

Hope Creek Generating Station

Offsite Dose Calculation Manual (ODCM)

for station

Radioactive Effluent Controls (REC)

(PSEG NUCLEAR, LLC)

Revision 30

Prepared by: **Rick Heathwaite** See SAP 80130866 / 0400 **06/03/2025**
REMP/REC Program Manager Date

Reviewed by: **Jason Nordin** See SAP 80130866 / 0410 **07/24/2025**
Hope Creek Chemistry Manager Date

Accepted by: **Coley Chappell** See SAP 80130866 / 0420 **07/21/2025**
FRC Chairman Date

Meeting #: **F2025-13**

Approved by: **Robbi McLaughlin** See SAP 80130866 / 0430 **08/14/2025**
Hope Creek Plant Manager Date

Effective Date **08/14/2025**

Revision Summary

This revision is effective on the Effective Date after review and acceptance by FRC and the final approval by the Plant Manager.

Item No.	Rev. 30 Page No.	Description of Change	Type of Change
NA	Numerous throughout	Revised to include Improved Technical Specification (ITS) references, using dual-annotations {CTS:....} and {ITS:} to indicate the differences throughout the procedure.	Editorial-ITS
NA	Numerous throughout	Correct misspelling errors.	Editorial
1.	1	<p>Removed unnecessary references from the Salem tech specification and added additional regulatory guides, CFRs, and NUREGs that are applicable to this ODCM.</p> <p>Justification: Clarifies that only the Hope Creek technical specifications apply to the HC ODCM and that the Salem technical specifications do not apply.</p>	Editorial
2.	1, 2, 6, 13, 19, 24, 28, 29, 32, 33, 34, 35, 36, 38	<p>Changed Hope Creek Radiological Effluent Controls (REC) from CTS: 6.8.4.g to ITS 5.5.3.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS modeling NUREG 1433 Revision 5 as described in LR-N24-0029.</p>	Editorial-ITS
3.	1, 2, 6, 32, 50, 67	<p>Changed Hope Creek Radiological Environmental Monitoring Program (REMP) requirements from CTS 6.9.1.7 to ITS 5.6.2.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS as described in LR-N24-0029.</p>	Editorial-ITS
4.	1, 6	<p>Changed Hope Creek Radiological Environmental Monitoring Program (REMP) requirements from CTS 6.8.4.h to ITS REMP definition.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS modeling NUREG 1433 Revision 5 as described in LR-N24-0029.</p>	Editorial-ITS
5.	1, 6	<p>Changed Hope Creek Radiological Environmental Monitoring Program (REMP) requirements from CTS 6.9.1.6 to ITS 5.6.1.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS modeling NUREG 1433 Revision 5 as described in LR-N24-0029.</p>	Editorial-ITS

Item No.	Rev. 30 Page No.	Description of Change	Type of Change
6.	2	<p>Changed Hope Creek ODCM requirements from CTS 6.14 to ITS 5.5.1.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS modeling NUREG 1433 Revision 5 as described in LR-N24-0029.</p>	Editorial-ITS
7.	5	<p>Added definition of Functional/Functionality for Hope Creek.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS using Operable/Operability definition to refer to TS items only as described in LR-N24-0029.</p>	Editorial-ITS
8.	5	<p>Revised definition of Member(s) of the Public to match the definition in 10 CFR 20: "Member of the public means any individual except when that individual is receiving an occupational dose."</p> <p>Justification: This definition is in alignment with the definitions used for the tech specs in support of the Wind Port Project.</p>	Editorial
9.	5	<p>Added definition of MODES for Hope Creek.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS as described in LR-N24-0029.</p>	Editorial-ITS
10.	6	<p>Change definition of Operable/Operability for Hope Creek.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS as described in LR-N24-0029.</p>	Editorial-ITS
11.	6	<p>Deleted definition of Operational Condition for Hope Creek.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS as described in LR-N24-0029.</p>	Editorial-ITS
12.	6	<p>Revised definition of Rated Thermal Power to include abbreviation.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS as described in LR-N24-0029.</p>	Editorial-ITS

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13.	6	<p>Revised definition of Site Boundary to match the definition in 10 CFR 20: “Site boundary means that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee. (10 CFR 20) (See Figure 1.1)</p> <p>Justification: This definition is in alignment with the definitions used for the tech specs in support of the Wind Port Project.</p>	Editorial
14.	7	<p>Revised definition of Unrestricted Area to match the definition in 10 CFR 20: “Unrestricted area means an area, access to which is neither limited nor controlled by the licensee.” (10 CFR 20) (See Figure 1.1)</p> <p>Justification: This definition is in alignment with the definitions used for the tech specs in support of the Wind Port Project.</p>	Editorial
15.	8	<p>Changed the definition of “R” in Table 1-1 from 18 months (550 days) to 24 months (730 days). Added new surveillance frequency of “18M” in Table 1-1 “At least once per 18 months (550 days)</p> <p>Justification: This supports the move to a 24 month fuel cycle detailed in 80133658R0 P130R0</p>	Editorial
16.	9	<p>Replaced CTS Table 1.2, “OPERATIONAL CONDITIONS,” with ITS Table 1.2, “MODES,”</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS as described in LR-N24-0029.</p>	Editorial-ITS
17.	10 24, 28, 29, 30, 33, 34, 36, 50	<p>Moved Figure 5.1-1 to the end of Section 1 Definitions. Renamed Figure to Figure 1.1. New map showing by color the Site Boundary, NJWP Parcels, and the Exclusion Areas.</p> <p>Updated document to point to Figure 1.1</p> <p>Justification: Section 5.0 Design Features was eliminated from the ODCM as not needed. That section is in Tech Specs and is overriding. The Figure 5.1-1 name changed to Figure 1.1, because the figure was moved from Section 5 (which is deleted) to Section 1 (Definitions). The map was updated</p>	Editorial

Item No.	Rev. 30 Page No.	Description of Change	Type of Change
18.	9, 10, 11, 12	<p>Replaced reference to “OPERATIONAL CONDITIONS,” with “MODES,” and specific OPERATIONAL CONDITION with ITS associated MODE.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS as described in LR-N24-0029.</p>	Editorial-ITS
19.	4, 11, 12, 13, 14, 15, 16, 19, 21, 29, 35, 36, 42, 45, 48	<p>Replaced OPERABLE/OPERABILITY/inoperable with FUNCTIONAL/FUNCTIONALITY/nonfunctional.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS using Operable/Operability definition to refer to TS items only as described in LR-N24-0029.</p>	Editorial-ITS
20.	20	<p>Added the following wording to the footnote to TABLE 3.3.7.11-1: RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION At all times “when ventilation is in service”.</p> <p>Justification: This clarifies that if ventilation has been secured, then releases from the North and South vents cannot take place; therefore, compensatory sampling would not be necessary to take place.</p>	Editorial
21.	22	<p>Changed the Calibration Frequency for the 2.e Sampler Flow Rate Monitor from “R” to “18M” in Table 4.3.7.11-2</p> <p>Justification: This supports the move to a 24 month fuel cycle detailed in 80133658R0 P130R0</p>	Editorial
22.	25	<p>Removed the Weekly Grab Sample for the noble gases from the Turbine Building Circulating Water Dewatering Sump</p> <p>Justification: With modern gamma spectroscopy equipment, meeting the required LLD values for noble gas can be routinely met during the routine Principal Gamma Emitters required LLD requirements</p>	Editorial

Item No.	Rev. 30 Page No.	Description of Change	Type of Change
23.	27	<p>Deleted the following footnote: ** The grab sample from the Turbine Building Circulating Water Dewatering Sump for dissolved and entrained noble gases is required monthly from the composite sampler.</p> <p>Justification: With the removal of the weekly grab sample requirement for the dissolved and entrained noble gases, the footnote no longer applies. The LLDs for noble gases can be met with the routine weekly composite sample collection.</p>	Editorial
24.	28, 29, 33, 34, 35, 36, 38	<p>Deleted reference to CTS 6.9.2, "Special Reports."</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS as described in LR-N24-0029, TS 6.9.2 deleted, reports submitted to NRC in accordance with 10 CFR 50.4.</p>	Editorial-ITS
25.	32	<p>Deleted the following lined through words from the last paragraph. Release of tritium and noble gas is based upon average reactor concentrations. The detailed methodology is in Appendix G.</p> <p>Justification: Appendix G was revised to only address tritium from the TLOV system per the engineering calculations.</p>	Editorial
26.	40	<p>Moved the following Controls to one page. Control 3.12.1 Monitoring Program. Control 3.12.2 Land Use Census. Control 3.12.3 Interlaboratory Comparison Program. Changed the following wording "Salem and Hope Creek Generating Stations Common Radiological Environmental Monitoring Program" to: PSEG Nuclear Common REMP ODCM.</p> <p>Justification: Moving the three controls that each state that they have been moved to the PSEG Nuclear Common REMP ODCM saved space in the document</p>	Editorial
27.	39, 49	<p>Added requirement 3/4.11.5, "Outside Temporary Storage Tanks."</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS as described in LR-N24-0029, Section 5.5 DOC LA05.</p>	Editorial-ITS

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28.	47	<p>Deleted Section 5.0 Design Features</p> <p>Justification: The figure showing the unrestrictive areas and site boundary was updated and moved to Section 1.0 Definitions.</p>	Editorial
29.	50	<p>Revised references to TS Chapter 5.0 to reference Chapter 4.0.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS as described in LR-N24-0029.</p>	Editorial-ITS
30.	50,51,52	<p>Renumbered sections on 6.0 Administrative Controls.</p> <p>6.9.1.7 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT TO 6.1 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT and 6.15 MAJOR CHANGES TO RADIOACTIVE LIQUID, GASEOUS AND SOLID WASTE TREATMENT TO 6.2 MAJOR CHANGES TO RADIOACTIVE LIQUID, GASEOUS AND SOLID WASTE TREATMENT</p> <p>Justification: The annual radioactive effluent release report section number 6.9.1.7 reflected the section of the current technical specification; whereas section number 6.15 is not associated with current or ITS technical specifications.</p>	Editorial
31.	56	<p>Added the following sentence to the last paragraph of section 1.3.2.b "However, if the calculated RE4861 setpoint value is less than 25 percent of the default setpoint in Table 1-1, then Management can decide to make no setpoint changes (See Appendix A for more information).</p> <p>Justification: This allow flexibility for management to determine if a setpoint needs to be changed.</p>	Editorial
32.	56	<p>Revised default MPCe value to 9.84E-06 uCi/ml</p> <p>Justification: Revised to a more conservative MPCe value which will lower the setpoint values.</p>	Technical

Item No.	Rev. 30 Page No.	Description of Change	Type of Change
33.	57	<p>Insert the word “and/” before “or” in the following “increase CTBD or reduce RR”. Added a 4th step that allow management to determine that a setpoint change is not required based on the post-dilution $\mu\text{Ci/ml}$ / MPC ratio value < 1.</p> <p>Justification: The methodology allows both actions to ensure that the default setpoint remains conservative.</p>	Editorial
34.	61, 62	<p>Updated reference to Table 2-1.1 for the values for Ki, Li and Mi. Table 2-1 was named to 2-1.1. and added Table 2-1.2 which contains the noble gas data from Table 5 of ANSI N237-1976/ANS 18.1 Source Term Specifications.</p> <p>Justification: The data in these two tables are used with the data in Table 2-2 to calculate default noble gas radiation monitors setpoints.</p>	Editorial
35.	63	<p>Relocated all $\mu\text{Ci/sec}$ values to Table 2-2 after they were determined using the updated X/Q value for site boundary.</p> <p>Justification: Moved these calculated values to a Table 2-2 which prevents an error likely situation that they might be missed if the site boundary X/Q is updated in the future.</p>	Editorial
36.	67	<p>Added the word “Annual” before Radioactive Effluent Release Report and an “A” before (RERR).</p> <p>Justification: This error was missed in the revision 29 process.</p>	Editorial
37.	67	<p>Clarified that Section 3.1 Special Dose Analysis will use the current five-year annual average meteorological data instead of the current year’s annual average meteorology.</p> <p>Justification: This data is less variable than the annual meteorological data. In addition, the current year’s annual average meteorological data is not available until late February or early March of the following year, which delays the necessary dose analyses.</p>	Editorial
38.	68	<p>Deleted Section 4.0 : RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM</p> <p>Justification: This Section has been moved to the PSEG Nuclear Common REMP ODCM in revision 29. This section is no longer needed. ¶</p>	Editorial

Item No.	Rev. 30 Page No.	Description of Change	Type of Change
39.	69	<p>Updated Figure 1-1 to show correct discharge path of the Condensate Storage Tank to either Equipment Drain Sample Tanks or to the Floor Drain Sample Tanks through the RE4861 radiation Monitor.</p> <p>Justification: Correction to figure to properly reflect discharges from the CST.</p>	Editorial
40.	71	<p>Updated Table 1-1 with revised MPCe value and calculated setpoints for radiation monitors RE4861, RE8817 and RE4557 depending on release source.</p> <p>Added a footnote that setpoints were rounded to one significant digit.</p> <p>Justification: The analysis of MPCe in Appendix A indicates that a liquid effluent setpoint change is required to the default setpoint to maintain conservatism.</p>	Technical
41.	72-73	<p>Added ADULT to Table 1-2 SITE RELATED INGESTION DOSE COMMITMENT FACTOR, Aio (FISH AND INVERTEBRATE CONSUMPTION)</p> <p>Justification: Clarifies what age group these dose factors are for.</p>	Editorial
42.	74-77	<p>Added Tables 1-3 and 1-4 SITE RELATED TEENAGER and CHILD INGESTION DOSE COMMITMENT FACTOR, Aio (FISH AND INVERTEBRATE CONSUMPTION)</p> <p>Justification: This change updates the ODCM to match how the effluent tracking software is calculating dose to all three age groups and picks the age group with the highest dose.</p>	Editorial
43.	78	<p>Renumbered Table 1-3 Bioaccumulation Factors to Table 1-5</p> <p>Justification: This change reflects the addition of two new tables to the ODCM.</p>	Editorial
44.	81	<p>Updated Dose Factors for Noble Gases to include those in the effluent tracking program and renumbered Table 2-1 to Table 2-1.1.</p> <p>Justification: This change aligns the ODCM to the effluent tracking program data files and that another table was added to Table 2-1.</p>	Editorial

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45.	82	Added a new Table 2-1.2 that contains the expected source term in steam obtained from Table 5 of ANSI N-237 Table 5. This table uses the Ki values from Table 2-1.1 to obtain the Ci time Ki values used to determine the default noble gas radiation monitor setpoints.	Editorial																					
46.	83	<p>Updated Table 2-2 to add the distance to Site Boundary in the North sector (0.56 miles N),</p> <p>Added a section to this table that shows the site reduction factor to achieve the 1500 mrem Iodine & Particulate Dose Rate Limit of 1500 mrem/year of Section 2.3.2.</p> <table border="1"> <tr> <td>1500 mrem/yr Instantaneous Limit from Section 2.3.2</td> <td>Calculated</td> <td>Default</td> <td>Units</td> <td rowspan="5">Section 2.3.2 discusses the back calculation of what release rate of iodine and particulates would be needed to approach the 1500 mrem/yr instantaneous dose limit.</td> </tr> <tr> <td>Reduction Factor</td> <td>Coordinated with SGS</td> <td>2</td> <td>Unitless</td> </tr> <tr> <td>Release Rate</td> <td>2.16E+01</td> <td>N/A</td> <td>µCi/sec</td> </tr> <tr> <td>Seconds per 7 days</td> <td>N/A</td> <td>604,800</td> <td>seconds</td> </tr> <tr> <td>Total µCi</td> <td>1.31E+07</td> <td>N/A</td> <td>µCi</td> </tr> </table> <p>Justification: Previous ODCM revisions used 0.5 miles as Site Boundary and the data from UFSAR Table 2.3-31. With the work being performed for the Wind Port, the correct Site Boundary distance had to be updated. Moving the calculated values in Section 2.3.2 to this table will reduce an error likely situation.</p>	1500 mrem/yr Instantaneous Limit from Section 2.3.2	Calculated	Default	Units	Section 2.3.2 discusses the back calculation of what release rate of iodine and particulates would be needed to approach the 1500 mrem/yr instantaneous dose limit.	Reduction Factor	Coordinated with SGS	2	Unitless	Release Rate	2.16E+01	N/A	µCi/sec	Seconds per 7 days	N/A	604,800	seconds	Total µCi	1.31E+07	N/A	µCi	Editorial
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Reduction Factor	Coordinated with SGS	2	Unitless																					
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Seconds per 7 days	N/A	604,800	seconds																					
Total µCi	1.31E+07	N/A	µCi																					
47.	84	<p>Updated Table 2-3 for the Site Boundary location at 0.56 miles North Sector.</p> <p>Justification: Previous ODCM revisions used 0.5 miles as Site Boundary and the data from UFSAR Table 2.3-31. With the work being performed for the Wind Port, the correct Site Boundary distance had to be updated. Moving the calculated values in Section 2.3.2 to this table will reduce an error likely situation.</p>	Editorial																					
48.	100-107	<p>A complete revision to Appendix A Evaluation of Default MPC Values for Liquid Effluents.</p> <p>Justification: A periodic 3-year review of liquid effluents showed a decline in the number of curies released from Hope Creek has occurred since the MPCe value was changed in revision 29. The use of a more conservative MPCe value (lower) reduces the calculated default setpoints for RE4861, RE8817, and RE4557. The Appendix was revised to add clarity to both the MPC calculation and to the setpoint calculation. Revised to set a default value for RE8817.</p>	Technical																					

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49.	129-132	<p>Revised Appendix G Miscellaneous Tritium Releases – Calculational Methodology to remove noble gas from this appendix.</p> <p>Justification: The calculational methodology that is presented in this appendix was specific to tritium only. Noble gas was never intended to be calculated. This change resolves a typographical error that was entered in revision 29</p>	Editorial
50.	20	<p>Provides a note to state that monitoring of the radioactivity rate of noble gases at the recombiner after-condenser discharge is performed by the Offgas Pre-treatment Rad Monitor.</p> <p>Justification: Changed to align with Hope Creek License Amendment converting to the Improved TS as described in LR-N24-0029, Section 3.7.5 DOC LA01.</p>	Editorial-ITS

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HOPE CREEK GENERATING STATION
OFFSITE DOSE CALCULATION MANUAL FOR RADIOACTIVE EFFLUENT CONTROLS

INTRODUCTION

This Document conforms to the requirements of 10CFR20, 10CFR72.44, 10CFR50 Appendix I, and 40CFR190 as well as the guidance of Regulatory Guides 4.15, 1.21, 1.23 and NUREGs 1302, 0133, and includes the items required by Tech Spec or Generic Letter 89-01, as applicable.

A. This document **DOES** contain:

- Description of the methodologies and parameters used for the Radiological Effluent Controls (REC) requirements established by Hope Creek Technical Specification {CTS: 6.8.4.g} {ITS: 5.5.3}.
- CONTROLS, ACTIONS, CALCULATIONS, and BASES for the Hope Creek REC, including:
 - The calculation of radioactive liquid and gaseous effluent monitoring instrumentation alarm and/or trip setpoints, or conservative defaults.
 - The calculation of radioactive liquid and gaseous concentrations, dose rates, cumulative quarterly and yearly doses, and projected doses.
 - The information that should be included in the Annual Radioactive Effluent Release Report required by Technical Specification {CTS: 6.9.1.7} {ITS: 5.6.2} Hope Creek Unit 1.
 - Maximum Permissible Concentrations (MPCs) for radioactive liquid effluent concentration limits.

B. This document **DOES NOT** contain:

- Description of the methodologies and parameters used for the PSEG Nuclear common Radiological Environmental Monitoring Program (REMP) requirements established by Hope Creek {CTS: Technical Specifications 6.8.4.h} {ITS: REMF definition 1.20 in the PSEG common REMF ODCM}.
- CONTROLS, ACTIONS, CALCULATIONS, and BASES for the PSEG Common REMF for Salem and Hope Creek Nuclear Generating Stations.
- Lists and graphical descriptions of the specific sample locations for the REMF
- Description of information that should be included in the PSEG Common Annual Radiological Environmental Operating Report as required by Technical Specification {CTS: 6.9.1.6} {ITS: 5.6.1} for Hope Creek Unit 1.

Conversely, the above methodologies and parameters pertaining to CONTROLS, ACTIONS, CALCULATIONS, and BASES for environmental monitoring of Salem and Hope Creek Generating Stations can be found in the PSEG Nuclear Common REMF Offsite Dose Calculation Manual (Common REMF ODCM).

The Hope Creek Radioactive Effluent Controls Offsite Dose Calculation Manual (Hope Creek REC ODCM) is a supporting document to the Hope Creek Technical Specifications. The previous Limiting Conditions for Operations that were contained in the Radiological Effluent Technical Specifications (RETS) are now included in the ODCM as Radiological Effluent Controls (REC). The ODCM contains two parts: Part I - Radiological Effluent Controls, and Part II – Calculational Methodologies.

Part I includes the following:

- The Radiological Effluent Controls Program required by Technical Specifications **{CTS: 6.8.4}** **{ITS: 5.5.3}**
- Descriptions of the information that should be included in the Annual Radioactive Effluent Release Report required by Technical Specifications **{CTS: 6.9.1.7}** **{ITS: 5.6.2}**.

Part II describes the methodologies and parameters used for:

- the calculation of radioactive liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints; and
- the calculation of radioactive liquid and gaseous concentrations, dose rates, cumulative quarterly and yearly doses, and projected doses.

Part II also contains a graphical description of the liquid and gaseous waste treatment systems.

Revisions to the ODCM shall be made in accordance with the Technical Specifications Section **{CTS: 6.14}** **{ITS: 5.5.1}**.

The current licensing basis applies Maximum Permissible Concentrations (MPCs) for radioactive liquid effluent concentration limits. Since the MPC values were removed from 10CFR20 effective 1/1/94, the MPC values are provided as Appendix F to the ODCM. As discussed in the Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment No.121, letters between the Nuclear Management and Resources Council (NUMARC) concerning the differences between the “old” 10CFR20 and the “new” 10CFR20 allowed continued use of the instantaneous release limits (MPCs). The NUMARC letter of April 28, 1993, concluded that the RETS that reference the “old” Part 20 are generally more restrictive than the comparable requirements of the “new” Part 20, and therefore, in accordance with 10 CFR 20.1008, the existing RETS could remain in force after the licensee implements the “new” Part 20. The letter stated that the existing RETS which reference the “old” Part 20 would maintain the level of required protection of public health and safety and would be consistent with the requirements of the “new” Part 20. The “new” 10 CFR Part 20 was effective January 1, 1994. Versions of 10 CFR Part 20 prior to January 1, 1994, are considered to be the “old” 10 CFR Part 20.

PART I – RADIOLOGICAL EFFLUENT CONTROLS

1.0 DEFINITIONS

1.0 DEFINITIONS

The following terms are defined so that uniform interpretation of these CONTROLS may be achieved. The defined terms appear in capitalized type and are applicable throughout these CONTROLS.

1.1 ACTION

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

1.2 CHANNEL CALIBRATION

A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds with the necessary range and accuracy to known values of the parameter that the channel monitors. The CHANNEL CALIBRATION shall encompass the entire channel, including the required sensor, alarm, display, and trip functions, and shall include the CHANNEL FUNCTIONAL TEST. Calibration of instrument channels with resistance temperature detector (RTD) or thermocouple sensors may consist of an in place qualitative assessment of sensor behavior and normal calibration of the remaining adjustable devices in the channel. Whenever an RTD or thermocouple sensing element is replaced, the next required CHANNEL CALIBRATION shall include an in place cross calibration that compares the other sensing elements with the recently installed sensing monitor. The CHANNEL CALIBRATION may be performed by means of any series of sequential, overlapping, or total channel steps so that the entire channel is calibrated.

1.3 CHANNEL CHECK

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

1.4 CHANNEL FUNCTIONAL TEST

A CHANNEL FUNCTIONAL TEST shall be:

- A. Analog channels - the injection of a simulated signal into the channel as close to the sensor as practicable to verify **{CTS: OPERABILITY} {ITS: FUNCTIONALITY}** including alarm and/or trip functions and channel failure trips.
- B. Bi stable channels – the injection of a simulated signal into the sensor to verify **{CTS: OPERABILITY} {ITS: FUNCTIONALITY}** including alarm and/or trip functions.

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

1.5 CONTROL

The Limiting Conditions for Operation (LCOs) that were contained in the Radiological Effluent Technical Specifications were transferred to the OFFSITE DOSE CALCULATION MANUAL (ODCM) and were renamed CONTROLS. This is to distinguish between those LCOs that were retained in the Technical Specifications and those LCOs or CONTROLS that were transferred to the ODCM.

1.6 DOSE EQUIVALENT I-131

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

1.0 DEFINITIONS

1.7 FREQUENCY NOTATION

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

1.8 {ITS: FUNCTIONAL / FUNCTIONALITY}

A system, structure, or component is FUNCTIONAL or has FUNCTIONALITY when it is capable of performing its function(s) as described in the design and licensing basis. FUNCTIONALITY includes the ability of required support systems to perform their related support function(s) for equipment required to be OPERABLE by the TS.}

1.9 LOWER LIMIT OF DETECTION (LLD)

As Defined by Reg Guide 1.21 Rev 2: The *a priori* 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 a 5% probability of falsely concluding that a blank observation represents a real signal (see NUREG-1301, NUREG-1302, and NUREG/CR-4007, "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," issued September 1984 (Ref.51).

The LLD is more simply an *a priori* (predefined) limit representing the required capability of a measurement for a system or methodology. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions for the concentration at which the analyte will no longer be reliably detected with certainty (i.e. method must be able to detect the analyte with certainty to a value at or below the LLD).

1.10 MEMBER(S) OF THE PUBLIC

Member of the public means any individual except when that individual is receiving an occupational dose. (10CFR20)

1.11 {ITS: MODE}

A MODE shall correspond to any one inclusive combination of mode switch position, average reactor coolant temperature, and reactor vessel head closure bolt tensioning specified in Table 1.2 with fuel in the reactor vessel.}

1.12 OFF-GAS RADWASTE TREATMENT SYSTEM (GASEOUS RADWASTE TREATMENT SYSTEM)

An OFF-GAS RADWASTE TREATMENT SYSTEM (GASEOUS RADWASTE TREATMENT SYSTEM) is any system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system offgases from the main condenser evacuation system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

1.13 OFFSITE DOSE CALCULATION MANUAL (ODCM)

The Hope Creek Generating Station OFFSITE DOSE CALCULATION MANUAL (ODCM) is separated into two separate documents.

The first document, the Hope Creek Generating Station Radioactive Effluent Controls (REC) ODCM, shall contain the methodology and parameters used in the calculation of offsite doses due to radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring alarm/trip setpoints, The REC ODCM shall also contain (1) the Radioactive Effluent Controls Program required by Technical Specification Section {CTS: 6.8.4.g} {ITS: 5.5.3}.and (2) descriptions of the information that should be included in the Annual Radioactive Effluent Release Reports required by Technical Specification Section {CTS: 6.9.1.7} {ITS:.5.6.2}

The second document, The PSEG Nuclear Common REMP ODCM, shall contain the conduct of the environmental radiological monitoring program. The Common ODCM shall also contain (1) the Radiological Environmental Monitoring Program {CTS: required by Technical

1.0 DEFINITIONS

Specification Section 6.8.4.h) **{ITS: NA}** and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating Report required by Technical Specification Section **{CTS: 6.9.1.6}** **{ITS: 5.6.1}**.

1.14 OPERABLE - OPERABILITY

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

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

1.15 {CTS: OPERATIONAL CONDITION – CONDITION

An OPERATIONAL CONDITION (i.e. CONDITION) shall be any one inclusive combination of mode switch position and average reactor coolant temperature as specified in Table 1.2} **{ITS: NA}**

1.16 PURGE – PURGING

PURGE or PURGING shall be the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration, or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.

1.17 RATED THERMAL POWER {ITS: (RTP)}

{CTS: RATED THERMAL POWER} {ITS: RTP} shall be a total reactor core heat transfer rate to the reactor coolant of 3902 MWT.

1.18 REPORTABLE EVENT

A REPORTABLE EVENT shall be any of those conditions specified in Section 50.73 to 10CFR Part 50 or 10CFR 72.75.

1.19 SITE BOUNDARY

Site boundary means that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee. (10CFR20) (See Figure 1.1)

1.20 SOURCE CHECK

SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.

1.21 THERMAL POWER

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

1.22 UNRESTRICTED AREA

Unrestricted area means an area, access to which is neither limited nor controlled by the licensee. (10CFR20) (See Figure 1.1)

1.23 VENTILATION EXHAUST TREATMENT SYSTEM

A VENTILATION EXHAUST TREATMENT SYSTEM shall be any system designed and installed to reduce gaseous radioiodine and radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and/or HEPA filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment. Such a system is not considered to have any

1.0 DEFINITIONS

effect on noble gas effluents. Engineered Safety Feature (ESF) atmospheric cleanup systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

1.24 VENTING

VENTING shall be the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration, or other operating condition, in such a manner that replacement air or gas is not provided or required during VENTING. Vent, used in system names, does not imply a VENTING process.

1.0 DEFINITIONS

TABLE 1.1 SURVEILLANCE FREQUENCY NOTATION

NOTATION	FREQUENCY
S	At least once per 12 hours
D	At least once per 24 hours
W	At least once per 7 days
M	At least once per 31 days
Q	At least once per 92 days
SA	At least once per 184 days
A	At least once per 366 days
R	At least once per 24 months (730 days)
S/U	Prior to each reactor startup
P	Prior to each radioactive release
Z	During startup, prior to exceeding 30% of RATED THERMAL POWER, if not performed within the previous 7 days
N/A	Not Applicable
18M	At least once per 18 months (550 days)

1.0 DEFINITIONS

{CTS: TABLE 1.2 OPERATIONAL CONDITIONS

CONDITION	MODE SWITCH POSITION	AVERAGE REACTOR COOLANT TEMPERATURE
1. Power Operation	Run	Any temperature
2. Startup	Startup/Hot Standby	Any temperature
3. Hot Shutdown	Shutdown#, ***	> 200°F
4. Cold Shutdown	Shutdown#, ##, ***	≤ 200°F+
5. Refueling*	Shutdown or Refuel **, #	≤ 140°F

The reactor mode switch may be placed in the Run, Startup/Hot Standby, or Refuel position to test the switch interlock functions and related instrumentation provided that the control rods are verified to remain fully inserted by a second licensed operator or other technically qualified member of the unit technical staff. If the reactor mode switch is placed in the Refuel position, the one-rod-out interlock shall be OPERABLE.

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

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

** See Special Test Exceptions Technical Specification sections 3.10.1 and 3.10.3.

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

+ See Special Test Exception Technical Specification 3.10.8.}

{ITS: Table 1.2: MODES

MODE	TITLE	REACTOR MODE SWITCH POSITION	AVERAGE REACTOR COOLANT TEMPERATURE (°F)
1	Power Operation	Run	NA
2	Startup	Refuel ^(a) or Startup/Hot Standby	NA
3	Hot Shutdown ^(a)	Shutdown	> 200
4	Cold Shutdown ^(a)	Shutdown	≤ 200
5	Refueling ^(b)	Shutdown or Refuel	NA




(a) All reactor vessel head closure bolts fully tensioned.

(b) One or more reactor vessel head closure bolts less than fully tensioned.}

1.0 DEFINITIONS

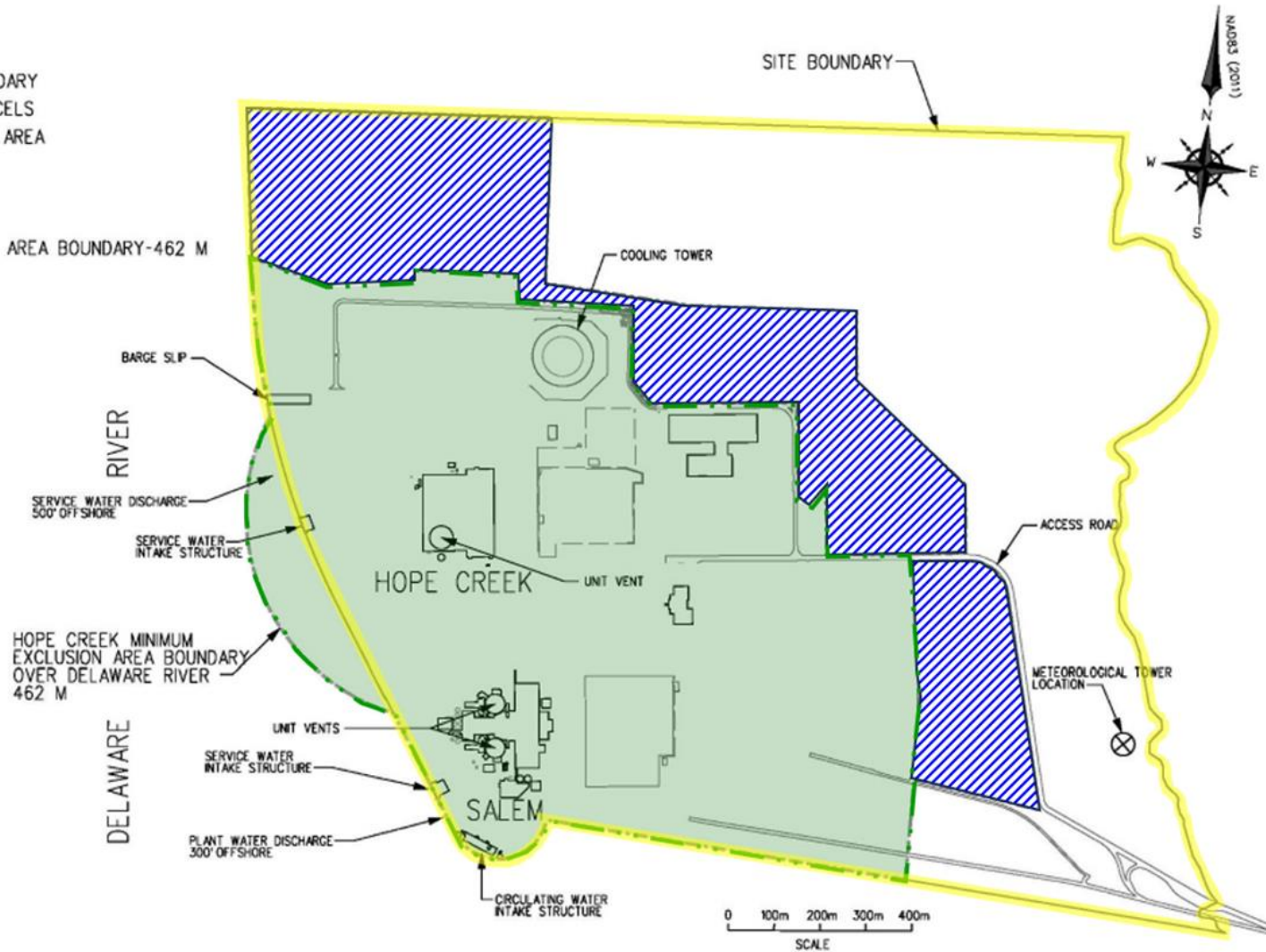
FIGURE 1.1 AREA PLOT PLAN OF SITE

LEGEND:

-  SITE BOUNDARY
-  NJWP PARCELS
-  EXCLUSION AREA

NOTES:

- 1. MINIMUM EXCLUSION AREA BOUNDARY-462 M



3/4 CONTROLS AND SURVEILLANCE REQUIREMENTS

3/4.0 APPLICABILITY

3.0 CONTROLS

3.0.1 Compliance with the CONTROLS contained in the succeeding CONTROLS is required during the {CTS: OPERATIONAL CONDITIONS} {ITS: MODES} or other conditions specified therein; except that upon failure to meet the CONTROLS, the associated ACTION requirements shall be met.

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

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

1. At least {CTS: STARTUP} {ITS: MODE 2} within the next 6 hours,
2. At least {CTS: HOT SHUTDOWN} {ITS: MODE 3} within the following 6 hours, and
3. At least {CTS: COLD SHUTDOWN} {ITS: MODE 4} within the subsequent 24 hours.

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

This CONTROL is not applicable in {CTS: OPERATIONAL CONDITION} {ITS: MODE} 4 or 5.

3.0.4 Entry into {CTS: an OPERATIONAL CONDITIONS} {ITS: a MODE} or other specified condition shall not be made when the conditions of the CONTROLS are not met, and the associated ACTION requires a shutdown if they are not met within a specified time interval. Entry into {CTS: an OPERATIONAL CONDITION} {ITS: a MODE} or other specified condition may be made in accordance with ACTION requirements when conformance to them permits continued operation of the facility for an unlimited period of time. This provision shall not prevent passage through or to {CTS: OPERATIONAL CONDITIONS} {ITS: MODES} as required to comply with ACTION requirements. Exceptions to these requirements are stated in the individual CONTROLS.

3.0.5 Equipment removed from service or declared {CTS: inoperable} {ITS: nonfunctional} to comply with ACTIONS may be returned to service under administrative control solely to perform testing to demonstrate its {CTS: OPERABILITY} {ITS: FUNCTIONALITY} or the {CTS: OPERABILITY} {ITS: FUNCTIONALITY} of other equipment. This is an exception to CONTROL 3.0.2 for the system returned to service under administrative control to perform the testing required to demonstrate {CTS: OPERABILITY} {ITS: FUNCTIONALITY}.

