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STATION

OFFSITE DOSE CALCULATION MANUAL

(ODCM)

1. Does this manual/manual revision:

   a. Make changes in the facility as described in the FSAR? ☐ Yes ☑ No
   b. Make changes in procedures as described in the FSAR? ☐ Yes ☑ No
   c. Involve tests or experiments not described in the FSAR? ☐ Yes ☑ No
   d. Involve changes to the existing Operating License or require additional license requirements? ☐ Yes ☑ No

2. If any of the above questions are answered yes, a safety evaluation per NHY Procedure 11210 is required.

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ABSTRACT

The Seabrook Station Offsite Dose Calculation Manual is divided into two parts: (1) the Radiological Effluent Controls Program for both in-plant radiological effluent monitoring of liquids and gases, along with the Radiological Environmental Monitoring Program (REMP) (Part A); and (2) approved methods to determine effluent monitor setpoint values and estimates of doses and radionuclide concentrations occurring beyond the boundaries of the Station resulting from normal Station operation (Part B).

The sampling and analysis requirements of the Radioactive Effluent Controls Program, specified in Part A, provide the inputs for the models of Part B in order to calculate offsite doses and radionuclide concentrations necessary to determine compliance with the dose and concentration requirements of the Station Technical Specification 6.7.4.g. The REMP required by Technical Specification 6.7.4.h, and as specified within Part A, with sample point locations listed in Part B, provides the means to determine that measurable concentrations of radioactive materials released as a result of the operation of Seabrook Station are not significantly higher than expected.

TABLE OF CONTENTS

CONTENT PAGE

PART A: RADIOLOGICAL EFFLUENT MONITORING PROGRAMS

1.0 INTRODUCTION A.1-1

2.0 RESPONSIBILITIES FOR PART A A.2-1

3.0 LIQUID EFFLUENT SAMPLING AND ANALYSIS PROGRAM A.3-1

4.0 GASEOUS EFFLUENT SAMPLING AND ANALYSIS PROGRAM A.4-1

5.0 RADIOGICAL ENVIRONMENTAL MONITORING A.5-1

5.1 SAMPLING AND ANALYSIS PROGRAM A.5-1

5.2 LAND USE CENSUS A.5-2

PART B: RADIOLOGICAL CALCULATIONAL METHODS AND PARAMETERS

1.0 INTRODUCTION B.1-1

RESPONSIBILITIES FOR PART B B.1-1

1.2 SUMMARY OF METHODS, DOSE FACTORS, LIMITS, CONSTANTS, VARIABLES AND DEFINITIONS B.1-1

2.0 METHOD TO CALCULATE OFF-SITE LIQUID CONCENTRATIONS B.2-1

2.1 METHOD TO DETERMINE F_1^{ENG} AND C_1^{NG} B.2-1

2.2 METHOD TO DETERMINE RADIONUCLIDE CONCENTRATION FOR EACH LIQUID EFFLUENT PATHWAY B.2-2

2.2.1 Waste Test Tanks Pathway B.2-2
2.2.2 Turbine Building Sump Pathway B.2-3
2.2.3 Steam Generator Blowdown Flash Tank Pathway B.2-3

3.0 OFF-SITE DOSE CALCULATION METHODS B.3-1

3.1 INTRODUCTORY CONCEPTS B.3-1

3.2 METHOD TO CALCULATE TOTAL BODY DOSE FROM LIQUID RELEASES B.3-3

3.3 METHOD TO CALCULATE MAXIMUM ORGAN DOSE FROM LIQUID RELEASES B.3-6

3.4 METHOD TO CALCULATE THE TOTAL BODY DOSE RATE FROM NOBLE GASES B.3-8

SUPERSEDED

TABLE OF CONTENTS

CONTENT PAGE

PART B: RADIOLOGICAL CALCULATIONAL METHODS AND PARAMETERS

3.0 OFF-SITE DOSE CALCULATION METHODS

3.5 METHOD TO CALCULATE THE SKIN DOSE RATE FROM NOBLE GASES B.3-11

3.6 METHOD TO CALCULATE THE CRITICAL ORGAN DOSE RATE FROM IODINES, TRITIUM AND PARTICULATES WITH $T_{1/2}$ GREATER THAN 8 DAYS B.3-14

3.7 METHOD TO CALCULATE THE GAMMA AIR DOSE FROM NOBLE GASES B.3-17

3.8 METHOD TO CALCULATE THE BETA AIR DOSE FROM NOBLE GASES B.3-19

3.9 METHOD TO CALCULATE THE CRITICAL ORGAN DOSE FROM TRITIUM, IODINES AND PARTICULATES B.3-21

3.10 METHOD TO CALCULATE DIRECT DOSE FROM PLANT OPERATION B.3-23

3.11 DOSE PROJECTIONS B.3-24

4.0 ENVIRONMENTAL MONITORING PROGRAM B.4-1

5.0 SETPOINT DETERMINATIONS B.5-1

5.1 LIQUID EFFLUENT INSTRUMENTATION SETPOINTS B.5-2

5.2 GASEOUS EFFLUENT INSTRUMENTATION SETPOINTS B.5-9

6.0 LIQUID AND GASEOUS EFFLUENT STREAMS, RADIATION MONITORS, AND RADWASTE TREATMENT SYSTEMS B.6-1

7.0 BASES FOR DOSE CALCULATION METHODS B.7-1

8.0 BASES FOR LIQUID AND GASEOUS MONITOR SETPOINTS B.8-1

REFERENCES R-1

SUPERSEDED

LIST OF TABLES

NUMBER	TITLE	PAGE
	PART A	
A.3-1	Radioactive Liquid Waste Sampling and Analysis Program	A.3-2
A.4-1	Radioactive Gaseous Waste Sampling and Analysis Program	A.4-2
A.5-1	Radiolgical Environmental Monitoring Program	A.5-3
A.5-2	Detection Capabilities for Environmental Sample Analysis	A.5-7
A.5-3	Reporting Levels for Radioactivity Concentration in Environmental Samples	A.5-10
	PART B	
B.1-1	Summary of Radiological Effluent Technical Specifications and Implementing Equations	B.1-3
B.1-2	Summary of Method I to Calculate Unrestricted Area Liquid Concentrations	B.1-6
B.1-3	Summary of Method I to Calculate Off-Site Doses from Liquid Releases	B.1-7
B.1-4	Summary of Method I to Calculate Dose Rates	B.1-8
B.1-5	Summary of Method I to Calculate Doses to Air from Noble Gases	B.1-9
B.1-6	Summary of Method I to Calculate Dose to an Individual from Tritium, Iodine and Particulates	B.1-10
B.1-7	Summary of Methods for Setpoint Determinations	B.1-11
B.1-8	Summary of Variables	B.1-12
B.1-9	Definition of Terms	B.1-16
B.1-10	Dose Factors Specific for Seabrook Station for Noble Gas Releases	B.1-17
B.1-11	Dose Factors Specific for Seabrook Station for Liquid Releases	B.1-18

SUPERSEDED

LIST OF TABLES

NUMBER	TITLE	PAGE
	PART B (Continued)	
B.1-12	Dose and Dose Rate Factors Specific for Seabrook Station for Tritium, Iodine and Particulate Releases	B.1-19
B.1-13	Combined Skin Dose Factors Specific for Seabrook Station Special Receptors for Noble Gases	B.1-20
B.1-14	Dose and Dose Rate Factors Specific for Seabrook Station Special Receptors for Iodines, Tritium and Particulates	B.1-21
B.1-15	Ground Level to Vent Stack Elevation Release Point Correction Factor	B.1-22
B.4-1	Radiological Environmental Monitoring Stations	B.4-2
B.7-1	Usage Factors for Various Liquid Pathways at Seabrook Station	B.7-4
B.7-2	Environmental Parameters for Gaseous Effluents at Seabrook Station	B.7-24
B.7-3	Usage Factors for Various Gaseous Pathways at Seabrook Station	B.7-26
B.7-4	Seabrook Station Dilution Factors Primary Vent Stack	B.7-32
B.7-5	Seabrook Station Dilution Factors for Special Receptors Primary Vent Stack	B.7-33
B.7-6	Seabrook Station Atmospheric Diffusion and Deposition Factors Ground-Level Release Pathway	B.7-34

SUPERSEDED

LIST OF FIGURES

NUMBER	TITLE	PAGE
	PART B	
B.4-1	Radiological Environmental Monitoring Locations Within 4 km of Seabrook Station	B.4-5
B.4-2	Radiological Environmental Monitoring Locations Between 4 km and 12 km from Seabrook Station	B.4-6
B.4-3	Radiological Environmental Monitoring Locations Outside 12 km of Seabrook Station	B.4-7
B.4-4	Direct Radiation Monitoring Locations Within 4 km of Seabrook Station	B.4-8
B.4-5	Direct Radiation Monitoring Locations Between 4 km and 12 km from Seabrook Station	B.4-9
B.4-6	Direct Radiation Monitoring Locations Outside 12 km of Seabrook Station	B.4-10
B.6-1	Liquid Effluent Streams, Radiation Monitors and Radwaste Treatment System at Seabrook Station	B.6-2
B.6-2	Gaseous Effluent Streams, Radiation Monitors and Radwaste Treatment System at Seabrook Station	B.6-3

SUPERSEDED

<u>LIST OF EFFECTIVE PAGES</u>

PAGE	REV.
Cover	7
Disclaimer	7
Abstract	7
TOC 1	7
2	7
List of Figures	7
List of Tables 1	7
2	7
LOEP 1	7
2	7
A.1-1	4
A.2-1	4
A.3-1	4
A.3-2	4
A.3-3	4
A.3-4	4
A.3-5	4
A.3-6	4
A.4-1	4
A.4-2	4
A.4-3	4
A.4-4	4
A.4-5	4
A.5-1	4
A.5-2	4
A.5-3	4
A.5-4	4
A.5-5	4
A.5-6	4
A.5-7	4
A.5-8	4
A.5-9	4
A.5-10	4
B.1-1	4
B.1-2	4

PAGE	REV.
B.1-3	4
B.1-4	4
B.1-5	4
B.1-6	4
B.1-7	4
B.1-8	7
B.1-9	7
B.1-10	7
B.1-11	7
B.1-12	4
B.1-13	4
B.1-14	7
B.1-15	7
B.1-16	4
B.1-17	7
B.1-18	7
B.1-19	7
B.1-20	7
B.1-21	7
B.1-22	7
B.2-1	7
B.2-2	7
B.2-3	7
B.2-4	7
B.3-1	4
B.3-2	4
B.3-3	4
B.3-4	4
B.3-5	7
B.3-6	4
B.3-7	7
B.3-8	7
B.3-9	7
B.3-10	7
B.3-11	7
B.3-12	7
B.3-13	7
B.3-14	7
B.3-15	7
B.3-16	7
B.3-17	7
B.3-18	7
B.3-19	7
B.3-20	7
B.3-21	7

SUPERSEDED

LIST OF EFFECTIVE PAGES

PAGE	REV.
B.3-22	7
B.3-23	7
B.3-24	7
B.3-25	7
B.3-26	7
B.4-1	5
B.4-2	5
B.4-3	4
B.4-4	4
B.4-5	4
B.4-6	5
B.4-7	5
B.4-8	5
B.4-9	5
B.4-10	5
B.5-1	7
B.5-2	4
B.5-3	7
B.5-4	4
B.5-5	7
B.5-6	7
B.5-7	7
B.5-8	7
B.5-9	7
B.5-10	7
B.5-11	7
E.5-12	7
B.5-13	7
B.6-1	4
B.6-2	4
B.6-3	4
B.7-1	4
B.7-2	7
B.7-3	7
B.7-4	7
B.7-5	7
B.7-6	7
B.7-7	7
B.7-8	7
B.7-9	7
B.7-10	7
B.7-11	7
B.7-12	7

PAGE	REV.
B.7-13	7
B.7-14	7
B.7-15	7
B.7-16	7
B.7-17	7
B.7-18	7
B.7-19	7
B.7-20	7
B.7-21	7
B.7-22	7
B.7-23	7
B.7-24	7
B.7-25	7
B.7-26	7
B.7-27	7
B.7-28	7
B.7-29	7
B.7-30	7
B.7-31	7
B.7-32	7
B.7-33	7
B.7-34	7
B.8-1	4
B.8-2	4
B-8-3	4
B.8-4	4
B.8-5	4
B.8-6	7
B.8-7	7
B.8-8	7
B.8-9	7
B.8-10	7
R-1	7

SUPERSEDED

TABLE B.1-8
(continued)

Summary of Variables

Variable	Definition	Units
D_{mo}	= Dose to the maximum organ	mrem
D^S	= Dose to skin from beta and gamma	mrem
D_{tb}	= Dose to the total body	mrem
DF	= Dilution factor	ratio
DF_{min}	= Minimum allowable dilution factor	ratio
DF'_c	= Composite skin dose factor	$\frac{mrem-sec}{\mu Ci-yr}$
DFB_i	= Total body gamma dose factor for nuclide "i" (Table B.1-10)	$\frac{mrem-m^3}{pCi-yr}$
DFB_c	= Composite total body dose factor	$\frac{mrem-m^3}{pCi-yr}$
DFL_{itb}	= Site-specific, total body dose factor for a liquid release of nuclide "i" (Table B.1-11)	$\frac{mrem}{\mu Ci}$
DFL_{imo}	= Site-specific, maximum organ dose factor for a liquid release of nuclide "i" (Table B.1-11)	$\frac{mrem}{\mu Ci}$
DFG_{ico}	= Site-specific, critical organ dose factor for a gaseous release of nuclide "i" (Table B.1-12)	$\frac{mrem}{\mu Ci}$
DFG'_{ico}	= Site-specific, critical organ dose rate factor for a gaseous release of nuclide "i" (Table B.1-12)	$\frac{mrem-sec}{\mu Ci-yr}$
DFS_i	= Beta skin dose factor for nuclide "i" (Table B.1-10)	$\frac{mrem-m^3}{pCi-yr}$
DF'_i	= Combined skin dose factor for nuclide "i" (Table B.1-10)	$\frac{mrem-sec}{\mu Ci-yr}$
DF^{γ}_i	= Gamma air dose factor for nuclide "i" (Table B.1-10)	$\frac{mrad-m^3}{pCi-yr}$

SUPERSEDED

TABLE B.1-8
(continued)

Summary of Variables

Variable	Definition	Units
DF_i^β	= Beta air dose factor for nuclide "i" (Table B.1-10)	$\frac{mrad\text{-}m^3}{pCi\text{-}yr}$
$\dot{D}_{co}$	= Critical organ dose rate due to iodines and particulates	$\frac{mrem}{yr}$
$\dot{D}_{skin}$	= Skin dose rate due to noble gases	$\frac{mrem}{yr}$
$\dot{D}_{tb}$	= Total body dose rate due to noble gases	$\frac{mrem}{yr}$
D/Q	= Deposition factor for dry deposition of elemental radioiodines and other particulates	$\frac{1}{m^2}$
EL(R)	= Ground level to vent stack elevation release point (R) correction factor	Dimensionless
F_d	= Flow rate out of discharge tunnel	gpm or ft^3/sec
F_m	= Flow rate past liquid waste test tank monitor	gpm
F	= Flow rate past plant vent monitor	$\frac{cc}{sec}$
f_1; f_2; f_3	= Fraction of total MPC associated with Paths 1, 2, and 3	Dimensionless
F_1^{ENG}	= Total fraction of MPC in liquid pathways (excluding noble gases)	Dimensionless
MPC_i	= Maximum permissible concentration for radionuclide "i" (10CFR20, Appendix B, Table 2, Column 2)	$\frac{\mu Ci}{cc}$
Q_i	= Release to the environment for radionuclide "i"	curies, or µcuries
$\dot{Q}_i$	= Release rate to the environment for radionuclide "i"	µCi/sec

