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Nuclear LLC

Technical Specification Section 6.9.1.8 (Salem)
Technical Specification Section 6.9.1.7 (Hope Creek)

LR-N18-0047

APR 26 2018

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington DC 20555-001

Salem Nuclear Generating Station, Unit Nos. 1 and 2
Renewed Facility Operating License Nos. DPR-70 and DPR-75
NRC Docket Nos. 50-272 and 50-311

Hope Creek Generating Station
Renewed Facility Operating License No. NPF-57
NRC Docket No. 50-354

Subject: 2017 Annual Radioactive Effluent Release Report (RERR)

As required with Section 6.9.1.8 of Appendix A to Renewed Facility Operating License Nos. DPR-70 (Unit 1) and DPR-75 (Unit 2) for Salem Nuclear Generating Stations (SGS), and Section 6.9.1.7 of Appendix A to Renewed Facility Operating License NPF-57 for Hope Creek Generating Station (HCGS), PSEG Nuclear hereby transmits one (1) copy of the combined 2017 Annual Radioactive Effluent Release Report (Enclosure 1). Reports SGS RERR-66 and HCGS RERR-40 were combined into one (1) report that summarizes information pertaining to the releases of radioactive materials in liquid, gaseous and solid form from the SGS and the HCGS for the period January 1, 2017 to December 31, 2017.

There are no regulatory commitments contained in this letter.

If you have any questions or comments on this transmittal, please contact Mr. Rick Heathwaite at (856) 339-2076.

Sincerely,

Patrick A. Martino
Plant Manager
Salem Generating Stations

Edward T. Casulli
Plant Manager
Hope Creek Generating Station

Enclosure 1: 2017 Annual Radioactive Effluent Release Report for Salem and Hope Creek Generating Stations

Enclosure 2: Revision 28 of Salem and Hope Creek Generating Stations' Offsite Dose Calculation Manual

cc: Mr. David Lew, Administrator - Region I - USNRC
Mr. James Kim, Project Manager - USNRC
Ms. Lisa Regner, Project Manager - USNRC
Mr. Patrick Finney, Salem Senior Resident Inspector - USNRC
Mr. Justin Hawkins, Hope Creek Senior Resident Inspector - USNRC
Mr. Joseph T. Furia, NRC Inspector - Region I - USNRC
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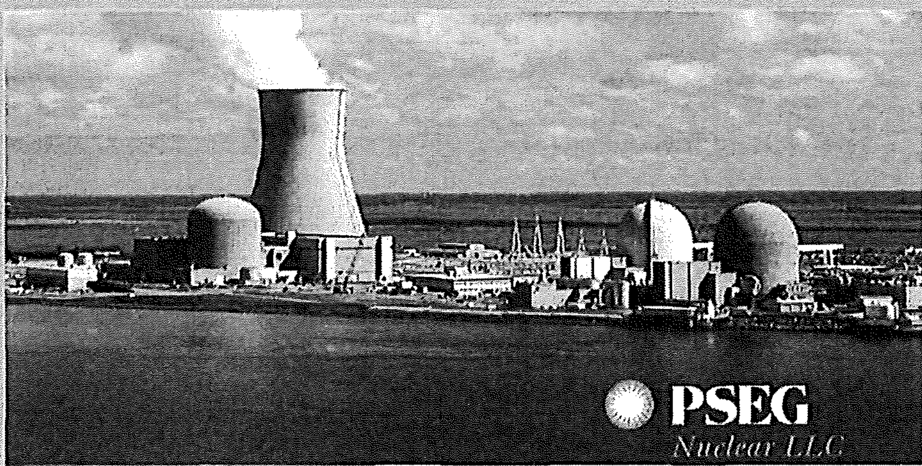
Mr. Lee Marabella, Corporate Commitment Tracking Coordinator - w/o attachment
Mr. Thomas Cachaza, Salem Commitment Tracking Coordinator - w/o attachment
Mr. Thomas MacEwen, Hope Creek Commitment Tracking Coordinator - w/o attachment

Enclosure 1

2017 Annual Radioactive Effluent Release Report

Salem and Hope Creek Generating Stations



PSEG Nuclear

Salem and Hope Creek Generating Stations

Radiological Effluent Controls

2017 Annual Radiological Effluent Release Report

JANUARY 1 THROUGH DECEMBER 31, 2017

Report Prepared by: ______________ Date 04/02/2018
Rick Heathwaite (REMP/REC Program Manager)

Station Reviews and Approvals

Salem

______________ Date 4/10/18
Paul Martitz (RP Superintendent)

______________ Date 4/10/18
Michael Brummitt (Chem. Manager)

______________ Date 4/10/18
Patrick Martino (Plant Manager)

Hope Creek

______________ Date 4/10/18
Harold Trimble (RP Manager)

______________ Date 4/19/18
Shelly Kugler (Chem. Manager)

______________ Date 4/20/18
Edward Casulli (Plant Manager)

SGS RERR-66
DOCKET NO. 50-272
DOCKET NO. 50-311
OPERATING LICENSE NO. DPR-070
OPERATING LICENSE NO. DPR-075

HCGS RERR-40
DOCKET NO. 50-354

OPERATING LICENSE NO. NPF-057

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I. Executive Summary

In 2017, the Salem Generating Station (SGS) and the Hope Creek Generating Station (HCGS) released to the environment through the radioactive liquid and gaseous effluents approximately 0.36 curies of noble gas, 0.39 curies of fission and activation products and 2,058 curies of tritium. The dose from both liquid and gaseous effluents was conservatively calculated for the Maximum Exposed Member of the Public. The results of those calculations and their comparison to the allowable limits were as follows:

Gaseous and liquid radiation doses to members of the public at the highest dose receptor

Effluent	Applicable Organ	Estimated Dose	Age Group	Receptor Location	% of Applicable Limit	Limit	Units
Noble Gas	Gamma – Air Dose	1.31E-04	All	Site Boundary	4.37E-04	30	mRad
	Beta – Air Dose	5.77E-05			9.61E-05	60	
Iodine, Particulate, C-14 & Tritium	Bone	3.99E-01	Child	4.6 miles SW	8.86E-01	45	mrem
Liquid	Total Body	1.53E-04	Adult	0.75 mi. N of Salem	1.70E-03	9	mrem
	Gi-Lli	3.43E-04			1.14E-03	30	

The calculated doses from the radiological effluents released from the three units were a very small percentage of the allowable limits.

The Total Dose to the Critical Receptor as required by section 3.11.4 of the SGS and HCGS ODCMs was determined to be 4.88E-01 mrem. The dose calculated was below the limits of 40 CFR 190 and 10 CFR 72.104 (25 mrem) to the total body and critical organ other than the thyroid.

Maximum TEDE doses to Members of the Public and personnel not having access to the Radiologically Controlled Area (RCA) were calculated as 2.24E-02 mrem and 2.01E+00 mrem, respectively. These doses were a small fraction of the 10 CFR 20.1301 dose limit of 100 mrem.

II. Introduction

This report, SGS-RERR-66/HCGS-RERR-40, summarizes information pertaining to the releases of radioactive materials in liquid, gaseous and solid forms from SGS and HCGS for the period January 1, 2017, to December 31, 2017.

SGS Unit 1 is a Westinghouse Pressurized Water Reactor that has a licensed core thermal power of 3,459 MW_{th} and an approximate net electrical output of 1,180 MW_e. SGS Unit 1 achieved initial criticality on December 11, 1976, and began commercial operation on June 30, 1977.

SGS Unit 2 is a Westinghouse Pressurized Water Reactor that has a licensed core thermal power of 3,459 MW_{th} and an approximate net electrical output of 1,178 MW_e.

SGS Unit 2 achieved initial criticality on August 2, 1980, and began commercial operation on October 13, 1981.

HCGS is a General Electric Boiling Water Reactor that has an up rated core thermal power of 3,840 MW_{th} and an approximate net electrical output of 1,212 MW_e. The HCGS achieved initial criticality on June 28, 1986 and began commercial operation on December 20, 1986.