3/4 CONTROLS AND SURVEILLANCE REQUIREMENTS

4.0 SURVEILLANCE REQUIREMENTS

- 4.0.1 Surveillance Requirements shall be met during the {CTS: OPERATIONAL CONDITIONS} {ITS: MODES} or other conditions specified for individual CONTROLS unless otherwise stated in an individual Surveillance Requirement.
- 4.0.2 Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25 percent of the specified surveillance interval.
- 4.0.3 Failure to perform a Surveillance Requirement within the allowed surveillance interval, defined by CONTROL 4.0.2, shall constitute a failure to meet the {CTS: OPERABILITY} {ITS: FUNCTIONALITY} requirements for a CONTROL. The time limits of the ACTION requirements are applicable at the time it is identified that a Surveillance Requirement has not been performed. The ACTION requirements may be delayed for up to 24 hours to permit the completion of the surveillance when the allowed outage time limits of the ACTION requirements are less than 24 hours. Surveillance Requirements do not have to be performed on {CTS: inoperable} {ITS: nonfunctional} equipment.
- 4.0.4 Entry into {CTS: an OPERATIONAL CONDITION} {ITS: a MODE} or other specified applicable condition shall not be made unless the Surveillance Requirement(s) associated with the CONTROLS have been performed within the applicable surveillance interval or as otherwise specified. This provision shall not prevent passage through or to {CTS: OPERATIONAL CONDITIONS} {ITS: MODES} as required to comply with ACTION requirements.

3/4.3 INSTRUMENTATION

3/4.3.7.10 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

- 3.3.7.10 In accordance with Hope Creek Technical Specifications {CTS: 6.8.4.g.1} {ITS: 5.5.3.a}, the radioactive liquid effluent monitoring instrumentation channels shown in Table 3.3.7.10-1 shall be {CTS: OPERABLE} {ITS: FUNCTIONAL} with their Alarm/Trip setpoints set to ensure that the limits of CONTROL 3.11.1.1 are not exceeded. The Alarm/Trip setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: During all liquid releases via these pathways.

ACTION:

- a. With a radioactive liquid effluent monitoring instrumentation channel Alarm/Trip setpoint less conservative than required by the above CONTROL, immediately suspend the release of radioactive liquid effluents monitored by the affected channel or declare the channel {CTS: inoperable} {ITS: nonfunctional}, or change the setpoint so it is acceptably conservative.
- b. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels {CTS: OPERABLE} {ITS: FUNCTIONAL}, take the ACTION shown in Table 3.3.7.10-1.
- c. Exert best efforts to return the instrument to {CTS: OPERABLE} {ITS: FUNCTIONAL} status within 30 days and, if unsuccessful, explain in the next Radioactive Effluent Release report why the {CTS: inoperability} {ITS: nonfunctionality} was not corrected in a timely manner.
- d. The provisions of CONTROL 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

- 4.3.7.10 Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated {CTS: OPERABLE} {ITS: FUNCTIONAL} by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST at the frequencies shown in Table 4.3.7.10- 1

3/4.3 INSTRUMENTATION

3/4.3.7.10 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

TABLE 3.3.7.10-1 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS {CTS: OPERABLE} {ITS: FUNCTIONAL}	ACTION
1. Radioactivity Monitors Providing Alarm and Automatic Termination of Release		
a. Liquid Radwaste Discharge Line to the Cooling Tower Blowdown Line	1 (RE4861)	110
b. Turbine Building Circulating Water Dewatering Sump Discharge Line to the Cooling Tower*	1 (RE4557)	110
2. Radioactivity Monitors Providing Alarm but not Providing Automatic Termination of Release		
a. Cooling Tower Blowdown Effluent	1 (RE8817)	111
3. Flow Rate Measurement Devices		
a. Liquid Radwaste Discharge Line to the Cooling Tower Blowdown Line	1 (FITN119, FITN120)	112
b. Cooling Tower Blowdown Weir***	1 (FIT2164)	112
c. Turbine Building Circulating Water Dewatering Sump Discharge Line**	N/A	N/A

3/4.3 INSTRUMENTATION

3/4.3.7.10 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

TABLE 3.3.7.10-1: RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION (Continued)

TABLE NOTATIONS

ACTION 110¹ - With the number of channels **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** less than required by the Minimum Channels **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** requirement, effluent releases via this pathway may continue provided that prior to initiating a release:

- a. At least two independent samples are analyzed in accordance with CONTROL 4.11.1.1.2, and
- b. At least two technically qualified members of the Facility Staff independently verify the release rate calculations and discharge line valving.

Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 111¹ - With the number of channels **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** less than required by the Minimum Channels **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** requirement, effluent releases via this pathway may continue provided that, at least once per 12 hours, grab samples are collected and analyzed for principal gamma emitters, I-131, and dissolved and entrained noble gases at the lower limits of detection required in ODCM CONTROL Table 4.11.1.1.1-1.B, and the Surveillance Requirement 4.11.1.1.2 is performed. Otherwise, suspend the release of radioactive effluents via this pathway.

ACTION 112 - With the number of channels **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** less than required by the Minimum Channels **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves generated in place may be used to estimate flow.

* See Appendix A for setpoint determination for the Turbine Building Circulating Water Dewatering Sump (TBCWDWS). Different setpoints are established for this monitor based on its use for batch release or continuous release. Automatic termination of releases from the TBCWDWS is by trip of the sump pump(s). ACTION 110 only applies to batch releases for the TBCWDWS. Continuous releases are not authorized with the TBCWDWS radiation monitor inoperable.

¹ ACTION 110 IF an RMS monitor is **{CTS: inoperable}** **{ITS: nonfunctional}** solely as the result of the loss of Control Room alarm annunciation, THEN one of the following actions is acceptable to satisfy the ODCM ACTION statement compensatory surveillance requirement:

ACTION 111

1. TAKE Grab Samples AND conduct radiometric analysis per the specific monitor's ACTION statement,

OR

2. TAKE local monitor readings at a frequency equal to or greater (more frequently) than the ACTION statement.

3/4.3 INSTRUMENTATION

3/4.3.7.10 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

TABLE 3.3.7.10-1: RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION (Continued)

TABLE NOTATIONS

** There are no discharge process flow rate measurement devices for this pathway. Conservative assumptions are made for release rates. The maximum release rate from the sump is 100 gpm. This value should be used for setpoint calculations to determine compliance with CONTROL 3.11.1.1. More realistic values may be used to calculate total activity released and dose consequences. Actual values should be used if process flow measurement devices are installed.

*** During periods when releases are made using the Service Water Bypass Line for dilution, the Cooling Tower Blowdown Weir flow measurement device is bypassed. During this configuration, the number of channels {CTS: OPERABLE} {ITS: FUNCTIONAL} for the flow rate measurement device is less than required by the Minimum Channels {CTS: OPERABLE} {ITS: FUNCTIONAL} requirement. Effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves generated in place may be used to estimate flow. The flow rate when releases are being made using the Service Water Bypass Line must have a minimum of 12,000 gpm to maintain the minimum dilution factor required for liquid releases to the Delaware River.

3/4.3 INSTRUMENTATION

3/4.3.7.10 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

TABLE 4.3.7.10-2 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. Radioactivity Monitors Providing Alarm and Automatic Termination of Release				
a. Liquid Radwaste Discharge Line to the Cooling Tower Blowdown Line	D	P	R(3)	Q(1)
b. Turbine Building Circulating Water Dewatering Sump Discharge Line to the Cooling Tower*	D(5)	M	R(3)	Q(1)(6)
2. Radioactivity Monitors Providing Alarm but not Providing Automatic Termination of Release				
a. Cooling Tower Blowdown Effluent	D	M	R(3)	Q(2)
3. Flow Rate Measurement Devices				
a. Liquid Radwaste Discharge Line to the Cooling Tower Blowdown Line	D(4)	N/A	R	Q
b. Cooling Tower Blowdown Weir	D(4)	N/A	R	Q

3/4.3 INSTRUMENTATION

3/4.3.7.10 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

TABLE 4.3.7.10-2: RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS (Continued)

TABLE NOTATIONS

- (1) The CHANNEL FUNCTIONAL TEST shall demonstrate that automatic isolation of release from this pathway and control room alarm annunciation occur if any of the following conditions exist:
 - a. Instrument indicates measured levels at or above the Alarm/Trip setpoint, or
 - b. Circuit failure, or
 - c. Instrument indicates a downscale failure.
- (2) The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exist:
 - a. Instrument indicates measured levels at or above the Alarm/Trip setpoint, or
 - b. Circuit failure, or
 - c. Instrument indicates a downscale failure.
- (3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS)/National Institute of Standards and Testing (NIST) or using standards that have been obtained from suppliers that participate in assurance activities with NBS/NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration or are NBS/NIST traceable shall be used.
- (4) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days on which continuous, periodic, or batch releases are made.
- (5) In addition to performing channel check on rad monitor, PERFORM:
 - a. CHANNEL CHECK – daily, including verification of sample flow through the radiation monitor during sump pump operation.
- (6) Isolation is demonstrated by securing the discharge pump during the functional check

3/4.3 INSTRUMENTATION

3/4.3.7.11 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

3.3.7.11 In accordance with Hope Creek Technical Specifications **{CTS: 6.8.4.g.1}** **{ITS: 5.5.3.a}**, the radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.3.7.11-1 shall be **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** with their alarm/trip setpoints set to ensure that the limits of CONTROLS 3.11.2.1 are not exceeded. The alarm/trip setpoints of these channels meeting CONTROLS 3.11.2.1 shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

APPLICABILITY: As shown in Table 3.3.7.11-1

ACTION:

- a. With a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above CONTROL, immediately suspend the release of radioactive gaseous effluents monitored by the affected channel, or declare the channel **{CTS: inoperable}** **{ITS: nonfunctional}**, or change the setpoint so it is acceptably conservative.
- b. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels be **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}**, take the ACTION shown in Table 3.3.7.11-1.
- c. Exert best efforts to return the instrument to be **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** status within 30 days and, if unsuccessful, explain in the next Radioactive Effluent Release Report pursuant to CONTROL 6.1 why this **{CTS: inoperability}** **{ITS: nonfunctionality}** was not corrected in a timely manner.
- d. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.3.7.11 Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4.3.7.11-2.

3/4.3 INSTRUMENTATION

3/4.3.7.11 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

TABLE 3.3.7.11-1 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
1. Deleted			
2. Filtration, Recirculation and Ventilation Monitoring System			
a. Noble Gas Activity Monitor	1 (RE4811A)	*	123
b. Iodine Sampler	1	*	125
c. Particulate Sampler	1	*	125
d. Flow Rate Monitor	1 (FT4811-1/2/3/4)	*	122
e. Sampler Flow Rate Monitor	1 (FT4811A, FT4811B)	*	122
3. South Plant Vent Monitoring System			
a. Noble Gas Activity Monitor	1 (RE4875B)	*	123
b. Iodine Sampler	1	*	125
c. Particulate Sampler	1	*	125
d. Flow Rate Monitor	1 (FT4816)	*	122
e. Sampler Flow Rate Monitor	1 (FL4875B, FT4875C)	*	122
4. North Plant Vent Monitoring System			
a. Noble Gas Activity Monitor#	1 (RE4873B)	*	123
b. Iodine Sampler	1	*	125
c. Particulate Sampler	1	*	125
d. Flow Rate Monitor	1 (FT4873)	*	122
e. Sampler Flow Rate Monitor	1 (FT4873B, FT4873C)	*	122

* At all times when ventilation is in service.

Monitoring of the radioactivity rate of noble gases at the recombiner after-condenser discharge is performed by the Offgas Pre-treatment Rad Monitor as required by {CTS: 4.11.2.7.1} {ITS: Technical Requirements Manual 13.3.7.1}

3/4.3 INSTRUMENTATION

3/4.3.7.11 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

TABLE 3.3.7.11-1: RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
(Continued)

TABLE NOTATIONS

ACTION 122 -	With the number of channels channels {CTS: OPERABLE} {ITS: FUNCTIONAL} less than required by the Minimum Channels channels {CTS: OPERABLE} {ITS: FUNCTIONAL} requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours. Otherwise, suspend release of radioactive effluents via this pathway.
ACTION 123 ¹ -	With the number of channels channels {CTS: OPERABLE} {ITS: FUNCTIONAL} less than required by the Minimum Channels channels {CTS: OPERABLE} {ITS: FUNCTIONAL} requirement, effluent releases via this pathway may continue provided grab samples are taken at least once per 12 hours and these samples are analyzed for principal gamma emitters (noble gases) at the lower limits of detection required in ODCM CONTROL Table 4.11.2.1.2-1.A or B within 24 hours. Otherwise, suspend release of radioactive effluents via this pathway.
ACTION 124 -	DELETED
ACTION 125 -	With the number of channels channels {CTS: OPERABLE} {ITS: FUNCTIONAL} less than required by the Minimum Channels channels {CTS: OPERABLE} {ITS: FUNCTIONAL} requirement, effluent releases via this pathway may continue provided that within 8 hours samples are continuously collected with auxiliary sampling equipment as required in Table 4.11.2.1.2-1.

¹ ACTION 123 IF an RMS monitor is **{CTS: inoperable}** **{ITS: nonfunctional}** solely as the result of the loss of Control Room alarm annunciation, THEN one of the following actions is acceptable to satisfy the ODCM ACTION statement compensatory surveillance requirement:

1. TAKE Grab Samples AND conduct radiometric analysis per the specific monitor’s ACTION statement,

OR

2. TAKE local monitor readings at a frequency equal to or greater (more frequently) than the ACTION statement.

3/4.3 INSTRUMENTATION

3/4.3.7.11 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

TABLE 4.3.7.11-2 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	MODES IN WHICH SURVEILLANCE REQUIRED
1. Deleted					
2. Filtration, Recirculation and Ventilation Monitoring System					
a. Noble Gas Activity Monitor	D	M	R(2)	Q(1)	*
b. Iodine Sampler	W	N/A	N/A	N/A	*
c. Particulate Sampler	W	N/A	N/A	N/A	*
d. Flow Rate Monitor	D	N/A	R	Q	*
e. Sampler Flow Rate Monitor	D	N/A	18M	Q	*
3. South Plant Vent Monitoring System					
a. Noble Gas Activity Monitor	D	M	R(2)	Q(1)	*
b. Iodine Sampler	W	N/A	N/A	N/A	*
c. Particulate Sampler	W	N/A	N/A	N/A	*
d. Flow Rate Monitor	D	N/A	R	Q	*
e. Sampler Flow Rate Monitor	D	N/A	R	Q	*
4. North Plant Vent Monitoring System					
a. Noble Gas Activity Monitor	D	M	R(2)	Q(1)	*
b. Iodine Sampler	W	N/A	N/A	N/A	*
c. Particulate Sampler	W	N/A	N/A	N/A	*
d. Flow Rate Monitor	D	N/A	R	Q	*
e. Sampler Flow Rate Monitor	D	N/A	R	Q	*

3/4.3 INSTRUMENTATION

3/4.3.7.11 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

TABLE 4.3.7.11-2: RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION
SURVEILLANCE REQUIREMENTS (Continued)

TABLE NOTATIONS

* At all times

- (1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that the control room alarm annunciation occurs if any of the following conditions exist:
- a. The instrument indicates measured levels above the alarm setpoint.
 - b. Circuit failure.
 - c. Instrument indicates a downscale failure.
- (2) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS)/National Institute of Standards and Testing (NIST) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS/NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration or are NBS/NIST traceable shall be used.

- 3/4.11 RADIOACTIVE EFFLUENTS
- 3/4.11.1 LIQUID EFFLUENTS
- 3/4.11.1.1 CONCENTRATION

CONTROLS

3.11.1.1 In accordance with the Hope Creek Technical Specifications {**CTS:** 6.8.4.g.2 and 3} {**ITS:** 5.5.3.b and 5.5.3.c}, the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (See Figure 1.1) shall be limited to the concentrations specified in 10 CFR Part 20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} microcuries/ml.

APPLICABILITY: At all times.

ACTION:

- a. With the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeding the above limits, immediately restore the concentration to within the above limits.
- b. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

- 4.11.1.1.1 Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program in Table 4.11.1.1.1-1.
- 4.11.1.1.2 The results of the radioactivity analyses shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits of CONTROL 3.11.1.1.

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.1 CONCENTRATION

TABLE 4.11.1.1.1-1: RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM ¹

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) ^(a) (uCi/ml)		
A. Batch Waste 1) Release ^(b) Sample Tanks 2) Turbine Building Circulating Water Dewatering Sump when released in Batch Mode*	P Each Batch	P Each Batch	Principal Gamma Emitters ^(c)	5x10 ⁻⁷		
			I-131	1x10 ⁻⁶		
			Dissolved and Entrained Gases (Gamma Emitters)	1x10 ⁻⁵		
			M Composite ^(d)	Q Composite ^(d)	H-3	1x10 ⁻⁵
					Gross Alpha	1x10 ⁻⁷
				Sr-89, Sr-90	5x10 ⁻⁸	
					Fe-55	1x10 ⁻⁶
3) Condensate Storage Tank Spill Retention Dike and Turbine Building Roof Catch Basins via the CST Spill Retention Dike	P Each Batch	P Each Batch	Principal Gamma Emitters ^(c)	5x10 ⁻⁷		
			I-131	1x10 ⁻⁶		
			H-3	1x10 ⁻⁵		
		Q Composite ^(d)	Sr-89, Sr-90	5x10 ⁻⁸		
			Fe-55	1x10 ⁻⁶		
B. Continuous Releases ^(e) 1) Station Service Water System (SSWS) (If contaminated as indicated by SACS or RACS system) 2) Turbine Building Circulating Water Dewatering Sump*	Continuous	W Composite ^(d)	Principal Gamma Emitters ^(c)	5x10 ⁻⁷		
			I-131	1x10 ⁻⁶		
			Dissolved and Entrained Gases (Gamma Emitters)	1x10 ⁻⁵		
			M Composite	Q Composite	H-3	1x10 ⁻⁵
					Gross Alpha	1x10 ⁻⁷
			Sr-89, Sr-90	5x10 ⁻⁸		
				Fe-55	1x10 ⁻⁶	
3) Ground Water Remediation	W Grab Sample	W	Principal Gamma Emitters ^(c)	5x10 ⁻⁷		
			H-3	1x10 ⁻⁵		
		M Composite ^(d)	Q Composite ^(d)	Gross Alpha	1x10 ⁻⁷	
				Sr-89, Sr-90	5x10 ⁻⁸	
		Fe-55	1x10 ⁻⁶			

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.1 CONCENTRATION

TABLE 4.11.1.1.1-1: RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM (Cont.)

TABLE NOTATIONS

- 1 A statistically positive activity detected at or below the required LLD shall be considered a true value and shall be accounted for and reported in the Annual Radioactive Effluent Release Report.
- (a) The LLD is defined, for purposes of these CONTROLS as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{\frac{2.71}{T} + 4.66 * S_b}{E * V * 2.22E6 * Y * \exp(-\lambda\Delta t)}$$

WHERE:

LLD = The "*a priori*" lower limit of detection as defined above, as microcuries per unit mass or volume

2.71 = Poisson-Normal approximation¹

4.66 = Statistical factor from NUREG 1302

S_b = Standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate, as counts per minute

T = Sample count time in minutes

E = Counting efficiency, as counts per disintegration

V = Sample size in units of mass or volume

2.22E6 = Number of disintegrations per minute per microcurie,

Y = Fractional radiochemical yield, when applicable

λ = Radioactive decay constant for the particular radionuclide (sec⁻¹), and

Δt = Elapsed time between midpoint of sample collection and time of counting (sec) for plant effluents.

Typical values of T, 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.

¹ Lloyd A. Currie, Limits for Qualitative Detection and Quantitative Determination: Application to Radiochemistry, Anal. Chem. 40, 586-593 (1968).

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.1 CONCENTRATION

TABLE 4.11.1.1.1-1: RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM (Cont.)

TABLE NOTATIONS

- (b) A batch release is the discharge of liquid waste of a discrete volume. Prior to sampling for analyses, each batch shall be isolated, and then thoroughly mixed by a method described in the ODCM to assure representative sampling.
- (c) The principal gamma emitters for which the LLD CONTROL applies exclusively are Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. Ce-144 shall also be measured, but with an LLD of 5×10^{-6} . This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report pursuant to CONTROL 6.1.
- (d) A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen that is representative of the liquids released.
- (e) A continuous release is the discharge of liquid waste of a non-discrete volume; e.g., from a volume of a system that has an input flow during the continuous release.
- * The Turbine Building Circulating Water Dewatering Sump (TBCWDS) is a normal radwaste discharge pathway and is monitored as such because of possible contamination from the Turbine Building Ventilation drains. Securing the sump pump provides discharge termination. Siphoning does not occur due to the differential height between the sump and the discharge point. Releases from the TBCWDS below the setpoint of 2X background are considered continuous releases. Sampling of continuous releases is performed using a continuous composite sampler. Samples for analyses required in Table 4.11.1.1.1-1 for continuous releases are obtained from the composite sampler. Releases from the sump at levels at or above 2x background may be performed as batch releases. Samples for analyses required in Table 4.11.1.1.1-1 for batch releases are obtained from the sump.

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.2 DOSE

CONTROLS

3.11.1.2 In accordance with Hope Creek Technical Specifications {CTS: 6.8.4.g.4 and 5} {ITS: 5.5.3.d and 5.5.3.e}, the dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each reactor unit to UNRESTRICTED AREAS (see Figure 1.1) shall be limited:

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

APPLICABILITY: At all times.

ACTION:

- a. With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to {CTS: Technical Specification 6.9.2} {ITS: 10 CFR 50.4}, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.
- b. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.1.2 Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.3 LIQUID WASTE TREATMENT SYSTEM

CONTROLS

3.11.1.3 In accordance with the Hope Creek Technical Specifications **{CTS: 6.8.4.g.6}** **{ITS: 5.5.3.f}**, the liquid radwaste treatment system shall be **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** and appropriate portions of the system shall be used to reduce the radioactive materials in liquid wastes prior to their discharge when the projected doses due to the liquid effluent, from each reactor unit, to UNRESTRICTED AREAS (see Figure 1.1) would exceed 0.06 mrem to the total body or 0.2 mrem to any organ in any 31-day period.

APPLICABILITY: At all times.

ACTION:

- a. With radioactive liquid waste being discharged and in excess of the above limits and any portion of the liquid Radwaste treatment system not in operation, prepare and submit to the Commission within 30 days, pursuant to **{CTS: Technical Specification 6.9.2}** **{ITS: 10 CFR 50.4}**, a Special Report that includes the following information:
 1. Explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the **{CTS: inoperable}** **{ITS: nonfunctional}**,
 2. Action(s) taken to restore the **{CTS: inoperable}** **{ITS: nonfunctional}** equipment to **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** status, and
 3. Summary description of action(s) taken to prevent a recurrence.
- b. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

- 4.11.1.3.1 Doses due to liquid releases from each reactor unit to UNRESTRICTED AREAS shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM.
- 4.11.1.3.2 The installed liquid Radwaste treatment system shall be demonstrated **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** by meeting CONTROLS 3.11.1.1 and 3.11.1.2.

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.1 DOSE RATE

CONTROLS

3.11.2.1 In accordance with the Hope Creek Technical Specifications **{CTS: 6.8.4.g.3 and 7}** **{ITS: 5.5.3.c and 5.5.3.g}**, the dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY (see Figure 1.1) shall be limited to the following:

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

APPLICABILITY: At all times.

ACTION:

- a. With the dose rate(s) exceeding the above limits, immediately restore the release rate to within the above limit(s).
- b. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.1.1 The dose rate due to noble gases in gaseous effluents shall be determined continuously to be within the above limits in accordance with the methodology and parameters in the ODCM.

4.11.2.1.2 The dose rate due to iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 4.11.2.1.2-1.

3/4.11.2 GASEOUS EFFLUENTS

TABLE 4.11.2.1.2-1: RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM¹

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) ^(a) (μCi/ml)
A. Not used				
B. Containment PURGE	P Each PURGE ^(c) Grab Sample	P Each PURGE ^(c)	Principal Gamma Emitters ^(b)	1x10 ⁻⁴
		P	H-3	1x10 ⁻⁶
C. North Plant Vent South Plant Vent FRVS ^(g)	M ^{(c), (d)} Grab Sample	M ^(c)	Principal Gamma Emitters ^(b)	1x10 ⁻⁴
			H-3	1x10 ⁻⁶
D. All Release Types as listed in B and C above	Continuous ^(e)	W ^(f) Charcoal Sample	I-131	1x10 ⁻¹²
		W ^(f) Particulate Sample	Principal Gamma Emitters ^(b)	1x10 ⁻¹¹
		M Composite Particulate Sample	Gross Alpha	1x10 ⁻¹¹
		Q Composite Particulate Sample	Sr-89, Sr-90	1x10 ⁻¹¹
		Noble Gas Monitor	Noble Gasses Gross Beta or Gamma	1x10 ⁻⁶
E. TLOV ^(h)	Continuous ^(e)	See Appendix G for Computational Methodology		

¹ A statistically positive activity detected at or below the required LLD shall be considered a true value and shall be accounted for and reported in the Annual Radioactive Effluent Release Report.

3/4.11.2 GASEOUS EFFLUENTS

TABLE 4.11.2.1.2-1: RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM (Continued)

TABLE NOTATION

- (a) The LLD is defined in Table 4.11.1.1.1-1
- (b) The principal gamma emitters for which the LLD CONTROL applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for 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 emissions. 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 Radioactive Effluent Release Report pursuant to CONTROL {CTS: 6.9.1.7} {ITS: 5.6.2}.
- (c) Sampling and analysis shall also be performed following shutdown, startup or a THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period. This requirement does not apply if:
1. Analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has not increased more than a factor of three; and
 2. The noble gas monitor shows that effluent activity has not increased by more than a factor of three.
- (d) Tritium grab samples shall be taken at least once per 7 days from the spent fuel pool area, whenever fuel is in the spent fuel pool.
- (e) The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with CONTROLS 3.11.2.1, 3.11.2.2 and 3.11.2.3.
- (f) Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing, or after removal from sampler. Sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup or THERMAL POWER change exceeding 15 percent of RATED THERMAL POWER in 1 hour and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement does not apply if (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has not increased more than a factor of 3; and (2) the noble gas monitor shows that effluent activity has not increased by more than a factor of three.
- (g) Table 4.11.2.1.2-1, Notations "c", and "f" do not apply. Monthly samples for principle gamma emitters and tritium are required only if the FRVS Vent Fan(s) is in service greater than 8 hours. For noble gas and tritium, representative samples of Reactor Building may be obtained for compliance in lieu of skid samples. FRVS continuous samples are required when FRVS Vent Fan(s) is in service for greater than 2 hours.
- (h) The TLOV system is comprised of four turbine building vents. Release of tritium is based upon average reactor concentrations. The detailed methodology is in Appendix G.

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.2 DOSE - NOBLE GASES

CONTROLS

3.11.2.2 In accordance with the Hope Creek Technical Specification {CTS: 6.8.4.g.5 and 8} {ITS: 5.5.3.e and 5.5.3.h}, the air dose due to noble gases released in gaseous effluents, from each reactor unit to areas at and beyond the SITE BOUNDARY (see Figure 1.1) shall be limited to the following:

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

APPLICABILITY: At all times.

ACTION:

- a. With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to {CTS: Technical Specification 6.9.2} {ITS: 10 CFR 50.4}, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the release and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.
- b. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

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

3/4.11.2 GASEOUS EFFLUENTS

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

3.11.2.3 In accordance with Hope Creek Technical Specification {CTS: 6.8.4.g.5 and 9} {ITS: 5.5.3.e and 5.5.3.i}, the dose to a MEMBER OF THE PUBLIC from iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, from each reactor unit to areas at and beyond the SITE BOUNDARY (see Figure 1.1) shall be limited to the following:

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

APPLICABILITY: At all times.

ACTION:

- a. With the calculated dose from the release of iodine-131, iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.
- b. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

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

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.4 GASEOUS RADWASTE TREATMENT

CONTROLS

3.11.2.4 In accordance with Hope Creek Technical Specifications **{CTS: 6.8.4.g.6}** **{ITS: 5.5.3.f}**, the GASEOUS RADWASTE TREATMENT SYSTEM shall be in operation.

APPLICABILITY: Whenever the main condenser steam jet air ejector is in operation.

ACTION:

- a. With gaseous radwaste from the main condenser air ejector system being discharged without treatment for more than 7 days, prepare and submit to the Commission within 30 days, pursuant to **{CTS: Technical Specification 6.9.2}** **{ITS: 10 CFR 50.4}**, a Special Report that includes the following information:
 - 1. Identification of any **{CTS: inoperable}** **{ITS: nonfunctional}** equipment or subsystems, and the reason for the **{CTS: inoperability}** **{ITS: nonfunctionality}**,
 - 2. Action(s) taken to restore the **{CTS: inoperable}** **{ITS: nonfunctional}** equipment to **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** status, and
 - 3. Summary description of action(s) taken to prevent a recurrence.
- b. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.4 The readings of the relevant instruments shall be checked every 12 hours when the main condenser air ejector is in use to ensure that the gaseous radwaste treatment system is functioning.

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.5 VENTILATION EXHAUST TREATMENT

CONTROLS

- 3.11.2.5 In accordance with Hope Creek Technical Specifications **{CTS: 6.8.4.g.6}** **{ITS: 5.5.3.f}**, the VENTILATION EXHAUST TREATMENT SYSTEM for the Reactor Building and the Service and Radwaste Building shall be **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** and the appropriate portions of the system shall be used to reduce release of radioactivity when the projected dose in 31 days due to gaseous effluent releases from each unit to areas at and beyond the SITE BOUNDARY (see Figure 1.1), would exceed:
- a. 0.2 mrad to air for gamma radiation, or
 - b. 0.4 mrad to air for beta radiation, or
 - c. 0.3 mrem to any organ of a MEMBER OF THE PUBLIC.

APPLICABILITY: At all times.

ACTION:

- a. With radioactive ventilation exhaust being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days, pursuant to **{CTS: Technical Specification 6.9.2}** **{ITS: 10 CFR 50.4}**, a Special Report that includes the following information:
 1. Identification of any **{CTS: inoperable}** **{ITS: nonfunctional}** equipment or subsystems, and the reason for the **{CTS: inoperability}** **{ITS: nonfunctionality}**,
 2. Action(s) taken to restore the **{CTS: inoperable}** **{ITS: nonfunctional}** equipment to **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** status, and
 3. Summary description of action(s) taken to prevent a recurrence.
- b. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

- 4.11.2.5.1 Doses due to gaseous releases from each unit to areas at and beyond the SITE BOUNDARY shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM, when the VENTILATION EXHAUST TREATMENT SYSTEM is not being fully utilized.
- 4.11.2.5.2 The installed VENTILATION EXHAUST TREATMENT SYSTEM shall be considered **{CTS: OPERABLE}** **{ITS: FUNCTIONAL}** by meeting CONTROLS 3.11.2.1, 3.11.2.2, and 3.11.2.3.

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.8 VENTING OR PURGING

CONTROLS

3.11.2.8 VENTING or PURGING of the Mark I containment drywell shall be through either the reactor building ventilation system or the filtration, recirculation and ventilation system.¹

APPLICABILITY: Whenever the containment is vented or purged.

ACTION:

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

SURVEILLANCE REQUIREMENTS

4.11.2.8 The containment shall be determined to be aligned for VENTING or PURGING through either the reactor building ventilation system, the filtration, recirculation and ventilation system, or the hardened torus vent within 4 hours prior to the start of and at least once per 12 hours during VENTING or PURGING of the drywell.

¹ Following Type A Integrated Leakage Rate Testing, the Mark I containment drywell may be vented through the hardened torus vent.

3/4.11.4 TOTAL DOSE

CONTROLS

3.11.4 In accordance with Hope Creek Technical Specification {CTS: 6.8.4.g.11} {ITS: 5.5.3.j}, the annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 mrem to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem.

APPLICABILITY: At all times.

ACTION:

- a. With the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of CONTROLS 3.11.1.2a, 3.11.1.2b, 3.11.2.2a, 3.11.2.2b, 3.11.2.3a, or 3.11.2.3b, calculations should be made including direct radiation contributions from the units and including outside storage tanks, etc. to determine whether the limits of CONTROL 3.11.4 have been exceeded. If such is the case, prepare and submit to the Commission within 30 days, pursuant to {CTS: Technical Specification 6.9.2} {ITS: 10 CFR 50.4}, a Special Report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report, as defined in 10 CFR Part 20.2203 (iv), shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits, and if the release condition resulting in violation of 40 CFR Part 190 or 10 CFR 72.104 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR Part 190 and 10 CFR 72.104. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.
- b. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

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

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

**{ITS: 3/4.11.5 OUTSIDE TEMPORARY STORAGE TANKS
CONTROLS**

3.11.4 In accordance with Technical Specification 5.5.6.b, the quantity of radioactive material contained in any outside temporary tank shall be limited to less than the amount that would result in a concentration that is 10 times the limits in 10 CFR 20, Appendix B, Table 2, Column 2, at the nearest potable water supply and the nearest surface water supply in an unrestricted area, in the event of an uncontrolled release of the tanks' contents.

APPLICABILITY: At all times.

ACTION:

- a. With the quantity of radioactive material in any of the above tanks exceeding the above limit, immediately suspend all additions of radioactive material to the tank, within 48 hours reduce the tank contents to within the limit, and describe the events leading to this condition in the next Radioactive Effluent Release Report, pursuant to Specification 5.6.2.
- b. The provisions of CONTROL 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.5.1 The quantity of radioactive material contained in each of the above tanks shall be determined to be within the above limit by analyzing a representative sample of the tank's contents every 7 days when radioactive materials are being added to the tank. }

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.1 MONITORING PROGRAM

CONTROLS

This Section has been moved to the PSEG Nuclear Common REMP ODCM.

3/4.12.2 LAND USE CENSUS

CONTROLS

This Section has been moved to the PSEG Nuclear Common REMP ODCM.

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

CONTROLS

This Section has been moved to the PSEG Nuclear Common REMP ODCM.

BASES
FOR
SECTION 3.0 AND 4.0
CONTROLS AND SURVEILLANCE REQUIREMENTS

NOTE: The BASES contained in the succeeding pages summarize the reasons for the CONTROLS of Sections 3.0 and 4.0 but are not considered a part of these CONTROLS.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.3 INSTRUMENTATION

BASES

3/4.3.7.10 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The alarm/trip setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The **{CTS: OPERABILITY ITS: FUNCTIONALITY}** and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

3/4.3.7.11 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The alarm/trip setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM. This will ensure the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The **{CTS: OPERABILITY ITS: FUNCTIONALITY}** and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

Allowable Time for Return to Service for Loss of Particulate and Iodine Sampling

The Noble Gas monitor will be one of the first indications that an abnormal radiological condition exists in the effluent ventilation system. The Noble Gas monitor has an alarm function and the alarm setpoint is determined in accordance with the methodology contained in the Hope Creek Offsite Dose Calculation Manual. Radioactive Gaseous Effluent Monitoring Instrumentation, Table 3.3.7.11-1, ACTION 123 allows compensatory noble gas sampling to be collected within 12 hours of a declaration of **{CTS: inoperable} {ITS: nonfunctional}** monitor.

There is no particulate and iodine monitor provided with the monitoring system and therefore there are no early indications that an abnormal radiological condition exists in the effluent ventilation system from particulate or iodine releases. Particulate and iodine samples are normally continuously collected and sampled on a weekly basis and analyzed in the laboratory. Doses are calculated after laboratory analyses are complete. Doses are then compared against the quarterly and yearly limits.

If the particulate and iodine monitoring sample collection devices were out of service for 8 hours out of a quarter (2190 hours), the calculated dose to the public would be affected by < 1% (8 hours/2190 hours in a quarter = 0.00365 = 0.365%). Radioactive Gaseous Effluent Monitoring Instrumentation, Table 3.3.7.11-1, ACTION 122 requires a once per four-hour flow estimation to be made when sample flow for the instrument is out of service.

Because of the 4-hour flow verification/estimation for ACTION 122, it is very unlikely that the iodine and particulate monitoring would be out of service for 8 hours.

If the control room's indication of either process flow or sample flow is lost, then ACTION 122 allows a condition to continue, if flow is estimated every 4-hours. A loss of sample flow indication would require Radiation Protection to visit the vent Radiation Monitoring System (RMS) skid to perform a direct read of the sample flow instrumentation in accordance with Section 5.3 of HC.RP-ST-ZZ-0004. At this time, should the loss of sample flow be due to a loss of continuous sampling (pump failure), then ACTION 125 would be invoked, and the setup of alternate sampling would occur at this time and sample flow would then be obtained. The setup for alternate particulate and iodine sampling would normally be less than 4 hours due to the active 4-hour estimates required by ACTION 122.