SUPERSEDED

TABLE B.1-14

Dose and Dose Rate Factors Specific for Seabrook Station Special Receptors[(1)] for Iodine, Tritium, and Particulate Releases

Radionuclide	Education Center Critical Organ Dose Factor $DFG_{icoE}(\frac{mrem}{\mu Ci})$	Education Center Critical Organ Dose Rate Factor $DFG'_{icoE}(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr})$	The "Rocks" Critical Organ Dose Factor $DFG_{icoR}(\frac{mrem}{\mu Ci})$	The "Rocks" Critical Organ Dose Rate Factor $DFG'_{icoR}(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr})$
H-3	6.45E-11	2.03E-03	6.85E-10	2.16E-02
Cr-51	4.98E-09	2.12E-01	2.66E-08	1.07E+00
Mn-54	1.39E-06	6.24E+01	5.84E-06	2.55E+02
Fe-59	3.09E-07	1.29E+01	1.74E-06	6.78E+01
Co-58	3.89E-07	1.72E+01	2.01E-06	8.11E+01
Co-60	2.17E-05	9.78E+02	8.83E-05	3.97E+03
Zn-65	7.34E-07	3.31E+01	3.23E-06	1.37E+02
Sr-89	1.15E-07	3.63E+00	1.23E-06	3.88E+01
Sr-90	5.14E-06	1.62E+02	5.48E-05	1.73E+03
Zr-95	3.38E-07	1.35E+01	2.22E-06	8.14E+01
Nb-95	1.53E-07	6.43E+00	8.59E-07	3.37E+01
Mo-99	1.62E-08	5.58E-01	1.50E-07	4.92E+00
Ru-103	1.30E-07	5.33E+00	7.74E-07	2.95E+01
Ag-110m	3.43E-06	1.55E+02	1.54E-05	6.47E+02
Sb-124	6.96E-07	2.89E+01	4.04E-06	1.56E+02
I-131	7.79E-07	2.47E+01	8.27E-06	2.61E+02
I-133	1.84E-07	5.83E+00	1.95E-06	6.18E+01
Cs-134	6.83E-06	3.08E+02	2.78E-05	1.25E+03
Cs-137	1.03E-05	4.64E+02	4.19E-05	1.89E+03
Ba-140	1.14E-07	3.85E+00	1.10E-06	3.56E+01
Ce-141	4.09E-08	1.45E+00	3.59E-07	1.20E+01
Ce-144	6.95E-07	2.27E+01	7.02E-06	2.25E+02
Other*	2.26E-06	1.02E+02	9.56E-06	4.16E+02

* Dose factors to be used in Method I calculations for any "other" detected gamma emitting radionuclide which is not included in the above list.

(1) See Seabrook Station Unit 1 Technical Specification Figure 5.1-1.

TABLE B.1-15

Ground Level to Vent Stack Elevation Release Point Correction Factor

Receptor Point (R)	Release Type	Correction Factor EL(R)
1. Maximum Off-Site Receptor	a. Noble Gases	12.1
	b. Iodine, Tritium, and Particulates	12.5
2. The "Rocks"	a. Noble Gases	9.4
	b. Iodine, Trituim, and Particulates	9.4
3. The "Education Center"	a. Noble Gases	14.3
	b. Iodine, Tritium, and Particulates	14.3

SUPERSEDED

2.0 METHOD TO CALCULATE OFF-SITE LIQUID CONCENTRATIONS

Chapter 2 contains the basis for station procedures used to demonstrate compliance with Technical Specification 3.11.1.1, which limits the total fraction of MPC in liquid pathways, other than noble gases (denoted here as F_1^{ENG}) at the point of discharge from the station to the environment (see Figure B.6-1). F_1^{ENG} is limited to less than or equal to one, i.e.,

$$F_1^{ENG} \leq 1.$$

The total concentration of all dissolved and entrained noble gases at the point of discharge from the multiport diffuser from all station sources combined, denoted C_1^{NG}, is limited to 2E-04 μCi/ml, i.e.,

$$C_1^{NG} \leq 2E\text{-}04 \ \mu Ci/ml.$$

2.1 Method to Determine F_1^{ENG} and C_1^{NG}

First, determine the total fraction of MPC (excluding noble gases), at the point of discharge from the station from all significant liquid sources denoted F_1^{ENG}; and then separately determine the total concentration at the point of discharge of all dissolved and entrained noble gases from all station sources, denoted C_1^{NG}, as follows:

$$F_1^{ENG} = \sum_i \frac{C_{pi}}{MPC_i} \leq 1. \quad \left(\frac{\mu Ci/ml}{\mu Ci/ml}\right) \qquad (2\text{-}1)$$

and:

SUPERSEDED

$$C_1^{NG} = \sum_i C_{1i}^{NG} \leq 2E-04 \quad (2-2)$$

(μCi/ml) (μCi/ml) (μCi/ml)

where:

F_1^{ENG} = Total fraction of MPC in liquids, excluding noble gases, at the point of discharge from the multiport diffuser

C_{pi} = Concentration at point of discharge from the multiport diffuser of radionuclide "i", except for dissolved and entrained noble gases, from all tanks and other significant sources, p, from which a discharge may be made (including the waste test tanks and any other significant source from which a discharge can be made). C_{pi} is determined by dividing the product of the measured radionuclide concentration in liquid waste test tanks or effluent streams times their discharge flow rate by the total available dilution water flow rate of circulating and service water at the time of release (μCi/ml).

MPC_i = Maximum permissible concentration of radionuclide "i" except for dissolved and entrained noble gases from 10CFR20, Appendix B, Table II, Column 2 (μCi/ml)

C_1^{NG} = Total concentration at point of discharge of all dissolved and entrained noble gases in liquids from all station sources (μCi/ml)

C_{1i}^{NG} = Concentration at point of discharge of dissolved and entrained noble gas "i" in liquids from all station sources (μCi/ml)

2.2 Method to Determine Radionuclide Concentration for Each Liquid Effluent Source

2.2.1 Waste Test Tanks

C_{pi} is determined for each radionuclide detected from the activity in a representative grab sample of any of the waste test tanks and the predicted flow at the point of discharge.

The batch releases are normally made from two 25,000-gallon capacity waste test tanks. These tanks normally hold liquid waste evaporator

distillate. The waste test tanks can also contain other waste such as liquid taken directly from the floor drain tanks when that liquid does not require processing in the evaporator, distillate from the boron recovery evaporator when the BRS evaporator is substituting for the waste evaporator, and distillate from the Steam Generator Blowdown System evaporators and flash steam condensers when that system must discharge liquid off-site.

If testing indicates that purification of the waste test tank contents is required prior to release, the liquid can be circulated through the waste demineralizer and filter.

The contents of the waste test tank may be reused in the Nuclear System if the sample test meets the purity requirements.

Prior to discharge, each waste test tank is analyzed for principal gamma emitters in accordance with the liquid sample and analysis program outlined in Part A to the ODCM.

2.2.2 Turbine Building Sump

The Turbine Building sump collects leakage from the Turbine Building floor drains and discharges the liquid unprocessed to the circulating water system.

Sampling of this potential source is normally done once per week for determining the radioactivity released to the environment (see Table A.3-1).

2.2.3 Steam Generator Blowdown Flash Tank

The steam generator blowdown evaporators normally process the liquid from the steam generator blowdown flash tank when there is primary to secondary leakage. Distillate from the evaporators can be sent to the waste test tanks or recycled to the condensate system. When there is no primary to secondary leakage, flash tank liquid is processed through the steam generator blowdown demineralizers and returned to the secondary side.

SUPERSEDED

Steam generator blowdown is only subject to sampling and analysis when all or part of the blowdown liquid is being discharged to the environment instead of the normal recycling process (see Table A.3-1).

K = $918/F_d$; where F_d is the average (typically monthly average) dilution flow of the Circulating Water System at the point of discharge from the multiport diffuser (in ft^3/sec). For normal operations with a cooling water flow of 918 ft^3/sec, K is equal to 1.

Equation 3-1 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Liquid releases via the multiport diffuser to unrestricted areas (at the edge of the initial mixing or prompt dilution zone that corresponds to a factor of 10 dilution), and

2. Any continuous or batch release over any time period.

3.2.2 Method II

Method II consists of the models, input data and assumptions (bioaccumulation factors, shore-width factor, dose conversion factors, and transport and buildup times) in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific data or assumptions have been identified in the ODCM. The general equations (A-3 and A-7) taken from Regulatory Guide 1.109, and used in the derivation of the simplified Method I approach as described in the Bases section, are also applied to Method II assessments, except that doses calculated to the whole body from radioactive effluents are evaluated for each of the four age groups to determine the maximum whole body dose of an age-dependent individual via all existing exposure pathways. Table B.7-1 lists the usage factors of Method II calculations. As noted in Section B.7.1, the mixing ratio associated with the edge of the 1°F surface isotherm above the multiport diffuser may be used in Method II calculations.

3.3 Method to Calculate Maximum Organ Dose from Liquid Releases

Technical Specification 3.11.1.2 limits the maximum organ dose commitment to a Member of the Public from radioactive material in liquid effluents to 5 mrem per quarter and 10 mrem per year per unit. Technical Specification 3.11.1.3 requires liquid radwaste treatment when the maximum organ dose projected exceeds 0.2 mrem in any 31 days (see Subsection 3.11 for dose projections). Technical Specification 3.11.4 limits the maximum organ dose commitment to any real member of the public from all station sources (including liquids) to 25 mrem in a year except for the thyroid, which is limited to 75 mrem in a year.

Use Method I first to calculate the maximum organ dose from a liquid release to unrestricted areas (see Figure B.6-1) as it is simpler to execute and more conservative than Method II.

Use Method II if a more refined calculation of organ dose is needed, i.e., Method I indicates the dose may be greater than the limit.

Use Equation 3-2 to estimate the maximum organ dose from individual or combined liquid releases. See Section 7.1.2 for basis.

3.3.1 Method I

The increment in maximum organ dose from a liquid release is:

$$D_{mo} = k \sum_i Q_i \quad DFL_{imo} \qquad (3\text{-}2)$$

$$(\text{mrem}) = (\ ) \ (\mu\text{Ci}) \ \left(\frac{\text{mrem}}{\mu\text{Ci}}\right)$$

where:

DFL_{imo} = Site-specific maximum organ dose factor (mrem/μCi) for a liquid release. It is the highest of the four age groups. See Table B 1-11.

Q_i = Total activity (μCi) released for radionuclide "i". (For strontiums, use the most recent measurement available.)

K = $918/F_d$; where F_d is the average (typically monthly average) dilution flow of the Circulating Water System at the point of discharge from the multiport diffuser (in ft^3/sec). For normal operations with a cooling water flow of 918 ft^3/sec, K is equal to 1.

Equation 3-2 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Liquid releases via the multiport diffuser to unrestricted areas (at the edge of the initial mixing or prompt dilution zone that corresponds to a factor of 10 dilution), and

2. Any continuous or batch release over any time period.

3.3.2 Method II

Method II consists of the models, input data and assumptions (bioaccumulation factors, shore-width factor, dose conversion factors, and transport and buildup times) in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific data or assumptions have been identified in the ODCM. The general equations (A-3 and A-7) taken from Regulatory Guide 1.109, and used in the derivation of the simplified Method I approach as described in the Bases section, are also applied to Method II assessments, except that doses calculated to critical organs from radioactive effluents are evaluated for each of the four age groups to determine the maximum critical organ of an age-dependent individual via all existing exposure pathways. Table B.7-1 lists the usage factors for Method II calculations. As noted in Section B.7.1, the mixing ratio associated with the edge of the $1^{O}F$ surface isotherm above the multiport diffuser may be used in Method II calculations.

SUPERSEDED

3.4 Method to Calculate the Total Body Dose Rate From Noble Gases

Technical Specification 3.11.2.1 limits the dose rate at any time to the total body from noble gases at any location at or beyond the site boundary to 500 mrem/year. The Technical Specification indirectly limits peak release rates by limiting the dose rate that is predicted from continued release at the peak rate. By limiting $\dot{D}_{tb}$ to a rate equivalent to no more than 500 mrem/year, we assure that the total body dose accrued in any one year by any member of the general public is less than 500 mrem.

Use Method I first to calculate the Total Body Dose Rate from the peak release rate via the station vents[(1)]. Method I applies at all release rates.

Use Method II if a more refined calculation of $\dot{D}_{tb}$ is desired by the station (i.e., use of actual release point parameters with annual or actual meteorology to obtain release-specific X/Qs) or if Method I predicts a dose rate greater than the Technical Specification limit to determine if it had actually been exceeded during a short time interval. See Section 7.2.1 for basis.

Compliance with the dose rate limits for noble gases are continuously demonstrated when effluent release rates are below the plant vent noble gas activity monitor alarm setpoint by virtue of the fact that the alarm setpoint is based on a value which corresponds to the off-site dose rate limit, or a value below it. Determinations of dose rate for compliance with Technical Specifications are performed when the effluent monitor alarm setpoint is exceeded, or as required by the Action Statement (Technical Specification 3.3.3.10, Table 3.3-10) when the monitor is inoperable.

---

(1) The primary vent stack mix mode release X/Qs are assumed in the ODCM Method I equations when the correction factor for release point elevation, EL(R), is set at 1.0.

SUPERSEDED

3.4.1 Method I

The Total Body Dose Rate due to noble gases can be determined as follows:

$$\dot{D}_{tb} = 0.85 * EL(R) * \sum_i \dot{Q}_i \quad DFB_i \qquad (3\text{-}3)$$

$$\left(\frac{mrem}{yr}\right) = \left(\frac{pCi\text{-}sec}{\mu Ci\text{-}m^3}\right) (\quad) \quad \left(\frac{\mu Ci}{sec}\right) \left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$$

where:

EL(R) = Ground level to vent stack Elevation Release Point (R) correction factor (dimensionless). For primary vent stack releases, EL(STACK) equals 1.0. For ground level releases, EL(GRD) equals 12.1 for the maximum off-site receptor, as shown on Table B.1-15.

$\dot{Q}_i$ = The release rate at the station vents (uCi/sec), for each noble gas radionuclide, "i", shown in Table B.1-10.

DFB_i = Total body gamma dose factor (see Table B.1-10).

Equation 3-3 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Normal operations (nonemergency event), and
2. Noble gas releases via any station vent to the atmosphere.

3.4.2 Method II

Method II consists of the model and input data (whole body dose factors) in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific data or assumptions have been identified in the ODCM. The general equation (B-8) taken from Regulatory Guide 1.109, and used in the derivation of the simplified Method I approach as described in the Bases section, is also applied to a Method II assessment. No credit for a shielding

factor (S_F) associated with residential structures is assumed. Concurrent meteorology with the release period may be utilized for the gamma atmospheric dispersion factor identified in ODCM Equation 7-3 (Section 7.2.1), and determined as indicated in Section 7.3.2 for the release point (either ground level or elevated) from which recorded effluents have been discharged.

