RMD CONTROL COPY # 3008

STATION

OFFSITE DOSE CALCULATION MANUAL

(ODCM)

INFORMATION ONLY.

1. Does this manual/manual revision:

   a. Make changes in the facility as described in the UFSAR? ☐ Yes ☑ No

   b. Make changes in procedures as described in the UFSAR? ☐ Yes ☑ No

   c. Involve tests or experiments not described in the UFSAR? ☐ 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 NAMM Procedure 11210 is required. (The individual performing this review shall have completed 10 CFR 50.59 training.)

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SORC REVIEW COMPLETED DURING MEETING NUMBER: 93-131 DATE: 9/22/93

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North Atlantic Energy Service Corporation

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ABSTRACT

The Station OffSite Dose Calculation Manual (ODCM) is divided into two parts: (1) the in-plant Radiological Effluent Monitoring Program requirements for liquid and gas sampling and analysis, along with the Radiological Environmental Monitoring Program requirements (Part A); and (2) approved methods to determine effluent monitor setpoint values and estimates of doses and radionuclide concentrations occurring beyond the boundaries of Seabrook Station resulting from normal Station operation (Part B).

The sampling and analysis programs 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 3/4.11. The Radiological Environmental Monitoring Program required by Technical Specification 3/4.12 and outlined within this manual 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.

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PART A

RADIOLOGICAL EFFLUENT MONITORING PROGRAMS

1.0 INTRODUCTION

The purpose of Part A of the ODCM (Off-Site Dose Calculation Manual) is to describe the sampling and analysis programs conducted by the Station which provides input to the models in Part B for calculating liquid and gaseous effluent concentrations, monitor setpoints, and off-site doses. The results of Part B calculations are used to determine compliance with the concentration and dose requirements of Technical Specification 3/4.11.

The Radiological Environmental Monitoring Program required as a minimum to be conducted (per Technical Specification 3/4.12) is described in Part A, with the identification of current locations of sampling stations being utilized to meet the program requirements listed in Part B. The information obtained from the conduct of the Radiological Environmental Monitoring Program provides data on measurable levels of radiation and radioactive materials in the environment necessary to evaluate the relationship between quantities of radioactive materials released in effluents and resultant radiation doses to individuals from principal pathways of exposure. The data developed in the surveillance and monitoring programs described in Part A to the ODCM provide a means to confirm that measurable concentrations of radioactive materials released as a result of Seabrook Station operations are not significantly higher than expected based on the dose models in Part B.

2.0 RESPONSIBILITIES FOR PART A

All changes to Part A of the ODCM shall be reviewed and approved by the Station Operations Review Committee (SORC) and the Nuclear Regulatory Commission prior to implementation.

It shall be the responsibility of the Station Manager to ensure that the ODCM is used in the performance of the surveillance requirements and administrative controls of the appropriate portions of the Technical Specifications.

3.0 LIQUID EFFLUENT SAMPLING AND ANALYSIS PROGRAM

Radioactive liquid wastes shall be sampled and analyzed in accordance with the program specified in Table A.3-1 for Seabrook Unit 1. The results of the radioactive analysis shall be used as appropriate with the methodology of Part B of the ODCM to assure that the concentrations of liquid effluents at the point of release from the multiport diffuser of the circulating water system are maintained within the limits of Technical Specification 3.11.1.1 for Unit 1.

Radioactive effluent information for liquids obtained from this sampling and analysis program shall also be used in conjunction with the methodologies in Part B to demonstrate compliance with the dose objectives and surveillance requirements of Technical Specifications 3/4.11.1.2, 3/4.11.1.3, and 3/4.11.4.

TABLE A.3-1

Radioactive Liquid Waste Sampling and Analysis Program

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (1) (uci/ml)
A. Liquid Radwaste Test Tanks	P Each Batch	P Each Batch	Principal Gamma Emitters(3)	$5x10^{-7}$
			I-131	$1x10^{-6}$
(Batch Release)(2)	P One Batch/M	M	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
	P Each Batch	M(4) Composite	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	P Each Batch	Q(4) Composite	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$
B. Turbine Building Sump Effluent(8)	W Grab Sample	W	Principal Gamma Emitters(3)	$5x10^{-7}$
			I-131	$1x10^{-6}$
(Continuous Release(5)	W Grab Sample	M	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$

TABLE A.3-1

Radioactive Liquid Waste Sampling and Analysis Program
(continued)

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (1) (uci/ml)
	W Grab Sample	M	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	W Grab Sample	Q	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$
C. Steam Generator Blowdown Flash Tank(6)(8) (Continuous Release)(5)	W Grab Sample	W	Principal Gamma Emitters(3)	$5x10^{-7}$
			I-131	$1x10^{-6}$
	W Grab Sample	M	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
	W Grab Sample	M	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	W Grab Sample	Q	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$

TABLE A.3-1

Radioactive Liquid Waste Sampling and Analysis Program
(continued)

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (1) (uci/ml)
D. Service Water(7)	W Grab Sample	W	Principal Gamma Emitters(3)	$5x10^{-7}$
			I-131	$1x10^{-6}$
	W Grab Sample	M	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
	W Grab Sample	M	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	W Grab Sample	Q	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$

P - Prior to Discharge
W - Weekly
M - Monthly
Q - Quarterly

TABLE A.3-1

Notations

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

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

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

Where:

LLD = the "a priori" lower limit of detection (microcurie per unit mass or volume),

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

E = the counting efficiency (counts per disintegration),

V = the sample size (units of mass or volume),

2.22×10^{-6} = the number of disintegrations per minute per microcurie,

Y = the fractional radiochemical yield, when applicable,

λ = the radioactive decay constant for the particular radionuclide (s^{-1}), and

Δt = the elapsed time between the midpoint of sample collection and the time of counting(s).

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

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

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

TABLE A.3-1

Notations
(Continued)

(3) The principal gamma emitters for which the LLD specification applies include the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Semiannual Radioactive Effluent Release Report in accordance with Technical Specification 6.8.1.4. Isotopes which are not detected should be reported as "not detected." Values determined to be below detectable levels are not used in dose calculations.

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

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

(6) Sampling and analysis is only required when Steam Generator Blowdown is directed to the discharge transition structure.

(7) Principal gamma emitters shall be analyzed weekly in Service Water. Sample and analysis requirements for dissolved and entrained gases, tritium, gross alpha, strontium 89 and 90, and Iron 55 shall only be required when analysis for principal gamma emitters exceeds the LLD.

The following are additional sampling and analysis requirements:

a. PCCW sampled and analyzed weekly for principal gamma emitters.

b. Sample Service Water System (SWS) daily for principal gamma emitters whenever primary component cooling water (PCCW) activity exceeds $1x10^{-3}$ uC/cc.

c. With the PCCW System radiation monitor inoperable, sample PCCW and SWS daily for principal gamma emitters.

d. With a confirmed PCCW/SWS leak and PCCW activity in excess of $1x10^{-4}$ uC/cc, sample SWS every 12 hours for principal gamma emitters.

e. The setpoint on the PCCW head tank liquid rate-of-change alarm will be set to ensure that its sensitivity to detect a PCCW/SWS leak is equal to or greater than that of an SWS radiation monitor, located in the unit's combined SWS discharge, with an LLD of $1x10^{-8}$ uC/cc. If this sensitivity cannot be achieved, the SWS will be sampled once every 12 hours.

(8) If the Turbine Building Sump (Steam Generator Blowdown Flash Tank) isolate due to high concentration of radioactivity, that liquid stream will be sampled and analyzed for Iodine-131 and principal gamma emitters prior to release.

4.0 GASEOUS EFFLUENT SAMPLING AND ANALYSIS PROGRAM

Radioactive gaseous wastes shall be sampled and analyzed in accordance with the program specified in Table A.4-1 for Seabrook Unit 1. The results of the radioactive analyses shall be used as appropriate with the methodologies of Part B of the ODCM to assure that the dose rates due to radioactive materials released in gaseous effluents from the site to areas at and beyond the site boundary are within the limits of Technical Specification 3.11.2.1 for Unit 1.

Radioactive effluent information for gaseous wastes obtained from this sampling and analysis program shall also be used in conjunction with the methodologies in Part B to demonstrate compliance with the dose objectives and surveillance requirements of Technical Specifications 3/4.11.2.2, 3/4.11.2.3, 3/4.11.2.4, and 3/4.11.4.

TABLE A.4-1

Radioactive Gaseous Waste Sampling and Analysis Program

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection(1) (LLD) (uCi/cc)
1. Plant Vent	M(3)(4) Grab Sample	M	Principal Gamma Emitters(2)	$1x10^{-4}$
			H-3	$1x10^{-6}$
	Continuous(5)	W(6) Charcoal Sample	I-131	$1x10^{-12}$
	Continuous(5)	W(6) Particulate Sample	Principal Gamma Emitters (2)	$1x10^{-11}$
	Continuous(5)	M Composite Particulate Sample	Gross Alpha	$1x10^{-11}$
	Continuous(5)	Q Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$
2. Condenser Air Removal Exhaust	M(7) Grab Sample	M(7)	Principal Gamma Emitters	$1x10^{-4}$
			H-3	$1x10^{-6}$

TABLE A.4-1

Radioactive Gaseous Waste Sampling
and Analysis Program
(continued)

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection(1) (LLD) (uCi/cc)
3. Gland Steam Packing Exhauster	Continuous	W Particulate Sample	Principal Gamma Emitters(2)	1×10^{-11}
	Continuous	W Charcoal Sample	I-131	1×10^{-12}
	Continuous	M Composite Particulate Sample	Gross Alpha	1×10^{-11}
	Continuous	Q Composite Particulate Sample	Sr-89, Sr-90	1×10^{-11}
4. Containment Purge	P(3) Each Purge Grab Sample	P Each Purge	Principal Gamma Emitters (2)	1×10^{-4}
			H-3 (oxide)	1×10^{-6}

TABLE A.4-1

Notations

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

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

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

Where:

LLD = the "a priori" lower limit of detection (microcurie per unit mass or volume),

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

E = the counting efficiency (counts per disintegration),

V = the sample size (units of mass or volume),

2.22×10^{-6} = the number of disintegrations per minute per microcurie,

Y = the fractional radiochemical yield, when applicable,

λ = the radioactive decay constant for the particular radionuclide (s^{-1}), and

Δt = the elapsed time between the midpoint of sample collection and the time of counting(s).

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

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

TABLE A.4-1

Radioactive Gaseous Waste Sampling and Analysis Program
(continued)

Notations

(2) The principal gamma emitters for which the LLD specification applies includes the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 in noble gas releases and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, Ce-141, and Ce-144, in iodine and particulate releases. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Semiannual Radioactive Effluent Release Report in accordance with Technical Specification 6.8.1.4. Isotopes which are not detected should be reported as "not detected." Values determined to be below detectable levels are not used in dose calculations.

(3) Sampling and analysis shall also be performed following shutdown, startup, or a THERMAL POWER change exceeding 15 percent of RATED THERMAL POWER within a one hour period unless; 1) analysis shows that the DOSE EQUIVALENT I-131 concentrations in the primary coolant has not increased more than a factor of 3; and 2) the noble gas activity monitor for the plant vent has not increased by more than a factor of 3. For containment purge, requirements apply only when purge is in operation.

(4) Tritium grab samples shall be taken at least once per 24 hours when the refueling canal is flooded.

(5) The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Technical Specifications 3.11.2.1, 3.11.2.2, and 3.11.2.3.

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

(7) Samples shall be taken prior to start-up of condenser air removal system when there have been indications of a primary to secondary leak.

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING

5.1 Sampling and Analysis Program

The Radiological Environmental Monitoring Program (REMP) provides representative measurements of radiation and radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposure of members of the public resulting from station operation. This monitoring program is required by Technical Specification 3.12.1. The monitoring program implements Section IV.B.2 of Appendix I to 10CFR, Part 50, and thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of effluent measurements and the modeling of the environmental exposure pathways which have been incorporated into Part B of the ODCM.

The initially specified monitoring program will be effective for at least the first three years of commercial operation. Following this period, program changes may be initiated based on operational experience.

In accordance with Technical Specification surveillance requirements, 4.12.1, sampling and analyses shall be conducted as specified in Table A.5-1 for locations shown in Section 4 of Part B to the ODCM. Detection capability requirements, and reporting levels for radioactivity concentrations in environmental samples are shown on Tables A.5-2 and A.5-3, respectively.

It should be noted that Technical Specification 3.12.1.C requires that if milk or fresh leafy vegetable samples are <u>unavailable</u> from one or more sample locations required by the REMP, new specific locations for obtaining replacement samples (if available) shall be added to the REMP within 30 days, and the specific locations, from which the samples are unavailable may then be deleted from the monitoring program. In this context, the term <u>unavailable</u> means that samples are no longer available to be collected now or in the future for reasons such as the permission from the owner to collect the samples has been withdrawn or he has gone out of business, thus causing the permanent lose of the sample location.

5.2 Land Use Census

As part of the Radiological Environmental Monitoring Program, Technical Specification 3/4.12.2 requires that a land use census be conducted annually during growing season to identify within a distance of 8 km the location in each of the 16 meteorological sectors of the nearest milk animal, the nearest residence, and the nearest garden of greater than 50 m^2 producing broad leaf vegetation.

The land use census ensures that changes in the use of area beyond the site boundary are identified, and appropriate modifications to the monitoring program and dose assessment models are made, if necessary. This census satisfies the requirements of Section IV.3.3 of Appendix I to 10CFR Part 50.

For the purpose of conducting the land use census as required by Technical Specification 4.12.2, station personnel should determine what survey methods will provide the necessary results considering the type of information to be collected and the use to which it will be put, such as the location of potential milk animal pathway for use in routine dose calculations. Land use census results shall be obtained by using a survey method, or combination of methods, which may include, but are not limited to, door-to-door surveys (i.e., roadside identification of locations), aerial surveys, or by consulting local agricultural authorities.

Technical Specification 3.12.2.b requires that new locations identified from the census that yield a calculated dose of dose commitment 20 percent greater than at a location from which samples are currently being obtained be added within 30 days to the REMP. These new locations required to be added to the sampling program shall only be those from which permission from the owner to collect samples can be obtained and sufficient sample volume is available.

TABLE A.5-1

Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
1. DIRECT RADIATION[b]	40 routine monitoring stations with two or more dosimeters placed as follows: An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY; An outer ring of stations, one in each meteorological sector, generally in the 6 to 8-km range from the site; The balance of the stations to be placed in special interest areas such as population centers, nearby residences, schools, and control locations.	Quarterly.	Gamma dose quarterly.
2. AIRBORNE Radioiodine and Particulates	Samples from five locations[d]: Three samples from close to the three SITE BOUNDARY locations, in different sectors, of high calculated long-term average ground-level D/Q. One sample from the vicinity of a community having the highest calculated long-term average ground-level D/Q.	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	Radioiodine Cannister: I-131 analysis weekly. Particulate Sampler: Gross beta radioactivity analysis following filter change[c]; Gamma isotopic analysis[e] of composite (by location) quarterly.

TABLE A.5-1
(Continued)

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
	One sample from a control location, as for example 15-30 km distant and in the least prevalent wind direction.		
3. WATERBORNE			
a. Surface	One sample in the discharge area. One sample from a control location.	Monthly grab sample.	Gamma isotopic analysis[e] monthly. Composite for tritium analysis quarterly.
b. Sediment from from shoreline	One sample from area with existing or potential recreational value.	Semiannually.	Gamma isotopic analysis[e] semiannually.
4. INGESTION			
a. Milk	Samples from milking animals in three locations within 5 km distance having the highest dose potential. If their are none, then, one sample from milking animals in each of three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per yr.[f] One sample from milking animals at a control location, as for example, 15-30 km distant and in the least prevalent wind direction.	Semimonthly when milking animals are on pasture, monthly at other times.	Gamma isotopic[e] and I-131 analysis on each sample.

TABLE A.5-1

Radiological Environmental Monitoring Program
(Continued)

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
b. Fish and Invertebrates	One sample of each of three commercially and recreationally important species in vicinity of plant discharge area. One sample of similar species in areas not influenced by plant discharge.	Sample in season, or semiannually if they are not seasonal.	Gamma isotopic analysis[e] on edible portions.
c. Food Products	Samples of three (if practical) different kinds of broad leaf vegetation[g] grown nearest each of two different off-site locations of highest predicted long-term average ground-level D/Q if milk sampling is not performed.	Monthly, when available.	Gamma isotopic[e] and I-131 analysis.
	One sample of each of the similar broad leaf vegetation[g] grown at a control location, as for example 15-30 km distant in the least prevalent wind direction, if milk sampling is not performed.	Monthly, when available.	Gamma isotopic[e] and I-131 analysis.

TABLE A.5-1
(Continued)

Table Notation

a) Specific parameters of distance and direction sector from the centerline of the Unit 1 reactor, and additional description where pertinent, shall be provided for each and every sample location in Table B.4-1 in the ODCM, Part B. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to circumstances such as hazardous conditions, seasonal unavailability and malfunction of automatic sampling equipment. If specimens are unobtainable due to sampling equipment malfunction, effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the radiological environmental monitoring program. Identify the cause of the unavailability of samples for that pathway and identify the new location(s), if available, for obtaining replacement samples in the next Semiannual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

b) A thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters.

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

d) Optimal air sampling locations are based not only on D/Q but on factors such as population in the area, year-round access to the site, and availability of power.

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

f) The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM, Part B.

g) If broad leaf vegetation is unavailable, other vegetation will be sampled.

TABLE A.5-2

Detection Capabilities for Environmental Sample Analysis[a,f,g]

Lower Limit of Detection (LLD)[b]

Analysis	Water (pCi/kg)	Airborne Particulate or Gas (pCi/m^3)	Fish and Invertebrates (pCi/kg, wet)	Milk (pCi/kg)	Food Products (pCi/kg, wet)	Sediment (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	3,000					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-Nb-95	15[c]					
I-131	15	0.07		1	60[e]	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15[c,d]			15[c,d]		

TABLE A.5-2
(Continued)

Table Notation

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

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

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

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

Where:

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

4.66 is a constant derived from the K_{alpha} and K_{beta} values for the 95% confidence level;

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

E is the counting efficiency, as counts per disintegration;

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

2.22 is the number of disintegrations per minute per picocurie;

Y is the fractional radiochemical yield, when applicable;

λ is the radioactive decay constant for the particular radionuclide as per second; and

Δt for environmental samples is the elapsed time between sample collection and time of counting, as seconds.

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

In calculating the LLD for a radionuclide determined by gamma ray spectrometry, the background shall include the typical contributions of other radionuclides normally present in the samples (e.g., Potassium-40 in milk samples).

TABLE A.5-2
(Continued)

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement. This does not preclude the calculation of an a posteriori LLD for a particular measurement based upon the actual parameters for the sample in question and appropriate decay correction parameters such as decay while sampling and during analysis. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report.

c) Parent only.

d) The Ba-140 LLD and concentration can be determined by the analysis of its short-lived daughter product La-140 subsequent to an eight-day period following collection. The calculation shall be predicated on the normal ingrowth equations for a parent-daughter situation and the assumption that any unsupported La-140 in the sample would have decayed to an insignificant amount (at least 3.6% of its original value). The ingrowth equations will assume that the supported La-140 activity at the time of collection is zero.

e) Broad leaf vegetation only.

f) If the measured concentration minus the three standard deviation uncertainty is found to exceed the specified LLD, the sample does not have to be analyzed to meet the specified LLD.

g) Required detection capabilities for thermoluminescent dosimeters used for environmental measurements shall be in accordance with recommendations of Regulatory Guide 4.13, Revision 1, July 1977.

TABLE A.5-3

Reporting Levels for Radioactivity Concentrations in Environmental Samples

Analysis	Water (pCi/kg)	Airborne Particulate or Gas (pCi/m^3)	Fish and Invertebrates (pCi/kg, wet)	Milk (pCi/kg)	Food Products (pCi/kg, wet)
H-3	30,000				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400*				
I-131	100	0.9		3	100**
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200*			300*	

* Parent only.
** Broad leaf vegetation only.

SEABROOK STATION ODCM

PART B

RADIOLOGICAL CALCULATIONAL METHODS AND PARAMETERS

1.0 INTRODUCTION

Part B of the ODCM (Off-Site Dose Calculation Manual) provides formal and approved methods for the calculation of off-site concentration, off-site doses and effluent monitor setpoints, and indicates the locations of environmental monitoring stations in order to comply with the Seabrook Station Radiological Effluent Technical Specifications (RETS), Sections 3/4.3.3.9, 3/4.3.3.10, and 3/4.11, as well as the REMP detailed in Part A of the manual. The ODCM forms the basis for station procedures which document the off-site doses due to station operation which are used to show compliance with the numerical guides for design objectives of Section II of Appendix I to 10CFR Part 50. The methods contained herein follow accepted NRC guidance, unless otherwise noted in the text.

1.1 Responsibilities for Part B

All changes to Part B of the ODCM shall be reviewed and approved by the Station Operations Review Committee (SORC) in accordance with Technical Specification 6.13 prior to implementation. Changes made to Part B shall be submitted to the Commission for their information in the Semiannual Radioactive Effluent Release Report for the period in which the change(s) was made effective.

It shall be the responsibility of the Station Manager to ensure that the ODCM is used in the performance of in-plant surveillance requirements and administrative controls of the appropriate portions of the Technical Specifications, and Effluent Control Program detailed in Part A of the manual. The Production Services Manager shall be responsible to ensure that the Radiological Environmental Monitoring Program described in Section 4 of Part B is implemented in accordance with Technical Specification 3/4.12 and Part A of this manual.

1.2 Summary of Methods, Dose Factors, Limits, Constants, Variables and Definitions

This section summarizes the Method I dose equations which are used as the primary means of demonstrating compliance with RETS. The concentration and setpoint methods are identified in Table B.1-2 through Table B.1-7. Where more refined dose calculations are needed, the use of Method II dose determinations are described in Sections 3.2 through 3.9 and 3.11. The dose factors used in the equations are in Tables B.1-10 through B.1-14 and the Regulatory Limits are summarized in Table B.1-1.

The variables and special definitions used in this ODCM, Part B, are in Tables B.1-8 and B.1-9.

TABLE B.1-1

Summary of Radiological Effluent Technical Specifications and Implementing Equations

Technical Specification		Category	Method I (1)	Limit
3.11.1.1	Liquid Effluent Concentration	Total Fraction of MPC Excluding Noble Gases	Eq. 2-1	$\leq$ 1.0
		Total Noble Gas Concentration	Eq. 2-2	$\leq 2 \times 10^{-4}$ µCi/ml
3.11.1.2	Liquid Effluent Dose	Total Body Dose	Eq. 3-1	$\leq$ 1.5 mrem in a qtr.
				$\leq$ 3.0 mrem in a yr.
		Organ Dose	Eq. 3-2	$\leq$ 5 mrem in a qtr.
				$\leq$ 10 mrem in a yr.
3.11.1.3	Liquid Radwaste Treatment Operability	Total Body Dose	Eq. 3-1	$\leq$ 0.06 mrem in a mo.
		Organ Dose	Eq. 3-2	$\leq$ 0.2 mrem in a mo.
3.11.2.1	Gaseous Effluents Dose Rate	Total Body Dose Rate from Noble Gases	Eq. 3-3	$\leq$ 500 mrem/yr.
		Skin Dose Rate from Noble Gases	Eq. 3-4	$\leq$ 3000 mrem/yr.
		Organ Dose Rate from I-131, I-133, Tritium and Particulates with $T_{1/2}$ > 8 Days	Eq. 3-5	$\leq$ 1500 mrem/yr.

TABLE B.1-1
(Continued)

Summary of Radiological Effluent Technical Specifications and Implementing Equations

Technical Specification		Category	Method I[1]	Limit
3.11.2.2	Gaseous Effluents Dose from Noble Gases	Gamma Air Dose from Noble Gases	Eq. 3-6	$\leq$ 5 mrad in a qtr. $\leq$ 10 mrad in a yr.
		Beta Air Dose from Noble Gases	Eq. 3-7	$\leq$ 10 mrad in a qtr. $\leq$ 20 mrad in a yr.
3.11.2.3	Gaseous Effluents Dose from I-131, I-133, Tritium, and Particulates	Organ Dose from Iodines, Tritium and Particulates with $T_{1/2}$ > 8 Days	Eq. 3-8	$\leq$ 7.5 mrem in a qtr. $\leq$ 15 mrem in a yr.
3.11.2.4	Ventilation Exhaust Treatment	Organ Dose	Eq. 3-8	$\leq$ 0.3 mrem in a mo.
3.11.4	Total Dose (from All Sources)	Total Body Dose	Footnote (2).	$\leq$ 25 mrem in a yr.
		Organ Dose		$\leq$ 25 mrem in a yr.
		Thyroid Dose		$\leq$ 75 mrem in a yr.
3.3.3.9	Liquid Effluent Monitor Setpoint			
	Liquid Waste Test Tank Monitor	Alarm Setpoint	Eq. 5-1	T.S. 3.11.1.1

TABLE B.1-1
(Continued)

Summary of Radiological Effluent Technical Specifications and Implementing Equations

Technical Specification		Category	Method I (1)	Limit
3.3.3.10	Gaseous Effluent Monitor Setpoint			
	Plant Vent Wide Range Gas Monitors	Alarm/Trip Setpoint for Total Body Dose Rate	Eq. 5-9	T.S. 3.11.2.1 (Total Body)
		Alarm/Trip Setpoint for Skin Dose Rate	Eq. 5-10	T.S. 3.11.2.1 (Skin)

(1) More accurate methods may be available (see subsequent chapters).

(2) Technical Specification 3.11.4.a requires this evaluation only if twice the limit of equations 3-1, 3-2, 3-12, 3-15 or 3-18 is reached. If this occurs a Method II calculation, using actual release point parameters with annual average or concurrent meteorology and identified pathways for a real individual, shall be made.