3/4.11 RADIOACTIVE EFFLUENTS

If the particulate and iodine monitor were out of service for 8 hours there would be no impact to the safe operation of the plant and no significant impact to the health and safety of the public. The dose impact missing 8 hours of sampling would be evaluated when samples are obtained for noble gas within the 12-hour time limit of ACTION 123.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.1 LIQUID EFFLUENTS

BASES

3/4.11.1.1 CONCENTRATION

This CONTROL is provided to ensure that the summation of concentrations of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than the concentration levels specified in the pre-1994 (old) 10 CFR Part 20, Appendix B, Table II, Column 2 (ODCM Appendix F). This CONTROL is achieved when the following equation is met after dilution:

$$\frac{\text{Concentration}_a}{MPC_a} + \frac{\text{Concentration}_b}{MPC_b} + \frac{\text{Concentration}_c}{MPC_c} + \dots \leq 1$$

The MPC Ratio Limit of 1 represents the Instantaneous Release Dose Limit of 500 mrem/yr (10 CFR Part 20.105). This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, to a MEMBER OF THE PUBLIC and (2) the limits of 10 CFR Part 20.106(a) to the population. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its MPC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits can be found in Currie, L. A., "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," NUREG/CR-4007 (September 1984), and the HASL Procedures Manual, HASL-300 (revised annually).

3/4.11.1.2 DOSE

This CONTROL is provided to implement the requirements of Sections II.A, III.A, and IV.A of Appendix I, 10 CFR Part 50. The CONTROL implements the guides set forth in Section II.A of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." Also, for freshwater sites with drinking water supplies that can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR Part 141. The dose calculation methodology and parameters in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purposes of Implementing Appendix I," April 1977.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.1.3 LIQUID RADWASTE TREATMENT

The **{CTS: OPERABILITY } {ITS: FUNCTIONALITY}** of the liquid Radwaste treatment system ensures that this system will be available for use whenever liquid effluents require treatment prior to their release to the environment. The requirement that the appropriate portions of this system be used, when specified, provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable". This CONTROL implements the requirements of General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the dose design objectives set forth the Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.2 GASEOUS EFFLUENTS

BASES

3/4.11.2.1 DOSE RATE

This CONTROL is provided to ensure that the dose at any time at and beyond the SITE BOUNDARY from gaseous effluents from all units on the site will be within the annual dose limits of 10 CFR Part 20 to UNRESTRICTED AREAS. The annual dose limits are the doses associated with the concentrations of 10 CFR Part 20, Appendix B, Table II, Column 1. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a MEMBER OF THE PUBLIC in an UNRESTRICTED AREA either within or outside the SITE BOUNDARY, to annual average concentrations exceeding the limits specified in Appendix B, Table II of 10 CFR Part 20 [10 CFR Part 20.106(b)]. For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of the individual will usually be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the SITE BOUNDARY. Examples of calculations for such MEMBERS OF THE PUBLIC with the appropriate occupancy factors shall be given in the ODCM. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrem/year to the total body or to less than or equal to 3000 mrem/yr to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a child via the inhalation pathway to less than or equal to 1500 mrem/year.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits can be found in Currie, L. A., "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," NUREG/CR-4007 (September 1984), and the HASL Procedures Manual, HASL-300 (revised annually).

3/4.11.2.2 DOSE – NOBLE GASES

This CONTROL is provided to implement the requirements of Section II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The CONTROL implements the guides set forth in Section II.B of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low as is reasonably achievable." The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The dose calculation methodology and parameters established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," Revision 1, July 1977. The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.2 GASEOUS EFFLUENTS

BASES

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

This CONTROL is provided to implement the requirements of Section II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The CONTROLS are the guides set forth in Section II.C of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." The ODCM calculational methods specified in Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methodology and parameters for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate controls for iodine-131, iodine-133, tritium, and radionuclides in particulate form with half-life greater than 8 days are dependent on the existing radionuclide pathways to man, in the areas at and beyond the SITE BOUNDARY. The pathways that were examined in the development of these calculations were: 1) individual inhalation of airborne radionuclides, 2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, 3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and 4) deposition on the ground with subsequent exposure of man.

Note: any new receptors must be located on land and not water to be considered in dose calculations.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.2 GASEOUS EFFLUENTS

BASES

3/4.11.2.4 GASEOUS RADWASTE TREATMENT

and

3/4.11.2.5 VENTILATION EXHAUST TREATMENT

The **{CTS: OPERABILITY }** **{ITS: FUNCTIONALITY}** of the GASEOUS RADWASTE TREATMENT SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM ensures that the system will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." This CONTROL implements the requirements of General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Section II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

3/4.11.2.8 VENTING OR PURGING

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

3/4.11.4 TOTAL DOSE

This CONTROL is provided to meet the dose limitations of 40 CFR Part 190 that have now been incorporated into 10 CFR Part 20 by 46 FR 18525 as well as the dose limitations specific to Independent Spent Fuel Storage Installation (ISFSI) operations in accordance with 10 CFR 72.104. Over the long term, as more storage casks are placed on the ISFSI pads, it is expected that ISFSI operations will become the prominent contributor to the dose limits in this section. ISFSI dose contribution is in the form of direct radiation as no liquid or gas releases are expected to occur. The PSEG 10 CFR 72.212 Report prepared in accordance with 10 CFR 72 requirements assumes a certain array of casks exists on the pads. The dose contribution from this array of casks in combination with historical uranium fuel cycle operations prior to ISFSI operations was analyzed to be within the 40 CFR 190 and 10 CFR 72.104 limits. The CONTROL requires the preparation and submittal of a Special Report whenever the calculated doses from plant including the ISFSI radioactive effluents exceed 25 mrem to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem. For sites containing up to 4 reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR Part 190 if the individual reactors remain within twice the dose design objectives of Appendix I, and if direct radiation doses from the reactor units including outside storage tanks, etc. are kept small. The Special Report will describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR Part 190 or 10 CFR 72.104 limits. For purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.2 GASEOUS EFFLUENTS

BASES

cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190 or 10 CFR 72.104, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 or 10 CFR 72.104 have not already been corrected), in accordance with the provisions of 40 CFR Part 190 or 10 CFR 72.104 and 10 CFR Part 20.405c, is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 or 10 CFR 72.104 until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190 or 10 CFR 72.104 and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in CONTROLS 3.11.1.1 and 3.11.2.1. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

3/4.11.5 {ITS: OUTSIDE TEMPORARY STORAGE TANKS}

{The tanks included in this requirement include any outside temporary tank.

Restricting the quantity of radioactive material contained in the specified tanks provides assurance that in the event of an uncontrolled release of the tanks' contents, the resulting concentrations would be less than 10 times the limits in 10 CFR 20, Appendix B, Table 2, Column 2, at the nearest potable water supply and the nearest surface water supply in an unrestricted area. }

6.0 ADMINISTRATIVE CONTROLS

6.1 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

In accordance with Hope Creek Technical Specifications {CTS: 6.9.1.7} {ITS: 5.6.2}, The Annual Radioactive Effluent Release Report¹ covering the operation of the unit, shall be submitted by May 1 of each year and in accordance with the requirements of 10CFR50.36a.

The Annual Radioactive Effluent Release Report (ARERR) shall include a summary of the quantities of radioactive liquid and gaseous effluents, and solid waste released from the unit as outlined in Regulatory Guide 1.21 "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste," Revision 2, June 2009, with data summarized on a quarterly basis following the format of Appendix B thereof.

The ARERR shall include an annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by-hour listing of wind speed, wind direction, atmospheric stability, and precipitation (if measured) on magnetic tape, or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability. The report shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit or station during the previous calendar year. The report shall also include an assessment of the radiation doses from radioactive liquid and gaseous effluents to MEMBERS OF THE PUBLIC due to their activities inside the SITE BOUNDARY (Figure 1.1) during the report period. All assumptions used in making these assessments, i.e., specific activity, exposure time and location, shall be included in these reports. The historical annual average meteorology or the meteorological conditions concurrent with the time of release of radioactive materials in gaseous effluents (as determined by sampling frequency and measurement) shall be used for determining the gaseous pathway doses. The assessment of radiation doses shall be performed in accordance with the OFFSITE DOSE CALCULATION MANUAL (ODCM).

The ARERR shall identify those radiological environmental sample parameters and locations where it is not possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In addition, the cause of the unavailability of samples for the pathway and the new location(s) for obtaining replacement samples should be identified. The report should also include a revised figure(s) and table(s) for the ODCM reflecting the new location(s).

¹ A single submittal may be made for a multiple unit station. The submittal should combine those sections that are common to all units at the station; however, for units with separate radwaste systems, the submittal shall specify the releases of radioactive material from each unit.

6.0 ADMINISTRATIVE CONTROLS

6.1 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

The ARERR shall also include an assessment of radiation doses to the likely most exposed MEMBER OF THE PUBLIC from reactor releases and other nearby uranium fuel cycle sources (including doses from primary effluent pathways and direct radiation) for the previous calendar year to show conformance with 40 CFR Part 190, Environmental Radiation Protection Standards for Nuclear Power Operation and 10 CFR 72.104 Criteria for Radioactive Materials in Effluents and Direct Radiation from an ISFSI.

Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in Regulatory Guide 1.109, Rev. 1, October 1977.

The ARERR shall include the following information for each class of solid waste (as defined by 10 CFR Part 61) shipped offsite during the report period:

- a. Container volume,
- b. Total curie quantity (specify whether determined by measurement or estimate),
- c. Principal radionuclides (specify whether determined by measurement or estimate),
- d. Type of waste (e.g., dewatered spent resin, compacted dry waste, evaporator bottoms),
- e. Type of container (e.g., LSA, Type A, Type B, Large Quantity), and
- f. Solidification agent or absorbent (e.g., cement, urea formaldehyde).

The ARERR shall include a list of descriptions of unplanned releases from the site to UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

The ARERR shall include any changes made during the reporting period to the PROCESS CONTROL PROGRAM (PCP), the OFFSITE DOSE CALCULATION MANUAL (ODCM), or radioactive waste systems. Also list new locations identified by the land use census pursuant to PSEG Nuclear Common REMP ODCM CONTROL 3.12.2 for dose calculations or environmental monitoring.

6.0 ADMINISTRATIVE CONTROLS**6.2** MAJOR CHANGES TO RADIOACTIVE LIQUID, GASEOUS AND SOLID WASTE TREATMENT SYSTEMS

- 6.2.1 Shall be reported to the Commission in the UFSAR for the period in which the evaluation was reviewed by the Plant Operations Review Committee (PORC). The discussion of each change shall contain:
- a. A summary of the evaluation that led to the determination that the change could be made in accordance with 10CFR50.59,
 - b. Sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information,
 - c. A detailed description of the equipment, components and processes involved and the interfaces with other plant systems,
 - d. An evaluation of the change, which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the license application and amendments thereto,
 - e. An evaluation of the change, which shows the expected maximum exposures to individual in the unrestricted area and to the general population that differ from those previously estimated in the license application and amendments thereto,
 - f. A comparison of the predicted releases of radioactive materials, in liquid and gaseous effluents and in solid waste, to the actual releases for the period prior to when the changes are to be made,
 - g. An estimate of the exposure to plant operating personnel as a result of the change, and
 - h. Documentation of the fact that the change was reviewed and found acceptable by the PORC.
- 6.2.2 Shall become effective upon review and acceptance by the PORC and signed by the Plant Manager.

PART II – CALCULATIONAL METHODOLOGIES

1.0 LIQUID EFFLUENTS

1.1 Liquid Effluent Concentration Limits - 10 CFR 20

CONTROL 3.11.1.1 limits the concentration of radioactive material in liquid effluents (after dilution in the Cooling-Tower Blowdown Discharge System) to less than the concentrations as specified in 10 CFR 20, Appendix B, Table II, Column 2 (Appendix F) for radionuclides other than noble gases. Noble gases are limited to a diluted concentration of 2.0E-04 $\mu\text{Ci/ml}$.

Release rates are controlled, and radiation monitor alarm setpoints are established as addressed below to ensure that these concentration limits are not exceeded.

Each batch release is sampled and analyzed per the requirements detailed in Table 4.11.1.1.1-1. The results from those analyses are then compared to the Maximum Permissible Concentration limits listed in Appendix F at the point of discharge to the UNRESTRICTED AREA using the following equation:

$$\sum_i^n \frac{C_i}{MPC_i} * \frac{RR}{CTBD+RR} \leq 1 \quad (1.1)$$

Where:

- 1 = MPC Ratio Limit, that represents the Instantaneous Release Dose Rate Limit of 500 mrem/yr (10 CFR Part 20.105)
- C_i = Concentration of radionuclide i in the mixture ($\mu\text{Ci/ml}$)
- MPC_i = The MPC value corresponding to radionuclide i from 10 CFR 20, Appendix B, Table II, Column 2 (Appendix F) ($\mu\text{Ci/ml}$)
- CTBD = Cooling Tower Blowdown Dilution or other dilution sources (GPM)
- RR = Release Rate (GPM)

If the MPC Ratio Limit of ≤ 1 is satisfied, then the tank may be released to the River.

1.2 Radiation Monitoring Instrumentation Controls

The liquid effluent monitoring instrumentation and controls at Hope Creek for controlling and monitoring normal radioactive material releases in accordance with the Hope Creek Radiological Effluent Controls are summarized as follows:

1. Alarm (and Automatic Termination) - Liquid Radwaste Discharge Line Monitor provides the alarm and automatic termination of liquid (RE4861) radioactive material releases from the liquid waste management system as required by CONTROL 3.3.7.10.

Circulating Water Dewatering Sump Discharge Monitor (RE4557) provides alarm and automatic termination of liquid radioactive releases from the circulating dewatering sump as required by CONTROL 3.3.7.10. Condensation drains from certain supply ventilation units and liquids from the fill and venting of the circulating water side of the condenser water boxes are directed to this sump. Automatic termination is performed by trip of the sump pumps on high gamma radiation signal.

2. Alarm (Only) - The Cooling-Tower Blowdown Effluent Monitor (RE8817) provides an Alarm function only for releases into the environment as required by CONTROL 3.3.7.10.

Liquid radioactive waste flow diagrams with the applicable, associated radiation monitoring instrumentation and controls are presented in Figure 1-1.

1.3 Liquid Effluent Monitor Setpoint Determination

Per the requirements of CONTROL 3.3.7.10, alarm setpoints shall be established for the liquid monitoring instrumentation to ensure that the release concentration limits of CONTROL 3.11.1.1 are met (i.e., the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS shall be limited to the concentrations specified in 10

CFR 20 Appendix B, Table II, Column 2, (Appendix F) for radionuclides and 2.0E-04 $\mu\text{Ci/ml}$ for dissolved or entrained noble gases).

1.3.1 Liquid Effluent Monitors

The purpose of establishing radiation monitor alarm setpoints is to provide a reasonable assurance that the MPC limit of ≤ 1 is maintained during the release. Based on the pre-release information, the Effective MPC value for a radionuclide distribution is calculated by the equation:

$$MPC_e = \sum_i C_i (\textit{gamma}) / \sum_i \frac{C_i}{MPC_i} (\textit{gamma}) \quad (1.2)$$

Where:

- MPC_e = The effective MPC value for a mixture of radionuclides ($\mu\text{Ci/ml}$)
- C_i = Concentration of radionuclide i in the mixture ($\mu\text{Ci/ml}$)
- MPC_i = The MPC value corresponding to radionuclide i from (old) 10 CFR 20, Appendix B, Table II, Column 2 (Appendix F) ($\mu\text{Ci/ml}$)

Conservative alarm setpoints for each release are determined using default parameters. The setpoints for the liquid effluent monitors at the Hope Creek Generating Station are determined by the following equation¹:

$$SP \leq \frac{MPC_e * CTBD}{RR} + bkg \quad (1.3)$$

Default values from Table 1-1:

Where:

- SP = Alarm setpoint corresponding to the maximum allowable release rate ($\mu\text{Ci/ml}$)
- MPC_e = The effective MPC value for the mixture of radionuclides in the effluent stream, ($\mu\text{Ci/ml}$)
- CTBD = The Cooling-Tower Blowdown Discharge rate at the time of release (gal/min)
- RR = The liquid effluent release rate (gal/min) at the monitor location (i.e., at the liquid radwaste monitor, at the TBCW monitor, or at the CTBD monitor)
- Bkg = The background of the monitor ($\mu\text{Ci/ml}$)

1.3.2 Liquid Effluent Monitor Correction Factors:

A correction factor of 0.80 is applied to the default setpoint calculation in order to account for radiation monitor uncertainties and for the contribution of non-gamma emitting radionuclides such as H-3, Sr-89, -90, and Fe-55 as follows:

a. Radiation Monitor Inaccuracies

Hope Creek PSBP 311649 lists a total loop accuracy of 30% for the liquid radwaste radiation monitors. A factor of 0.30 is applied to the default setpoint to ensure the trip setpoint is reached before the analytical limit is obtained.

b. Non-Gamma Emitting Radionuclides

Non-gamma emitting radionuclides are analyzed on a monthly and quarterly basis from composite samples of liquid radwaste releases. A conservative correction factor for non-gamma emitting radionuclides has been calculated as 0.50.

Adding the correction factor Equation 1.3 then becomes:

¹ Modified from the Addendum to NUREG 0133

$$SP \leq \frac{MPC_e * CTBD * [1 - CF]}{RR} + bkg \quad (1.4)$$

Where:

CF = Correction factor to account for non-gamma emitting nuclides and radiation monitor inaccuracies 0.80

The radioactivity monitor setpoint equation (1.4) remains valid during outages when the Cooling-Tower Blowdown discharge is potentially at its lowest value. Reduction of the waste stream flow (RR) may be necessary during these periods to meet the discharge criteria. Procedural restrictions prevent simultaneous batch liquid releases. The setpoints should be reduced to allow for potential or actual concurrent continuous releases such that the limits of ODCM CONTROL 3.11.1.1 are not exceeded.

1.3.3 Conservative Default Values

The unique characteristic of equation 1.4 is that as the MPCe concentration increases, then so does the setpoint. Likewise, as the MPCe concentration decreases, then the setpoint is also reduced. If the MPCe concentration is zero, then the setpoint cannot be calculated. In those cases, the default RE4861 setpoint value shall be used (See Appendix A for more information).

Conservative alarm setpoints for liquid radwaste radiation monitors are determined using default parameters. Table 1-1 summarizes all current default values in use for Hope Creek. They are based upon the following:

- a. Substitution of the effective MPC value with a default value of from Table 1-1 in $\mu\text{Ci/ml}$ for radwaste releases.
- b. Substitutions of the Cooling-Tower Blowdown discharge rate with the minimum average flow, in gal/min.
- c. Substitutions of the effluent release rate with the highest allowed rate, in gal/min.
- d. Substitution of a 0.80 correction factor (CF) to account for monitor inaccuracies and non-gamma emitting radionuclides.

The use of the conservative alarm setpoint is acceptable provided that the value used is at least as conservative as the release specific setpoint calculated in accordance with Equation 1.4 above. However, given that Equation 1.4 includes a correction factor of 0.80, it is reasonable not to establish a new setpoint until the calculated setpoint is reduced by 25% of the established default setpoint.

Procedural controls exist to verify the setpoint utilized is at or below what is required. Should the calculated setpoint be more conservative by more than 25%, then one of the following will be performed:

- a. Increase CTBD and/or reduce RR until calculated setpoint is > the default setpoint.
- b. Install new setpoint.
- c. Reprocess the tank to add more radioactivity.
- d. Based on the post-dilution $\mu\text{Ci/ml}$ / MPC ratio, Management determines that setpoint change is not required.

1.4 Liquid Effluent Dose Calculation - 10 CFR 50

1.4.1 Member of the Public Dose - Liquid Effluents

CONTROL 3.11.1.2 limits the dose or dose commitment to MEMBERS OF THE PUBLIC from radioactive materials in liquid effluents from Hope Creek Generating Station to:

- during any calendar quarter:

- ≤ 1.5 mrem to total body
- ≤ 5.0 mrem to any organ
- during any calendar year:
 - ≤ 3.0 mrem to total body
 - ≤ 10.0 mrem to any organ

Per the surveillance requirements to CONTROL 4.11.1.2, the following calculation methods shall be used for determining the dose or dose commitment due to the liquid radioactive effluents from Hope Creek.

$$D_o = \frac{8.35E-04 * VOL}{CTBD + RR} * \sum_i C_i * A_{io} \quad (1.5)$$

Where:

- D_o = Dose or dose commitment to organ o, including total body (mrem).
- A_{io} = Site-related ingestion dose commitment factor to the total body or any organ o for radionuclide i (mrem/hr per $\mu\text{Ci/ml}$).
- C_i = Average concentration of radionuclide i, in undiluted liquid effluent representative of volume VOL ($\mu\text{Ci/ml}$).
- VOL = Volume of liquid effluent released (gal).
- CTBD = Average Cooling-Tower Blowdown or other dilution source discharge rate during release period (gal/min).
- RR = Release Rate (GPM).
- 8.35E-04 = Conversion factor (1.67E-02 hr/min) and a near field dilution factor of 0.05 (refer to Appendix B for definition).

The site-related ingestion dose/dose commitment factors (A_{io}) are presented in Table 1-2 and have been derived in accordance with NUREG-0133 by the equation:

$$A_{io} = 1.14E + 05 [(U_I * B_{Ii}) + (U_F * B_{Fi})] DF_{io} \quad (1.6)$$

Where:

- A_{io} = Composite dose parameter for the total body or critical organ o of an adult for radionuclide i, for the fish and invertebrate ingestion pathways (mrem/hr per $\mu\text{Ci/ml}$).
- 1.14E+05 = Conversion factor ($\text{pCi}/\mu\text{Ci} * \text{ml/kg per hr/yr}$).
- U_I = Adult invertebrate consumption (5 kg/yr).
- B_{Ii} = Bioaccumulation factor for radionuclide i in invertebrates from Table 1-3 (pCi/kg per pCi/l).
- U_F = Adult fish consumption (21 kg/yr).
- B_{Fi} = Bioaccumulation factor for nuclide i in fish from Table 1-3 (pCi/kg per pCi/l).
- DF_{io} = Dose conversion factor for nuclide i for adults in preselected organ, o, from Table E-11 of Regulatory Guide 1.109 (mrem/pCi).

The radionuclides included in the periodic dose assessment per the requirements of CONTROL 3/4.11.1.2 are those as identified by gamma spectral analysis of the liquid waste samples collected and analyzed per the requirements of CONTROL 3/4.11.1.1, Table 4.11.1.1.1-1.

The radionuclides requiring radiochemical analysis (e.g., Sr-89 and Sr-90) will be added to the dose analysis at a frequency consistent with the required minimum analysis frequency of CONTROL Table 4.11.1.1.1-1.

1.4.2 Simplified Liquid Effluent Dose Calculation

In lieu of the individual radionuclide dose assessment as presented in Section 1.4.1, the following simplified dose calculation equation may be used for demonstrating compliance with the dose limits of CONTROL 3.11.1.2. (Refer to Appendix B for the derivation and justification for this simplified method.)

Total Body

$$D_{tb} = \frac{1.94E+02 * VOL}{CTBD} * \sum_i C_i \quad (1.7)$$

Maximum Organ

$$D_{max o} = \frac{5.28E+02 * VOL}{CTBD} * \sum_i C_i \quad (1.8)$$

Where:

D_{tb}	=	Conservatively evaluated total body dose (mrem).
$D_{max o}$	=	Evaluated maximum organ dose (mrem).
C_i	=	Average concentration of radionuclide i , in undiluted liquid effluent representative of the volume VOL ($\mu\text{Ci/ml}$).
VOL	=	Volume of liquid effluent released (gal).
$CTBD$	=	Average Cooling-Tower Blowdown or other dilution source discharge rate during release period (gal/min).
$1.94E+02$	=	Conversion factor ($1.67E-02$ hr/min), the conservative total body ingestion dose commitment factor (Zn-65 = $2.32E+05$ mrem/hr per $\mu\text{Ci/ml}$), and the near field dilution factor of 0.05. (See Appendix B)
$5.28E+02$	=	Conversion factor ($1.67E-02$ hr/min), the conservative maximum organ ingestion dose commitment factor (Fe-59, GILLI – $6.32E+05$ mrem/hr per $\mu\text{Ci/ml}$), and the near field dilution factor of 0.05 (See Appendix B).

1.5 Liquid Effluent Dose Projections

CONTROL 3.11.1.3 requires that the liquid radioactive waste processing system be used to reduce the radioactive material levels in the liquid waste prior to release when the 31-day projected doses exceed:

- 0.06 mrem to the total body, or
- 0.2 mrem to any organ.

The applicable liquid waste processing system for maintaining radioactive material releases ALARA are the drain filters and demineralizers as delineated in Figure 1-1.

Dose projections are made at least once per 31-days by the following equations:

$$D_{tbp} = (D_{tb} / d) * 31 \quad (1.9)$$

$$D_{maxp} = (D_{max} / d) * 31 \quad (1.10)$$

Where:

D_{tbp}	=	The total body dose projection for current 31-day period (mrem).
D_{tb}	=	The total body dose to date for current calendar quarter as determined by equation (1.5) or (1.7).

- D_{maxp} = The maximum organ dose to date for current calendar quarter as determined by equation (1.5 or (1.8)) (mrem).
- d = The number of days in the current calendar quarter at the end of the release.
- 31 = The number of days projected.

1.6 Representative Samples

A sample should be representative of the bulk stream or volume of effluent from which it is taken. Prior to sampling, large volumes of liquid waste should be mixed in as short a time interval as practicable to assure that any sediments or particulate solids are distributed uniformly in the waste mixture. Recirculation pumps for liquid waste tanks (collection or sample test tanks) should be capable of recirculating at a rate of not less than two tank volumes in eight hours. Minimum recirculation times and methods of recirculation are controlled by specific plant procedures.

2.0 GASEOUS EFFLUENTS

2.1 Radiation Monitoring Instrumentation and Controls

The gaseous effluent monitoring instrumentation and controls at Hope Creek for controlling and monitoring normal radioactive material releases in accordance with the Radiological Effluent CONTROLS are summarized as follows:

A. Filtration, Recirculation, and Ventilation System

The FRVS is maintained in a standby condition. Upon reactor building isolation, the FRVS recirculation system recirculates the reactor building air through HEPA and charcoal filters. Releases are made to the atmosphere via a reactor building vent or the South Plant Vent depending on mode of operation. Noble gas monitoring is provided by RE-4811A.

B. South Plant Vent

The SPV receives discharge from the radwaste evaporator, reactor building purge, auxiliary building radwaste area, condensate demineralizer, pipe chase, feedwater heater, and untreated ventilation sources. Effluents are monitored (for noble gas) by the RE-4875B monitor.

C. North Plant Vent

The NPV receives discharge from the gaseous radwaste treatment system (Offgas system) and untreated ventilation air sources. Effluents are monitored (for noble gases) by the RE-4573B monitor.

Gaseous radioactive waste flow diagrams with the applicable, associated radiation monitoring instrumentation controls are presented in Figure 2-1 and Figure 2-2.

2.2 Gaseous Effluent Monitor Setpoint Determination

2.2.1 Plant Vent, FRVS

Per the requirements of CONTROL 3.3.7.11, alarm setpoints shall be established for the gaseous effluent monitoring instrumentation to ensure that the release rate of noble gases does not exceed the limits of CONTROL 3.11.2.1, which corresponds to a dose rate at the SITE BOUNDARY of 500 mrem/year to the total body or 3000 mrem/year to the skin. Based on a grab sample analysis of the applicable release (i.e., of FRVS, pipe chase, gaseous radwaste treatment system air, etc.), the radiation monitoring alarm setpoints may be established by the following calculation method. The measured radionuclide concentrations and release rate are used to calculate the fraction of the allowable release rate, as limited by CONTROL 3.11.2.1, by the equations:

$$FRAC = [4.72E + 02 * X/Q * VF * \sum_i^n (C_i * K_i)] / 500 \quad (2.1)$$

$$FRAC = [4.72E + 02 * X/Q * VF * \sum_i^n (C_i * (L_i + 1.1M_i))] / 3000 \quad (2.2)$$

Where:

- FRAC = Fraction of the allowable release rate based on the identified radionuclide concentrations and the release flow rate.
- X/Q = Annual average meteorological dispersion to the controlling site boundary location (sec/m³).
- VF = Ventilation system flow rate for the applicable release point and monitor (ft³/min).
- C_i = Concentration of noble gas radionuclide i as determined by radioanalysis of grab sample (uCi/cm³)
- K_i = Total body dose conversion factor for noble gas radionuclide i (mrem/yr per μCi/m³), from Table 2-1.1

L_i	=	Beta skin dose conversion factor for noble gas radionuclide i (mrem/yr per $\mu\text{Ci}/\text{m}^3$), from Table 2-1.1
M_i	=	Gamma air dose conversion factor for noble gas radionuclide i (mrad/yr per $\mu\text{Ci}/\text{m}^3$), from Table 2-1.1
1.1	=	mrem skin dose per mrad gamma air dose (mrem/mrad)
$4.72\text{E}+02$	=	Conversion factor ($\text{cm}^3/\text{ft}^3 * \text{min}/\text{sec}$)
500	=	Total body dose rate limit (mrem/yr)
3000	=	Skin dose rate limit (mrem/yr)

Based on the more limiting FRAC (i.e., higher value) as determined above, the alarm setpoints for the applicable monitors may be calculated by the equation:

$$SP \leq [AF * \sum_i^n C_i / FRAC] + bkg \quad (2.3)$$

Where:

SP	=	Alarm setpoint corresponding to the maximum allowable release rate ($\mu\text{Ci}/\text{cm}^3$).
FRAC	=	Highest fraction of the allowable release rate as determined in equation (2.2).
bkg	=	Background of the monitor ($\mu\text{Ci}/\text{cm}^3$).
AF	=	Administrative allocation factor for the specific monitor (0.2 NPV, 0.2 SPV, 0.1 FRVS).

The allocation factor (AF) is an administrative control imposed to ensure that combined releases from Salem Units 1 and 2 and Hope Creek will not exceed the regulatory limits on release rate from the site (i.e., the release rate limits of CONTROL 3.11.2.1). Normally, the combined AF value for Salem Units 1 and 2 is 0.5 (0.25 per unit), with the remainder 0.5 allocated to Hope Creek. Any increase in AF above 0.5 for the Hope Creek Generating Station will be coordinated with the Salem Generating Station to ensure that the combined allocation factors for all units do not exceed 1.0.

2.2.2 Conservative Default Values

A conservative alarm setpoint can be established, in lieu of the individual radionuclide evaluation based on the grab sample analysis, to eliminate the potential of periodically having to adjust the setpoint to reflect minor changes in radionuclide distribution and variations in release flow rate. The alarm setpoint may be conservatively determined by the default values presented in Table 2-2.

These values are based upon:

- The maximum ventilation (or purge) flow rate,
- A radionuclide distribution adopted from ANSI N237- 1976/ANS 18.1 "Source Term Specifications", Table 5 (see Table 2-1.2) and,
- An administrative allocation factor of 0.5 to conservatively ensure that any releases from Hope Creek do not exceed the maximum allowable release rate.

For the noble gas radionuclide distribution from ANSI N237-1976/ANS 18.1 (Note Table C-1), the alarm setpoint based on the total body dose rate is more restrictive than the corresponding setpoint based on the skin dose rate. As an additional measure of conservatism, the default setpoints are set approximately 25% lower than the calculated setpoints. The resulting conservative, default setpoints are presented in Table 2-2. Note: Emergency Action Levels (EALs) are based on actual monitor readings not on alarm set points.

2.3 Gaseous Effluent Instantaneous Dose Rate Calculations - 10 CFR 20

2.3.1 Site Boundary Dose Rate - Noble Gases

CONTROL 3.11.2.1a limits the dose rate at the SITE BOUNDARY due to noble gas releases to ≤ 500 mrem/yr, total body and ≤ 3000 mrem/yr, skin. Radiation monitor alarm setpoints are established to ensure that these release limits are not exceeded. In the event any gaseous releases from the station results in an alarm setpoint (as determined in Section 2.2.1) being exceeded, an evaluation of the SITE BOUNDARY dose rate resulting from the release shall be performed using the following equations:

$$D_{tb} = X/Q * \sum_i^n (K_i * Q_i) \quad (2.4)$$

$$D_s = X/Q * \sum_i^n ((L_i + 1.1M_i) * Q_i) \quad (2.5)$$

Where:

- D_{tb} = Total body dose rate (mrem/yr).
- D_s = Skin dose rate (mrem/yr).
- X/Q = Atmospheric dispersion to the controlling SITE BOUNDARY location (sec/m³).
- Q_i = Average release rate of radionuclide i over the release period under evaluation (μ Ci/sec).
- K_i = Total body dose conversion factor for noble gas radionuclide i (mrem/yr per μ Ci/m³), from Table 2-1.1.
- L_i = Beta skin dose conversion factor for noble gas radionuclide i (mrad/yr per μ Ci/m³), from Table 2-1.1.
- M_i = Gamma air dose conversion factor for noble gas radionuclide i (mrad/yr per μ Ci/m³, from Table 2-1.1.
- 1.1 = mrem skin dose per mrad gamma air dose (mrem/mrad)

As appropriate, simultaneous releases from Salem Units 1 and 2 and Hope Creek will be considered in evaluating compliance with the release rate limits of CONTROL 3.11.2.1a, following any releases exceeding the above prescribed alarm setpoints. Monitor indications (readings) may be averaged over a time period not to exceed 15 minutes when determining noble gas release rate based on correlation of the monitor reading and monitor sensitivity. The 15-minute averaging is needed to allow for reasonable monitor response to potentially changing radioactive material concentrations and to exclude potential electronic spikes in monitor readings that may be unrelated to radioactive material releases. As identified, any electronic spiking monitor responses may be excluded from the analysis.

NOTE: For administrative purposes, more conservative alarm setpoints than those as prescribed above may be imposed. However, conditions exceeding these more limiting alarm setpoints do not necessarily indicate radioactive material release rates exceeding the dose limits of CONTROL 3.11.2.1a. Provided actual releases do not result in radiation monitor indications exceeding alarm setpoint values based on the above criteria, no further analyses are required for demonstrating compliance with the limits of CONTROL 3.11.2.1a.

Actual meteorological conditions concurrent with the release period or the default, annual average dispersion parameters as presented in Table 2-3 may be used for evaluating the gaseous effluent dose rate.

2.3.2 Site Boundary Dose Rate - Radioiodine and Particulates

CONTROL 3.11.2.1b limits the dose rate to ≤ 1500 mrem/yr to any organ for I-131, I-133, tritium and particulates with half-lives greater than 8 days. To demonstrate compliance with this limit, an evaluation is performed at a frequency no greater than that corresponding to the sampling and analysis time period (e.g., nominally once per 7 days). The following equation shall be used for the dose rate evaluation:

$$D_o = X/Q * \sum_i^n (R_{io} * Q_i) \quad (2.6)$$

Where:

- D_o = Average organ dose rate over the sampling time period (mrem/yr).
- X/Q = Atmospheric dispersion to the controlling SITE BOUNDARY location for the inhalation pathway (sec/m³).
- R_{io} = Dose parameter for radionuclide i (mrem/yr per $\mu\text{Ci}/\text{m}^3$) and organ o for the child inhalation pathway from Table 2-4.
- Q_i = Average release rate over the appropriate sampling period and analysis frequency for radionuclide i , I-131, I-133, tritium or other radionuclide in particulate form with half-life greater than 8 days ($\mu\text{Ci}/\text{sec}$).

By substituting 1500 mrem/yr for D_o and solving for Q_{I-131} , an allowable release rate for I-131 can be determined. Based on the annual average meteorological dispersion (See Table 2-3) and the most limiting potential pathway, age group and organ (inhalation, child, thyroid -- $R_i = 1.62\text{E}+07$ mrem/yr per $\mu\text{Ci}/\text{m}^3$), the allowable release rate for I-131 can be calculated. Reducing this release rate by a factor of 2 to account for potential dose contributions from other radioactive particulate material and other release points (e.g., Salem), the corresponding release rate allocated to Hope Creek is detailed in Table 2-2. For a 7-day period, which is the nominal sampling and analysis frequency for I-131, the cumulative release in μCi can be determined.

Therefore, as long as the I-131 releases in any 7-day period do not exceed the value in Table 2-2, no additional analyses are needed for verifying compliance with the CONTROL 3.11.2.1.b limits on allowable release rate.

2.4 Noble Gas Effluent Dose Calculations - 10 CFR 50

2.4.1 Unrestricted Area Dose - Noble Gases

CONTROL 3.11.2.2 requires a periodic assessment of releases of noble gases to evaluate compliance with the quarterly dose limits of ≤ 5 mrad, gamma-air and ≤ 10 mrad, beta-air and the calendar year limits ≤ 10 mrad, gamma-air and ≤ 20 mrad, beta-air.

The limits are applicable separately to each generating station and are not combined site limits. The following equations shall be used to calculate the gamma-air and beta-air doses:

$$D_\gamma = 3.17\text{E} - 08 * X/Q * \sum_i^n (M_i * Q_i) \quad (2.7)$$

$$D_\beta = 3.17\text{E} - 08 * X/Q * \sum_i^n (N_i * Q_i) \quad (2.8)$$

Where:

- D_γ = Air dose due to gamma emissions for noble gas radionuclides (mrad).
- D_β = Air dose due to beta emissions for noble gas radionuclides (mrad).
- X/Q = Atmospheric dispersion to the controlling SITE BOUNDARY location (sec/m³).
- Q_i = Cumulative release of noble gas radionuclide i over the period of interest (μCi).
- M_i = Air dose factor due to gamma emission from noble gas radionuclide i (mrad/yr per $\mu\text{Ci}/\text{m}^3$, from Table 2-1).

