_{ija} \times \left[\frac{1.0}{2(\lambda_i + 0.0021)} + \frac{B_{iv}}{240\lambda_i}\right] e^{-24\lambda_i}$$

$$(D_{ja}^{ing})_{C14} = (\chi/Q)^{sa} F' \, 5.5 \times 10^{7} U_a^L f_{C14} \, DFI_{C14,ja}$$

$$(D_{ja}^{ing})_{H3} = (\chi/Q)^{sa} F' \left(\frac{1.2 \times 10^{7}}{H}\right) U_a^L f_{H3} \, DFI_{H3,ja}$$

$(D_{ja}^{ing})_{part}$ = 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_e (time period that crops are exposed to contamination during growing season) = [hrs]
- ° t_b (time period over which the accumulation is evaluated) = [hrs]
- ° t_h (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)
- ° δ_i (r,θ) = (D/Q) [m^{-2}]
- ° f_ℓ (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)

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)

$(\chi/Q)^{sa}$ = 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: Rev. 12

$$D_{thy,inf} = D^{inh}_{thy,inf} + D^{milk}_{thy,inf}$$

where:

$$D^{milk}_{thy,inf} = (D^{milk}_{thy,inf})_{part} + (D^{milk}_{thy,inf})_{iodines} + (D^{milk}_{thy,inf})_{C14} + (D^{milk}_{thy,inf})_{H3}$$

$$D^{inh}_{thy,inf} = (\chi/Q)^{sa}\ F'\ 3.17 \times 10^4\ R_{inf} \sum_{part+I} f_i\ DFA_{i,thy,inf}$$

$$(D^{milk}_{thy,inf})_{part} = (D/Q)\ F'\ 1.1 \times 10^8 \sum_{part} U^m_{inf}\ f_i\ DFI_{i,thy,inf}$$

$$\times\ 6\ F_{mi} \left[\frac{0.2}{0.7[\lambda_i + 0.0021)} + \frac{Biv}{240\lambda_i}\right] e^{-24\lambda_i}$$

$$(D^{milk}_{thy,inf})_{iodines} = (D/Q)\ F'\ 5.5 \times 10^7 \sum_{iodines} U^m_{inf}\ f_i\ DFI_{i,thy,inf}$$

$$\times\ 6\ F_{mi} \left[\frac{1.0}{0.7(\lambda_i + 0.0021)} + \frac{B_{iv}}{240\lambda_i}\right] e^{-24\lambda_i}$$

$$(D^{milk}_{thy,inf})_{C14} = (\chi/Q)^{sa}\ F'\ 2.2 \times 10^7\ U^m_{inf}\ f_{C14}\ DFI_{C14,thy,inf}$$

$$\times\ 6\ f_{m,C14}\ \exp(-24\lambda_{C14})$$

$$(D^{milk}_{thy,inf})_{H3} = (\chi/Q)^{sa}\ F' \left[\frac{1.2 \times 10^7}{H}\right] U^m_{inf}\ f_{H3}\ DFI_{H3,thy,inf}$$

$$\times\ 6\ F_{m,H3}\ \exp(-24\lambda_{H3})$$

$D^{inh}_{thy,inf}$ = infant thyroid dose due to inhalation of airborne radioactivity [mrem/hr] (Ref.: Reg. Guide 1.109, Eqs. C-3 and C-4)

$(D^{milk}_{thy,inf})_{part}$ = 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_e (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) = 0 [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]

- λ_{Ei} = λi + 0.0021 [hr^{-1}] (see pgs 1.109-4 and 1.109-69)
- $\delta_i (r,\theta)$ = (D/Q) [m^{-2}]
- 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

$(D^{milk}_{thy,inf})_{iodines}$ = 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)

$(D^{milk}_{thy,inf})_{C14}$ = 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)

$(D^{milk}_{thy,inf})_{H3}$ = 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 [m³/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