TABLE B.1-2

Summary of Method I Equations to Calculate Unrestricted Area Liquid Concentrations

Equation Number	Category	Equation
2-1	Total Fraction of MPC in Liquids, Except Noble Gases	$F_i^{ENG} = \sum_p \sum_i \frac{C_{pi}}{MPC_i} \leq 1$
2-2	Total Activity of Dissolved and Entrained Noble Gases from all Station Sources	$C_1^{NG} \left(\frac{\mu Ci}{ml}\right) = \sum_i C_i^{NG} \leq 2E-04$

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TABLE B.1-3

Summary of Method I Equations to Calculate Off-Site Doses from Liquid Releases

Equation Number	Category	Equation
3-1	Total Body Dose	$D_{tb}(mrem) = k \sum_i Q_i \; DFL_{itb}$
3-2	Maximum Organ Dose	$D_{mo}(mrem) = k \sum_i Q_i \; DFL_{imo}$

TABLE B.1-4

Summary of Method I Equations to Calculate Dose Rates

Equation Number	Category	Equation
3-3	Total Body Dose Rate from Noble Gases	$\dot{D}_{tb}\left(\frac{mrem}{yr}\right) = 0.85 * EL(R) * \sum_i \dot{Q}_i \, DFB_i$
3-4	Skin Dose Rate from Noble Gases	$\dot{D}_{skin}\left(\frac{mrem}{yr}\right) = EL(R) * \sum_i \dot{Q}_i \, DF'_i$
3-5	Critical Organ Dose Rate from Iodines, Tritium, and Particulates with T 1/2 Greater than Eight Days	$\dot{D}_{co}\left(\frac{mrem}{yr}\right) = EL(R) * \sum_i \dot{Q}_i \, DFG'_{ico}$

TABLE B.1-5

Summary of Method I Equations to Calculate Doses to Air From Noble Gases

Category	Equation Number	Receptor Location[a]	Release Height[b]	Equation
Gamma Dose to Air From Noble Gases	3.6a	OS	E	$D^{\gamma}_{air} = 3.2E\text{-}07 * t^{-0.275} * \sum_i (Q_i * DF^{\gamma}_i)$
	3.6b	OS	G	$D^{\gamma}_{air} = 1.6E\text{-}06 * t^{-0.293} * \sum_i (Q_i * DF^{\gamma}_i)$
	3.6c	EC	E	$D^{\gamma}_{air} = 4.9E\text{-}10 * t^{-0.252} * \sum_i (Q_i * DF^{\gamma}_i)$
	3.6d	EC	G	$D^{\gamma}_{air} = 4.4E\text{-}09 * t^{-0.321} * \sum_i (Q_i * DF^{\gamma}_i)$
	3.6e	R	E	$D^{\gamma}_{air} = 5.1E\text{-}09 * t^{-0.155} * \sum_i (Q_i * DF^{\gamma}_i)$
	3.6f	R	G	$D^{\gamma}_{air} = 4.1E\text{-}08 * t^{-0.204} * \sum_i (Q_i * DF^{\gamma}_i)$

[a]OS = Off-Site, EC = Education Center, R = The "Rocks"
[b]E = Elevated, G = Ground

TABLE B.1-5

Summary of Method I Equations to Calculate Doses to Air From Noble Gases
(Continued)

Category	Equation Number	Receptor Location[a]	Release Height[b]	Equation
Beta Dose to Air From Noble Gases	3.7a	OS	E	$D^{\beta}_{air} = 4.1E\text{-}07 \cdot t^{-0.3} \cdot \sum_i (Q_i \cdot DF^{\beta}_i)$
	3.7b	OS	G	$D^{\beta}_{air} = 6.0E\text{-}06 \cdot t^{-0.319} \cdot \sum_i (Q_i \cdot DF^{\beta}_i)$
	3.7c	EC	E	$D^{\beta}_{air} = 1.8E\text{-}09 \cdot t^{-0.35} \cdot \sum_i (Q_i \cdot DF^{\beta}_i)$
	3.7d	EC	G	$D^{\beta}_{air} = 2.4E\text{-}08 \cdot t^{-0.347} \cdot \sum_i (Q_i \cdot DF^{\beta}_i)$
	3.7e	R	E	$D^{\beta}_{air} = 3.9E\text{-}08 \cdot t^{-0.249} \cdot \sum_i (Q_i \cdot DF^{\beta}_i)$
	3.7f	R	G	$D^{\beta}_{air} = 4.6E\text{-}07 \cdot t^{-0.267} \cdot \sum_i (Q_i \cdot DF^{\beta}_i)$

[a]OS = Off-Site, EC = Education Center, R = The "Rocks"
[b]E = Elevated, G = Ground

TABLE B.1-6

Summary of Method I Equations to Calculate Dose to an Individual from Tritium, Iodine and Particulates

Category	Equation Number	Receptor Location[a]	Release Height[b]	Equation
Dose to Critical Organ From Iodines, Tritium, and Particulates	3.8a	OS	E	$D_{co} = 14.8 * t^{-0.297} * \sum_i (Q_i * DFG_{ico})$
	3.8b	OS	G	$D_{co} = 17.7 * t^{-0.316} * \sum_i (Q_i * DFG_{ico})$
	3.8c	EC	E	$D_{co} = 3.3E-02 * t^{-0.349} * \sum_i (Q_i * DFG_{ico})$
	3.8d	EC	G	$D_{co} = 3.3E-2 * t^{-0.347} * \sum_i (Q_i * DFG_{ico})$
	3.8e	R	E	$D_{co} = 7.3E-02 * t^{-0.248} * \sum_i (Q_i * DFG_{ico})$
	3.8f	R	G	$D_{co} = 8.6E-02 * t^{-0.267} * \sum_i (Q_i * DFG_{ico})$

[a] OS = Off-Site, EC = Education Center, R = The "Rocks"
[b] E = Elevated, G = Ground

TABLE B.1-7

Summary of Methods for Setpoint Determinations

Equation Number	Category	Equation
5-1	Liquid Effluents:	
	Liquid Waste Test Tank Monitor (RM-6509)	$R_{setpoint} \left(\frac{\mu Ci}{ml} \right) = f_1 \frac{DF}{DF_{min}} \sum_i C_{mi}$
5-23	PCCW Rate-of-Change Alarm	$RC_{set}(gph) = 1x10^8 \cdot SWF \cdot \frac{1}{PCC}$
	Gaseous Effluents:	
	Plant Vent Wide Range Gas Monitors (RM-6528-1, 2, 3)	
5-5	Total Body	$R_{tb}\ (\mu Ci/sec) = 588 \frac{1}{DFB_c}$
5-6	Skin	$R_{skin}\ (\mu Ci/sec) = 3000 \frac{1}{DF'_c}$

TABLE B.1-8

Summary of Variables

Variable	Definition	Units
C_{li}^{NG}	= Concentration at point of discharge of dissolved and entrained noble gas "i" in liquid pathways from all station sources	µCi/ml
C_{l}^{NG}	= Total activity of all dissolved and entrained noble gases in liquid pathways from all station sources	$\frac{\mu Ci}{ml}$
C_{di}	= Concentration of radionuclide "i" at the point of liquid discharge	$\frac{\mu Ci}{ml}$
C_{i}	= Concentration of radionuclide "i"	µCi/ml
C_{pi}	= Concentration, exclusive of noble gases, of radionuclide "i" from tank "p" at point of discharge	$\frac{\mu Ci}{ml}$
C_{mi}	= Concentration of radionuclide "i" in mixture at the monitor	µCi/ml
D_{air}^{β}	= Beta dose to air	mrad
$D_{air\ E}^{\beta}$	= Beta dose to air at Education Center	mrad
$D_{air\ R}^{\beta}$	= Beta dose to air at "Rocks"	mrad
D_{air}^{γ}	= Gamma dose to air	mrad
$D_{air\ E}^{\gamma}$	= Gamma dose to air at Education Center	mrad

TABLE B.1-8
(Continued)

Summary of Variables

Variable	Definition	Units
$C^{\gamma}_{air\ R}$	= Gamma dose to air at "Rocks"	mrad
D_{co}	= Dose to the critical organ	mrem
D_{d}	= Direct dose	mrem
D^{γ}_{finite}	= Gamma dose to air, corrected for finite cloud	mrad
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	$\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}$
DFB_{i}	= Total body gamma dose factor for nuclide "i" (Table B.1-10)	$\frac{mrem\text{-}m^3}{pCi\text{-}yr}$
DFB_{c}	= Composite total body dose factor	$\frac{mrem\text{-}m^3}{pCi\text{-}yr}$
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)	$\frac{mrem}{\mu Ci}$

TABLE B.1-8
(Continued)

Summary of Variables

Variable	Definition	Units
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)	$\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}$
DFS_i	= Beta skin dose factor for nuclide "i" (Table B.1-10)	$\frac{mrem\text{-}m^3}{pCi\text{-}yr}$
DF'_i	= Combined skin dose factor for nuclide "i" (Table B.1-10)	$\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}$
DF^{γ}_i	= Gamma air dose factor for nuclide "i" (Table B.1-10)	$\frac{mrad\text{-}m^3}{pCi\text{-}yr}$
DF^{β}_i	= 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	$\frac{1}{m^2}$

TABLE B.1-8
(Continued)

Summary of Variables

Variable	Definition	Units
EL(R)	= 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; f_4	= Fraction of total MPC associated with Paths 1, 2, 3, and 4	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
$R_{setpoint}$	= Liquid monitor response for the limiting concentration at the point of discharge	µCi/ml
R_{skin}	= Response of the noble gas monitor at the limiting skin dose rate	cpm, or µCi/sec
R_{tb}	= Response of the noble gas monitor to limiting total body dose rate	cpm, or µCi/sec
S_F	= Shielding factor	Dimensionless
S_g	= Detector counting efficiency from the gas monitor calibration	$\frac{cpm}{\mu Ci/cc}$ or $\frac{mR/hr}{\mu Ci/cc}$
S_{gi}	= Detector counting efficiency for noble gas "i"	$\frac{cpm}{\mu Ci/cc}$ or $\frac{mR/hr}{\mu Ci/cc}$
S_l	= Detector counting efficiency from the liquid monitor calibration	$\frac{cps}{\mu Ci/ml}$
S_{li}	= Detector counting efficiency for radionuclide "i"	$\frac{cps}{\mu Ci/ml}$
X/Q	= Average undepleted atmospheric dispersion factor (Tables B.7-4 and B.7-5)	$\frac{sec}{m^3}$

TABLE B.1-8
(Continued)

Summary of Variables

Variable	Definition	Units
$[X/Q]^{\gamma}$	= Effective average gamma atmospheric dispersion factor (Tables B.7-4 and B.7-5)	$\frac{sec}{m^3}$
SWF	= Service Water System flow rate	gph
PCC	= Primary component cooling water measured (decay corrected) gross radioactivity concentration	uCi/ml
t^{-a}	= Unitless factor which adjusts the value of atmospheric dispersion factors for elevated or ground-level releases with a total release duration of t hours	Dimensionless

TABLE B.1-9

Definition of Terms

Critical Receptor - A hypothetical or real individual whose location and behavior cause him or her to receive a dose greater than any other possible real individual.

Dose - As used in Regulatory Guide 1.109, the term "dose," when applied to individuals, is used instead of the more precise term "dose equivalent," as defined by the International Commission on Radiological Units and Measurements (ICRU). When applied to the evaluation of internal deposition or radioactivity, the term "dose," as used here, includes the prospective dose component arising from retention in the body beyond the period of environmental exposure, i.e., the dose commitment. The dose commitment is evaluated over a period of 50 years. The dose is measured in mrem to tissue or mrad to air.

Dose Rate - The rate for a specific averaging time (i.e., exposure period) of dose accumulation.

Liquid Radwaste Treatment System - The components or subsystems which comprise the available treatment system as shown in Figure B.6-1.

TABLE B.1-10

Dose Factors Specific for Seabrook Station for Noble Gas Releases

Radio-nuclide	Gamma Total Body Dose Factor DFB_i ($\frac{mrem-m^3}{pCi-yr}$)	Beta Skin Dose Factor DFS_i ($\frac{mrem-m^3}{pCi-yr}$)	Combined Skin Dose Factor DF_i' ($\frac{mrem-sec}{\mu Ci-yr}$)	Beta Air Dose Factor DF_i^β ($\frac{mrad-m^3}{pCi-yr}$)	Gamma Air Dose Factor DF_i^γ ($\frac{mrad-m^3}{pCi-yr}$)
Ar-41	8.84E-03*	2.69E-03	1.09E-02	3.28E-03	9.30E-03
Kr-83m	7.56E-08	-----	1.81E-05	2.88E-04	1.93E-05
Kr-85m	1.17E-03	1.46E-03	2.35E-03	1.97E-03	1.23E-03
Kr-85	1.61E-05	1.34E-03	1.11E-03	1.95E-03	1.72E-05
Kr-87	5.92E-03	9.73E-03	1.38E-02	1.03E-02	6.17E-03
Kr-88	1.47E-02	2.37E-03	1.62E-02	2.93E-03	1.52E-02
Kr-89	1.66E-02	1.01E-02	2.45E-02	1.06E-02	1.73E-02
Kr-90	1.56E-02	7.29E-03	2.13E-02	7.83E-03	1.63E-02
Xe-131m	9.15E-05	4.76E-04	5.37E-04	1.11E-03	1.56E-04
Xe-133m	2.51E-04	9.94E-04	1.12E-03	1.48E-03	3.27E-04
Xe-133	2.94E-04	3.06E-04	5.83E-04	1.05E-03	3.53E-04
Xe-135m	3.12E-03	7.11E-04	3.74E-03	7.39E-04	3.36E-03
Xe-135	1.81E-03	1.86E-03	3.33E-03	2.46E-03	1.92E-03
Xe-137	1.42E-03	1.22E-02	1.14E-02	1.27E-02	1.51E-03
Xe-138	8.83E-03	4.13E-03	1.20E-02	4.75E-03	9.21E-03

*8.84E-03 = 8.84×10^{-3}

TABLE B.1-11

Dose Factors Specific for Seabrook Station
for
Liquid Releases

Radionuclide	Total Body Dose Factor DFL_{itb} $(\frac{mrem}{\mu Ci})$	Maximum Organ Dose Factor DFL_{imo} $(\frac{mrem}{\mu Ci})$
H-3	3.02E-13	3.02E-13
Na-24	1.38E-10	1.42E-10
Cr-51	1.83E-11	1.48E-09
Mn-54	5.15E-09	2.68E-08
Fe-55	1.26E-08	7.67E-08
Fe-59	8.74E-08	6.66E-07
Co-58	2.46E-09	1.40E-08
Co-60	6.15E-08	9.22E-08
Zn-65	2.73E-07	5.49E-07
Br-83	1.30E-14	1.89E-14
Rb-86	4.18E-10	6.96E-10
Sr-89	2.17E-10	7.59E-09
Sr-90	3.22E-08	1.31E-07
Nb-95	5.25E-10	1.58E-06
Mo-99	3.72E-11	2.67E-10
Tc-99m	5.22E-13	1.95E-12
Ag-110m	1.01E-08	6.40E-07
Sb-124	1.71E-09	9.89E-09
Sb-125	6.28E-09	8.31E-09
Te-127m	7.07E-08	1.81E-06
Te-127	3.53E-10	9.54E-08
Te-129m	1.54E-07	3.46E-06
Te-129	7.02E-14	1.05E-13
Te-131m	3.16E-08	2.94E-06
Te-132	9.06E-08	3.80E-06
I-130	2.75E-11	3.17E-09
I-131	2.30E-10	1.00E-07
I-132	6.28E-11	6.36E-11
I-133	3.85E-11	1.15E-08
I-134	1.19E-12	1.41E-12
I-135	5.33E-11	4.69E-10
Cs-134	3.24E-08	3.56E-08
Cs-136	2.47E-09	3.27E-09
Cs-137	3.58E-08	4.03E-08
Ba-140	1.70E-10	3.49E-09
La-140	1.07E-10	4.14E-08
Ce-141	3.85E-11	9.31E-09
Ce-144	1.96E-10	6.46E-08
Other*	3.12E-08	1.58E-06

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

TABLE B.1-12

Dose and Dose Rate Factors Specific for Seabrook Station
for
Iodines, Tritium and Particulate Releases

Radionuclide	Critical Organ Dose Factor DFG_{ico} ($\frac{mrem}{\mu Ci}$)	Critical Organ Dose Rate Factor DFG'_{ico} ($\frac{mrem\text{-}sec}{yr\text{-}\mu Ci}$)
H-3	3.08E-10	9.71E-03
Cr-51	8.28E-09	2.91E-01
Mn-54	1.11E-06	4.38E+01
Fe-59	1.06E-06	3.53E+01
Co-58	5.56E-07	2.00E+01
Co-60	1.21E-05	5.42E+02
Zn-65	2.33E-06	7.82E+01
Sr-89	1.98E-05	6.24E+02
Sr-90	7.21E-04	2.27E+04
Zr-95	1.10E-06	3.63E+01
Nb-95	2.01E-06	6.40E+01
Mo-99	1.63E-08	5.39E-01
Ru-103	3.03E-06	9.62E+01
Ag-110m	5.02E-06	1.80E+02
Sb-124	1.83E-06	6.15E+01
I-131	1.47E-04	4.64E+03
I-133	1.45E-06	4.57E+01
Cs-134	5.62E-05	1.81E+03
Cs-137	5.47E-05	1.79E+03
Ba-140	1.55E-07	5.01E+00
Ce-141	2.65E-07	8.45E+00
Ce-144	6.09E-06	1.93E+02
Other*	4.09E-06	1.29E+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.

TABLE B.1-13

Combined Skin Dose Factors Specific for Seabrook Station Special Receptors[1] for Noble Gas Release

Radionuclide	Education Center Combined Skin Dose Factor DF'_{iE} $(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr})$	The "Rocks" Combined Skin Dose Factor DF'_{iR} $(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr})$
Ar-41	1.57E-02	9.73E-02
Kr-83m	2.35E-05	1.07E-04
Kr-85m	3.84E-03	3.16E-02
Kr-85	2.16E-03	2.29E-02
Kr-87	2.31E-02	2.00E-01
Kr-88	2.23E-02	1.25E-01
Kr-89	3.73E-02	2.68E-01
Kr-90	3.15E-02	2.14E-01
Xe-131m	9.52E-04	8.96E-03
Xe-133m	1.99E-03	1.87E-02
Xe-133	9.20E-04	7.16E-03
Xe-135m	5.24E-03	3.07E-02
Xe-135	5.32E-03	4.23E-02
Xe-137	2.14E-02	2.16E-01
Xe-138	1.78E-02	1.21E-01

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

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	2.68E-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.

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

TABLE B.1-15

Vent Stack Elevation to Ground Level Release Point Correction Factor(1)

Receptor Point (R)	Release Type	Correction Factor(2) EL(GRD)
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, Tritium, and Particulates	9.4
3. The "Education Center"	a. Noble Gases	14.3
	b. Iodine, Tritium, and Particulates	14.3

Notes:

(1) 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.

(2) See Section 7.2.6 for a description of how the EL(GRD) were derived.

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:

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

and:

$$\underset{(\mu Ci/ml)}{C_1^{NG}} = \sum_i \underset{(\mu Ci/ml)}{C_i^{NG}} \leq \underset{(\mu Ci/ml)}{2E\text{-}04} \qquad (2\text{-}2)$$

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, PCCW, steam generator blowdown, or other 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_i^{NG} = Total concentration at point of discharge of all dissolved and entrained noble gases in liquids from all station sources (μCi/ml)

C_{li}^{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.

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).

2.2.4 Primary Component Cooling Water (PCCW) System

The PCCW System is used to cool selected primary components.

The system is normally sampled weekly to determine if there is any radwaste in-leakage. If leakage has been determined, the Service Water System is sampled to determine if any release to the environment has occurred.

3.0 OFF-SITE DOSE CALCULATION METHODS

Chapter 3 provides the basis for station procedures required to meet the Radiological Effluent Technical Specifications (RETS) dose and dose rate requirements contained in Section 3/4.11 of the station operating Technical Specifications. A simple, conservative method (called Method I) is listed in Tables B.1-2 to B.1-7 for each of the requirements of the RETS. Each of the Method I equations is presented in Sections 3.2 through 3.9. In addition, those sections include more sophisticated methods (called Method II) for use when more refined results are needed. This chapter provides the methods, data, and reference material with which the operator can calculate the needed doses, dose rates and setpoints. For the requirements to demonstrate compliance with Technical Specification off-site dose limits, the contribution from all measured ground level releases must be added to the calculated contribution from the vent stack to determine the Station's total radiological impact. The bases for the dose and dose rate equations are given in Chapter 7.0.

The Semiannual Radioactive Effluent Release Report, to be filed after January 1 each year per Technical Specification 6.8.1.4, requires that meteorological conditions concurrent with the time of release of radioactive materials in gaseous effluents, as determined by sampling frequency and measurement, be used for determining the gaseous pathway doses. For continuous release sources (i.e., plant vent, condenser air removal exhaust, and gland steam packing exhauster), concurrent quarterly average meteorology will be used in the dose calculations along with the quarterly total radioactivity released. For batch releases or identifiable operational activities (i.e., containment purge or venting to atmosphere of the Waste Gas System), concurrent meteorology during the period of release will be used to determine dose if the total noble gas or iodine and particulates released in the batch exceeds five percent of the total quarterly radioactivity released from the unit; otherwise quarterly average meteorology will be applied. Quarterly average meteorology will also be applied to batch releases if the hourly met data for the period of batch release is unavailable.

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.

3.1 Introductory Concepts

In part, the Radiological Effluent Technical Specifications (RETS) limit dose or dose rate. The term "dose" for ingested or inhaled radioactivity means the dose commitment, measured in mrem, which results from the exposure to radioactive materials that, because of uptake and deposition in the body, will continue to expose the body to radiation for some period of time after the source of radioactivity is stopped. The time frame over which the dose commitment is evaluated is 50 years. The phrases "annual dose" or dose in one year" then refers to the 50-year dose commitment resulting from exposure to one year's worth of releases. "Dose in a quarter" similarly means the 50-year dose commitment resulting from exposure to one quarter's releases. The term "dose," with respect to external exposures, such as to noble gas clouds, refers only to the doses received during the actual time period of exposure to the radioactivity released from the plant. Once the source of the radioactivity is removed, there is no longer any additional accumulation to the dose commitment.

"Dose rate" is the total dose or dose commitment divided by exposure period. For example, an individual who is exposed via the ingestion of milk for one year to radioactivity from plant gaseous effluents and receives a 50-year dose commitment of 10 mrem is said to have been exposed to a dose rate of 10 mrem/year, even though the actual dose received in the year of exposure may be less than 10 mrem.

In addition to limits on dose commitment, gaseous effluents from the station are also controlled so that the maximum or peak dose rates at the site boundary at any time are limited to the equivalent annual dose limits of 10CFR, Part 20 to unrestricted areas (if it were assumed that the peak dose rates continued for one year). These dose rate limits provide reasonable assurance that members of the public, either inside or outside the site boundary, will not be exposed to annual averaged concentrations exceeding the limits specified in Appendix B, Table II of 10CFR, Part 20 (10CFR20.106(a)).

The quantities ΔD and $\dot{D}$ are introduced to provide calculable quantities, related to off-site doses or dose rates that demonstrate compliance with the RETS.

Delta D, denoted ΔD, is the quantity calculated by the Chapter 3, Method I dose equations. It represents the conservative increment in dose. The ΔD calculated by Method I equations is not necessarily the actual dose received by a real individual, but usually provides an upper bound for a given release because of the conservative margin built into the dose factors and the selection and definition of critical receptors. The radionuclide specific dose factors in each Method I dose equation represent the greatest dose to any organ of any age group. (Organ dose is a function of age because organ mass and intake are functions of age.) The critical receptor assumed by "Method I" equations is then generally a hypothetical individual whose behavior - in terms of location and intake - results in a dose which is higher than any real individual is likely to receive. Method II allows for a more exact dose calculation for each individual if necessary.

D dot, denoted $\dot{D}$, is the quantity calculated in the Chapter 3 dose <u>rate</u> equations. It is calculated using the station's effluent monitoring system reading and an annual or long-term average atmospheric dispersion factor. $\dot{D}$ predicts the maximum off-site annual dose if the peak observed radioactivity release rate from the plant stack continued for one entire year. Since peak release rates, or resulting dose rates, are usually of short time duration on the order of an hour or less, this approach then provides assurance that 10CFR20.106 limits will be met.

Each of the methods to calculate dose or dose rate are presented in the following subsections and are summarized in Chapter 1. Each dose type has two levels of complexity. Method I is the simplest and contains many conservative factors. Method II is a more realistic analysis which makes use of the models in Regulatory Guide 1.109 (Revision 1), as noted in each subsection of Chapter 3 for the various exposure types. A detailed description of the methodology, assumptions, and input parameters to the dose models that are applied in each Method II calculation, if not already explicitly described in the ODCM, shall be documented and provided when this option is used for NRC reporting and Technical Specification dose compliance.

3.2 Method to Calculate the Total Body Dose from Liquid Releases

Technical Specification 3.11.1.2 limits the total body dose commitment to a member of the public from radioactive material in liquid effluents to 1.5 mrem per quarter and 3 mrem per year per unit. Technical Specification 3.11.1.3 requires liquid radwaste treatment when the total body dose estimate exceeds 0.06 mrem in any 31-day period. Technical Specification 3.11.4 limits the total body dose commitment to any real member of the public from all station sources (including liquids) to 25 mrem in a year.

Use Method I first to calculate the maximum total body dose from a liquid release from the station as it is simpler to execute and more conservative than Method II.

Use Method II if a more refined calculation of total body dose is needed, i.e., Method I indicates the dose might be greater than the Technical Specification limits.

To evaluate the total body dose, use Equation 3.1 to estimate the dose from the planned release and add this to the total body dose accumulated from prior releases during the month. See Section 7.1.1 for basis.

3.2.1 Method I

The increment in total body dose from a liquid release is:

$$D_{tb} = k \sum_i Q_i \, DFL_{itb} \qquad (3\text{-}1)$$

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

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 (?Ci) 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 3-1 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 for the shoreline exposure pathway. Aquatic food ingestion pathways shall limit credit taken for mixing zone dilution to the same value assumed in Method I (M_p = 0.10).

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:

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

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

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 ccrresponds 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 cf 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°F surface isotherm above the multiport diffuser may be used in Method II calculations for the shoreline exposure pathway. Aquatic food ingestion pathways shall limit credit taken for mixing zone dilution to the same value assumed in Method I ($M_p = 0.10$).

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.

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(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.

3.4.1 Method I

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

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

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

where:

EL(R) = 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. The sum of the dose rates from both plant vent stack and ground level releases must be considered for determination of Technical Specification compliance.

$\dot{Q}_i$ = The release rate at the station vents (μCi/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 vent stack) 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 peak release rate via 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.

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(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.

3.5.1 Method I

The Skin Dose Rate due to noble gases is:

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

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

where:

EL(R) = 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. The sum of the dose rates from both plant vent stack and ground level releases must be considered for determination of Technical Specification compliance.

$\dot{Q}_i$ = The release rate at the station vents (μCi/sec) for each noble gas 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 Sections 7.3.2 and 7.3.3 for the release point (either ground level or vent stack) 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:

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

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

where:

EL(R) = Elevation Release Point (R) correction factor (dimensionless). For primary vent stack releases, EL(STACK) equals 1.0. For

(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.

ground level releases, EL(GRD) equals 12.5 for the maximum off-site receptor, as shown on Table B.1.15. The sum of the dose rates from both plant vent stack and ground level releases must be considered for determination of Technical Specification compliance.

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 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 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 Sections 7.3.2 and 7.3.3 for the release point (either ground level or vent stack) 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 from the station gaseous effluent 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 general form of the gamma air dose equation is:

$$D^{\gamma}_{air} = 3.17E\text{-}02 \cdot [X/Q]^{\gamma} \cdot t^{-a} \cdot \sum_i (Q_i \cdot DF^{\gamma}_i) \tag{3-6}$$

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

where:

D^{γ}_{air} is the gamma air dose.

3.17E-02 is the number of pCi per μCi divided by the number of second per year,

$[X/Q]^{\gamma}$ is the average 1-hour gamma atmospheric dispersion factor,

t^{-a} is a unitless factor which adjusts the average 1-hour $[X/Q]^{\gamma}$ value for a release with a total duration of t hours,

Q_i is the total activity in μCi of each radionuclide "i" released to the atmosphere from the station gaseous effluent release point during the period of interest, and

DF^{γ}_{i} is the gamma dose factor to air for radionuclide "i" (see Table B.1-10).

Incorporating receptor location-specific atmospheric dispersion factors ($[X/Q]^{\gamma}$), adjustment factors (t^{-a}) for elevated and ground-level effluent release conditions, and occupancy factors when applicable (see Section 7.2.7), yields a series of equations by which the gamma air dose can be determined.

a. Maximum off-site receptor location, elevated release conditions:

$$D^{\gamma}_{air} = 3.2E\text{-}07 \bullet t^{-0.275} \bullet \sum_{i} (Q_i \bullet DF^{\gamma}_{i}) \quad (3\text{-}6a)$$

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

b. Maximum off-site receptor location, ground-level release conditions:

$$D^{\gamma}_{air} = 1.6E\text{-}06 \bullet t^{-0.293} \bullet \sum_{i} (Q_i \bullet DF^{\gamma}_{i}) \quad (3\text{-}6b)$$

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

c. Education Center receptor; elevated release conditions:

$$D^{\gamma}_{air} = 4.9E\text{-}10 \bullet t^{-0.252} \bullet \sum_i (Q_i \bullet DF^{\gamma}_i) \quad (3\text{-}6c)$$

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

d. Education Center receptor; ground-level release conditions:

$$D^{\gamma}_{air} = 4.4E\text{-}09 \bullet t^{-0.321} \bullet \sum_i (Q_i \bullet DF^{\gamma}_i) \quad (3\text{-}6d)$$

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

e. Receptor at the "Rocks"; elevated release conditions:

$$D^{\gamma}_{air} = 5.1E\text{-}09 \bullet t^{-0.155} \bullet \sum_i (Q_i \bullet DF^{\gamma}_i) \quad (3\text{-}6e)$$

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

f. Receptor at the "Rocks"; ground-level release conditions:

$$D^{\gamma}_{air} = 4.1E\text{-}08 \bullet t^{-0.204} \bullet \sum_i (Q_i \bullet DF^{\gamma}_i) \quad (3\text{-}6f)$$

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

Equations 3-6a through 3-6f 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 vent stack) from which recorded effluents have been discharged.

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 from gaseous effluent 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 general form of the beta air dose equation is:

$$D^{\beta}_{air} = 3.17E\text{-}02 \ast X/Q \ast t^{-a} \ast \sum (Q_i \ast DF^{\beta}_i) \qquad (3\text{-}7)$$

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

where:

D^{β}_{air} is the beta air dose,

3.17E-02 is the number of pCi per μCi divided by the number of seconds per year,

X/Q is the average 1-hour undepleted atmospheric dispersion factor,

t^{-a} is a unitless factor which adjusts the average 1-hour X/Q value for a release with a total duration of t hours,

Q_i is the total activity (μCi) of each radionuclide "i" released to the atmosphere during the period of interest, and

DF^{β}_{i} is the beta dose factor to air for radionuclide "i" (see Table B.1-10).