N_i = Air dose factor due to beta emissions from noble gas radionuclide i (mrad/yr per $\mu\text{Ci}/\text{m}^3$, Table 2-1).

$3.17\text{E}-08$ = Conversion factor (yr/sec).

2.4.2 Simplified Dose Calculation for Noble Gases

In lieu of the individual noble gas radionuclide dose assessment as presented above, the following simplified dose calculation equations may be used for verifying compliance with the dose limits of CONTROL 3.11.2.2 (Refer to Appendix C for the derivation and justification of this simplified method).

$$D_\gamma = \frac{3.17\text{E}-8}{0.5} * X/Q * M_{eff} * \sum_i^n Q_i \quad (2.9)$$

$$D_\beta = \frac{3.17\text{E}-8}{0.5} * X/Q * N_{eff} * \sum_i^n Q_i \quad (2.10)$$

Where:

M_{eff} = $8.1\text{E}+03$, effective gamma-air dose factor (mrad/yr per $\mu\text{Ci}/\text{m}^3$).

N_{eff} = $8.5\text{E}+03$, effective beta-air dose factor (mrad/yr per $\mu\text{Ci}/\text{m}^3$).

Q_i = Cumulative release for all noble gas radionuclides (μCi).

0.5 = Conservatism factor to account for potential variability in the radionuclide distribution.

Actual meteorological conditions concurrent with the release period or the default, annual average dispersion parameters as presented in Table 2-3, may be used for the evaluation of the gamma-air and beta-air doses.

2.5 Radioiodine and Particulate Dose Calculations - 10 CFR 50

2.5.1 Unrestricted Area Dose - Radioiodine and Particulates

In accordance with the requirements of CONTROL 3.11.2.3, a periodic assessment shall be performed to evaluate compliance with the quarterly dose limit of ≤ 7.5 mrem and calendar year limit of ≤ 15 mrem to any organ. The following equation shall be used to evaluate the maximum organ dose due to release of I-131, I-133, tritium and particulates with half-lives greater than 8 days:

$$D_{aop} = 3.17\text{E} - 08 * W * SF_p * \sum_i^n (R_{iaop} * Q_i) \quad (2.11)$$

Where:

D_{aop} = Dose or dose commitment via all pathways p and age group a (as identified in Table 2-3) to organ o , including the total body (mrem).

W = Atmospheric dispersion parameter to the controlling location(s) as identified in Table 2-3.

X/Q = Atmospheric dispersion for inhalation pathway and H-3 dose contribution via other pathways (sec/ m^3).

D/Q = Atmospheric deposition for vegetation, milk and ground plane exposure pathways (1/ m^2).

R_{iaop} = Dose factor for radionuclide i (mrem/yr per $\mu\text{Ci}/\text{m}^3$ or m^2 - mrem/yr per $\mu\text{Ci}/\text{sec}$) and organ o from Table 2-4 through Table 2-8 for each age group a and the applicable pathway p as identified in Table 2-3. Values for R_{iaop} were derived in accordance with the methods described in NUREG-0133.

Q_i = Cumulative release over the period of interest for radionuclide i - I-131, I-133, H-3 or radioactive material in particulate form with half-life greater than 8 days (μCi).

SF_p = Annual seasonal correction factor to account for fraction of the year that the applicable exposure pathway does not exist. SF_p is set to the default value of 1.

For evaluating the maximum exposed individual, the infant age group is controlling for the milk pathway. Should the Effluent Tracking Software not be available, then only the controlling age group as identified in Table 2-3 need be evaluated for compliance with Control 3.11.2.3.

2.5.2 Simplified Dose Calculation for Radioiodines and Particulates

In lieu of the individual radionuclide (I-131, I-133 and particulates) dose assessment for the resident/dairy location as presented above, the following simplified dose calculation equation may be used for verifying compliance with the dose limits of CONTROL 3.11.2.3 (Refer to Appendix D for the derivation and justification of this simplified method):

$$D_{\max o} = 3.17E - 08 * W * SF_p * R_{I-131} * \sum_i^n Q_i \quad (2.12)$$

Where:

- $D_{\max o}$ = Maximum organ dose (mrem).
- $RI-131$ = I-131 dose parameter for the thyroid for the identified controlling pathway.
= 1.05E+12, infant thyroid dose parameter with the cow-milk pathway controlling (m2 - mrem/yr per $\mu Ci/sec$).
- W = D/Q for radioiodine 1/m2 (See Table 2-3)
- Q_i = Cumulative release over the period of interest for radionuclide i, I-131 or radioactive material in particulate form with half-life greater than 8 days (μCi).
- SF_p = Annual seasonal correction factor to account for fraction of the year that the applicable exposure pathway does not exist. SF_p is set to the default value of 1.

The location of exposure pathways and the maximum organ dose calculation may be based on the available pathways in the surrounding environment of Hope Creek as identified by the annual land-use census (PSEG Nuclear Common REMP ODCM CONTROL 3.12.2). Otherwise, the dose will be evaluated based on the predetermined controlling pathways as identified in Table 2-3.

2.6 Gaseous Effluent Dose Projection

CONTROL 3.11.2.4 requires that the VENTILATION EXHAUST TREATMENT SYSTEM be used to reduce radioactive material levels prior to discharge when projected doses in 31-days exceed:

- 0.2 mrad to air from gamma radiation, or
- 0.4 mrad to air from beta radiation, or
- 0.3 mrem to any organ of a Member of the Public.

The applicable gaseous processing systems for maintaining radioactive material releases ALARA are the Gaseous Radwaste Treatment System and Exhaust Treatment System as delineated in Figures 2-1 and 2-2.

Dose projections are performed at least once per 31-days by the following equations:

$$D_{gp} = (D_g/d) * 31 \quad (2.13)$$

$$D_{dp} = (D_d/d) * 31 \quad (2.14)$$

$$D_{maxp} = (D_{max}/d) * 31 \quad (2.15)$$

Where:

D_{gp}	=	Gamma air dose projection for current 31-day period (mrad).
D_g	=	Gamma air dose to date for current calendar quarter as determined by equation (2.7) or (2.9) (mrad).
Dbp	=	Beta air dose projection for current 31-day period (mrad).
Db	=	Beta air dose to date for current calendar quarter as determined by equation (2.8) or (2.10) (mrad).
D_{maxp}	=	Maximum organ dose projection for current 31-day period (mrem).
D_{max}	=	Maximum organ dose to date for current calendar quarter as determined by equation (2.11) or (2.12) (mrem).
d	=	Number of days in current calendar quarter at the end of the release.
31	=	The number of days projected.

3.0 SPECIAL DOSE ANALYSIS

3.1 Dose Due to Activities Inside the Site Boundary

In accordance with Technical Specification **{CTS: 6.9.1.7} {ITS: 5.6.2}**, the Annual Radioactive Effluent Release Report (ARERR) submitted by May 1st of each year shall include an assessment of radiation doses from radioactive liquid and gaseous effluents to MEMBERS OF THE PUBLIC due to their activities inside the SITE BOUNDARY.

The calculation methods as presented in Sections 2.4 and 2.5 may be used for determining the maximum potential dose to a MEMBER OF THE PUBLIC located inside the site boundary. For the purpose of this calculation, a MEMBER OF THE PUBLIC is an adult individual who is not subject to occupational exposure (i.e., an un-monitored site worker) performing duties within the site boundary, and who is exposed to radioactive material in gaseous effluent for 2,000 hours per year via the inhalation and ground plane exposure pathways. The values for the atmospheric dispersion coefficients at the point of interest inside the site boundary (e.g., 0.25 mile) shall be developed from the current five-year annual meteorological data.

3.2 Total Dose to MEMBERS OF THE PUBLIC - 40 CFR 190 and 10 CFR 72.104

The Annual Radioactive Effluent Release Report (ARERR) submitted by May 1st of each year shall also include an assessment of the radiation dose to the likely most exposed MEMBER OF THE PUBLIC for reactor releases and other nearby uranium fuel cycle courses (including dose contributions from effluents and direct radiation from on-site sources). For the likely most exposed MEMBER OF THE PUBLIC in the vicinity of Artificial Island, the sources of exposure need only consider the Salem Generating station and the Hope Creek Generating Station which includes the Independent Spent Fuel Storage Installation (ISFSI): No other fuel cycle facilities contribute to the MEMBER OF THE PUBLIC dose for the Artificial Island vicinity.

The dose contribution from the operation of Salem Generating Stations will be estimated based on the methods as presented in the Salem Offsite Dose Calculation Manual (SGS ODCM).

As appropriate for demonstrating/evaluating compliance with the limits of CONTROL 3.11.4 (40 CFR 190) the results of the environmental monitoring program may be used for providing data on actual measured levels of radioactive material in the actual pathways of exposure.

3.2.1 Effluent Dose Calculations

For purposes of implementing the surveillance requirements of CONTROL 3/4.11.4 and the reporting requirements of CONTROL 6.1 (ARERR) dose calculations for the Hope Creek Generating Station may be performed using the calculation methods contained within the ODCM; the conservation controlling pathways and locations of Table 2-4 through Table 2-8 or the actual pathways and locations as identified by the land use census (PSEG Nuclear Common REMP ODCM CONTROL 3.12.2) may be used. Average annual meteorological dispersion parameters or meteorological conditions concurrent with the release period under evaluation may be used.

3.2.2 Direct Exposure Dose Determination

Any potentially significant direct exposure contribution to off-site individual doses may be evaluated based on the results of the environmental measurements (e.g., dosimetry, ion chamber measurements) and/or by the use of a radiation transport and shielding calculation method. Only during a non-typical condition will there exist any potential for significant on-site sources at Hope Creek that would yield potentially significant off-site doses (i.e., in excess of 1 mrem per year to a MEMBER OF THE PUBLIC), that would require detailed evaluation for demonstrating compliance with 40 CFR 190 or 10 CFR 72.104. However, should a situation exist whereby the direct exposure contribution is potentially significant, on-site measurements, off-site measurements and/or calculational techniques will be used for determination of dose for assessing 40 CFR 190 or 10 CFR 72.104 compliance.

3.2.3 Doses due to Carbon 14 in Gaseous Effluent

Because gaseous effluent releases from a boiling water reactor (BWR), such as the Hope Creek Generating Station, can contain significant quantities of C-14 (i.e., approximately 8 to 9.5 curies annually according to Revision 2 of Regulatory Guide 1.21), the NRC has recommended that licensees evaluate C-14 as a potential principal radionuclide for gaseous releases from their facility. The results in an evaluation conducted in response to SAP Order 70096339 identified C-14 as a principal radionuclide in gaseous effluent releases from the Hope Creek Generating Station.

3.2.4 Estimation of Carbon 14 Annual Release

The methodology for estimating the quantity C-14 released annually from the Hope Creek Generating Station incorporates the use of a normalized C-14 source term and a scaling factor based on power generation. NCRP Report No. 81, *Carbon-14 in the Environment*, has been identified by the NRC as a source for scaling factors (refer to section 1.9 in Revision 2 of Regulatory Guide 1.21). This approach is one of three NRC-recommended methods for estimating the quantity of C-14 discharged in gaseous effluent (refer to Regulatory position 1.9 in Revision 2 of Regulatory Guide 1.21). Electrical energy output value for the reporting period should be used to estimate the quantity of C-14 released.

3.2.5 Carbon 14 dose Determinations

The methodology for determining doses from C-14 in gaseous releases incorporates dose models described in Regulatory Guide 1.109. Estimated C-14 releases and average meteorological data for the reporting period should be used as input to the dose calculations. The doses due to C-14 in gaseous releases are calculated for receptors located at and beyond the site boundary. For doses at locations beyond the site boundaries, receptors shall be real individuals via active pathways as identified in the Annual Land Use Census. Doses due to C-14 in gaseous effluent and the assumptions used in the dose calculations shall be included in the Annual Radioactive Effluent Release Report.

FIGURE 1-1 LIQUID RADWASTE TREATMENT AND MONITORING SYSTEM

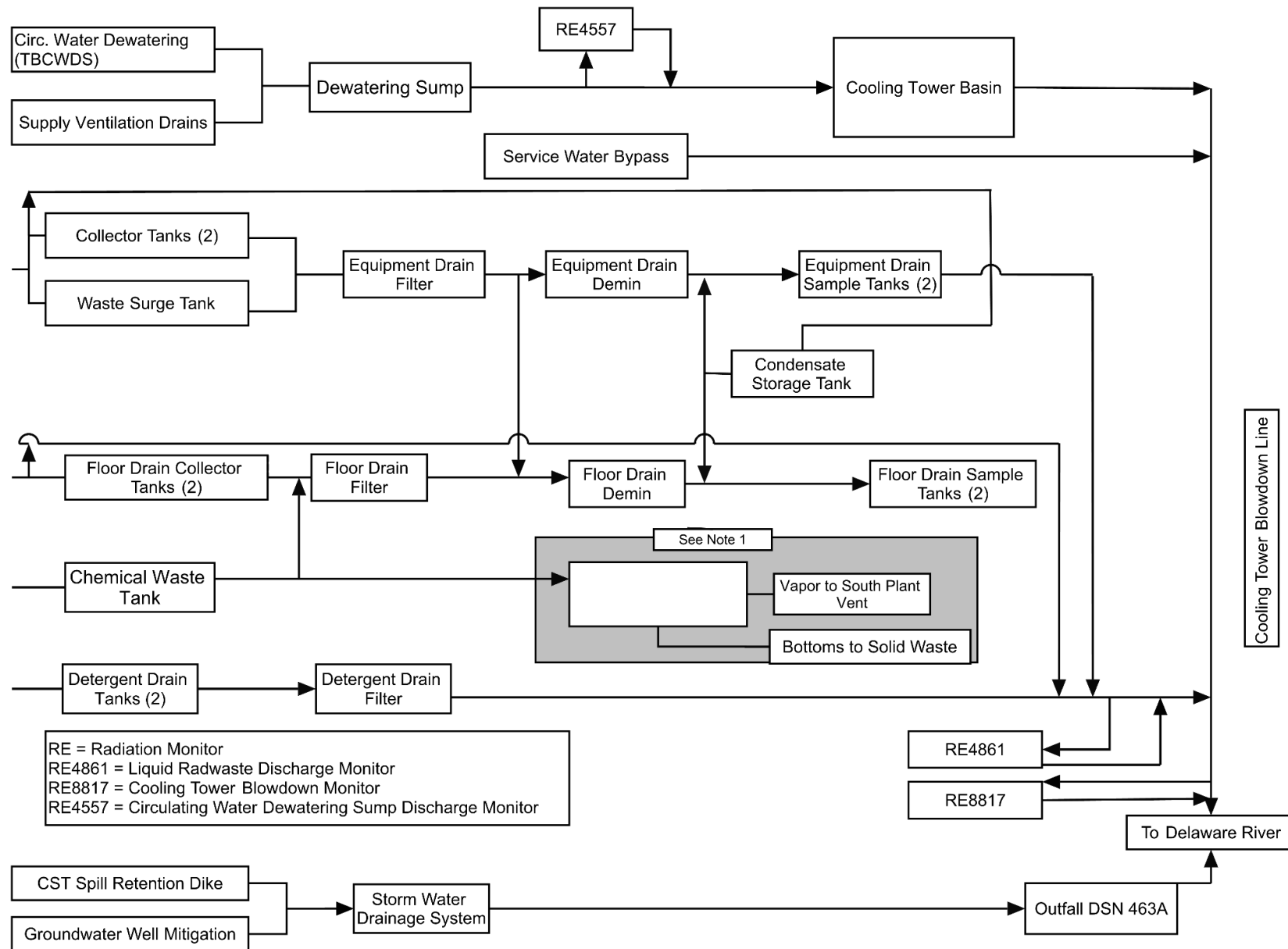
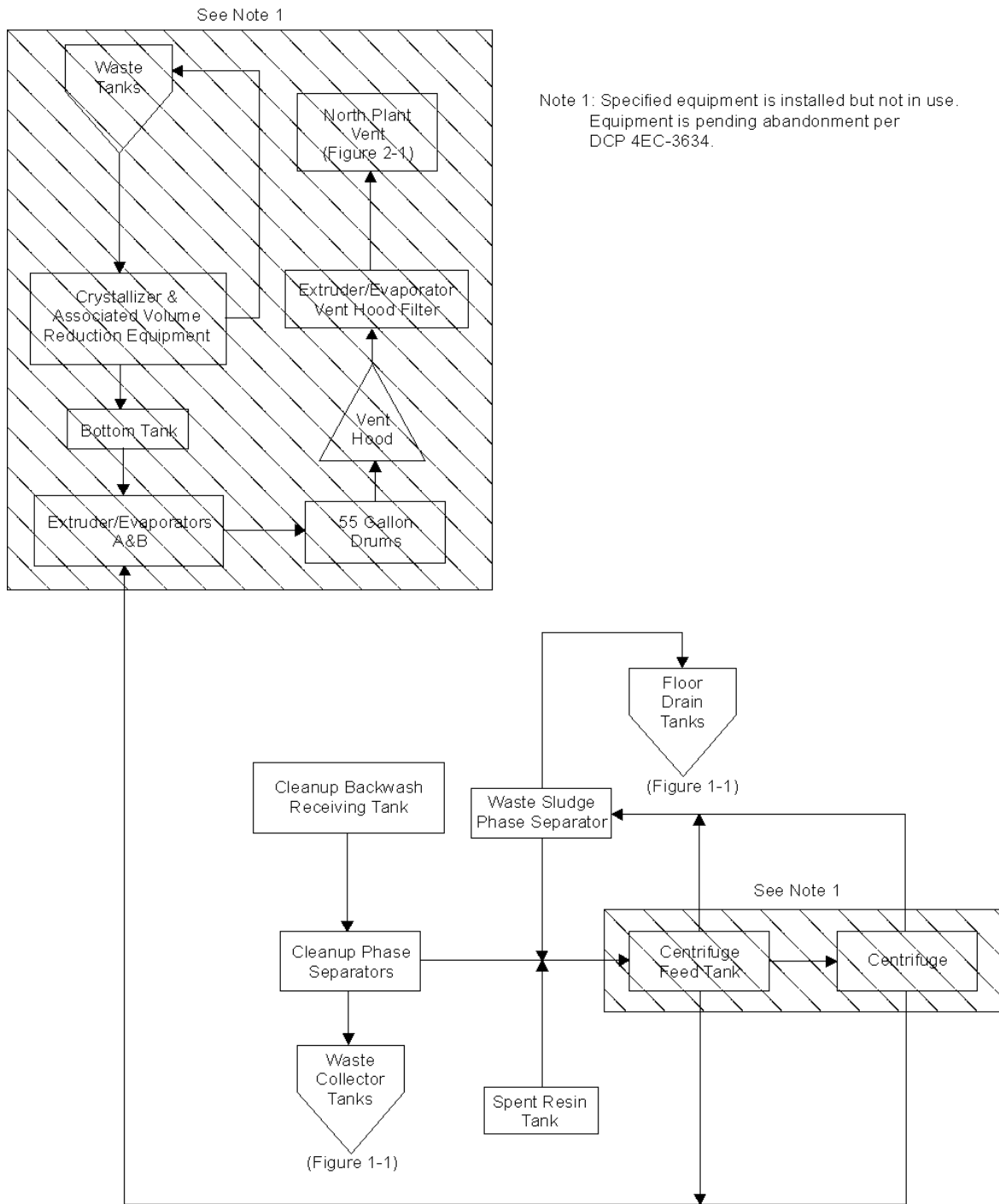


FIGURE 1-2 SOLID RADWASTE PROCESSING SYSTEM



Note 1: Specified equipment is installed but not in use. Equipment is pending abandonment per DCP 4EC-3634.

TABLE 1-1 PARAMETERS FOR LIQUID ALARM SETPOINT DETERMINATION

Parameter	Actual Value	Default Value	Units	Comments
MPC _e	Calc	9.84E-06*	μCi/ml	Calculated for each batch to be released
MPC I-131	3.0E-07	N/A	μCi/ml	Taken from 10 CFR 20, Appendix B, Table II, Column 2 (Appendix F)
C _i	Measured	N/A	μCi/ml	Taken from gamma spectral analysis of liquid effluent
MPC _i	Measured	N/A	μCi/ml	Taken from 10CFR20, Appendix B, Table II, Column 2 (Appendix F)
CTBD	Measured	12000	gpm	Cooling tower blowdown discharge
RR	Measured	176	gpm or	Determined prior to release, release rate can be adjusted for CONTROL compliance
		1300	gpm (CST)	
	Estimated	100	gpm (TBCW)	Maximum flow rate with both pumps running (50 gpm each)
SP (Setpoints)**				
A) RE4861	Calc	1.3E-04	μCi/ml	Default alarm setpoints; more conservative values may be used as appropriate and desirable for ensuring regulatory compliance and for maintaining releases ALARA
RE8817	Calc	2.0E-06	μCi/ml	Maximum alarm setpoint continuous release
RE4557	Calc	2.4E-06	μCi/ml	Maximum alarm setpoint continuous release; more conservative value may be established by plant procedure
B) RE4861	Calc	1.8E-05	μCi/ml	These setpoints are for condensate storage tank releases

* See Appendix A for basis

** Setpoints rounded to one significant digit.

TABLE 1-2 SITE RELATED ADULT INGESTION DOSE COMMITMENT FACTOR, A_{io} (FISH AND INVERTEBRATE CONSUMPTION)(mrem/hr per $\mu\text{Ci/ml}$)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	2.82E-01	2.82E-01	2.82E-01	2.82E-01	2.82E-01	2.82E-01
C-14	1.45E+04	2.90E+03	2.90E+03	2.90E+03	2.90E+03	2.90E+03	2.90E+03
Na-24	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01
P-32	4.69E+06	2.91E+05	1.81E+05	-	-	-	5.27E+05
Cr-51	-	-	5.58E+00	3.34E+00	1.23E+00	7.40E+00	1.40E+03
Mn-54	-	7.06E+03	1.35E+03	-	2.10E+03	-	2.16E+04
Mn-56	-	1.78E+02	3.15E+01	-	2.26E+02	-	5.67E+03
Fe-55	5.11E+04	3.53E+04	8.23E+03	-	-	1.97E+04	2.03E+04
Fe-59	8.06E+04	1.90E+05	7.27E+04	-	-	5.30E+04	6.32E+05
Co-57	-	1.42E+02	2.36E+02	-	-	-	3.59E+03
Co-58	-	6.03E+02	1.35E+03	-	-	-	1.22E+04
Co-60	-	1.73E+03	3.82E+03	-	-	-	3.25E+04
Ni-63	4.96E+04	3.44E+03	1.67E+03	-	-	-	7.18E+02
Ni-65	2.02E+02	2.62E+01	1.20E+01	-	-	-	6.65E+02
Cu-64	-	2.14E+02	1.01E+02	-	5.40E+02	-	1.83E+04
Zn-65	1.61E+05	5.13E+05	2.32E+05	-	3.43E+05	-	3.23E+05
Zn-69m	5.66E+03	1.36E+04	1.24E+03	-	8.22E+03	-	8.29E+05
Br-82	-	-	4.07E+00	-	-	-	4.67E+00
Br-83	-	-	7.25E-02	-	-	-	1.04E-01
Br-84	-	-	9.39E-02	-	-	-	7.37E-07
Br-85	-	-	3.86E-03	-	-	-	-
Rb-86	-	6.24E+02	2.91E+02	-	-	-	1.23E+02
Rb-88	-	1.79E+00	9.49E-01	-	-	-	2.47E-11
Rb-89	-	1.19E+00	8.34E-01	-	-	-	6.89E-14
Sr-89	4.99E+03	-	1.43E+02	-	-	-	8.00E+02
Sr-90	1.23E+05	-	3.01E+04	-	-	-	3.55E+03
Sr-91	9.18E+01	-	3.71E+00	-	-	-	4.37E+02
Sr-92	3.48E+01	-	1.51E+00	-	-	-	6.90E+02
Y-90	6.06E+00	-	1.63E-01	-	-	-	6.42E+04
Y-91m	5.73E-02	-	2.22E-03	-	-	-	1.68E-01
Y-91	8.88E+01	-	2.37E+00	-	-	-	4.89E+04
Y-92	5.32E-01	-	1.56E-02	-	-	-	9.32E+03
Y-93	1.69E+00	-	4.66E-02	-	-	-	5.35E+04
Zr-95	1.59E+01	5.11E+00	3.46E+00	-	8.02E+00	-	1.62E+04
Zr-97	8.81E-01	1.78E-01	8.13E-02	-	2.68E-01	-	5.51E+04
Nb-95	4.47E+02	2.49E+02	1.34E+02	-	2.46E+02	-	1.51E+06
Nb-97	3.75E+00	9.49E-01	3.46E-01	-	1.11E+00	-	3.50E+03
Mo-99	-	1.28E+02	2.43E+01	-	2.89E+02	-	2.96E+02
Tc-99m	1.30E-02	3.66E-02	4.66E-01	-	5.56E-01	1.79E-02	2.17E+01
Tc-101	1.33E-02	1.92E-02	1.88E-01	-	3.46E-01	9.81E-03	5.77E-14

TABLE 1-2: SITE RELATED ADULT INGESTION DOSE COMMITMENT FACTOR, A_{io} (FISH AND INVERTEBRATE CONSUMPTION) (continued)(mrem/hr per $\mu\text{Ci/ml}$)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	1.07E+02	-	4.60E+01	-	4.07E+02	-	1.25E+4
Ru-105	8.89E+00	-	3.51E+00	-	1.15E+02	-	5.44E+03
Ru-106	1.59E+03	-	2.01E+02	-	3.06E+03	-	1.03E+5
Ag-110m	1.56E+03	1.45E+03	8.60E+02	-	2.85E+03	-	5.91E+5
Sb-124	2.77E+02	5.23E+00	1.10E+02	6.71E-01	-	2.15E+02	7.86E+03
Sb-125	1.77E+02	1.98E+00	4.21E+01	1.80E-01	-	1.36E+02	1.95E+03
Sb-126	1.14E+02	2.31E+00	4.10E+01	6.96E-01	-	6.97E+01	9.29E+03
Te-125m	2.17E+02	7.86E+01	2.91E+01	6.52E+01	8.82E+02	-	8.66E+02
Te-127m	5.48E+02	1.96E+02	6.68E+01	1.40E+02	2.23E+03	-	1.84E+03
Te-127	8.90E+00	3.20E+00	1.93E+00	6.60E+00	3.63E+01	-	7.03E+02
Te-129m	9.31E+02	3.47E+02	1.47E+02	3.20E+02	3.89E+03	-	4.69E+03
Te-129	2.54E+00	9.55E-01	6.19E-01	1.95E+00	1.07E+01	-	1.92E+0
Te-131m	1.40E+02	6.85E+01	5.71E+01	1.08E+02	6.94E+02	-	6.80E+03
Te-131	1.59E+00	6.66E-01	5.03E-01	1.31E+00	6.99E+0	-	2.26E-01
Te-132	2.04E+02	1.32E+02	1.24E+02	1.46E+02	1.27E+03	-	6.24E+03
I-130	3.96E+01	1.17E+02	4.61E+01	9.91E+03	1.82E+02	-	1.01E+02
I-131	2.18E+02	3.12E+02	1.79E+02	1.02E+05	5.35E+02	-	8.23E+01
I-132	1.06E+01	2.85E+01	9.96E+00	9.96E+02	4.54E+01	-	5.35E+0
I-133	7.45E+01	1.30E+02	3.95E+01	1.90E+04	2.26E+02	-	1.16E+02
I-134	5.56E+00	1.51E+01	5.40E+00	2.62E+02	2.40E+01	-	1.32E-02
I-135	2.32E+01	6.08E+01	2.24E+01	4.01E+03	9.75E+01	-	6.87E+01
Cs-134	6.84E+03	1.63E+04	1.33E+04	-	5.27E+03	1.75E+03	2.85E+02
Cs-136	7.16E+02	2.83E+03	2.04E+03	-	1.57E+03	2.16E+02	3.21E+02
Cs-137	8.77E+03	1.20E+04	7.85E+03	-	4.07E+03	1.35E+03	2.32E+02
Cs-138	6.07E+00	1.20E+01	5.94E+00	-	8.81E+00	8.70E-01	5.12E-05
Ba-139	7.85E+00	5.59E-03	2.30E-01	-	5.23E-03	3.17E-03	1.39E+01
Ba-140	1.64E+03	2.06E+00	1.08E+02	-	7.02E-01	1.18E+00	3.38E+03
Ba-141	3.81E+00	2.88E-03	1.29E-01	-	2.68E-03	1.63E-03	1.80E-09
Ba-142	1.72E+00	1.77E-03	1.08E-01	-	1.50E-03	1.00E-03	2.43E-18
La-140	1.57E+00	7.94E-01	2.10E-01	-	-	-	5.83E+04
La-142	8.06E-02	3.67E-02	9.13E-03	-	-	-	2.68E+02
Ce-141	3.43E+00	2.32E+0	2.63E-01	-	1.08E+00	-	8.86E+03
Ce-143	6.04E-01	4.46E+02	4.94E-02	-	1.97E-01	-	1.67E+04
Ce-144	1.79E+02	7.47E+01	9.59E+0	-	4.43E+01	-	6.04E+4
Pr-143	5.79E+00	2.32E+00	2.87E-01	-	1.34E+00	-	2.54E+4
Pr-144	1.90E-02	7.87E-03	9.64E-04	-	4.44E-03	-	2.73E-09
Nd-147	3.96E+00	4.58E+00	2.74E-01	-	2.68E+00	-	2.20E+4
W-187	9.16E+00	7.66E+00	2.68E+00	-	-	-	2.51E+03
Np-239	3.53E-02	3.47E-03	1.91E-03	-	1.08E-02	-	7.11E+02

TABLE 1-3 SITE RELATED TEENAGER INGESTION DOSE COMMITMENT FACTOR, A_{io} (FISH AND INVERTEBRATE CONSUMPTION)(mrem/hr per $\mu\text{Ci/ml}$)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	2.17E-01	2.17E-01	2.17E-01	2.17E-01	2.17E-01	2.17E-01
C-14	1.58E+04	3.16E+03	3.16E+03	3.16E+03	3.16E+03	3.16E+03	3.16E+03
Na-24	1.55E-01	1.55E-01	1.55E-01	1.55E-01	1.55E-01	1.55E-01	1.55E-01
P-32	4.86E+06	3.01E+06	1.89E+05	-	-	-	4.09E+05
Cr-51	-	-	5.61E+00	3.12E+00	1.23E+00	8.01E+00	9.43E+02
Mn-54	-	6.94E+03	1.38E+03	-	2.07E+03	-	1.42E+04
Mn-56	-	2.94E-01	5.22E-02	-	3.72E-01	-	1.93E+01
Fe-55	5.35E+04	3.79E+04	8.84E+03	-	-	2.40E+04	1.64E+04
Fe-59	8.18E+04	1.91E+05	7.37E+04	-	-	6.02E+04	4.52E+05
Co-57	-	1.46E+02	2.45E+02	-	-	-	2.73E+03
Co-58	-	5.93E+02	1.37E+03	-	-	-	8.18E+03
Co-60	-	1.73E+03	3.90E+03	-	-	-	2.26E+04
Ni-63	5.15E+04	3.64E+03	1.75E+03	-	-	-	5.79E+02
Ni-65	2.96E-01	3.78E-02	1.72E-02	-	-	-	2.05E+00
Cu-64	-	6.09E+01	2.86E+01	-	1.54E+02	-	4.72E+03
Zn-65	1.46E+05	5.05E+05	2.36E+05	-	3.23E+05	-	2.14E+05
Zn-69m	1.81E+03	4.28E+03	3.92E+02	-	2.60E+03	-	2.35E+05
Br-82	-	-	2.60E+00	-	-	-	-
Br-83	-	-	7.47E-05	-	-	-	-
Br-84	-	-	2.31E-15	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	6.47E+02	3.04E+02	-	-	-	9.58E+01
Rb-88	-	8.52E-25	4.54E-25	-	-	-	7.30E-32
Rb-89	-	1.04E-28	7.37E-29	-	-	-	1.60E-37
Sr-89	5.35E+03		1.53E+02	-	-	-	6.37E+02
Sr-90	1.02E+05		2.53E+04	-	-	-	2.87E+03
Sr-91	1.73E+01		6.87E-01	-	-	-	7.83E+01
Sr-92	8.11E-02		3.46E-03	-	-	-	2.07E+00
Y-90	5.07E+00		1.36E-01	-	-	-	4.18E+04
Y-91m	1.18E-10		4.50E-12	-	-	-	5.56E-09
Y-91	9.52E+01		2.55E+00	-	-	-	3.90E+04
Y-92	5.28E-03		1.53E-04	-	-	-	1.45E+02
Y-93	3.54E-01		9.70E-03	-	-	-	1.08E+04
Zr-95	1.63E+01	5.14E+00	3.54E+00	-	7.56E+00	-	1.19E+04
Zr-97	3.54E-01	7.01E-02	3.23E-02	-	1.06E-01	-	1.90E+04
Nb-95	4.42E+02	2.45E+02	1.35E+02	-	2.38E+02	-	1.05E+06
Nb-97	3.93E-06	9.76E-07	3.56E-07	-	1.14E-06	-	2.33E-02
Mo-99	-	1.06E+02	2.02E+01	-	2.42E+02	-	1.90E+02
Tc-99m	8.37E-04	2.33E-03	3.02E-02	-	3.48E-02	1.30E-03	1.53E+00
Tc-101	4.27E-33	6.08E-33	5.97E-32	-	1.10E-31	3.70E-33	1.04E-39

TABLE 1-3: SITE RELATED TEENAGER INGESTION DOSE COMMITMENT FACTOR, A_{io} (FISH AND INVERTEBRATE CONSUMPTION) (continued)(mrem/hr per $\mu\text{Ci/ml}$)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	1.10E+02	-	4.70E+01	-	3.88E+02	-	9.19E+03
Ru-105	2.26E-01	-	8.77E-02	-	2.85E+00	-	1.82E+02
Ru-106	1.72E+03	-	2.17E+02	-	3.31E+03	-	8.24E+04
Ag-110m	1.52E+03	1.44E+03	8.78E+02	-	2.75E+03	-	4.05E+05
Sb-124	2.88E+02	5.30E+00	1.12E+02	6.53E-01	-	2.51E+02	5.80E+03
Sb-125	1.86E+02	2.04E+00	4.36E+01	1.78E-01	-	1.64E+02	1.45E+03
Sb-126	1.13E+02	2.31E+00	4.06E+01	6.40E-01	-	8.11E+01	6.69E+03
Te-125m	2.33E+02	8.41E+01	3.12E+01	6.52E+01	-	-	6.88E+02
Te-127m	5.92E+02	2.10E+02	7.04E+01	1.41E+02	2.40E+03	-	1.48E+03
Te-127	1.64E+00	5.83E-01	3.54E-01	1.13E+00	6.66E+00	-	1.27E+02
Te-129m	9.84E+02	3.65E+02	1.56E+02	3.18E+02	4.12E+03	-	3.70E+03
Te-129	1.63E-06	6.09E-07	3.97E-07	1.17E-06	6.85E-06	-	8.93E-06
Te-131m	8.64E+01	4.14E+01	3.46E+01	6.23E+01	4.32E+02	-	3.32E+03
Te-131	7.87E-18	3.25E-18	2.46E-18	6.07E-18	3.44E-17	-	6.46E-19
Te-132	1.74E+02	1.10E+02	1.04E+02	1.16E+02	1.06E+03	-	3.49E+03
I-130	1.07E+01	3.10E+01	1.24E+01	2.53E+03	4.77E+01	-	2.38E+01
I-131	2.14E+02	3.00E+02	1.61E+02	8.76E+04	5.17E+02	-	5.94E+01
I-132	3.61E+01	6.12E+01	1.87E+01	8.55E+03	1.07E+02	-	4.63E+01
I-133	8.05E-03	2.11E-02	7.56E-03	7.10E-01	3.32E-02	-	9.18E-03
I-134	3.35E-08	8.87E-08	3.19E-08	1.48E-06	1.40E-07	-	1.17E-09
I-135	1.97E+00	5.06E+00	1.88E+00	3.26E+02	8.00E+00	-	5.61E+00
Cs-134	7.02E+03	1.65E+04	7.66E+03	-	5.25E+03	2.00E+03	2.05E+02
Cs-136	6.84E+02	2.69E+03	1.81E+03	-	1.46E+03	2.31E+02	2.17E+02
Cs-137	2.25E-13	4.31E-13	2.16E-13	-	3.18E-13	3.70E-14	1.96E-16
Cs-138	9.40E+03	1.25E+04	4.35E+03	-	4.25E+03	1.65E+03	1.78E+02
Ba-139	5.21E-05	3.66E-08	1.52E-06	-	3.45E-08	2.52E-08	4.64E-04
Ba-140	1.66E+03	2.03E+00	1.07E+02	-	6.89E-01	1.37E+00	2.56E+03
Ba-141	7.76E-24	5.80E-27	2.59E-25	-	5.38E-27	3.97E-27	1.65E-29
Ba-142	5.66E-41	5.66E-44	3.49E-42	-	4.79E-44	3.77E-44	1.74E-52
La-140	1.10E+00	5.42E-01	1.44E-01	-	-	-	3.11E+04
La-142	2.45E-06	1.09E-06	2.71E-07	-	-	-	3.32E-02
Ce-141	3.63E+00	2.42E+00	2.78E-01	-	1.14E+00	-	6.93E+03
Ce-143	1.93E+02	8.00E+01	1.04E+01	-	4.78E+01	-	4.86E+04
Ce-144	3.95E-01	2.88E+02	3.21E-02	-	1.29E-01	-	8.65E+03
Pr-143	5.97E+00	2.38E+00	2.97E-01	-	1.38E+00	-	1.96E+04
Pr-144	1.69E-27	6.93E-28	8.58E-29	-	3.97E-28	-	1.87E-30
Nd-147	4.93E+00	4.01E+00	1.41E+00	-	-	-	1.09E+03
W-187	4.22E+00	4.59E+00	2.75E-01	-	2.70E+00	-	1.66E+04
Np-239	2.96E-02	2.80E-03	1.55E-03	-	8.77E-03	-	4.50E+02