2017 Electrical Output

Unit	$MW \cdot h_e$
SGS Unit 1	9,240,181
SGS Unit 2	8,730,754
HCGS	10,627,333

This report complies with the format described in Regulatory Guide 1.21, "Measuring, Evaluating and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water Cooled Nuclear Power Plants", Revision 1, June, 1974, as required by Control 6.9.1.8 of the SGS Units 1 and 2 Offsite Dose Calculation Manual (ODCM) and Control 6.9.1.7 of the HCGS ODCM. Revision 2, June 2009 of this Guide permits data tables to be supplied as annual tables.

Meteorological data was obtained in the format specified in Regulatory Guide 1.23, Revision 1 "Meteorological Monitoring Programs for Nuclear Power Plants," and retained on site. Detailed meteorological data was not presented in this report.

All vendor results for samples obtained in 2017 were received and included in the report calculations. Therefore, the 2017 report is complete and no supplements to the 2017 evaluating period will be required.

III. Supplemental Information

1. Regulatory Limits

The same regulatory limits apply to SGS Unit 1, SGS Unit 2 and HCGS. The limits were as follows:

Limit		Units	Receptor	ODCM and 10 CFR 50, Appendix I Design Objective Limits
1. Noble Gases:				
a.	≤ 500	mrem/yr	Total Body	ODCM Control 3.11.2.1.a
	≤ 3000		Skin	
b.	≤ 5	mRad	Air Gamma	Quarterly air dose limits: ODCM Control 3.11.2.2.a
	≤ 10		Air Beta	
c.	≤ 10	mRad	Air Gamma	Yearly air dose limits: ODCM Control 3.11.2.2.b
	≤ 20		Air Beta	
d.	≤ 10	mrem	Total Body (Gamma)	10 CFR 50, Appendix I, Section II.B.2(b)
	≤ 30		Skin (Beta)	

Limit		Units	Receptor	ODCM and 10 CFR 50, Appendix I Design Objective Limits
2. Iodines, Tritium, Particulates with Half-Lives > 8 days:				
a.	≤ 1500	mrem/yr	Any Organ	ODCM Control 3.11.2.1.b
b.	≤ 7.5	mrem	Any Organ	Quarterly dose limits: ODCM Control 3.11.2.3.a
c.	≤ 15	mrem	Any Organ	Yearly dose limits: ODCM Control 3.11.2.3.b
3. Liquid Effluents				
a.	The concentration limits in 10 CFR 20, Appendix B, Table II Col. 2 (pre 1994). For dissolved or entrained noble gases, the concentration shall be limited to 2E-04 uCi//ml.			ODCM Control 3.11.1.1
b.	≤ 1.5	mrem	Total Body	Quarterly dose limits ODCM Control 3.11.1.2.a
	≤ 5		Any Organ	
c.	≤ 3	mrem	Total Body	Yearly dose limits ODCM Control 3.11.1.2.b
	≤ 10		Any Organ	
4. Total Dose Limits				
a.	≤ 25	mrem	Total Body or Organ	Yearly dose limits ODCM Control 3.11.4 40 CFR 190 and 10 CFR 72.104
	≤ 75		Thyroid	
b.	≤ 100	mrem	Site TEDE Dose	10 CFR 20.1301

2. Maximum Permissible Concentration (MPC) Limits

Gaseous dose rates limits rather than maximum permissible concentration limits were used to calculate permissible release rates for gaseous releases. The maximum permissible dose rates for gaseous releases were defined in ODCM Controls 3.11.2.1.a and 3.11.2.1.b.

The Maximum Permissible Concentration Limit specified in 10 CFR 20, Appendix B, Table II, Column 2 (pre 1994) for identified nuclides, were used to calculate permissible release rates and concentrations for liquid release in accordance with the SGS Unit 1 and Unit 2 and the HCGS Offsite Dose Calculation Manual Control 3.11.1.1. The total activity concentration for all dissolved or entrained gases was limited to < 2E-04 uCi/ml.

3. Average Energy

The SGS ODCM and the HCGS ODCM limit the instantaneous dose equivalent rates due to the release of noble gases to less than or equal to 500 mrem/year to the total body and less than or equal to 3,000 mrem/year to the skin. The average beta and gamma energies of the radionuclide mixture in releases of fission and activation gases as described in Regulatory Guide 1.21, "Measuring, Evaluation, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," may be used to calculate doses in lieu of more sophisticated software. The SGS and HCGS radioactive effluent programs employ the methodologies presented in U.S. NRC 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 NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978. Therefore, average energies were not applicable to SGS and HCGS.

4. Measurements and Approximations of Total Radioactivity

A. Liquid Effluents:

Liquid effluents were monitored in accordance with Table 4.11-1 of the SGS ODCM and Table 4.11.1.1.1-1 of the HCGS ODCM.

During 2017, all batch liquid wastes were routed to sampling tanks for monitoring prior to release. The ODCMs require these tanks to be uniformly mixed for sampling and analysis before being released.

Batch releases were defined as:

- For SGS, releases from the Service Water Drums, which were collected and disposed via the Chemical Waste Basin, and the Chemical Volume Control System (CVCS) Monitor Tanks. During 2017, all batch liquid wastes from the Chemical Drain Tank and Laundry and Hot Shower Tanks were routed to Waste Monitor Holdup Tanks for monitoring prior to release. For flexibility in processing liquid effluents, the SGS Units 1 and 2 Liquid Radwaste Systems were cross-connected.
- For HCGS, releases from the Equipment Sample Tanks, Floor Drain Sample tanks, and Detergent Drain Tanks.

Continuous releases were defined as:

- For SGS, continuous liquid release pathways include Secondary System Leakage from the Condensate system and the Unit 1 Groundwater Recovery System through the Chemical Waste Basin.
- For HCGS, a continuous liquid effluent release path exists through the Circulating Water Dewatering Sump Discharge.

Representative samples were obtained in accordance with Table 4.11-1 of the SGS ODCM for SGS and Table 4.11.1.1.1-1 of the HCGS ODCM for HCGS. The total liquid activity discharged was determined by multiplying specific activities from the analyses by the volume of effluent discharged to the environment.

The detection requirements of Table 4.11-1 (SGS) and Table 4.11.1.1.1-1 (HCGS) of the ODCM were achieved. Radionuclides that were measured at concentrations below the ODCM-specified lower limit of detection (LLD) were considered present. A radionuclide for which no activity was detected while meeting the required LLD was considered absent.

B. Gaseous Effluents:

SGS Units 1 and 2:

Gaseous effluent streams at SGS were monitored and sampled in accordance with Table 4.11-2 of the ODCM. Each plant vent was the final release point for planned gaseous effluent releases and was continuously monitored by installed radiation monitors. The vent was also continuously sampled for iodine and particulates with fixed particulate and charcoal filters. The filter and charcoal were normally changed weekly, and analyzed on a multi-channel analyzer.

Sampling was also performed on all gas decay tanks and the containment atmosphere prior to release to the environment. The plant vent for each unit was normally sampled weekly for noble gases, particulates, iodine, and tritium.

The detection requirements of Table 4.11-2 of the ODCM were achieved or exceeded. A radionuclide detected at a concentration below the ODCM LLD was considered present. A radionuclide for which no activity was detected while meeting the required LLD was considered absent.

Continuous gaseous releases were quantified by routine sampling and isotopic analyses of the plant vent for each unit, as required by the ODCM. Specific activities for detected isotopes were multiplied by the total vent flow volume for the entire sampling period in order to determine the normal continuous release of radioactivity through each plant vent.

Batch noble gas releases were quantified by sampling each decay tank or containment atmosphere prior to release. The total activity in a batch release was determined by multiplying the specific activities for detected isotopes by the total volume of the gas discharged in that batch release.

Elevated plant vent radiation monitoring system readings while the channel was in an alarm state were treated as batch mode releases. If specific activity data from grab samples were not available, then the release was quantified by the use of the plant vent radiation monitors. The monitor response was converted to "specific activity" using historical efficiency factors. The total activity discharged was determined by multiplying the "specific activity" by the volume of effluent discharged while the channel was in an alarm state.

HCGS:

Gaseous effluent streams at HCGS were monitored and sampled in accordance with Table 4.11.2.1.2-1 of the ODCM. The North Plant Vent (NPV) and South Plant Vent (SPV) were the final release points for planned gaseous effluent releases. The NPV and SPV were continuously monitored for iodine, particulates and noble gases. These monitors have fixed particulate and charcoal filters. The particulate filters and charcoal cartridges were normally replaced and analyzed weekly. These analyses were performed on a multi-channel analyzer. The NPV and SPV were also normally sampled weekly for noble gases and tritium.