Incorporating receptor location-specific atmospheric dispersion factor (X/Q), adjustment factors (t^{-a}) for elevated and ground-level effluent release conditions, and occupancy factors when applicable (see Section 7.2.7) yields a series of equations by which the Beta Air Dose can be determined.

a. Maximum off-site receptor location, elevated release conditions:

$$D^{\beta}_{air} = 4.1E-7 * t^{-0.3} * \sum_{i}(Q_i * DF^{\beta}_{i}) \qquad (3\text{-}7a)$$

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

b. Maximum off-site receptor location, ground-level release conditions:

$$D^{\beta}_{air} = 6.0E-06 * t^{-0.319} * \sum_{i}(Q_i * DF^{\beta}_{i}) \qquad (3\text{-}7b)$$

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

c. Education Center receptor: elevated release conditions:

$$D^{\beta}_{air} = 1.8E-09 * t^{-0.35} * \sum_{i}(Q_i * DF^{\beta}_{i}) \qquad (3\text{-}7c)$$

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

d. Education Center receptor; ground-level release conditions:

$$D^{\beta}_{air} = 2.4E\text{-}08 \cdot t^{-0.347} \cdot \sum_i (Q_i \cdot DF^{\beta}_i) \qquad (3\text{-}7d)$$

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

e. Receptor at the "Rocks"; elevated release conditions:

$$D^{\beta}_{air} = 3.9E\text{-}08 \cdot t^{-0.249} \cdot \sum_i (Q_i \cdot DF^{\beta}_i) \qquad (3\text{-}7e)$$

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

f. Receptor at the "Rocks"; ground-level release conditions:

$$D^{\beta}_{air} = 4.6E\text{-}07 \cdot t^{-0.267} \cdot \sum_i (Q_i \cdot DF^{\beta}_i) \qquad (3\text{-}7f)$$

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

Equations 3-7a through 3-7f 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 Sections 7.3.2 and 7.3.3 for the release point (either ground level or vent stack) 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 gaseous effluent releases as it is simpler to execute and more conservative than Method 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

$$D_{co} = (X/Q)_{1hr}/(X/Q)_{an} * t^{-a} * \sum_i (Q_i * DFG_{ico}) \quad (3\text{-}8)$$

$$(\text{mrem}) = (\frac{\text{sec}}{m^3})/(\frac{\text{sec}}{m^3}) * (\quad) * \sum (\mu\text{Ci}) * (\frac{\text{mrem}}{\mu\text{Ci}})$$

where:

D_{co} is the critical organ dose from iodines, tritium, and particulates,

$(X/Q)_{1hr}$ is the average 1-hour depleted atmospheric dispersion factor.

$(X/Q)_{an}$ is the annual average depleted atmospheric dispersion.

t^{-a} is a unitless adjustment factor to account for a release with a total duration of t hours,

Q_i is the total activity in µCi of radionuclide "i" released to the atmosphere during the period of interest (for strontiums, use the most recent measurement), and

DFG_{ico} is the site-specific critical organ dose factor for radionuclide "i", see Table B.1-12. (For each radionuclide, it is the age group and organ with the largest dose factor.)

Incorporating receptor location-specific atmospheric dispersion factors ($(X/Q)_{1hr}$ and $(X/Q)_{an}$) and adjustment factors (t^{-a}) for elevated and ground-level release conditions, and incorporating occupancy factors when applicable (see Section 7.2.7), yields a series of equations by which the critical organ dose can be determined.

a. Maximum off-site receptor location, elevated release conditions:

$$D_{co} = 14.8 \cdot t^{-0.297} \cdot \sum_i (Q_i \cdot DFG_{ico}) \quad (3\text{-}8a)$$

$$(\text{mrem}) = (\ ) \cdot (\ ) \sum (\mu Ci \cdot \frac{\text{mrem}}{\mu Ci})$$

b. Maximum off-site receptor location, ground-level release conditions:

$$D_{co} = 17.7 \cdot t^{-0.316} \cdot \sum_i (Q_i \cdot DFG_{ico}) \quad (3\text{-}8b)$$

$$(\text{mrem}) = (\ ) \cdot (\ ) \sum (\mu Ci \cdot \frac{\text{mrem}}{\mu Ci})$$

c. Education Center receptor; elevated release conditions:

$$D_{co} = 3.3E\text{-}02 \cdot t^{-0.349} \cdot \sum_i (Q_i \cdot DFG_{ico}) \quad (3\text{-}8c)$$

$$(\text{mrem}) = (\ ) \cdot (\ ) \sum (\mu Ci \cdot \frac{\text{mrem}}{\mu Ci})$$

d. Education Center receptor; ground-level release conditions:

$$D_{co} = 3.3E\text{-}02 \cdot t^{-0.347} \cdot \sum_i (Q_i \cdot DFG_{ico}) \quad (3\text{-}8d)$$

$$(\text{mrem}) = (\ ) \cdot (\ ) \sum (\mu Ci \cdot \frac{\text{mrem}}{\mu Ci})$$

e. Receptor at the "Rocks"; elevated release conditions:

$$D_{CO} = 7.3E\text{-}02 \cdot t^{-0.248} \cdot \sum_i (Q_i \cdot DFG_{ico}) \qquad (3\text{-}8e)$$

$$(\text{mrem}) = (\quad) \cdot (\quad) \sum (\mu Ci \cdot \frac{\text{mrem}}{\mu Ci})$$

f. Receptor at the "Rocks"; ground-level release conditions:

$$D_{CO} = 8.6E\text{-}02 \cdot t^{-0.267} \cdot \sum_i (Q_i \cdot DFG_{ico}) \qquad (3\text{-}8f)$$

$$(\text{mrem}) = (\quad) \cdot (\quad) \sum (\mu Ci \cdot \frac{\text{mrem}}{\mu Ci})$$

Equations 3-8a through 3-8f 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 Sections 7.3.2 and 7.3.3 for the release point (either ground level or vent stack) 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 member 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.

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.

(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 3-6a), and the beta air dose D_{air}^{β} (Equation 3-7a) 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: $D_{air\ pr}^{\beta} = D_{air}^{\beta} \cdot R_3$

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 3-8a) 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: $D_{co\ pr} = D_{co} \cdot R_4 \cdot R_5$

4.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

The radiological environmental monitoring stations are listed in Table B.4-1. The locations of the stations with respect to the Seabrook Station are shown on the maps in Figures B.4-1 to B.4-6.

Direct radiation measurements are analyzed at the station. All other radiological analyses for environmental samples are performed at the Yankee Environmental Laboratory. The Laboratory participates in the U.S. Environmental Protection Agency's Environmental Radioactivity Laboratory Intercomparison Studies Program for all the species and matrices routinely analyzed.

Pursuant to Specification 4.12.2, the land use census will be conducted "during the growing season" at least once per 12 months. The growing season is defined, for the purposes of the land use census, as the period from June 1 to October 1. The method to be used for conducting the census will consist of one or more of the following, as appropriate: door-to-door survey, visual inspection from roadside, aerial survey, or consulting with local agricultural authorities.

Technical Specification 6.8.1.3 requires that the results of the Radiological Environmental Monitoring Program be summarized in the Annual Radiological Environmental Operating Report "in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, 1979." The general table format will be used with one exception and one clarification, as follows. The mean and range values will be based not upon detectable measurements only, as specified in the NRC Branch Technical Position, but upon all measurements. This will prevent the positive bias associated with the calculation of the mean and range based upon detectable measurements only. Secondly, the Lower Limit of Detection column will specify the LLD required by ODCM Table A.5-2 for that radionuclide and sample medium.

TABLE B.4-1

RADIOLOGICAL ENVIRONMENTAL MONITORING STATIONS [(a)]

Exposure Pathway and/or Sample	Sample Location and Designated Code		Distance From Unit 1 Containment (km)	Direction From the Plant
1. AIRBORNE (Particulate and Radioiodine)				
	AP/CF-01	PSNH Barge Landing Area	2.7	ESE
	AP/CF-02	Harbor Road	2.7	E
	AP/CF-03	SW Boundary	0.8	SW
	AP/CF-04	W. Boundary	1.0	W
	AP/CF-05	Winnacunnet H.S.[(b)]	4.0	NNE
	AP/CF-06	Georgetown Substation (Control)	24.0	SSW
2. WATERBORNE				
a. Surface	WS-01	Hampton-Discharge Area	5.3	E
	WS-51	Ipswich Bay (Control)	16.9	SSE
b. Sediment	SE-02	Hampton-Discharge Area[(b)]	5.3	E
	SE-07	Hampton Beach[(b)]	3.1	E
	SE-08	Seabrook Beach	3.2	ESE
	SE-52	Ipswich Bay (Control)[(b)]	16.9	SSE
	SE-57	Plum Island Beach (Control)[(b)]	15.9	SSE
3. INGESTION				
a. Milk	TM-04	Salisbury, MA	5.2	SW
	TM-09	Hampton, NH	5.5	NNW
	TM-10	Hampton Falls, NH	4.8	WNW
	TM-15	Hampton Falls, NH[(b)]	7.0	NW
	TM-20	Rowley, MA (Control)	16.3	S
b. Fish and Invertebrates[(c)]				
	FH-03	Hampton - Discharge Area	4.5	ESE
	FH-53	Ipswich Bay (Control)	16.4	SSE
	HA-04	Hampton - Discharge Area	5.5	E
	HA-54	Ipswich Bay (Control)	17.2	SSE
	MU-06	Hampton - Discharge Area	5.2	E
	MU-56	Ipswich Bay (Control)	17.4	SSE

TABLE B.4-1
(continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING STATIONS[a]

Exposure Pathway and/or Sample	Sample Location and Designated Code		Distance From Unit 1 Containment (km)	Direction From the Plant
4. DIRECT RADIATION				
	TL-1	Brimmer's Lane, Hampton Falls	1.1	N
	TL-2	Landing Rd., Hampton	3.2	NNE
	TL-3	Glade Path, Hampton Beach	3.1	NE
	TL-4	Island Path, Hampton Beach	2.4	ENE
	TL-5	Harbor Rd., Hampton Beach	2.7	E
	TL-6	PSNH Barge Landing Area	2.7	ESE
	TL-7	Cross Rd., Seabrook Beach	2.6	SE
	TL-8	Farm Lane, Seabrook	1.1	SSE
	TL-9	Farm Lane, Seabrook	1.1	S
	TL-10	Site Boundary Fence	1.0	SSW
	TL-11	Site Boundary Fence	1.0	SW
	TL-12	Site Boundary Fence	1.0	WSW
	TL-13	Inside Site Boundary	0.8	W
	TL-14	Trailer Park, Seabrook	1.1	WNW
	TL-15	Brimmer's Lane, Hampton Falls	1.4	NW
	TL-16	Brimmer's Lane, Hampton Falls	1.1	NNW
	TL-17	South Rd., N. Hampton	7.9	N
	TL-18	Mill Rd., N. Hampton	7.6	NNE
	TL-19	Appledore Ave., N. Hampton	7.9	NE
	TL-20	Ashworth Ave., Hampton Beach	3.4	ENE
	TL-21	Route 1A, Seabrook Beach	2.7	SE
	TL-22	Cable Ave., Salisbury Beach	7.6	SSE
	TL-23	Ferry Rd., Salisbury	8.1	S
	TL-24	Ferry Lots Lane, Salisbury	7.2	SSW
	TL-25	Elm St., Amesbury	7.6	SW
	TL-26	Route 107A, Amesbury	8.1	WSW

TABLE B.4-1
(continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING STATIONS[a]

Exposure Pathway and/or Sample	Sample Location and Designated Code		Distance From Unit 1 Containment (km)	Direction From the Plant
	TL-27	Highland St., S. Hampton	7.6	W
	TL-28	Route 150, Kensington	7.9	WNW
	TL-29	Frying Pan Lane, Hampton Falls	7.4	NW
	TL-30	Route 101C, Hampton	7.9	NNW
	TL-31	Alumni Drive, Hampton	4.0	NNE
	TL-32	Seabrook Elementary School	1.9	S
	TL-33	Dock Area, Newburyport	9.7	S
	TL-34	Bow St., Exeter	12.1	NW
	TL-35	Lincoln Ackerman School	2.4	NNW
	TL-36	Route 97, Georgetown (Control)	22	SSW
	TL-37	Plaistow, NH (Control)	26	WSW
	TL-38	Hampstead, NH (Control)	29	W
	TL-39	Fremont, NH (Control)	27	WNW
	TL-40	Newmarket, NH (Control)	24	NNW
	TL-41	Portsmouth, NH (Control)[b]	21	NNE
	TL-42	Ipswich, MA (Control)[b]	27	SSE

(a) Sample locations are shown on Figures B.4-1 to B.4-6.

(b) This sample location is not required by monitoring program defined in Part A of ODCM; program requirements specified in Part A do not apply to samples taken at this location.

(c) Samples will be collected pursuant to ODCM Table A.5-1. Samples are not required from all stations listed during any sampling interval (FH = Fish; HA = Lobsters; MU = Muscles). Table A.5-1 specifies that "one sample of three commercially and recreationally important species" be collected in the vicinity of the plant discharge area, with similar species being collected at a control location. (This wording is consistent with the NRC Final Environmental Statement for Seabrook Station.) Since the discharge area is off-shore, there is a great number of fish species that could be considered commercially or recreationally important. Some are migratory (such as striped bass), making them less desirable as an indicator of plant-related radioactivity. Some pelagic species (such as herring and mackerel) tend to school and wander throughout a large area, sometimes making catches of significant size difficult to obtain. Since the collection of all species would be difficult or impossible, and would provide unnecessary redundancy in terms of monitoring important pathways to man, three fish and invertebrate species have been specified as a minimum requirement. Samples may include marine fauna such as lobsters, clams, mussels, and bottom-dwelling fish, such as flounder or hake. Several similar species may be grouped together into one sample if sufficient sample mass for a single species is not available after a reasonable effort has been made (e.g., yellowtail flounder and winter flounder).