3.5 Method to Calculate the Skin Dose Rate from Noble Gases

Technical Specification 3.11.2.1 limits the dose rate at any time to the skin from noble gases at any location at or beyond the site boundary to 3,000 mrem/year. The Technical Specification indirectly limits peak release rates by limiting the dose rate that is predicted from continued release at the peak rate. By limiting $\dot{D}_{skin}$ to a rate equivalent to no more than 3,000 mrem/year, we assure that the skin dose accrued in any one year by any member of the general public is less than 3,000 mrem. Since it can be expected that the peak release rate on which $\dot{D}_{skin}$ is derived would not be exceeded without corrective action being taken to lower it, the resultant average release rate over the year is expected to be considerably less than the peak release rate.

Use Method I first to calculate the Skin Dose Rate from the peak release rate via the station vents[(1)]. Method I applies at all release rates.

Use Method II if a more refined calculation of $\dot{D}_{skin}$ is desired by the station (i.e., use of actual release point parameters with annual or actual meteorology to obtain release-specific X/Qs) or if Method I predicts a dose rate greater than the Technical Specification limit to determine if it had actually been exceeded during a short time interval. See Section 7.2.2 for basis.

Compliance with the dose rate limits for noble gases are continuously demonstrated when effluent release rates are below the plant vent noble gas activity monitor alarm setpoint by virtue of the fact that the alarm setpoint is based on a value which corresponds to the off-site dose rate limit, or a value below it. Determinations of dose rate for compliance with Technical Specifications are performed when the effluent monitor alarm setpoint is exceeded.

---

(1) The primary vent stack mix mode release X/Qs are assumed in the ODCM Method I equations when the correction factor for release point evaluation, EL(R), is set equal to 1.0.

3.5.1 Method I

The Skin Dose Rate due to noble gases is:

$$\dot{D}_{skin} = EL(R) * \sum_i \dot{Q}_i \quad DF_i' \qquad (3-4)$$

$$(\frac{mrem}{yr}) = (\quad) \quad (\frac{\mu Ci}{sec}) \quad (\frac{mrem-sec}{\mu Ci-yr})$$

where:

EL(R) = Ground level to vent stack Elevation Release Point (R) correction factor (dimensionless). For primary vent stack releases, EL(STACK) equals 1.0. For ground level releases, EL(GRD) equals 12.1 for the maximum off-site receptor,. as shown on Table B.1-15.

$\dot{Q}_i$ = The release rate at the station vents (μCi/sec) for each radionuclide, "i", shown in Table B.1-10.

DF_i' = combined skin dose factor (see Table B.1-10).

Equation 3-4 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Normal operations (nonemergency event), and
2. Noble gas releases via any station vent to the atmosphere.

3.5.2 Method II

Method II consists of the model and input data (skin dose factors) in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific data or assumptions have been identified in the ODCM. The general equation (B-9) taken from Regulatory Guide 1.109, and used in the derivation of the simplified Method I approach as described in the Bases section, is also applied to a Method II assessment, no credit for a shielding factor (S_F)

associated with residential structures is assumed. Concurrent meteorology with the release period may be utilized for the gamma atmospheric dispersion factor and undepleted atmospheric dispersion factor identified in ODCM Equation 7-8 (Section 7.2.2), and determined as indicted in Section 7.3.2 for the release point (either ground level or elevated) from which recorded effluents have been discharged.

3.6 Method to Calculate the Critical Organ Dose Rate from Iodines, Tritium and Particulates with $T_{1/2}$ Greater Than 8 Days

Technical Specification 3.11.2.1 limits the dose rate at any time to any organ from ^{131}I, ^{133}I, ^{3}H and radionuclides in particulate form with half lives greater than 8 days to 1500 mrem/year to any organ. The Technical Specification indirectly limits peak release rates by limiting the dose rate that is predicted from continued release at the peak rate. By limiting $\dot{D}_{co}$ to a rate equivalent to no more than 1500 mrem/year, we assure that the critical organ dose accrued in any one year by any member of the general public is less than 1500 mrem.

Use Method I first to calculate the Critical Organ Dose Rate from the peak release rate via the station vents(1). Method I applies at all release rates.

Use Method II if a more refined calculation of $\dot{D}_{co}$ is desired by the station (i.e., use of actual release point parameters with annual or actual meteorology to obtain release-specific X/Qs) or if Method I predicts a dose rate greater than the Technical Specification limit to determine if it had actually been exceeded during a short time interval. See Section 7.2.3 for basis.

3.6.1 Method I

The Critical Organ Dose Rate can be determined as follows:

$$\dot{D}_{co} = EL(R) * \sum_i \dot{Q}_i \quad DFG'_{ico} \qquad (3-5)$$

$$\left(\frac{mrem}{yr}\right) = (\quad) \quad \left(\frac{\mu Ci}{sec}\right) \quad \left(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}\right)$$

---

(1) The primary vent stack mix mode release X/Qs are assumed in the ODCM Method I equations when the correction factor for release point elevation, EL(R), is set equal to 1.0.

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where:

EL(R) = Ground level to vent stack Elevation Release Point (R) correction factor (dimensionless). For primary vent stack releases, EL(STACK) equals 1.0. For ground level releases, EL(GRD) equals 12.5 for the maximum off-site receptor, as shown on Table B.1.15.

DFG'_{ico} = Site-specific critical organ dose rate factor $(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr})$ for a gaseous release. See Table B.1-12.

$\dot{Q}_i$ = The activity release rate at the station vents of radionuclide "i" in μCi/sec (i.e., total activity measured of radionuclide "i" averaged over the time period for which the filter/charcoal sample collector was in the effluent stream). For i = Sr89 or Sr90, use the best estimates (such as most recent measurements).

Equation 3-5 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Normal operations (not emergency event), and
2. Tritium, I-131 and particulate releases via monitored station vents to the atmosphere.

3.6.2 <u>Method II</u>

Method II consists of the models, input data and assumptions in Appendix C of Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific data or assumptions have been identified in the ODCM (see Tables B.7-2 and B.7-3). The critical organ dose rate will be determined based on the location (site boundary, nearest resident, or farm) of receptor pathways as identified in the most recent annual land use census, or by conservatively assuming the existence of all pathways (ground plane, inhalation, ingestion of stored and leafy vegetables, milk, and meat) at an off-site location of maximum potential dose. Concurrent meteorology with the release period may be utilized for determination of atmospheric dispersion factors in accordance with Section 7.3.2 for the release point (either ground

level or elevated) from which recorded effluents have been discharged. The maximum critical organ dose rates will consider the four age groups independently, and take no credit for a shielding factor (S_F) associated with residential structures.

3.7 Method to Calculate the Gamma Air Dose from Noble Gases

Technical Specification 3.11.2.2 limits the gamma dose to air from noble gases at any location at or beyond the site boundary to 5 mrad in any quarter and 10 mrad in any year per unit. Dose evaluation is required at least once per 31 days.

Use Method I first to calculate the gamma air dose for the station vent[(1)] releases during the period.

Use Method II if a more refined calculation is needed (i.e., use of actual release point parameter with annual or actual meteorology to obtain release-specific X/Qs), or if Method I predicts a dose greater than the Technical Specification limit to determine if it had actually been exceeded. See Section 7.2.4 for basis.

3.7.1 Method I

The gamma air dose from station vent releases is:

$$D_{air}^{\gamma} = 2.7E\text{-}08 * EL(R) * \sum_i Q_i \quad DF_i^{\gamma} \qquad (3\text{-}6)$$

$$(\text{mrad}) = \left(\frac{\text{pCi-yr}}{\mu\text{Ci-m}^3}\right) (\quad) \qquad (\mu\text{Ci}) \quad \left(\frac{\text{mrad-m}^3}{\text{pCi-yr}}\right)$$

where:

Q_i = total activity (μCi) released to the atmosphere via station vents of each radionuclide "i" during the period of interest.

DF_i^{γ} = gamma dose factor to air for radionuclide "i". See Table B.1-10

EL(R) = Ground level to vent stack Elevation Release Point (R) correction factor (dimensionless). For primary vent stack releases, EL(STACK) equals 1.0. For ground level releases, EL(GRD) equals 12.1 for the maximum off-ste receptor, as shown on Table B.1-15.

---

(1) The primary vent stack mix mode release X/Qs are assumed in the ODCM Method I equations when the correction factor for release point elevation, EL(R), is set equal to 1.0.

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Equation 3-6 can be applied under the following conditions (otherwise justify Method I or consider Method II):

1. Normal operations (nonemergency event), and
2. Noble gas releases via station vents to the atmosphere.

3.7.2 Method II

Method II consists of the models, input data (dose factors) and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific data or assumptions have been identified in the ODCM. The general equations (B-4 and B-5) taken from Regulatory Guide 1.109, and used in the derivation of the simplified Method I approach as described in the Bases Section 7.2.4 are also applied to Method II assessments. Concurrent meteorology with the release period may be utilized for the gamma atmospheric dispersion factor identified in ODCM Equation 7-14, and determined as indicated in Section 7.3.2 for the release point (either ground level or elevated) from which recorded effluents have been discharged.

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3.8 Method to Calculate the Beta Air Dose from Noble Gases

Technical Specification 3.11.2.2 limits the beta dose to air from noble gases at any location at or beyond the site boundary to 10 mrad in any quarter and 20 mrad in any year per unit. Dose evaluation is required at least once per 31 days.

Use Method I first to calculate the beta air dose for the station vent[(1)] stack releases during the period. Method I applies at all dose levels.

Use Method II if a more refined calculation is needed (i.e., use of actual release point parameters with annual or actual meteorology to obtain release-specific X/Qs) or if Method I predicts a dose greater than the Technical Specification limit to determine if it had actually been exceeded. See Section 7.2.5 for basis.

3.8.1 Method I

The beta air dose from station vent releases is:

$$D^{\beta}_{air} = 2.6E\text{-}08 * EL(R) * \sum_i Q_i \quad DF^{\beta}_i \qquad (3\text{-}7)$$

$$(mrad) = \left(\frac{pCi\text{-}yr}{\mu Ci\text{-}m^3}\right) (\quad) \qquad (\mu Ci) \quad \left(\frac{mrad\text{-}m^3}{pCi\text{-}yr}\right)$$

where:

DF^{β}_i = Beta dose factor to air for radionuclide "i" (see Table B.1-10).

Q_i = Total activity (μCi) released to the atmosphere via station vents of each radionuclide "i" during the period of interest.

---

(1) The primary vent stack mix mode release X/Qs are assumed in the ODCM Method I equations when the corrective factor for release point elevation, EL(R), is set equal to 1.0.

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EL(R) = Ground level to vent stack Elevation Release Point (R) correction factor (dimensionless). For primary vent stack releases, EL(STACK) equals 1.0. For ground level releases, EL(GRD) equals 12.1 for the maximum off-site receptor, as shown on Table B.1-15.

Equation 3-7 can be applied under the following conditions (otherwise justify Method I or consider Method II):

1. Normal operations (nonemergency event), and
2. Noble gas releases via station vents to the atmosphere.

3.8.2 Method II

Method II consists of the models, input data (dose factors) and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific data or assumptions have been identified in the ODCM. The general equations (B-4 and B-5) taken from Regulatory Guide 1.109, and used in the derivation of the simplified Method I approach as described in the Bases Section 7.2.5, are also applied to Method II assessments. Concurrent meteorology with the release period may be utilized for the atmospheric dispersion factor identified in ODCM Equation 7-15, and determined, as indicated in Section 7.3.2 for the release point (either ground level or elevated) from which recorded effluents have been discharged.

3.9 Method to Calculate the Critical Organ Dose from Iodines, Tritium and Particulates

Technical Specification 3.11.2.3 limits the critical organ dose to a member of the public from radioactive iodines, tritium, and particulates with half-lives greater than 8 days in gaseous effluents to 7.5 mrem per quarter and 15 mrem per year per unit. Technical Specification 3.11.4 limits the total body and organ dose to any real member of the public from all station sources (including gaseous effluents) to 25 mrem in a year except for the thyroid, which is limited to 75 mrem in a year.

Use Method I first to calculate the critical organ dose from a vent release as it is simpler to execute and more conservative than Methoo II.

Use Method II if a more refined calculation of critical organ dose is needed (i.e., Method I indicates the dose is greater than the limit). See Section 7.2.6 for basis.

3.9.1 Method I

$$D_{co} = EL(R) * \sum_i Q_i \ DFG_{ico} \qquad (3\text{-}8)$$

$$(\text{mrem}) = (\quad) \quad (\mu\text{Ci}) \quad \left(\frac{\text{mrem}}{\mu\text{Ci}}\right)$$

Q_i = Total activity (μCi) released to the atmosphere of radionuclide "i" during the period of interest. For strontiums, use the most recent measurement.

DFG_{ico} = Site-specific critical organ dose factor (mrem/μCi). For each radionuclide it is the age group and organ with the largest dose factor. See Table B.1-12.

EL(R) = Ground level to vent stack Elevation Release Point (R) correction factor (dimensionless). For primary vent stack releases, EL(STACK) equals 1.0. For ground level releases, EL(GRD) equals 12.5 for the maximum off-site receptor, as shown on Table B.1-15.

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Equation 3-8 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Normal operations (nonemergency event),

2. Iodine, tritium, and particulate releases via station vents to the atmosphere, and

3. Any continuous or batch release over any time period.

3.9.2 METHOD II

Method II consists of the models, input data and assumptions in Appendix C of Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific data or assumptions have been identified in the ODCM (see Tables B.7-2 and B.7-3). The critical organ dose will be determined based on the location (site boundary, nearest resident, or farm) of receptor pathways, as identified in the most recent annual land use census, or by conservatively assuming the existence of all pathways (ground plane, inhalation, ingestion of stored and leafy vegetables, milk and meat) at an off-site location of maximum potential dose. Concurrent meteorology with the release period may be utilized for determination of atmospheric dispersion factors in accordance with Section 7.3.2 for the release point (either ground level or elevated) from which recorded effluents have been discharged. The maximum critical organ dose will consider the four age groups independently, and use a shielding factor (S_F) of 0.7 associated with residential structures.

3.10 Method to Calculate Direct Dose from Plant Operation

Technical Specification 3.11.4 restricts the dose to the whole body or any organ to any membe: of the public from all uranium fuel cycle sources (including direct radiation from station facilities) to 25 mrem in a calendar year (except the thyroid, which is limited to 75 mrem). It should be noted that since there are no uranium fuel cycle facilities within 5 miles of the station, only station sources need be considered for determining compliance with Technical Specification 3.11.4.

3.10.1 Method

The direct dose from the station will be determined by obtaining the dose from TLD locations situated on-site near potential sources of direct radiation, as well as those TLDs near the site boundary which are part of the environmental monitoring program, and subtracting out the dose contribution from background. Additional methods to calculate the direct dose may also be used to supplement the TLD information, such as high pressure ion chamber measurements, or analytical design calculations of direct dose from identified sources (such as solid waste storage facilities).