A small quantity of gaseous effluent was released via the Filtration, Recirculation, and Ventilation System (FRVS) vent during FRVS testing periods. The FRVS was continuously monitored for noble gases when in service, and has fixed particulate and charcoal filters. When the system was in vent mode for greater than two hours, samples were collected at the end of the release period. During periods of extended runs, samples were normally taken weekly.

The detection requirements of Tables 4.11.2.1.2-1 of the ODCM were. A radionuclide detected at a concentration below the ODCM LLD was considered present. A radionuclide for which no activity was detected while meeting the required LLD was considered absent.

Batch noble gas releases (i.e. primary containment purge) were quantified by pre-release sampling and isotopic analysis. The total radioactivity released was estimated by multiplying the specific activities for detected isotopes by the containment volume.

The SGS and HCGS ODCMs required LLD for airborne and liquid releases were as follows:

Liquid	**LLD** *(uCi/ml)*
Principal Gamma Emitters: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141)	5E-07
Ce-144 – **HCGS**	5E-06
Ce-144 – **SGS**	2E-06
I-131	1E-06
Entrained Gases	1E-05
H-3	1E-05
Gross Alpha	1E-07
Sr-89, Sr-90	5E-08
Fe-55	1E-06

Airborne	**LLD** *(uCi/cc)*
Gross Alpha, Sr-89, Sr-90	1E-11
H-3	1E-06
I-131	1E-12
Principal Gamma Emitters: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137,Ce-141, Ce-144	1E-11
Noble Gas: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, Xe-138	1E-04

5. Estimated Total Error

The estimated total error reported for continuous and batch liquid releases for all three stations was within 27%. The estimated total error for continuous and batch gaseous releases, and solid waste was within 35%.

6. Non-Routine Planned Discharges and Unplanned Discharges

Regulatory Guide 1.21, Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste, Revision 2 defines a *non-routine, planned discharge* as an effluent release from a release point that is not defined in the ODCM but that has been planned, monitored, and discharged in accordance with 10 CFR 20.2001 and an *unplanned discharge* as the unintended or unexpected discharge of liquid or airborne radioactive material to the unrestricted area.

SGS Unit 1

Liquid	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Number of Non-Routine Planned Discharges	0	0	0	0	0
Number of Unplanned Discharges	0	0	0	0	0
Total Curies Discharged	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Gaseous	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Total**
Number of Non-Routine Planned Discharges	0	0	0	0	0
Number of Unplanned Discharges	0	0	0	0	0
Total Curies Discharged	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**

N/A (Not Applicable)

SGS Unit 2

Liquid	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Number of Non-Routine Planned Discharges	0	0	0	0	0
Number of Unplanned Discharges	0	0	0	0	0
Total Curies Discharged	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Gaseous	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Total**
Number of Non-Routine Planned Discharges	0	39	0	0	39
Number of Unplanned Discharges	0	0	0	0	0
Total Curies Discharged	**N/A**	**2.19E-02**	**N/A**	**N/A**	**2.19E-02**

N/A (Not Applicable)

There were 39 gaseous discharges through the Containment Equipment Hatch that were non-routine planned discharges during the second quarter 2017. The ODCM was revised in September 2017 to include the containment equipment hatch in the ODCM as a gaseous release type.

HCGS:

Liquid	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Number of Non-Routine Planned Discharges	0	0	1	0	1
Number of Unplanned Discharges	0	1	0	0	1
Total Curies Discharged	**N/A**	**1.91E-02**	**6.66E-04**	**N/A**	**1.98E-02**
Gaseous	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Total**
Number of Non-Routine Planned Discharges	3	3	3	3	12
Number of Unplanned Discharges	0	0	0	0	
Total Curies Discharged	**1.44**	**1.58**	**1.12**	**1.51**	**5.65**

N/A (Not Applicable)

1. An unplanned liquid discharge occurred between June 6 and July 11, 2017 (CAP 20770666). A routine sample of the Low Volume Oily Waste (LVOW) system effluent detected tritium at 4.8E-06 µCi/ml. This system is normally clean. Sample results were verified in duplicate. The confirmatory samples both showed 2.6E-06 µCi/ml, consistent with expected dilution due to rain.

   The most probable cause is recapture of plant vent effluents in precipitation. Weather and low system inputs may have contributed to detectable tritium in the Low Volume Oily Waste System.

   A release of radioactivity through an alternate pathway requires additional sampling and generation of a permit to account for the activity released. The detected activity concentration is below the ODCM reportability threshold of 3E-05 µCi/ml, and Environmental Affairs has verified that there was no NJPDES reporting requirement.

   A composite sampler was set up on 7/7/17 to provide continuous monitoring of the new release pathway, including verification that no gamma activity was present. Chemistry prepared a release permit to meet ODCM requirements. The composite sampler remained in operation until samples verified that no tritium was present in the system.

2. In August, a planned non-routine discharge to the Cooling Tower Blowdown occurred from a tanker used to store rainwater collected from the HCGS Turbine Building Roofing System (CAP 20774293). The tanker collects roof run off from catch containments that contained tritium. The tanker water was batch released to the cooling tower blowdown line. Sampling and analysis were performed prior to release. The tanker contained only tritium at a concentration of 2.75E-05 µCi/ml and was included in the effluent accountability program. Composite samples were also analyzed for strontium and gross alpha. No activity was detected.

3. The lubricating oil ventilation system that discharges to the Turbine Building Roof had monthly (3 per quarter) release permits issued for the estimated tritium released via the airborne pathway. This is considered a non-routine planned discharge. The monthly permits were generated to account for the combined gaseous dose from the lube oil roof vents. This activity was calculated as a function of the average monthly RCS tritium concentration and the differential temperature between the lube oil system and the ambient temperature.

7. Significant Events

SGS Unit 1

None

SGS Unit 2

None

HCGS

None

8. Changes_to the Offsite Dose Calculation Manuals

Both the SGS and HCGS ODCMs were revised in 2017. Revision 28 of both ODCMs were issued in September 2017. These changes can be reviewed in the Revision Summary of each individual station ODCM, which were included as supplements to this report.

9. Changes to the Process Control Program

There were no changes to RW-AA-100, Process Control Program for Radioactive Wastes, during 2017.

10. Radioactive Effluent Monitoring Instrumentation Out of Service for More than 30 Days

A. SGS Unit 1:

1. Containment Fan Coolers – Service Water Line discharge liquid radiation monitors 1R13A was declared out of service on 9/28/2016 and was returned to service on 9/6/2017 (CAP: 20743629). Detector 1R13A was found damaged from stand pipe turbulence and was replaced and detector calibration completed satisfactory.

   The 1R13A CFCU Service Water radiation monitor was not corrected in a timely manner since an alternate standpipe restraint needed to be implemented to restore the channel. This required development of an Engineering Change Package (issued on 5/26/2017) and fabrication of the stabilizer plates (August 2017) prior to installation.

B. SGS Unit 2:

2. Chemical Waste Basin liquid radiation monitor 2R37 was declared out of service on 11/02/2016 and was returned to service on 12/31/2016 at 20:26. The 2016 ARERR indicated that the monitor was not returned to service as of 12/31/2016. The monitor was taken out of service to perform maintenance on the non-radioactive liquid waste basin liner. The required compensatory sampling was performed (CAP: 20750062).

3. Steam Generator Blowdown Line liquid radiation monitor 2R19A was declared out of service on 9/20/2016. It was returned to service 6/29/2017. It

was out of service for this length of time due to issues encountered during implementation of DCP 80111425 to replace the 2R19A-D detectors with high temperature detectors. There were failures of two separate detectors and pre-amplifiers during installation. One pre-amplifier and one detector were repaired by the vendor within 30 days. However, the 2R19A remained out of service, due to the long lead time in securing parts for the detector (CAP: 20751649). The required compensatory sampling had been performed.