FIGURE B.4-1

RADIOLOGICAL ENVIRONMENTAL MONITORING LOCATIONS
WITHIN 4 KILOMETERS OF SEABROOK STATION

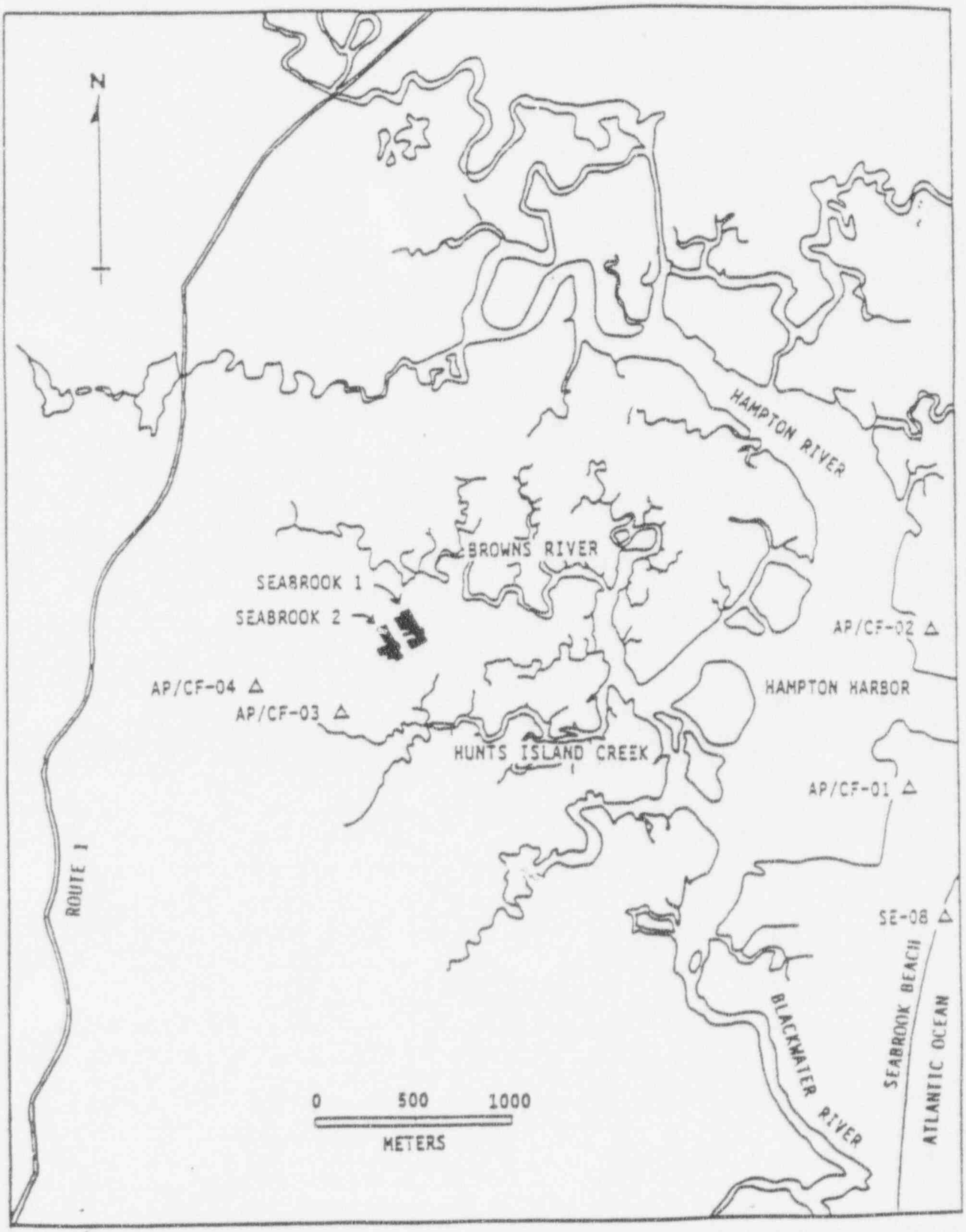


FIGURE B.4-2

RADIOLOGICAL ENVIRONMENTAL MONITORING LOCATIONS
BETWEEM 4 KILOMETERS AND 12 KILOMETERS FROM SEABROOK STATION

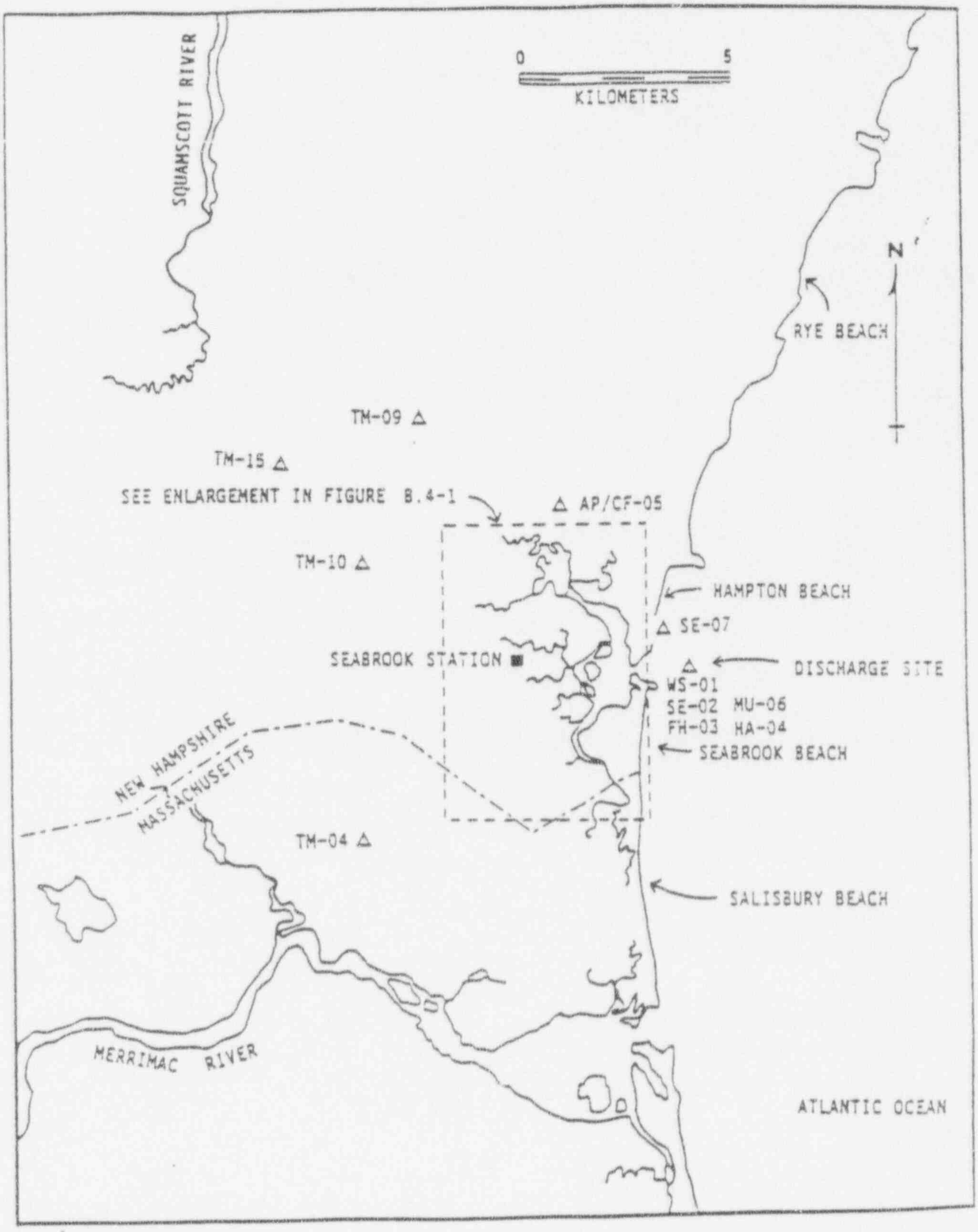


FIGURE B.4-3

RADIOLOGICAL ENVIRONMENTAL MONITORING LOCATIONS
OUTSIDE 12 KILOMETERS OF SEABROOK STATION

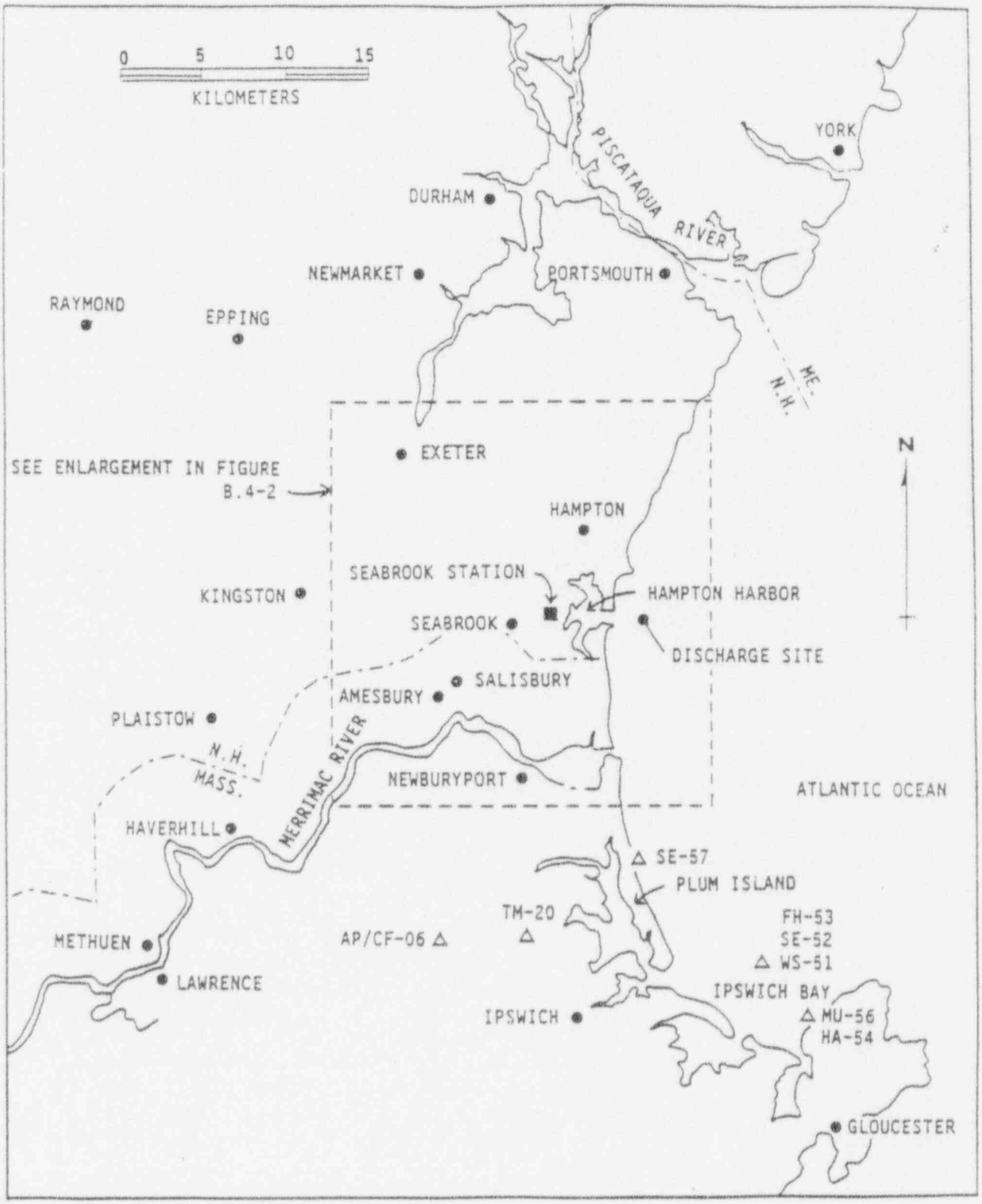


FIGURE B.4-4

DIRECT RADIATION MONITORING LOCATIONS WITHIN 4 KILOMETERS OF SEABROOK STATION

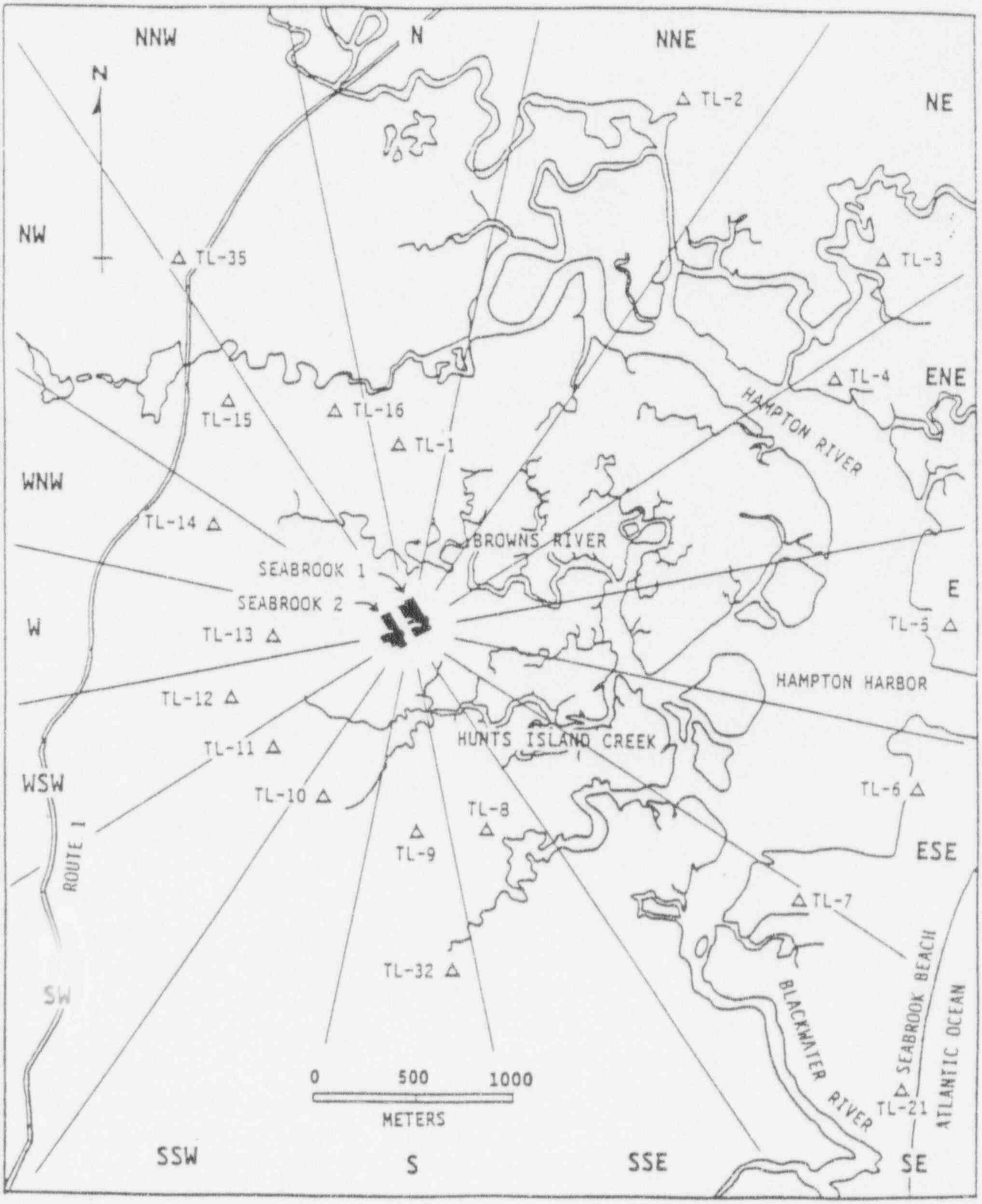


FIGURE B.4-5

DIRECT RADIATION MONITORING LOCATIONS BETWEEN 4 KILOMETERS AND 12 KILOMETERS FROM SEABROOK STATION

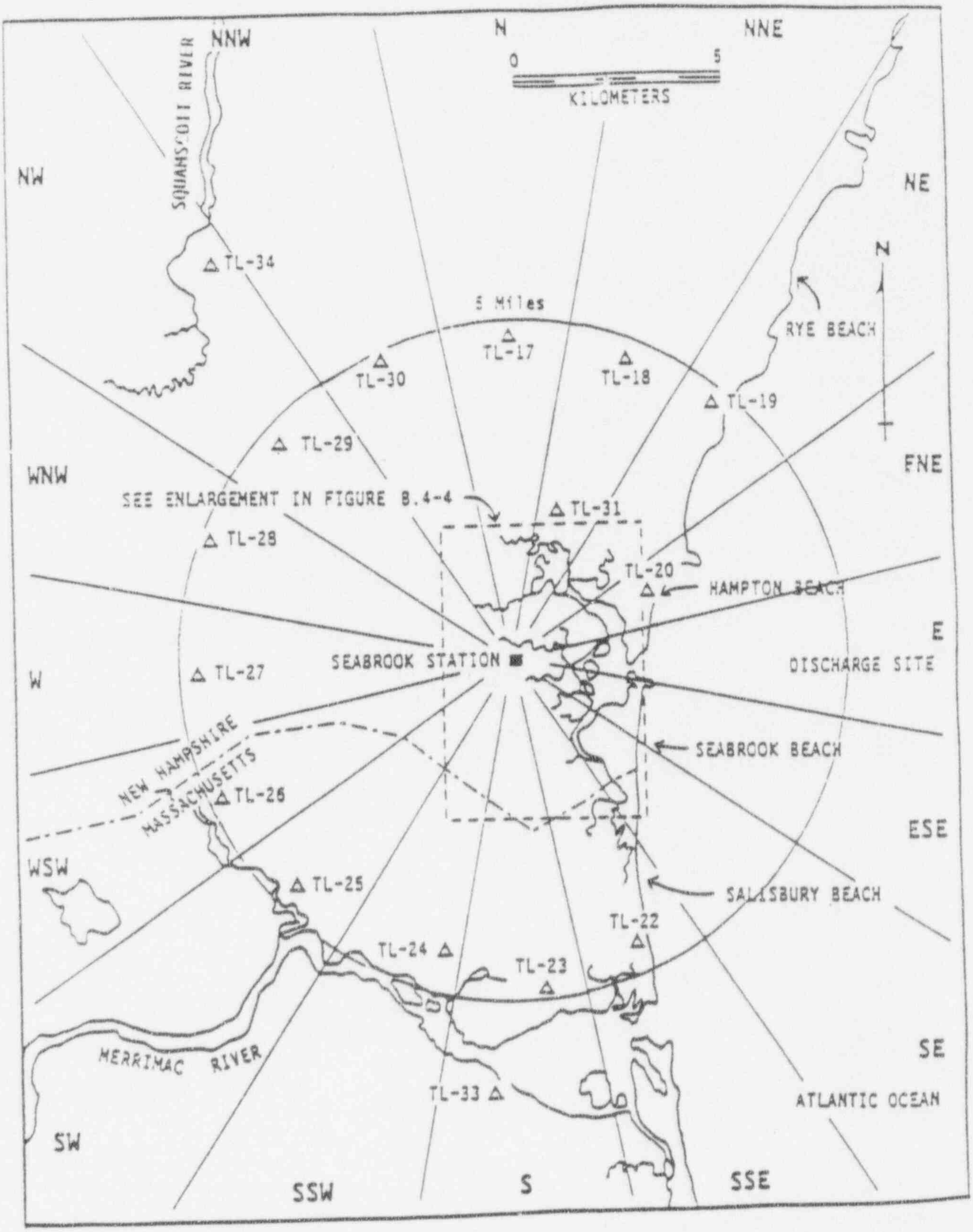
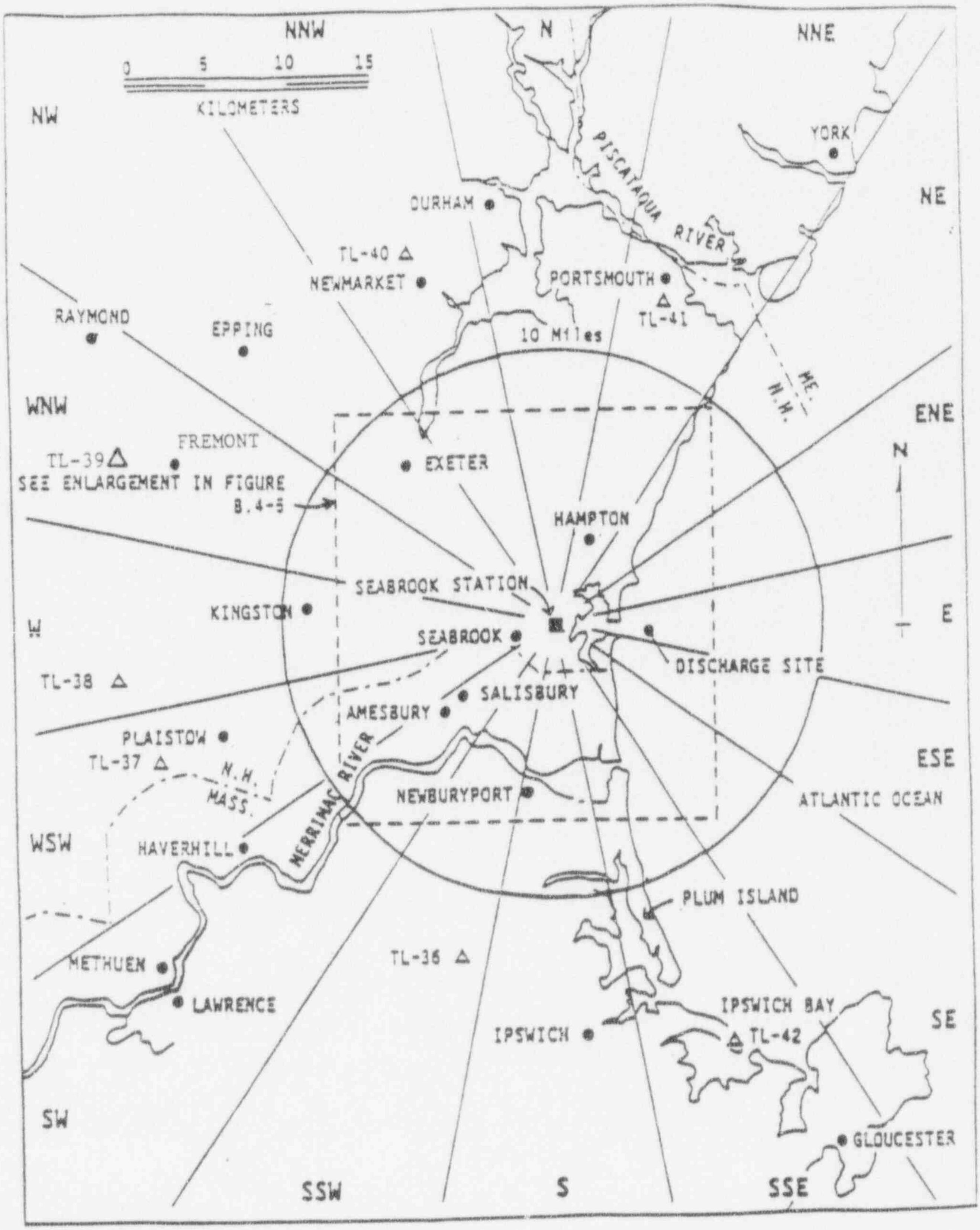


FIGURE B.4-6

DIRECT RADIATION MONITORING LOCATIONS OUTSIDE
12 KILOMETERS OF SEABROOK STATION



5.0 SETPOINT DETERMINATIONS

Chapter 5 contains the methodology for the calculation of effluent monitor setpoints to implement the requirements of the radioactive effluent monitoring systems Technical Specifications 3.3.3.9 and 3.3.3.10 for liquids gases, respectively.

Example setpoint calculations are provided for each of the required effluent monitors.

5.1 Liquid Effluent Instrumentation Setpoints

Technical Specification 3.3.3.9 requires that the radioactive liquid effluent instrumentation in Table 3.3-12 of the Technical Specifications have alarm setpoints in order to ensure that Technical Specification 3.11.1.1 is not exceeded. Technical Specification 3.11.1.1 limits the activity concentration in liquid effluents to the appropriate MPCs in 10CFR20 and a total noble gas MPC.

5.1.1 Liquid Waste Test Tank Monitor (RM-6509)

The liquid waste test tank 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. It is also used to monitor discharges from various waste sumps to the environment.

5.1.1.1 Method to Determine the Setpoint of the Liquid Waste Test Tank Monitor (RM-6509)

The instrument response (µCi/ml) for the limiting concentration at the point of discharge is the setpoint, denoted $R_{setpoint}$, and is determined as follows:

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

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

where:

$$DF = \frac{F_d}{F_m} = \text{Dilution factor (dimensionless)} \qquad (5\text{-}2)$$

F_m = Flow rate past monitor (gpm)

F_d = Flow rate out of discharge tunnel (gpm)

DF_{min} = Minimum allowable dilution factor (dimensionless)

f_1 = $1 - (f_2 + f_3 + f_4)$; 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, f_3, and f_4 are the similar fractions for Turbine Building sump, steam generator blowdown, and primary component cooling pathways, respectively: $(f_1 + f_2 + f_3 + f_4 \leq 1)$.

$$DF_{min} = \sum_i \frac{C_{mi}}{MPC_i} \tag{5-3}$$

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

$$\sum_i C_{mi} = 2.15E\text{-}05 + 7.48E\text{-}05 + 2.56E\text{-}05 = 1.22E\text{-}04$$

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

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

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

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

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

$$DF_{min} = 7$$

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:

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

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

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

$$= 2750$$

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:

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

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

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

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

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

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, as determined by the most recent grab sample isotopic analysis. If the total activity is less than 10 percent of MPC, the setpoints of RM-6521 are calculated as follows:

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

where: $DF' = \dfrac{\text{Circulating water flow rate (gpm)}}{\text{Flow rate pass-monitor (gpm)}}$

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

f_2 = $1 - (f_1 + f_3 + f_4)$; where the f values are described above.

In addition, a warning alarm setpoint can be determined by multiplying the high trip alarm point by an administratively selected fraction (as an example, 0.25).

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

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:

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

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

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:

$$RC_{set} = 1x10^{-8} \frac{\mu Ci}{ml} \cdot 1.0x10^{6} \text{ gph } (1/1x10^{-5} \frac{\mu Ci}{ml})$$

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

As a result, for other PCCW activities, the RC_{set} which would also relate to a detection of a minimum service water concentration of $1x10^{-8}$ µCi/ml can be found from:

$$RC_{set} = \frac{1x10^{-5} \cdot \mu Ci/ml \cdot 1000 \text{ gph}}{PCC} \quad (5\text{-}24)$$

5.1.5 PCCW Radiation Monitor

The PCCW radiation monitor will alert the operator in the Main Control Room of a leak to the PCCW System from a radioactively contaminated system.

The PCCW radiation monitor alarm is based on a trend of radiation levels in the PCCW System. The background radiation of the PCCW is determined by evaluating the radiation levels over a finite time period. The alert alarm setpoint is set at 1.5 x background, and the high alarm setpoint is set at 2 x background, per Technical Specification Table 3.3-6.

5.2 Gaseous Effluent Instrumentation Setpoints

Technical Specification 3.3.3.10 requires that the radioactive gaseous effluent instrumentation in Table 3.3-13 of the Technical Specifications have their alarm setpoints set to insure that Technical Specification 3.11.2.1 is not exceeded.

5.2.1 Plant Vent Wide-Range Gas Monitors (RM-6528-1,2 and 3)

The plant vent wide-range gas monitors are shown on Figure B.6-2.

5.2.1.1 Method to Determine the Setpoint of the Plant Vent Wide Range Gas Monitors (RM-6528-1,2 and 3)

The maximum allowable setpoint for the plant vent wide-range gas monitor (readout response in μCi/sec) is set by limiting the off-site noble gas dose rate to the total body or to the skin, and is denoted $R_{setpoint}$. $R_{setpoint}$ is the lesser of:

$$R_{tb} = 588 \frac{1}{DFB_c} \qquad (5\text{-}5)$$

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

and:

$$R_{skin} = 3{,}000 \frac{1}{DF'_c} \qquad (5\text{-}6)$$

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

where:

R_{tb} = Response of the monitor at the limiting total body dose rate (μCi/sec)

$$588 = \frac{500}{(1E+06)\quad(8.5E-07)} \left(\frac{mrem\text{-}\mu Ci\text{-}m^3}{yr\text{-}pCi\text{-}sec}\right)$$

500 = Limiting total body dose rate (mrem/yr)

1E+06 = Number of pCi per μCi (pCi/μCi)

8.5E-07 = $[X/Q]^{\gamma}$, maximum off-site long-term average gamma atmospheric dispersion factor for primary vent stack releases (sec/m^3)

DFB_c = Composite total body dose factor ($mrem\text{-}m^3/pCi\text{-}yr$)

$$= \frac{\sum_i \dot{Q}_i \, DFB_i}{\sum_i \dot{Q}_i} \quad (5\text{-}7)$$

$\dot{Q}_i$ = The release rate of noble gas "i" in the mixture, for each noble gas identified in the off-gas (μCi/sec)

DFB_i = Total body dose factor (see Table B.1-10) ($mrem\text{-}m^3/pCi\text{-}yr$)

R_{skin} = Response of the monitor at the limiting skin dose rate (μCi/sec)

3,000 = Limiting skin dose rate (mrem/yr)

DF'_c = Composite skin dose factor (mrem-sec/μCi-yr)

$$= \frac{\sum_i \dot{Q}_i \, DF'_i}{\sum_i \dot{Q}_i} \quad (5\text{-}8)$$

DF'_i = Combined skin dose factor (see Table B.1-10) (mrem-sec/μCi-yr)

5.2.1.2 Plant Vent Wide Range Gas Monitor Setpoint Example

The following setpoint example for the plant vent wide range gas monitors demonstrates the use of equations 5-5 and 5-6 for determining setpoints.

This setpoint example is based on the following data (see Table B.1-10 for DFB_i and DF_i'):

i	$\dot{Q}_i$ $(\frac{\mu Ci}{sec})$	DFB_i $(\frac{mrem\text{-}m^3}{pCi\text{-}yr})$	DF_i' $(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr})$
Xe-138	1.03E+04	8.83E-03	1.20E-02
Kr-87	4.73E+02	5.92E-03	1.38E-02
Kr-88	2.57E+02	1.47E-02	1.62E-02
Kr-85m	1.20E+02	1.17E-03	2.35E-03
Xe-135	3.70E+02	1.81E-03	3.33E-03
Xe-133	1.97E+01	2.94E-04	5.83E-04

$$DFB_c = \frac{\sum_i \dot{Q}_i \, DFB_i}{\sum_i \dot{Q}_i} \qquad (5\text{-}7)$$

$$\sum_i \dot{Q}_i \, DFB_i = (1.03E{+}04)(8.83E{-}03) + (4.73E{+}02)(5.92E{-}03)$$

$$+ (2.57E{+}02)(1.47E{-}02) + (1.20E{+}02)(1.17E{-}03)$$

$$+ (3.70E{+}02)(1.81E{-}03) + (1.97E{+}01)(2.94E{-}04)$$

$$= 9.83E{+}01 \ (\mu Ci\text{-}mrem\text{-}m^3/sec\text{-}pCi\text{-}yr)$$

$$\sum_i \dot{Q}_i = 1.03E{+}04 + 4.73E{+}02 + 2.57E{+}02$$

$$+ 1.20E+02 + 3.70E+02 + 1.97E+01$$

$$= 1.15E+04 \ \mu Ci/sec$$

$$DFB_c = \frac{9.83E+01}{1.15E+04}$$

$$= 8.52E-03 \ (mrem\text{-}m^3/pCi\text{-}yr)$$

$$R_{tb} = 588 \ \frac{1}{DFB_c} \qquad (5\text{-}5)$$

$$= (588) \ \frac{1}{(8.52E-03)}$$

$$= 6.90E+04 \ \mu Ci/sec$$

and next;

$$DF'_c = \frac{\sum_i \dot{Q}_i \ DF'_i}{\sum_i \dot{Q}_i} \qquad (5\text{-}8)$$

$$\sum_i \dot{Q}_i \ DF'_i = (1.03E+04)(1.20E-02) + (4.73E+02)(1.38E-02)$$
$$+ (2.57E+02)(1.62E-02) + (1.20E+02)(2.35E-03)$$
$$+ (3.70E+02)(3.33E-03) + (1.97E+01)(6.83E-04)$$

$$= 1.38E+02 \ (\mu Ci\text{-}mrem\text{-}sec/sec\text{-}\mu Ci\text{-}yr)$$

$$DF'_c = \frac{1.36E+02}{1.15E+04}$$

$$= 1.18E-02 \ \ (mrem\text{-}sec/\mu Ci\text{-}yr)$$

$$R_{skin} = 3{,}000 \ \frac{1}{DF'_c} \qquad (5\text{-}6)$$

$$= (3{,}000) \frac{1}{(1.18E\text{-}02)}$$

$$= 2.54E{+}05 \ \mu Ci/sec$$

The setpoint, $R_{setpoint}$, is the lesser of R_{tb} and R_{skin}. For the noble gas mixture in this example R_{tb} is less than R_{skin}, indicating that the total body dose rate is more restrictive. Therefore, in this example the plant vent wide-range gas monitors should each be set at no more than 6.90E+04 μCi/sec above background, or at some administrative fraction of the above value.

In the event that no activity is expected to be released, or can be measured in the system to be vented, the gaseous monitor setpoint should be based on Xe-133.

6.0 LIQUID AND GASEOUS EFFLUENT STREAMS, RADIATION MONITORS AND RADWASTE TREATMENT SYSTEMS

Figure B.6-1 shows the liquid effluent streams, radiation monitors and the appropriate Liquid Radwaste Treatment System. Figure B.6-2 shows the gaseous effluent streams, radiation monitors and the appropriate Gaseous Radwaste Treatment System.

For more detailed information concerning the above, refer to the Seabrook Station Final Safety Analysis Report, Sections 11.2 (Liquid Waste System), 11.3 (Gaseous Waste System) and 11.5 (Process and Effluent Radiological Monitoring and Sampling System).

The turbine gland seal condenser exhaust is an unmonitored release path. The iodine and particulate gaseous releases will be determined by continuously sampling the turbine gland seal condenser exhaust. The noble gas releases will be determined by the noble gas released via the main condenser air evacuation exhaust and ratioing them to the turbine gland seal condenser exhaust by use of the flow rates.

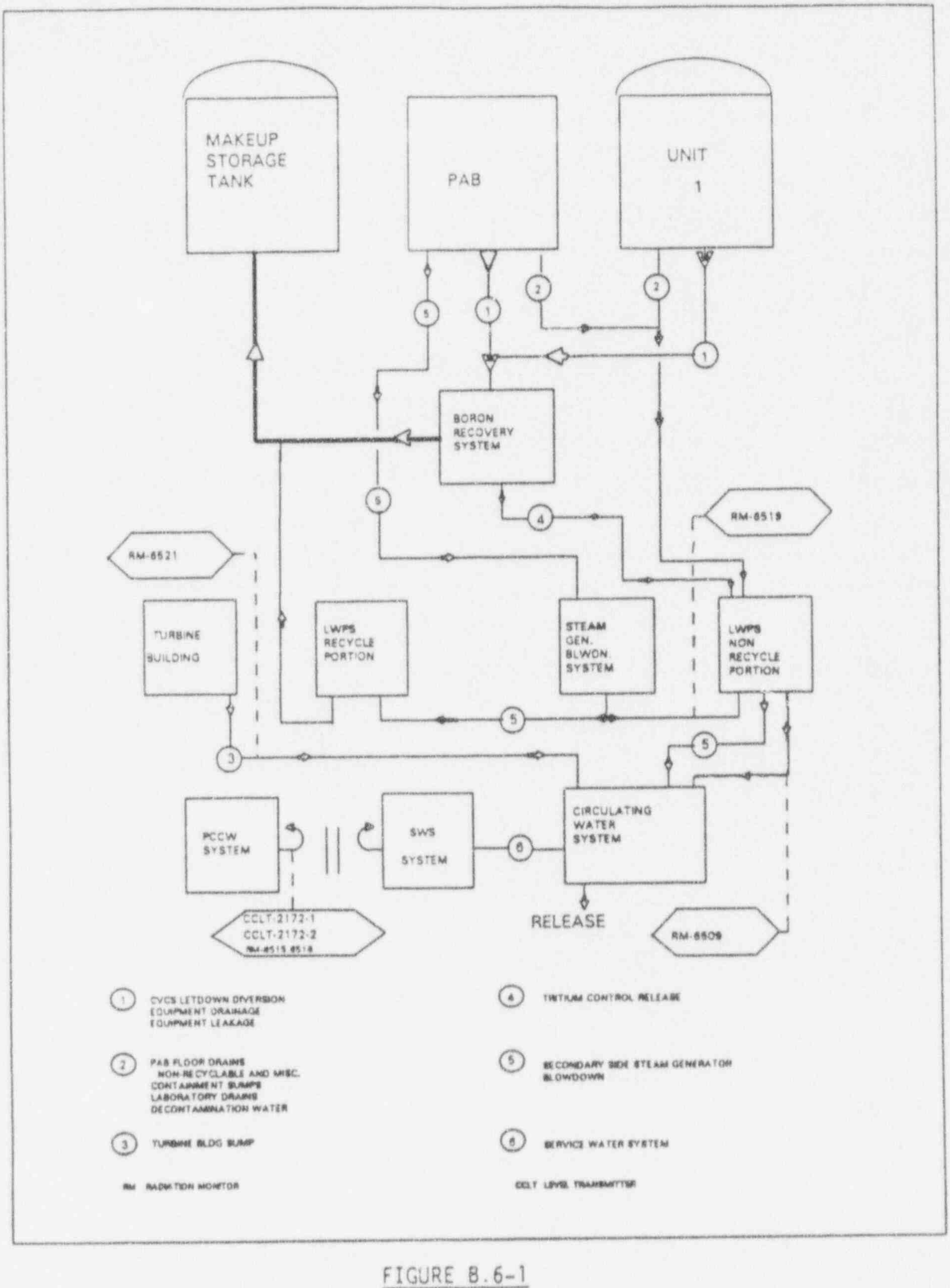


FIGURE B.6-1

Liquid Effluent Streams, Radiation Monitors, and Radwaste Treatment System at Seabrook Station

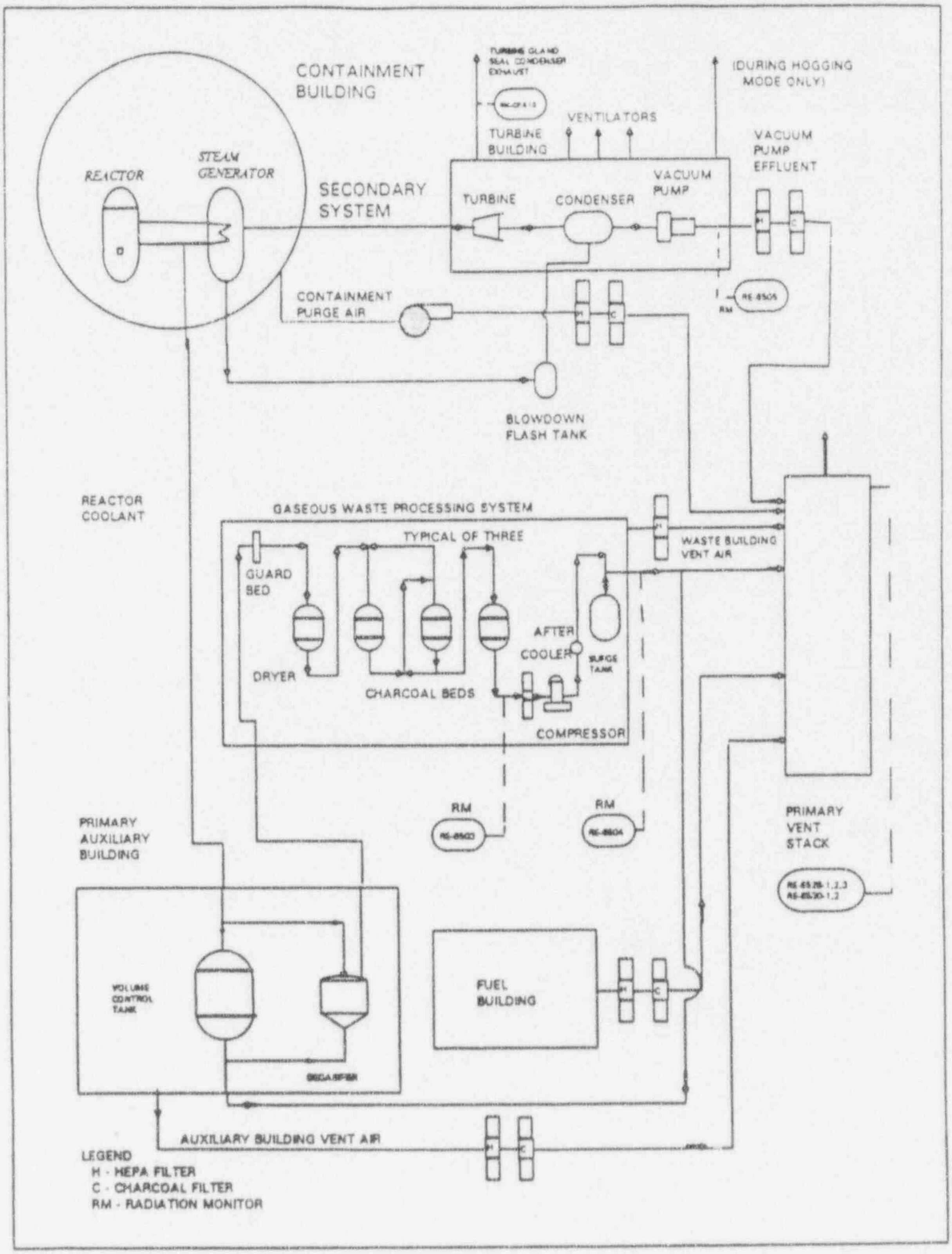


FIGURE B.6-2

Gaseous Effluent Streams, Radiation Monitors, and Radwaste Treatment System at Seabrook Station

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 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 multiport diffusers. (Credit for additional dilution to the outer edge of the prompt mixing zone which corresponds to the 1°F surface isotherm (mixing ratio .025) can be applied in the Method II calculation for shoreline exposures only since the edge of this isotherm typically does not reach the shoreline receptor points during the tidal cycle. The mixing ratio for equatic food pathways in Method II assessments shall be limited to the same value (0.10) as applied in Method I for near-field mixing, or prompt dilution only.

The requirements for the determination of radiological impacts resulting from releases in liquid effluents is derived from 10CFR50, 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 one 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 1,000 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 ten 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 (reference "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 three miles through the 19-foot 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 (M_p) to account for the mixing ratio (reciprocal of the dilution factor) of effluents in the environment at the point of exposure. Table 1, in Regulatory 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 saltwater 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 one 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 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 finfish. 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 finfish might be exposed. However, even this dilution credit is conservative since it neglects the plant's 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. Not withstanding the above expected dilution credit afforded at the 1 degree isotherm, all Method II aquatic food pathway dose calculations shall conservatively assume credit for prompt dilution only with an $M_p = 0.10$. When dose impacts from the fish and invertebrate pathways are then added to the conservative dose impacts derived for shoreline exposures, 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 10CFR50, Seabrook has determine site-specific mixing ratios which factor in its plant design.

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. Appendix A provides an example of the development of a Method I liquid dose conversion factor for site-specific conditions at Seabrook.