The dose determined from direct measurements or calculations will be related to the nearest real person off-site, as well as those individuals on-site involved in activities at either the Education Center or the Rocks boat landing, to assess the contribution of direct radiation to the total dose limits of Technical Specification 3.11.4 in conjunction with liquid and gaseous effluents.

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3.11 Dose Projections

Technical Specifications 3.11.1.3 and 3.11.2.4 require that appropriate portions of liquid and gaseous radwaste treatment systems, respectively, be used to reduce radioactive effluents when it is projected that the resulting dose(s) would exceed limits which represent small fractions of the "as low as reasonably achievable" criteria of Appendix I to 10CFR Part 50. The surveillance requirements of these Technical Specifications state that dose projections be performed at least once per 31 days when the liquid radwaste treatment systems or gaseous radwaste treatment systems are not being fully utilized.

Since dose assessments are routinely performed at least once per 31 days to account for actual releases, the projected doses shall be determined by comparing the calculated dose from the last (typical of expected operations) completed 31-day period to the appropriate dose limit for use of radwaste equipment, adjusted if appropriate for known or expected differences between past operational parameters and those anticipated for the next 31 days.

3.11.1 Liquid Dose Projections

The 31-day liquid dose projections are calculated by the following:

(a) Determine the total body D_{tb} and organ dose D_{mo} (Equations 3-1 and 3-2, respectively) for the last typical completed 31-day period. The last typical 31-day period should be one without significant identified operational differences from the period being projected to, such as full power operation vs. periods when the plant is shut down.

(b) Calculate the ratio (R_1) of the total estimated volume of batch releases expected to be released for the projected period to that actually released in the reference period.

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(c) Calculate the ratio (R_2) of the estimated gross primary coolant activity for the projected period to the average value in the reference period. Use the most recent value of primary coolant activity as the projected value if no trend in decreasing or increasing levels can be determined.

(d) Determine the projected dose from:

Total Body: $D_{tb\ pr} = D_{tb} \cdot R_1 \cdot R_2$

Max. Organ: $D_{mo\ pr} = D_{mo} \cdot R_1 \cdot R_2$

3.11.2 Gaseous Dose Projections

For the gaseous radwaste treatment system, the 31-day dose projections are calculated by the following:

(a) Determine the gamma air dose D_{air}^{γ} (Equation 3-6), and the beta air dose D_{air}^{β} (Equation 3-7) from the last typical 31-day operating period.

(b) Calculate the ratio (R_3) of anticipated number of curies of noble gas to be released from the hydrogen surge tank to the atmosphere over the next 31 days to the number of curies released in the reference period on which the gamma and beta air doses are based. If no differences between the reference period and the next 31 days can be identified, set R_3 to 1.

(c) Determine the projected dose from:

Gamma Air: $D_{air\ pr}^{\gamma} = D_{air}^{\gamma} \cdot R_3$

Beta Air: $D_{air\ pr}^{\beta} = D_{air}^{\beta} \cdot R_3$

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For the ventilation exhaust treatment system, the critical organ dose from iodines, tritium, and particulates are projected for the next 31 days by the following:

(a) Determine the critical organ dose D_{co} (Equation 3-8) from the last typical 31-day operating period.

(b) Calculate the ratio (R_4) of anticipated primary coolant dose equivalent I-131 for the next 31 days to the average dose equivalent I-131 level during the reference period. Use the most current determination of DE I-131 as the projected value if no trend can be determined.

(c) Calculate the ratio (R_5) of anticipated primary system leakage rate to the average leakage rate during the reference period. Use the current value of the system leakage as an estimate of the anticipated rate for the next 31 days if no trend can be determined.

(d) Determine the projected dose from:

Critical Organ: $D_{co\ pr} = D_{co} \cdot R_4 \cdot R_5$

f_1 = $1 - (f_2 + f_3)$; where f_1 is the fraction of the total contribution of MPC at the discharge point to be associated with the test tank effluent pathway and, f_2 and f_3 are the similar fractions for Turbine Building sump and steam generator blowdown pathways, respectively: $(f_1 + f_2 + f_3 \leq 1)$.

$$DF_{min} = \sum_i \frac{C_{mi}}{MPC_i} \quad (5\text{-}3)$$

MPC_i = MPC for radionuclide "i" from 10CFR20, Appendix B, Table II, Column 2 (µCi/ml). In the event that no activity is expected to be discharged, or can be measured in the system, the liquid monitor setpoint should be based on the most restrictive MPC for an "unidentified" mixture given in 10CFR20, Appendix B, notes.

C_{mi} = Activity concentration of radionuclide "i" in mixture at the monitor (µCi/ml)

5.1.1.2 Liquid Waste Test Tank Monitor Setpoint Example

The activity concentration of each radionuclide, C_{mi}, in the waste test tank is determined by analysis of a representative grab sample obtained at the radwaste sample sink. This setpoint example is based on the following data:

i	C_{mi} (µCi/ml)	MPC_i (µCi/ml)
Cs-134	2.15E-05	9E-06
Cs-137	7.48E-05	2E-05
Co-60	2.56E-05	3E-05

$$\sum_i C_{mi} = 2.15E\text{-}05 + 7.48E\text{-}05 + 2.56E\text{-}05$$

$(\frac{\mu Ci}{ml})$ $(\frac{\mu Ci}{ml})$ $(\frac{\mu Ci}{ml})$ $(\frac{\mu Ci}{ml})$

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$$= 1.22E\text{-}04 \quad (\frac{\mu Ci}{ml})$$

$$DF_{min} = \sum_i \frac{C_{mi}}{MPC_i} \quad (5\text{-}3)$$

$$\left(\frac{\mu Ci\text{-}ml}{ml\text{-}\mu Ci}\right)$$

$$= \frac{2.15E\text{-}05}{9E\text{-}06} + \frac{7.48E\text{-}05}{2E\text{-}05} + \frac{2.56E\text{-}05}{3E\text{-}05}$$

$$\left(\frac{\mu Ci\text{-}ml}{ml\text{-}\mu Ci}\right) \quad \left(\frac{\mu Ci\text{-}ml}{ml\text{-}\mu Ci}\right) \quad \left(\frac{\mu Ci\text{-}ml}{ml\text{-}\mu Ci}\right)$$

$$DF_{min} = 7$$

The minimum dilution factor, DF_{min}, needed to discharge the mixture of radionuclides in this example is 7. The release rate of the waste test tank is between 10 and 150 gpm. The circulating water discharge flow can vary from 10,500 to 412,000 gpm of dilution water. With the dilution flow taken as 412,000 gpm and the release rate from the waste test tank taken as 150 gpm, the DF is:

$$DF = \frac{F_d}{F_m} \quad (5\text{-}4)$$

$$\frac{(gpm)}{(gpm)}$$

$$= \frac{412{,}000 \text{ gpm}}{150 \text{ gpm}}$$

$$= 2750$$

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Under these conditions, and with the fraction f_1 of total MPC to be associated with the test tank selected as 0.6, the setpoint of the liquid radwaste discharge monitor is:

$$R_{setpoint} = f_1 \frac{DF}{DF_{min}} \sum_i C_{mi} \qquad (5\text{-}1)$$

$$\frac{\mu Ci}{ml} \quad (\ )(\ ) \quad (\frac{\mu Ci}{ml})$$

$$= 0.6 \quad \frac{2750}{7} \quad 1.22E\text{-}04$$

$$(\ )\ (\ ) \quad (\frac{\mu Ci}{ml})$$

$$= 2.87E\text{-}02\ \mu Ci/ml \text{ or } \mu Ci/cc$$

In this example, the alarm of the liquid radwaste discharge monitor should be set at 2.87E-02 µCi/cc above background.

5.1.2 Turbine Building Drains Liquid Effluent Monitor (RM-6521)

The Turbine Building drains liquid effluent monitor continuously monitors the Turbine Building sump effluent line. The only sources to the Sump Effluent System are from the secondary steam system. Activity is expected in the Turbine Building Sump Effluent System only if a significant primary-to-secondary leak is present. If a primary-to-secondary leak is present, the activity in the sump effluent system would be comprised of only those radionuclides found in the secondary system, with reduced activity from decay and dilution.

The Turbine Building drains liquid effluent monitor provides alarm and automatic termination of release prior to exceeding the concentration limits specified in 10CFR20, Appendix B, Table II, Column 2 to the environment. The alarm setpoint for this monitor will be determined using the same method as that of the liquid waste test tank monitor if the total sump activity is greater than 10 percent of MPC. If the total activity is less than 10 percent of MPC, the setpoints of RM-6521 are calculated as follows:

SUPERSEDED

$$\text{High Trip Monitor Setpoint } (\mu Ci/ml) = f_2 \, (DF') \, (1.0E\text{-}07 \; \mu Ci/ml) \qquad (5\text{-}21)$$

where:

$$DF' = \frac{\text{Circulating water flow rate (gpm)}}{\text{Flow rate post-monitor (gpm)}}$$

1.0E-07 μCi/ml = most restrictive MPC value for an unidentified mixture given in 10CFR20, Appendix B, Note 3b.

f_2 = $1 - (f_1 + f_3)$; where the f values are described above.

$$\text{Warning Alarm Monitor Setpoint } (\mu Ci/ml) = \left(\text{High Trip Monitor Setpoint}\right)(0.25) \qquad (5\text{-}22)$$

5.1.3 Steam Generator Blowdown Liquid Sample Monitor (RM-6519)

The steam generator blowdown liquid sample monitor is used to detect abnormal activity concentrations in the steam generator blowdown flash tank liquid discharge

The alarm setpoint for the steam generator blowdown liquid sample monitor, when liquid is to be discharged from the site, will be determined using the same approach as the Turbine Building drains liquid effluent monitor.

For any liquid monitor, in the event that no activity is expected to be discharged, or can be measured in the system, the liquid monitor setpoint should be based on the most restrictive MPC for an "unidentified" mixture given in 10CFR20, Appendix B notes.

5.1.4 PCCW Head Tank Rate-of-Change Alarm Setpoint

A rate-of-change alarm on the liquid level in the Primary Component Cooling Water (PCCW) head tank will work in conjunction with the PCCW radiation monitor to alert the operator in the Main Control Room of a leak to

the Service Water System from the PCCW System. For the rate-of-change alarm, a setpoint is selected based on detection of an activity level equivalent to 10^{-8} μCi/ml in the discharge of the Service Water System. The activity in the PCCW is determined in accordance with the liquid sampling and analysis program described in Part A, Table A.3-1 of the ODCM and is used to determine the setpoint.

The rate-of-change alarm setpoint is calculated from:

$$RC_{set} = 1\times10^{-8} \cdot SWF \cdot \frac{1}{PCC} \quad (5\text{-}23)$$

$$(\frac{gal}{hr}) = (\frac{\mu Ci}{ml}) \quad (\frac{gal}{hr}) \quad (\frac{ml}{\mu Ci})$$

where:

RC_{set} = The setpoint for the PCCW head tank rate-of-change alarm (in gallons per hour).

1×10^{-8} = The minimum detectable activity level in the Service Water System due to a PCCW to SWS leak (μCi/ml).

SWF = Service Water System flow rate (in gallons per hour).

PCC = Primary Component Cooling Water measured (decay corrected) gross radioactivity level (μCi/ml).

As an example, assume a PCCW activity concentration of 1×10^{-5} μCi/ml with a service water flow rate of only 80 percent of the normal flow of 21,000 gpm. The rate-of-change setpoint is then:

$$RC_{set} = 1\times10^{-8} \frac{\mu Ci}{ml} \cdot 1.0\times10^{6} \text{ gph } (1/1\times10^{-5} \frac{\mu Ci}{ml})$$

$$RC_{set} = 1000 \text{ gph}$$

As a result, for other PCCW activities, the RC_{set} which would also relate to a detection of a minimum service water concentration of 1×10^{-8} µCi/ml can be found from:

$$RC_{set} = \frac{1\times10^{-5} \cdot \mu Ci/ml \cdot 1000\ gph}{PCC} \qquad (5\text{-}24)$$

SUPERSEDED

7.0 BASES FOR DOSE CALCULATION METHODS

7.1 Liquid Release Dose Calculations

This section serves: (1) to document the development and conservative nature of Method I equations to provide background information to Method I users, and (2) to identify the general equations, parameters and approaches to Method II-type dose assessments.

Method I may be used to show that the Technical Specifications which limit off-site total body dose from liquids (3.11.1.2 and 3.11.1.3) have been met for releases over the appropriate periods. The quarterly and annual dose limits in Technical Specification 3.11.1.2 are based on the ALARA design objectives in 10CFR50, Appendix I Subsection II A. The minimum dose values noted in Technical Specification 3.11.1.3 are "appropriate fractions," as determined by the NRC, of the design objective to ensure that radwaste equipment is used as required to keep off-site doses ALARA.

Method I was developed such that "the actual exposure of an individual ... is unlikely to be substantially underestimated" (10CFR50, Appendix I). The definition, below, of a single "critical receptor" (a hypothetical or real individual whose behavior results in a maximum potential dose) provides part of the conservative margin to the calculation of total body dose in Method I. Method II allows that actual individuals, associated with identifiable exposure pathways, be taken into account for any given release. In fact, Method I was based on a Method II analysis for a critical receptor assuming all principal pathways present instead of any real individual. That analysis was called the "base case;" it was then reduced to form Method I. The general equations used in the base case analysis are also used as the starting point in Method II evaluations The base case, the method of reduction, and the assumptions and data used are presented below.

The steps performed in the Method I derivation follow. First, the dose impact to the critical receptor [in the form of dose factors DFL_{itb} (mrem/μCi)] for a unit activity release of each radioisotope in liquid effluents was derived. The base case analysis uses the general equations, methods, data and assumptions in Regulatory Guide 1.109 (Equations A-3 and

SUPERSEDED

A-7, Reference A). The liquid pathways contributing to an individual dose are due to consumption of fish and invertebrates, shoreline activities, and swimming and boating near the discharge point. A normal operating plant discharge flow rate of 918 ft^3/sec was used with a mixing ratio of 0.10. The mixing ratio of 0.10 corresponds to the minimum expected prompt dilution or near-field mixing zone created at the ocean surface directly above the multiport diffusers. (Credit for additional dilution to the outer edge of the prompt mixing zone which corresponds to the $1^{O}F$ surface isotherm can be applied in the Method II calculation.) The location of the critical receptor is assumed to be the edge of the mixing zone at the ocean surface. The transit time used for the aquatic food pathway was 24 hours and for shoreline activity 0.0 hours. Table B.7-1 outlines the human consumption and use factors used in the analysis. The resulting, site-specific, total body dose factors appear in Table B.1-11.

7.1.1 Dose to the Total Body

For any liquid release, during any period, the increment in total body dose from radionuclide "i" is:

$$\Delta D_{tb} = K \quad Q_i \quad DFL_{itb} \qquad (7\text{-}1)$$

$$(\text{mrem}) \; (\;) \; (\mu Ci) \; (\frac{\text{mrem}}{\mu Ci})$$

where:

DFL_{itb} = Site-specific total body dose factor (mrem/μCi) for a liquid release. It is the highest of the four age groups. See Table B.1-11.

Q_i = Total activity (μCi) released for radionuclide "i".

K = $918/F_d$ (dimensionless); where F_d is the average dilution flow of the Circulating Water System at the point of discharge from the multiport diffuser (in ft^3/sec).