TABLE 1-4 SITE RELATED CHILD INGESTION DOSE COMMITMENT FACTOR, A_{io} (FISH AND INVERTEBRATE CONSUMPTION)(mrem/hr per $\mu\text{Ci/ml}$)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	2.04E+04	4.09E+03	4.09E+03	4.09E+03	4.09E+03	4.09E+03	4.09E+03
C-14	1.72E-01	1.72E-01	1.72E-01	1.72E-01	1.72E-01	1.72E-01	1.72E-01
Na-24	6.43E+06	3.01E+05	2.48E+05	-	-	-	1.78E+05
P-32	-	-	6.10E+00	3.39E+00	9.26E-01	6.19E+00	3.24E+02
Cr-51	-	5.45E+03	1.45E+03	-	1.53E+03	-	4.58E+03
Mn-54	-	2.69E-01	6.08E-02	-	3.26E-01	-	3.90E+01
Mn-56	7.18E+04	3.81E+04	1.18E+04	-	-	2.15E+04	7.05E+03
Fe-55	1.01E+05	1.64E+05	8.18E+04	-	-	4.76E+04	1.71E+05
Fe-59	-	1.34E+02	2.72E+02	-	-	-	1.10E+03
Co-57	-	4.86E+02	1.49E+03	-	-	-	2.84E+03
Co-58	-	1.44E+03	4.25E+03	-	-	-	7.99E+03
Co-60	6.85E+04	3.67E+03	2.33E+03	-	-	-	2.47E+02
Ni-63	3.84E-01	3.61E-02	2.11E-02	-	-	-	4.43E+00
Ni-65	-	5.67E+01	3.43E+01	-	1.37E+02	-	2.66E+03
Cu-64	1.54E+05	4.11E+05	2.55E+05	-	2.59E+05	-	7.21E+04
Zn-65	2.39E+03	4.07E+03	4.81E+02	-	2.37E+03	-	1.33E+05
Zn-69m	-	-	2.89E+00	-	-	-	-
Br-82	-	-	9.95E-05	-	-	-	-
Br-83	-	-	2.84E-15	-	-	-	-
Br-84	-	-	-	-	-	-	-
Br-85	-	6.35E+02	3.90E+02	-	-	-	4.09E+01
Rb-86	-	8.29E-25	5.76E-25	-	-	-	4.07E-26
Rb-88	-	9.68E-29	8.60E-29	-	-	-	8.44E-31
Rb-89	7.10E+03	-	2.03E+02	-	-	-	2.75E+02
Sr-89	9.28E+04	-	2.35E+04	-	-	-	1.25E+03
Sr-90	2.27E+01	-	8.58E-01	-	-	-	5.02E+01
Sr-91	1.06E-01	-	4.26E-03	-	-	-	2.01E+00
Sr-92	6.78E+00	-	1.81E-01	-	-	-	1.93E+04
Y-90	1.56E-10	-	5.66E-12	-	-	-	3.04E-07
Y-91m	1.27E+02	-	3.40E+00	-	-	-	1.69E+04
Y-91	7.00E-03	-	2.00E-04	-	-	-	2.02E+02
Y-92	4.69E-01	-	1.29E-02	-	-	-	7.00E+03
Y-93	1.99E+01	4.37E+00	3.89E+00	-	6.25E+00	-	4.55E+03
Zr-95	4.52E-01	6.53E-02	3.85E-02	-	9.38E-02	-	9.89E+03
Zr-97	5.22E+02	2.03E+02	1.45E+02	-	1.91E+02	-	3.76E+05
Nb-95	4.99E-06	9.01E-07	4.21E-07	-	1.00E-06	-	2.78E-01
Nb-97	-	1.01E+02	2.51E+01	-	2.17E+02	-	8.39E+01
Mo-99	1.02E-03	2.01E-03	3.33E-02	-	2.92E-02	1.02E-03	1.14E+00
Tc-99m	5.59E-33	5.85E-33	7.42E-32	-	9.98E-32	3.09E-33	1.86E-32
Tc-101	2.04E+04	4.09E+03	4.09E+03	4.09E+03	4.09E+03	4.09E+03	4.09E+03

TABLE 1-4: SITE RELATED CHILD INGESTION DOSE COMMITMENT FACTOR, A_{io} (FISH AND INVERTEBRATE CONSUMPTION) (continued)(mrem/hr per $\mu\text{Ci/ml}$)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	1.41E+02	-	5.42E+01	-	3.55E+02	-	3.65E+03
Ru-105	2.99E-01	-	1.08E-01	-	2.63E+00	-	1.95E+02
Ru-106	2.29E+03	-	2.86E+02	-	3.10E+03	-	3.57E+04
Ag-110m	1.74E+03	1.18E+03	9.40E+02	-	2.19E+03	-	1.40E+05
Sb-124	3.56E+02	4.62E+00	1.25E+02	7.87E-01	-	1.98E+02	2.23E+03
Sb-125	2.32E+02	1.79E+00	4.87E+01	2.15E-01	-	1.29E+02	5.55E+02
Sb-126	1.35E+02	2.07E+00	4.85E+01	7.92E-01	-	6.45E+01	2.72E+03
Te-125m	3.07E+02	8.33E+01	4.10E+01	8.63E+01	-	-	2.97E+02
Te-127m	7.83E+02	2.11E+02	9.30E+01	1.87E+02	2.23E+03	-	6.34E+02
Te-127	2.17E+00	5.85E-01	4.65E-01	1.50E+00	6.17E+00	-	8.47E+01
Te-129m	1.30E+03	3.63E+02	2.02E+02	4.20E+02	3.82E+03	-	1.59E+03
Te-129	2.16E-06	6.03E-07	5.13E-07	1.54E-06	6.32E-06	-	1.35E-04
Te-131m	1.13E+02	3.90E+01	4.15E+01	8.02E+01	3.78E+02	-	1.58E+03
Te-131	1.04E-17	3.16E-18	3.09E-18	7.93E-18	3.14E-17	-	5.45E-17
Te-132	2.23E+02	9.86E+01	1.19E+02	1.44E+02	9.15E+02	-	9.92E+02
I-130	1.34E+01	2.70E+01	1.39E+01	2.97E+03	4.04E+01	-	1.26E+01
I-131	2.77E+02	2.79E+02	1.59E+02	9.23E+04	4.58E+02	-	2.48E+01
I-132	4.68E+01	5.78E+01	2.19E+01	1.07E+04	9.64E+01	-	2.33E+01
I-133	1.02E-02	1.87E-02	8.59E-03	8.66E-01	2.86E-02	-	2.20E-02
I-134	4.23E-08	7.85E-08	3.61E-08	1.81E-06	1.20E-07	-	5.21E-08
I-135	2.48E+00	4.47E+00	2.11E+00	3.96E+02	6.85E+00	-	3.41E+00
Cs-134	8.50E+03	1.39E+04	2.94E+03	-	4.32E+03	1.55E+03	7.52E+01
Cs-136	8.11E+02	2.23E+03	1.44E+03	-	1.19E+03	1.77E+02	7.83E+01
Cs-137	2.86E-13	3.98E-13	2.52E-13	-	2.80E-13	3.01E-14	1.83E-13
Cs-138	1.19E+04	1.14E+04	1.68E+03	-	3.71E+03	1.33E+03	7.13E+01
Ba-139	6.86E-05	3.66E-08	1.99E-06	-	3.20E-08	2.15E-08	3.96E-03
Ba-140	2.15E+03	1.88E+00	1.25E+02	-	6.12E-01	1.12E+00	1.09E+03
Ba-141	1.02E-23	5.74E-27	3.33E-25	-	4.96E-27	3.37E-26	5.84E-24
Ba-142	7.33E-41	5.27E-44	4.09E-42	-	4.27E-44	3.10E-44	9.56E-43
La-140	1.43E+00	4.99E-01	1.68E-01	-	-	-	1.39E+04
La-142	3.20E-06	1.02E-06	3.20E-07	-	-	-	2.02E-01
Ce-141	4.83E+00	2.41E+00	3.58E-01	-	1.06E+00	-	3.01E+03
Ce-143	2.58E+02	8.09E+01	1.38E+01	-	4.48E+01	-	2.11E+04
Ce-144	5.25E-01	2.85E+02	4.12E-02	-	1.19E-01	-	4.17E+03
Pr-143	7.98E+00	2.40E+00	3.96E-01	-	1.30E+00	-	8.61E+03
Pr-144	2.26E-27	7.00E-28	1.14E-28	-	3.70E-28	-	1.51E-24
Nd-147	6.29E+00	3.72E+00	1.67E+00	-	-	-	5.23E+02
W-187	5.60E+00	4.54E+00	3.51E-01	-	2.49E+00	-	7.18E+03
Np-239	3.84E-02	2.76E-03	1.94E-03	-	7.97E-03	-	2.04E+02

TABLE 1-5 BIOACCUMULATION FACTORS (pCi/kg per pCi/liter)

ELEMENT	SALTWATER FISH*	SALTWATER INVERTEBRATES*
H	9.00E-01	9.30E-01
C	1.80E+03	1.40E+03
Na	6.70E-02	1.90E-01
P	3.00E+03	3.00E+04
Cr	4.00E+02	2.00E+03
Mn	5.50E+02	4.00E+02
Fe	3.00E+03	2.00E+04
Co	1.00E+02	1.00E+03
Ni	1.00E+02	2.50E+02
Cu	6.70E+02	1.70E+03
Zn	2.00E+03	5.00E+04
Br	1.50E-02	3.10E+00
Rb	8.30E+00	1.70E+01
Sr	2.00E+00	2.00E+01
Y	2.50E+01	1.00E+03
Zr	2.00E+02	8.00E+01
Nb	3.00E+04	1.00E+02
Mo	1.00E+01	1.00E+01
Tc	1.00E+01	5.00E+01
Ru	3.00E+00	1.00E+03
Rh	1.00E+01	2.00E+03
Ag	3.30E+03	3.30E+03
Sb	4.00E+01	5.40E+00
Te	1.00E+01	1.00E+02
I	1.00E+01	5.00E+01
Cs	4.00E+01	2.50E+01
Ba	1.00E+01	1.00E+02
La	2.50E+01	1.00E+03
Ce	1.00E+01	6.00E+02
Pr	2.50E+01	1.00E+03
Nd	2.50E+01	1.00E+03
W	3.00E+01	3.00E+01
Np	1.00E+01	1.00E+01
As	3.30E+02	3.30E+02

* Values in this table are taken from Regulatory Guide 1.109 except for phosphorus (fish) which is adapted from NUREG/CR-1336 and silver, arsenic and antimony which are taken from UCRL 50564, Rev. 1, October 1972.

FIGURE 2-1 GASEOUS RADWASTE TREATMENT SYSTEM

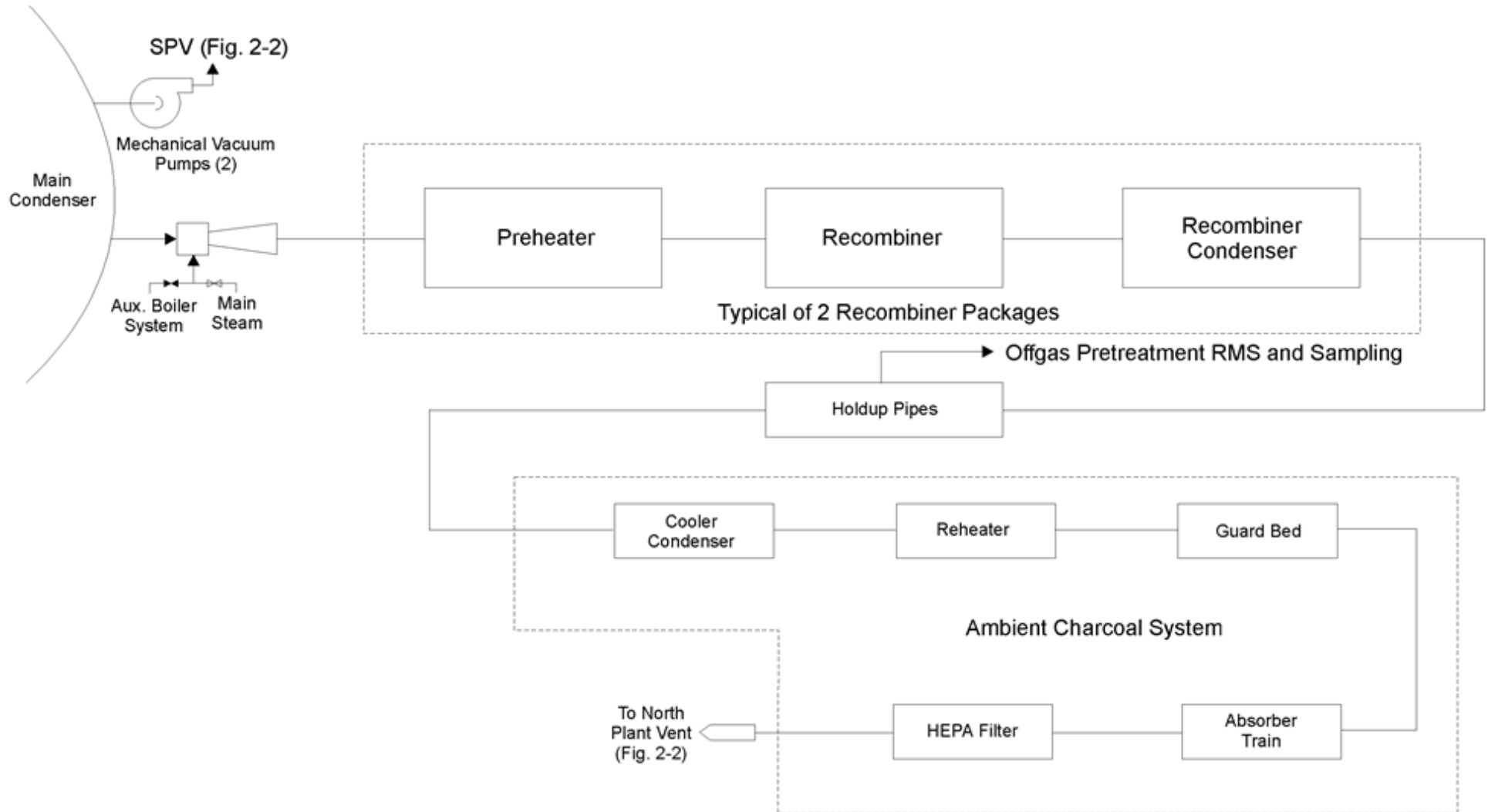
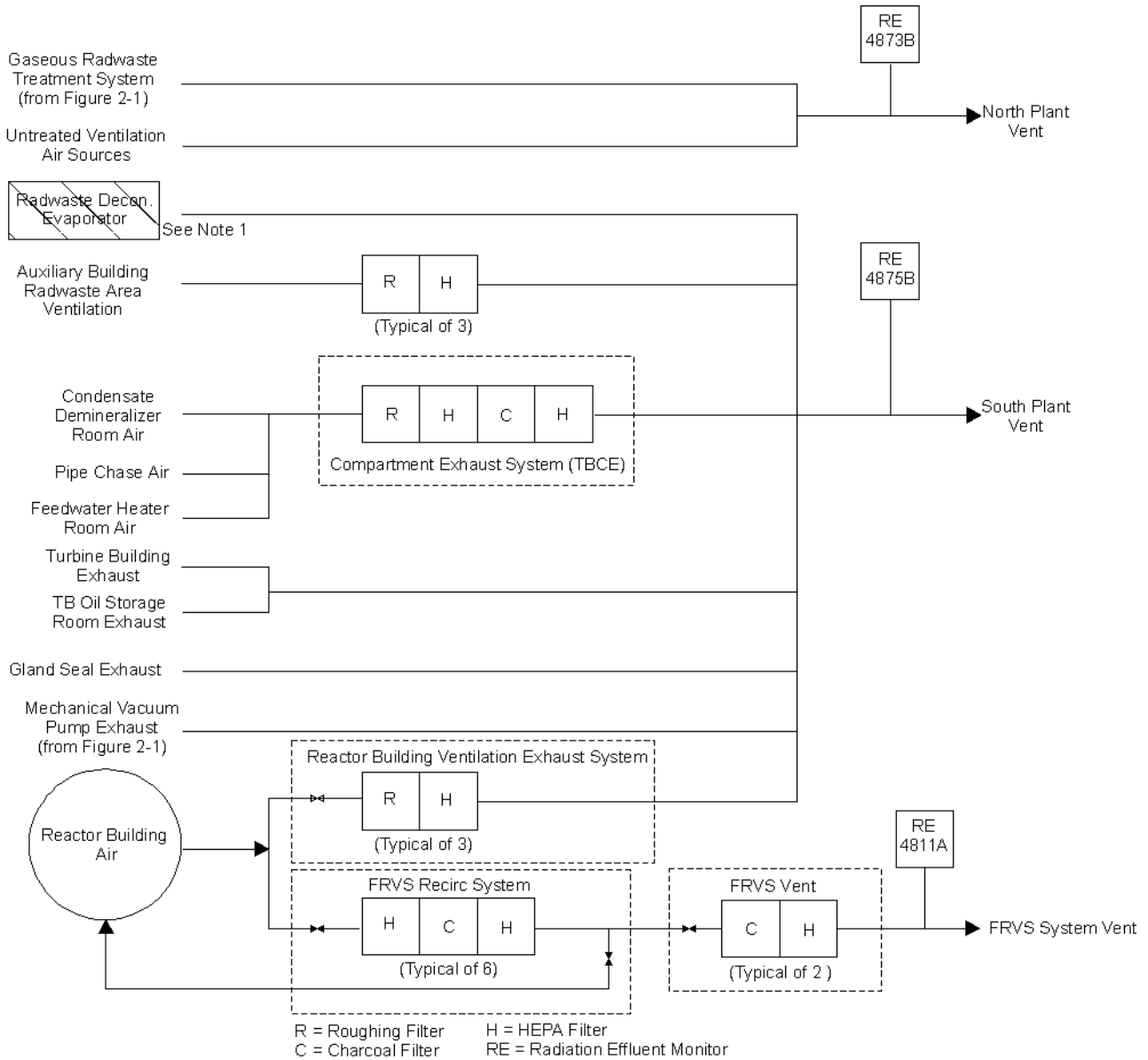


FIGURE 2-2 VENTILATION EXHAUST TREATMENT SYSTEM



**Note 1: Specified equipment is installed but not in use.
Equipment pending abandonment per DCP 4EC-3634.**

TABLE 2-1.1 DOSE FACTORS FOR NOBLE GASES

Radionuclide	Total Body Dose Factor K_i (mrem/yr per $\mu\text{Ci}/\text{m}^3$)	Skin Dose Factor L_i (mrem/yr per $\mu\text{Ci}/\text{m}^3$)	Gamma Air Dose Factor M_i (mrad/yr per $\mu\text{Ci}/\text{m}^3$)	Beta Air Dose Factor N_i (mrad/yr per $\mu\text{Ci}/\text{m}^3$)
Kr-83m	7.56E-02	-	1.93E+01	2.88E+02
Kr-85m	1.17E+03	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

TABLE 2-1.2 ANSI N-237 TABLE 5 EXPECTED NOBLE GAS CONCENTRATION LEVELS ($\mu\text{Ci}/\text{cm}^3$)
USED FOR DEFAULT SETPOINT CALCULATION

Nuclide	C_i ($\mu\text{Ci}/\text{cm}^3$)	Percent Abundance of the Mix	Total Body	Skin
			$C_i * K_i$ ($\text{mRem}/\text{yr}/(\text{m}^3/\text{cm}^3)$)	$C_i * (L_i + (1.1 * M_i))$ ($\text{mRem}/\text{yr}/(\text{m}^3/\text{cm}^3)$)
Kr-83m	1.10E-03	0.73%	8.32E-05	2.34E-02
Kr-85m	1.90E-03	1.26%	2.22E+00	5.34E+00
Kr-87	6.60E-03	4.39%	3.91E+01	1.09E+02
Kr-88	6.60E-03	4.39%	9.70E+01	1.26E+02
Kr-89	4.10E-02	27.24%	6.81E+02	1.19E+03
Xe-131m	4.70E-06	0.00%	4.30E-04	3.04E-03
Xe-133m	9.00E-05	0.06%	2.26E-02	1.22E-01
Xe-133	2.60E-03	1.73%	7.64E-01	1.81E+00
Xe-135m	8.40E-03	5.58%	2.62E+01	3.70E+01
Xe-135	7.20E-03	4.78%	1.30E+01	2.86E+01
Xe-137	4.70E-02	31.23%	6.67E+01	6.51E+02
Xe-138	2.80E-02	18.61%	2.47E+02	3.99E+02
Total	1.50E-01	100.0%	1.17E+03	2.55E+03

TABLE 2-2 PARAMETERS FOR GASEOUS ALARM SETPOINT DETERMINATION

Parameter	Actual Value	Default Value	Units	Comments
X/Q	Calculated	2.14E-06	sec/m ³	0.56 miles, N From FSAR Table 2.3-31
VF (NPV)	Measured	41,900	ft ³ /min	Maximum Operation
VF (SPV)	Measured	440,180	ft ³ /min	Maximum Operation
VF (FRVS)	Measured	9,000	ft ³ /min	Maximum Operation
FRAC (NPV)	99.3	N/A	mrem/yr per m ³ /cm ³	From Equation 2-1
FRAC (SPV)	1042.6	N/A	mrem/yr per m ³ /cm ³	From Equation 2-1
FRAC (FRVS)	21.3	N/A	mrem/yr per m ³ /cm ³	From Equation 2-1
AF (NPV)	Coordinated with SGS	0.2	Unitless	Administrative allocation factor to ensure releases do not exceed release rate limit
AF (SPV)	Coordinated with SGS	0.2	Unitless	Administrative allocation factor to ensure releases do not exceed release rate limit
AF (FRVS)	Coordinated with SGS	0.1	Unitless	Administrative allocation factor to ensure releases do not exceed release rate limit
ΣCi	N/A	1.50E-01	μCi/cm ³	Table 2-1.2
K _i	Nuclide Specific	N/A Specific	mrem/yr per μCi/m ³	Table 2-1.1
L _i	Nuclide Specific	N/A	mrem/yr per μCi/m ³	Table 2-1.1
M _i	Nuclide Specific	N/A	mrads/yr per μCi/m ³	Table 2-1.1
Setpoints	Calculated Setpoint	Default Setpoint		
NPV (RE 4873B)	3.03E-04	2.43E-04	μCi/cm ³	As an additional measure of conservatism, the default setpoints are set approximately 25% lower than the calculated setpoints.
SPV (RE 4875B)	2.89E-05	2.31E-05	μCi/cm ³	
FRVS (RE 4811A)	7.06E-04	5.65E-04	μCi/cm ³	
Iodine & Particulate Release Rate Limit to 1500 mrem/yr Instantaneous Limit from Section 2.3.2	Calculated	Default	Units	Section 2.3.2 discusses the back calculation of what release rate of iodine and particulates would be needed to approach the 1500 mrem/yr instantaneous dose limit.
Reduction Factor	Coordinated with SGS	2	Unitless	
Release Rate	2.16E+01	N/A	μCi/sec	
Seconds per 7 days	N/A	604,800	seconds	
Total μCi	1.31E+07	N/A	μCi	

TABLE 2-3 CONTROLLING LOCATIONS, PATHWAYS AND ATMOSPHERIC DISPERSION FOR DOSE CALCULATIONS

ODCM CONTROL	Location ¹	Pathway(s)	Controlling Age Group	X/Q (sec/m ³)	D/Q (1/m ²)
3.11.2.1a - Dose Rate – Noble Gas	Site Boundary (0.56 miles, N)	Noble Gases direct exposure	ALL	2.14E-06	N/A
3.11.2.1b - Dose Rate – Iodine-131, Iodine-133, H-3 and Particulates with half-lives greater than 8 days	Site Boundary (0.56 miles, N)	Inhalation	Child	2.14E-06	N/A
3.11.2.2 - Dose – Noble Gas	Site Boundary (0.56 miles, N)	Gamma-Air Beta-Air	ALL	2.14E-06	N/A
3.11.2.3 - Dose – Iodine-131, Iodine-133, H-3 and Particulates with half-lives greater than 8 days	Site Boundary (0.56 miles, N)	Ground plane, Inhalation	Child	2.14E-06	1.44E-08
3.11.2.3 - Dose – Iodine-131, Iodine-133, H-3 and Particulates with half-lives greater than 8 days	Residence/Dairy (4.9 miles, W) ²	Ground Plane, Inhalation, Meat, Vegetation, Milk	Infant ³	7.20E-08	1.32E-10

¹ The identified controlling locations, pathways and atmospheric dispersion are from the Artificial Island Radiological Monitoring Program and the Hope Creek FSAR.

² Location and distance are determined from the performance of the annual land use census as required by the PSEG Nuclear Common REMP ODCM CONTROL 3.12.2.

³ When dose from C-14 is determined, then Child will become the Controlling Age Group.

TABLE 2-4 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, INHALATION PATHWAY DOSE FACTORSADULT (mrem/yr per $\mu\text{Ci}/\text{m}^3$)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03
C-14	1.82E+04	3.41E+03	3.41E+03	3.41E+03	3.41E+03	3.41E+03	3.41E+03
P-32	1.32E+06	7.71E+04	5.01E+04	-	-	-	8.64E+04
Cr-51	-	-	1.00E+02	5.95E+01	2.28E+01	1.44E+04	3.32E+03
Mn-54	-	3.96E+04	6.30E+03	-	9.84E+03	1.40E+06	7.74E+04
Fe-55	2.46E+04	1.70E+04	3.94E+03	-	-	7.21E+04	6.03E+03
Fe-59	1.18E+04	2.78E+04	1.06E+04	-	-	1.02E+06	1.88E+5
Co-57	-	6.92E+02	6.71E+02	-	-	3.70E+05	3.14E+04
Co-58	-	1.58E+03	2.07E+03	-	-	9.28E+05	1.06E+5
Co-60	-	1.15E+04	1.48E+04	-	-	5.97E+06	2.85E+5
Ni-63	4.32E+05	3.14E+04	1.45E+04	-	-	1.78E+05	1.34E+04
Zn-65	3.24E+04	1.03E+05	4.66E+04	-	6.90E+04	8.64E+05	5.34E+04
Rb-86	-	1.35E+05	5.90E+04	-	-	-	1.66E+04
Sr-89	3.04E+05	-	8.72E+03	-	-	1.40E+06	3.50E+05
Sr-90	9.92E+07	-	6.10E+06	-	-	9.60E+06	7.22E+05
Y-91	4.62E+05	-	1.24E+04	-	-	1.70E+06	3.85E+05
Zr-95	1.07E+05	3.44E+04	2.33E+04	-	5.42E+04	1.77E+06	1.50E+05
Nb-95	1.41E+04	7.82E+03	4.21E+03	-	7.74E+03	5.05E+05	1.04E+05
Ru-103	1.53E+03	-	6.58E+02	-	5.83E+03	5.05E+05	1.10E+05
Ru-106	6.91E+04	-	8.72E+03	-	1.34E+05	9.36E+06	9.12E+05
Ag-110m	1.08E+04	1.00E+04	5.94E+03	-	1.97E+04	4.63E+06	3.02E+05
Sb-124	3.12E+04	5.89E+02	1.24E+04	7.55E+01	-	2.48E+06	4.06E+05
Sb-125	5.34E+04	5.95E+02	1.26E+04	5.40E+01	-	1.74E+06	1.01E+05
Te-125m	3.42E+03	1.58E+03	4.67E+02	1.05E+03	1.24E+04	3.14E+05	7.06E+04
Te-127m	1.26E+04	5.77E+03	1.57E+03	3.29E+03	4.58E+04	9.60E+05	1.50E+05
Te-129m	9.76E+03	4.67E+03	1.58E+03	3.44E+03	3.66E+04	1.16E+06	3.83E+05
I-131	2.52E+04	3.58E+04	2.05E+04	1.19E+07	6.13E+04	-	6.28E+03
I-132	1.16E+03	3.26E+03	1.16E+03	1.14E+05	5.18E+03	-	4.06E+02
I-133	8.64E+03	1.48E+04	4.52E+03	2.15E+06	2.58E+04	-	8.88E+03
I-134	6.44E+02	1.73E+03	6.15E+02	2.98E+04	2.75E+03	-	1.01E+0
I-135	2.68E+03	6.98E+03	2.57E+03	4.48E+05	1.11E+04	-	5.25E+03
Cs-134	3.73E+05	8.48E+05	7.28E+05	-	2.87E+05	9.76E+04	1.04E+04
Cs-136	3.90E+04	1.46E+05	1.10E+05	-	8.56E+04	1.20E+04	1.17E+04
Cs-137	4.78E+05	6.21E+05	4.28E+05	-	2.22E+05	7.52E+04	8.40E+03
Ba-140	3.90E+04	4.90E+01	2.57E+03	-	1.67E+01	1.27E+06	2.18E+05
Ce-141	1.99E+04	1.35E+04	1.53E+03	-	6.26E+03	3.62E+05	1.20E+05
Ce-144	3.43E+06	1.43E+06	1.84E+05	-	8.48E+05	7.78E+06	8.16E+05
Pr-143	9.36E+03	3.75E+03	4.64E+02	-	2.16E+03	2.81E+05	2.00E+05
Nd-147	5.27E+03	6.10E+03	3.65E+02	-	3.56E+03	2.21E+05	1.73E+05

TABLE 2-4 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, INHALATION PATHWAY DOSE FACTORS (Continued)TEENAGER (mrem/yr per $\mu\text{Ci}/\text{m}^3$)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03
C-14	2.60E+04	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03	4.87E+03
P-32	1.89E+06	1.10E+05	7.16E+04	-	-	-	9.28E+04
Cr-51	-	-	1.35E+02	7.50E+01	3.07E+01	2.10E+04	3.00E+03
Mn-54	-	5.11E+04	8.40E+03	-	1.27E+04	1.98E+06	6.68E+04
Fe-55	3.34E+04	2.38E+04	5.54E+03	-	-	1.24E+05	6.39E+03
Fe-59	1.59E+04	3.70E+04	1.43E+04	-	-	1.53E+06	1.78E+05
Co-57	-	6.92E+02	9.20E+02	-	-	5.86E+05	3.14E+04
Co-58	-	2.07E+03	2.78E+03	-	-	1.34E+06	9.52E+04
Co-60	-	1.51E+04	1.98E+04	-	-	8.72E+06	2.59E+05
Ni-63	5.80E+05	4.34E+04	1.98E+04	-	-	3.07E+05	1.42E+04
Zn-65	3.86E+04	1.34E+05	6.24E+04	-	8.64E+04	1.24E+06	4.66E+04
Rb-86	-	1.90E+05	8.40E+04	-	-	-	1.77E+04
Sr-89	4.34E+05	-	1.25E+04	-	-	2.42E+06	3.71E+05
Sr-90	1.08E+08	-	6.68E+06	-	-	1.65E+07	7.65E+05
Y-91	6.61E+05	-	1.77E+04	-	-	2.94E+06	4.09E+05
Zr-95	1.46E+05	4.58E+04	3.15E+04	-	6.74E+04	2.69E+06	1.49E+05
Nb-95	1.86E+04	1.03E+04	5.66E+03	-	1.00E+04	7.51E+05	9.68E+04
Ru-103	2.10E+03	-	8.96E+02	-	7.43E+03	7.83E+05	1.09E+05
Ru-106	9.84E+04	-	1.24E+04	-	1.90E+05	1.61E+07	9.60E+05
Ag-110m	1.38E+04	1.31E+04	7.99E+03	-	2.50E+04	6.75E+06	2.73E+05
Sb-124	4.30E+04	7.94E+02	1.68E+04	9.76E+01	-	3.85E+06	3.98E+05
Sb-125	7.38E+04	8.08E+02	1.72E+04	7.04E+01	-	2.74E+06	9.92E+04
Te-125m	4.88E+03	2.24E+03	6.67E+02	1.40E+03	-	5.36E+05	7.50E+04
Te-127m	1.80E+04	8.16E+03	2.18E+03	4.38E+03	6.54E+04	1.66E+06	1.59E+05
Te-129m	1.39E+04	6.58E+03	2.25E+03	4.58E+03	5.19E+04	1.98E+06	4.05E+05
I-131	3.54E+04	4.91E+04	2.64E+04	1.46E+07	8.40E+04	-	6.49E+03
I-132	1.59E+03	4.38E+03	1.58E+03	1.51E+05	6.92E+03	-	1.27E+03
I-133	1.22E+04	2.05E+04	6.22E+03	2.92E+06	3.59E+04	-	1.03E+04
I-134	8.88E+02	2.32E+03	8.40E+02	3.95E+04	3.66E+03	-	2.04E+01
I-135	3.70E+03	9.44E+03	3.49E+03	6.21E+05	1.49E+04	-	6.95E+03
Cs-134	5.02E+05	1.13E+06	5.49E+05	-	3.75E+05	1.46E+05	9.76E+03
Cs-136	5.15E+04	1.94E+05	1.37E+05	-	1.10E+05	1.78E+04	1.09E+04
Cs-137	6.70E+05	8.48E+05	3.11E+05	-	3.04E+05	1.21E+05	8.48E+03
Ba-140	5.47E+04	6.70E+01	3.52E+03	-	2.28E+01	2.03E+06	2.29E+05
Ce-141	2.84E+04	1.90E+04	2.17E+03	-	8.88E+03	6.14E+05	1.26E+05
Ce-144	4.89E+06	2.02E+06	2.62E+05	-	1.21E+06	1.34E+07	8.64E+05
Pr-143	1.34E+04	5.31E+03	6.62E+02	-	3.09E+03	4.83E+05	2.14E+05
Nd-147	7.86E+03	8.56E+03	5.13E+02	-	5.02E+03	3.72E+05	1.82E+05

TABLE 2-4 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, INHALATION PATHWAY DOSE FACTORS (Continued)CHILD (mrem/yr per $\mu\text{Ci}/\text{m}^3$)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
C-14	3.59E+04	6.73E+03	6.73E+03	6.73E+03	6.73E+03	6.73E+03	6.73E+03
P-32	2.60E+06	1.14E+05	9.88E+04	-	-	-	4.22E+04
Cr-51	-	-	1.54E+02	8.55E+01	2.43E+01	1.70E+04	1.08E+03
Mn-54	-	4.29E+04	9.51E+03	-	1.00E+04	1.58E+06	2.29E+04
Fe-55	4.74E+04	2.52E+04	7.77E+03	-	-	1.11E+05	2.87E+03
Fe-59	2.07E+04	3.34E+04	1.67E+04	-	-	1.27E+06	7.07E+04
Co-57	-	9.03E+02	1.07E+03	-	-	5.07E+05	1.32E+04
Co-58	-	1.77E+03	3.16E+03	-	-	1.11E+06	3.44E+04
Co-60	-	1.31E+04	2.26E+04	-	-	7.07E+06	9.62E+04
Ni-63	8.21E+05	4.63E+04	2.80E+04	-	-	2.75E+05	6.33E+03
Zn-65	4.26E+04	1.13E+05	7.03E+04	-	7.14E+04	9.95E+05	1.63E+04
Rb-86	-	1.98E+05	1.14E+05	-	-	-	7.99E+03
Sr-89	5.99E+05	-	1.72E+04	-	-	2.16E+06	1.67E+05
Sr-90	1.01E+08	-	6.44E+06	-	-	1.48E+07	3.43E+05
Y-91	9.14E+05	-	2.44E+04	-	-	2.63E+06	1.84E+05
Zr-95	1.90E+05	4.18E+04	3.70E+04	-	5.96E+04	2.23E+06	6.11E+04
Nb-95	2.35E+04	9.18E+03	6.55E+03	-	8.62E+03	6.14E+05	3.70E+04
Ru-103	2.79E+03	-	1.07E+03	-	7.03E+03	6.62E+05	4.48E+04
Ru-106	1.36E+05	-	1.69E+04	-	1.84E+05	1.43E+07	4.29E+05
Ag-110m	1.69E+04	1.14E+04	9.14E+03	-	2.12E+04	5.48E+06	1.00E+05
Sb-124	5.74E+04	7.40E+02	2.00E+04	1.26E+02	-	3.24E+06	1.64E+05
Sb-125	9.84E+04	7.59E+02	2.07E+04	9.10E+01	-	2.32E+06	4.03E+04
Te-125m	6.73E+03	2.33E+03	9.14E+02	1.92E+03	-	4.77E+05	3.38E+04
Te-127m	2.49E+04	8.55E+03	3.02E+03	6.07E+03	6.36E+04	1.48E+06	7.14E+04
Te-129m	1.92E+04	6.85E+03	3.04E+03	6.33E+03	5.03E+04	1.76E+06	1.82E+05
I-131	4.81E+04	4.81E+04	2.73E+04	1.62E+07	7.88E+04	-	2.84E+03
I-132	2.12E+03	4.07E+03	1.88E+03	1.94E+05	6.25E+03	-	3.22E+03
I-133	1.66E+04	2.03E+04	7.70E+03	3.85E+06	3.38E+04	-	5.48E+03
I-134	1.17E+03	2.16E+03	9.95E+02	5.07E+04	3.30E+03	-	9.55E+02
I-135	4.92E+03	8.73E+03	4.14E+03	7.92E+05	1.34E+04	-	4.44E+03
Cs-134	6.51E+05	1.01E+06	2.25E+05	-	3.30E+05	1.21E+05	3.85E+03
Cs-136	6.51E+04	1.71E+05	1.16E+05	-	9.55E+04	1.45E+04	4.18E+03
Cs-137	9.07E+05	8.25E+05	1.28E+05	-	2.82E+05	1.04E+05	3.62E+03
Ba-140	7.40E+04	6.48E+01	4.33E+03	-	2.11E+01	1.74E+06	1.02E+05
Ce-141	3.92E+04	1.95E+04	2.90E+03	-	8.55E+03	5.44E+05	5.66E+04
Ce-144	6.77E+06	2.12E+06	3.61E+05	-	1.17E+06	1.20E+07	3.89E+05
Pr-143	1.85E+04	5.55E+03	9.14E+02	-	3.00E+03	4.33E+05	9.73E+04
Nd-147	1.08E+04	8.73E+03	6.81E+02	-	4.81E+03	3.28E+05	8.21E+04