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:

$$\Delta D_{tb} = k\, Q_i\, DFL_{itb}$$

$$(\text{mrem})\ (\ )\ (\mu\text{Ci})\ \left(\frac{\text{mrem}}{\mu\text{Ci}}\right) \qquad (7\text{-}1)$$

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:

$$\Delta D_{mo} = k\, Q_i\, DFL_{imo} \qquad (7\text{-}2)$$

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

where:

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

* Regulatory Guide 1.109

** 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.

*** Regional shoreline use associated with mudflats - Maine Yankee Atomic Power Station Environmental Report.

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:

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

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

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" ($\mu Ci/sec$).

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:

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

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

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. 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. 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.

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

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

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

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.

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

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

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/Q^{γ}) from Reference 8 that:

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

$$\left(\frac{mrad}{yr}\right) = \left(\frac{mrad}{yr}\right)\left(\frac{sec}{m^3}\right)\left(\frac{m^3}{sec}\right)$$

and

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

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

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

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

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

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

substituting:

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

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

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

$$\left(\frac{mrem}{yr}\right) = \left(\frac{pCi\text{-}sec\text{-}mrem}{\mu Ci\text{-}m^3\text{-}mrad}\right)\left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)\left(\frac{pCi\text{-}sec}{\mu Ci\text{-}m^3}\right)\left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right) \quad (7\text{-}10)$$

$$= \sum_i [0.94\ DF_i^\gamma + 0.82\ DFS_i]$$

define:

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

then:

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

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

The EL(R) term is a dimensionless correction factor that is applied when calculating the dose impact from a ground level release point. For primary vent stack releases, this correction factor is equal to 1.0 since the dose conversion factors derived for all Method I applications are based on meteorological dispersion parameters calculated for this mixed mode elevation release height. For release points other than the primary vent stack, the EL(R) correction factor reflects the difference between ground level dispersion and that associated with the primary vent stack. This is done so that the same list of mixed mode (primary vent stack) Dose Conversion Factors (DCFs) can be used for either ground level or vent stack releases. The EL(GRD) correction factors are derived by calculating all the specific nuclide dose conversion factors in the same way as was done for the vent stack release point (see Appendix A for example calculation of a vent stack release point DCF), but substituting in the equivalent ground level release point dispersion factors for each critical receptor point. Then, for each radionuclide, a ratio between the ground level DCF and the vent stack DCF was calculated, with the largest ratio for each release type selected to represent the correction factor for use with the Method I dose equations. Table B.1-15 lists the correction factors calculated in this way for each release type.

factor for use with the Method I dose equations. Table B.1-15 lists the correction factors calculated in this way for each release type.

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.

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:

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

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

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

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

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

Eq. 3-8 is rewritten in the form:

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

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

where:

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

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

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 expected atmospheric dispersion factors.

In accordance with the Basis Statement 3/4.11.2.1 in NUREG-0472, and the base's section for the organ dose rate limit given for Technical Specification 3.11.2.1, a Method II dose rate calculation, for compliance purposes, can be based on restricting the inhalation pathway to a child's thyroid to less than or equal to 1,500 mrem/yr. Concurrent meteorology with time of release may also be used to assess compliance for a Method II calculation.

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 3.11.2.2 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.

NUREG/CR-2919 presents a methodology for determining atmospheric dispersion factors (CHI/Q values) for intermittent releases at user specified receptor locations (intermittent releases being defined as releases with durations between 1 and 8,760 hours). The CHI/Q values for intermittent releases are determined by linearly interpolating (on a log-log basis) between an hourly 15-percentile CHI/Q value and an annual average CHI/Q value as a function of release duration. This methodology has been adopted to produce a set of time-dependent atmospheric dispersion factors for Method I calculations.

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 $D^{\gamma}_{finite} = D^{\gamma}\,[X/Q]^{\gamma}/[X/Q]$:

$$\Delta D^{\gamma}_{air} = 3.17E{+}4\ [X/Q]^{\gamma} \sum_i Q_i\ DF^{\gamma}_i \qquad (7\text{-}14)$$

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

where:

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

$[X/Q]^{\gamma}$ = Annual average gamma atmospheric dispersion factor for the receptor location of interest.

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".

Incorporating the term t^{-a} and the conversion factor for Ci to µCi (to accommodate the use of a release rate Q in µCi), and substituting the average 1-hour gamma atmospheric dispersion factor in place of the annual average gamma atmospheric dispersion factor in Equation 7-14 leads to:

$$D^{\gamma}_{air} = 3.17E{-}02 \bullet [X/Q]^{\gamma} \bullet t^{-a} \bullet \sum_i \left(Q_i \bullet DF^{\gamma}_i\right) \qquad (3\text{-}6)$$

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

For an elevated release, the equation used for an off-site receptor is:

$$D^{\gamma}_{air} = 3.17E\text{-}02 \bullet [1.0E\text{-}05] \bullet t^{-0.275} \bullet \sum_i \left(Q_i \bullet DF^{\gamma}_i\right)$$

which leads to:

$$D^{\gamma}_{air} = 3.2E\text{-}07 \bullet t^{-0.275} \bullet \sum_i \left(Q_i \bullet DF^{\gamma}_i\right) \tag{3-6a}$$

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

For a ground-level release, the equation used for an off-site receptor is:

$$D^{\gamma}_{air} = 3.17E\text{-}02 \bullet [4.9E\text{-}05] \bullet t^{-0.293} \bullet \sum_i \left(Q_i \bullet DF^{\gamma}_i\right)$$

which leads to:

$$D^{\gamma}_{air} = 1.6E\text{-}06 \bullet t^{-0.293} \bullet \sum_i \left(Q_i \bullet DF^{\gamma}_i\right) \tag{3-6b}$$

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

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 3.11.2.2, 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:

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

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

where:

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

Incorporating the term t^{-a} into Equation 7-15 leads to:

$$D^{\beta}_{air} = 3.17E\text{-}02 \cdot X/Q \cdot t^{-a} \cdot \sum_i \left(Q_i \cdot DF^{\beta}_i\right) \qquad (3\text{-}7)$$

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

Where X/Q = average 1-hour undepleted atmospheric dispersion factor.

For an elevated release, the equation used for an off-site receptor is:

$$D^{\beta}_{air} = 3.17E\text{-}02 \cdot 1.3E\text{-}05 \cdot t^{-0.3} \cdot \sum_i \left(Q_i \cdot DF^{\beta}_i\right)$$

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

which leads to:

$$D^{\beta}_{air} = 4.1E\text{-}07 \bullet t^{-0.3} \bullet \sum_i \left(Q_i \bullet DF^{\beta}_i\right) \qquad (3\text{-}7a)$$

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

For a ground-level release, the equation used for an off-site receptor is:

$$D^{\beta}_{air} = 3.17E\text{-}02 \bullet 1.9E\text{-}04 \bullet t^{-0.319} \bullet \sum_i \left(Q_i \bullet DF^{\beta}_i\right)$$

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

which leads to:

$$D^{\beta}_{air} = 6.0E\text{-}06 \bullet t^{-0.319} \bullet \sum_i \left(Q_i \bullet DF^{\beta}_i\right) \qquad (3\text{-}7b)$$

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

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.

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. Six 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 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. Appendix A provides an example of the development of Method I gaseous dose conversion factor for site-specific conditions at Seabrook.

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.

Applying this information, it follows that the general form for the critical organ dose equation is:

$$D_{co} = (X/Q)_{1\ hr}/(X/Q)_{an} * t^{-a} * \sum_i (Q_i * DFG_{ico}) \qquad (3\text{-}8)$$

$$mrem = \left(\frac{sec}{m^3}\right) / \left(\frac{sec}{m^3}\right) * () * \sum \left(\mu Ci * \frac{mrem}{\mu Ci}\right)$$

Substituting specific values associated with the maximum off-site receptor location and elevated release condition yields:

$$D_{co} = (1.12E\text{-}05)/(7.55E\text{-}07) * t^{-0.297} * \sum_i (Q_i * DFG_{ico})$$

which reduces to:

$$D_{co} = 14.8 * t^{-0.297} * \sum_i (Q_i * DFG_{ico}) \qquad (3\text{-}8a)$$

For the maximum off-site receptor location and ground-level release conditions, the equation is:

$$D_{co} = (1.71E\text{-}04)/(9.64E\text{-}06) * t^{-0.316} * \sum_i (Q_i * DFG_{ico})$$

which reduces to:

$$D_{co} = 17.7 * t^{-0.316} * \sum_i (Q_i * DFG_{ico}) \qquad (3\text{-}8b)$$

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:

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

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. There are two special receptor locations on-site. 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 on-site 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 five 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.

For the Education Center, and the "Rocks", the OFs are:

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

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:

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

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

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.

---

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

7.2.7.2 Skin Dose Rate From Noble Gases

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

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

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)

= 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:

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

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

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).

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

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:

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

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

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 previously.

EL(R) = Defined previously.

DFG'_{icoE} and DFG'_{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 <u>Gamma Dose to Air From Noble Gases</u>

Method I was derived from Equation (3-6):

$$D^{\gamma}_{air} = 3.17E\text{-}02 * [X/Q]^{\gamma} * t^{-a} * \sum_i (\dot{Q}_i * DF^{\gamma}_i) \qquad (3\text{-}6)$$

where all terms of the equation are as defined previously.

Incorporating the specific OF and the atmospheric dispersion factor, the gamma air dose equation for the Education Center for elevated releases:

$$D^{\gamma}_{air} = 3.17E\text{-}02 * 1.1E\text{-}05\ t^{-0.252} * 0.0014 * \sum_i (Q_i * DF^{\gamma}_i)$$

which reduces to:

$$D^{\gamma}_{air} = 4.9E\text{-}10 * t^{-0.252} * \sum_i (Q_i * DF^{\gamma}_i) \qquad (3\text{-}6c)$$

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

For ground-level releases, the gamma air dose equation for the Education Center becomes:

$$D^{\gamma}_{air} = 3.17E\text{-}02 * 1.0E\text{-}04\ t^{-0.321} * 0.0014 * \sum_i (Q_i * DF^{\gamma}_i)$$

which reduces to:

$$D^{\gamma}_{air} = 4.4E\text{-}09 * t^{-0.321} * \sum_i (Q_i * DF^{\gamma}_i) \qquad (3\text{-}6d)$$

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

Incorporating the specific OF and atmospheric dispersion factors for the "Rocks" yields the gamma air dose equation for elevated releases:

$$D^{\gamma}_{air} = 3.17E\text{-}02 * 2.1E\text{-}05 * t^{-0.155} * 0.0076 * \sum_i (Q_i * DF^{\gamma}_i)$$

which reduces to:

$$D^{\gamma}_{air} = 5.1E\text{-}09 * t^{-0.155} * \sum_i (Q_i * DF^{\gamma}_i) \quad (3\text{-}6e)$$

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

For ground-level releases, the gamma air dose equation for the "Rocks" becomes:

$$D^{\gamma}_{air} = 3.17E\text{-}02 * 1.7E\text{-}04\ t^{-0.204} * 0.0076 * \sum_i (Q_i * DF^{\gamma}_i)$$

which reduces to:

$$D^{\gamma}_{air} = 4.1E\text{-}08 * t^{-0.204} * \sum_i (Q_i * DF^{\gamma}_i) \quad (3\text{-}6f)$$

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

7.2.7.5 Beta Dose to Air From Noble Gases

Method I was derived as described in Section 7.2.5. The general form of the dose equation is:

$$D^{\beta}_{air} = 3.17E\text{-}02 * X/Q * t^{-a} * \sum_i (Q_i * DF^{\beta}_i) \quad (3\text{-}7)$$

where all terms in the equation are as defined in Section 7.2.5.

Incorporating the specific OF and atmospheric dispersion factor for elevated releases into Equation 3-7 yields the following beta dose equation for the Education Center:

$$D^{\beta}_{air} = 3.17E\text{-}02 * 4.0E\text{-}05 * t^{-0.35} * 0.0014 * \sum_i (Q_i * DF^{\beta}_i)$$

which reduces to:

$$D^{\beta}_{air} = 1.8E\text{-}09 \cdot t^{-0.35} \cdot \sum_i (Q_i \cdot DF^{\beta}_i) \qquad (3\text{-}7c)$$

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

For ground-level releases, the beta air dose equation for the Education Center becomes:

$$D^{\beta}_{air} = 3.17E\text{-}02 \cdot 5.5E\text{-}04 \cdot t^{-0.347} \cdot 0.0014 \cdot \sum_i (Q_i \cdot DF^{\beta}_i)$$

which reduces to:

$$D^{\beta}_{air} = 2.4E\text{-}08 \cdot t^{-0.347} \cdot \sum_i (Q_i \cdot DF^{\beta}_i) \qquad (3\text{-}7d)$$

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

Incorporating the specific OF and atmospheric dispersion factors for the "Rocks" yields the beta air dose equation for elevated releases:

$$D^{\beta}_{air} = 3.17E\text{-}02 \cdot 1.6E\text{-}04 \cdot t^{-0.249} \cdot 0.0076 \cdot \sum_i (Q_i \cdot DF^{\beta}_i)$$

which reduces to:

$$D^{\beta}_{air} = 3.9E\text{-}08 \cdot t^{-0.249} \cdot \sum_i (Q_i \cdot DF^{\beta}_i) \qquad (3\text{-}7e)$$

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

For ground-level releases, the beta air dose equation for the "Rocks" becomes:

$$D^{\beta}_{air} = 3.17E\text{-}02 \cdot 1.9E\text{-}03 \cdot t^{-0.267} \cdot 0.0076 \cdot \sum_i (Q_i \cdot DF^{\beta}_i)$$

which reduces to:

$$D^{\beta}_{air} = 4.6E\text{-}07 * t^{-0.267} * \sum_i (Q_i * DF^{\beta}_i) \quad (3\text{-}7f)$$

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

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

Method I was derived as described in Section 7.2.3. The Critical Organ Dose equations for receptors at the Education Center and the "Rocks" were derived from Equation 3-8. The following general equation incorporates (i) a ratio of the average 1-hour depleted atmospheric dispersion factor to the average annual depleted atmospheric dispersion factor, (ii) the unitless t^{-a} term, and (iii) the OF:

$$D_{co} = (X/Q)_{1\text{-}hr}/(X/Q)_{an} * t^{-a} * OF * \sum_i (Q_i * DFG_{ico})$$

$$(mrem) = \left(\frac{sec}{m^3}\right) / \left(\frac{sec}{m^3}\right) * (\ ) * (\ ) * \Sigma \left(\mu Ci * \frac{mrem}{\mu Ci}\right)$$

Applying the Education Center-specific factors for elevated release conditions produces the equation:

$$D_{co} = (3.72E\text{-}05)/(1.56E\text{-}06) * t^{-0.349} * 0.0014 * \sum_i (Q_i * DFG_{ico})$$

which reduces to:

$$D_{co} = 3.3E\text{-}02 * t^{-0.349} * \sum_i (Q_i * DFG_{ico}) \quad (3\text{-}8c)$$

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

For a ground-level release, the equation for a receptor at the Education Center is:

$$D_{co} = (5.21E\text{-}04)/(2.23E\text{-}05) \cdot t^{-0.347} \cdot 0.0014 \cdot \sum_i (Q_i \cdot DFG_{ico})$$

which reduces to:

$$D_{co} = 3.3E\text{-}02 \cdot t^{-0.347} \cdot \sum_i (Q_i \cdot DFG_{ico}) \qquad (3\text{-}8d)$$

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

The specific Critical Organ Dose equation for a receptor at the "Rocks" under elevated release conditions is:

$$D_{co} = (1.54E\text{-}04)/(1.61E\text{-}05) \cdot t^{-0.248} \cdot 0.0076 \cdot \sum_i (Q_i \cdot DFG_{ico})$$

which reduces to:

$$D_{co} = 7.3E\text{-}02 \cdot t^{-0.248} \cdot \sum_i (Q_i \cdot DFG_{ico}) \qquad (3\text{-}8e)$$

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

For a ground-level release, the equation for a receptor at the "Rocks" is:

$$D_{co} = (1.80E\text{-}03)/(1.59E\text{-}04) \cdot t^{-0.267} \cdot 0.0076 \cdot \sum_i (Q_i \cdot DFG_{ico})$$

which reduces to:

$$D_{co} = 8.6E\text{-}02 \cdot t^{-0.267} \cdot \sum_i (Q_i \cdot DFG_{ico}) \qquad (3\text{-}8f)$$

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

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	[illegible]	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

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).

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 (1/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 (1/yr)	Meat (kg/yr)	Inhalation (m^3/yr)
Adult	0.00	0.00	0.00	8000.00	8000.00
Teen	0.00	0.00	0.00	8000.00	8000.00
Child	0.00	0.00	0.00	3700.00	3700.00
Infant	0.00	0.00	0.00	14[illegible]0	1400.00

* Regulatory Guide 1.109

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 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 individual from existing and potential gaseous pathways for the Method I analysis.

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.

7.3.2 Seabrook Station Atmospheric Dispersion Model

The time average atmospheric dispersion factors for use in both Method I and Method II are computed for routine 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 Average Atmospheric Dispersion Factors for Receptors

The calculation of Method I and Method II atmospheric diffusion factors (undepleted CHI/Q, depleted CHI/Q, D/Q, and gamma CHI/Q values) utilize 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 Rocks" (244m NE) and the Ed Center (488w SW) as measured from a recent site aerial 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.

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 $\left(\frac{sec}{m^3}\right)$	-	-	7.5E-07	-	-	7.5-07
X/Q undepleted $\left(\frac{sec}{m^3}\right)$	-	8.2E-07	-	-	8.2E-07	-
D/Q $\left(\frac{1}{m^2}\right)$	-	-	1.5E-08**	-	-	1.5E-08
X/Q^{γ} $\left(\frac{sec}{m^3}\right)$	8.5E-07	8.5E-07	-	8.5E-07	-	-

* 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 $\left(\frac{sec}{m^3}\right)$	-	-	1.5E-06	-	-	1.5E-06
X/Q undepleted $\left(\frac{sec}{m^3}\right)$	-	1.6E-06	-	-	1.6E-06	-
D/Q $\left(\frac{1}{m^2}\right)$	-	-	2.7E-08	-	-	-
X/Q^{γ} $\left(\frac{sec}{m^3}\right)$	1.1E-06	1.1E-06	-	1.1E-06	-	-
The "Rocks": (ENE - 244 meters)						
X/Q depleted $\left(\frac{sec}{m^3}\right)$	-	-	1.6E-05	-	-	1.6E-05
X/Q undepleted $\left(\frac{sec}{m^3}\right)$	-	1.7E-05	-	-	1.7E-05	-
D/Q $\left(\frac{1}{m^2}\right)$	-	-	1.1E-07	-	-	-
X/Q^{γ} $\left(\frac{sec}{m^3}\right)$	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[a]		
	The Rocks	Ed Center	Site Boundary
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.

8.0 BASES FOR LIQUID AND GASEOUS MONITOR SETPOINTS

8.1 Basis for the Liquid Waste Test Tank Monitor Setpoint

The liquid waste test tank monitor setpoint must ensure that Specification 3.3.3.9 is not exceeded for the appropriate in-plant pathways. The liquid waste test tank monitor is placed upstream of the major source of dilution flow.

The derivation of Equation 5-1 begins with the general equation for the response of a radiation monitor:

$$R = \sum_i C_{mi} \quad S_{1i} \qquad (8\text{-}1)$$

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

where:

R = Response of the monitor (cps)

S_{1i} = Detector counting efficiency for radionuclide "i" (cps/(μCi/ml))

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

The detector calibration procedure for the liquid waste test tank monitor at Seabrook Station establishes a counting efficiency by use of a known calibration source standard and a linearity response check. Therefore, in Equation 8-1 one may substitute S_1 for S_{1i}, where S_1 is the detector counting efficiency determined from the calibration procedure. Therefore, Equation 8-1 becomes:

$$R = S_1 \quad \sum_i C_{mi} \qquad (8\text{-}2)$$

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

The MPC for a given radionuclide must not be exceeded at the point of discharge. When a mixture of radionuclides is present, 10CFR20 specifies that the concentration at the point of discharge shall be limited as follows:

$$\sum_i \frac{C_{di}}{MPC_i} \leq 1 \qquad (8\text{-}3)$$

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

where:

C_{di} = Activity concentration of radionuclide "i" in the mixture at the point of discharge (μCi/ml)

MPC_i = MPC for radionuclide "i" from 10CFR20, Appendix B, Table II, Column 2 (μCi/ml)

The activity concentration of radionuclide "i" at the point of discharge is related to the activity concentration of radionuclide "i" at the monitor as follows:

$$C_{di} = C_{mi} \frac{F_m}{F_d} \qquad (8\text{-}4)$$

$$\left(\frac{\mu Ci}{ml}\right) = \left(\frac{\mu Ci}{ml}\right)\left(\frac{gpm}{gpm}\right)$$

where:

C_{di} = Activity concentration of radionuclide "i" in the mixture at the point of discharge (μCi/ml)

F_m = Flow rate past monitor (gpm)

F_d = Flow rate out of discharge tunnel (gpm)

Substituting the right half of Equation 8-4 for C_{di} in Equation 8-3 and solving for F_d/F_m yields the minimum dilution factor needed to comply with Equation 8-3:

$$DF_{min} \leq \frac{F_d}{F_m} \geq \sum_i \frac{C_{mi}}{MPC_i} \qquad (8\text{-}5)$$

$$(\frac{gpm}{gpm}) \qquad (\frac{\mu Ci\text{-}ml}{ml\text{-}\mu Ci})$$

where:

F_d = Flow rate out of discharge tunnel (gpm)

F_m = Flow rate past monitor (gpm)

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

MPC_i = MPC for radionuclide "i" from 10CFR20, Appendix B, Table II, Column 2 (μCi/ml)

If F_d/F_m is less than DF_{min}, then the tank may not be discharged until either F_d or F_m or both are adjusted such that:

$$\frac{F_d}{F_m} \geq DF_{min} \qquad (8\text{-}5)$$

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

Usually F_d/F_m is greater than DF_{min} (i.e., there is more dilution than necessary to comply with Equation 8-3). The response of the liquid waste test tank monitor at the setpoint is therefore:

$$R_{setpoint} = f_1 \frac{DF}{DF_{min}} S_1 \sum_i C_{mi} \qquad (8\text{-}6)$$

$$\frac{\mu Ci}{ml} = (\ )\ (\ )\ (\frac{cps\text{-}ml}{\mu Ci})\ (\frac{\mu Ci}{ml})$$

where f_1 is equal to the fraction of the total contribution of MPC at the discharge point to the environment to be associated with the test tank effluent pathway, such that the total sum of the fractions for the four liquid discharge pathways is equal to or less than one ($f_1 + f_2 + f_3 + f_4 \leq 1$).

The monitoring system is designed to incorporate the detector efficiency, S_1, into its software. This results in an automatic readout in µCi/cc or µCi/ml for the monitor response. Since this procedure for converting cps to µCi/ml is inherently done by the system software, the monitor response setpoint can be calculated in terms of the total waste test tank activity concentration in µCi/ml determined by the laboratory analysis. Therefore, the setpoint calculation for the liquid waste test tank is:

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

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

8.2 Basis for the Plant Vent Wide Range Gas Monitor Setpoints

The setpoints of the plant vent wide range gas monitors must ensure that Technical Specification 3.11.2.1.a is not exceeded. Sections 3.4 and 3.5 show that Equations 3-3 and 3-4 are acceptable methods for determining compliance with that Technical Specification. Which equation (i.e., dose to total body or skin) is more limiting depends on the noble gas mixture. Therefore, each equation must be considered separately. The derivations of Equations 5-5 and 5-6 begin with the general equation for the response R of a radiation monitor:

$$R = \sum_i S_{gi} \quad C_{mi} \qquad (8\text{-}7)$$

$$(cpm) = \left(\frac{cpm\text{-}cm^3}{\mu Ci}\right) \left(\frac{\mu Ci}{cm^3}\right)$$

where:

R = Response of the instrument (cpm)

S_{gi} = Detector counting efficiency for noble gas "i" (cpm/(μCi/cm^3))

C_{mi} = Activity concentration of noble gas "i" in the mixture at the noble gas activity monitor (μCi/cm^3)

C_{mi}, the activity concentration of noble gas "i" at the noble gas activity monitor, may be expressed in terms of $\dot{Q}_i$ by dividing by F, the appropriate flow rate. In the case of the plant vent noble gas activity monitors the appropriate flow rate is the plant vent flow rate.

$$C_{mi} = \dot{Q}_i \quad \frac{1}{F} \tag{8-8}$$

$$\left(\frac{\mu Ci}{cm^3}\right) = \left(\frac{\mu Ci}{sec}\right) \left(\frac{sec}{cm^3}\right)$$

where:

$\dot{Q}_i$ = The release rate of noble gas "i" in the mixture, for each noble gas listed in Table B.1-10.

F = Appropriate flow rate (cm^3/sec)

Substituting the right half of Equation 8-8 into Equation 8-7 for C_{mi} yields:

$$R = \sum_i \quad S_{gi} \quad \dot{Q}_i \quad \frac{1}{F} \tag{8-9}$$

$$(cpm) \qquad \left(\frac{cpm\text{-}cm^3}{\mu Ci}\right) \left(\frac{\mu Ci}{sec}\right) \left(\frac{sec}{cm^3}\right)$$

As in the case before, for the liquid waste test tank monitor, the plant vent wide range gas monitor establishes the detector counting efficiency by use of a calibration source. Therefore, S_g can be substituted for S_{gi}

in Equation 8-9, where S_g is the detector counting efficiency determined from the calibration procedure. Therefore, Equation 8-9 becomes:

$$R = S_g \frac{1}{F} \sum_i \dot{Q}_i \qquad (8\text{-}10)$$

$$(\text{cpm}) = (\frac{\text{cpm-cm}^3}{\mu\text{Ci}}) (\frac{\text{sec}}{\text{cm}^3}) (\frac{\mu\text{Ci}}{\text{sec}})$$

The total body dose rate due to noble gases is determined with Equation 3-3:

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

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

where:

$\dot{D}_{tb}$ = total body dose rate (mrem/yr)

0.85 = (1.0E+06) x (8.5E-07) (pCi-sec/μCi-m^3)

1E+06 = number of pCi per μCi (pCi/μCi)

8.5E-07 = $[X/Q]^{\gamma}$, maximum off-site average gamma atmospheric dispersion factor (sec/m^3) for primary vent stack releases

EL(R) = Release point correction factor = 1.0 for primary vent stack

$\dot{Q}_i$ = As defined above.

DFB_i = total body dose factor (see Table B.1-10) (mrem-m^3/pCi-yr)

A composite total body gamma dose factor, DFB_c, may be defined such that:

$$DFB_c \sum_i \dot{Q}_i = \sum_i \dot{Q}_i \quad DFB_i \tag{8-11}$$

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

Solving Equation 8-11 for DFB_c yields:

$$DFB_c = \frac{\sum_i \dot{Q}_i \; DFB_i}{\sum_i \dot{Q}_i} \tag{5-7}$$

Technical Specification 3.11.2.1.a limits the dose rate to the total body from noble gases at any location at or beyond the site boundary to 500 mrem/yr. By setting $\dot{D}_{tb}$ equal to 500 mrem/yr and substituting DFB_c for DFB_i in Equation 3-3, one may solve for $\sum_i \dot{Q}_i$ at the limiting whole body noble gas dose rate:

$$\sum_i \dot{Q}_i = 588 \quad \frac{1}{DFB_c} \tag{8-12}$$

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

Substituting this result for $\sum_i \dot{Q}_i$ in Equation 8-10 yields R_{tb}, the response of the monitor at the limiting noble gas total body dose rate:

$$R_{tb} = 588 \quad S_g \quad \frac{1}{F} \quad \frac{1}{DFB_c} \tag{8-13}$$

$$(cpm) = (\frac{mrem\text{-}\mu Ci\text{-}m^3}{yr\text{-}pCi\text{-}sec}) \; (\frac{cpm\text{-}cm^3}{\mu Ci}) \; (\frac{sec}{cm^3}) \; (\frac{pCi\text{-}yr}{mrem\text{-}m^3})$$

The skin dose rate due to noble gases is determined with Equation 3-4:

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

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

where:

$EL(R)$ = 1.0 for primary vent stack release (dimensionless)

$\dot{D}_{skin}$ = Skin dose rate (mrem/yr)

$\dot{Q}_i$ = As defined above.