4. Steam Generator Blowdown Line liquid radiation monitor 2R19D was declared out of service on 8/29/2017. It was returned to service 01/16/2018. The 2R19D Steam Generator Blowdown radiation monitor was not corrected in a timely manner due to failure of the new replacement detector during repair of the 2R19D radiation monitor. A new sample chamber and detector were installed during the 30 day ODCM action statement but the detector failed immediately upon powering up. The old detector was sent back to the vendor for refurbishment and was installed and retested satisfactorily following repair. The required compensatory sampling had been performed (CAP 20774247, 20775434, and 20776147).

5. Steam Generator Blowdown Flow Measurement Device 2FA3178 for Steam Generator Blowdown Flow Loop 21 was declared out of service on 7/7/2017 (CAP 20769938 and 20772779). It was returned to service on 8/9/2017. The 21 Steam Generator Blowdown Flow Loop had a calibration performed in accordance with Surveillance Test 50182618 on 07/07/2017. While performing the 18 month calibration, the instrument equalizing valve for S2GBD-2FA3178 (21 Steam Generator Drain and Blowdown Outlet to Blowdown Tank Flow Meter) transmitter was indicated to be difficult to operate with minor leakage observed from the packing. When returning the 2FA3178 transmitter back to service, the equalizing valve would not seat. As such, control room indication was not returned to normal, declaring the 21 Steam Generator Blowdown Loop inoperable. CAP 20769938 was generated to document the described condition and corrective maintenance order 60135561 was created and planned to have the equalizing valve replaced.

   It was discovered that the existing valve was to be replaced was obsolete. The "new" replacement valve for the obsolete part had a long lead time and Procurement Engineering was requested to prepare an evaluation for a Swagelok valve in stock as a suitable replacement. Both the original and replacement manifolds were of a similar 3 valve construction and performed in the same manner. Due to some concern about the suitability of the Teflon packing the station opted for a valve with Grafoil packing.

   Once all the proper paperwork was complete for the new part, the valve was replaced on 08/09/2018, and the 21 Steam Generator Blowdown Flow Loop was declared operable. The required compensatory actions were performed.

6. Due to numerous issues related to the availability of radiation monitoring instrumentation SGS management chartered the Radiation Monitoring System Performance Team to improve the reliability of required instrumentation.

C. HCGS:

None

11. Elevated Gaseous Radiation Monitor Responses

During the 2017 reporting period, none of the effluent radiation monitors elicited an elevated response during the discharge of liquid and gaseous effluent from either of the SGS Units 1 and 2 or from the HCGS.

12. Independent Spent Fuel Storage Installation (ISFSI)

There have been no gaseous or liquid releases from the Independent Spent Fuel Storage Installation (ISFSI) since it was placed in service in the summer of 2006. The direct dose from the ISFSI pad to the Critical Receptor located at 4.6 miles in the SW sector, Members of the Public and personnel not having access to the Radiologically Controlled Area (RCA) was determined using the dosimetry results from the 2017 Radiological Environmental Monitoring Program (REMP) and the formula provided in ANSI/HPS N13.37-2014 as follows:

$$D_2 = OF * \left(\left(D_1 * R_1^{\,2} \right) / R_2^{\,2} \right)$$

Where:

D_1 = Dose that was measured from TLD Location 16S2

D_2 = Dose that will be extrapolated to Security Checkpoint, Sewage Treatment Plant (STP) and Critical Receptor

R_1 = Distance from the source to the location where D1 was obtained

R_2 = Distance to the location that dose will be extrapolated

OF = Occupancy Factor (1 = full time, 0.25 = 2000 hrs.)

Location Of Extrapolated Dose	R_1 *(ft.)* *Distance from ISFSI to TLD 16S2*	R_2 *(ft.)* *Distance from ISFSI to Location*	D_1 *(mrem)* *Net Dose of TLD 16S2* D_1 = A - B	A Gross Annual Dose at 16S2 *(mrem)*	B Background Dose at 16S2 *(mrem)*	OF Occupancy Factor	D_2 *(mrem)* Extrapolated Dose for Location
Security Checkpoint	203	6,275	58.3	112.9	54.6	0.25	**1.51E-02**
STP	203	575	58.3	112.9	54.6	0.25	**1.80E+00**
Critical Receptor	203	24,288	58.3	112.9	54.6	1.00	**4.04E-03**
Nearest Resident	203	19,536	58.3	112.9	54.6	1.00	**6.25E-03**

13. Effluent Trends

The following trend graphs displays the total curies of liquid and gaseous effluents released for SGS and HCGS from 2005 through 2017.

Figure 1
Fision and Activation Gases Released in Gaseous Effluents, Salem Unit 1, Salem Unit 2 and Hope Creek Unit 1, 2005 -2017

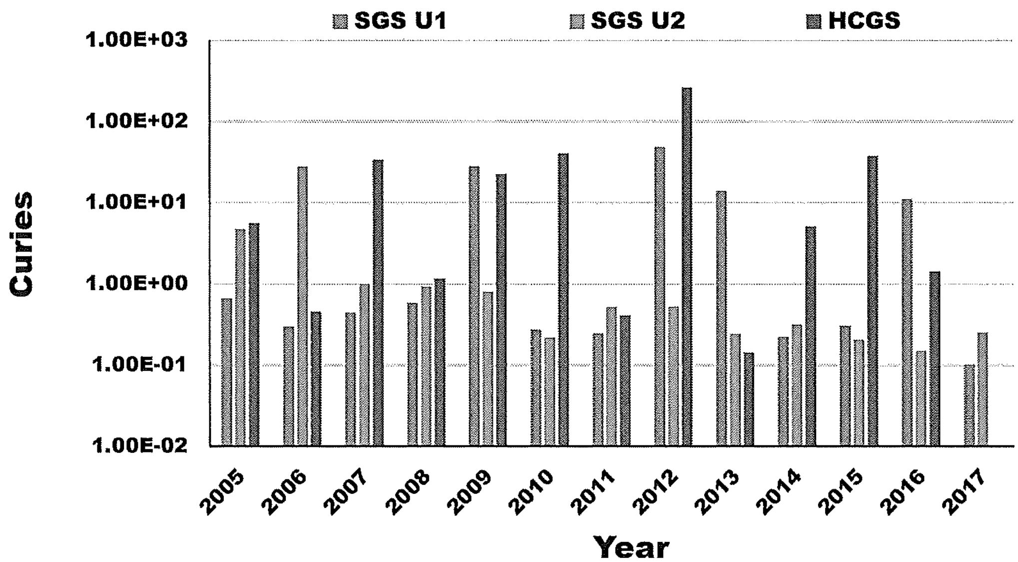


Figure 2
Iodines Released in Gaseous Effluents, Salem Unit 1, Salem Unit 2 and Hope Creek Unit 1, 2005 - 2017

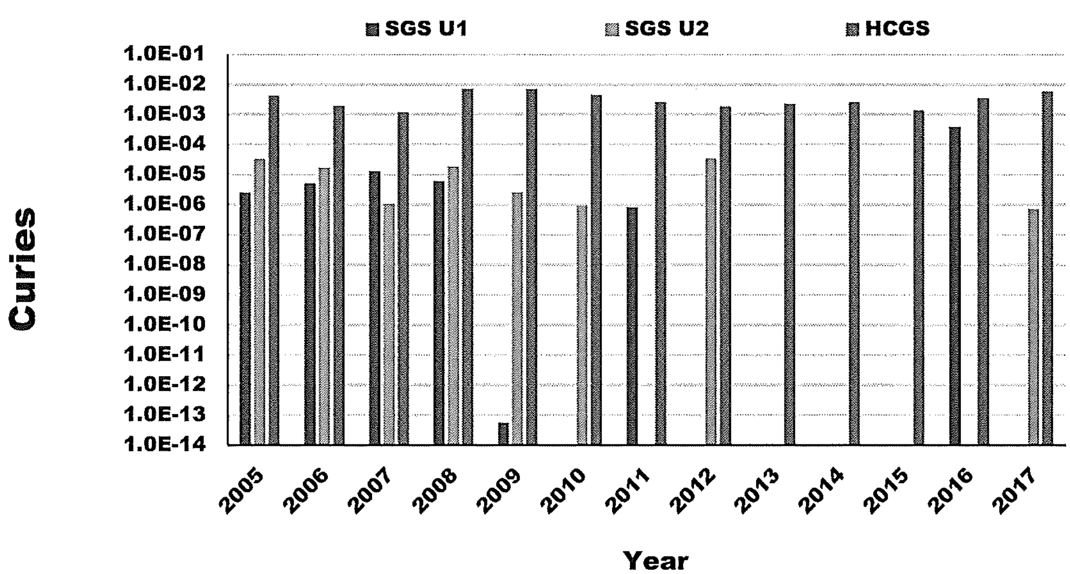


Figure 3
Particulates Released in Gaseous Effluents,
Salem Unit 1, Salem Unit 2 and Hope Creek Unit 1,
2005 - 2017