TABLE 2-4 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, INHALATION PATHWAY DOSE FACTORS (Continued)INFANT (mrem/yr per $\mu\text{Ci}/\text{m}^3$)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02
C-14	2.65E+04	5.31E+03	5.31E+03	5.31E+03	5.31E+03	5.31E+03	5.31E+03
P-32	2.03E+06	1.12E+05	7.74E+04	-	-	-	1.61E+04
Cr-51	-	-	8.95E+01	5.75E+01	1.32E+01	1.28E+04	3.57E+02
Mn-54	-	2.53E+04	4.98E+03	-	4.98E+03	1.00E+06	7.06E+03
Fe-55	1.97E+04	1.17E+04	3.33E+03	-	-	8.69E+04	1.09E+03
Fe-59	1.36E+04	2.35E+04	9.48E+03	-	-	1.02E+06	2.48E+04
Co-57	-	6.51E+02	6.41E+02	-	-	3.79E+05	4.86E+03
Co-58	-	1.22E+03	1.82E+03	-	-	7.77E+05	1.11E+04
Co-60	-	8.02E+03	1.18E+04	-	-	4.51E+06	3.19E+04
Ni-63	3.39E+05	2.04E+04	1.16E+04	-	-	2.09E+05	2.42E+03
Zn-65	1.93E+04	6.26E+04	3.11E+04	-	3.25E+04	6.47E+05	5.14E+04
Rb-86	-	1.90E+05	8.82E+04	-	-	-	3.04E+03
Sr-89	3.98E+05	-	1.14E+04	-	-	2.03E+06	6.40E+04
Sr-90	4.09E+07	-	2.59E+06	-	-	1.12E+07	1.31E+05
Y-91	5.88E+05	-	1.57E+04	-	-	2.45E+06	7.03E+04
Zr-95	1.15E+05	2.79E+04	2.03E+04	-	3.11E+04	1.75E+06	2.17E+04
Nb-95	1.57E+04	6.43E+03	3.78E+03	-	4.72E+03	4.79E+05	1.27E+04
Ru-103	2.02E+03	-	6.79E+02	-	4.24E+03	5.52E+05	1.61E+04
Ru-106	8.68E+04	-	1.09E+04	-	1.07E+05	1.16E+07	1.64E+05
Ag-110m	9.98E+03	7.22E+03	5.00E+03	-	1.09E+04	3.67E+06	3.30E+04
Sb-124	3.79E+04	5.56E+02	1.20E+04	1.01E+02	-	2.65E+06	5.91E+04
Sb-125	5.17E+04	4.77E+02	1.09E+04	6.23E+01	-	1.64E+06	1.47E+04
Te-125m	4.76E+03	1.99E+03	6.58E+02	1.62E+03	-	4.47E+05	1.29E+04
Te-127m	1.67E+04	6.90E+03	2.07E+03	4.87E+03	3.75E+04	1.31E+06	2.73E+04
Te-129m	1.41E+04	6.09E+03	2.23E+03	5.47E+03	3.18E+04	1.68E+06	6.90E+04
I-131	3.79E+04	4.44E+04	1.96E+04	1.48E+07	5.18E+04	-	1.06E+03
I-132	1.69E+03	3.54E+03	1.26E+03	1.69E+05	3.95E+05	-	1.90E+03
I-133	1.32E+04	1.92E+04	5.60E+03	3.56E+06	2.24E+04	-	2.61E+03
I-134	9.21E+02	1.88E+03	6.65E+02	4.45E+04	2.09E+03	-	1.29E+03
I-135	3.86E+03	7.60E+03	2.77E+03	6.96E+05	8.47E+03	-	1.83E+03
Cs-134	3.96E+05	7.03E+05	7.45E+04	-	1.90E+05	7.97E+04	1.33E+03
Cs-136	4.83E+04	1.35E+05	5.29E+04	-	5.64E+04	1.18E+04	1.43E+03
Cs-137	5.49E+05	6.12E+05	4.55E+04	-	1.72E+05	7.13E+04	1.33E+03
Ba-140	5.60E+04	5.60E+01	2.90E+03	-	1.34E+01	1.60E+06	3.84E+04
Ce-141	2.77E+04	1.67E+04	1.99E+03	-	5.25E+03	5.17E+05	2.16E+04
Ce-144	3.19E+06	1.21E+06	1.76E+05	-	5.38E+05	9.84E+06	1.48E+05
Pr-143	1.40E+04	5.24E+03	6.99E+02	-	1.97E+03	4.33E+05	3.72E+04
Nd-147	7.94E+03	8.13E+03	5.00E+02	-	3.15E+03	3.22E+05	3.12E+04

TABLE 2-5 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, GRASS-COW-MILK PATHWAY DOSE FACTORSADULT (mrem/yr per $\mu\text{Ci}/\text{m}^3$) FOR H-3 AND C-14
($\text{m}^2 \cdot \text{mrem}/\text{yr}$ per $\mu\text{Ci}/\text{sec}$) FOR OTHERS

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	7.63E+02	7.63E+02	7.63E+02	7.63E+02	7.63E+02	7.63E+02
C-14	3.63E+05	7.26E+04	7.26E+04	7.26E+04	7.26E+04	7.26E+04	7.26E+04
P-32	1.71E+10	1.06E+09	6.60E+08	-	-	-	1.92E+09
Cr-51	-	-	2.86E+04	1.71E+04	6.30E+03	3.80E+04	7.20E+06
Mn-54	-	8.40E+06	1.60E+06	-	2.50E+06	-	2.57E+07
Fe-55	2.51E+07	1.73E+07	4.04E+06	-	-	9.67E+06	9.95E+06
Fe-59	2.98E+07	7.00E+07	2.68E+07	-	-	1.95E+07	2.33E+08
Co-57	-	1.28E+06	2.13E+06	-	-	-	3.25E+07
Co-58	-	4.72E+06	1.06E+07	-	-	-	9.57E+07
Co-60	-	1.64E+07	3.62E+07	-	-	-	3.08E+08
Ni-63	6.73E+09	4.66E+08	2.26E+08	-	-	-	9.73E+07
Zn-65	1.37E+09	4.36E+09	1.97E+09	-	2.92E+09	-	2.75E+09
Rb-86	-	2.59E+09	1.21E+09	-	-	-	5.11E+08
Sr-89	1.45E+09	-	4.16E+07	-	-	-	2.33E+08
Sr-90	4.68E+10	-	1.15E+10	-	-	-	1.35E+09
Y-91	8.60E+03	-	2.30E+02	-	-	-	4.73E+06
Zr-95	9.46E+02	3.03E+02	2.05E+02	-	4.76E+02	-	9.62E+05
Nb-95	8.25E+04	4.59E+04	2.47E+04	-	4.54E+04	-	2.79E+08
Ru-103	1.02E+03	-	4.39E+02	-	3.89E+03	-	1.19E+05
Ru-106	2.04E+04	-	2.58E+03	-	3.94E+04	-	1.32E+06
Ag-110m	5.83E+07	5.39E+07	3.20E+07	-	1.06E+08	-	2.20E+10
Sb-124	2.57E+07	4.86E+05	1.02E+07	6.24E+04	-	2.00E+07	7.31E+08
Sb-125	2.04E+07	2.28E+05	4.86E+06	2.08E+04	-	1.58E+07	2.25E+08
Te-125m	1.63E+07	5.90E+06	2.18E+06	4.90E+06	6.63E+07	-	6.50E+07
Te-127m	4.58E+07	1.64E+07	5.58E+06	1.17E+07	1.86E+08	-	1.54E+08
Te-129m	6.04E+07	2.25E+07	9.57E+06	2.08E+07	2.52E+08	-	3.04E+08
I-131	2.96E+08	4.24E+08	2.43E+08	1.39E+11	7.27E+08	-	1.12E+08
I-132	1.64E-01	4.37E-01	1.53E-01	1.53E+01	6.97E-01	-	8.22E-02
I-133	3.97E+06	6.90E+06	2.10E+06	1.01E+09	1.20E+07	-	6.20E+06
I-134	-	-	-	-	-	-	-
I-135	1.39E+04	3.63E+04	1.34E+04	2.40E+06	5.83E+04	-	4.10E+04
Cs-134	5.65E+09	1.34E+10	1.10E+10	-	4.35E+09	1.44E+09	2.35E+08
Cs-136	2.61E+08	1.03E+09	7.42E+08	-	5.74E+08	7.87E+07	1.17E+08
Cs-137	7.38E+09	1.01E+10	6.61E+09	-	3.43E+09	1.14E+09	1.95E+08
Ba-140	2.69E+07	3.38E+04	1.76E+06	-	1.15E+04	1.93E+04	5.54E+07
Ce-141	4.84E+03	3.27E+03	3.71E+02	-	1.52E+03	-	1.25E+07
Ce-144	3.58E+05	1.50E+05	1.92E+04	-	8.87E+04	-	1.21E+08
Pr-143	1.59E+02	6.37E+01	7.88E+00	-	3.68E+01	-	6.96E+05
Nd-147	9.42E+01	1.09E+02	6.52E+00	-	6.37E+01	-	5.23E+05

TABLE 2-5 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, GRASS-COW-MILK PATHWAY DOSE FACTORS (Continued)TEENAGER (mrem/yr per $\mu\text{Ci}/\text{m}^3$) FOR H-3 AND C-14
($\text{m}^2 * \text{mrem}/\text{yr}$ per $\mu\text{Ci}/\text{sec}$) FOR OTHERS

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	9.94E+02	9.94E+02	9.94E+02	9.94E+02	9.94E+02	9.94E+02
C-14	6.70E+05	1.34E+05	1.34E+05	1.34E+05	1.34E+05	1.34E+05	1.34E+05
P-32	3.15E+10	1.95E+09	1.22E+09	-	-	-	2.65E+09
Cr-51	-	-	5.00E+04	2.78E+04	1.10E+04	7.13E+04	8.40E+06
Mn-54	-	1.40E+07	2.78E+06	-	4.17E+06	-	2.87E+07
Fe-55	4.45E+07	3.16E+07	7.36E+06	-	-	2.00E+07	1.37E+07
Fe-59	5.20E+07	1.21E+08	4.68E+07	-	-	3.82E+07	2.87E+08
Co-57	-	2.25E+06	3.76E+06	-	-	-	4.19E+07
Co-58	-	7.95E+06	1.83E+07	-	-	-	1.10E+08
Co-60	-	2.78E+07	6.26E+07	-	-	-	3.62E+08
Ni-63	1.18E+10	8.35E+08	4.01E+08	-	-	-	1.33E+08
Zn-65	2.11E+09	7.31E+09	3.41E+09	-	4.68E+09	-	3.10E+09
Rb-86	-	4.73E+09	2.22E+09	-	-	-	7.00E+08
Sr-89	2.67E+09	-	7.66E+07	-	-	-	3.18E+08
Sr-90	9.92E+07	-	6.10E+06	-	-	9.60E+06	7.22E+05
Y-91	1.58E+04	-	4.24E+02	-	-	-	6.48E+06
Zr-95	1.65E+03	5.22E+02	3.59E+02	-	7.67E+02	-	1.20E+06
Nb-95	1.41E+05	7.80E+04	4.30E+04	-	7.57E+04	-	3.34E+08
Ru-103	1.81E+03	-	7.75E+02	-	6.40E+03	-	1.52E+05
Ru-106	3.75E+04	-	4.73E+03	-	7.23E+04	-	1.80E+06
Ag-110m	9.63E+07	9.11E+07	5.54E+07	-	1.74E+08	-	2.56E+10
Sb-124	4.59E+07	8.46E+05	1.79E+07	1.04E+05	-	4.01E+07	9.25E+08
Sb-125	3.65E+07	3.99E+05	8.54E+06	3.49E+04	-	3.21E+07	2.84E+08
Te-125m	3.00E+07	1.08E+07	4.02E+06	8.39E+06	-	-	8.86E+07
Te-127m	8.44E+07	2.99E+07	1.00E+07	2.01E+07	3.42E+08	-	2.10E+08
Te-129m	1.11E+08	4.10E+07	1.75E+07	3.57E+07	4.62E+08	-	4.15E+08
I-131	5.38E+08	7.53E+08	4.04E+08	2.20E+11	1.30E+09	-	1.49E+08
I-132	2.90E-01	7.59E-01	2.72E-01	2.56E+01	1.20E+00	-	3.31E-01
I-133	7.24E+06	1.23E+07	3.75E+06	1.72E+09	2.15E+07	-	9.30E+06
I-134	-	-	-	-	-	-	-
I-135	2.47E+04	6.35E+04	2.35E+04	4.08E+06	1.00E+05	-	7.03E+04
Cs-134	9.81E+09	2.31E+10	1.07E+10	-	7.34E+09	2.80E+09	2.87E+08
Cs-136	4.45E+08	1.75E+09	1.18E+09	-	9.53E+08	1.50E+08	1.41E+08
Cs-137	1.34E+10	1.78E+10	6.20E+09	-	6.06E+09	2.35E+09	2.53E+08
Ba-140	4.85E+07	5.95E+04	3.13E+06	-	2.02E+04	4.00E+04	7.49E+07
Ce-141	8.87E+03	1.35E+04	6.81E+02	-	2.79E+03	-	1.69E+07
Ce-144	6.58E+05	2.72E+05	3.54E+04	-	1.63E+05	-	1.66E+08
Pr-143	2.92E+02	1.17E+02	1.45E+01	-	6.77E+01	-	9.61E+05
Nd-147	1.81E+02	1.97E+02	1.18E+01	-	1.16E+02	-	7.11E+05

TABLE 2-5 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, GRASS-COW-MILK PATHWAY DOSE FACTORS (Continued)CHILD (mrem/yr per $\mu\text{Ci}/\text{m}^3$) FOR H-3 AND C-14
($\text{m}^2 \cdot \text{mrem}/\text{yr}$ per $\mu\text{Ci}/\text{sec}$) FOR OTHERS

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03
C-14	1.65E+06	3.29E+05	3.29E+05	3.29E+05	3.29E+05	3.29E+05	3.29E+05
P-32	7.77E+10	3.64E+09	3.00E+09	-	-	-	2.15E+09
Cr-51	-	-	1.02E+05	5.66E+04	1.55E+04	1.03E+05	5.41E+06
Mn-54	-	2.09E+07	5.58E+06	-	5.87E+06	-	1.76E+07
Fe-55	1.12E+08	5.93E+07	1.84E+07	-	-	3.35E+07	1.10E+07
Fe-59	1.20E+08	1.95E+08	9.71E+07	-	-	5.65E+07	2.03E+08
Co-57	-	3.84E+06	7.77E+06	-	-	-	3.14E+07
Co-58	-	1.21E+07	3.72E+07	-	-	-	7.08E+07
Co-60	-	4.32E+07	1.27E+08	-	-	-	2.39E+08
Ni-63	2.96E+10	1.59E+09	1.01E+09	-	-	-	1.07E+08
Zn-65	4.13E+09	1.10E+10	6.85E+09	-	6.94E+09	-	1.93E+09
Rb-86	-	8.77E+09	5.39E+09	-	-	-	5.64E+08
Sr-89	6.62E+09	-	1.89E+08	-	-	-	2.56E+08
Sr-90	1.12E+11	-	2.83E+10	-	-	-	1.51E+09
Y-91	3.91E+04	-	1.04E+03	-	-	-	5.21E+06
Zr-95	3.84E+03	8.45E+02	7.52E+02	-	1.21E+03	-	8.81E+05
Nb-95	3.18E+05	1.24E+05	8.84E+04	-	1.16E+05	-	2.29E+08
Ru-103	4.29E+03	-	1.65E+03	-	1.08E+04	-	1.11E+05
Ru-106	9.24E+04	-	1.15E+04	-	1.25E+05	-	1.44E+06
Ag-110m	2.09E+08	1.41E+08	1.13E+08	-	2.63E+08	-	1.68E+10
Sb-124	1.09E+08	1.41E+08	3.81E+07	2.40E+05	-	6.03E+07	6.79E+08
Sb-125	8.70E+07	1.41E+06	1.82E+07	8.06E+04	-	4.85E+07	2.08E+08
Te-125m	7.38E+07	2.00E+07	9.84E+06	2.07E+07	-	-	7.12E+07
Te-127m	2.08E+08	5.60E+07	2.47E+07	4.97E+07	5.93E+08	-	1.68E+08
Te-129m	2.72E+08	7.61E+07	4.23E+07	8.78E+07	8.00E+08	-	3.32E+08
I-131	1.30E+09	1.31E+09	7.46E+08	4.34E+11	2.15E+09	-	1.17E+08
I-132	6.86E-01	1.26E+00	5.80E-01	5.85E+01	1.93E+00	-	1.48E+00
I-133	1.76E+07	2.18E+07	8.23E+06	4.04E+09	3.63E+07	-	8.77E+06
I-134	-	-	-	-	-	-	-
I-135	5.84E+04	1.05E+05	4.97E+04	9.30E+06	1.61E+05	-	8.00E+04
Cs-134	2.26E+10	3.71E+10	7.83E+09	-	1.15E+10	4.13E+09	2.00E+08
Cs-136	1.00E+09	2.76E+09	1.79E+09	-	1.47E+09	2.19E+08	9.70E+07
Cs-137	3.22E+10	3.09E+10	4.55E+09	-	1.01E+10	3.62E+09	1.93E+08
Ba-140	1.17E+08	1.03E+05	6.84E+06	-	3.34E+04	6.12E+04	5.94E+07
Ce-141	2.19E+04	1.09E+04	1.62E+03	-	4.78E+03	-	1.36E+07
Ce-144	1.62E+06	5.09E+05	8.66E+04	-	2.82E+05	-	1.33E+08
Pr-143	7.23E+02	2.17E+02	3.59E+01	-	1.17E+02	-	7.80E+05
Nd-147	4.45E+02	3.60E+02	2.79E+01	-	1.98E+02	-	5.71E+05

TABLE 2-5 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(i)}$, GRASS-COW-MILK PATHWAY DOSE FACTORS (Continued)

INFANT (mrem/yr per $\mu\text{Ci}/\text{m}^3$) FOR H-3 AND C-14
($\text{m}^2 \cdot \text{mrem}/\text{yr}$ per $\mu\text{Ci}/\text{sec}$) FOR OTHERS

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	2.38E+03	2.38E+03	2.38E+03	2.38E+03	2.38E+03	2.38E+03
C-14	3.23E+06	6.89E+05	6.89E+05	6.89E+05	6.89E+05	6.89E+05	6.89E+05
P-32	1.60E+11	9.42E+09	6.21E+09	-	-	-	2.17E+09
Cr-51	-	-	1.61E+05	1.05E+05	2.30E+04	2.05E+05	4.71E+06
Mn-54	-	3.89E+07	8.83E+06	-	8.63E+06	-	1.43E+07
Fe-55	1.35E+08	8.72E+07	2.33E+07	-	-	4.27E+07	1.11E+07
Fe-59	2.25E+08	3.93E+08	1.55E+08	-	-	1.16E+08	1.88E+08
Co-57	-	8.95E+06	1.46E+07	-	-	-	3.05E+07
Co-58	-	2.43E+07	6.06E+07	-	-	-	6.05E+07
Co-60	-	8.81E+07	2.08E+08	-	-	-	2.10E+08
Ni-63	3.49E+10	2.16E+09	1.21E+09	-	-	-	1.07E+08
Zn-65	5.55E+09	1.90E+10	8.78E+09	-	9.23E+09	-	1.61E+10
Rb-86	-	2.22E+10	1.10E+10	-	-	-	5.69E+08
Sr-89	1.26E+10	-	3.61E+08	-	-	-	2.59E+08
Sr-90	1.22E+11	-	3.10E+10	-	-	-	1.52E+09
Y-91	7.33E+04	-	1.95E+03	-	-	-	5.26E+06
Zr-95	6.83E+03	1.66E+03	1.18E+03	-	1.79E+03	-	8.28E+05
Nb-95	5.93E+05	2.44E+05	1.41E+05	-	1.75E+05	-	2.06E+08
Ru-103	8.69E+03	-	2.91E+03	-	1.81E+04	-	1.06E+05
Ru-106	1.90E+05	-	2.38E+04	-	2.25E+05	-	1.44E+06
Ag-110m	3.86E+08	2.82E+08	1.86E+08	-	4.03E+08	-	1.46E+10
Sb-124	2.09E+08	3.08E+06	6.49E+07	5.56E+05	-	1.31E+08	6.46E+08
Sb-125	1.49E+08	1.45E+06	3.07E+07	1.87E+05	-	9.38E+07	1.99E+08
Te-125m	1.51E+08	5.04E+07	2.04E+07	5.07E+07	-	-	7.18E+07
Te-127m	4.21E+08	1.40E+08	5.10E+07	1.22E+08	1.04E+09	-	1.70E+08
Te-129m	5.59E+08	1.92E+08	8.62E+07	2.15E+08	1.40E+09	-	3.34E+08
I-131	2.72E+09	3.21E+09	1.41E+09	1.05E+12	3.75E+09	-	1.15E+08
I-132	1.42E+00	2.89E+00	1.03E+00	1.35E+02	3.22E+00	-	2.34E+00
I-133	3.72E+07	5.41E+07	1.58E+07	9.84E+09	6.36E+07	-	9.16E+06
I-134	-	-	-	1.01E-09	-	-	-
I-135	1.21E+05	2.41E+05	8.80E+04	2.16E+07	2.69E+05	-	8.74E+04
Cs-134	3.65E+10	6.80E+10	6.87E+09	-	1.75E+10	7.18E+09	1.85E+08
Cs-136	1.96E+09	5.77E+09	2.15E+09	-	2.30E+09	4.70E+08	8.76E+07
Cs-137	5.15E+10	6.02E+10	4.27E+09	-	1.62E+10	6.55E+09	1.88E+08
Ba-140	2.41E+08	2.41E+05	1.24E+07	-	5.73E+04	1.48E+05	5.92E+07
Ce-141	4.33E+04	2.64E+04	3.11E+03	-	8.15E+03	-	1.37E+07
Ce-144	2.33E+06	9.52E+05	1.30E+05	-	3.85E+05	-	1.33E+08
Pr-143	1.49E+03	5.59E+02	7.41E+01	-	2.08E+02	-	7.89E+05
Nd-147	8.82E+02	9.06E+02	5.55E+01	-	3.49E+02	-	5.74E+05

TABLE 2-6 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(i)}$, VEGETATION PATHWAY DOSE FACTORSADULT (mrem/yr per $\mu\text{Ci}/\text{m}^3$) FOR H-3 AND C-14
($\text{m}^2 \cdot \text{mrem}/\text{yr}$ per $\mu\text{Ci}/\text{sec}$) FOR OTHERS

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03
C-14	8.97E+05	1.79E+05	1.79E+05	1.79E+05	1.79E+05	1.79E+05	1.79E+05
P-32	1.40E+09	8.73E+07	5.42E+07	-	-	-	1.58E+08
Cr-51	-	-	4.66E+04	2.79E+04	1.03E+04	6.19E+04	1.17E+07
Mn-54	-	3.11E+08	5.94E+07	-	9.27E+07	-	9.54E+08
Fe-55	2.09E+08	1.45E+08	3.37E+07	-	-	8.06E+07	8.29E+07
Fe-59	1.27E+08	2.99E+08	1.14E+08	-	-	8.35E+07	9.96E+08
Co-57	-	1.17E+07	1.95E+07	-	-	-	2.97E+08
Co-58	-	3.09E+07	6.92E+07	-	-	-	6.26E+08
Co-60	-	1.67E+08	3.69E+08	-	-	-	3.14E+09
Ni-63	1.04E+10	7.21E+08	3.49E+08	-	-	-	1.50E+08
Zn-65	3.17E+08	1.01E+09	4.56E+08	-	6.75E+08	-	6.36E+08
Rb-86	-	2.19E+08	1.02E+08	-	-	-	4.32E+07
Sr-89	9.96E+09	-	2.86E+08	-	-	-	1.60E+09
Sr-90	6.05E+11	-	1.48E+10	-	-	-	1.75E+10
Y-91	5.13E+06	-	1.37E+05	-	-	-	2.82E+09
Zr-95	1.19E+06	3.81E+05	2.58E+05	-	5.97E+05	-	1.21E+09
Nb-95	1.42E+05	7.91E+04	4.25E+04	-	7.81E+04	-	4.80E+08
Ru-103	4.80E+06	-	2.07E+06	-	1.83E+07	-	5.61E+08
Ru-106	1.93E+08	-	2.44E+07	-	3.72E+08	-	1.25E+10
Ag-110m	1.06E+07	9.76E+06	5.80E+06	-	1.92E+07	-	3.98E+09
Sb-124	1.04E+08	1.96E+06	4.11E+07	2.52E+05	-	8.08E+07	2.95E+09
Sb-125	1.36E+08	1.52E+06	3.25E+07	1.39E+05	-	1.05E+08	1.50E+09
Te-125m	9.66E+07	3.50E+07	1.29E+07	2.90E+07	3.93E+08	-	3.86E+08
Te-127m	3.49E+08	1.25E+08	4.26E+07	8.92E+07	1.42E+09	-	1.17E+09
Te-129m	2.55E+08	9.50E+07	4.03E+07	8.75E+07	1.06E+09	-	1.28E+09
I-131	8.09E+07	1.16E+08	6.63E+07	3.79E+10	1.98E+08	-	3.05E+07
I-132	5.74E+01	1.54E+02	5.38E+01	5.38E+03	2.45E+02	-	2.89E+01
I-133	2.12E+06	3.69E+06	1.12E+06	5.42E+08	6.44E+06	-	3.31E+06
I-134	1.06E-04	2.88E-04	1.03E-04	5.00E-03	4.59E-04	-	2.51E-07
I-135	4.08E+04	1.07E+05	3.94E+04	7.04E+06	1.71E+05	-	1.21E+05
Cs-134	4.66E+09	1.11E+10	9.07E+09	-	3.59E+09	1.19E+09	1.94E+08
Cs-136	4.20E+07	1.66E+08	1.19E+08	-	9.24E+07	1.27E+07	1.89E+07
Cs-137	6.36E+09	8.70E+09	5.70E+09	-	2.95E+09	9.81E+08	1.68E+08
Ba-140	1.29E+08	1.62E+05	8.43E+06	-	5.49E+04	9.25E+04	2.65E+08
Ce-141	1.96E+05	1.33E+05	1.51E+04	-	6.17E+04	-	5.08E+08
Ce-144	3.29E+07	1.38E+07	1.77E+06	-	8.16E+06	-	1.11E+10
Pr-143	6.34E+04	2.54E+04	3.14E+03	-	1.47E+04	-	2.78E+08
Nd-147	3.34E+04	3.86E+04	2.31E+03	-	2.25E+04	-	1.85E+08

TABLE 2-6 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, VEGETATION PATHWAY DOSE FACTORS (Continued)TEENAGER (mrem/yr per $\mu\text{Ci}/\text{m}^3$) FOR H-3 AND C-14
($\text{m}^2 \cdot \text{mrem}/\text{yr}$ per $\mu\text{Ci}/\text{sec}$) FOR OTHERS

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03
C-14	1.45E+06	2.91E+05	2.91E+05	2.91E+05	2.91E+05	2.91E+05	2.91E+05
P-32	1.61E+09	9.96E+07	6.23E+07	-	-	-	1.35E+08
Cr-51	-	-	6.20E+04	3.44E+04	1.36E+04	8.85E+04	1.04E+07
Mn-54	-	4.52E+08	8.97E+07	-	1.35E+08	-	9.27E+08
Fe-55	3.25E+08	2.31E+08	5.38E+07	-	-	1.46E+08	9.98E+07
Fe-59	1.81E+08	4.22E+08	1.63E+08	-	-	1.33E+08	9.98E+08
Co-57	-	1.79E+07	3.00E+07	-	-	-	3.34E+08
Co-58	-	4.38E+07	1.01E+08	-	-	-	6.04E+08
Co-60	-	2.49E+08	5.60E+08	-	-	-	3.24E+09
Ni-63	1.61E+10	1.13E+09	5.45E+08	-	-	-	1.81E+08
Zn-65	4.24E+08	1.47E+09	6.86E+08	-	9.41E+08	-	6.23E+08
Rb-86	-	2.73E+08	1.28E+08	-	-	-	4.05E+7
Sr-89	1.51E+10	-	4.33E+08	-	-	-	1.80E+09
Sr-90	7.51E+11	-	1.85E+11	-	-	-	2.11E+10
Y-91	7.87E+06	-	2.11E+05	-	-	-	3.23E+09
Zr-95	1.74E+06	5.49E+05	3.78E+05	-	8.07E+05	-	1.27E+09
Nb-95	1.92E+05	1.06E+05	5.86E+04	-	1.03E+05	-	4.55E+08
Ru-103	6.87E+06	-	2.94E+06	-	2.42E+07	-	5.74E+08
Ru-106	3.09E+08	-	3.90E+07	-	5.97E+08	-	1.48E+10
Ag-110m	1.52E+07	1.44E+07	8.74E+06	-	2.74E+07	-	4.04E+09
Sb-124	1.55E+08	2.85E+06	6.03E+07	3.51E+05	-	1.35E+08	3.11E+09
Sb-125	2.14E+08	2.34E+06	5.00E+07	2.04E+05	-	1.88E+08	1.66E+09
Te-125m	1.48E+08	5.34E+07	1.98E+07	4.14E+07	-	-	4.37E+08
Te-127m	5.51E+08	1.96E+08	6.56E+07	1.31E+08	2.24E+09	-	1.37E+09
Te-129m	3.67E+08	1.36E+08	5.81E+07	1.18E+08	1.54E+09	-	1.38E+09
I-131	7.70E+07	1.08E+08	5.79E+07	3.14E+10	1.85E+08	-	2.13E+07
I-132	5.18E+01	1.36E+02	4.87E+01	4.57E+03	2.14E+02	-	5.91E+01
I-133	1.97E+06	3.34E+06	1.02E+06	4.66E+08	5.86E+06	-	2.53E+06
I-134	9.59E-05	2.54E-04	9.13E-05	4.24E-03	4.01E-04	-	3.35E-06
I-135	3.68E+04	9.48E+04	3.52E+04	6.10E+06	1.50E+05	-	1.05E+05
Cs-134	7.09E+09	1.67E+10	7.74E+09	-	5.30E+09	2.02E+09	2.08E+08
Cs-136	4.29E+07	1.69E+08	1.13E+08	-	9.19E+07	1.45E+07	1.36E+07
Cs-137	1.01E+10	1.35E+10	4.69E+09	-	4.59E+09	1.78E+09	1.92E+08
Ba-140	1.38E+08	1.69E+05	8.91E+06	-	5.75E+04	1.14E+05	2.13E+08
Ce-141	2.82E+05	1.88E+05	2.16E+04	-	8.86E+04	-	5.38E+08
Ce-144	5.27E+07	2.18E+07	2.83E+06	-	1.30E+07	-	1.33E+10
Pr-143	7.12E+04	2.84E+04	3.55E+03	-	1.65E+04	-	2.34E+08
Nd-147	3.63E+04	3.94E+04	2.36E+03	-	2.32E+04	-	1.42E+08

TABLE 2-6 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, VEGETATION PATHWAY DOSE FACTORS (Continued)CHILD (mrem/yr per $\mu\text{Ci}/\text{m}^3$) FOR H-3 AND C-14
($\text{m}^2 * \text{mrem}/\text{yr}$ per $\mu\text{Ci}/\text{sec}$) FOR OTHERS

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	4.01E+03	4.01E+03	4.01E+03	4.01E+03	4.01E+03	4.01E+03
C-14	3.50E+06	7.01E+05	7.01E+05	7.01E+05	7.01E+05	7.01E+05	7.01E+05
P-32	3.37E+09	1.58E+08	1.30E+08	-	-	-	9.30E+07
Cr-51	-	-	1.18E+05	6.54E+04	1.79E+04	1.19E+05	6.25E+06
Mn-54	-	6.61E+08	1.76E+08	-	1.85E+08	-	5.55E+08
Fe-55	8.00E+08	4.24E+08	1.31E+08	-	-	2.40E+08	7.86E+07
Fe-59	4.01E+08	6.49E+08	3.23E+08	-	-	1.88E+08	6.76E+08
Co-57	-	2.99E+07	6.04E+07	-	-	-	2.45E+08
Co-58	-	6.47E+07	1.98E+08	-	-	-	3.77E+08
Co-60	-	3.78E+08	1.12E+09	-	-	-	2.10E+09
Ni-63	3.95E+10	2.11E+09	1.34E+09	-	-	-	1.42E+08
Zn-65	8.12E+08	2.16E+09	1.35E+09	-	1.36E+09	-	3.80E+08
Rb-86	-	4.52E+08	2.78E+08	-	-	-	2.91E+07
Sr-89	3.59E+10	-	1.03E+09	-	-	-	1.39E+09
Sr-90	1.24E+12	-	3.15E+11	-	-	-	1.67E+10
Y-91	1.87E+07	-	5.01E+05	-	-	-	2.49E+09
Zr-95	3.90E+06	8.58E+05	7.64E+05	-	1.23E+06	-	8.95E+08
Nb-95	4.10E+05	1.59E+05	1.14E+05	-	1.50E+05	-	2.95E+08
Ru-103	1.55E+07	-	5.94E+06	-	3.89E+07	-	3.99E+08
Ru-106	7.45E+08	-	9.30E+07	-	1.01E+09	-	1.16E+10
Ag-110m	3.22E+07	2.17E+07	1.74E+07	-	4.05E+07	-	2.58E+09
Sb-124	3.52E+08	4.57E+06	1.23E+08	7.78E+05	-	1.96E+08	2.20E+09
Sb-125	4.99E+08	3.85E+06	1.05E+08	4.62E+05	-	2.78E+08	1.19E+09
Te-125m	3.51E+08	9.50E+07	4.67E+07	9.84E+07	-	-	3.38E+08
Te-127m	1.32E+09	3.56E+08	1.57E+08	3.16E+08	3.77E+09	-	1.07E+09
Te-129m	8.54E+08	2.39E+08	1.33E+08	2.75E+08	2.51E+09	-	1.04E+09
I-131	1.43E+08	1.44E+08	8.18E+07	4.76E+10	2.36E+08	-	1.28E+07
I-132	9.20E+01	1.69E+02	7.77E+01	7.84E+03	2.59E+02	-	1.99E+02
I-133	3.59E+06	4.44E+06	1.68E+06	8.25E+08	7.40E+06	-	1.79E+06
I-134	1.70E-04	3.16E-04	1.46E-04	7.28E-03	4.84E-04	-	2.10E-04
I-135	6.54E+04	1.18E+05	5.57E+04	1.04E+07	1.81E+05	-	8.98E+04
Cs-134	1.60E+10	2.63E+10	5.54E+09	-	8.14E+09	2.92E+09	1.42E+08
Cs-136	8.06E+07	2.22E+08	1.43E+08	-	1.18E+08	1.76E+07	7.79E+06
Cs-137	2.39E+10	2.29E+10	3.38E+09	-	7.46E+09	2.68E+09	1.43E+08
Ba-140	2.77E+08	2.43E+05	1.62E+07	-	7.90E+04	1.45E+05	1.40E+08
Ce-141	6.35E+05	3.26E+05	4.84E+04	-	1.43E+05	-	4.07E+08
Ce-144	1.27E+08	3.98E+07	6.78E+06	-	2.21E+07	-	1.04E+10
Pr-143	1.48E+05	4.46E+04	7.37E+03	-	2.41E+04	-	1.60E+08
Nd-147	7.16E+04	5.80E+04	4.49E+03	-	3.18E+04	-	9.18E+07