DF'_i = Combined skin dose factor (see Table B.1-10) (mrem-sec/µCi-yr)

A composite combined skin dose factor, DF'_c, may be defined such that:

$$DF'_c \sum_i \dot{Q}_i = \sum_i \dot{Q}_i \; DF'_i \qquad (8\text{-}14)$$

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

Solving Equation 8-14 for DF'_c yields:

$$DF'_c = \frac{\sum_i \dot{Q}_i \; DF'_i}{\sum_i \dot{Q}_i} \qquad (5\text{-}8)$$

Technical Specification 3.11.2.1.a limits the dose rate to the skin from noble gases at any location at or beyond the site boundary to 3,000 mrem/yr. By setting $\dot{D}_{skin}$ equal to 3,000 mrem/yr and substituting DF'_c for DF'_i in Equation 3-4 one may solve for $\sum_i \dot{Q}_i$ at the limiting skin noble gas dose rate:

$$\sum_i \dot{Q}_i = 3{,}000 \quad \frac{1}{DF'_c} \qquad (8\text{-}15)$$

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

Substituting this result for $\sum_i \dot{Q}_i$ in Equation 8-10 yields R_{skin}, the response of the monitor at the limiting noble gas skin dose rate:

$$R_{skin} = 3{,}000 \quad S_g \quad \frac{1}{F} \quad \frac{1}{DF'_c} \qquad (8\text{-}16)$$

$$(cpm) \quad (\frac{mrem}{yr}) \quad (\frac{cpm\text{-}cm^3}{\mu Ci}) \quad (\frac{sec}{cm^3}) \quad (\frac{\mu Ci\text{-}yr}{mrem\text{-}sec})$$

As with the liquid monitoring system, the gaseous monitoring system is also designed to incorporate the detector efficiency, S_g, into its software. The monitor also converts the response output to a release rate (μCi/sec) by using a real time stack flow rate measurement input. Therefore, multiplying by the stack flow rate measurement (F), the Equations 8-15 and 8-16 become:

$$R_{tb} = 588 \quad \frac{1}{DFB_c} \qquad (5\text{-}5)$$

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

$$R_{skin} = 3000 \quad \frac{1}{DF'_c} \qquad (5\text{-}6)$$

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

8.3 Basis for PCCW Head Tank Rate-of-Change Alarm Setpoint

The PCCW head tank rate-of-change alarm 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 based on detection of an activity level of 10^{-8}μCi/cc in the discharge of the Service Water System has been selected. This activity level was chosen because it is the minimum detectable level of a service water monitor if such a monitor were installed. The use of rate-of-change alarm with information obtained from the liquid sampling and analysis commitments described in Table A.3-1 of Part A ensure that potential releases from the

Service Water System are known. Sampling and analysis requirements for the Service Water System extend over various operating ranges with increased sampling and analysis at times when leakage from the PCCW to the service water is occurring and/or the activity level in the PCCW is high.

REFERENCES

A. Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I", U.S. Nuclear Regulatory Commission, Revision 1, October 1977.

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C. Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases From Light-Water Cooled Reactors", U.S. Nuclear Regulatory Commission, March 1976.

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APPENDIX A

DOSE CONVERSION FACTORS

APPENDIX A
Dose Conversion Factors

I. Liquid Pathways - Seabrook Site Specific DCF's

The models used to assess doses resulting from effluents into liquids is derived from Appendix A of Reg. Guide 1.109. Since Seabrook is a salt water site, the assumed pathways of exposure taken from Reg Guide 1.109 are Aquatic foods - fish; Aquatic foods -invertebrates; and dose from shoreline deposits (direct dose). No drinking water or irrigation pathways exist because of the salt water environment. In addition, exposures resulting from boating and swimming activities have been included for key radionuclides even though Reg. Guide 1.109 identifies these pathways as not contributing any significant contribution to the total dose, and therefore does not provide dose equations for them. For completeness, the swimming and boating pathways have been includes using the dose models from the HERMES code (HEDL-TME-71-168, Dec. 1971), section G, Water Immersion.

The Method I dose conversion factors are derived by calculating the dose impact to individuals via the site specific pathways for a unit activity release (1 curie per nuclide). For each pathway, doses by radionuclide are calculated for each of the 7 organs (including whole body) for each of the four age groups (adult, teen, child, and infant). The Method I dose factor for each nuclide is then selected by taking the highest factor for any organ in any of the age groups for all the exposure pathways combined. The list of dose factors in the ODCM then represents a combination of different limiting organs and age groups which, when used to calculate a dose impact from a mix of radionuclides released in liquid effluents, gives a conservative dose since it combines the exposure to different organs and age groups as if there was a single critical organ-age group.

As an example of how the liquid dose conversion factors are developed, the following calculation for Co-60 is shown. The critical organ/age group is selected based on the full assessment of all organs and age groups.

Factor for fish Ingestion:

The general equation for ingestion doses in RG 1.109 is eq. A-3.

$$1119.7 \cdot \frac{U_{ap} \cdot M_p}{F} \cdot \sum_i Q_i \cdot B_{ip} \cdot D_{aipj} \cdot e^{-\lambda \cdot t_p}$$

The full assessment for the ODCM dose factors indicated that for i = Co-60, the maximum dose (mrem/yr) is to the GI-LLI of an adult as the target organ and age group, therefore:

$U_{ap} := 21$ kg/yr adult usage factor for fish

$M_p := 0.1$ mixing ratio for near field dilution provided by submerged multiport diffuser.

$F := 918$ cu. ft./sec effluent flow rate for circulating water system

$Q_i := 1.0$ curies/year relased of C0-60 assumed

$B_{ip} := 100$ equilibrium bioaccumulation factor for C0-60 in salt water fish, in liters/kg

$D_{aipj} := 4.02 \cdot 10^{-5}$ mrem/pCi, adult GI-LLI ingestion dose factor from RG-1.109, table E-11.

$\lambda := 1.501 \cdot 10^{-5}$ decay constant for C0-60 in 1/hrs.

$t_p := 24$ time between release and ingestion, in hrs.

1119.7 is the factor to convert from Ci/yr per ft3/sec to pCi/liter. note that RG 1.109 uses 1100 as a rounded approximation.

Therefore the dose from fish to adult GI-LLI is (mrem/yr):

$$1119.7 \cdot \frac{U_{ap} \cdot M_p}{F} \cdot Q_i \cdot B_{ip} \cdot D_{aipj} \cdot e^{-\lambda \cdot t_p} = 0.0103$$

Factor for invertabrate ingestion:

Next, the dose from invertebrates to the adult GI-LLI is given by the same general equation but with the following variables changed:

$U_{ap} := 5$ kg/yr usage factor

$B_{ip} := 1000$ l/kg bioaccumulation factor

all other variables the same as above

therefore the dose from invertebrates is (mrem/yr):

$$1119.7 \cdot \frac{U_{ap} \cdot M_p}{F} \cdot Q_i \cdot B_{ip} \cdot D_{aipj} \cdot e^{-\lambda \cdot t_p} = 0.0245$$

Factor for shoreline direct dose:

The general equation for direct dose from shoreline deposits is taken from equation A-7 in RG-1.109 as (mrem/yr):

$$111970 \cdot \frac{U_{ap} \cdot M_p \cdot W}{F} \cdot \sum_i Q_i \cdot T \cdot D_{aipj} \cdot e^{-\lambda \cdot t_p} \cdot \left[1 - e^{-\lambda \cdot t_b}\right]$$

It is assumed that all internal organ doses also receive exposure from direct external sources, therefore each organ dose due to ingestion must have and external component added. For the above equation, the site specific variables for an adult exposure to a 1 curie per year release of CO-60 are:

$U_{ap} := 334$ hrs/year usage factor used for assumed shoreline activities at Seabrook.

$M_p := .1$ mixing ratio for near field dilution provided by the submerged multiport diffuser and assume to be extended to the beach continuously.

$W := 0.5$ shorewidth factor for ocean sites. dimensionless

$T := 1.923 \cdot 10^{3}$	radioactive half life in days for C0-60
$D_{aipj} := 1.70 \cdot 10^{-8}$	dose factor for C0-60 due to deposits in sediments, units of (mrem/hr)/(pCi/m2)
$t_p := 0.$	transit time to point of exposure, hrs
$t_b := 131400$	period that sediment is assumed to be exposed to water contamination for long term buildup, set at 15 years for Method I DCF's
$Q_i := 1.0$	curies per year, Co-60 assumed
111970	conversion factor to convert (Ci/yr)/(ft3/sec) to pCi/liter and account for the proportionality constant used in sediment model

Therefore the dose to the whole body and each organ due to direct exposure to the shoreline (mrem/yr) is:

$$111970 \cdot \frac{U_{ap} \cdot M_p \cdot W}{F} \cdot Q_i \cdot T \cdot D_{aipj} \cdot e^{-\lambda \cdot t_p} \cdot \left[1 - e^{-\lambda \cdot t_b}\right] = 0.0573$$

Direct dose due to Swimming:

The dose due to immersion in water (swimming) is taken from the HERMES computer code. The original ODCM calculation was based on some preliminary dilution assumptions which gave a near field prompt dilution factor for the multiport diffuser of 8. For single unit operation with both service water and circulating water flow (412,000 gpm), a value on 10 is more realistic. This surface area of the plume is restricted to a small area over the diffuser and does not touch the shoreline approx. 1 mile away. Since the over all impact from swimming is small when compared to the other exposure pathways, the original conservatism on dilution are kept here.

The dose from swimming is given by the following equation:

$$1.0 \cdot 10^{12} \cdot \frac{U_p}{F_a} \cdot \sum_i Q_i \cdot DF_{im} \qquad \text{(mrem/yr)}$$

Where:

$U_p := 45$	hrs/yr, usage factor for swimming for maximum age group (teen) from HERMES.
$F_a := 6.56 \cdot 10^{11}$	liters/yr, estimated annual dilution effluent flow in multiport diffuser
$Q_i := 1.0$	Curies/yr, assumed release rate of nuclide i.
$DF_{im} := 4.6 \cdot 10^{-6}$	mrem-liters per hrs-pCi, dose factor for Co-60 for water immersion taken from HERMES.
$1.0 \cdot 10^{12}$	constant for pCi/Ci

Therefore the swimming dose for a 1 curie release of Co-60 is (mrem/yr):

$$1.0 \cdot 10^{12} \cdot U_p \cdot \frac{M_p}{F_a} \cdot Q_i \cdot DF_{im} = 3.155 \cdot 10^{-5}$$

As can be seen, the contribution of the swimming dose is only about one 30000ths of the total of the RG 1.109 pathways, and can be ignored in the case of Co-60. Similarly, the boating dose as given in HERMES is taken as half of the swimming dose, and corrected for change in usage assumptions). The resulting dose is found to be less than the swimming dose and can also therefore be discounted in this case.

Total liquid Pathway dose:

The sum of the above liquid pathway doses can now be added to give the total maximum individual dose to the critical organ (adult-GI-LLI) for Co-60. This gives:

$$0.0103 + 0.0245 + 0.0573 = 0.0921 \quad \text{mrem/yr}$$

Since the internal doses given by the RG-1.109 methods actually are 50 yr dose commitments resulting from one year exposure to the quantity of activity assumed to be released into the water, and the direct dose represents the dose received for the period assumed to be exposed to the pathway, and the activity release was taken as a unit quantity (i.e. Q= 1 Ci), the above total liquid pathway dose can be stated as site specific committed dose factor in mrem/Ci released. For Method I in the ODCM, the critical organ dose factor is seen to be 0.0921 mrem/Ci, as shown above. The value reported on Table B.1-11 (9.22 E-08 mrem/uCi) was generated by a computational routine which gives rise to the round-off difference between it and the above example. The whole body site specific dose factor for the ODCM was calculated in the same way treating the whole body as a separate organ.

II. Gaseous Pathways - Seabrook Site Specific DCF's

The models used to assess doses resulting from gaseous effluents in the form of iodines, tritium, and particulates are derived from Appendix C of Reg. Guide 1.109. For Seabrook, it is assumed that at the off site location which exhibits minimum atmospheric dilution for plant releases the following exposure pathways exist: inhalation, ground plane, ingestion of goats milk, meat, stored vegetables, and leafy vegetables.

The Method I dose and dose rate factors are derived by calculating the dose impact to all age group individuals via the site specific pathways for a unit activity release (1 curie per nuclide). For each pathway, doses by nuclide are calculated for each of 7 organs (including the whole body) for each of the 4 age groups. The Method I dose factor for each nuclide is then selected by taking the highest factor for any organ in any of the age groups for all exposure pathways combined. The list of dose factors in the ODCM then represents a combination of different limiting organs and age groups which, when used to calculate the dose impact from a mix of radionuclides released into the atmosphere, gives a conservative dose since it combines the exposure to different organs and age groups as if they were for all the same critical organ-age group.

As an example of how the gaseous particulate dose factors are developed, the following calculation for Mn-54 is shown. The critical organ/age group for Mn-54 was selected gased on a full assessment of all organ and age group combinations. For elevated releases from the plant vent stack to the maximum site boundary (max. dose point due to meteorology), the critical organ and age group for Mn-54 was determined to be the GI-LLI for the adult.

PART A: Inhalation Dose Contibution:

The general equations for inhalation doses in RG 1.109 are eq. C-3, and C-4 which together give:

$$3.17\cdot 10^{4}\cdot R_{a}\cdot\left[\frac{X}{Q}\right]\cdot\sum_{i} Q_{i}\cdot DFA_{ija} = D_{ja}$$

Where for the case of Mn-54 releases, the variables above are defined as:

$3.17\cdot 10^{4}$ is the number of pCi/Ci divided by the number of second per year

$R_a := 8000$ the breathing rate for age group a (adults) in m^3 /yr.

$\frac{X}{Q} = 7.5 \cdot 10^{-7}$ the long term average depleted atmospheric dispersion factor, in sec/m^3, at the maximum exposure point off site (S.B.)

$Q_i := 1$ the release rate of nuclide i to the atmosphere in Ci/yr

$DFA_{ija} := 9.67 \cdot 10^{-6}$ the inhalation dose factor for nuclide i (Mn-54), organ j (GI-LLI), and age group a (adult) taken from RG 1.109, table E-7, in mrem/pCi inhaled.

Therefore, the inhalation dose to the maximum potential off site individual is given as:

$$3.17 \cdot 10^{4} \cdot R_a \cdot \left[\frac{X}{Q}\right] \cdot Q_i \cdot DFA_{ija} = 0.00184 \quad \text{mrem/yr per Ci}$$

PART B: Ground Plane Direct Dose Contribution:

The general equations for ground plane external direct dose in RG 1.109 are equations C-1 and C-2 which together give the dose DG as:

$$8760 \cdot 1.0 \cdot 10^{12} \cdot S_F \cdot \left[\frac{D}{Q}\right] \cdot \sum_i Q_i \cdot \frac{1 - e^{-\lambda_i \cdot t_b}}{\lambda_i} \cdot DFG_{ij}$$

Where for the case of Mn-54 releases, the variables in the above equation are defined as:

$1.0 \cdot 10^{12}$ is the number of pCi per Ci

$S_F := 0.7$ the shielding factor provided by residential structures (dimensionless) for use in calculation accumulated doses over time. Note that for determination of dose rate factors (i.e. instantaneous dose rates) the shielding factor is set equal to 1.0, or in affect no credit for dose reduction is taken for determination of dose rates at points in time.

$\frac{D}{Q} = 1.5 \cdot 10^{-8}$ the long term average relative deposition factor at the maximum site boundary location, in 1/m^2

$\lambda_i := 0.8105$ is the radiological decay constant for Mn-54 (nuclide i in this case) in 1/yr.

$t_b := 15$ is the time in years over which accumulation is evaluated (approx. midpoint of plant operating life)

$DFG_{ij} := 5.80 \cdot 10^{-9}$ external dose factor to the whole body, or any internal organ j, for standing on contaminated ground from Mn-54 (RG 1.109 Table E-6) in mrem/hr per pCi/m^2

$Q_i := 1.0$ is the unit release quantity assumed for each nuclide i, in Ci/yr.

8760 is the number of hours in a year

Therefore, the contribution to the total dose made by exposure to the ground plane at the maximum off site exposure location for Mn-54 is given as:

$$8760 \cdot 1.0 \cdot 10^{12} \cdot S_F \cdot \left[\frac{D}{Q}\right] \cdot Q_i \cdot \frac{1 - e^{-\lambda_i \cdot t_b}}{\lambda_i} \cdot DFG_{ij} = 0.658$$

mrem per yr per Ci

PART C: Ingestion Dose Contribution:

As an initial step to determining the dose contribution from ingestion of milk, meat, stored vegetables, and leafy vegetables, we must first calculate the radionuclide concentration in forage, produce, and leafy vegetables resulting from atmospheric tranfers of the activity to the surface of the vegetation and onto the soil for root uptake. For all radioiodines and particulate nuclides (except tritium and C-14), the concentration of nuclide i in and on the vegetation at a point of interest can be calculated using R.G. 1.109 equations C-5 and C-6, which combined gives:

$$1.14\cdot 10^{8}\cdot\left[\frac{D}{Q}\right]\cdot Q_{i}\cdot\left[r\cdot\frac{1-e^{-\lambda_{Ei}\cdot t_{e}}}{Y_{v}\cdot\lambda_{Ei}}+B_{iv}\cdot\frac{1-e^{-\lambda_{i}\cdot t_{b}}}{P\cdot\lambda_{i}}\right]\cdot e^{-\lambda_{i}\cdot t_{h}}$$

PART C.1: Concentration in Produce (stored vegetables)

For the case of Mn-54 released in air emissions to the maximum site boundary, the concentration of Mn in produce grown in the hypothetical garden at that location can be calculated from the above equation where the variables are defined as:

$1.14\cdot 10^{8}$	is the number of pCi per Ci divided by the number of hours in a year (8760).
$\frac{D}{Q} = 1.5\cdot 10^{-8}$	is the relative deposition factor, in 1/m2, at the maximum exposure point off site (S. B.)
$Q_{i} := 1$	the release rate of nuclide i to the atmosphere in Ci/yr
$r := 0.2$	fraction of deposited activity retained on crops, leafy vegetables, or pasture grass (1.0 for iodines)

$\lambda_{Ei} := 0.00219$ effective removal rate constant for Mn-54 from crops due to decay and weathering, in hr-1

$t_b := 131400.$ soil exposure time to deposition, in (equal to 15 yrs, or mid plant life)

$Y_v := 2.0$ agricultural productivity (yeild) for produce, in kg/m-2

$B_{iv} := 2.9 \cdot 10^{-2}$ concentration factor for uptake of Mn-54 from soil by edible parts of crops in pCi/kg (wet weight) per pCi/kg dry soil

$\lambda_i := 9.252 \cdot 10^{-5}$ radioactive decay constant for Mn-54, in hrs-1

$P := 240.$ effective surface density of soil. in kg/m2

$t_h := 1440.$ crop holdup time after harvest and before ingestion, in hrs

$t_e := 1440.$ crop exposure time to plume, in hrs

Therefore, the concentration of Mn-54 in stored vegetables produced at the location of maximum deposition for a unit activity release is given as:

$$1.14 \cdot 10^{8} \cdot \left[\frac{D}{Q}\right] \cdot Q_i \cdot \left[r \cdot \frac{1 - e^{-\lambda_{Ei} \cdot t_e}}{Y_v \cdot \lambda_{Ei}} + B_{iv} \cdot \frac{1 - e^{-\lambda_i \cdot t_b}}{P \cdot \lambda_i} \right] \cdot e^{-\lambda_i \cdot t_h} = 67.379$$

pCi/kg

PART C.2: Leafy Vegetable Concentration:

For leafy vegetables, the above equation is repeated with the value for t.h, crop holdup time after harvest is changed from 1440 hrs to 24 hrs, i.e.:

$t_h := 24$ crop holdup time after harvest, in hrs.

Therefore the concentration of Mn-54 in leafy vegetables at the maximum deposition point due to a unit activity release is given as:

$$1.14 \cdot 10^{8} \cdot \left[\frac{D}{Q}\right] \cdot Q_i \cdot \left[r \cdot \frac{1 - e^{-\lambda_{Ei} \cdot t_e}}{Y_v \cdot \lambda_{Ei}} + B_{iv} \cdot \frac{1 - e^{-\lambda_i \cdot t_b}}{P \cdot \lambda_i} \right] \cdot e^{-\lambda_i \cdot t_h} = 76.811$$

pCi/kg

PART C.3.a: Animal Feed Concentration (pasture): C_p

Next, we can repeat the above calculation to determine the concentration of Mn-54 in pasture grass used as animal feed. This will allow for the determination of dose contribution from milk and meat.
For pasture grass, all the above variables remain the same except for :

$Y_v := 0.70$ for agricultural productivity of pasture grasses, kg/m2

$t_e := 720.$ for grass exposure time to plume, hrs

$t_h := 0.0$ for holdup time after harvest

Using these variables in the above equation gives the concentration in pasture grass as:

$$1.14 \cdot 10^{8} \cdot \left[\frac{D}{Q}\right] \cdot Q_i \cdot \left[r \cdot \frac{1 - e^{-\lambda_{Ei} \cdot t_e}}{Y_v \cdot \lambda_{Ei}} + B_{iv} \cdot \frac{1 - e^{-\lambda_i \cdot t_b}}{P \cdot \lambda_i} \right] \cdot e^{-\lambda_i \cdot t_h} = 179.227$$

pCi/kg

PART C.3.b: Animal Feed Concentration (stored feed): C_s

For stored feed that would be given to goats, or meat animals, the average concentration would be calculated by changing the following variables in the above calculation to:

$Y_v := 2.0$ agricultural productivity for stored feed

$t_e := 1440.$ feed crop exposure time to plume in hrs

$t_h := 2160.$ feed crop holdup time after harvest, hrs

Putting these values back into the above equation gives the concentration in stored animal feed (goat and meat animal) of Mn-54 for a unit activity release to the maximum exposure point.

$$1.14 \cdot 10^{8} \cdot \left[\frac{D}{Q}\right] \cdot Q_i \cdot \left[r \cdot \frac{1 - e^{-\lambda_{Ei} \cdot t_e}}{Y_v \cdot \lambda_{Ei}} + B_{iv} \cdot \frac{1 - e^{-\lambda_i \cdot t_b}}{P \cdot \lambda_i} \right] \cdot e^{-\lambda_i \cdot t_h} = 63.037$$

pCi/kg

PART C 3.c.: Concentration in Goat's Milk: C_m

The Mn-54 concentration in milk is dependent on the amount and contamination level of the feed consumed by the animal. The radionuclide concentration in milk is estimated from RG 1.109 general equation C-10 as:

$$F_m \cdot C_v \cdot Q_F \cdot e^{-\lambda_i \cdot t_f} = \text{conc. in milk, pCi/liter}$$

where the variables are defined as:

$F_m := 2.5 \cdot 10^{-4}$ average fraction of animal's daily intake of Mn-54 which appears in each liter of milk, in days/liter

$Q_F := 6.0$ amount of feed consumed by a goat per day, in kg/day (50 kg/d for meat)

$t_f := 2.0$ average transport time of activity from feed into milk and to receptor, in days.

$\lambda_i := 2.22 \cdot 10^{-3}$ decay constant of Mn-54 ,in days-1

In addition, the C.v term for the concentration of a nuclide in the animal's feed is given from RG 1.109 general equation C-11 as:

$$C_v = f_p \cdot f_s \cdot C_p + \left[1 - f_p\right] \cdot C_s + f_p \cdot \left[1 - f_s\right] \cdot C_s$$

where the following equals:

$f_p := 0.5$ fraction of the year that animals graze on pasture

$f_s := 1.0$ fraction of daily feed that is pasture grass when the animal grazes on pasture

$C_p := 179.227$ concentration of Mn-54 in pasture grass as calculated from above, pCi/kg

$C_s := 63.037$ concentration of Mn-54 in stored feed as calculated from above, in pCi/kg

Therefore, the concentration in the total animal's feed is estimated to be :

$$f_p \cdot f_s \cdot C_p + \left[1 - f_p\right] \cdot C_s + f_p \cdot \left[1 - f_s\right] \cdot C_s = 121.132$$

pCi/kg

When this value of 121.132 is put back into the above general equation for nuclide concentration in milk, we get:

$$[\, C_v := 121.132 \quad \text{pCi/kg} \,]$$

and

$$F_m \cdot C_v \cdot Q_F \cdot e^{-\lambda_i \cdot t_f} = 0.181$$ pCi/liter of Mn-54 in goats milk

PART C.3.d. : Concentration in Meat: C_f

Similar to milk, the concentration of the nuclide in animal meat is calculated. RG 1.109 general equation C-12 is given as:

$$C_f = F_f \cdot C_v \cdot Q_F \cdot e^{-\lambda_i \cdot t_s}$$

Here the variables are set as:

$F_f := 8.0 \cdot 10^{-4}$	fraction of animals daily intake of Mn-54 which appears in each kg of flesh, in days/kg
$Q_F := 50.0$	animal's daily feed intake, in kg/day
$t_s := 20.0$	average time from slaughter to consumption, in days
$C_v := 121.132$	concentration on Mn-54 in animal's feed, same as calculated above for goat, in pCi/kg

Therefore, the concentration of Mn-54 in animal meat is calculated to be:

$$F_f \cdot C_v \cdot Q_F \cdot e^{-\lambda_i \cdot t_s} = 4.635$$ pCi/kg in meat for Mn-54

PART D: DOSE FROM INGESTION OF FOODS PRODUCED AT MAXIMUM LOCATION

Now that we have calculated the concentration of Mn-54 in milk, meat, leafy vegetables, and stored vegetables produced at a location of maximum air deposition, the resulting dose to any organ j and age group a can be calculated from the following general equation C-13 taken from RG 1.109:

$$\sum_i DFI_{ija} \cdot \left[U_{va} \cdot f_g \cdot C_v + U_{ma} \cdot C_m + U_{Fa} \cdot C_f + U_{La} \cdot f_l \cdot C_L\right]$$

For Mn-54 set equal to i, we find that from the evaluation of all organs for all age groups for combination of all exposure pathways, the adults GI-LLI is the critical age group/organ. Therefore, the variables in the above dose equation can be defined as:

$DFI_{ija} := 1.40 \cdot 10^{-5}$	ingestion dose factor for adults/GI-LLI for Mn-54, in mrem/pCi ingested (RG 1.109, Table E-11)
$U_{va} := 520.0$	vegetable ingestion rates for adults, kg/yr
$f_g := 0.76$	fraction of stored vegetables grown in the garden
$f_l := 1.0$	fraction of leafy vegetables grown in the garden
$U_{ma} := 310.0$	milk ingestion rate for adults, liter/yr

$U_{Fa} := 110.0$ meat ingestion rate for adults, kg/yr

$U_{La} := 64.0$ leafy vegetable ingestion rate for adults, kg/yr

$C_v := 67.379$ concentration of Mn-54 in stored vegetables, in pCi/kg (from above)

$C_m := 0.181$ concentration of Mn-54 in milk, in pCi/liter (from above)

$C_f := 4.635$ concentration of Mn-54 in meat, in pCi/kg (from above)

$C_L := 76.811$ concentration of Mn-54 in leafy vegetables, in pCi/kg (from above)

The dose from the combination of ingestion pathways for this example is calculated by substituting the above listed variables back into the ingestion dose equation:

$$DFI_{ija} \cdot \left[U_{va} \cdot f_g \cdot C_v + U_{ma} \cdot C_m + U_{Fa} \cdot C_f + U_{La} \cdot f_l \cdot C_L\right] = 0.4495$$

mrem-/yr per Ci

By breaking the above dose equation down into the different pathways which combine to give the total ingestion dose, we can see the individual dose contribution made by each exposure pathway.

Therefore, we have:

Dose for ingestion of stored vegetables $\quad DFI_{ija} \cdot U_{va} \cdot f_g \cdot C_v = 0.373$

Dose for ingestion of goat's milk $\quad DFI_{ija} \cdot U_{ma} \cdot C_m = 7.855 \cdot 10^{-4}$

Dose for ingestion of meat $DFI_{ija} \cdot U_{Fa} \cdot C_{f} = 0.00714$

Dose for ingestion of leafy vegetables $DFI_{ija} \cdot U_{La} \cdot f_{l} \cdot C_{L} = 0.0688$

PART E: TOTAL DOSE FROM ALL EXPOSURE PATHWAY

The total dose from all exposure pathways assumed to be present at the maximum receptor location can be found by simply adding the individual pathway doses calculated above. Since all the calculations above assumed a unit activity release from the plant vent stack, the combined dose can be stated as dose factor per unit activity released. This then demonstrates the development of the Seabrook ODCM Method I dose factors for gaseous release of particulates from the vent stack.

Inhalation dose (Part A)	0.00184 mrem/yr per Ci
Ground plane dose (Part B)	0.658 mrem/yr per Ci
Ingestion dose total (Part D)	0.449 mrem/yr per Ci

Total dose all pathways (critical organ is GI-LLI of an adult for Mn-54)	1.11 mrem/yr per Ci

APPENDIX B

Process Control Program

Requirement: Technical Specification 6.12.2.a requires that licensee initiated changes to the Process Control Program be submitted to the Commission in the Annual Radioactive Effluent Release Report for the period in which the change(s) were made.