F_{C14}	=	f_i for Carbon-14 (see Section 3.5.1.1 above)
F_{H3}	=	f_i for tritium
U^m_{inf}	=	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)
6	=	amount of feed consumed by a goat per day [kg/day] (from Table E-3 of the Guide, Q_F factor)
$(\chi/Q)_{sa}$	=	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]

3.5.2 Method 2: (Backup Method)

3.5.2.1 Organ Doses:

The following equation should be used:

$$D_j = 3.17E\text{-}08 * V_1 * t_1 * \sum_i [(10^6 * R_a * P_{ij} * X/Q_1 + P_{oij} * D/Q_1) * C_{i1}] \quad \text{(mrem)} \qquad (3.5.2\text{-}1)$$

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 3.5-3.

P_{ij} values listed in Table 3.5-15 and 3.5-16 respectively are the dose rate conversion factors for tritium and carbon-14 from inhalation and ingestion of leafy and stored vegetables and ingestion of goat's milk.

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 contaminated ground, ingestion of leafy and stored vegetables in m^2(mrem/yr per uCi/sec) from Table 3.5-9.

The dose factors P_{ij}, P_{oij} are based on the critical individual organ for the child 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,

C_{i1} = the station ventilation exhaust duct release concentration of radionuclide, i, (uCi/cc) (from the isotopic analyses performed on the filter cartridge taken from the station ventilation exhaust monitor),

V_1 = 1.73E+08 cc/sec (3.66E+05 cfm), station ventilation exhaust duct 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,

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,

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_{oij} 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.

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	1.81E-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

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-[illegible]	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	3.1[illegible]-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	9.10E-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

TABLE 3.5-1 (CONT'D)

Radio-nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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	1.05E-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

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

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	9.30E-06
Te-127m	2.25E-06	1.02E-06	2.73E-07	5.48E-07	8.17E-06	2.07E-04	1.99E-05
Te-127	2.51E-10	1.14E-10	5.52E-11	1.77E-10	9.10E-10	1.40E-06	1.01E-05
Te-129m	1.74E-06	8.23E-07	2.81E-07	5.72E-07	6.49E-06	2.47E-04	5.06E-05
Te-129	8.87E-12	4.22E-12	2.20E-12	6.48E-12	3.32E-11	4.12E-07	2.02E-07
Te-131m	1.23E-08	7.51E-09	5.03E-09	9.06E-09	5.49E-08	2.97E-05	7.76E-05
Te-131	1.97E-12	1.04E-12	6.30E-13	1.55E-12	7.72E-12	2.92E-07	1.89E-09
Te-132	4.50E-08	3.63E-08	2.74E-08	3.07E-08	2.44E-07	5.61E-05	5.79E-05
I-130	7.80E-07	2.24E-06	8.96E-07	1.86E-04	3.44E-06	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-0	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

TABLE 3.5-2 (CONT'D)

Radio-nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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

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-0[illegible]	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-LLI
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-06	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

TABLE 3.5-3 (CONT'D)

Radio-nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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	2.22F-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

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	1.00E-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

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
Te-132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I-130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	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	3.18E-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)

Radio-nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ce-141	1.98E-05	1.19E-05	1.42E-06	No Data	3.75E-06	3.69E-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

Pathway	Infant	Child	Teen	Adult
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	3.8	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)]

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(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	5.3E-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	3.1E-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	7.7E-02
I	2.0E-02	6.0E-03[4]	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	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.

TABLE 3.5-7

HUMIDITY PARAMETERS AT RECEPTORS

<u>Monthly Average Absolute Humidity (gm/m³)</u>

January	3.06
February	3.09
March	3.83
April	5.71
May	8.19
June	12.62
July	15.53
August	14.62
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 Distance* (Meters)	Nearest Site Boundary Elevation** (Meters)	Nearest Residence(+) Distance* (Meters)	Nearest Residence(+) Elevation** (Meters)	Nearest Vegetable Garden(+) Distance* (Meters)	Nearest Vegetable Garden(+) Elevation** (Meters)	Nearest Milk Animal(++) Distance* (Meters)	Nearest Milk Animal(++) 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	18.2	-	-
SE	1105	26.0	1007	19.8	1260	21.3	-	-
SSE	876	30.0	789	30.8	1920	51.4	-	-
S	610	25.0	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 3862 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

