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STATION

OFFSITE DOSE CALCULATION MANUAL

(ODCM)

1. Does this manual/manual revision:

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

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

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TABLE OF CONTENTS

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TABLE OF CONTENTS

LIST OF EFFECTIVE PAGES

PAGE	REV.	PAGE	REV.
Cover	10	B.1-2	4
		B.1-3	4
Disclaimer	8	B.1-4	4
		B.1-5	4
Abstract	8	B.1-6	8
		B.1-7	4
TOC 1	10	B.1-8	7
2	10	B.1-9	7
		B.1-10	7
List of Figures	8	B.1-11	7
		B.1-12	4
List of Tables 1	8	B.1-13	4
2	8	B.1-14	8
		B.1-15	7
LOEP 1	10	B.1-16	4
2	10	B.1-17	/
3	10	B.1-18	10
		B.1-19	7
A.1-1	10	B.1-20	7
		B.1-21	7
A.2-1	4	B.1-22	8
A.3-1	4	B.2-1	8
A.3-2	4	B.2-2	8
A.3-3	4	B.2-3	7
A.3-4	4	B.2-4	8
A.3-5	4		
A.3-6	4	B.3-1	10
		B.3-2	10
A.4-1	4	B.3-3	10
A.4-2	4	B.3-4	10
A.4-3	4	B.3-5	10
A.4-4	4	B.3-6	10
A.4-5	4	B.3-7	10
		B.3-8	10
A.5-1	4	B.3-9	10
A.5-2	4	B.3-10	10
A.5-3	4	B.3-11	10
A.5-4	4	B.3-12	10
A.5-5	4	B.3-13	10
A.5-6	4	B.3-14	10
A.5-7	4	B.3-15	10
A.5-8	4	B.3-16	10
A.5-9	4	B.3-17	10
A.5-10	4	B.3-18	10
		B.3-19	10
B.1-1	8	B.3-20	10

LIST OF EFFECTIVE PAGES

PAGE	REV.	PAGE	REV.
B.3-21	10	B.7-9	8
B.3-22	10	B.7-10	8
B.3-23	10	B.7-11	7
B.3-24	10	B.7-12	8
B.3-25	10	B.7-13	8
B.3-26	10	B.7-14	8
B.3-27	10	B.7-15	8
B.3-28	10	B.7-16	8
B.3-29	10	B.7-17	8
		B.7-18	8
B.4-1	9	B.7-19	8
B.4-2	9	B.7-20	8
B.4-3	/	B.7-21	8
B.4-4	4	B.7-22	8
B.4-5	9	B.7-23	8
B.4-6	9	B.7-24	8
B.4-7	8	B.7-25	8
B.4-8	8	B.7-26	8
B.4-9	8	B.7-27	8
B.4-10	8	B.7-28	8
		B.7-29	8
B.5-1	7	B.7-30	8
B.5-2	4	B.7-31	8
B.5-3	8	B.7-32	8
B.5-4	4	B.7-33	8
B.5-5	10	B.7-34	8
B.5-6	10	B.7-35	8
B.5-7	10	B.7-36	8
B.5-8	10	B.7-37	8
B.5-9	7	B.7-38	8
B.5-10	7	B.7-39	8
B.5-11	7	B.7-40	8
B.5-12	7		
B.5-13	7	B.8-1	4
		B.8-2	4
B.6-1	4	B-8-3	4
B.6-2	8	B.8-4	8
B.6-3	8	B.8-5	4
		B.8-6	7
B.7-1	4	B.8-7	7
B.7-2	10	B.8-8	7
B.7-3	8	B.8-9	7
B.7-4	8	B.8-10	7
B.7-5	10		
B.7-6	8	R-1	7
B.7-7	8		
B.7-8	8	A-1	8

LIST OF EFFECTIVE PAGES

PAGE	REV.	PAGE	REV.
A-2	8		
A-3	8		
A-4	8		
A-5	8		
A-6	8		
A-7	8		
A-8	8		
A-9	8		
A-10	8		
A-11	8		
A-12	8		
A-13	8		
A-14	8		
A-15	8		
A-16	8		
A-17	8		
A-18	8		
A-19	8		

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.

TABLE B.1-10

Dose Factors Specific for Seabrook Station
for
Noble Gas Releases

Radionuclide	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.