Response: No changes were made to the Process Control Program during the reporting period.

APPENDIX C

Radioactive Liquid Effluent Monitoring Instrumentation

Requirement: Radioactive Liquid Effluent Monitoring Instrumentation channels are required to be operable in accordance with Technical Specification 3.3.3.9.b. With less than the minimum number of channels operable for 30 days, Technical Specification 3.3.3.9.b requires that an explanation for the delay in correcting the inoperability be provided the next Annual Effluent Release Report in accordance with Technical Specification 6.8.1.4.

Response: A review of the Action Statement Status tracking system archive indicated Technical Specification 3.3.3.9 was never entered for more than 30 consecutive days during the reporting period.

APPENDIX D

Radioactive Gaseous Effluent Monitoring Instrumentation

Requirement: Radioactive Gaseous Effluent Monitoring Instrumentation channels are required to be operable in accordance with Technical Specification 3.3.3.10.b. With less than the minimum number of channels operable for 30 days, Technical Specification 3.3.3.10.b requires that an explanation for the delay in correcting the inoperability be provided in the next Annual Effluent Release Report in accordance with Technical Specification 6.8.1.4.

Response: A review of the Action Statement Status tracking system archive indicated Technical Specification 3.3.3.10 was never entered for more than 30 consecutive days during the reporting period.

APPENDIX E

Liquid Holdup Tanks

Requirement: Technical Specification 3.11.1.4 limits the quantity of radioactive material contained in any temporary unprotected outdoor tank. With the quantity of radioactive material in any temporary unprotected outdoor tank exceeding the limits of Technical Specification 3.11.1.4, a description of the events leading in this condition is required in the next Annual Effluent Release Report pursuant to Technical Specification 6.8.1.4.

Response: There were no outside temporary tanks utilized for the storage of radioactive material during the reporting period.

APPENDIX F

Radwaste Treatment Systems

Requirement: Technical Specification 6.14.1.a requires that licensee initiated changes to the Radwaste Treatment Systems (liquid, gaseous, and solid) be submitted to the Commission in the Annual Radioactive Effluent Release Report for the period in which the change was made.

Response: There were no major changes made to Radwaste Treatment Systems during the reporting period.

APPENDIX G

Unplanned Releases

Requirement: Technical Specification 6.8.1.4 requires that the Annual Radioactive Effluent Release Report include a list and description of unplanned releases of radioactive materials in gaseous and liquid effluents made during the reporting period from the site to UNRESTRICTED AREAS.

Response: There were no unplanned releases of radioactive materials from the site to UNRESTRICTED AREAS during the reporting period.

ENCLOSURE 2 TO NYN-94053

SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

43.0 FT WIND DATA   STABILITY CLASS A   CLASS FREQUENCY (PERCENT) = 1.70

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
C-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
4-7	0	0	0	0	0	1	6	0	0	2	6	5	2	0	0	0	0	22
(1)	.00	.00	.00	.00	.00	.68	4.05	.00	.00	1.35	4.05	3.38	1.35	.00	.00	.00	.00	14.86
(2)	.00	.00	.00	.00	.00	.01	.07	.00	.00	.02	.07	.06	.02	.00	.00	.00	.00	.25
8-12	0	1	0	3	1	3	29	6	1	6	22	13	11	11	1	0	0	108
(1)	.00	.68	.00	2.03	.68	2.03	19.59	4.05	.68	4.05	14.86	8.78	7.43	7.43	.68	.00	.00	72.97
(2)	.00	.01	.00	.03	.01	.03	.33	.07	.01	.07	.25	.15	.13	.13	.01	.00	.00	1.24
13-18	0	0	2	2	1	0	2	0	0	1	5	1	0	3	1	0	0	18
(1)	.00	.00	1.35	1.35	.68	.00	1.35	.00	.00	.68	3.38	.68	.00	2.03	.68	.00	.00	12.16
(2)	.00	.00	.02	.02	.01	.00	.02	.00	.00	.01	.06	.01	.00	.03	.01	.00	.00	.21
19-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
GT 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
ALL SPEEDS	0	1	2	5	2	4	37	6	1	9	33	19	13	14	2	0	0	148
(1)	.00	.68	1.35	3.38	1.35	2.70	25.00	4.05	.68	6.08	22.30	12.84	8.78	9.46	1.35	.00	.00	100.00
(2)	.00	.01	.02	.06	.02	.05	.43	.07	.01	.10	.38	.22	.15	.16	.02	.00	.00	1.70

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

43.0 FT WIND DATA STABILITY CLASS B CLASS FREQUENCY (PERCENT) = 3.26

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
C-3	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	4
(1)	.00	.00	.35	.35	.00	.00	.00	.00	.00	.00	.00	.35	.35	.00	.00	.00	.00	1.41
(2)	.00	.00	.01	.01	.00	.00	.00	.00	.00	.00	.00	.01	.01	.00	.00	.00	.00	.05
4-7	0	1	1	0	3	4	2	4	1	2	10	7	7	5	3	0	0	50
(1)	.00	.35	.35	.00	1.06	1.41	.71	1.41	.35	.71	3.53	2.47	2.47	1.77	1.06	.00	.00	17.67
(2)	.00	.01	.01	.00	.03	.05	.02	.05	.01	.02	.12	.08	.08	.06	.03	.00	.00	.58
8-12	0	0	0	6	10	9	25	5	3	4	14	19	21	36	14	1	0	167
(1)	.00	.00	.00	2.12	3.53	3.18	8.83	1.77	1.06	1.41	4.95	6.71	7.42	12.72	4.95	.35	.00	59.01
(2)	.00	.00	.00	.07	.12	.10	.29	.06	.03	.05	.16	.22	.24	.41	.16	.01	.00	1.92
13-18	0	0	0	3	3	0	0	0	2	1	9	3	5	16	17	1	0	60
(1)	.00	.00	.00	1.06	1.06	.00	.00	.00	.71	.35	3.18	1.06	1.77	5.65	6.01	.35	.00	21.20
(2)	.00	.00	.00	.03	.03	.00	.00	.00	.02	.01	.10	.03	.06	.18	.20	.01	.00	.69
19-24	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	2
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.35	.00	.35	.00	.00	.71
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.01	.00	.00	.02
GT 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
ALL SPEEDS	0	1	2	10	16	13	27	9	6	7	33	30	35	57	35	2	0	283
(1)	.00	.35	.71	3.53	5.65	4.59	9.54	3.18	2.12	2.47	11.66	10.60	12.37	20.14	12.37	.71	.00	100.00
(2)	.00	.01	.02	.12	.18	.15	.31	.10	.07	.08	.38	.35	.40	.6[illegible]	.40	.02	.00	3.26

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

43.0 FT WIND DATA   STABILITY CLASS C   CLASS FREQUENCY (PERCENT) = 5.58

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
C-3	0	1	1	0	1	0	0	0	0	1	1	0	2	0	0	0	0	7
(1)	.00	.21	.21	.00	.21	.00	.00	.00	.00	.21	.21	.00	.41	.00	.00	.00	.00	1.44
(2)	.00	.01	.01	.00	.01	.00	.00	.00	.00	.01	.01	.00	.02	.00	.00	.00	.00	.08
4-7	8	5	0	2	9	11	10	9	1	2	6	15	10	13	3	4	0	108
(1)	1.65	1.03	.00	.41	1.86	2.27	2.06	1.86	.21	.41	1.24	3.09	2.06	2.68	.62	.82	.00	22.27
(2)	.09	.06	.00	.02	.10	.13	.12	.10	.01	.02	.07	.17	.12	.15	.03	.05	.00	1.24
8-12	11	5	6	19	31	19	29	6	4	7	21	19	29	51	30	2	0	289
(1)	2.27	1.03	1.24	3.92	6.39	3.92	5.98	1.24	.82	1.44	4.33	3.92	5.98	10.52	6.19	.41	.00	59.59
(2)	.13	.06	.07	.22	.36	.22	.33	.07	.05	.08	.24	.22	.33	.59	.35	.02	.00	3.33
13-18	2	0	1	0	2	1	0	2	1	6	6	9	3	17	20	2	0	72
(1)	.41	.00	.21	.00	.41	.21	.00	.41	.21	1.24	1.24	1.86	.62	3.51	4.12	.41	.00	14.85
(2)	.02	.00	.01	.00	.02	.01	.00	.02	.01	.07	.07	.10	.03	.20	.23	.02	.00	.83
19-24	0	0	0	0	0	0	0	0	0	0	3	1	2	0	3	0	0	9
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.62	.21	.41	.00	.62	.00	.00	1.86
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.01	.02	.00	.03	.00	.00	.10
GT 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
ALL SPEEDS	21	11	8	21	43	31	39	17	6	16	37	44	46	81	56	8	0	485
(1)	4.33	2.27	1.65	4.33	8.87	6.39	8.04	3.51	1.24	3.30	7.63	9.07	9.48	16.70	11.55	1.65	.00	100.00
(2)	.24	.13	.09	.24	.49	.36	.45	.20	.07	.18	.43	.51	.53	.93	.64	.09	.00	5.58

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

43.0 FT WIND DATA   STABILITY CLASS D   CLASS FREQUENCY (PERCENT) = 48.11

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2
(1)	.00	.00	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.05
(2)	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.02
C-3	19	24	22	25	22	12	13	15	26	15	19	25	37	35	38	45	0	392
(1)	.45	.57	.53	.60	.53	.29	.31	.36	.62	.36	.45	.60	.89	.84	.91	1.08	.00	9.38
(2)	.22	.28	.25	.29	.25	.14	.15	.17	.30	.17	.22	.29	.43	.40	.44	.52	.00	4.51
4-7	135	82	71	83	113	81	111	125	67	78	74	81	111	134	154	111	0	1611
(1)	3.23	1.96	1.70	1.99	2.70	1.94	2.66	2.99	1.60	1.87	1.77	1.94	2.66	3.21	3.69	2.66	.00	38.55
(2)	1.55	.94	.82	.96	1.30	.93	1.28	1.44	.77	.90	.85	.93	1.28	1.54	1.77	1.28	.00	18.54
8-12	115	83	100	78	95	83	65	35	23	61	133	107	118	236	228	72	0	1632
(1)	2.75	1.99	2.39	1.87	2.27	1.99	1.56	.84	.55	1.46	3.18	2.56	2.82	5.65	5.46	1.72	.00	39.05
(2)	1.32	.96	1.15	.90	1.09	.96	.75	.40	.26	.70	1.53	1.23	1.36	2.72	2.62	.83	.00	18.79
13-18	12	15	59	30	7	2	5	4	6	30	30	18	39	100	94	15	0	466
(1)	.29	.36	1.41	.72	.17	.05	.12	.10	.14	.72	.72	.43	.93	2.39	2.25	.36	.00	11.15
(2)	.14	.17	.68	.35	.08	.02	.06	.05	.07	.35	.35	.21	.45	1.15	1.08	.17	.00	5.36
19-24	0	2	10	13	3	0	0	1	0	1	1	12	12	6	5	0	0	66
(1)	.00	.05	.24	.31	.07	.00	.00	.02	.00	.02	.02	.29	.29	.14	.12	.00	.00	1.58
(2)	.00	.02	.12	.15	.03	.00	.00	.01	.00	.01	.01	.14	.14	.07	.06	.00	.00	.76
GT 24	0	0	1	7	2	0	0	0	0	0	0	0	0	0	0	0	0	10
(1)	.00	.00	.02	.17	.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.24
(2)	.00	.00	.01	.08	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.12
ALL SPEEDS	281	206	264	236	242	178	194	180	122	185	257	243	317	512	519	243	0	4179
(1)	6.72	4.93	6.32	5.65	5.79	4.26	4.64	4.31	2.92	4.43	6.15	5.81	7.59	12.25	12.42	5.81	.00	100.00
(2)	3.23	2.37	3.04	2.72	2.79	2.05	2.23	2.07	1.40	2.13	2.96	2.80	3.65	5.89	5.97	2.80	.00	48.11

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

43.0 FT WIND DATA STABILITY CLASS E CLASS FREQUENCY (PERCENT) = 25.51

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	1	1	0	1	0	0	0	0	0	0	0	1	1	0	1	0	0	6
(*)	.05	.05	.00	.05	.00	.00	.00	.00	.00	.00	.00	.05	.05	.00	.05	.00	.00	.27
(2)	.01	.01	.00	.01	.00	.00	.00	.00	.00	.00	.00	.01	.01	.00	.01	.00	.00	.07
C-3	23	14	21	34	32	15	21	18	48	62	47	43	74	59	62	45	0	618
(1)	1.04	.63	.95	1.53	1.44	.68	.95	.81	2.17	2.80	2.12	1.94	3.34	2.66	2.80	2.03	.00	27.89
(2)	.26	.16	.24	.39	.37	.17	.24	.21	.55	.71	.54	.49	.85	.68	.71	.52	.00	7.11
4-7	18	8	15	22	67	43	40	41	54	86	82	157	218	130	110	52	0	1143
(1)	.81	.36	.68	.99	3.02	1.94	1.81	1.85	2.44	3.88	3.70	7.08	9.84	5.87	4.96	2.35	.00	51.58
(2)	.21	.09	.17	.25	.77	.49	.46	.47	.62	.99	.94	1.81	2.51	1.50	1.27	.60	.00	13.16
8-12	3	10	13	6	10	12	19	12	9	34	67	62	44	41	32	3	0	377
(1)	.14	.45	.59	.27	.45	.54	.86	.54	.41	1.53	3.02	2.80	1.99	1.85	1.44	.14	.00	17.01
(2)	.03	.12	.15	.07	.12	.14	.22	.14	.10	.39	.77	.71	.51	.47	.37	.03	.00	4.34
13-18	0	0	10	9	6	0	0	3	0	5	14	2	3	1	5	1	0	59
(1)	.00	.00	.45	.41	.27	.00	.00	.14	.00	.23	.63	.09	.14	.05	.23	.05	.00	2.66
(2)	.00	.00	.12	.10	.07	.00	.00	.03	.00	.06	.16	.02	.03	.01	.06	.01	.00	.68
19-24	0	0	2	5	1	1	0	0	0	0	0	0	0	0	0	0	0	9
(1)	.00	.00	.09	.23	.05	.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.41
(2)	.00	.00	.02	.06	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.10
GT 24	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	4
(1)	.00	.00	.05	.00	.14	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.18
(2)	.00	.00	.01	.00	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05
ALL SPEEDS	45	33	62	77	119	71	80	74	111	187	210	265	340	231	210	101	0	2216
(1)	2.03	1.49	2.80	3.47	5.37	3.20	3.61	3.34	5.01	8.44	9.48	11.96	15.34	10.42	9.48	4.56	.00	100.00
(2)	.52	.38	.71	.89	1.37	.82	.92	.85	1.28	2.15	2.42	3.05	3.91	2.66	2.42	1.16	.00	25.51

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

43.0 FT WIND DATA STABILITY CLASS F CLASS FREQUENCY (PERCENT) = 8.67

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	1	0	1	0	0	0	0	0	1	1	0	0	0	2	3	0	0	9
(1)	.13	.00	.13	.00	.00	.00	.00	.00	.13	.13	.00	.00	.00	.27	.40	.00	.00	1.20
(2)	.01	.00	.01	.00	.00	.00	.00	.00	.01	.01	.00	.00	.00	.02	.03	.00	.00	.10
C-3	8	14	5	21	10	2	12	7	14	20	41	61	79	73	45	18	0	430
(1)	1.06	1.86	.66	2.79	1.33	.27	1.59	.93	1.86	2.66	5.44	8.10	10.49	9.69	5.98	2.39	.00	57.10
(2)	.09	.16	.06	.24	.12	.02	.14	.08	.16	.23	.47	.70	.91	.84	.52	.21	.00	4.95
4-7	3	1	0	4	12	1	1	1	6	12	32	35	61	63	51	24	0	307
(1)	.40	.13	.00	.53	1.59	.13	.13	.13	.80	1.59	4.25	4.65	8.10	8.37	6.77	3.19	.00	40.77
(2)	.03	.01	.00	.05	.14	.01	.01	.01	.07	.14	.37	.40	.70	.73	.59	.28	.00	3.53
8-12	0	0	0	2	0	0	2	0	0	0	0	3	0	0	0	0	0	7
(1)	.00	.00	.00	.27	.00	.00	.27	.00	.00	.00	.00	.40	.00	.00	.00	.00	.00	.93
(2)	.00	.00	.00	.02	.00	.00	.02	.00	.00	.00	.00	.03	.00	.00	.00	.00	.00	.08
13-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
19-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
GT 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
ALL SPEEDS	12	15	6	27	22	3	15	8	21	33	73	99	140	138	99	42	0	753
(1)	1.59	1.99	.80	3.59	2.92	.40	1.99	1.06	2.79	4.38	9.69	13.15	18.59	18.33	13.15	5.58	.00	100.00
(2)	.14	.17	.07	.31	.25	.03	.17	.09	.24	.38	.84	1.14	1.61	1.59	1.14	.48	.00	8.67

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

43.0 FT WIND DATA   STABILITY CLASS G   CLASS FREQUENCY (PERCENT) = 7.17

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	1	1	0	0	1	0	0	0	0	0	1	0	1	4	0	0	0	9
(1)	.16	.16	.00	.00	.16	.00	.00	.00	.00	.00	.16	.00	.16	.64	.00	.00	.00	1.44
(2)	.01	.01	.00	.00	.01	.00	.00	.00	.00	.00	.01	.00	.01	.05	.00	.00	.00	.10
C-3	6	4	5	10	5	3	1	0	1	11	30	84	135	133	48	19	0	495
(1)	.96	.64	.80	1.61	.80	.48	.16	.00	.16	1.77	4.82	13.48	21.67	21.35	7.70	3.05	.00	79.45
(2)	.07	.05	.06	.12	.06	.03	.01	.00	.01	.13	.35	.97	1.55	1.53	.55	.22	.00	5.70
4-7	3	0	0	0	1	0	0	0	0	1	8	9	19	41	32	5	0	119
(1)	.48	.00	.00	.00	.16	.00	.00	.00	.00	.16	1.28	1.44	3.05	6.58	5.14	.80	.00	19.10
(2)	.03	.00	.00	.00	.01	.00	.00	.00	.00	.01	.09	.10	.22	.47	.37	.06	.00	1.37
8-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
13-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
19-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
GT 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
ALL SPEEDS	10	5	5	10	7	3	1	0	1	12	39	93	155	178	80	24	0	623
(1)	1.61	.80	.80	1.61	1.12	.48	.16	.00	.16	1.93	6.26	14.93	24.88	28.57	12.84	3.85	.00	100.00
(2)	.12	.06	.06	.12	.08	.03	.01	.00	.01	.14	.45	1.07	1.78	2.05	.92	.28	.00	7.17

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C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

43.0 FT WIND DATA STABILITY CLASS ALL CLASS FREQUENCY (PERCENT) = 100.00

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	3	2	2	1	1	0	0	0	1	1	1	1	2	7	4	0	0	26
(1)	.03	.02	.02	.01	.01	.00	.00	.00	.01	.01	.01	.01	.02	.08	.05	.00	.00	.30
(2)	.03	.02	.02	.01	.01	.00	.00	.00	.01	.01	.01	.01	.02	.08	.05	.00	.00	.30
C-3	56	57	55	91	70	32	47	40	89	109	138	214	328	300	193	127	0	1946
(1)	.64	.66	.63	1.05	.81	.37	.54	.46	1.02	1.25	1.59	2.46	3.78	3.45	2.22	1.46	.00	22.40
(2)	.64	.66	.63	1.05	.81	.37	.54	.46	1.02	1.25	1.59	2.46	3.78	3.45	2.22	1.46	.00	22.40
4-7	167	97	87	111	205	141	170	180	129	183	218	309	428	386	353	196	0	3360
(1)	1.92	1.12	1.00	1.28	2.36	1.62	1.96	2.07	1.48	2.11	2.51	3.56	4.93	4.44	4.06	2.26	.00	38.68
(2)	1.92	1.12	1.00	1.28	2.36	1.62	1.96	2.07	1.48	2.11	2.51	3.56	4.93	4.44	4.06	2.26	.00	38.68
8-12	129	99	119	114	147	126	169	64	40	112	257	223	223	375	305	78	0	2580
(1)	1.48	1.14	1.37	1.31	1.69	1.45	1.95	.74	.46	1.29	2.96	2.57	2.57	4.32	3.51	.90	.00	29.70
(2)	1.48	1.14	1.37	1.31	1.69	1.45	1.95	.74	.46	1.29	2.96	2.57	2.57	4.32	3.51	.90	.00	29.70
13-18	14	15	72	44	19	3	7	9	9	43	64	33	50	137	137	19	0	675
(1)	.16	.17	.83	.51	.22	.03	.08	.10	.10	.49	.74	.38	.58	1.58	1.58	.22	.00	7.77
(2)	.16	.17	.83	.51	.22	.03	.08	.10	.10	.49	.74	.38	.58	1.58	1.58	.22	.00	7.77
19-24	0	2	12	18	4	1	0	1	0	1	4	13	15	6	9	0	0	86
(1)	.00	.02	.14	.21	.05	.01	.00	.01	.00	.01	.05	.15	.17	.07	.10	.00	.00	.99
(2)	.00	.02	.14	.21	.05	.01	.00	.01	.00	.01	.05	.15	.17	.07	.10	.00	.00	.99
GT 24	0	0	2	7	5	0	0	0	0	0	0	0	0	0	0	0	0	14
(1)	.00	.00	.02	.08	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.16
(2)	.00	.00	.02	.08	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.16
ALL SPEEDS	369	272	349	386	451	303	393	294	268	449	682	793	1046	1211	1001	420	0	8687
(1)	4.25	3.13	4.02	4.44	5.19	3.49	4.52	3.38	3.09	5.17	7.85	9.13	12.04	13.94	11.52	4.83	.00	100.00
(2)	4.25	3.13	4.02	4.44	5.19	3.49	4.52	3.38	3.09	5.17	7.85	9.13	12.04	13.94	11.52	4.83	.00	100.00

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SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

209.0 FT WIND DATA   STABILITY CLASS A   CLASS FREQUENCY (PERCENT) = 1.72

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
C-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
4-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8-12	0	0	0	3	1	2	22	4	2	3	8	10	4	1	1	0	0	61
(1)	.00	.00	.00	2.03	.68	1.35	14.86	2.70	1.35	2.03	5.41	6.76	2.70	.68	.68	.00	.00	41.22
(2)	.00	.00	.00	.03	.01	.02	.26	.05	.02	.03	.09	.12	.05	.01	.01	.00	.00	.71
13-18	0	1	2	1	0	0	15	3	0	6	17	11	13	8	0	0	0	77
(1)	.00	.68	1.35	.68	.00	.00	10.14	2.03	.00	4.05	11.49	7.43	8.78	5.41	.00	.00	.00	52.03
(2)	.00	.01	.02	.01	.00	.00	.17	.03	.00	.07	.20	.13	.15	.09	.00	.00	.00	.89
19-24	0	0	2	0	0	0	0	1	0	0	2	0	1	3	1	0	0	10
(1)	.00	.00	1.35	.00	.00	.00	.00	.68	.00	.00	1.35	.00	.68	2.03	.68	.00	.00	6.76
(2)	.00	.00	.02	.00	.00	.00	.00	.01	.00	.00	.02	.00	.01	.03	.01	.00	.00	.12
GT 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
ALL SPEEDS	0	1	4	4	1	2	37	8	2	9	27	21	18	12	2	0	0	148
(1)	.00	.68	2.70	2.70	.68	1.35	25.00	5.41	1.35	6.08	18.24	14.19	12.16	8.11	1.35	.00	.00	100.00
(2)	.00	.01	.05	.05	.01	.02	.43	.09	.02	.10	.31	.24	.21	.14	.02	.00	.00	1.72

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SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

209.0 FT WIND DATA STABILITY CLASS B CLASS FREQUENCY (PERCENT) = 3.31

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
C-3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
(1)	.00	.00	.70	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.70
(2)	.00	.00	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02
4-7	1	1	0	0	0	1	0	1	1	1	3	1	2	3	1	0	0	16
(1)	.35	.35	.00	.00	.00	.35	.00	.35	.35	.35	1.05	.35	.70	1.05	.35	.00	.00	5.61
(2)	.01	.01	.00	.00	.00	.01	.00	.01	.01	.01	.03	.01	.02	.03	.01	.00	.00	.19
8-12	0	0	0	4	9	9	16	4	1	4	15	10	7	14	6	1	0	100
(1)	.00	.00	.00	1.40	3.16	3.16	5.61	1.40	.35	1.40	5.26	3.51	2.46	4.91	2.11	.35	.00	35.09
(2)	.00	.00	.00	.05	.10	.10	.19	.05	.01	.05	.17	.12	.08	.16	.07	.01	.00	1.16
13-18	0	0	2	3	5	2	10	6	4	1	12	11	23	34	11	0	0	124
(1)	.00	.00	.70	1.05	1.75	.70	3.51	2.11	1.40	.35	4.21	3.86	8.07	11.93	3.86	.00	.00	43.51
(2)	.00	.00	.02	.03	.06	.02	.12	.07	.05	.01	.14	.13	.27	.39	.13	.00	.00	1.44
19-24	0	0	0	0	0	0	0	1	1	2	7	1	5	10	13	1	0	41
(1)	.00	.00	.00	.00	.00	.00	.00	.35	.35	.70	2.46	.35	1.75	3.51	4.56	.35	.00	14.39
(2)	.00	.00	.00	.00	.00	.00	.00	.01	.01	.02	.08	.01	.06	.12	.15	.01	.00	.48
GT 24	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	2
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.35	.00	.35	.00	.00	.70
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.01	.00	.00	.02
ALL SPEEDS	1	1	4	7	14	12	26	12	7	8	37	23	38	61	32	2	0	285
(1)	.35	.35	1.40	2.46	4.91	4.21	9.12	4.21	2.46	2.81	12.98	8.07	13.33	21.40	11.23	.70	.00	100.00
(2)	.01	.01	.05	.08	.16	.14	.30	.14	.08	.09	.43	.27	.44	.71	.37	.02	.00	3.31

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SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

209.0 FT WIND DATA   STABILITY CLASS C   CLASS FREQUENCY (PERCENT) =   5.64

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
C-3	1	0	0	1	1	2	0	0	2	0	0	0	0	0	0	0	0	7
(1)	.21	.00	.00	.21	.21	.41	.00	.00	.41	.00	.00	.00	.00	.00	.00	.00	.00	1.44
(2)	.01	.00	.00	.01	.01	.02	.00	.00	.02	.00	.00	.00	.00	.00	.00	.00	.00	.08
4-7	3	1	0	1	3	4	3	0	1	2	3	7	4	7	3	5	0	47
(1)	.62	.21	.00	.21	.62	.82	.62	.00	.21	.41	.62	1.44	.82	1.44	.62	1.03	.00	9.67
(2)	.03	.01	.00	.01	.03	.05	.03	.00	.01	.02	.03	.08	.05	.08	.03	.06	.00	.55
8-12	9	3	2	18	23	20	31	11	2	3	9	12	16	19	10	1	0	189
(1)	1.85	.62	.41	3.70	4.73	4.12	6.38	2.26	.41	.62	1.85	2.47	3.29	3.91	2.06	.21	.00	38.89
(2)	.10	.03	.02	.21	.27	.23	.36	.13	.02	.03	.10	.14	.19	.22	.12	.01	.00	2.19
13-18	5	9	1	5	5	1	8	9	3	8	18	8	24	49	23	3	0	179
(1)	1.03	1.85	.21	1.03	1.03	.21	1.65	1.85	.62	1.65	3.70	1.65	4.94	10.08	4.73	.62	.00	36.83
(2)	.06	.10	.01	.06	.06	.01	.09	.10	.03	.09	.21	.09	.28	.57	.27	.03	.00	2.08
19-24	3	0	1	0	0	0	0	1	1	3	7	6	2	15	13	0	0	52
(1)	.62	.00	.21	.00	.00	.00	.00	.21	.21	.62	1.44	1.23	.41	3.09	2.67	.00	.00	10.70
(2)	.03	.00	.01	.00	.00	.00	.00	.01	.01	.03	.08	.07	.02	.17	.15	.00	.00	.60
GT 24	0	0	0	0	0	0	0	0	0	0	4	1	2	2	3	0	0	12
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.82	.21	.41	.41	.62	.00	.00	2.47
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05	.01	.02	.02	.03	.00	.00	.14
ALL SPEEDS	21	13	4	25	32	27	42	21	9	16	41	34	48	92	52	9	0	486
(1)	4.32	2.67	.82	5.14	6.58	5.56	8.64	4.32	1.85	3.29	8.44	7.00	9.88	18.93	10.70	1.85	.00	100.00
(2)	.24	.15	.05	.29	.37	.31	.49	.24	.10	.19	.48	.39	.56	1.07	.60	.10	.00	5.64