TABLE 2-7 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, MEAT PATHWAY DOSE FACTORSADULT (mrem/yr per $\mu\text{Ci}/\text{m}^3$) FOR H-3 AND C-14
($\text{m}^2 \cdot \text{mrem}/\text{yr}$ per $\mu\text{Ci}/\text{sec}$) FOR OTHERS

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	3.25E+02	3.25E+02	3.25E+02	3.25E+02	3.25E+02	3.25E+02
C-14	3.33E+05	6.66E+04	6.66E+04	6.66E+04	6.66E+04	6.66E+04	6.66E+04
P-32	4.66E+09	2.90E+08	1.80E+08	-	-	-	5.24E+08
Cr-51	-	-	7.05E+03	4.21E+03	1.55E+03	9.35E+03	1.77E+06
Mn-54	-	9.18E+06	1.75E+06	-	2.73E+06	-	2.81E+07
Fe-55	2.93E+08	2.03E+08	4.72E+07	-	-	1.13E+08	1.16E+08
Fe-59	2.66E+08	6.24E+08	2.39E+08	-	-	1.74E+08	2.08E+09
Co-57	-	5.64E+06	9.37E+06	-	-	-	1.43E+08
Co-58	-	1.82E+07	4.09E+07	-	-	-	3.69E+08
Co-60	-	7.52E+07	1.66E+08	-	-	-	1.41E+09
Ni-63	1.89E+09	1.31E+08	6.33E+07	-	-	-	2.73E+07
Zn-65	3.56E+08	1.13E+09	5.12E+08	-	7.57E+08	-	7.13E+08
Rb-86	-	4.87E+08	2.27E+08	-	-	-	9.60E+07
Sr-89	3.02E+08	-	8.66E+06	-	-	-	4.84E+07
Sr-90	1.24E+10	-	3.05E+09	-	-	-	3.59E+08
Y-91	1.13E+06	-	3.03E+04	-	-	-	6.23E+08
Zr-95	1.87E+06	6.01E+05	4.07E+05	-	9.42E+05	-	1.90E+09
Nb-95	2.30E+06	1.28E+06	6.87E+05	-	1.26E+06	-	7.76E+09
Ru-103	1.05E+08	-	4.53E+07	-	4.01E+08	-	1.23E+10
Ru-106	2.80E+09	-	3.54E+08	-	5.40E+09	-	1.81E+11
Ag-110m	6.68E+06	6.18E+06	3.67E+06	-	1.22E+07	-	2.52E+09
Sb-124	1.98E+07	3.74E+05	7.84E+06	4.80E+04	-	1.54E+07	5.62E+08
Sb-125	1.91E+07	2.13E+05	4.55E+06	1.94E+04	-	1.47E+07	2.10E+08
Te-125m	3.59E+08	1.30E+08	4.81E+07	1.08E+08	1.46E+09	-	1.43E+09
Te-127m	1.12E+09	3.99E+08	1.36E+08	2.85E+08	4.53E+09	-	3.74E+09
Te-129m	1.13E+09	4.23E+08	1.79E+08	3.90E+08	4.73E+09	-	5.71E+09
I-131	1.07E+07	1.54E+07	8.80E+06	5.03E+09	2.63E+07	-	4.05E+06
I-132	-	-	-	-	-	-	-
I-133	3.65E-01	6.35E-01	1.94E-01	9.34E+01	1.11E+00	-	5.71E-01
I-134	-	-	-	-	-	-	-
I-135	-	-	-	-	-	-	-
Cs-134	6.58E+08	1.56E+09	1.28E+09	-	5.06E+08	1.68E+08	2.74E+07
Cs-136	1.21E+07	4.76E+07	3.43E+07	-	2.65E+07	3.63E+06	5.41E+06
Cs-137	8.72E+08	1.19E+09	7.81E+08	-	4.05E+08	1.35E+08	2.31E+07
Ba-140	2.87E+07	3.61E+04	1.88E+06	-	1.23E+04	2.07E+04	5.92E+07
Ce-141	1.40E+04	9.50E+03	1.08E+03	-	4.41E+03	-	3.63E+07
Ce-144	1.46E+06	6.09E+05	7.83E+04	-	3.61E+05	-	4.93E+08
Pr-143	2.10E+04	8.41E+03	1.04E+03	-	4.85E+03	-	9.18E+07
Nd-147	7.07E+03	8.17E+03	4.89E+02	-	4.78E+03	-	3.92E+07

TABLE 2-7 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, MEAT PATHWAY DOSE FACTORS (Continued)TEENAGER (mrem/yr per $\mu\text{Ci}/\text{m}^3$) FOR H-3 AND C-14
($\text{m}^2 * \text{mrem}/\text{yr}$ per $\mu\text{Ci}/\text{sec}$) FOR OTHERS

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	1.94E+02	1.94E+02	1.94E+02	1.94E+02	1.94E+02	1.94E+02
C-14	2.81E+05	5.62E+04	5.62E+04	5.62E+04	5.62E+04	5.62E+04	5.62E+04
P-32	3.93E+09	2.44E+08	1.53E+08	-	-	-	3.31E+08
Cr-51	-	-	5.64E+03	3.13E+03	1.24E+03	8.05E+03	9.47E+05
Mn-54	-	7.00E+06	1.39E+06	-	2.09E+06	-	1.44E+07
Fe-55	2.38E+08	1.69E+08	3.94E+07	-	-	1.07E+08	7.31E+07
Fe-59	2.12E+08	4.95E+08	1.91E+08	-	-	1.56E+08	1.17E+09
Co-57	-	4.53E+06	7.59E+06	-	-	-	8.45E+07
Co-58	-	1.41E+07	3.24E+07	-	-	-	1.94E+08
Co-60	-	5.83E+07	1.31E+08	-	-	-	7.60E+08
Ni-63	1.52E+09	1.07E+08	5.15E+07	-	-	-	1.71E+07
Zn-65	2.50E+08	8.69E+08	4.05E+08	-	5.56E+08	-	3.68E+08
Rb-86	-	4.07E+08	1.91E+08	-	-	-	6.02E+07
Sr-89	2.55E+08	-	7.29E+06	-	-	-	3.03E+07
Sr-90	8.05E+09	-	1.99E+09	-	-	-	2.26E+08
Y-91	9.54E+05	-	2.56E+04	-	-	-	3.91E+08
Zr-95	1.50E+06	4.73E+05	3.25E+05	-	6.95E+05	-	1.09E+09
Nb-95	1.79E+06	9.95E+05	5.48E+05	-	9.65E+05	-	4.26E+09
Ru-103	8.57E+07	-	3.66E+07	-	3.02E+08	-	7.16E+09
Ru-106	2.36E+09	-	2.97E+08	-	4.55E+09	-	1.13E+11
Ag-110m	5.06E+06	4.79E+06	2.91E+06	-	9.13E+06	-	1.34E+09
Sb-124	1.62E+07	2.98E+05	6.31E+06	3.67E+04	-	1.41E+07	3.26E+08
Sb-125	1.56E+07	1.71E+05	3.66E+06	1.49E+04	-	1.37E+07	1.22E+08
Te-125m	3.03E+08	1.09E+08	4.05E+07	8.47E+07	-	-	8.94E+08
Te-127m	9.41E+08	3.34E+08	1.12E+08	2.24E+08	3.82E+09	-	2.35E+09
Te-129m	9.50E+08	3.53E+08	1.50E+08	3.07E+08	3.97E+09	-	3.57E+09
I-131	8.92E+06	1.25E+07	6.71E+06	3.65E+09	2.15E+07	-	2.47E+06
I-132	-	-	-	-	-	-	-
I-133	3.05E-01	5.18E-01	1.58E-01	7.23E+01	9.09E-01	-	3.92E-01
I-134	-	-	-	-	-	-	-
I-135	-	-	-	-	-	-	-
Cs-134	5.23E+08	1.23E+09	5.71E+08	-	3.91E+08	1.49E+08	1.53E+07
Cs-136	9.40E+06	3.70E+07	2.48E+07	-	2.01E+07	3.17E+06	2.98E+06
Cs-137	7.24E+08	9.63E+08	3.36E+08	-	3.28E+08	1.27E+08	1.37E+07
Ba-140	2.38E+07	2.91E+04	1.53E+06	-	9.87E+03	1.96E+04	3.66E+07
Ce-141	1.18E+04	7.87E+03	9.04E+02	-	3.71E+03	-	2.25E+07
Ce-144	1.23E+06	5.08E+05	6.60E+04	-	3.04E+05	-	3.09E+08
Pr-143	1.76E+04	7.04E+03	8.78E+02	-	4.09E+03	-	5.80E+07
Nd-147	6.23E+03	6.77E+03	4.06E+02	-	3.98E+03	-	2.44E+07

TABLE 2-7 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, MEAT PATHWAY DOSE FACTORS (Continued)CHILD (mrem/yr per $\mu\text{Ci}/\text{m}^3$) FOR H-3 AND C-14
($\text{m}^2 * \text{mrem}/\text{yr}$ per $\mu\text{Ci}/\text{sec}$) FOR OTHERS

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	2.34E+02	2.34E+02	2.34E+02	2.34E+02	2.34E+02	2.34E+02
C-14	5.29E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05	1.06E+05
P-32	7.42E+09	3.47E+08	2.86E+08	-	-	-	2.05E+08
Cr-51	-	-	8.79E+03	4.88E+03	1.33E+03	8.91E+03	4.66E+05
Mn-54	-	8.01E+06	2.13E+06	-	2.25E+06	-	6.72E+06
Fe-55	4.57E+08	2.42E+08	7.51E+07	-	-	1.37E+08	4.49E+07
Fe-59	3.76E+08	6.09E+08	3.03E+08	-	-	1.77E+08	6.34E+08
Co-57	-	5.92E+06	1.20E+07	-	-	-	4.85E+07
Co-58	-	1.64E+07	5.02E+07	-	-	-	9.58E+07
Co-60	-	6.93E+07	2.04E+08	-	-	-	3.84E+08
Ni-63	2.91E+09	1.56E+08	9.91E+07	-	-	-	1.05E+07
Zn-65	3.75E+08	1.00E+09	6.22E+08	-	6.30E+08	-	1.76E+08
Rb-86	-	5.77E+08	3.55E+08	-	-	-	3.71E+07
Sr-89	4.82E+08	-	1.38E+07	-	-	-	1.87E+07
Sr-90	1.04E+10	-	2.64E+09	-	-	-	1.40E+08
Y-91	1.80E+06	-	4.82E+04	-	-	-	2.40E+08
Zr-95	2.66E+06	5.85E+05	5.21E+05	-	8.38E+05	-	6.11E+08
Nb-95	3.10E+06	1.21E+06	8.62E+05	-	1.13E+06	-	2.23E+09
Ru-103	1.55E+08	-	5.96E+07	-	3.90E+08	-	4.01E+09
Ru-106	4.44E+09	-	5.54E+08	-	5.99E+09	-	6.90E+10
Ag-110m	8.39E+06	5.67E+06	4.53E+06	-	1.06E+07	-	6.74E+08
Sb-124	2.92E+07	3.79E+05	1.02E+07	6.45E+04	-	1.62E+07	1.83E+08
Sb-125	2.85E+07	2.20E+05	5.97E+06	2.64E+04	-	1.59E+07	6.80E+07
Te-125m	5.69E+08	1.54E+08	7.59E+07	1.60E+08	-	-	5.49E+08
Te-127m	1.77E+09	4.78E+08	2.11E+08	4.24E+08	5.06E+09	-	1.44E+09
Te-129m	1.79E+09	5.00E+08	2.78E+08	5.77E+08	5.26E+09	-	2.18E+09
I-131	1.65E+07	1.66E+07	9.46E+06	5.50E+09	2.73E+07	-	1.48E+06
I-132	-	-	-	-	-	-	-
I-133	5.67E-01	7.02E-01	2.66E-01	1.30E+02	1.17E+00	-	2.83E-01
I-134	-	-	-	-	-	-	-
I-135	-	-	-	-	-	-	-
Cs-134	9.22E+08	1.51E+09	3.19E+08	-	4.69E+08	1.68E+08	8.16E+06
Cs-136	1.62E+07	4.46E+07	2.88E+07	-	2.37E+07	3.54E+06	1.57E+06
Cs-137	1.33E+09	1.28E+09	1.88E+08	-	4.16E+08	1.50E+08	7.99E+06
Ba-140	4.38E+07	3.84E+04	2.56E+06	-	1.25E+04	2.29E+04	2.22E+07
Ce-141	2.22E+04	1.11E+04	1.64E+03	-	4.86E+03	-	1.38E+07
Ce-144	2.32E+06	7.26E+05	1.24E+05	-	4.02E+05	-	1.89E+08
Pr-143	3.34E+04	1.00E+04	1.66E+03	-	5.43E+03	-	3.60E+07
Nd-147	1.17E+04	9.47E+03	7.33E+02	-	5.19E+03	-	1.50E+07

TABLE 2-8 PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, GROUND PLANE PATHWAY DOSE FACTORS $(m^2 * mrem/yr \text{ per } \mu Ci/sec)$

Nuclide	Any Organ	Skin
H-3	-	-
C-14	-	-
P-32	-	-
Cr-51	4.68E+06	5.51E+06
Mn-54	1.34E+09	1.63E+09
Fe-55	-	-
Fe-59	2.75E+08	3.21E+08
Co-57	1.88E+08	2.07E+08
Co-58	3.82E+08	4.44E+08
Co-60	2.16E+10	2.53E+10
Ni-63	-	-
Zn-65	7.45E+08	8.59E+08
Rb-86	8.98E+06	1.03E+07
Sr-89	2.16E+04	2.51E+04
Sr-90	-	-
Y-91	1.08E+06	1.21E+06
Zr-95	2.48E+08	2.84E+08
Nb-95	1.36E+08	1.61E+08
Ru-103	1.09E+08	1.26E+08
Ru-106	4.21E+08	5.07E+08
Ag-110m	3.47E+09	4.01E+09
Te-125m	1.55E+06	2.13E+06
Te-127m	9.17E+04	1.08E+05
Te-129m	2.00E+07	2.31E+07
I-131	1.72E+07	2.09E+07
I-132	1.24E+06	1.46E+06
I-133	2.47E+06	2.98E+06
I-134	4.49E+05	5.30E+05
I-135	2.56E+06	8.01E+09
Cs-134	6.75E+09	2.95E+06
Cs-136	1.49E+08	1.71E+08
Cs-137	1.04E+10	1.20E+10
Ba-140	2.05E+07	2.35E+07
Ce-141	1.36E+07	1.54E+07
Ce-144	6.95E+07	-
Pr-143	-	8.04E+07
Nd-147	8.40E+06	1.01E+07

APPENDIX A
EVALUATION OF DEFAULT MPC VALUES
FOR LIQUID EFFLUENTS

APPENDIX A: EVALUATION OF DEFAULT MPC VALUES FOR LIQUID EFFLUENTS

In accordance with the requirements of CONTROL 3.3.7.10 the radioactive effluent monitors shall be operable with alarm setpoints established to ensure that the limits of CONTROL 3.11.1.1 are not exceeded. CONTROL 3.11.1.1 requires that the concentration of radioactive material at the point of discharge to the UNRESTRICTED AREA shall be limited to the concentrations of (old) 10 CFR 20, Appendix B, Table II, Column 2 (Appendix F). The determination of allowable radionuclide concentration and corresponding alarm setpoint is a function of both the concentration limit calculation and the liquid effluent monitor setpoint calculation.

- a) Each batch tank to be released is sampled and analyzed per the requirements detailed in Table 4.11.1.1.1-1. The results from those analyses are then compared to the Maximum Permissible Concentration limits listed in Appendix F at the point of discharge to the UNRESTRICTED AREA using the following equation:

$$\sum_i^n \frac{C_i}{MPC_i} * \frac{RR}{CTBD+RR} \leq 1 \tag{A1.1}$$

Where:

- 1 = MPC Ratio Limit that represents the Instantaneous Release Dose Limit of 500 mrem/yr (10 CFR Part 20.105).
- C_i = Concentration of radionuclide i in the mixture (μCi/ml)
- MPC_i = The 10 CFR 20, Appendix B, Table II, Column II MPC value for radionuclide i (μCi/ml) [ODCM Appendix F].
- = 2E-04 (μCi/ml) for dissolved or entrained noble gases.
- CTBD= Cooling Tower Blowdown Dilution (GPM) or other source of dilution water [Table 1-1].
- RR = Release Rate (GPM) [Table 1-1].

If this equation is satisfied, then the tank may be released to the river.

For example given the following information:

- Cs-137 concentrations of (listed below) in a tank of volume 15,000 gallons (Floor Drain Sample Tank OBT-346),
- the MPC limit for Cs-137 of 2.0E-05 μCi/ml,
- RR of 176 gpm,
- CTBD of 12,000 gpm

Substituting in these value in Equation A1.1 will determine if the tank meets the acceptance criteria.

$$\sum_i^n \frac{1.0E - 03}{2.0E - 05} * \frac{176}{12000 + 176} = 0.72$$

Repeat for each different concentration.

Example	Cs-137 Concentration μCi/ml	MPC Limit μCi/ml	MPC Value at the discharge point	MPC Ratio Limit of ≤ 1 Achieved
1.	1.0E-03	2.0E-05	0.72	Yes
2.	2.0E-03	2.0E-05	1.45	No
3.	3.0E-03	2.0E-05	2.17	No

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In these examples the first concentration of 1.0E-03 could be discharged, however examples 2 and 3 could not be discharged. To release this tank at those higher concentrations without reprocessing the tank, then either RR and/or CTBD values must be changed. Either reduce RR and/or increase CTBD values until the results are ≤ 1 .

- b) The second set of equations is the establishment of radiation monitor alarm setpoints based upon the nuclide concentrations in the sample. The purpose of the alarm setpoint is to provide a reasonable assurance that the MPC limit of ≤ 1 is maintained during the release. Based on the pre-release information, the Effective MPC value (MPC_e) for a radionuclide distribution is calculated by the equation:

$$MPC_e = \sum_i C_i (\text{gamma}) / \sum_i \frac{C_i}{MPC_i} (\text{gamma}) \quad (\text{A1.2})$$

Where:

MPC_e = The effective MPC value for a mixture of radionuclides ($\mu\text{Ci/ml}$)

C_i = Concentration of radionuclide i in the mixture ($\mu\text{Ci/ml}$)

MPC_i = The "old" 10 CFR 20, Appendix B, Table II, Column II MPC value for radionuclide i [ODCM Appendix F] ($\mu\text{Ci/ml}$).

When a tank contains only one nuclide, the Effective MPC value (MPC_e) will not change. For example, given Cs-137 of three different concentrations of 1.0E-03 $\mu\text{Ci/ml}$, 2.0E-03 $\mu\text{Ci/ml}$, and 3.0E-03 $\mu\text{Ci/ml}$ the MPC_e value will remain at 2.0E-05 $\mu\text{Ci/ml}$.

$$2.0E - 05 \mu\text{Ci/ml} = 1.0E - 03 \mu\text{Ci/ml} / \sum_i \frac{1.0E - 03 \mu\text{Ci/ml}}{2.0E - 05 \mu\text{Ci/ml}}$$

$$2.0E - 05 \mu\text{Ci/ml} = 2.0E - 03 \mu\text{Ci/ml} / \sum_i \frac{2.0E - 03 \mu\text{Ci/ml}}{2.0E - 05 \mu\text{Ci/ml}}$$

$$2.0E - 05 \mu\text{Ci/ml} = 3.0E - 03 \mu\text{Ci/ml} / \sum_i \frac{3.0E - 03 \mu\text{Ci/ml}}{2.0E - 05 \mu\text{Ci/ml}}$$

Conservative alarm setpoints for each release are determined using default parameters. Table 1-1 summarizes all current default values in use for Hope Creek.

A. Liquid Radwaste Monitor (RE4861)

Setpoints are determined by the following equation.

$$SP \leq \frac{MPC_e * CTBD}{RR} + bkg \quad (\text{A1.3})$$

Default values from Table 1-1 are used in this calculation.

Where:

MPC_e = Effective MPC in the sample obtained from equation A1.2, $\mu\text{Ci/ml}$

CTBD = 12,000 gpm

RR = 176 gpm (LRW)

Bkg = 0 $\mu\text{Ci/ml}$

Correction Factor:

A correction factor must be applied to the default setpoint calculation to account for radiation monitor uncertainties and the contribution of non-gamma emitting radionuclides such as H-3, Sr-89, Sr-90, and Fe-55.

a. Radiation Monitor Inaccuracies

Hope Creek PSBP 311649 lists a total loop accuracy of 30% for the liquid radwaste radiation monitors. Therefore, a factor of 0.30 is applied to the default setpoint to ensure the trip setpoint is reached before the analytical limit is reached.

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b. Non-Gamma Emitting Radionuclides

Non-gamma emitting radionuclides are analyzed on a monthly and quarterly basis from composite samples of liquid radwaste releases. The values below represent the historical maximum reactor coolant values for non-gamma emitting nuclides (H-3 is an assumed maximum). Reactor coolant values were chosen to represent the maximum concentration of non-gamma emitting radionuclides that could be released from the Hope Creek station in liquid effluent.

Nuclide	MPC ($\mu\text{Ci/ml}$)	Activity ($\mu\text{Ci/ml}$)	Activity / MPC
H-3	3E-03	1.0E-01	33.3
Fe-55	8E-04	4.7E-04	0.59
Sr-89	3E-06	1.6E-06	0.53
Sr-90	3E-07	2.0E-08	0.07
Total			34.5

The concentration values are further diluted by a minimum factor of 68 prior to release to the Delaware River. The minimum dilution factor is obtained by using the minimum cooling tower blowdown flowrate of 12,000 gpm and the maximum release rate of 176 gpm.

A conservative correction factor for non-gamma emitting radionuclides can be obtained by using the highest Concentration / MPC ratio and the minimum dilution factor as follows:

$$\text{Correction Factor (non-gamma)} = 34.5 / 68 = 0.5.$$

An overall correction factor can be obtained by adding the correction factor for radiation monitor inaccuracies and non-gamma emitting radionuclides as follows:

$$\text{Overall Correction Factor (CF)} = 0.3 + 0.5 = 0.8.$$

Adding these two correction factors to Equation A1.3, then that equation becomes Equation A1.4

$$SP \leq \frac{MPC_e * CTBD * [1 - CF]}{RR} + bkg \quad (\text{A1.4})$$

As the MPCe value increases, due to the increase in the tank activity to be released, the radiation monitor setpoint will also increase. However, when the tank contain only one radionuclide, then the setpoint becomes fixed and has no ratio to the concentration being released. The examples given above for the calculation of the Cs-137 MPCe value of 2.0E-05 $\mu\text{Ci/ml}$ (Eq A1.2) is used in determining the setpoint (Eq A1.4). Substituting in these MPCe values into Equation A1.4 the setpoint value will not change.

APPENDIX A: EVALUATION OF DEFAULT MPC VALUES FOR LIQUID EFFLUENTS

Example	Cs-137 Concentration $\mu\text{Ci/ml}$	MPC _e $\mu\text{Ci/ml}$	RE4861 Liquid Radwaste Monitor Setpoint (Eq. A1.4) $\mu\text{Ci/ml}$
1.	1.0E-03	2.0E-05	2.73E-04
2.	2.0E-03	2.0E-05	2.73E-04
3.	3.0E-03	2.0E-05	2.73E-04

$$2.73E - 04 \text{ mCi/ml} \leq \frac{2.0E-05 \frac{\text{mCi}}{\text{ml}} * 12,000 \text{ gpm} * [1-0.8]}{176 \text{ gpm}} + 0$$

With a single nuclide present in a tank, the MPC_e value will not change regardless of the changing concentration and thus the monitor setpoint will not change.

Therefore, the radiation monitor setpoint is only a check that a tank with different higher activity was released without adequate evaluation.

B. Default Setpoints

To eliminate the need to change the alarm setpoints as a function of changing radionuclide distributions in a tank (i.e., with each tank), a default alarm setpoint can be established¹. This default setpoint is based on an evaluation of the historical radionuclide distribution from Hope Creek. The year that contains the lowest MPC_e value would be used to establish the default setpoints. This evaluation occurs every three years. Should the lowest observed MPC_e value remain higher than the current lowest evaluation period MPC_e value, then no further action is required.

Table A-1 contains the liquid curies released from Hope Creek from 2018 through 2022. Reviewing the annual sum of the MPC_e values for each year, the lowest value found was 9.84E-06 $\mu\text{Ci/ml}$ (2019).

This MPC_e value is lower than the current MPC_e value (3.40E-05 $\mu\text{Ci/ml}$) contained in revision 29 of the ODCM.

Using the MPC_e value of 9.84E-06 the default alarm setpoint for RE4861 is calculated as:

$$1.34E - 04 \mu\text{Ci/ml} \leq \frac{9.84E-06 \frac{\text{mCi}}{\text{ml}} * 12,000 \text{ gpm} * [1-0.8]}{176 \text{ gpm}} + 0 \quad (\text{A1.4A})$$

The Effluent Tracking Software calculates the pre-release setpoint for each batch tank release. The software also calculates both the minimum dilution (gpm) from the cooling tower blowdown (CTBD) and the maximum discharge rate (gpm) from the discharge pump (RR) to ensure that the MPC ratio limit of ≤ 1 is maintained.

The unique characteristic of equation A1.4A is that as the MPC_e concentration increases, then so does the setpoint. Likewise, as the MPC_e concentration decreases, then the setpoint is also reduced. If the MPC_e concentration is zero, then the setpoint cannot be calculated. In those cases, the default RE4861 setpoint value shall be used.

Given that Equation A1.4A includes a conservative correction factor of 80%, it is reasonable to stipulate that the default setpoint of 1.34E-04 $\mu\text{Ci/ml}$ would not need to be changed until the calculated setpoint is at or below 25% (1.05E-04 $\mu\text{Ci/ml}$). The use of the default alarm setpoint is acceptable provided that the value used is at least as conservative as the release specific setpoint calculated in accordance with Equation A1.4 above within the 25% allowance.

Procedural controls exist to verify the setpoint utilized is at or below what is required. Should the calculated setpoint be more conservative by more than 25%, then one of the following will be performed:

- Increase CTBD and/or Reduce RR until calculated setpoint is \geq the default setpoint,
- Install new setpoint,
- Reprocess the tank to add more radioactivity,

¹ NUREG 0133 Page AA-1

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- d. Based on the post-dilution $\mu\text{Ci/ml}$ / MPC ratio, Management determines that setpoint change is not required.

The impact of increasing CTBD and/or decreasing RR on the setpoint calculation is illustrated below using an MPC_e fraction value of 7.00E-06:

Example	Default Setpoint ($\mu\text{Ci/ml}$)	MPC _e Ratio of Tank ($\mu\text{Ci/ml}$)	CTBD (gpm)	RR (gpm)	Calculated Setpoint ($\mu\text{Ci/ml}$)	Percent Difference from Default Setpoint
1	1.34E-04	7.00E-06	12000	176	9.55E-05	-40.4%
2	1.34E-04	7.00E-06	12000	100	1.68E-04	20.2%
3	1.34E-04	7.00E-06	18000	176	1.43E-04	6.4%
4	1.34E-04	7.00E-06	15000	25	8.40E-04	84.0%

In example 1 the calculated setpoint using the default values for CTBD and RR results in a calculated setpoint that is 40.4% lower than the default setpoint of 1.34E-04 $\mu\text{Ci/ml}$. In example 2 by reducing RR from the default release rate of 176 gpm to 100 gpm, then the calculated setpoint would be 20.2% higher than the default setpoint. Therefore, no setpoint change would be required. Examples 3 and 4 manipulate the values for both CTBD and/or RR to calculate the adjusted setpoint to be less conservative (i.e., higher) than the default setpoint.

Reducing the pump discharge rate (RR) from the tank to be discharged from 176 gpm to 100 gpm or increasing the dilution rate (CTBD) from 12,000 gpm to 18,000 gpm brings or reducing RR to 25 gpm and increasing the dilution rate to 15,000 gpm, the calculated setpoint of the tank will be greater than the default setpoint. Therefore, no changes would be required to be made to the default setpoint. One additional approach would be to return the tank for processing to add activity.

C. Cooling Tower Blowdown Radiation Monitor (RE8817)

The cooling tower blowdown radiation monitor provides an Alarm only function for releases into the environment. The cooling tower blowdown is the final release point for liquid effluents from Hope Creek station to the Delaware River. This setpoint is not determined using dilution flow and release rate flow. This results in an extremely low value as the activity in liquid effluents continues to be reduced. Therefore, a conservative setpoint reduction factor of 0.2 (1-0.8) is used to prevent spurious alarms.

$$SP \leq MPC_e * (1 - 0.8) \tag{A1.4B}$$

$$SP \leq 9.84E - 06 - \mu\text{Ci/ml} * 0.2$$

$$SP < 1.97E - 06 \mu\text{Ci/ml (RE8817)} \text{ (rounded to } 2.0E-06)$$

D. Turbine Building Circulating Water Dewatering Sump Radiation Monitor (RE4557)

The Turbine Building Circulating Water Dewatering Sump Radiation Monitor (RE4557) provides automatic termination of liquid radioactive releases from the Circulating Water Dewatering Sump. The sump discharges to the circulating water system to the cooling tower. Plant design and procedures maintain the setpoint at <2 times background radiation levels. Releases from the sump at gamma activity concentrations less than the monitor setpoint are considered continuous releases since inputs to the sump would occur during discharge. Releases of activity above the established continuous release setpoint may be performed on a batch basis following sampling and analysis of the sump contents. Hope Creek calculation SP-0004 established a setpoint for the monitor at 1.4E-02 $\mu\text{Ci/ml}$ based on a postulated release of reactor steam into the sump. Using the MPC_e determined for Liquid Radwaste and Cooling Tower Blowdown monitors, a more conservative maximum default value for batch releases can be determined:

$$SP \leq \frac{MPC_e * CTBD * [1 - CF]}{RR} + bkg$$

$$SP \leq \frac{9.84E-06 * 12000 * (1-0.8)}{100} + 0 \tag{A1.4C}$$

$$SP < 2.36E - 04 \mu\text{Ci/ml (batch releases only)}$$

APPENDIX A: EVALUATION OF DEFAULT MPC VALUES FOR LIQUID EFFLUENTS

Default values from Table 1-1:

Where: MPC _e	=	9.84E-06 μCi/ml
CTBD	=	12000 gpm
RR	=	100 gpm
Bkg	=	0 μCi/ml
CF	=	0.8

For continuous releases, the maximum setpoint should be less than 2.4E-06 μCi/ml above background to limit dose consequences from this pathway. (4HE-0241, CVF-98-0002)

E. Releases from the Condensate Storage Tank

If the Condensate Storage Tank (CST) requires release to the Delaware River, the discharge path would be through installed piping connected to the liquid Radwaste discharge path such that both the Liquid Radwaste Discharge Monitor and the Cooling Tower Blowdown monitor could detect and isolate/alarm on high concentrations of radionuclides. Default setpoints are determined for potential releases from the CST.

a. Liquid Radwaste Monitor (RE4861)

$$SP \leq \frac{MPC_e * CTBD * [1 - CF]}{RR} + bkg$$

Default values from Table 1-1:

Where:

MPC _e	=	9.84E-06 μCi/ml
CTBD	=	12000 gpm
RR	=	1300 gpm
Bkg	=	0 μCi/ml
CF	=	0.8

$$SP \leq \frac{9.84E-06 * 12,000 * [1 - 0.8]}{1,300} + 0 \quad \text{(A1.4D)}$$

$$SP < 1.82E - 05 \mu\text{Ci/ml (RE4861)}$$

b. Cooling Tower Blowdown Radiation Monitor (RE8817)

The cooling tower blowdown radiation monitor provides an Alarm only function for releases into the environment. The cooling tower blowdown is the final release point for liquid effluents from Hope Creek station to the Delaware River.

$$SP \leq MPC_e * (1 - 0.8) \quad \text{(A1.4E)}$$

$$SP \leq 9.84E - 06 \mu\text{Ci/ml} * 0.2$$

$$SP < 1.97E - 06 \mu\text{Ci/ml (RE8817)}$$

APPENDIX A: EVALUATION OF DEFAULT MPC VALUES FOR LIQUID EFFLUENTS

TABLE A-1 CALCULATION OF EFFECTIVE MPC (MPC_e) - HOPE CREEK

Nuclide	MPC	2018 Activity Released	2018 MPCe	2019 Activity Released	2019 MPCe	2020 Activity Released	2020 MPCe	2021 Activity Released	2021 MPCe	2022 Activity Released	2022 MPCe
Na-24	3.00E-05	7.69E-05	2.56E+00			1.97E-05	6.57E-01				
Cr-51	2.00E-03	2.56E-03	1.28E+00	4.58E-05	2.29E-02			1.17E-04	5.85E-02	2.30E-04	1.15E-01
Mn-54	1.00E-04	1.51E-02	1.51E+02	2.54E-03	2.54E+01	4.82E-02	4.82E+02	5.42E-04	5.42E+00	1.51E-03	1.51E+01
Mn-56	1.00E-04									3.89E-07	3.89E-03
Fe-59	5.00E-05	1.02E-04	2.04E+00			2.43E-07	4.86E-03			5.62E-06	1.12E-01
Co-57	4.00E-04	4.85E-06	1.21E-02			1.01E-04	2.53E-01				
Co-58	9.00E-05	9.08E-03	1.01E+02	1.92E-03	2.13E+01	2.06E-02	2.29E+02	6.12E-05	6.80E-01	4.53E-04	5.04E+00
Co-60	3.00E-05	3.21E-02	1.07E+03	5.84E-03	1.95E+02	9.68E-02	3.23E+03	5.39E-03	1.80E+02	7.96E-03	2.65E+02
Zn-65	1.00E-04	2.70E-03	2.70E+01	1.68E-04	1.68E+00	4.70E-03	4.70E+01			4.68E-04	4.68E+00
Zn-69m	6.00E-05									4.06E-06	6.76E-02
Y-91	3.00E-05							9.66E-08	3.22E-03		
Zr-95	6.00E-05	2.28E-05	3.80E-01			4.74E-06	7.90E-02				
Nb-95	1.00E-04	6.09E-05	6.09E-01								
Mo-99	4.00E-05	1.87E-06	4.68E-02								
Tc-99m	3.00E-03	1.90E-06	6.33E-04								
Sb-122	3.00E-05	4.79E-04	1.60E+01	1.39E-04	4.63E+00					7.46E-05	2.49E+00
Sb-124	2.00E-05	2.87E-03	1.44E+02	3.27E-03	1.64E+02			4.74E-05	2.37E+00	9.59E-04	4.80E+01
Sb-125	1.00E-04	3.71E-04	3.71E+00	6.48E-04	6.48E+00	1.98E-05	1.98E-01	2.50E-06	2.50E-02	3.63E-04	3.63E+00
I-131	3.00E-07	1.04E-06	3.46E+00	3.40E-04	1.13E+03	3.02E-07	1.01E+00	4.46E-07	1.49E+00		
I-133	1.00E-06			1.42E-07	1.42E-01			6.83E-05	6.83E+01		
I-134	2.00E-05									5.04E-07	2.52E-02
Cs-134	9.00E-06	2.57E-03	2.85E+02	8.66E-04	9.62E+01	1.66E-02	1.84E+03	8.39E-05	9.32E+00	4.33E-04	4.81E+01
Cs-136	6.00E-05			2.18E-05	3.63E-01					8.77E-07	1.46E-02
Cs-137	2.00E-05	9.13E-03	4.57E+02	8.21E-04	4.11E+01	1.81E-02	9.04E+02	2.02E-04	1.01E+01	1.26E-03	6.32E+01
Total Curies (Gamma)		7.72E-02		1.66E-02		2.05E-01		6.51E-03		1.37E-02	
SUM (Ci/MPCi) (Gamma)			2.26E+03		1.69E+03		6.73E+03		2.77E+02		4.56E+02
MPCe (µCi/ml)			3.41E-05		9.84E-06		3.05E-05		2.35E-05		3.01E-05

APPENDIX B

TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS
LIQUID RADIOACTIVE EFFLUENTS

APPENDIX B: TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS – LIQUID RADIOACTIVE EFFLUENTS

The radioactive liquid effluents from Hope Creek from 1997 through 1999 were evaluated to determine the dose contribution of the radionuclide distribution. This analysis was performed to evaluate the use of a limited dose analysis for determining environmental doses, providing a simplified method of determining compliance with the dose limits of CONTROL 3.11.1.2. For the expected radionuclide distribution of effluent from Hope Creek during 1997 to 1999, the controlling organ is the GI-LLI (Bone dose was controlling in 1997 due to relatively high percentage of Fe-55). The calculated GI-LLI dose is predominately a function of the Zn-65, Fe-55, and Fe-59 releases. These radionuclides also contribute the large majority of the calculated total body dose. The results of this evaluation are presented in Table B-1.

For purposes of simplifying the details of the dose calculation process, it is conservative to identify a controlling, dose significant radionuclide and limit the calculation process to the use of the dose conversion factor for this nuclide. Multiplication of the total release (i.e., cumulative activity for all radionuclides) by this dose conversion factor provides for a dose calculation method that is simplified while also being conservative.