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 metcorology 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 rate 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 (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 3-1 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 $1^{o}F$ 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:

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

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

where:

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

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

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

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

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

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

3.3.2 Method II

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

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

$$(\frac{mrem}{yr}) = (\frac{pCi\text{-}s^{-1}c}{\mu Ci\text{-}m^3}) (\quad) \quad (\frac{\mu Ci}{sec}) (\frac{mrem\text{-}m^3}{\mu Ci\text{-}yr})$$

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 (uCi/sec), for each noble gas radionuclide, "i", shown in Table B.1-10.

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

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

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

3.4.2 Method II

Method II consists of the model and input data (whole body dose factors) in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific data or assumptions have been identified in the ODCM. The general equation (B-8) taken from Regulatory Guide 1.109, and used in the derivation of the simplified Method I approach as described in the Basis 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 the peak release rate via the station vents[1]. Method I applies at all release rates.

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

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

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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 evaluation, EL(R), is set equal to 1.0.

3.5.1 Method I

The Skin Dose Rate due to noble gases is:

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

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

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 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:

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

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

---

(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.

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 12.5 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 $\left(\frac{\text{mrem-sec}}{\mu\text{Ci-yr}}\right)$ 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 for the station vent[1] releases during the period.

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

3.7.1 Method I

The gamma air dose from station vent releases is:

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

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

where:

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

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

---

(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.

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 doses from both plant vent stack and ground level releases must be considered for determination of Technical Specification compliance.

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

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

3.7.2 Method II

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

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

3.8.1 Method I

The beta air dose from station vent releases is:

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

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

where:

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

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

---

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

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 doses from both plant vent stack and ground level releases must be considered for determination of Technical Specification compliance.

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

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

3.8.2 Method II

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

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

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

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

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

EL(R) = Elevation Release Point (R) correction factor (dimensionless). For primary vent stack releases, EL(STACK) equals 1.0. For ground level releases, EL(GRD) equals 12.5 for the maximum

off-site receptor, as shown on Table B.1-15. The sum of the doses from both plant vent stack and ground level releases must be considered for determination of Technical Specification compliance.

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

1. Normal operations (nonemergency event),

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

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

3.9.2 METHOD II

Method II consists of the models, input data and assumptions in Appendix C of Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific data or assumptions have been identified in the ODCM (see Tables B.7-2 and B.7-3). The critical organ dose will be determined based on the location (site boundary, nearest resident, or farm) of receptor pathways, as identified in the most recent annual land use census, or by conservatively assuming the existence of all pathways (ground plane, inhalation, ingestion of stored and leafy vegetables, milk and meat) at an off-site location of maximum potential dose. Concurrent meteorology with the release period may be utilized for determination of atmospheric dispersion factors in accordance with 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 3-6), and the beta air dose D_{air}^{β} (Equation 3-7) from the last typical 31-day operating period.

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

(c) Determine the projected dose from:

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

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

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

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

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

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

(d) Determine the projected dose from:

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

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

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

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

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

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

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

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:

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

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

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).

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

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

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

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

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

5.1.4 PCCW Head Tank Rate-of-Change Alarm Setpoint

A rate-of-change alarm on the liquid level in the Primary Component Cooling Water (PCCW) head tank will work in conjunction with the PCCW radiation monitor to alert the operator in the Main Control Room of a leak to the Service Water System from the PCCW System. For the rate-of-change alarm, a setpoint is selected based on detection of an activity level equivalent to 10^{-8} µCi/ml in the discharge of the Service Water System. The activity in the PCCW is determined in accordance with the liquid sampling and analysis program described in Part A, Table A.3-1 of the ODCM and is used to determine the setpoint.

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

$$RC_{set} = 1 \times 10^{-8} \cdot SWF \cdot \frac{1}{PCC} \qquad (5\text{-}23)$$

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

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:

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

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.

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 mixing ratio of 0.10 corresponds to the minimum expected prompt dilution or near-field mixing zone created at the ocean surface directly above the multiport diffusers. (Credit for additional dilution to the outer edge of the prompt mixing zone which corresponds to the $1^{\circ}F$ 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 attentuate 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

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.1-1a. 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:

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

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

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 (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:

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

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