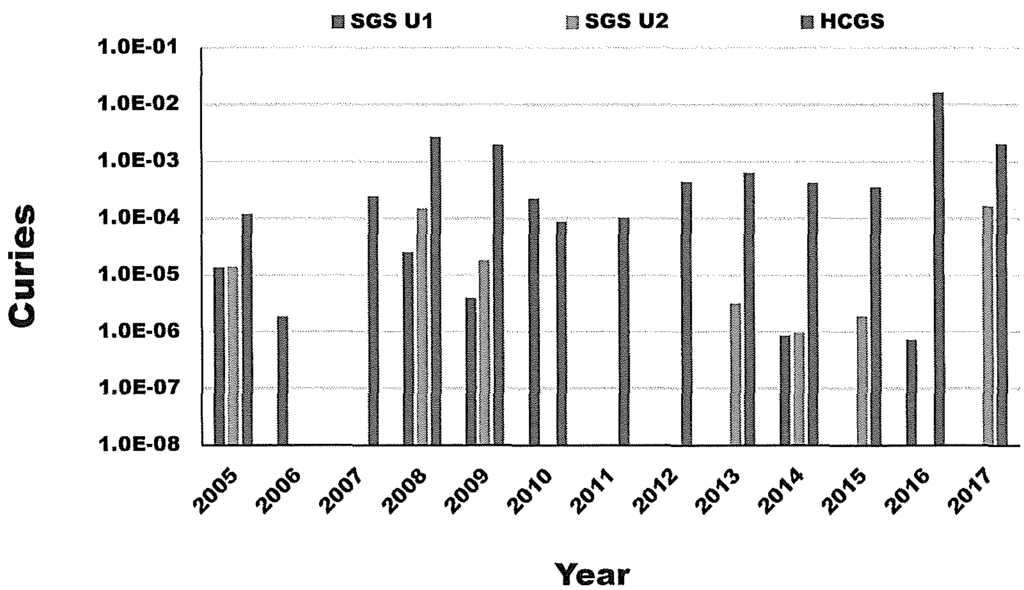


Figure 4
Tritium Released in Gaseous Effluents,
Salem Unit 1, Salem Unit 2 and Hope Creek Unit 1,
2005 - 2017

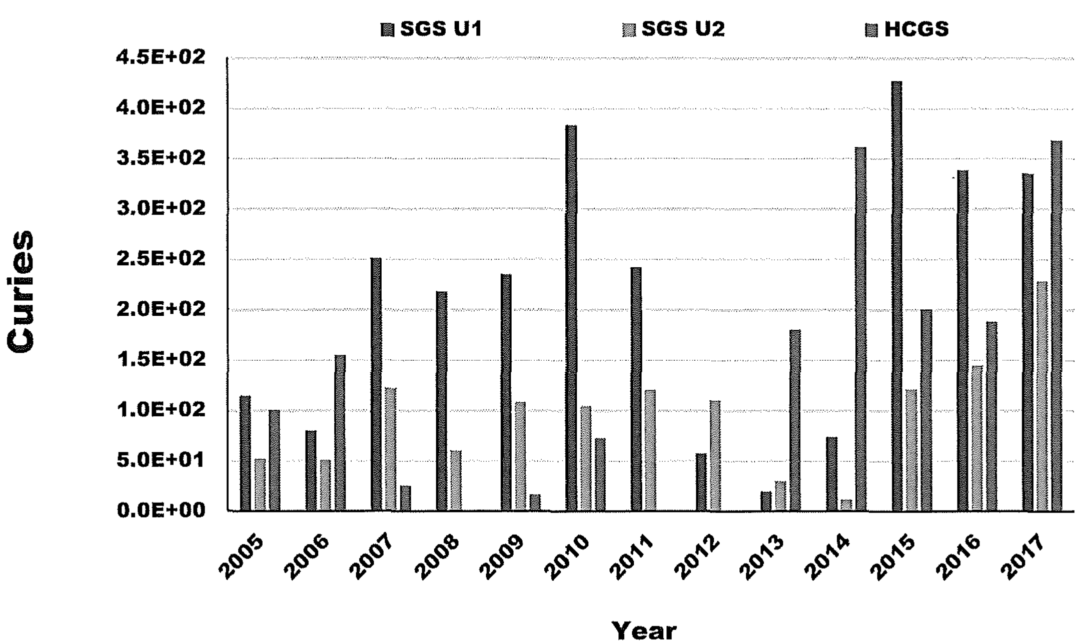


Figure 5
Fission and Activation Products Released in Liquid Effluents, Salem Unit 1, Salem Unit 2 and Hope Creek Unit 1, 2005 - 2017

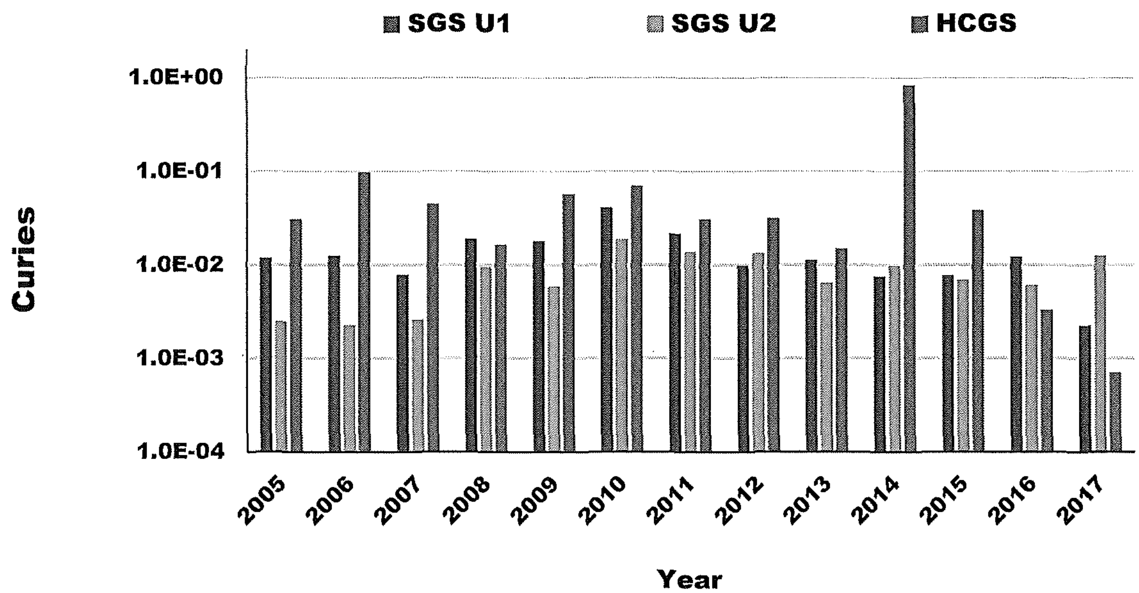
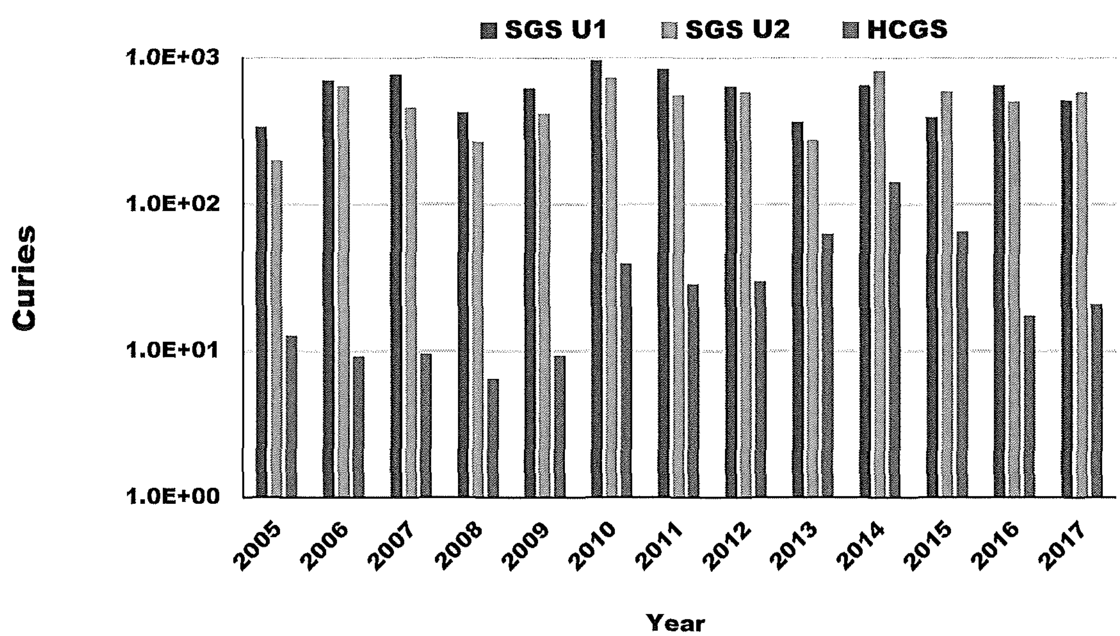