Method I is more conservative than Method II in the region of the Technical Specification limits because the dose factors DFL_{itb} used in Method I were chosen for the base case to be the highest of the four age groups (adult, teen, child and infant) for that radionuclide. In effect each radionuclide is conservatively represented by its own critical age group.

7.1.2 Dose to the Critical Organ

The methods to calculate maximum organ dose parallel to the total body dose methods (see Section 7.1.1).

For each radionuclide, a dose factor (mrem/μCi) was determined for each of seven organs and four age groups. The largest of these was chosen to be the maximum organ dose factor (DFL_{imo}) for that radionuclide. DFL_{imo} also includes the external dose contribution to the critical organ.

For any liquid release, during any period, the increment in dose from radionuclide "i" to the maximum organ is:

$$\Delta D_{mo} = k \quad Q_i \quad DFL_{imo} \tag{7-2}$$

$$(\text{mrem}) \quad (\ ) \quad (\mu\text{Ci}) \quad \left(\frac{\text{mrem}}{\mu\text{Ci}}\right)$$

where:

DFL_{imo} = Site-specific maximum organ dose factor (mrem/μCi) for a liquid release. See Table B.1-11.

Q_i = Total activity (μCi) released for radionuclide "i".

K = $918/F_d$ (dimensionless); where F_d is the average dilution flow of the Circulating Water System at the point of discharge from the multiport diffuser (in ft^3/sec).

TABLE B.7-1

Usage Factors for Various Liquid Pathways at Seabrook Station
(From Reference A, Table E-5*, except as noted. Zero where no pathway exists)

AGE	VEG. (KG/YR)	LEAFY VEG. (KG/YR)	MILK (LITER/YR)	MEAT (KG/YR)	FISH (KG/YR)	INVERT. (KG/YR)	POTABLE WATER (LITER/YR)	SHORELINE (HR/YR)	SWIMMING*** (HR/YR)	BOATING*** (HR/YR)
Adult	0.00	0.00	0.00	0.00	21.00	5.00	0.00	334.00**	8.00	52.00
Teen	0.00	0.00	0.00	0.00	16.00	3.80	0.00	67.00	45.00	52.00
Child	0.00	0.00	0.00	0.00	6.90	1.70	0.00	14.00	28.00	29.00
Infant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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* Regulatory Guide 1.109
** Regional shoreline use associated with mudflats - Maine Yankee Atomic Power Station Environmental Report
*** HERMES; "A Digital Computer Code for Estimating Regional Radiological Effects from Nuclear Power Industry," HEDL, December 1971. Note, for Method II analyses, these pathways need not be evaluated since they represent only a small fraction of the total dose contribution associated with the other pathways.

7.2 Gaseous Release Dose Calculations

7.2.1 Total Body Dose Rate From Noble Gases

This section serves: (1) to document the development of the Method I equation, (2) to provide background information to Method I users, and (3) to identify the general equations, parameters and approaches to Method II-type dose rate assessments.

Method I may be used to show that the Technical Specification which limits total body dose rate from noble gases released to the atmosphere (Technical Specification 3.11.2.1) has been met for the peak noble gas release rate.

Method I was derived from general equation B-8 in Regulatory Guide 1.109 as follows:

$$\dot{D}_{tb} = 1E{+}06 \; [X/Q]^{\gamma} \sum_i \dot{Q}_i \; DFB_i \qquad (7\text{-}3)$$

$$\left(\frac{mrem}{yr}\right) = \left(\frac{pCi}{\mu Ci}\right) \left(\frac{sec}{m^3}\right) \quad \left(\frac{\mu Ci}{sec}\right) \quad \left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$$

where:

$[X/Q]^{\gamma}$ = Maximum off-site receptor location long-term average gamma atmospheric dispersion factor.

= 8.5E-07 (sec/m^3).

$\dot{Q}_i$ = Release rate to the environment of noble gas "i" (μCi/sec).

DFB_i = Gamma total body dose factor, $\left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$. See Table B.1-10. (Regulatory Guide 1.109, Table B-1).

Equation 7-3 reduces to:

$$\dot{D}_{tb} = 0.85 * EL(R) * \sum_i \dot{Q}_i \; DFB_i \qquad (3\text{-}3)$$

$$\left(\frac{mrem}{yr}\right) = \left(\frac{pCi\text{-}sec}{\mu Ci\text{-}m^3}\right) \left(\quad \right) \quad \left(\frac{\mu Ci}{sec}\right) \quad \left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$$

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The selection of critical receptor, outlined in Section 7.3 is inherent in the derived Method I, since the maximum expected off-site long-term average atmospheric dispersion factors were used for a primary vent stack release. The EL(R) term is added to the above equation as a dimensionless correction factor to be applied when calculating the impact from ground level release points. For primary vent stack releases, this correction factor is equal to 1.0 since the dose conversion factors are based on meteorological dispersion parameters derived for this release point. For release points other than the primary vent stack, the correction factor reflects the difference between ground level dispersion and that associated with the primary vent stack. All noble gases in Table B.1-10 should be considered.

A Method II analysis could include the use of actual concurrent meteorology to assess the dose rates as the result of a specific release.

7.2.2 Skin Dose Rate From Noble Gases

This section serves: (1) to document the development of the Method I equation, (2) to provide background information to Method I users, and (3) to identify the general equations parameters and approaches to Method II-type dose rate assessments. The methods to calculate skin dose rate parallel the total body dose rate methods in Section 7.2.1. Only the differences are presented here.

Method I may be used to show that the Technical Specification which limits skin dose rate from noble gases released to the atmosphere (Technical Specification 3.11.2.1) has been met for the peak noble gas release rate.

The annual skin dose limit is 3,000 mrem (from NBS Handbook 69, Reference D, pages 5 and 6, is 30 rem/10). The factor of 10 reduction is to account for nonoccupational dose limits.

It is the skin dose commitment to the critical, or most limiting, off-site receptor assuming long-term site average meteorology and that the release rate reading remains constant over the entire year.

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Method I was derived from the general equation B-9 in Regulatory Guide 1.109 as follows:

$$D^S = 1.11 \quad D^{\gamma}_{air} + 3.17E{+}04 \sum_i Q_i \; [X/Q] \quad DFS_i \qquad (7\text{-}4)$$

$$(\frac{mrem}{yr}) = (\frac{mrem}{mrad}) \; (\frac{mrad}{yr}) \quad (\frac{pCi\text{-}yr}{Ci\text{-}sec}) \quad \frac{Ci}{yr} \; (\frac{sec}{m^3}) \; (\frac{mrem\text{-}m^3}{pCi\text{-}yr})$$

where:

1.11 = Average ratio of tissue to air absorption coefficients (will convert mrad in air to mrem in tissue).

DFS_i = Beta skin dose factor for a semi-infinite cloud of radionuclide "i" which includes the attenuation by the outer "dead" layer of the skin.

$$D^{\gamma}_{air} = 3.17E{+}04 \sum_i Q_i \quad [X/Q] \quad DF_i^{\gamma} \qquad (7\text{-}5)$$

$$(\frac{mrad}{yr}) \quad (\frac{pCi\text{-}yr}{Ci\text{-}sec}) \quad (\frac{Ci}{yr}) \; (\frac{sec}{m^3}) \; \frac{mrad\text{-}m^3}{pCi\text{-}yr}$$

DF^{γ}_i = Gamma air dose factor for a uniform semi-infinite cloud of radionuclide "i".

Now it is assumed for the definition of (X/QY) from Reference B that:

$$D^{\gamma}_{finite} = D^{\gamma}_{air} \quad [X/Q]^{\gamma}/[X/Q] \qquad (7\text{-}6)$$

$$(\frac{mrad}{yr}) = (\frac{mrad}{yr}) \; (\frac{sec}{m^3}) \quad (\frac{m^3}{sec})$$

and $$Q_i = 31.54 \quad \dot{Q}_i \qquad (7\text{-}7)$$

$$(\frac{Ci}{yr}) = (\frac{Ci\text{-}sec}{\mu Ci\text{-}yr}) \; (\frac{\mu Ci}{sec})$$

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so: $\dot{D}_{skin} = 1.11 \quad 1E{+}06\ [X/Q]^{\gamma} \sum_i \dot{Q}_i \quad DF_i^{\gamma}$ (7-8)

$$\left(\frac{mrem}{yr}\right) = \left(\frac{mrem}{mrad}\right) \left(\frac{pCi}{\mu Ci}\right) \left(\frac{sec}{m^3}\right) \quad \left(\frac{\mu Ci}{sec}\right) \left(\frac{mrad\text{-}m^3}{pCi\text{-}yr}\right)$$

$$+ \ 1E{+}06\ X/Q \sum_i \dot{Q}_i \quad DFS_i$$

$$\left(\frac{pCi}{\mu Ci}\right) \quad \frac{sec}{m^3} \quad \frac{\mu Ci}{sec} \left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$$

substituting

$[X/Q]^{\gamma} = 8.5E{-}07\ sec/m^3$

$X/Q = 8.2E{-}07\ sec/m^3$

gives $\dot{D}_{skin} = 0.94 \sum_i \dot{Q}_i \quad DF_i^{\gamma} + 0.82 \sum_i \dot{Q}_i \quad DFS_i$ (7-9)

$$\left(\frac{mrem}{yr}\right) = \left(\frac{pCi\text{-}sec\text{-}mrem}{\mu Ci\text{-}m^3\text{-}mrad}\right)\left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)\left(\frac{pCi\text{-}sec}{\mu Ci\text{-}m^3}\right)\left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$$

$$= \sum_i \dot{Q}_i\ [0.94\ DF_i^{\gamma} + 0.82\ DFS_i] \qquad (7\text{-}10)$$

define

$$DF_i' = 0.94\ DF_i^{\gamma} + 0.82\ DFS_i \qquad (7\text{-}11)$$

then: $\dot{D}_{skin} = EL(R) * \sum_i \dot{Q}_i \quad DF_i'$ (3-4)

$$\left(\frac{mrem}{yr}\right) = (\quad) \quad \left(\frac{\mu Ci}{sec}\right) \quad \left(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}\right)$$

The EL(R) term is added to the above equation as a dimensionless correction factor to be applied when calculating the impact from ground level release points. For

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primary vent stack releases, this correction factor is equal to 1.0 since the dose conversion factors are based on meteorological dispersion parameters derived for this release point. For release points other than the primary vent stack, the correction factor reflects the difference between ground level dispersion and that associated with the primary vent stack.

The selection of critical receptor, outlined in Section 7.3, is inherent in the derived Method I, as it is based on the determined maximum expected off-site atmospheric dispersion factors. All noble gases in Table B.1-10 must be considered.

7.2.3 Critical Organ Dose Rate From Iodines, Tritium and Particulates With Half-Lives Greater Than Eight Days

This section serves: (1) to document the development of the Method I equation, (2) to provide background information to Method I users, and (3) to identify the general equation's parameters and approached to Method II type dose rate assessments. The methods to calculate skin dose rate parallel the total body dose rate methods in Section 7.2.1. Only the differences are presented here.

Method I may be used to show that the Technical Specification which limits organ dose rate from iodines, tritium and radionuclides in particulate form with half lives greater than 8 days released to the atmosphere (Technical Specification 3.11.2.1) has been met for the peak above-mentioned release rates. The annual organ dose limit is 1500 mrem (from NBS Handbook 69, Reference D, pages 5 and 6). It is evaluated by looking at the critical organ dose commitment to the most limiting off-site receptor assuming long-term site average meteorology.

The equation for $\dot{D}_{CO}$ is derived by modifying Equation 3-8 from Section 3.9 as follows:

$$D_{CO} = EL(R) * \sum_{i} Q_i \, DFG_{iCO} \qquad (3\text{-}8)$$

(mrem) ( ) (µCi) $(\frac{mrem}{\mu Ci})$

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applying the conversion factor, 3.154E+07 (sec/yr) and converting Q to $\dot{Q}$ in µCi/sec yields

$$\dot{D}_{co} = 3.154E+07 * EL(R) * \sum_i \dot{Q}_i \quad DFG_{ico} \qquad (7\text{-}12)$$

$$(\frac{mrem}{yr}) = (\frac{sec}{yr}) \quad (\ ) \quad (\frac{\mu Ci}{sec}) \ (\frac{mrem}{\mu Ci})$$

Eq. 3-8 is rewritten in the form:

$$\dot{D}_{co} = EL(R) * \sum_i \dot{Q}_i \quad DFG'_{ico} \qquad (3\text{-}5)$$

$$(\frac{mrem}{yr}) \quad (\ ) \quad (\frac{\mu Ci}{sec}) \quad (\frac{mrem\text{-}sec}{\mu Ci\text{-}yr})$$

where

$$DFG'_{ico} = 3.154E+07 \quad DFG_{ico} \qquad (7\text{-}13)$$

$$(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}) = (\frac{sec}{yr}) \quad (\frac{mrem}{\mu Ci})$$

In the case of the dose rate conversion factor (DFG'_{ico}), the dose conversion factors for iodine and particulate exposure pathways (DFG_{ico}) are derived with the Shielding Factor (SF) for ground plane exposure set equal to 1.0. For accumulated doses over extended periods, the DFG_{ico} are calculated with SF = 0.7, as referenced in Regulatory Guide 1.109.

The selection of critical receptor, outlined in Section 7.3 is inherent in Method I, as are the maximum expected off-site atmospheric dispersion factors.

Should Method II be needed, the analysis for critical receptor, critical pathway(s) and atmospheric dispersion factors may be performed with concurrent meteorology and latest land use census data to identify existing pathways.

SUPERSEDED

7.2.4 Gamma Dose to Air From Noble Gases

This section serves: (1) to document the development and conservative nature of Method I equations to provide background information to Method I users, and (2) to identify the general equations, parameters and approaches to Method II-type dose assessments.

Method I may be used to show that the Technical Specification 3.11.2.1 which limits off-site gamma air dose from gaseous effluents has been met for releases over appropriate periods. This Technical Specification is based on the objective in 10CFR50, Appendix I, Subsection B.1, which limits the estimated gamma air dose in off-site unrestricted areas.

For any noble gas release, in any period, the increment in dose is taken from Equations B-4 and B-5 of Regulatory Guide 1.109 with the added assumption that $D^{\gamma}_{finite} = D^{\gamma}[X/Q]^{\gamma}/[X/Q]$:

$$\Delta D^{\gamma}_{air} = 3.17E{+}04\ [X/Q]^{\gamma} \sum_i Q_i \quad DF^{\gamma}_i \qquad (7\text{-}14)$$

$$(\text{mrad}) = \left(\frac{\text{pCi-yr}}{\text{Ci}\ \ \text{sec}}\right)\ (\text{sec/m}^3) \qquad (\text{Ci})\ \left(\frac{\text{mrad-m}^3}{\text{yr-pCi}}\right)$$

where:

3.17E+04 = Number of pCi per Ci divided by the number of seconds per year.

$[X/Q]^{\gamma}$ = Maximum off-site long-term average gamma atmospheric dispersion factor for the primary vent stack release point.

= 8.5E-07 (sec/m^3)

Q_i = Number of curies of noble gas "i" released.

DF^{γ}_i = Gamma air dose factor for a uniform semi-infinite cloud of radionuclide "i".