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

209.0 FT WIND DATA STABILITY CLASS D CLASS FREQUENCY (PERCENT) = 48.14

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	3
(1)	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00	.02	.00	.02	.00	.00	.00	.07
(2)	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.01	.00	.01	.00	.00	.00	.03
C-3	12	14	11	11	12	5	9	4	9	6	6	8	11	13	19	16	0	166
(1)	.29	.34	.27	.27	.29	.12	.22	.10	.22	.14	.14	.19	.27	.31	.46	.39	.00	4.00
(2)	.14	.16	.13	.13	.14	.06	.10	.05	.10	.07	.07	.09	.13	.15	.22	.19	.00	1.93
4-7	78	50	44	59	75	63	63	53	42	42	44	45	42	59	72	76	0	907
(1)	1.88	1.21	1.06	1.42	1.81	1.52	1.52	1.28	1.01	1.01	1.06	1.08	1.01	1.42	1.74	1.83	.00	21.87
(2)	.91	.58	.51	.68	.87	.73	.73	.62	.49	.49	.51	.52	.49	.68	.84	.88	.00	10.53
8-12	127	71	69	73	61	96	96	89	64	63	78	74	87	141	135	87	0	1411
(1)	3.06	1.71	1.66	1.76	1.47	2.31	2.31	2.15	1.54	1.52	1.88	1.78	2.10	3.40	3.25	2.10	.00	34.02
(2)	1.47	.82	.80	.85	.71	1.11	1.11	1.03	.74	.73	.91	.86	1.01	1.64	1.57	1.01	.00	16.37
13-18	112	70	93	16	15	19	27	31	20	49	108	77	98	216	183	33	0	1167
(1)	2.70	1.69	2.24	.39	.36	.46	.65	.75	.48	1.18	2.60	1.86	2.36	5.21	4.41	.80	.00	28.13
(2)	1.30	.81	1.08	.19	.17	.22	.31	.36	.23	.57	1.25	.89	1.14	2.51	2.12	.38	.00	13.54
19-24	22	44	27	21	6	1	11	5	3	24	28	12	39	84	43	10	0	380
(1)	.53	1.06	.65	.51	.14	.02	.27	.12	.07	.58	.68	.29	.94	2.03	1.04	.24	.00	9.16
(2)	.26	.51	.31	.24	.07	.01	.13	.06	.03	.28	.32	.14	.45	.97	.50	.12	.00	4.41
GT 24	1	16	17	15	3	0	0	2	1	2	4	11	24	10	8	0	0	114
(1)	.02	.39	.41	.36	.07	.00	.00	.05	.02	.05	.10	.27	.58	.24	.19	.00	.00	2.75
(2)	.01	.19	.20	.17	.03	.00	.00	.02	.01	.02	.05	.13	.28	.12	.09	.00	.00	1.32
ALL SPEEDS	352	265	261	195	173	184	206	184	139	186	268	228	301	524	460	222	0	4148
(1)	8.49	6.39	6.29	4.70	4.17	4.44	4.97	4.44	3.35	4.48	6.46	5.50	7.26	12.63	11.09	5.35	.00	100.00
(2)	4.08	3.08	3.03	2.26	2.01	2.14	2.39	2.14	1.61	2.16	3.11	2.65	3.49	6.08	5.34	2.58	.00	48.14

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(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

209.0 FT WIND DATA STABILITY CLASS E CLASS FREQUENCY (PERCENT) = 25.58

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
C-3	6	8	5	12	2	11	11	11	9	5	8	12	11	5	6	3	0	125
(1)	.27	.36	.23	.54	.09	.50	.50	.50	.41	.23	.36	.54	.50	.23	.27	.14	.00	5.67
(2)	.07	.09	.06	.14	.02	.13	.13	.13	.10	.06	.09	.14	.13	.06	.07	.03	.00	1.45
4-7	20	18	27	23	24	40	54	27	30	40	24	27	16	31	30	35	0	466
(1)	.91	.82	1.23	1.04	1.09	1.81	2.45	1.23	1.36	1.81	1.09	1.23	.73	1.41	1.36	1.59	.00	21.14
(2)	.23	.21	.31	.27	.28	.46	.63	.31	.35	.46	.28	.31	.19	.36	.35	.41	.00	5.41
8-12	40	25	18	10	11	11	38	53	65	94	99	97	101	132	102	42	0	938
(1)	1.81	1.13	.82	.45	.50	.50	1.72	2.40	2.95	4.26	4.49	4.40	4.58	5.99	4.63	1.91	.00	42.56
(2)	.46	.29	.21	.12	.13	.13	.44	.62	.75	1.09	1.15	1.13	1.17	1.53	1.18	.49	.00	10.89
13-18	11	11	10	2	4	4	9	24	15	43	85	99	110	93	62	3	0	585
(1)	.50	.50	.45	.09	.18	.18	.41	1.09	.68	1.95	3.86	4.49	4.99	4.22	2.81	.14	.00	26.54
(2)	.13	.13	.12	.02	.05	.05	.10	.28	.17	.50	.99	1.15	1.28	1.08	.72	.03	.00	6.79
19-24	0	5	0	1	5	1	3	4	0	4	18	5	5	3	4	2	0	60
(1)	.00	.23	.00	.05	.23	.05	.14	.18	.00	.18	.82	.23	.23	.14	.18	.09	.00	2.72
(2)	.00	.06	.00	.01	.06	.01	.03	.05	.00	.05	.21	.06	.06	.03	.05	.02	.00	.70
GT 24	0	5	3	12	6	1	0	1	0	1	0	0	0	0	1	0	0	30
(1)	.00	.23	.14	.54	.27	.05	.00	.05	.00	.05	.00	.00	.00	.00	.05	.00	.00	1.36
(2)	.00	.06	.03	.14	.07	.01	.00	.01	.00	.01	.00	.00	.00	.00	.01	.00	.00	.35
ALL SPEEDS	77	72	63	60	52	68	115	120	119	187	234	240	243	264	205	85	0	2204
(1)	3.49	3.27	2.86	2.72	2.36	3.09	5.22	5.44	5.40	8.48	10.62	10.89	11.03	11.98	9.30	3.86	.00	100.00
(2)	.89	.84	.73	.70	.60	.79	1.33	1.39	1.38	2.17	2.72	2.79	2.82	3.06	2.38	.99	.00	25.58

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SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

209.0 FT WIND DATA   STABILITY CLASS F   CLASS FREQUENCY (PERCENT) = 8.60

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
C-3	2	2	5	3	0	14	3	2	2	5	8	6	8	4	3	2	0	69
(1)	.27	.27	.67	.40	.00	1.89	.40	.27	.27	.67	1.08	.81	1.08	.54	.40	.27	.00	9.31
(2)	.02	.02	.06	.03	.00	.16	.03	.02	.02	.06	.09	.07	.09	.05	.03	.02	.00	.80
4-7	10	1	6	5	8	6	5	12	18	14	14	10	14	14	13	13	0	163
(1)	1.35	.13	.81	.67	1.08	.81	.67	1.62	2.43	1.89	1.89	1.35	1.89	1.89	1.75	1.75	.00	22.00
(2)	.12	.01	.07	.06	.09	.07	.06	.14	.21	.16	.16	.12	.16	.16	.15	.15	.00	1.89
8-12	28	19	6	3	1	0	3	7	23	31	43	34	50	61	54	33	0	396
(1)	3.78	2.56	.81	.40	.13	.00	.40	.94	3.10	4.18	5.80	4.59	6.75	8.23	7.29	4.45	.00	53.44
(2)	.32	.22	.07	.03	.01	.00	.03	.08	.27	.36	.50	.39	.58	.71	.63	.38	.00	4.60
13-18	9	2	0	1	0	0	0	1	2	6	11	17	20	22	16	6	0	113
(1)	1.21	.27	.00	.13	.00	.00	.00	.13	.27	.81	1.48	2.29	2.70	2.97	2.16	.81	.00	15.25
(2)	.10	.02	.00	.01	.00	.00	.00	.01	.02	.07	.13	.20	.23	.26	.19	.07	.00	1.31
19-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
GT 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
ALL SPEEDS	49	24	17	12	9	20	11	22	45	56	76	67	92	101	86	54	0	741
(1)	6.61	3.24	2.29	1.62	1.21	2.70	1.48	2.97	6.07	7.56	10.26	9.04	12.42	13.63	11.61	7.29	.00	100.00
(2)	.57	.28	.20	.14	.10	.23	.13	.26	.52	.65	.88	.78	1.07	1.17	1.00	.63	.00	8.60

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SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

209.0 FT WIND DATA STABILITY CLASS G CLASS FREQUENCY (PERCENT) = 7.02

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.17	.00	.00	.17
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.01
C-3	4	2	5	3	4	4	2	4	6	2	6	3	6	6	3	4	0	64
(1)	.66	.33	.83	.50	.66	.66	.33	.66	.99	.33	.99	.50	.99	.99	.50	.66	.00	10.58
(2)	.05	.02	.06	.03	.05	.05	.02	.05	.07	.02	.07	.03	.07	.07	.03	.05	.00	.74
4-7	15	4	5	3	3	2	5	3	9	16	20	21	31	13	21	16	0	187
(1)	2.48	.66	.83	.50	.50	.33	.83	.50	1.49	2.64	3.31	3.47	5.12	2.15	3.47	2.64	.00	30.91
(2)	.17	.05	.06	.03	.03	.02	.06	.03	.10	.19	.23	.24	.36	.15	.24	.19	.00	2.17
8-12	20	7	6	0	0	2	1	5	16	11	27	22	42	50	46	52	0	307
(1)	3.31	1.16	.99	.00	.00	.33	.17	.83	2.64	1.82	4.46	3.64	6.94	8.26	7.60	8.60	.00	50.74
(2)	.23	.08	.07	.00	.00	.02	.01	.06	.19	.13	.31	.26	.49	.58	.53	.60	.00	3.56
13-18	2	1	0	0	0	0	0	0	0	2	7	5	1	6	13	9	0	46
(1)	.33	.17	.00	.00	.00	.00	.00	.00	.00	.33	1.16	.83	.17	.99	2.15	1.49	.00	7.60
(2)	.02	.01	.00	.00	.00	.00	.00	.00	.00	.02	.08	.06	.01	.07	.15	.10	.00	.53
19-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
GT 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
ALL SPEEDS	41	14	16	6	7	8	8	12	31	31	60	51	80	75	84	81	0	605
(1)	6.78	2.31	2.64	.99	1.16	1.32	1.32	1.98	5.12	5.12	9.92	8.43	13.22	12.40	13.88	13.39	.00	100.00
(2)	.48	.16	.19	.07	.08	.09	.09	.14	.36	.36	.70	.59	.93	.87	.97	.94	.00	7.02

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SEABROOK JAN93-DEC93 MET DATA JOINT FREQUENCY DISTRIBUTION (210-FOOT TOWER)

209.0 FT WIND DATA   STABILITY CLASS ALL   CLASS FREQUENCY (PERCENT) = 100.00

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	0	0	0	0	1	0	0	0	0	0	0	1	0	1	1	0	0	4
(1)	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.01	.00	.01	.01	.00	.00	.05
(2)	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.01	.00	.01	.01	.00	.00	.05
C-3	25	26	28	30	19	36	25	21	28	18	28	29	36	28	31	25	0	433
(1)	.29	.30	.32	.35	.22	.42	.29	.24	.32	.21	.32	.34	.42	.32	.36	.29	.00	5.02
(2)	.29	.30	.32	.35	.22	.42	.29	.24	.32	.21	.32	.34	.42	.32	.36	.29	.00	5.02
4-7	127	75	82	91	113	116	130	96	101	115	108	111	109	127	140	145	0	1786
(1)	1.47	.87	.95	1.06	1.31	1.35	1.51	1.11	1.17	1.33	1.25	1.29	1.26	1.47	1.62	1.68	.00	20.73
(2)	1.47	.87	.95	1.06	1.31	1.35	1.51	1.11	1.17	1.33	1.25	1.29	1.26	1.47	1.62	1.68	.00	20.73
8-12	224	125	101	111	106	140	207	173	173	209	279	259	307	418	354	216	0	3402
(1)	2.60	1.45	1.17	1.29	1.23	1.62	2.40	2.01	2.01	2.43	3.24	3.01	3.56	4.85	4.11	2.51	.00	39.48
(2)	2.60	1.45	1.17	1.29	1.23	1.62	2.40	2.01	2.01	2.43	3.24	3.01	3.56	4.85	4.11	2.51	.00	39.48
13-18	139	94	108	28	29	26	69	74	44	115	258	228	289	428	308	54	0	2291
(1)	1.61	1.09	1.25	.32	.34	.30	.80	.86	.51	1.33	2.99	2.65	3.35	4.97	3.57	.63	.00	26.59
(2)	1.61	1.09	1.25	.32	.34	.30	.80	.86	.51	1.33	2.99	2.65	3.35	4.97	3.57	.63	.00	26.59
19-24	25	49	30	22	11	2	14	12	5	33	62	24	52	115	74	13	0	543
(1)	.29	.57	.35	.26	.13	.02	.16	.14	.06	.38	.72	.28	.60	1.33	.86	.15	.00	6.30
(2)	.29	.57	.35	.26	.13	.02	.16	.14	.06	.38	.72	.28	.60	1.33	.86	.15	.00	6.30
GT 24	1	21	20	27	9	1	0	3	1	3	8	12	27	12	13	0	0	158
(1)	.01	.24	.23	.31	.10	.01	.00	.03	.01	.03	.09	.14	.31	.14	.15	.00	.00	1.83
(2)	.01	.24	.23	.31	.10	.01	.00	.03	.01	.03	.09	.14	.31	.14	.15	.00	.00	1.83
ALL SPEEDS	541	390	369	309	288	321	445	379	352	493	743	664	820	1129	921	453	0	8617
(1)	6.28	4.53	4.28	3.59	3.34	3.73	5.16	4.40	4.08	5.72	8.62	7.71	9.52	13.10	10.69	5.26	.00	100.00
(2)	6.28	4.53	4.28	3.59	3.34	3.73	5.16	4.40	4.08	5.72	8.62	7.71	9.52	13.10	10.69	5.26	.00	100.00

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

North Atlantic
April 29, 1994

ENCLOSURE 3 TO NYN-94053

Seabrook Station
Supplemental Effluent Release Report
Radiological Impact Assessment For 1993

I. Introduction

Doses resulting from liquid and gaseous effluents from Seabrook Station during 1993 were calculated in accordance with Method II as defined in the Station Offsite Dose Calculation Manual (ODCM). The calculational methods used follow the models in Regulatory Guide 1.109. The calculations included maximum total body doses and organ doses from all liquid releases, maximum offsite organ doses resulting from airborne iodines, tritium and particulate radionuclides, and maximum offsite beta air and gamma air doses from airborne noble gases. Doses were also calculated for the special receptor locations inside the site boundary: the Education Center and the "Rocks". In addition, the direct dose from plant operation was calculated. These doses from effluent releases and direct shine during 1993 are summarized in Table A.

The calculated maximum annual total body dose and the maximum organ dose from liquid effluents represent, respectively, 0.04% and 0.06% of the dose limits established by Technical Specification 3.11.1.2. The calculated annual maximum dose from airborne iodine, tritium and particulate radionuclides for offsite receptor locations represents 0.002% of the dose limit established by Technical Specification 3.11.2.3, whereas the calculated maximum annual beta air and gamma air doses from airborne noble gases for offsite receptor locations represent, respectively, 0.0004% and 0.0003% of the dose limits established by Technical Specification 3.11.2.2. The calculated annual beta air and gamma air doses from airborne noble gases for the Education Center were zero because the wind did not blow in that direction during actual releases. Whereas for the "Rocks" the annual doses were 0.0002% and 0.0007% of the limits in Technical Specification 3.11.2.2. The calculated annual doses from airborne iodines, tritium and particulate radionuclides at the Education Center and the "Rocks" were, respectively, 0.000003% and 0.000006% of the limits in Technical Specification 3.11.2.3.

The sum of the maximum whole body doses from all exposure pathways for the liquid and gaseous effluents, plus the direct whole body dose from station operation, was 1.4E-3 mrem to a hypothetical individual. This total whole body dose conservatively represents 0.006% of the annual whole body dose limit for a member of the public as set forth in 40CFR190, and demonstrates compliance with that code.

II. Method for Calculating the Total Body and Maximum Organ Doses Resulting from Liquid Releases

The computer code IDLE, which is consistent with the models in Regulatory Guide 1.109 (Reference 1), was used to calculate the total body and organ doses resulting from liquid effluents from Seabrook Station. The general equations A-3, A-4, A-5, A-6 and A-7 from Regulatory Guide 1.109 are applied in IDLE. The total body doses and the organ doses are evaluated for each of the four age groups (i.e., infant, child, teen and adult) to determine the maximum total body dose and maximum organ dose via all existing exposure pathways (i.e., fish and aquatic invertebrate ingestion, and shoreline exposure) to an age-dependent individual. The values for the various factors considered in equations A-3 through A-7 have been taken from Regulatory Guide 1.109 and the Station Offsite Dose Calculation Manual (ODCM) (Reference 2). The specific values used for the usage factor (U_{ap}), mixing ratio (M_p), bioaccumulation factor (B_{ip}), dose factors (D_{aipj}), transit time (t_p), transfer constant from water to sediment (K_c), exposure time for sediment or soil (t_b), and shore width factor (W) are provided by the reference sources as summarized in Table B. The flow rate of the liquid effluent (F) and the radionuclide activities (Q_i) are measured specifically prior to each liquid release. The values for half lives for radionuclides (T_i) and their radioactive decay constants (λ_i) have been taken from Kocher (Reference 3).

The exposure pathways considered in the calculations of total body and maximum organ doses resulting from liquid discharges from Seabrook Station have been limited to ingestion of aquatic foods and exposure to shoreline deposits. The dose calculations do not include the ingestion of potable water and irrigated vegetation as potential exposure pathways because the liquid effluents from the plant are discharged into salt water.

Table A presents the calculated liquid pathway doses for each calendar quarter and also the total for the year.

III. Method for Calculating the Gamma and Beta Air Doses from Noble Gases

The computer codes AIRAD and AEOLUS 2 (Mod 06) were used for the calculation of both the gamma and beta air doses resulting from noble gases present in gaseous effluents released from Seabrook Station. The features and use of AEOLUS 2 for the calculation of atmospheric dispersion factors (i.e., Chi/Q factors) from recorded meteorological data (i.e., meteorological data measurements taken during the time of the release) are described in section B.7.3.2 of Seabrook's ODCM. Meteorological dispersion factors concurrent with periods of batch gas releases are calculated along with the values for quarterly average dispersion factors. The atmospheric dispersion factors calculated using AEOLUS 2 were, in turn, used in the gamma and beta air dose calculations by AIRAD. AIRAD is consistent with the models presented in Regulatory Guide 1.109, general equations B-4 and B-5. The values for the dose factors, DF_i^γ and DF_i^β, have been taken from Table B-1 in Regulatory Guide 1.109.

Table A lists the calculated air doses for each calendar quarter, and the total for the year.

IV. Method for Calculating the Critical Organ Dose Resulting from Iodines, Tritium and Particulates with $T_{1/2}$ Greater than 8 Days in Gaseous Releases

The computer codes AEOLUS 2 (Mod 06) and ATMODOS were used for the calculation of the organ doses resulting from iodines, tritium and particulates with half-lives greater than 8 days present in gaseous effluents released from Seabrook Station. The features and use of AEOLUS 2 for the calculation of atmospheric dispersion factors (i.e., Chi/Q factors) from recorded meteorological data (i.e., meteorological data measurements taken during the time of the release) are described in section B.7.3.2 of Seabrook's ODCM. Meteorological dispersion factors concurrent with periods of batch gas releases were calculated along with the values for quarterly average dispersion factors. The atmospheric dispersion factors calculated using AEOLUS 2 were, in turn, used in the dose calculations by ATMODOS. ATMODOS calculates the organ doses (i.e., dose to bone, liver, kidney, lung, lower large intestine, total body, and skin) due to the presence of radionuclides other than noble gases in gaseous effluents, and is consistent with the models presented in Appendix C of Regulatory Guide 1.109. The pathways considered in the dose calculations are the ground plane, inhalation, and ingestion of stored vegetables, fresh garden vegetables, milk and meat. The critical organ dose is determined for the offsite location (e.g., site boundary, nearest resident or farm) of receptor pathways as identified in the most recent annual land use census. The total body dose contributions via the ground plane and inhalation pathways as calculated by ATMODOS have also been included in the total body dose estimates for the special receptor locations inside the site boundary. Equations C-1 through C-13 are applied in the ATMODOS calculation of the critical organ doses. The input data and assumptions are those provided in Appendix C of Regulatory Guide 1.109, except where site-specific data and assumptions have been identified in Tables B.7-2 and B.7-3 of Seabrook's ODCM. These two ODCM tables provide the options for special conditions, depending on the type of receptor being evaluated at a specific location, that are to be applied in Method II calculations. The receptor type controls the exposure pathways for calculational purposes. The receptor types used in the dose calculations were a resident receptor (which considered the ground plane, inhalation and vegetable ingestion exposure pathways), a milk receptor (which considered the ground plane, inhalation, vegetable and milk ingestion exposure pathways) and a boundary and radius receptor (both of which considered the ground plane and inhalation exposure pathways). The resident and milk receptor locations for the various sector were based on the 1993 land use census data for Seabrook Station (Table D). The radius receptor locations were applied at several distances in each sector to insure that the location of the maximum doses were not overlooked.

Depletion of the plume during transport is considered by AEOLUS 2 in the calculations of atmospheric dispersion factors (e.g., calculation of $[X/Q]^D$). A shielding factor (S_F) of 0.7 is applied for residential structures. The source for the values of the various factors used in equations C-1 through C-13 are summarized in Table C.

V. REFERENCES

1. Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purposes of Evaluating Compliance with 10CFR Part 50, Appendix I, Reg. Guide 1.109, Rev 1, Oct. 1977.

2. Station Offsite Dose Calculation Manual, Rev 12.

3. Kocher, D.C., Dose-Rate Conversion Factors for Exposure to Photons and Electrons, Health Physics, Vol. 45, No. 3, Sept. 1983.

TABLE A

Seabrook Station
Effluent and Waste Disposal Semiannual Report 1993

Maximum[a] Off-Site Doses and Dose Commitments to Members of the Public

Source		Dose (mrem)[b] 1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year[c]
Liquid Effluents:						
Total Body Dose		4.6E-04 (1)	3.7E-04 (1)	1.7E-04 (1)	7.4E-05 (2)	1.1E-03
Organ Dose		2.5E-03 (3)	1.9E-03 (3)	9.2E-04 (3)	1.7E-04 (4)	5.6E-03
Airborne Effluents:						
Iodines, Tritium, and Particulates		6.2E-06 (5)	2.9E-05 (6)	1.7E-04 (7)	1.1E-04 (8)	3.2E-04
Noble Gases	Beta Air (mrad)	7.4E-06 (9)	2.5E-05 (10)	2.0E-06 (9)	2.9E-06 (11)	3.7E-05
	Gamma Air (mrad)	7.0E-06 (9)	4.4E-05 (10)	5.1E-06 (9)	1.0E-05 (11)	6.6E-05
Doses (mrem) at Receptor Locations Inside Site Boundary[d]:						
Education Center (SW, 488m):						
Beta Air Dose (mrad)		---	---	---	---	---
Gamma Air Dose (mrad)		---	---	---	---	---
Organ Dose (mrem)		---	1.7E-07 (12)	---	2.6E-07 (13)	4.3E-07
The "Rocks" (NE/ENE, 244m):						
Beta Air Dose (mrad)		---	---	---	2.4E-05	2.4E-05
Gamma Air Dose (mrad)		---	---	---	4.9E-05	4.9E-05
Organ Dose (mrem)		9.2E-09 (12)	5.4E-08 (12)	1.5E-08 (12)	7.6E-07 (13)	8.4E-07
Direct Dose From Plant Operation[e]						0

NOTES:

(a) "Maximum means the largest fraction of corresponding 10CFR50, Appendix I, dose design objective.

(b) The numbered footnotes indicate the age group, organ, and location (compass sector and distance from stack in meters) of the dose receptor, where appropriate.

(1) Child
(2) Adult
(3) Child/Bone
(4) Adult/GI-LLI
(5) Child/Whole Body, S-1000
(6) Child/Whole Body, SW-1000
(7) Child/Whole Body, W-1000
(8) Child/Whole Body, N-1000
(9) WSW-1022 Meters
(10) SE-2276
(11) NE-2276
(12) Teen/Whole Body
(13) Teen/Lung

(c) "Maximum" dose for the year is the sum of the maximum doses for each quarter. This results in a conservative yearly dose estimate, but still well within the limits of 10CFR50.

(d) For each special receptor location, the whole body and organ doses calculated for the airborne effluent releases were adjusted by the occupancy factor provided in Seabrook's ODCM (i.e., 0.0014 for the Education Center and 0.0076 for the "Rocks").

(e) Only station sources are considered since there are no other facilities within five miles of Seabrook Station. 1993 data for the closest off-site environmental TLD locations in each sector (as listed in Table B.4-1 of Seabrook's ODCM) were compared to preoperation data from 1986-1988 for the same locations. No statistical difference which could be attributed to station sources was identified.

TABLE B

Sources of the Values of Factors Used in Liquid Dose Equations

Factor	Source
U_{ap}	Table B.7-1, Station ODCM
M_p	Section B.7.1, Station ODCM (value=0.1 for aquatic foods and 0.025 for shoreline)
B_{ip}	Table A-1, Reg. Guide 1.109
D_{aipj}	Tables E-11 through E-14, R.G. 1.109
t_p	Section B.7.1, Station ODCM
K_c	Reg. Guide 1.109
t_b	Reg. Guide 1.109
W	Table A-2, Reg. Guide 1.109 (value=0.5)

TABLE C

Sources of Values for the Factors Used in Dose Equations for Gaseous Releases

Factor	Source
t_b	Reg. Guide 1.109
λ_i	Kocher (Reference 3)
DFG_{ij}	Table E-6, Reg. Guide 1.109
$[X/Q]^D$	Calculated by AEOLUS 2 (Mod 5)
R_a	Table B.7-3, Station ODCM
DFA_{ija}	Tables E-7 through E-10, R.G.1.109
d_i	Reg. Guide 1.109
P, t_e, t_h and Y_v	Table B.7-2, Station ODCM
r	Table E-15, Reg. Guide 1.109
B_{iv}	Table E-1, Reg. Guide 1.109
p	Reg. Guide 1.109
H	Table B.7-2, Station ODCM
F_m	Tables E-1 and E-2, R.G. 1.109
Q_F	Table E-3, Reg. Guide 1.109
t_f	Reg. Guide 1.109
f_p	Table B.7-2, Station ODCM
f_s	Table B.7-2, Station ODCM
F_f	Table E-1, Reg. Guide 1.109
t_s	Table E-15, Reg. Guide 1.109
DFI_{ija}	Tables E-11 through E-14, R.G.1.109
U_a^v, U^m	Table B.7-3, Station ODCM
U_a^F, U_a^L	Table B.7-3, Station ODCM
f_g, f_1	Reg. Guide 1.109
σ_i	Calculated by AEOLUS 2 (Mod 5)
λ_w	Table E-15, Reg. Guide 1.109
Q_F	Table E-3, Reg. Guide 1.109

TABLE D

Receptor Locations* for Seabrook Station

Sector	Nearest Resident mile (km)	Nearest Garden mile (km)	Milk Animal within 5 Mi Radius mile (km)
N	0.6 (1.0)	2.6 (4.2)	---
NNE	2.0 (3.2)	2.0 (3.2)	---
NE	1.5 (2.4)	---	---
ENE	1.5 (2.4)	---	---
E	1.6 (2.6)	---	---
ESE	1.5 (2.4)	---	---
SE	1.5 (2.4)	---	---
SSE	0.6 (1.0)	0.7 (1.1)	---
S	0.6 (1.0)	0.8 (1.3)	---
SSW	0.6 (1.0)	0.8 (1.3)	---
SW	0.6 (1.0)	0.8 (1.3)	3.2 (5.2)
WSW	0.7 (1.1)	0.7 (1.1)	---
W	0.6 (1.0)	0.7 (1.1)	---
WNW	0.6 (1.0)	1.0 (1.6)	3.0 (4.8) 3.8 (6.1) 4.8 (7.7)
NW	0.6 (1.0)	0.7 (1.1)	4.4 (7.1)
NNW	0.7 (1.1)	0.7 (1.1)	3.4 (5.5)

* Locations based on 1993 Land Use Census.