For the evaluation of the maximum organ dose, it is conservative to use the Fe-59 dose conversion factor (6.32E5 mrem/hr per $\mu\text{Ci/ml}$). By this approach, the maximum organ dose will be overestimated since this nuclide has the highest organ dose fraction of all the radionuclides evaluated. For the total body calculation, the Zn-65 dose factor (2.32E5 mrem/hr per $\mu\text{Ci/ml}$, total body) is the highest among the identified dominant nuclides.

For evaluating compliance with the dose limits of CONTROL 3.11.1.2, the following simplified equations may be used:

Total Body

$$D_{tb} = \frac{8.35E - 04 * VOL * A_{io} * C_i}{CTBD} \quad (B.1)$$

Where:

D_{tb} = Dose to the total body (mrem)

$A_{i,tb}$ = 2.32E5, total body ingestion dose conversion factor for Zn-65 where A is dose conversion factor, i is isotope which is Zn-65, and TB is the total body (mrem/hr per $\mu\text{Ci/ml}$)

VOL = Volume of liquid effluent released (gal)

C_i = Total concentration of all radionuclides ($\mu\text{Ci/ml}$)

CTBD = Average cooling tower blowdown discharge rate during release period (gal/min)

8.35E-04 = conversion factor (1.67E-2 hr/min) and the near field dilution factor 0.05

APPENDIX B TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS - LIQUID RADIOACTIVE EFFLUENTS

Substituting the value for the Zn-65 total body dose conversion factor, the equation simplified to:

$$D_{tb} = \frac{1.94E + 02 * VOL * C_i}{CTBD} \quad (B.2)$$

Maximum Organ

$$D_{max} = 8.35E - 4 * VOL * A_{i,GI-LLI} * \sum_i C_i / CTBD \quad (B.3)$$

Where: D_{max} = Maximum organ dose (mrem)
 $A_{i,GI-LLI}$ = 6.32E5, GI-LLI ingestion dose conversion factor for Fe-59 where A is dose conversion factor, i is isotope which is Fe-59 and o is maximum organ which is the GI-LLI (mrem/hr per $\mu\text{Ci/ml}$).

Substituting the value for $A_{i,GI-LLI}$ the equation simplifies to:

$$D_{max} = 5.28E + 2 * VOL * \sum_i C_i / CTBD \quad (B.4)$$

Tritium is not included in the limited analysis dose assessment for liquid releases, because the potential dose resulting from normal reactor releases is relatively negligible.

Near Field Dilution Factor

The near field dilution factor stems from NUREG-0133, Section 4.3. For plants with cooling towers, such as Hope Creek, a dilution factor is allowed so that the product of the average blowdown flow (in CFS) and the dilution factor is 1000 cfs or less. UFSAR Section 2.2.12 states that the dilution by river flow ranges from 14- to 40-fold in the mixing zone of effluent discharges and that existing cross currents tend to improve this overall dilution. The average minimum cooling tower blowdown for Hope Creek is 1.90E4 GPM (from FSAR 11.2). This converts to 42 CFS. Selecting a dilution factor of 20 (between 14 and 40 from the UFSAR) yields a product of 880 CFS, which is less than the 1000 cfs allowed by NUREG-0133. This near field dilution factor of 20 is inverted to a multiple of 0.05, which is used in the liquid effluent dose calculations.

APPENDIX B TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS - LIQUID RADIOACTIVE EFFLUENTS

TABLE B-1 ADULT DOSE CONTRIBUTIONS FISH AND INVERTEBRATE PATHWAYS - HOPE CREEK

Nuclide	Release (Ci)	TB Dose Fraction	GI-LLI Dose Fraction	Bone Dose Fraction	Liver Dose Fraction	Year
Fe-55	2.28E-01	0.77	0.63	0.96	0.86	1997
Fe-55	6.40E-03	0.12	0.12	0.58	0.22	1998
Fe-55	2.83E-02	0.1	0.04	0.43	0.15	1999
Mn-54	1.74E-02	*	0.05	0	0.01	1997
Mn-54	7.48E-03	0.02	0.14	0	0.05	1998
Mn-54	6.87E-02	0.04	0.1	0	0.07	1999
Co-58	5.68E-04	*	*	0	*	1997
Co-58	7.67E-04	*	*	0	*	1998
Co-58	3.30E-03	*	*	0	*	1999
Fe-59	2.65E-03	0.08	0.23	0.02	0.05	1997
Fe-59	1.62E-04	0.03	0.09	0.02	0.03	1998
Fe-59	1.72E-02	0.51	0.7	0.4	0.5	1999
Co-60	7.05E-03	0.01	0.03	0	*	1997
Co-60	6.78E-03	0.06	0.2	0	0.01	1998
Co-60	2.05E-02	0.03	0.04	0	*	1999
Zn-65	1.29E-03	0.12	0.06	0.02	0.07	1997
Zn-65	1.39E-03	0.75	0.4	0.4	0.68	1998
Zn-65	3.37E-03	0.32	0.07	0.16	0.27	1999

* = Less than 0.01

APPENDIX C

TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS - GASEOUS RADIOACTIVE
EFFLUENTS – NOBLE GASES

APPENDIX C: TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS – GASEOUS RADIOACTIVE EFFLUENTS - NOBLE GASES

Overview

The evaluation of doses due to releases of radioactive material to the atmosphere can be simplified using effective dose transfer factors instead of using dose factors which are radionuclide specific. These effective factors, which are based on typical radionuclide distributions of releases, can be applied to the total radioactivity releases to approximate the dose in the environment. Instead of having to perform individual radionuclide dose analysis only a single multiplication (i.e., K_{eff} , M_{eff} , or N_{eff} times the total quantity of radioactive material releases) would be needed. The approach provides a reasonable estimate of the actual dose while eliminating the need for a detailed calculation technique.

Determination of Effective Dose Factors

Effective dose transfer factors are calculated by the following equations:

$$K_{eff} = \sum_i^n (K_i * f_i) \quad (C.1)$$

- Where:
- K_{eff} = The effective total body factor due to gamma emissions from all noble gases released.
 - K_i = The total body dose factor due to gamma emissions from each noble gas radionuclide i released.
 - f_i = The fractional abundance of noble gas radionuclide i relative to the total noble gas activity.

$$(L + 1.1M_{eff}) = \sum_i^n ((L_i + 1.1M_i) * f_i) \quad (C.2)$$

- Where:
- $(L + 1.1M_{eff})$ = The effective skin dose factor due to beta and gamma emissions from all noble gases released.
 - $(L_i + 1.1M_i)$ = The skin dose factor due to beta and gamma emissions from each noble gas radionuclide i released.

$$M_{eff} = \sum_i^n (M_i * f_i) \quad (C.3)$$

- Where:
- M_{eff} = The effective air dose factor due to gamma emissions from all noble gases released.
 - M_i = The air dose factor due to gamma emissions from each noble gas radionuclide i released

$$N_{eff} = \sum_i^n (N_i * f_i) \quad (C.4)$$

- Where:
- N_{eff} = The effective air dose factor due to beta emissions from all noble gases released.
 - N_i = The air dose factor due to beta emissions from each noble gas radionuclide i released.

Normally, it would be expected that past radioactive effluent data would be used for the determination of the effective dose factors. However, the noble gas releases from Hope Creek have a short history and with continued excellent fuel performance, has hampered efforts in collecting and detecting appreciable noble gas mixes of radionuclides. So, to provide a reasonable basis for the derivation of the effective noble gas dose factors, the source terms from ANSI N237-1976/ANS-18.1, "Source Term Specifications", Table 5 has been used as representing a typical distribution. The effective dose factors as derived are presented in Table C-1.

APPENDIX C: TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS – GASEOUS RADIOACTIVE EFFLUENTS – NOBLE GASES

Application

To provide an additional degree of conservatism, a factor of 0.50 is introduced into the dose calculation process when the effective dose transfer factor is used. This conservatism provides additional assurance that the evaluation of doses using a single effective factor will not significantly underestimate any actual doses in the environment.

For evaluating compliance with the dose limits of CONTROL 3.11.2.2, the following simplified equations may be used:

$$D_{\gamma} = \frac{3.17E-08}{0.50} * X/Q * M_{eff} * \sum_i^n Q_i \quad (C.5)$$

$$D_{\beta} = \frac{3.17E-08}{0.50} * X/Q * N_{eff} * \sum_i^n Q_i \quad (C.6)$$

Where:	D_{γ}	=	Air dose due to gamma emissions for the cumulative release of all noble gases (mrad)
	D_{β}	=	Air dose due to beta emissions for the cumulative release of all noble gases (mrad)
	X/Q	=	Atmospheric dispersion to the controlling site boundary (sec/m3)
	M _{eff}	=	8.1E3, effective gamma-air dose factor (mrad/yr per μCi/m3)
	N _{eff}	=	8.5E3, effective beta-air dose factor (mrad/yr per μCi/m3)
	Q _i	=	Cumulative release for all noble gas radionuclides (μCi)
	3.17E-08	=	Conversion factor (yr/sec)
	0.50	=	Conservatism factor to account for the variability in the effluent data

Combining the constants, the dose calculation equations simplify to:

$$D_{\gamma} = 5.14E - 4 * X/Q * \sum_i^n Q_i \quad (C.7)$$

$$D_{\beta} = 5.39E - 4 * X/Q * \sum_i^n Q_i \quad (C.8)$$

The effective dose factors are to be used on a limited basis for the purpose of facilitating the timely assessment of radioactive effluent releases, particularly during periods of computer malfunction where a detailed dose assessment may be unavailable.

APPENDIX C: TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS – GASEOUS RADIOACTIVE EFFLUENTS – NOBLE GASES

TABLE C-1 EFFECTIVE DOSE FACTORS NOBLE GASES - TOTAL BODY AND SKIN

Radionuclide	f_i	Total Body Dose Factor (K_{eff}) (mrem/yr per $\mu\text{Ci}/\text{m}^3$)	Total Skin Dose Factor ($L + 1.1 M_{eff}$) (mrem/yr per $\mu\text{Ci}/\text{m}^3$)
Kr-83m	0.01	N/A	N/A
Kr-85m	0.01	1.0E1	2.8E1
Kr-87	0.04	2.4E2	6.6E2
Kr-88	0.04	5.9E2	7.6E2
Kr-89	0.27	4.5E3	7.9E3
Xe-133	0.02	5.9E0	1.4E1
Xe-135	0.05	9.0E1	2.0E2
Xe-135m	0.06	1.9E2	2.6E2
Xe-137	0.31	4.4E2	4.3E3
Xe-138	0.19	1.7E3	2.7E3
Total		7.8E3	1.7E4

APPENDIX C: TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS – GASEOUS RADIOACTIVE EFFLUENTS – NOBLE GASES

TABLE C-2 EFFECTIVE DOSE FACTORS NOBLE GASES - GAMMA AIR AND BETA AIR

Radionuclide	f_i	Gamma Air Dose Factor (M_{eff}) (mrad/yr per $\mu\text{Ci}/\text{m}^3$)	Beta Air Dose Factor (N_{eff}) (mrad/yr per $\mu\text{Ci}/\text{m}^3$)
Kr-83m	0.01	N/A	3.0E0
Kr-85m	0.01	1.2E1	2.0E1
Kr-87	0.04	2.5E2	4.1E2
Kr-88	0.04	6.1E2	1.2E2
Kr-89	0.27	4.7E3	2.9E3
Xe-133	0.02	7.0E0	2.1E1
Xe-135	0.05	9.6E1	1.2E2
Xe-135m	0.06	2.0E2	4.4E1
Xe-137	0.31	4.7E2	3.9E3
Xe-138	0.19	1.8E3	9.0E2
Total		8.1E3	8.4E3

* Based on noble gas distribution from ANSI N237-1976/ANS-18.1, "Source Term Specification".

APPENDIX D

TECHNICAL BASIS FOR EFFECTIVE DOSE PARAMETERS - GASEOUS RADIOACTIVE EFFLUENTS –
PARTICULATES AND IODINES

APPENDIX D: TECHNICAL BASIS FOR EFFECTIVE DOSE PARAMETERS – GASEOUS RADIOACTIVE EFFLUENTS – PARTICULATES AND IODINES

The pathway dose factors for the controlling infant age group were evaluated to determine the controlling pathway, organ and radionuclide. This analysis was performed to provide a simplified method for determining compliance with CONTROL 3.11.2.3. For the infant age group, the controlling pathway is the grass - cow - milk (g/c/m) pathway. An infant receives a greater radiation dose from the g/c/m pathway than any other pathway. Of this g/c/m pathway, the maximum exposed organ including the total body, is the thyroid, and the highest dose contributor is radionuclide I-131. The results of this evaluation are presented in Table D-1.

For purposes of simplifying the details of the dose calculation process, it is conservative to identify a controlling, dose significant organ and radionuclide and limit the calculation process to the use of the dose conversion factor for the organ and radionuclide. Multiplication of the total release (i.e., cumulative activity for all radionuclides) by this dose conversion factor provides for a dose calculation method that is simplified while also being conservative.

For the evaluation of the dose commitment via a controlling pathway and age group, it is conservative to use the infant, g/c/m, thyroid, I-131 pathway dose factor (1.67E12 m²*mrem/yr per μCi/sec). By this approach, the maximum dose commitment will be overestimated since I-131 has the highest pathway dose factor of all radionuclides evaluated.

For evaluating compliance with the dose limits of CONTROL 3.11.2.3, the following simplified equation may be used:

$$D_{max} = 3.17E - 8 * W * R_{I-131} * \sum_i^n Q_i \quad (D.1)$$

Where:	D _{max}	=	Maximum organ dose (mrem)
	W	=	Atmospheric dispersion parameter to the controlling location (s) as identified in Table 2-3.
	X/Q	=	Atmospheric dispersion for inhalation pathway (sec/m ³)
	D/Q	=	Atmospheric disposition for vegetation, milk and ground plane exposure pathways (m ⁻²)
	Q _i	=	Cumulative release over the period of interest for radioiodines and particulates (μCi).
	3.17E-8	=	Conversion factor (yr/sec)
	R _{I-131}	=	I-131 dose parameter for the thyroid for the identified controlling pathway. = 1.05E12, infant thyroid dose parameter with the grass - cow - milk pathway controlling (m ² mrem/yr per μCi/sec)

The ground plane exposure and inhalation pathways need not be considered when the above simplified calculational method is used because of the overall negligible contribution of these pathways to the total thyroid dose. It is recognized that for some particulate radionuclides (e.g., Co-60 and Cs-137), the ground exposure pathway may represent a higher dose contribution than either the vegetation or milk pathway. However, use of the I-131 thyroid dose parameter for all radionuclides will maximize the organ dose calculation, especially considering that no other radionuclide has a higher dose parameter for any organ via any pathway than I-131 for the thyroid via the milk pathway.

APPENDIX D TECHNICAL BASIS FOR EFFECTIVE DOSE PARAMETERS - GASEOUS RADIOACTIVE EFFLUENTS – PARTICULATES AND IODINES

The location of exposure pathways and the maximum organ dose calculation may be based on the available pathways in the surrounding environment of Hope Creek as identified by the annual land-use census required by the PSEG Nuclear Common REMP ODCM CONTROL 3.12.2. Otherwise, the dose will be evaluated based on the predetermined controlling pathways as identified in Table 2-3.

TABLE D-1 INFANT DOSE CONTRIBUTIONS – FRACTION OF TOTAL ORGAN AND BODY DOSE

Target Organs	Grass – Cow – Milk	Ground Plan
Total Body	0.02	0.15
Bone	0.23	0.14
Liver	0.09	0.15
Thyroid	0.59	0.15
Kidney	0.02	0.15
Lung	0.01	0.14
GI-LLI	0.02	0.15

TABLE D-2 INFANT DOSE CONTRIBUTIONS – FRACTION OF DOSE CONTRIBUTION BY PATHWAY

Pathway	Frac
Grass – Cow – Milk	0.92
Ground Plane	0.08
Inhalation	N/A

APPENDIX E

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM -

SAMPLE TYPE, LOCATION AND ANALYSIS

APPENDIX E: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLE TYPE,
LOCATION, AND ANALYSIS

This section has been relocated to the PSEG Nuclear Common REMP ODCM..

APPENDIX F

MAXIMUM PERMISSIBLE CONCENTRATIONS

LIQUID EFFLUENTS

APPENDIX F: MAXIMUM PERMISSIBLE CONCENTRATION (MPC) VALUES FOR LIQUID EFFLUENTS

The following radionuclide concentrations were obtained from 10 CFR 20 Appendix B, Table II, Column 2 revised January 1, 1988 and referred to as the "old" 10 CFR 20.

TABLE F-1 MAXIMUM PERMISSIBLE CONCENTRATIONS

Element	Isotope	Soluble Conc. ($\mu\text{Ci/ml}$)	Insoluble Conc. ($\mu\text{Ci/ml}$)
Actinium (89)	Ac-227	2E-6	3E-4
	Ac-228	9E-5	9E-5
Americium (95)	Am-241	4E-6	3E-5
	Am-242m	4E-6	9E-5
	Am-242	1E-4	1E-4
	Am-243	4E-6	3E-5
Antimony (51)	Am-244	5E-3	5E-3
	Sb-122	3E-5	3E-5
	Sb-124	2E-5	2E-5
Arsenic (33)	Sb-125	1E-4	1E-4
	Sb-126	3E-6	3E-6
	As-73	5E-4	5E-4
	As-74	5E-5	5E-5
Astatine (85)	As-76	2E-5	2E-5
	As-77	8E-5	8E-5
	At-211	2E-6	7E-5
Barium (56)	Ba-131	2E-4	2E-4
	Ba-140	3E-5	2E-5
Berkelium (97)	Bk-249	6E-4	6E-4
	Bk-250	2E-4	2E-4
Beryllium (4)	Be-7	2E-3	2E-3
Bismuth (83)	Bi-206	4E-5	4E-5
	Bi-207	6E-5	6E-5
	Bi-210	4E-5	4E-5
	Bi-212	4E-4	4E-4
Bromine (35)	Br-82	3E-4	4E-5
Cadmium (48)	Cd-109	2E-4	2E-4
	Cd-115m	3E-5	3E-5
	Cd-115	3E-5	4E-5
Calcium (20)	Ca-45	9E-6	2E-4
	Ca-47	5E-5	3E-5
Californium (98)	Cf-249	4E-6	2E-5
	Cf-250	1E-5	3E-5
	Cf-251	4E-6	3E-5
	Cf-252	7E-6	7E-6
	Cf-253	1E-4	1E-4
	Cf-254	1E-7	1E-7

APPENDIX F: MAXIMUM PERMISSIBLE CONCENTRATION (MPC) VALUES FOR LIQUID EFFLUENTS

TABLE F-1 MAXIMUM PERMISSIBLE CONCENTRATIONS (Continued)

Element	Isotope	Soluble Conc. ($\mu\text{Ci/ml}$)	Insoluble Conc. ($\mu\text{Ci/ml}$)
Carbon (6)	C-14	8E-4	-----
Cerium (58)	Ce-141	9E-5	9E-5
	Ce-143	4E-5	4E-5
	Ce-144	1E-5	1E-5
Cesium (55)	Cs-131	2E-3	9E-4
	Cs-134m	6E-3	1E-3
	Cs-134	9E-6	4E-5
	Cs-135	1E-4	2E-4
	Cs-136	9E-5	6E-5
Chlorine (17)	Cs-137	2E-5	4E-5
	Cl-36	8E-5	6E-5
	Cl-38	4E-4	4E-4
Chromium (24)	Cr-51	2E-3	2E-3
Cobalt (27)	Co-57	5E-4	4E-4
	Co-58m	3E-3	2E-3
	Co-58	1E-4	9E-5
	Co-60	5E-5	3E-5
Copper (29)	Cu-64	3E-4	2E-4
Curium (96)	Cm-242	2E-5	2E-5
	Cm-243	5E-6	2E-5
	Cm-244	7E-6	3E-5
	Cm-245	4E-6	3E-5
	Cm-246	4E-6	3E-5
	Cm-247	4E-6	2E-5
	Cm-248	4E-7	1E-6
Dysprosium (66)	Cm-249	2E-3	2E-3
	Dy-165	4E-4	4E-4
	Dy-166	4E-5	4E-5
Einsteinium (99)	Es-253	2E-5	2E-5
	Es-254m	2E-5	2E-5
	Es-254	1E-5	1E-5
	Es-255	3E-5	3E-5
Erbium (68)	Er-169	9E-5	9E-5
	Er-171	1E-4	1E-4
Europium (63)	Eu-152 (9.2 hrs)	6E-5	6E-5
	Eu-152 (13 yrs)	8E-5	8E-5
	Eu-154	2E-5	2E-5
	Eu-155	2E-4	2E-4
Fermium (100)	Fm-254	1E-4	1E-4
	Fm-255	3E-5	3E-5
	Fm-256	9E-7	9E-7
Fluorine (9)	F-18	8E-4	5E-4
Gadolinium (64)	Gd-153	2E-4	2E-4
	Gd-159	8E-5	8E-5
Gallium (31)	Ga-72	4E-5	4E-5
Germanium (32)	Ge-71	2E-3	2E-3
Gold (79)	Au-196	2E-4	1E-4
	Au-198	5E-5	5E-5
	Au-199	2E-4	2E-4
Hafnium (72)	Hf-181	7E-5	7E-5
Holmium (67)	Ho-166	3E-5	3E-5

APPENDIX F: MAXIMUM PERMISSIBLE CONCENTRATION (MPC) VALUES FOR LIQUID EFFLUENTS

TABLE F-1 MAXIMUM PERMISSIBLE CONCENTRATIONS (Continued)

Element	Isotope	Soluble Conc. ($\mu\text{Ci/ml}$)	Insoluble Conc. ($\mu\text{Ci/ml}$)
Hydrogen (3)	H-3	3E-3	3E-3
Indium (49)	In-113m	1E-3	1E-3
	In-114m	2E-5	2E-5
	In-115m	4E-4	4E-4
	In-115	9E-5	9E-5
Iodine (53)	I-125	2E-7	2E-4
	I-126	3E-7	9E-5
	I-129	6E-8	2E-4
	I-131	3E-7	6E-5
	I-132	8E-6	2E-4
	I-133	1E-6	4E-5
	I-134	2E-5	6E-4
	I-135	4E-6	7E-5
Iridium (77)	Ir-190	2E-4	2E-4
	Ir-192	4E-5	4E-5
	Ir-194	3E-5	3E-5
Iron (26)	Fe-55	8E-4	2E-3
	Fe-59	6E-5	5E-5
Lanthanum (57)	La-140	2E-5	2E-5
	La-141	3E-6	3E-6
Lead (82)	Pb-203	4E-4	4E-4
	Pb-210	1E-7	2E-4
	Pb-212	2E-5	2E-5
Lutetium (71)	Lu-177	1E-4	1E-4
Manganese (25)	Mn-52	3E-5	3E-5
	Mn-54	1E-4	1E-4
	Mn-56	1E-4	1E-4
Mercury (80)	Hg-197m	2E-4	2E-4
	Hg-197	3E-4	5E-4
	Hg-203	2E-5	1E-4
Molybdenum (42)	Mo-99	2E-4	4E-5
Neodymium (60)	Nd-144	7E-5	8E-5
	Nd-147	6E-5	6E-5
	Nd-149	3E-4	3E-4
Neptunium (93)	Np-237	3E-6	3E-5
	Np-239	1E-4	1E-4
Nickel (28)	Ni-59	2E-4	2E-3
	Ni-63	3E-5	7E-4
	Ni-65	1E-4	1E-4
Niobium (41)	Nb-93m	4E-4	4E-4
	Nb-95	1E-4	1E-4
	Nb-97	9E-4	9E-4
Osmium (76)	Os-185	7E-5	7E-5
	Os-191m	3E-3	2E-3
	Os-191	2E-4	2E-4
	Os-193	6E-5	5E-5
Palladium (46)	Pd-103	3E-4	3E-4
	Pd-109	9E-5	7E-5
Phosphorus (15)	P-32	2E-5	2E-5
Platinum (78)	Pt-191	1E-4	1E-4
	Pt-193m	1E-3	1E-3
	Pt-193	9E-4	2E-3

APPENDIX F: MAXIMUM PERMISSIBLE CONCENTRATION (MPC) VALUES FOR LIQUID EFFLUENTS

TABLE F-1 MAXIMUM PERMISSIBLE CONCENTRATIONS (Continued)

Element	Isotope	Soluble Conc. ($\mu\text{Ci/ml}$)	Insoluble Conc. ($\mu\text{Ci/ml}$)
	Pt-197m	1E-3	9E-4
	Pt-197	1E-4	1E-4
Plutonium (94)	Pu-238	5E-6	3E-5
	Pu-239	5E-6	3E-5
	Pu-240	5E-6	3E-5
	Pu-241	2E-4	1E-3
	Pu-242	5E-6	3E-5
	Pu-243	3E-4	3E-4
Polonium (84)	Po-210	7E-7	3E-5
Potassium (19)	K-42	3E-4	2E-5
Praseodymium(59)	Pr-142	3E-5	3E-5
	Pr-143	5E-5	5E-5
Promethium (61)	Pm-147	2E-4	2E-4
	Pm-149	4E-5	4E-5
Protactinium(91)	Pa-230	2E-4	2E-4
	Pa-231	9E-7	2E-5
	Pa-233	1E-4	1E-4
Radium (88)	Ra-223	7E-7	4E-6
	Ra-224	2E-6	5E-6
	Ra-226	3E-8	3E-5
	Ra-228	3E-8	3E-5
Rhenium (75)	Re-183	6E-4	3E-4
	Re-186	9E-5	5E-5
	Re-187	3E-3	2E-3
	Re-188	6E-5	3E-5
Rhodium (45)	Rh-103m	1E-2	1E-2
	Rh-105	1E-4	1E-4
Rubidium (37)	Rb-86	7E-5	2E-5
	Rb-87	1E-4	2E-4
Ruthenium (44)	Ru-97	4E-4	3E-4
	Ru-103	8E-5	8E-5
	Ru-105	1E-4	1E-4
	Ru-106	1E-5	1E-5
Samarium (62)	Sm-147	6E-5	7E-5
	Sm-151	4E-4	4E-4
	Sm-153	8E-5	8E-5
Scandium (21)	Sc-46	4E-5	4E-5
	Sc-47	9E-5	9E-5
	Sc-48	3E-5	3E-5
Selenium (34)	Se-75	3E-4	3E-4
Silicon (14)	Si-31	9E-4	2E-4
Silver (47)	Ag-105	1E-4	1E-4
	Ag-110m	3E-5	3E-5
	Ag-111	4E-5	4E-5
Sodium (11)	Na-22	4E-5	3E-5
	Na-24	2E-4	3E-5
Strontium (38)	Sr-85m	7E-3	7E-3
	Sr-85	1E-4	2E-4
	Sr-89	3E-6	3E-5
	Sr-90	3E-7	4E-5

APPENDIX F: MAXIMUM PERMISSIBLE CONCENTRATION (MPC) VALUES FOR LIQUID EFFLUENTS

TABLE F-1 MAXIMUM PERMISSIBLE CONCENTRATIONS (Continued)

Element	Isotope	Soluble Conc. ($\mu\text{Ci/ml}$)	Insoluble Conc. ($\mu\text{Ci/ml}$)
	Sr-91	7E-5	5E-5
	Sr-92	7E-5	6E-5
Sulfur (16)	S-35	6E-5	3E-4
Tantalum (73)	Ta-182	4E-5	4E-5
Technetium (43)	Tc-96m	1E-2	1E-2
	Tc-96	1E-4	5E-5
	Tc-97m	4E-4	2E-4
	Tc-97	2E-3	8E-4
	Tc-99m	6E-3	3E-3
	Tc-99	3E-4	2E-4
Tellurium (52)	Te-125m	2E-4	1E-4
	Tc-127m	6E-5	5E-5
	Te-127	3E-4	2E-4
	Te-129m	3E-5	2E-5
	Te-129	8E-4	8E-4
	Te-131m	6E-5	4E-5
	Te-132	3E-5	2E-5
Terbium (65)	Tb-160	4E-5	4E-5
Thallium (81)	Tl-200	4E-4	2E-4
	Tl-201	3E-4	2E-4
	Tl-202	1E-4	7E-5
	Tl-204	1E-4	6E-5
Thorium (90)	Th-227	2E-5	2E-5
	Th-228	7E-6	1E-5
	Th-230	2E-6	3E-5
	Th-231	2E-4	2E-4
	Th-232	2E-6	4E-5
	Th-natural	2E-6	2E-5
	Th-234	2E-5	2E-5
Thulium (69)	Tm-170	5E-5	5E-5
	Tm-171	5E-4	5E-4
Tin (50)	Sn-113	9E-5	8E-5
	Sn-124	2E-5	2E-5
Tungsten (74)	W-181	4E-4	3E-4
	W-185	1E-4	1E-4
	W-187	7E-5	6E-5
Uranium (92)	U-230	5E-6	5E-6
	U-232	3E-5	3E-5
	U-233	3E-5	3E-5
	U-234	3E-5	3E-5
	U-235	3E-5	3E-5
	U-236	3E-5	3E-5
	U-238	4E-5	4E-5
	U-240	3E-5	3E-5
	U-natural	3E-5	3E-5
Vanadium (23)	V-48	3E-5	3E-5
Ytterbium (70)	Yb-175	1E-4	1E-4
Yttrium	Y-90	2E-5	2E-5
	Y-91m	3E-3	3E-3

APPENDIX F: MAXIMUM PERMISSIBLE CONCENTRATION (MPC) VALUES FOR LIQUID EFFLUENTS

TABLE F-1 MAXIMUM PERMISSIBLE CONCENTRATIONS (Continued)

Element	Isotope	Soluble Conc. ($\mu\text{Ci/ml}$)	Insoluble Conc. ($\mu\text{Ci/ml}$)
	Y-91	3E-5	3E-5
	Y-92	6E-5	6E-5
	Y-93	3E-5	3E-5
Zinc (30)	Zn-65	1E-4	2E-4
	Zn-69m	7E-5	6E-5
	Zn-69	2E-3	2E-3
Zirconium (40)	Zr-93	8E-4	8E-4
	Zr-95	6E-5	6E-5
	Zr-97	2E-5	2E-5
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radio - active half-life greater than 2 hours		3E-6	3E-6
Any single radionuclide not listed above, which decays by alpha emission or spontaneous fission.		3E-8	3E-8

Notes:

1. If the identity of any radionuclide is not known, the limiting values for purposes of this table shall be: 3E-8 $\mu\text{Ci/ml}$.
2. If the identity and concentration of each radionuclide are known, the limiting values should be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix B for the specific radionuclide not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e. "unity").

APPENDIX G

MISCELLANEOUS TRITIUM RELEASES – CALCULATIONAL METHODOLOGY

APPENDIX G: MISCELLANEOUS TRITIUM RELEASES – CALCULATIONAL METHODOLOGY

The HCGS Turbine Building roof has 19 penetrations that were evaluated whether they could be gaseous effluent release pathways to the environment. Of these, two penetrations (south plant vent and north plant vent) have been previously included in the ODCM as gaseous release pathways and detailed in Table 4.11.2.1.2-1: Radioactive Gaseous Waste Sampling and Analysis Program. Of the remaining 17 penetrations four have been identified as potential gaseous effluent release points due to the migration of turbine gland seal steam into the lube oil system, as a result of the high operating pressure of the gland steam while the lube oil system is under a slight vacuum¹:

- 3 inch Reactor Feedwater Pump Turbine (RFPT) vent line
- 3 inch Generator Hydrogen Seal Oil (GHSO) vent line
- 8 inch Main Turbine Lube Oil (MTLO) vapor extractor vent line
- 10 inch Generator Hydrogen Seal Oil (GHSO) vent line

These miscellaneous release points were added to the ODCM in revision 29. There is no easy way to sample these release points for tritium. Therefore, tritium releases are estimated based upon the calculational methodology detailed below².

The calculational methodology for determining tritium activity released to the environment is based on the following equations:

Density of Moist Air (ρ)³

$$\rho = \frac{1}{(0.370486*(T_{LO}+0459.67))*(1+1.607858*W_{s@104F})/A_p} \quad (G-1)$$

Where:

ρ	=	Density of moist air lb/ft ³
	=	0.0634 lb/ft ³
T_{LO}	=	Gaseous effluent temperature at the vent line entrance (120 °F)
459.67	=	Absolute temperature °F
$W_{s@104F}$ lb _w /lb _{da}	=	Humidity ratio of saturated moist air at 104 °F for the Turbine Building Areas = 0.049145
A_p	=	Atmospheric Pressure psia
	=	14.696 psia

Mass fraction of the gland steam in the condensate of gas effluent (M)

$$M = (W_{LO} - W_{TB})/W_{LO} \quad (G-2)$$

Where:

M	=	Mass fraction of the gland steam in the condensate of gas effluent = 0.469 unitless
W_{LO}	=	Humidity ratio of moist air at the entrance of vent lines = 0.0491 lb _w /lb _{da}

¹ PSEG106-PR-001, Design and Operating Information for Hope Creek Turbine Building Roof Vent Structures, June 2015, Enercon Services, Inc.

² PSEG106-PR-004, Radioactive Effluent Evaluation for Hope Creek Lube Oil System Vent Lines, June 2015, Enercon Services, Inc.

³ Eq. 28, Chapter 1 of ASHRAE Handbook, 2009.

APPENDIX G: MISCELLANEOUS TRITIUM RELEASES – CALCULATIONAL METHODOLOGY

W_{TB} = Humidity ratio of ambient moist air in the Turbine Building = 0.261 lbw/lbda

Mass Flow Rate

$$MF_i = V_i * p * 60 \tag{G-3}$$

Where:

- MF_i = Mass Flow Rate for release point (i) lb/hr
 - = 1198.615 lb/hr 3 inch Reactor Feedwater Pump Turbine (RFPT) vent line
 - = 159.815 lb/hr 3 inch Generator Hydrogen Seal Oil (GHSO) vent line
 - = 2663.588 lb/hr 8 inch Main Turbine Lube Oil (MTLO) vapor extractor vent line
 - = 2720.665 lb/hr 10 inch Generator Hydrogen Seal Oil (GHSO) vent line
- V_i = Maximum Volume Air Flow Rate for release point (i) cfm
 - 3 inch RFPT vent line = 315 cfm
 - 3 inch GHSO vent line = 42 cfm
 - 8 inch MTLO vapor extractor vent line = 700 cfm
 - 10 inch GHSO vent line = 715 cfm
- p = Density of moist air lb/ft³ = 0.0634 lb/ft³ (equation G-1)
- 60 = minutes per hour

Humidity of Saturated Moist Air¹

$$H_{sat_a} = 6.2222E-10 * F_a^4 - 7.3813E-08 * F_a^3 + 6.0352E-06 * F_a^2 - 7.0517E-05 * F_a + 1.5499E-03 \tag{G-4}$$

Where:

- H_{sat_a} = Humidity ratio of saturated moist air at outside temperature for month (a) unitless
- F_a = Monthly average outside temperature (°F) for month (a)

Maximum Condensate Mass Flow Rate (lb/hr)

$$MC_{MFR_{ia}} = MF_{ia} / (1 - \frac{1}{W_{s@104F} - H_{sat_a}}) \tag{G-5}$$

Where:

- $MC_{MFR_{ia}}$ = Maximum Condensate Mass Flow Rate for release point (i) for month (a) lb/hr
- MF_{ia} = Mass Flow Rate for release point (i) for month (a) lb/hr from equation (G-3)
- $W_{s@104F}$ = Humidity ratio of saturated moist air at 104 OF for the Turbine Building Areas
 - = 0.049145 lbw/lbda
- H_{sat_a} = Humidity ratio of saturated moist air at outside temperature for month (i) unitless from equation (G-4)

¹ Table 1 of ASHRAE Handbook, 2009

APPENDIX G: MISCELLANEOUS TRITIUM RELEASES – CALCULATIONAL METHODOLOGY

Maximum Condensate Volume Flow Rate (gpm)

$$MC_{VFR_{ia}} = MC_{MFR_{ia}} / 500 \quad (G-6)$$

Where:

$MC_{VFR_{ia}}$ = Maximum Condensate Volume Flow Rate for release point (i) for month (a) gpm

$MC_{MFR_{ia}}$ = Maximum Condensate Mass Flow Rate for release point (i) for month (a) lb/hr from equation (G-5)

500 = lb/hr per gpm

Monthly Tritium Release (uCi/cc)

$$\mu Ci_i / cc_a = (\sum MC_{VFR_{ia}} * 3785.412 * M_a) * \mu Ci_{i_{RXa}} * M_{GS} \quad (G-7)$$

Where:

$\mu Ci_i / cc_a$ = concentration released from all four vent releases for nuclide (i) for month (a) $\mu Ci/cc$

$MC_{VFR_{ia}}$ = Maximum Condensate Volume Flow Rate for release point (i) for month (a) gpm

3785.412 = ml/m per g/m

Ma = Minutes per month (a)

$\mu Ci_{i_{RXa}}$ = Average reactor concentration of nuclide (i) for month (a) $\mu Ci/cc$

MGS = Fraction of Gland Seal Steam Condensate Water = 0.469 unitless from equation (G-2)