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which leads to:

$$D_{air}^{\gamma} = 2.7E-08 * EL(R) * \sum_i Q_i \quad DF_i^{\gamma} \qquad (3-6)$$

$$(mrad) = (\frac{pCi-yr}{\mu Ci-m^3}) \; (\quad) \qquad (\mu Ci) \; (\frac{mrad-m^3}{pCi-yr})$$

As done above, the EL(R) correction factor has been added to allow for the determination of dose impacts from ground level release points utilizing the same dose equation as used for the primary vent stack.

The major difference between Method I and Method II is that Method II would use actual or concurrent meteorology with a specific noble gas release spectrum to determine $[X/Q]^{\gamma}$ rather than use the site's long-term average meteorological dispersion values.

7.2.5 Beta Dose to Air From Noble Gases

This section serves: (1) to document the development and conservative nature of Method I equations to provide background information to Method I users, and (2) to identify the general equations, parameters and approaches to Method II-type dose assessments.

Method I may be used to show that Technical Specification 3.11.2.1, which limits off-site beta air dose from gaseous effluents, has been met for releases over appropriate periods. This Technical Specification is based on the objective in 10CFR50, Appendix I, Subsection B.1, which limits the estimated beta air dose in off-site unrestricted area locations.

For any noble gas release, in any period, the increment in dose is taken from Equations B-4 and B-5 of Regulatory Guide 1.109:

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$$\Delta D^{\beta}_{air} = 3.17E\text{-}02 \quad X/Q \sum_i Q_i \quad DF^{\beta}_i \qquad (7\text{-}15)$$

$$(mrad) = \left(\frac{pCi\text{-}yr}{\mu Ci\text{-}sec}\right) \left(\frac{sec}{m^3}\right) \quad (\mu Ci) \left(\frac{mrad\text{-}m^3}{pCi\text{-}yr}\right)$$

where: DF^{β}_i = Beta air dose factors for a uniform semi-infinite cloud of radionuclide "i".

substituting

X/Q = Maximum off-site long-term average undepleted atmospheric dispersion factor for the primary vent stack release point.

= 8.2E-07 sec/m^3.

We have

$$D^{\beta}_{air} = 2.6E\text{-}08 * EL(R) * \sum_i Q_i \quad DF^{\beta}_i \qquad (3\text{-}7)$$

$$(mrad) = \left(\frac{pCi\text{-}yr}{\mu Ci\text{-}m^3}\right) (\quad) \quad (\mu Ci) \quad \left(\frac{mrad\text{-}m^3}{pCi\text{-}yr}\right)$$

As done above, the EL(R) correction factor has been added to allow for the determination of dose impacts from ground level release points utilizing the same dose equation as used for the primary vent stack.

7.2.6 Dose to Critical Organ From Iodines, Tritium and Particulates With Half-Lives Greater Than Eight Days

This section serves: (1) to document the development and conservative nature of Method I equations to provide background information to Method I users, and (2) to identify the general equations, parameters and approaches to Method II-type dose assessments.

SUPERSEDED

Method I may be used to show that the Technical Specifications which limit off-site organ dose from gases (3.11.2.3 and 3.11.4) have been met for releases over the appropriate periods. Technical Specification 3.11.2.3 is based on the ALARA objectives in 10CFR50, Appendix I, Subsection II C. Technical Specification 3.11.4 is based on Environmental Standards for Uranium Fuel Cycle in 40CFR190, which applies to direct radiation as well as liquid and gaseous effluents. These methods apply only to iodine, tritium, and particulates in gaseous effluent contribution.

Method I was developed such that "the actual exposure of an individual ... is unlikely to be substantially underestimated" (10CFR50, Appendix I). The use below of a single "critical receptor" provides part of the conservative margin to the calculation of critical organ dose in Method I. Method II allows that actual individuals, associated with identifiable exposure pathways, be taken into account for any given release. In fact, Method I was based on a Method II analysis of a critical receptor assuming all pathways present. That analysis was called the "base case"; it was then reduced to form Method I. The base case, the method of reduction, and the assumptions and data used are presented below.

The steps performed in the Method I derivation follow. First, the dose impact to the critical receptor [in the form of dose factors DFG_{ico} (mrem/μCi)] for a unit activity release of each iodine, tritium, and particulate radionuclide with half lives greater than eight days to gaseous effluents was derived. Seven exposure pathways (ground plane, inhalation, stored vegetables, leafy vegetables, milk, and meat ingestion) were assumed to exist at the site boundary (not over water or marsh areas) which exhibited the highest long-term X/Q. Doses were then calculated to six organs (bone, liver, kidney, lung, GI-LLI, and thyroid), as well as for the whole body and skin for four age groups (adult, teenager, child, and infant) due to the seven combined exposure pathways. For each radionuclide, the highest dose per unit activity release for any organ (or whole body) and age group was then selected to become the Method I site-specific dose factors. The base case, or Method I analysis, uses the general equations methods, data, and assumptions in Regulatory Guide 1.109 (Equation C-2 for doses resulting from direct exposure to contaminated ground plane; Equation C-4 for doses

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associated with inhalation of all radionuclides to different organs of individuals of different age groups; and Equation C-13 for doses to organs of individuals in different age groups resulting from ingestion of radionuclides in produce, milk, meat, and leafy vegetables in Reference A). Tables B.7-2 and B.7-3 outline human consumption and environmental parameters used in the analysis. It is conservatively assumed that the critical receptor lives at the "maximum off-site atmospheric dispersion factor location" as defined in Section 7.3.

The resulting site-specific dose factors are for the maximum organ which combine the limiting age group with the highest dose factor for any organ with each nuclide. These critical organ, critical age dose factors are given in Table B.1-12.

For any iodine, tritium, and particulate gas release, during any period, the increment in dose from radionuclide "i" is:

$$\Delta D_{ico} = Q_i DFG_{ico} \qquad (7\text{-}16)$$

where DFG_{ico} is the critical dose factor for radionuclide "i" and Q_i is the activity of radionuclide "i" released in microcuries.

7.2.7 Special Receptor Gaseous Release Dose Calculations

Technical Specification 6.8.1.4 requires that the doses to individuals involved in recreational activities within the site boundary are to be determined and reported in the annual Semiannual Effluent Report.

The gaseous dose calculations for the special receptors parallel the bases of the gaseous dose rates and doses in Sections 7.2.1 through 7.2.5. Only the differences are presented here. The special receptor XQs are given in Table B.7-5.

7.2.7.1 Total Body Dose Rate From Noble Gases

Method I was derived from Regulatory Guide 1.109 as follows:

SUPERSEDED

$$\dot{D}_{tb} = 1E{+}06\ [X/Q]^{\gamma} \sum_{i} \dot{Q}_i\ DFB_i \qquad (7\text{-}3)$$

General Equation (7-3) is then multiplied by an Occupancy Factor (OF) to account for the time an individual will be at the on-site receptor locations during the year. For the Education Center, and the "Rocks", the OFs are:

$$\text{Education Center} - \frac{12.5\ \text{hrs/yr}^{(1)}}{8760\ \text{hrs/yr}} = 0.0014$$

$$\text{The "Rocks"} - \frac{67\ \text{hrs/yr}^{(1)}}{8760\ \text{hrs/yr}} = 0.0076$$

substituting

$[X/Q]^{\gamma}$ = 1.1E-06 sec/m^3 (Education Center) for primary vent stack releases.

= 5.0E-06 sec/m^3 (The "Rocks") for primary vent stack releases.

multiplying by

OF = 0.0014 (Education Center)

= 0.0076 (The "Rocks")

and adding the release point correction factor EL(R) gives:

$$\dot{D}_{tbE} = 0.0015 * EL(R) * \sum_{i} \dot{Q}_i\ DFB_i \qquad \text{(mrem/yr)} \qquad (7\text{-}17)$$

$$\dot{D}_{tbR} = 0.038 * EL(R) * \sum_{i} \dot{Q}_i\ DFB_i \qquad \text{(mrem/yr)} \qquad (7\text{-}18)$$

---

(1) Taken from Seabrook Station Technical Specifications (Figure 5.1-1).

where:

$\dot{D}_{tbE}$, and $\dot{D}_{tbR}$ = Total body dose rates due to noble gases to an individual at the Education Center and the "Rocks" (recreational site), respectively.

$\dot{Q}_i$ = Defined previously.

DFB_i = Defined previously.

EL(R) = Defined previously.

7.2.7.2 Skin Dose Rate From Noble Gases

Method I was derived from Equation (7-8):

$$\dot{D}_{skin} = 1.11 \quad 1E{+}06\ [X/Q]^{\gamma} \sum_i \dot{Q}_i \ DF_i^{\gamma} + \tag{7-8}$$

$$1E{+}06\ X/Q \sum_i \dot{Q}_i\ DFS_i$$

substituting

$[X/Q]^{\gamma}$ = 1.1E-06 sec/m^3 (Education Center) for primary vent stack releases.

= 5.0E-06 sec/m^3 (The "Rocks") for primary vent stack releases.

X/Q = 1.6E-06 sec/m^3 (Education Center) for primary vent stack releases.

= 1.7E-05 sec/m^3 (The "Rocks") for primary vent stack releases.

multiplying by

OF = 0.0014 (Education Center)

SUPERSEDED

= 0.0076 (The "Rocks")

gives

$$\dot{D}_{skinE} = 0.0014 \sum_i \dot{Q}_i \; [1.22\ DF_i^{\gamma} + 1.60\ DFS_i] \; (mrem/yr)$$

$$\dot{D}_{skinR} = 0.0076 \sum_i \dot{Q}_i \; [5.55\ DF_i^{\gamma} + 17.0\ DFS_i] \; (mrem/yr)$$

and with the addition of the release point correction factor EL(R), the equations can be written:

$$\dot{D}_{skinE} = 0.0014 * EL(R) * \sum_i \dot{Q}_i \; DF'_{iE} \; (mrem/yr) \quad (7\text{-}19)$$

$$\dot{D}_{skinR} = 0.0076 * EL(R) * \sum_i \dot{Q}_i \; DF'_{iR} \; (mrem/yr) \quad (7\text{-}20)$$

where:

$\dot{D}_{skinE}$ and $\dot{D}_{skinR}$ = The skin dose rate due to noble gases to an individual at the Education Center and the "Rocks," respectively.

$\dot{Q}_i$ = Defined previously.

EL(R) = Defined previously.

DF'_{iE} and DF'_{iR} = The combined skin dose factors for radionuclide "i" for the Education Center, and the "Rocks", respectively (see Table B.1-13).

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7.2.7.3 Critical Organ Dose Rate From Iodines, Tritium and Particulates With Half-Lives Greater Than Eight Days

The equations for $\dot{D}_{co}$ are derived in the same manner as in Section 7.2.2, except that the occupancy factors are also included. Therefore:

$$\dot{D}_{coE} = 0.0014 * EL(R) * \sum_{i} \dot{Q}_i \ DFG'_{icoE} \ (mrem/yr) \qquad (7-21)$$

$$\dot{D}_{coR} = 0.0076 * EL(R) * \sum_{i} \dot{Q}_i \ DFG'_{icoR} \ (mrem/yr) \qquad (7-22)$$

where:

$\dot{D}_{coE}$ and $\dot{D}_{coR}$ = The critical organ dose rates to an individual at the Education Center and the "Rocks", respectively.

$\dot{Q}_i$ = Defined previc_sly.

EL(R) = Defined previously.

DF'_{icoE} and DF'_{icoR} = The critical organ dose rate factors for radionuclide "i" for the Education Center and the "Rocks," respectively (see Table B.1-14).

7.2.7.4 Gamma Dose to Air From Noble Gases

Method I was derived from Equation (7-14):

$$D^{\gamma}_{air} = 3.17E+04 \ [X/Q]^{\gamma} \sum_{i} Q_i \ DF^{\gamma}_i \qquad (7-14)$$

SUPERSEDED

substituting

$[X/Q]^{\gamma}$ = 1.1E-06 sec/m^3 (Education Center) for primary vent stack releases.

= 5.0E-06 sec/m^3 (The "Rocks") for primary vent stack releases.

multiplying by

OF = 0.0014 (Education Center)

= 0.0076 (The "Rocks")

and 1E-06 Ci/μCi, plus adding the release point correction factor EL(R)

gives

$$D^{\gamma}_{airE} = 4.88E\text{-}11 * EL(R) * \sum_i Q_i \, DF^{\gamma}_i \quad \text{(mrad)} \qquad (7\text{-}23)$$

$$D^{\gamma}_{airR} = 1.20E\text{-}09 * EL(R) * \sum_i Q_i \, DF^{\gamma}_i \quad \text{(mrad)} \qquad (7\text{-}24)$$

where:

D^{γ}_{airE} and D^{γ}_{airR} = The gamma air doses to an individual at the Education Center and the "Rocks," respectively.

Q_i = Total activity (μCi) released to the atmosphere via the station vents of each radionuclide "i".

DF^{γ}_i, DF^{γ}_i, and EL(R) = Defined previously.

SUPERSEDED

7.2.7.5 Beta Dose to Air From Noble Gases

Method I was derived from Equation (7-15):

$$D^{\beta}_{air} = 3.17E{+}04\ X/Q \sum_{i} Q_i\ DF^{\beta}_i \qquad (7\text{-}15)$$

substituting

X/Q = 1.6E-06 sec/m^3 (Education Center) for primary vent stack releases.

= 1.7E-05 sec/m^3 (The "Rocks") for primary vent stack releases.

multiplying by

OF = 0.0014 (Education Center)

= 0.0076 (The "Rocks")

and 1E-06 Ci/µCi, plus adding the release point correction factor EL(R)

gives

$$D^{\beta}_{airE} = 7.1E{-}11 * EL(R) * \sum_{i} Q_i\ DF^{\beta}_i \quad \text{(mrad)} \qquad (7\text{-}25)$$

$$D^{\beta}_{airR} = 4.1E{-}09 * EL(R) * \sum_{i} Q_i\ DF^{\beta}_i \quad \text{(mrad)} \qquad (7\text{-}26)$$

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where:

D^{β}_{airE} and D^{β}_{airR} = The beta air doses to an individual at the Education Center and the "Rocks," respectively.

Q_i = Total activity (μCi) released to the atmosphere via the station vents of each radionuclide 'i".

DF^{β}_{i}, DF^{β}_{i}, and EL(R) = Defined previously.

7.2.7.6 <u>Critical Organ Dose From Iodines, Tritium and Particulates With Half-Lives Greater Than Eight Days</u>

Method I was derived in the same manner as Equation (3-8):

$$D_{co} = EL(R) * \sum_i Q_i \ DFG_{ico} \qquad (3\text{-}8)$$

multiplying by:

OF = 0.0014 (Educatior Center)

= 0.0076 (The "Rocks")

and 1E-06 Ci/μCi; plus substituting the location specific DFGs

gives

$$D_{coE} = 0.0014 * EL(R) * \sum_i Q_i DFG_{icoE} \qquad \text{(mrem)} \qquad (7\text{-}27)$$

$$D_{coR} = 0.0076 * EL(R) * \sum_i Q_i \ DFG_{icoR} \qquad \text{(mrem)} \qquad (7\text{-}28)$$

where:

D_{coE} and D_{coR} = The critical organ doses of an individual at the Education Center and the "Rocks," respectively.