Figure 6
Tritium Released in Liquid Effluents, Salem Unit 1, Salem Unit 2 and Hope Creek Unit 1, 2005 - 2017



14. Carbon-14 in Gaseous Effluents

The NRC has identified Carbon-14 (C-14) as a potential principal radionuclide for gaseous effluent (refer to Regulatory Position 1.9 in Revision 2 of Regulatory Guide 1.21). Since the publication of Regulatory Guide 1.21, "*Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste*", Revision 1, June 1974, the radioactive effluents from commercial nuclear power plants have decreased to the point that C-14 was likely to be a principal radionuclide in gaseous effluents. Gaseous effluent releases from a boiling water reactor (BWR), such as the HCGS, and pressurized water reactor (PWR), such as the SGS Units 1 and 2, can contain significant quantities of C-14, the NRC has recommended that licensees evaluate C-14 as a potential principal radionuclide for gaseous releases from their facility. Those evaluations have determined that C-14 was a "principal radionuclide" in gaseous effluent from each of the three stations.

The assessment methodology used to estimate the quantity of C-14 discharged in gaseous effluent from the SGS and HCGS involved the use of a normalized C-14 source term and scaling factors based on power generation from EPRI Technical Report 1021106, "*Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents*", December 2010. This method was selected based on guidance offered in Regulatory Guide 1.21, and incorporates dose models described in Regulatory Guide 1.109, "*Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I*", Revision 1, October 1977.

The following assumptions were incorporated into the method:

- Only C-14 in the form of CO_2 was incorporated into vegetation through photosynthesis, which causes dose via the ingestion exposure pathways.
- The concentration of C-14 in vegetation was proportional to the concentration of C-14 in air (per equation C-8 in Regulatory Guide 1.109).
- 95% of C-14 released from a BWR (i.e., HCGS) and 30% of C-14 released from a PWR (i.e., SGS Units 1 and 2) was in the form of CO_2 (EPRI Technical Report 1021106).

Using scaling factors and 2017 power generation data, the estimated total C-14 released in 2017 was 10.54 Ci from SGS Unit 1, 9.96 Ci from SGS Unit 2, and 18.19 Ci from the HCGS.

The calculated dose contribution of C-14 was determined using the methodology detailed in the HCGS's and SGS's ODCMs. The calculated maximum total body and organ (bone) doses from C-14 occurred for a child receptor at 4.6 miles SW (Table 1) using the pathways of inhalation, meat and vegetation. The calculated doses from the estimated C-14 in gaseous effluents represent about 100% of the total bone dose from both SGS and HCGS.

Table 1
Quarterly and Annual Bone Doses from Radioactive Gaseous Effluent Releases from the Site to the Critical Receptor (Child) and Pathway (Inhalation, Meat, Food Products and Ground Shine) 2017.

Bone Dose from Other Radionuclides (mrem)	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Total**
SGS Unit 1	0.00E+00	0.00E+00	0.00E+00	3.43E-08	3.43E-08
SGS Unit 2	0.00E+00	2.37E-05	0.00E+00	0.00E+00	2.37E-05
HCGS	2.41E-06	3.65E-07	3.78E-07	3.13E-07	3.46E-06
Total Dose from Other Radionuclides (mrem)	**2.41E-06**	**2.41E-05**	**3.78E-07**	**3.47E-07**	**2.72E-05**
Bone Dose from C-14 (mrem)	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Total**
SGS Unit 1	2.71E-02	2.71E-02	2.74E-02	2.74E-02	1.09E-01
SGS Unit 2	2.56E-02	2.56E-02	2.59E-02	2.59E-02	1.03E-01
HCGS	4.66E-02	4.72E-02	4.70E-02	4.68E-02	1.88E-01
Total Dose from C-14 (mrem)	**9.94E-02**	**9.94E-02**	**1.01E-01**	**1.01E-01**	**3.99E-01**
Total Dose From All Nuclides (mrem)	**9.94E-02**	**9.94E-02**	**1.01E-01**	**1.01E-01**	**3.99E-01**
Percent of dose from C-14	100.00%	99.98%	100.00%	100.00%	99.99%

15. Modification to Previous Radioactive Effluent Release Reports - Errata Data Section

None

IV. Radiological Impact on Man

1. Effluent Doses

The doses from liquid and gaseous effluent represent the maximum potential radiation dose for a member of the general public following the methodology in the station's ODCM and reported by the SGS's EMS database program and HCGS's OpenEMS database program.

The annual doses presented in the tables below represent calculations for the four quarters of 2017. The radiological impacts from liquid and gaseous effluent discharges from SGS Units 1 and 2 and HCGS are presented in Tables 2 and 3, respectively, and demonstrate compliance with applicable regulatory limits. Dose limit values presented in bold font are regulatory limits. The quarterly doses must not exceed the quarterly limit in any quarter and the summation of two or more quarterly doses must not exceed the annual dose limit.

A. Doses from Liquid Effluent:

Quarterly and Annual Total Body and Critical Organ doses from liquid effluent were calculated using the methodology described in the SGS and HCGS ODCMs at the controlling receptor location of 0.75 miles N of SGS. Usage factors and dose conversion factors used in the liquid dose calculations were those presented in the SGS and HCGS ODCMs.

Table 2
2017 Doses and Percent of the Limits from Liquid Effluents by Operating Unit

HCGS					
Liquid Effluent Parameter	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Annual**
***Total Body Dose Limit* (mrem)**	**1.50E+00**				**3.00E+00**
Maximum Total Body Dose (mrem)	1.77E-05	1.71E-05	4.38E-05	7.83E-06	8.65E-05
% Dose Limit	1.18E-03	1.14E-03	2.92E-03	5.22E-04	2.88E-03
Organ Dose Limit (mrem)	**5.00E+00**				**1.00E+01**
Maximum Organ Dose (mrem)	6.34E-05	2.15E-05	1.19E-04	8.15E-06	2.12E-04
% Dose Limit	1.27E-03	4.29E-04	2.38E-03	1.63E-04	2.12E-03

Table 2
2017 Doses and Percent of the Limits from Liquid Effluents by Operating Unit (continued)

SGS Unit 1					
Liquid Effluent Parameter	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Annual**
Total Body Dose Limit (mrem)	**1.50E+00**				**3.00E+00**
Maximum Total Body Dose (mrem)	5.83E-06	9.64E-06	8.77E-07	7.59E-06	2.31E-05
% Dose Limit	3.88E-04	6.43E-04	5.84E-05	5.06E-04	7.69E-04
Organ Dose Limit (mrem)	**5.00E+00**				**1.00E+01**
Maximum Organ Dose (mrem)	6.91E-06	9.90E-06	9.86E-07	9.58E-06	2.64E-05
% Dose Limit	1.38E-04	1.98E-04	1.97E-05	1.92E-04	2.64E-04