P_{oij}

CONTAMINATED GROUND, INGESTION OF LEAFY AND STORED VEGETABLES DOSE RATE CONVERSION FACTORS FOR CHILD
m^2(mrem/yr/μCi/sec)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
N-13	4.0E+04	4.0E+04	4.0E+04	4.0E+-4	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.[illegible]E+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-91M	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

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
!C-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	3.08+09
TE-125M	4.2E+08	1.1E+08	5.7E+07	1.2E+08	1.6E+06	1.6E+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	9.7E08	2.9E+08	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
I-130	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	3.6E+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

TABLE 3.5-9 (CONT'D)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
PR-143	1.4E+05	4.2E+04	6.8E+03	-	2.3E+04	-	1.5E+08
PR-144	1.8E+03	1.8E+03	1.[illegible]E+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
m²(mrem/yr/μCi/sec)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
F-18	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

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	4.3E+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	1.3E+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	9.7E+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	3.3+02	9.8E+01	1.6E+01	-	5.3E+01	-	3.5E+05

TABLE 3.5-10 (CONT'D)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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_{oij}

CHILD INGESTION OF GOAT'S MILK DOSE RATE CONVERSION FACTORS
m^2 (mrem/yr/μCi/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
SB-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	3.1E+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-LLI
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 DOSE RATE CONVERSION FACTORS
m^2 (mrem/yr/µCi/sec)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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+08
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+00	-	-	-	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.[illegible]-12 (CONT'D)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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
TE-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)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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/µCi/sec)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
F-18	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	-	-	2.2E+07	5.8E+06
FE-59	1.0E+08	1.8E+08	7.0E+07	-	-	5.2E+07	8.4E+07
CO-58	-	1.1E+07	2.8E+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+U0	-	2.9E-02	-	-	-	8.6E+03
ZR-95	3.1E+03	7.7E+02	5.4E+02	-	8.3E+02	-	3.8E+05

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-02	-	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	3.2E+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	2.3E+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	6.7E+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)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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_{oij}

INFANT INGESTION OF GOAT'S MILK DOSE RATE CONVERSION FACTORS
m² (mrem/yr/μCi/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	9.3E+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

TABLE 3.5-14 (CONT'D)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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.

TABLE 3.5-16

P_{ij}

CHILD INGESTION OF GOAT'S MILK DOSE RATE CONVERSION FACTORS
(mrem per pCi)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
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 [No Longer in Use]

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 tower are used in the computerized method, to determine X/Q and D/Q values at the locations given in Table 3.5.-8.

4.2.2 Long-Term X/Q and D/Q Values

Sector-average atmospheric concentration dispersion factors $(X/Q)^{SA}$, gamma dispersion factors $(\bar{X}/Q)^{SA}$ and relative deposition factors (D/Q) are calculated every hour using 60 one-minute meteorological data values obtained from the meteorological tower. 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 $(X/Q)^{SA}$ 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.

(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 XOQDOQ 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 XOQDOQ 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 tower.

(f) Sector- average $(X/Q)^{SA}$ 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.

(h) 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.

(i) 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:

Calculated Effective Height Range (m)	Applicability Regulatory Guide 1.111 Rev. 1 Curve
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" $(\chi/Q)^{SA}$ which permit evaluation of external air and whole body doses from finite clouds of multi-energetic gamma sources. The basic definition of the χ/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 χ/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 χ/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

	A	B	C	D
REC 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: 458 meters, NNE	457 meters, ESE	[illegible]8 meters, NNE	458 meters, NNE
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 X/Q_1	3 6.6E-07 sec/m³ (1) 4 1.33E-06 sec/m³ (3)	8.44E-07 sec/m³ (2)	1.[illegible] sec/m³ (3)	[illegible].33E-06 sec/m³ (3)