Q_i = The total activity (μCi) released to the atmosphere of radionuclide "i".

DFG_{icoE} and DFG_{icoR} = The critical organ dose factors (mrem/μCi) for the Education Center and the "Rocks," respectively for each radionuclide "i". The factors represent the age group and organ with the largest dose factor (see Table B.1-14).

EL(P) = Defined previously.

The special receptor equations can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Normal operations (nonemergency event).

2. Applicable radionuclide releases via the station vents to the atmosphere.

If Method I cannot be applied, or if the Method I dose exceeds this limit, or if a more refined calculation is required, then Method II may be applied.

TABLE B.7-2

Environmental Parameters for Gaseous Effluents at Seabrook Station
(Derived from Reference A)*

Variable		Vegetables		Cow Milk		Goat Milk		Meat	
		Stored	Leafy	Pasture	Stored	Pasture	Stored	Pasture	Stored
YV	Agricultural Productivity (Kg/M^2)	2.	2.	0.70	2.	0.70	2.	0.70	2.
P	Soil Surface Density (KG/M^2)	240.	240.	240.	240.	240.	240.	240.	240.
T	Transport Time to User (HRS)			48.	48.	48.	48.	480.	480.
TB	Soil Exposure Time(1) (HRS)	131400.	131400.	131400.	131400.	131400.	131400	131400.	131400.
TF	Crop Exposure Time to Plume (HRS)	1440.	1440.	720.	1,440.	720.	1,440.	720.	1,440.
TH	Holdup After Harvest (HRS)	1440.	24.	0.	2160.	0.	2160.	0.	2160.
QF	Animals Daily Feed (KG/DAY)			50.	50.	6.	6.	50.	50.
FP	Fraction of Year on Pasture(2)			0.50		0.50		0.50	
FS	Fraction Pasture when on Pasture(3)			1.		1.		1.	
FG	Fraction of Stored Veg. Grown in Garden	0.76							
FL	Fraction of Leafy Veg. Grown in Garden		1.0						
FI	Fraction Elemental Iodine = 0.5								
H	Absolute Humidity = 5.60(4) (gm/M^3)								

* Regulatory Guide 1.109, Rev. 1

SUPERSEDED

TABLE B.7-2
(Continued)

Notes:

(1) For Method II dose/dose rate analyses of identified radioactivity releases of less than one year, the soil exposure time for that release may be set at 8760 hours (1 year) for all pathways.

(2) For Method II dose/dose rate analyses performed for releases occurring during the first or fourth calendar quarters, the fraction of time animals are assumed to be on pasture is zero (nongrowing season). For the second and third calendar quarters, the fraction of time on pasture (FP) will be set at 1.0. FP may also be adjusted for specific farm locations if this information is so identified and reported as part of the land use census.

(3) For Method II analyses, the fraction of pasture feed while on pasture may be set to less than 1.0 for specific farm locations if this information is so identified and reported as part of the land use census.

(4) For all Method II analyses, an absolute humidity value equal to 5.6 (gm/m^3) shall be used to reflect conditions in the Northeast (Reference: Health Physics Journal, Vol. 39 (August), 1980; Page 318-320, Pergammon Press).

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TABLE B.7-3

Usage Factors for Various Gaseous Pathways at Seabrook Station
(from Reference A, Table E-5)*

Maximum Receptor:

Age Group	Vegetables (kg/yr)	Leafy Vegetables (kg/yr)	Milk (l/yr)	Meat (kg/yr)	Inhalation (m^3/yr)
Adult	520.00	64.00	310.00	110.00	8000.00
Teen	630.00	42.00	400.00	65.00	8000.00
Child	520.00	26.00	330.00	41.00	3700.00
Infant	0.00	0.00	330.00	0.00	1400.00

The "Rocks" and Education Center:

Age Group	Vegetables (kg/yr)	Leafy Vegetables (kg/yr)	Milk (l/yr)	Meat (kg/yr)	Inhalation (m^3/yr)
Adult	0.00	0.00	0.00	0.00	8000.0
Teen	0.00	0.00	0.00	0.00	8000.0
Child	0.00	0.00	0.00	0.00	3700.0
Infant	0.00	0.00	0.00	0.00	1400.0

* Regulatory Guide 1.109

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7.3 Receptor Points and Average Atmospheric Dispersion Factors for Important Exposure Pathways

The gaseous effluent dose equations (Method I) have been simplified by assuming an individual whose behavior and living habits inevitably lead to a higher dose than anyone else. The following exposure pathways to gaseous effluents listed in Regulatory Guide 1.109 (Reference A) have been considered:

1. Direct exposure to contaminated air;

2. Direct exposure to contaminated ground;

3. Inhalation of air;

4. Ingestion of vegetables;

5. Ingestion of cow's and goat's milk; and

6. Ingestion of meat.

Section 7.3.1 details the selection of important off-site and on-site locations and receptors. Section 7.3.2 describes the atmospheric model used to convert meteorological data into atmospheric dispersion factors. Section 7.3.3 presents the maximum atmospheric dispersion factors calculated at each of the off-site receptor locations.

7.3.1 Receptor Locations

The most limiting site boundary location in which individuals are, or likely to be located as a place of residence was assumed to be the receptor for all the gaseous pathways considered. This provides a conservative estimate of the dose to an individua' from existing and potential gaseous pathways for the Method I analysis.

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This point is the west sector, 974 meters from the center of the reactor units for undepleted, depleted, and gamma X/Q calculations, and the northwest section, 914 meters for calculations with D/Q the dispersion parameter.

The site boundary in the NNE through SE sectors is located over tidal marsh (e.g., over water), and consequently are not used as locations for determining maximum off-site receptors (Reference NUREG 0133).

Two other locations (on-site) were analyzed for direct ground plane exposure and inhalation only. They are the "Rocks" (recreational site) and the Education Center shown on Figure 5.1-1 of the Technical Specifications.

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7.3.2 Seabrook Station Atmospheric Dispersion Model

The time average atmospheric dispersion factors are computed for routine (long-term) ground level releases using the AEOLUS-2 Computer Code (Reference B).

AEOLUS-2 produces the following average atmospheric dispersion factors for each location:

1. Undepleted X/Q dispersion factors for evaluating ground level concentrations of noble gases;

2. Depleted X/Q dispersion factors for evaluating ground level concentrations of iodines and particulates;

3. Gamma X/Q dispersion factors for evaluating gamma dose rates from a sector averaged finite noble gas cloud (multiple energy undepleted source); and

4. D/Q deposition factors for evaluating dry deposition of elemental radioiodines and other particulates.

Gamma dose rate is calculated throughout this ODCM using the finite cloud model presented in "Meteorology and Atomic Energy - 1968" (Reference E, Section 7-5.2.5. That model is implemented through the definition of an effective gamma atmospheric dispersion factor, $[X/Q^{\gamma}]$ (Reference B, Section 6), and the replacement of X/Q in infinite cloud dose equations by the $[X/Q^{\gamma}]$.

7.3.3 Long-Term Average Atmospheric Dispersion Factors for Receptors

The calculation of Method I atmospheric diffusion factors (undepleted CHI/Q, depleted CHI/Q, D/Q, and gamma CHI/Q values) utilized a methodology generally consistent with US NRC Regulatory Guide 1.111 (Revision 1) criteria and the methodology for calculating routine release diffusion factors as represented by the XOQDOQ computer code (NUREG/CR-2919). The primary vent

stack is treated as a "mixed-mode" release, as defined in Regulatory Guide 1.111. Effluents are considered to be part-time ground level/part-time elevated releases depending on the ratio of the primary vent stack effluent exist velocity relative to the speed of the prevailing wind. All other release points (e.g., Turbine Building and Chemistry lab hoods) are considered ground-level releases.

In addition, Regulatory Guide 1.111 discusses the concept that constant mean wind direction models like AEOLUS-2 do not describe spatial and temporal variations in airflow such as the recirculation of airflow which can occur during prolonged periods of atmospheric stagnation. For sites near large bodies of water like Seabrook, the onset and decay of sea breezes can also results in airflow reversals and curved trajectories. Consequently, Regulatory Guide 1.111 states that adjustments to constant mean wind direction model outputs may be necessary to account for such spatial and temporal variations in air flow trajectories. Recirculation correction factors have been applied to the diffusion factors. The recirculation correction factors used are compatible to the "default open terrain" recirculation correction factors used by the XOQDOQ computer code.

The relative deposition rates, D/Q values, were derived using the relative deposition rate curves presented in Regulatory Guide 1.111 (Revision 1). These curves provide estimates of deposition rates as a function of plume height, stability class, and plume travel distance.

Receptor Locations

For ground-level releases, the downwind location of "The Rocks" (244m NE/ENE) and the Ed Center (406m SW) were taken as the distance from the nearest point on the Unit 1 Administrative Building/Turbine Building complex. For the site boundary, the minimum distances from the nearest point on the Administration Building/Turbine Building complex to the site boundary within a 45-degree sector centered on the compass direction of interest as measured from FSAR Figure 2.1-4A were used (with the exception that the NNE-NE-ENE-E-ESE-SE site boundary sectors were not evaluated because of their over-water locations).

For primary vent stack releases, the distances from the Unit 1 primary vent stack to "The ⁻ks" (244m NE) and the Ed Center (488w SW) as measured from a recent si ‹erial photograph were used. For the site boundary, the minimum distances from the Unit 1 primary vent stack to the site boundary within a 45-degree sector centered on the compass direction of interest as measured from FSAR Figure 2.1-4A were used (with the exception that the NNE-NE-ENE-E-ESE-SE site boundary sectors were not evaluated because of their over-water locations).

Meteorological Data Bases

For "The Rocks" and Ed Center receptors, the diffusion factors represent six-year averages during the time period January 1980 through December 1983 and January 1987 through December 1988 (with the exception that, because of low data recovery, April 1979 and May 1979 were substituted for April 1980 and May 1980). For the site boundary receptors, both six-year average growing season (April through September) and year-round (January through December) diffusion factors were generated, with the higher of the two chosen to represent the site boundary.

The meteorological diffusion factor used in the development of the ODCM Method I dose models are summarized on Tables B.7-4 through B.7-6.

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TABLE B.7-4

Seabrook Station Dilution Factors*
Primary Vent Stack

	Dose Rate to Individual			Dose to Air		Dose to Critical Organ
	Total Body	Skin	Critical Organ	Gamma	Beta	Thyroid
X/Q depleted ($\frac{sec}{m^3}$)	-	-	7.5E-07	-	-	7.5E-07
X/Q undepleted ($\frac{sec}{m^3}$)	-	8.2E-07	-	-	8.2E-07	-
D/Q ($\frac{1}{m^2}$)	-	-	1.5E-08**	-	-	1.5E-08
X/Q^{γ} ($\frac{sec}{m^3}$)	8.5E-07	8.5E-07	-	8.5E-07	-	-

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* West site boundary, 974 meters from Containment Building
**Northwest site boundary, 914 meters from Containment Building

TABLE B.7-5

Seabrook Station Dilution Factors for Special (On-Site) Receptors Primary Vent Stack

	Dose Rate to Individual			Dose to Air		Dose to Critical Organ
	Total Body	Skin	Critical Organ	Gamma	Beta	Thyroid
Education Center: (SW - 488 meters)						
X/Q depleted ($\frac{sec}{m^3}$)	-	-	1.5E-06	-	-	1.5E-06
X/Q undepleted ($\frac{sec}{m^3}$)	-	1.6E-06	-	-	1.6E-06	-
D/Q ($\frac{1}{m^2}$)	-	-	2.7E-08	-	-	-
X/Q^{γ} ($\frac{sec}{m^3}$)	1.1E-06	1.1E-06	-	1.1E-06	-	-
The "Rocks" (ENE - 244 meters)						
X/Q depleted ($\frac{sec}{m^3}$)	-	-	1.6E-05	-	-	1.6E-05
X/Q undepleted ($\frac{sec}{m^3}$)	-	1.7E-05	-	-	1.7E-05	-
D/Q ($\frac{1}{m^2}$)	-	-	1.1E-07	-	-	-
X/Q^{γ} ($\frac{sec}{m^3}$)	5.0E-06	5.0E-06	-	5.0E-06	-	-

TABLE B.7-6

Seabrook Station
Atmospheric Diffusion and Deposition Factors
Ground-Level Release Pathway

Diffusion Factor	RECEPTOR The Rocks	Ed Center	Site Boundary (a)
Undepleted CHI/Q, sec/m^3	1.6×10^{-4} (244m ENE)	2.3×10^{-5} (406m SW)	1.0×10^{-5} (823m W)
Depleted CHI/Q, sec/m^3	1.5×10^{-4} (244m ENE)	2.1×10^{-5} (406m SW)	9.4×10^{-6} (823m W)
D/Q, m^{-2}	5.1×10^{-7} (244m ENE)	1.0×10^{-7} (406m SW)	5.1×10^{-8} (823m W)
Gamma CHI/Q, sec/m^3	2.6×10^{-5} (244m ENE)	5.3×10^{-6} (406m SW)	3.4×10^{-6} (823m W)

(a) The highest site boundary diffusion and deposition factors occurred during the April through September growing season. Note that for the primary vent stack release pathway, none of the off-site receptor diffusion and deposition factors (located at 0.25-mile increments beyond the site boundary) exceeded the site boundary diffusion and deposition factors.

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ENCLOSURE 4 - ATTACHMENT 2

0001

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

January 31, 1991

Docket No. 50-443

RECEIVED
FEB 04 1991
LICENSING

Mr. Ted C. Feigenbaum
President and Chief Executive Officer
New Hampshire Yankee Division
Public Service Company of New Hampshire
Post Office Box 300
Seabrook, New Hampshire 03874

Dear Mr. Feigenbaum:

SUBJECT: SEABROOK OFFSITE DOSE CALCULATION MANUAL (TAC NO. 77672)

In a letter dated October 26, 1990, you provided a revised Seabrook Offsite Dose Calculation Manual (ODCM) for NRC review. The purpose of this letter is to notify you that the ODCM may be used on an interim basis; however, permanent use should await approval by the NRC staff of the written documentation cited below.

The ODCM, in general, contains methodology that should give conservative (Method I) or realistic (Method II) values of doses and dose rates due to routine releases of gaseous and liquid effluents from the Seabrook site. However, you are requested to provide written documentation by April 1, 1991 of any deviations in methodology, assumptions and input parameters from Regulatory Guide 1.109 in using Method II. In addition, you are requested to provide and justify the bases used in determining the occupancy factors for the "Rocks" and Education Center, in not monitoring airborne activity near the point of highest calculated long term site boundary D/Q from primary vent releases and in using a lower mixing ratio than that recommended in NUREG-0133. Equations that contain the term EL(R) should also be modified to show that there is actually a summation over two values of EL(R). These comments are addressed more fully as items 1 through 5 in Section A of the enclosure and were discussed during a December 26, 1990 telecon with your staff. The additional comments in the enclosure are offered for consideration as improvements to a future revision of the Seabrook ODCM.

Sincerely,

G E Edison

Gordon E. Edison, Senior Project Manager
Project Directorate I-3
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosure:
As stated

cc w/enclosure: See next page

9102070071 4pp.