SGS Unit 2					
Liquid Effluent Parameter	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Annual**
Total Body Dose Limit (mrem)	**1.50E+00**				**3.00E+00**
Maximum Total Body Dose (mrem)	4.60E-06	3.26E-05	2.23E-06	6.06E-06	4.33E-05
% Dose Limit	3.07E-04	2.18E-03	1.48E-04	4.04E-04	1.44E-03
Organ Dose Limit (mrem)	**5.00E+00**				**1.00E+01**
Maximum Organ Dose (mrem)	5.94E-06	9.01E-05	4.85E-06	8.66E-06	1.05E-04
% Dose Limit	1.19E-04	1.80E-03	9.71E-05	1.73E-04	1.05E-03

SGS Units 1&2 + HCGS Site Total					
Liquid Effluent Parameter	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Annual**
Total Body Dose Limit (mrem)	**4.50E+00**				**9.00E+00**
Maximum Total Body Dose (mrem)	2.81E-05	5.93E-05	4.69E-05	2.15E-05	1.53E-04
% Dose Limit	6.25E-04	1.32E-03	1.04E-03	4.77E-04	1.70E-03
Organ Dose Limit (mrem)	**1.50E+01**				**3.00E+01**
Maximum Organ Dose (mrem)	7.63E-05	1.22E-04	1.25E-04	2.64E-05	3.43E-04
% Dose Limit	5.08E-04	8.10E-04	8.32E-04	1.76E-04	1.14E-03

B. Doses from Gaseous Effluent using Default Conservative Meteorology:

Quarterly doses from gaseous effluent were calculated using the methodology described in the SGS and HCGS ODCMs. Usage factors and dose conversion factors used in the gaseous dose calculations were those presented in the SGS and HCGS ODCMs.

The individual doses from radioactive gaseous effluents (presented in Table 3) were calculated for the controlling locations described in the SGS and HCGS ODCMs using the methodology in the ODCMs by the SGS's EMS and the HCGS OpenEMS database programs. The dose contribution from C-14 was determined by manual calculations for SGS 1 and 2 and OpenEMS for HCGS using the methodology listed in the stations' ODCMs and added to the appropriate organ from the EMS or OpenEMS printouts.

Table 3
2017 Doses and Percent of the Limits from Gaseous Effluents by Operating Unit

HCGS							
Gaseous Effluent Parameter			Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Annual
Gaseous Dose From Noble Gas	Gamma Air	**Dose Limit** (mrad)	5.00E+00				1.00E+01
		Max Gamma Air Dose (mrad)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		% Dose Limit	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Beta Air	**Dose Limit** (mrad)	1.00E+01				2.00E+01
		Maximum Beta Air Dose (mrad)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		% Dose Limit	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gaseous Dose From I-131, I-133, H-3, C-14* and Particulate Nuclides with half-life > 8 Days		**Organ Dose Limit** (mrem)	7.50E+00				1.50E+01
	* without C-14 Dose	ODCM Critical Receptor (mrem)	2.41E-06	3.65E-07	3.78E-07	3.13E-07	3.46E-06
		% Dose Limit	3.21E-05	4.87E-06	5.04E-06	4.17E-06	2.31E-05
	* with C-14 Dose	ODCM Critical Receptor (mrem)	4.67E-02	4.67E-02	4.72E-02	4.72E-02	1.87E-01
		% Dose Limit	6.23E-01	6.23E-01	6.30E-01	6.30E-01	1.25E+00

Table 3
2017 Doses and Percent of the Limits from Gaseous Effluents by Operating Unit (cont.)

SGS Unit 1							
Gaseous Effluent Parameter			Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Annual
Gaseous Dose From Noble Gas	Gamma Air	Dose Limit (mrad)	5.00E+00				1.00E+01
		Max Gamma Air Dose (mrad)	1.39E-05	2.46E-07	1.51E-05	8.69E-06	3.79E-05
		% Dose Limit	2.77E-04	4.93E-06	3.02E-04	1.74E-04	3.79E-04
	Beta Air	Dose Limit (mrad)	1.00E+01				2.00E+01
		Maximum Beta Air Dose (mrad)	5.32E-06	1.05E-07	5.33E-06	5.58E-6	1.63E-05
		% Dose Limit	5.32E-05	1.05E-06	5.33E-05	5.58E-05	8.17E-05
Gaseous Dose From I-131, I-133, H-3, C-14* and Particulate Nuclides with half-life > 8 Days		Organ Dose Limit (mrem)	7.50E+00				1.50E+01
	* without C-14 Dose	ODCM Critical Receptor (mrem)	1.76E-04	4.99E-04	5.98E-04	4.70E-04	1.74E-03
		% Dose Limit	2.35E-03	6.65E-03	7.98E-03	6.27E-03	1.16E-02
	* with C-14 Dose	ODCM Critical Receptor (mrem)	2.71E-02	2.71E-02	2.74E-02	2.74E-02	1.09E-01
		% Dose Limit	3.61E-01	3.61E-01	3.65E-01	3.65E-01	7.24E-01

SGS Unit 2							
Gaseous Effluent Parameter			Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Annual
Gaseous Dose From Noble Gas	Gamma Air	Dose Limit (mrad)	5.00E+00				1.00E+01
		Max Gamma Air Dose (mrad)	2.88E-05	5.57E-06	2.29E-05	3.60E-05	9.33E-05
		% Dose Limit	5.75E-04	1.11E-04	4.59E-04	7.20E-04	9.33E-04
	Beta Air	Dose Limit (mrad)	1.00E+01				2.00E+01
		Maximum Beta Air Dose (mrad)	1.05E-05	6.73E-06	9.22E-06	1.49E-05	4.14E-05
		% Dose Limit	1.05E-04	6.75E-05	9.22E-05	1.49E-04	2.07E-04
Gaseous Dose From I-131, I-133, H-3, C-14* and Particulate Nuclides with half-life > 8 Days		Organ Dose Limit (mrem)	7.50E+00				1.50E+01
	* without C-14 Dose	ODCM Critical Receptor (mrem)	4.58E-04	5.39E-04	9.25E-05	1.26E-04	1.22E-03
		% Dose Limit	6.11E-03	7.19E-03	1.23E-03	1.67E-03	8.10E-03
	* with C-14 Dose	ODCM Critical Receptor (mrem)	2.56E-02	2.56E-02	2.59E-02	2.59E-02	1.03E-01
		% Dose Limit	3.41E-01	3.42E-01	3.45E-01	3.45E-01	6.85E-01

Table 3
2017 Doses and Percent of the Limits from Gaseous Effluents by Operating Unit (cont.)

SGS-HCGS Site Total							
Gaseous Effluent Parameter			Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Annual
Gaseous Dose From Noble Gas	Gamma Air	**Dose Limit** (mrad)	1.50E+01				3.00E+01
		Max Gamma Air Dose (mrad)	4.27E-05	5.82E-06	3.80E-05	4.47E-05	1.31E-04
		% Dose Limit	2.85E-04	3.88E-05	2.53E-04	2.98E-04	4.37E-04
	Beta Air	**Dose Limit** (mrad)	3.00E+01				6.00E+01
		Maximum Beta Air Dose (mrad)	1.58E-05	6.84E-06	1.46E-05	2.05E-05	5.77E-05
		% Dose Limit	5.27E-05	2.28E-05	4.85E-05	6.83E-05	9.61E-05
Gaseous Dose From I-131, I-133, H-3, C-14* and Particulate Nuclides with half-life > 8 Days		**Organ Dose Limit** (mrem)	2.25E+01				4.50E+01
	* without C-14 Dose	ODCM Critical Receptor (mrem)	6.36E-04	1.04E-03	6.91E-04	5.96E-04	2.96E-03
		% Dose Limit	2.83E-03	4.61E-03	3.07E-03	2.65E-03	6.58E-03
	* with C-14 Dose	ODCM Critical Receptor (mrem)	9.94E-02	9.94E-02	1.01E-01	1.01E-01	3.99E-01
		% Dose Limit	4.42E-01	4.42E-01	4.47E-01	4.47E-01	8.86E-01

C. <u>Doses from Gaseous Effluent using Annual Average Meteorology</u>:

As a check on the use of conservative historical meteorological dispersion (*X*/Q) and deposition values (D/Q), the 2017 gaseous release curies (Tables 2C-1, 2C-2 and 2C-3) for each of the three units and the 2017 annual average dispersion and deposition data (Table 4) were used to calculate doses to the critical receptors and pathways identified by the 2017 Land Use Census (LUC) using the NRC approved GASPAR computer program. The methods used to determine gaseous doses were consistent with the methods described in SGS and HCGS ODCMs and in NRC Regulatory Guide 1.109. The 2017 LUC did not identify any gardens greater than 500 ft^2 within five miles producing broadleaf vegetation; however, that pathway was included in the dose analysis. Using the 2017 meteorology data the calculated doses were lower than that reported in Table 3 that used the conservative ODCM default meteorology (Table 5).