ENCLOSURE

COMMENTS ON SEABROOK ODCM

DATED OCTOBER 26, 1990

A. The licensee should respond to the following items by April 1, 1991:

1. When Method II is used to calculate dose rates, a statement should accompany the reported doses which 1) states that Regulatory Guide 1.109 has been followed or 2) explicitly describes any deviations in methodology, assumptions and input parameters from Regulatory Guide 1.109 and the bases for the deviations.

2. The bases used in determining the occupancy factors of 67 hours/year for the "Rocks" and 12.5 hours/year for the Education Center should be provided and justified.

3. Justification should be provided for displacing the nearest monitor for airborne activity sampling approximately 90° from the direction in which the highest primary vent stack long term annual average site boundary D/Q (Table B.7-4) is calculated.

4. The bases for the use of a mixing ratio of 0.10 for Method I and 0.025 for use with Method II for the dose due to liquid effluents should be justified, since Section 4.3 of NUREG-0133 recommends a value of 1.0.

5. Equations that contain the term EL(R) (e.g., in Sections 3.4, 3.5, 3.6, 7.2.1, 7.2.2 and 7.2.3) should be modified to show that there is actually a sum over EL(R)=1.0 and EL(R)="value from Table B.1-15."

B. The following items are offered for consideration as improvements to a future revision of the Seabrook ODCM:

1. Section 6.1.2 should contain a statement indicating how it is to be determined that the Turbine Building Sump activity is not greater than 10% of MPC.

2. The methodology to determine the setpoint of the Primary Component Cooling Water System monitor should be added to Section 5.1.

3. A fraction, f_{x}, should be added to Section 5.1 to account for the activity released past the Primary Component Cooling Water System monitor.

4. In Section 5.1, the "$\leq$ " in Equation B-3 should be changed to " = ".

5. The methodology to determine the setpoints for the radioactivity monitors on a) the Gaseous Waste Processing System and b) the Turbine Gland Seal Condenser Exhaust should be added to the ODCM.

6. A summation over all sources of radioactive material in liquid effluents should be added to Equation 2-1.

7. Equation 2-1 should include the contribution to the offsite concentration due to releases from the Primary Component Cooling Water Systems.

8. It is acceptable to follow the recommendation of Basis Statement 3/4.11.2.1 (in NUREG-0472 and the Seabrook ODCM) and base compliance with the organ dose rate limit of Technical Specification 3.11.2.1 on the thyroid dose to a child via the inhalation pathway.

9. The ground plane dose calculation for Mn-54 and Co-60 should be checked.

10. The first part of the definition EL(R) following Eq. 3-3 should apparently read "vent stack Elevation Release Point (R) to ground level."

11. The last sentence in the first paragraph of Section 7.2.3 should be deleted, since it is out of place.

12. The source, release pathway and the radioactivity monitor for the Primary Component Cooling Water System should be added to Figure B.6.1.

13. The Turbine Gland Seal Condenser Exhaust Monitor should be shown in Figure B.6-2.

14. Attention should be given to including legible figures of sampling locations in Section 4.0.

15. The Interlaboratory Comparison Program should be identified in the ODCM.

16. The calculation methodology for deriving EL(R) should be documented or referenced in Table B.1-15.

ENCLOSURE 4 - ATTACHMENT 3

New Hampshire
Yankee

Ted C. Feigenbaum
President and
Chief Executive Officer

NYN-91055

March 29, 1991

United States Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Document Control Desk

References:
(a) Facility Operating License No. NPF-86, Docket No. 50-443

(b) USNRC Letter dated January 31, 1991, "Seabrook Offsite Dose Calculation Manual (TAC No. 77672), G.E. Edison to T.C. Feigenbaum

(c) NHY Letter NYN-90189 dated October 26, 1990, "Request for Offsite Dose Calculation Manual Review", T.C. Feigenbaum to USNRC

(d) October 16, 1990 Meeting between NHY and NRC, Noticed September 28, 1990

(e) NHY Letter SBN-1168 dated July 22, 1986, "Seabrook Station Offsite Dose Calculation Manual, (ODCM); Revised Manual, G.S. Thomas to V.S. Noonan

Subject: Request for Additional Information

Gentlemen:

In response to a request from the NRC Staff [Reference (b)] New Hampshire Yankee (NHY) is providing information regarding Staff comments on the Seabrook Station Offsite Dose Calculation Manual (ODCM). Detailed responses to the Staff comments are provided in the Enclosure. It is anticipated that the ODCM will be revised to incorporate the appropriate items from the Enclosure by July 1991. We trust that this information should satisfactorily address your concerns.

Should you require additional information regarding this matter please contact Mr. James M. Peschel, Regulatory Compliance Manager, at (603) 474-9521, extension 3772.

Very truly yours,

Ted C Feigenbaum

Ted C. Feigenbaum

TCF:JMP/act
Enclosure

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ENCLOSURE 1 TO NYN-91055

RESPONSE TO NRC COMMENTS ON SEABROOK ODCM
DATED OCTOBER 26, 1990

Comment A.1:

When Method II is used to calculate dose rates, a statement should accompany the reported doses which 1) states that Regulatory Guide 1.109 has been followed or 2) explicitly describes any deviations in methodology, assumptions and input parameters from Regulatory Guide 1.109 and the bases for the deviations.

Response A.1:

Dose assessment reports prepared in accordance with the requirements of the ODCM will include a statement indicating that the appropriate portions of Regulatory Guide 1.109 (as identified in the individual subsections of the ODCM for each class of effluent exposure) have been used to determine dose impact from station releases. Any deviation from the methodology, assumptions, or parameters given in Regulatory Guide 1.109 and not already identified in the bases of the ODCM will be explicitly described in the effluent report along with the bases for the deviation.

The next amendment to the Seabrook ODCM will include the above statement as documentation of this commitment.

Comment A.2:

The bases used in determining the occupancy factors of 67 hours/year for the "Rocks" and 12.5 hours/year for the Education Center should be provided and justified.

Response A.2:

The "Rocks" is a boat landing area which provides access to Browns River and Hampton Harbor. The Seabrook FSAR, Chapter 2.1, indicates little boating activity in either Browns River or nearby Hunts Island Creek has been observed upon which to determine maximum or conservative usage factors for this onsite shoreline location. As a result, a default value for shoreline activity as provided in Regulatory Guide 1.109, Table E-5, for maximum individuals was utilized for determining the "Rocks" occupancy factor. The 67 hours/year corresponds to the usage factor for a teenager involved in shoreline recreation. This is the highest usage factor of all four age groups listed in Regulatory Guide 1.109, and has been used in the ODCM to reflect the maximum usage level irrespective of age.

Regulatory Guide 1.109 does not provide a maximum individual usage factor for activities similar to those which would be associated with the Seabrook Education Center. Therefore, the usage factor used in the ODCM for the Education Center reflects the observed usage patterns of visitors to the facility. Individuals in the public who walk in to look at the exhibits on display and pick up available information stay approximately 1.5 hours each. Tour groups who schedule visits to the facility stay approximately 2.5 hours. For conservatism, it was assumed

that an individual in a tour group would return 5 times in a year, and stay 2.5 hours on each visit. These assumptions when multiplied together provide the occupancy factor of 12.5 hours/year used in the ODCM for public activities associated with the Education Center.

The next amendment to the ODCM will include the above description as documentation of the bases of the occupancy factors used for onsite receptors.

Comment A.3:

Justification should be provided for displacing the nearest monitor for airborne activity sampling approximately 90 degrees from the direction in which the highest primary vent stack long term annual average site boundary D/Q (Table B.7-4) is calculated.

Response A.3:

The intent of the D/Q value cited in Table B.7-4 of the ODCM is for calculations of dose to man resulting from deposition of radioactivity through the food crop and forage pathways. Since these pathways are open most effectively during the growing season, a maximum 6-month growing season D/Q value (Northwest site boundary) was generated using 6 years of meteorological data (for the months of April through September). This D/Q value is intended only for the specialized purpose of calculating maximum individual doses with pathways that include food ingestion.

For the purpose of siting air sampling stations, a maximum 12-month annual D/Q value has been used. The 12-month D/Q is appropriate for this situation because the air samplers are intended for direct measurement of airborne radioactivity year-round. Using the 12-month D/Qs (based on 6 years of met data), the sector with the highest primary vent stack long term annual average site boundary D/Q shifts to the Southwest sector. A continuous sampler (station AP/CF-03) is currently located near this point at 0.8 km from the Unit 1 Containment in the Southwest sector.

Comment A.4:

The bases for the use of a mixing ratio of 0.10 for Method I and 0.025 for use with Method II for the dose due to liquid effluents should be justified, since Section 4.3 of NUREG-0133 recommends a value of 1.0.

Response A.4:

The requirements for the determination of radiological impacts resulting from releases in liquid effluents is derived from 10 CFR part 50, Appendix I. Section III.A.2 of Appendix I indicates that in making the assessment of doses to hypothetical receptors, "The applicant may take account of any real phenomenon or factors actually affecting the estimate of radiation exposure, including the characteristics of the plant, modes of discharge of radioactive materials, physical processes tending to attenuate the quantity of radioactive material to which an individual would be exposed, and the effects of averaging exposures over time during which determining factors may fluctuate." In accessing the

liquid exposure pathways that characterize Seabrook Station, the design and physical location of the circulating water discharge system needs to be considered within the scope of Appendix I.

Seabrook utilizes an offshore submerged multiport diffuser discharger for rapid dissipation and mixing of thermal effluents in the ocean environment. The 22-port diffuser section of the discharge system is located in approximately 50 to 60 feet of water with each nozzle 7 to 10 feet above the sea floor. Water is discharged in a generally eastward direction away from the shoreline through the multiport diffuser, beginning at a location over 1 mile due east of Hampton Harbor inlet. This arrangement effectively prevents the discharge plume (at least to the 1 degree or 40 to 1 dilution isopleth) from impacting the shoreline over the tidal cycle.

Eleven riser shafts with two diffuser nozzles each form the diffuser, and are spaced about 100 feet apart over a distance of about 1000 feet. The diffusers are designed to maintain a high exit velocity of about 7.5 feet per second during power operations. Each nozzle is angled approximately 20 degrees up from the horizontal plane to prevent bottom scour. These high velocity jets passively entrain about 10 volumes of fresh ocean water into the near field jet mixing region before the plume reaches the water surface. This factor of 10 mixing occurs in a very narrow zone of less than 300 feet from the diffuser by the time the thermally buoyant plume reaches the ocean surface. This high rate of dilution occurs within about 70 seconds of discharge from the diffuser nozzles.

The design of the multiport diffuser to achieve a 10 to 1 dilution in the near field jet plume, and a 40 to 1 dilution in the near mixing zone associated with the 1 degree isotherm, has been verified by physical model tests (ref. "Hydrothermal Studies Of Bifurcated Diffuser Nozzles And Thermal Backwashing - Seabrook Station", Alden Research Laboratories, July, 1977).

During shutdown periods when the plant only requires service water cooling flow, the high velocity jet mixing created by the normal circulating water flow at the diffuser nozzles is reduced. However, mixing within the discharge tunnel water volume is significantly increased (factor of about 5) due to the long transit time (approximately 50 hours) for batch waste discharged from the plant to travel the 3 miles through the 19 ft diameter tunnels to the diffuser nozzles. Additional mixing of the thermally buoyant effluent in the near field mixing zone assures that an equivalent overall 10 to 1 dilution occurs by the time the plume reaches the ocean surface.

The dose assessment models utilized in the ODCM are taken from NRC Regulatory Guide 1.109. The liquid pathway equations include a parameter (Mp) to account for the mixing ratio (reciprocal of the dilution factor) of effluents in the environment at the point of exposure. Table 1 in Reg. Guide 1.109 defines the point of exposure to be the location that is anticipated to be occupied during plant lifetime, or have potential land and water usage and food pathways as could actually exist during the term of plant operation. For Seabrook, the potable water and land irrigation pathways do not exist since salt water is used as the receiving water body for the circulating water discharge. The three pathways that have been factored into the assessment models are

shoreline exposures, ingestion of invertebrates, and fish ingestion.

With respect to shoreline exposures, both the mixing ratios of 0.1 and 0.025 are extremely conservative since the effluent plume which is discharged over 1 mile offshore never reaches the beach where this type of exposure could occur. Similarly, bottom dwelling invertebrates either taken from mud flats near the shoreline, or from the area of the diffuser, are not exposed to the undiluted effluent plume. The shore area is beyond the reach of the surface plume of the discharge, and the design of the upward directed discharge nozzles along with the thermal buoyancy of the effluent, force the plume to quickly rise to the surface without affecting bottom organisms.

Consequentially, the only assumed exposure pathway which might be impacted by the near field plume of the circulating water discharge is fin fish. However, the mixing ratio of 0.1 is very conservative because fish will avoid both the high exit velocity provided by the discharge nozzles and the high thermal temperature difference between the water discharged from the diffuser and the ambient water temperature in the near field. In addition, the dilution factor of 10 is achieved within 70 seconds of discharge, and confined to a very small area thus prohibiting any significant quantity of fish from reaching equilibrium conditions with radioactivity concentrations created in the water environment.

The mixing ratio of 0.025 which corresponds to the 1 degree thermal near field mixing zone is a more realistic assessment of the dilution to which fin fish might be exposed. However, even this dilution credit is conservative since it neglects the plants operational design which discharges radioactivity by batch mode. Batch discharges are on the order of only a few hours in duration several times per week, and thus the maximum discharge concentrations are not maintained in the environment long enough to allow fish to reach equilibrium uptake concentrations as assumed in the dose assessment modeling. When dose impacts from the fish pathway are then added to the very conservative dose impacts derived for shoreline exposures and invertebrate ingestion, the total calculated dose is very unlikely to have underestimated the exposure to any real individual.

The recommended value for dilution of 1.0 given in NUREG-0133 is a simplistic assumption provided so that a single model could be used with any plant design and physical discharge arrangement. For plants that utilize a surface canal type discharge structure where little entrainment mixing in the environment occurs, a dilution factor of 1.0 is a reasonable assumption. However, in keeping with the guidance provided in Appendix I to 10 CFR 50, Seabrook has determined site specific mixing ratios which factor in its plant design.

The next amendment to the ODCM will include the above description as documentation of the bases of the mixing ratios used in the liquid dose assessment models.

Comment A.5:

Equations that contain the term EL(R) (e.g., in Sections 3.4,

3.5, 3.6, 7.2.1, 7.2.2 and 7.2.3) should be modified to show that there is actually a sum over EL(R)=1.0 and EL(R)="value from Table B.1-15."

Response:

The purpose of the EL(R) term in each of the dose equations in the ODCM is to permit assessment of radiological impacts from plant effluents for both plant vent stack releases, as well as any contribution from ground level sources such as chem lab hoods if they occur. It is not meant to imply that the calculated contribution from different release sources do not need to be added together to determine Station compliance with the Radiological Effluent Technical Specifications. Station procedures which implement the methods given in the ODCM recognize that all plant releases need to be considered in determining offsite dose assessments.

In order to insure that this requirement is clearly understood, the next amendment to the ODCM will include a clarification that states that the sum of doses from both plant vent stack (EL(R)=1.0) and ground level releases (EL(R)= "values from Table B.1-15") must be considered for determination of Technical Specification compliance.