Table 4
2017 Annual Average Undepleted X/Q, Depleted X/Q and D/Q and Active Exposure Pathways

Receptor Location	Un-depleted X/Q (sec./m^3)	Depleted X/Q (sec./m^3)	D/Q (1/m^2)	Active Exposure Pathways
HCGS Site- Boundary (0.5 mi N)	1.4E-06	1.3E-06	1.0E-08	Plume Immersion, Ground Deposition, Inhalation
SGS Site-Boundary (0.83 mi N)	6.6E-07	5.9E-07	4.4E-09	Plume Immersion, Ground Deposition, Inhalation
ODCM Dairy (4.9mi W)	6.7E-08	5.0E-08	1.5E-10	Plume Immersion, Ground Deposition, Inhalation, Milk Ingestion
Resident (3.7mi NW)	1.5E-07	1.2E-07	5.7E-10	Plume Immersion, Ground Deposition, Inhalation
Resident-Garden (4.4mi WSW)	9.5E-08	7.2E-08	2.4E-10	Plume Immersion, Ground Deposition, Inhalation Vegetable Ingestion
Resident-Meat (4.2mi NNE)	7.6E-08	5.8E-08	3.1E-10	Plume Immersion, Ground Deposition, Inhalation, Meat Ingestion
Resident-Garden-Meat (4.6mi SW)	9.0E-08	6.8E-08	2.6E-10	Plume Immersion, Ground Deposition, Inhalation, Meat Ingestion, Vegetable Ingestion

Figure 7

Locations of Dose Calculation Receptors with 2017 Wind Rose Overlay

Note: Wind rose depicts fraction of time wind transports gaseous effluents from each of the sixteen compass sectors.

Table 5
2017 Total Body and Critical Organ Doses at Receptor Locations Using Annual Average X/Q and D/Q Data by Operating Unit

Operating Unit	ODCM Site Boundary Critical Organ Doses Inhalation, Ground Plane (0.5 / 0.8 mi N)			
	Excluding C-14		Including C-14	
	Organ (mrem)	Total Body (mrem)	Organ (mrem)	Total Body (mrem)
SGS Unit 1	5.68E-03	5.68E-03	5.68E-03	5.68E-03
SGS Unit 2	4.12E-03	4.02E-03	4.12E-03	4.02E-03
HCGS	1.30E-02	1.20E-02	1.30E-02	1.20E-02
Site Total	**2.28E-02**	**2.17E-02**	**2.28E-02**	**2.17E-02**
Operating Unit	**ODCM Dairy Critical Organ Doses** Inhalation, Ground Plane, Milk (4.9 mi W)			
	Excluding C-14		Including C-14	
	Organ (mrem)	Total Body (mrem)	Organ (mrem)	Total Body (mrem)
SGS Unit 1	1.38E-03	1.38E-03	7.26E-02	1.69E-02
SGS Unit 2	8.71E-04	8.67E-04	6.89E-02	1.56E-02
HCGS	2.89E-03	1.37E-03	1.26E-01	2.83E-02
Site Total	**5.14E-03**	**3.62E-03**	**2.68E-01**	**6.08E-02**
Operating Unit	**Nearest Resident Critical Organ Doses** Inhalation, Ground Plane (3.7 mi NW)			
	Excluding C-14		Including C-14	
	Organ (mrem)	Total Body (mrem)	Organ (mrem)	Total Body (mrem)
SGS Unit 1	1.29E-03	1.29E-03	1.29E-03	1.29E-03
SGS Unit 2	8.76E-04	8.61E-04	8.76E-04	8.61E-04
HCGS	1.38E-03	1.28E-03	1.38E-03	1.28E-03
Site Total	**3.54E-03**	**3.43E-03**	**3.54E-03**	**3.43E-03**
Operating Unit	**Resident - Garden Critical Organ Doses** Inhalation, Ground Plane, Vegetation (4.4 mi WSW)			
	Excluding C-14		Including C-14	
	Organ (mrem)	Total Body (mrem)	Organ (mrem)	Total Body (mrem)
SGS Unit 1	3.32E-03	3.32E-03	1.12E-01	2.57E-02
SGS Unit 2	2.07E-03	2.07E-03	1.06E-01	2.33E-02
HCGS	3.88E-03	3.25E-03	1.92E-01	4.16E-02
Site Total	**9.28E-03**	**8.64E-03**	**4.10E-01**	**9.06E-02**

Table 5

2017 Total Body and Critical Organ Doses at Receptor Locations Using Annual Average X/Q and D/Q Data by Each Operating Unit (continued)

Operating Unit	Meat Critical Organ Doses Inhalation, Ground Plane, Meat 4.2 mi NNE			
	Excluding C-14		Including C-14	
	Organ (mrem)	Total Body (mrem)	Organ (mrem)	Total Body (mrem)
SGS Unit 1	8.17E-04	8.17E-04	1.35E-02	3.40E-03
SGS Unit 2	5.46E-04	5.38E-04	1.28E-02	3.03E-03
HCGS	8.48E-04	7.97E-04	2.31E-02	5.31E-03
Site Total	**2.21E-03**	**2.15E-03**	**4.94E-02**	**1.17E-02**

Operating Unit	Meat - Garden Critical Organ Doses Inhalation, Ground Plane, Meat, Vegetation 4.6 mi SW			
	Excluding C-14		Including C-14	
	Organ (mrem)	Total Body (mrem)	Organ (mrem)	Total Body (mrem)
SGS Unit 1	3.30E-03	3.30E-03	1.22E-01	2.77E-02
SGS Unit 2	2.06E-03	2.05E-03	1.16E-01	2.52E-02
HCGS	3.90E-03	3.22E-03	2.09E-01	4.50E-02
Site Total	**9.26E-03**	**8.57E-03**	**4.48E-01**	**9.79E-02**

As set forth in 10CFR50 Appendix I ALARA requirement for gaseous effluent was met if a licensee demonstrates that the estimated annual external dose from gaseous effluent to any individual in unrestricted areas does not exceed 5 mrem to the total body or 15 mrem to the skin. Compliance with these limits was demonstrated for 2017 gaseous effluents by the calculated total body and skin doses from external exposure pathways (i.e., plume and ground deposition) at the controlling site boundary location in the north sector. The calculated total body dose and skin dose from the combined gaseous releases for the site represent less than 0.43% (Total Body) and less than 0.15% (Organ) of the respective dose limits (Table 5 Site Boundary Location). This confirms that no single unit's radioactive gaseous effluent releases exceeded the Appendix I dose limits. These doses (presented below) were calculated using the GASPAR computer program, which was consistent with the methods described in Regulatory Guide 1.109.

Dose Parameter from Table 5 Site Boundary	Annual Dose (mrem)
Total Body Dose from Noble Gases, Iodines, Particulates, H-3 and C-14:	2.17E-02
Percent of Appendix I Annual Limit (5 mrem):	0.43%
Skin Dose from Noble Gases, Iodines, Particulates, H-3 and C-14:	2.28E-02
Percent of Appendix I Annual Limit (15 mrem):	0.15%

2. Total Dose to a Member of the Public, Resulting from Radioactive Effluent Releases and Radiation from Uranium Fuel Cycle Sources

40 CFR 190 and 10 CFR 72.104 limit the total dose to a "Real Individual" to 25 mrem to the total body, 75 mrem to the thyroid and 25 mrem to other organs other than the thyroid. The maximum annual total body and organ doses from gaseous and liquid pathways with all other uranium fuel cycle sources present on site were calculated as required by section 3.11.4 of the SGS and HCGS ODCMs. The direct dose from the ISFSI pad was determined using the Radiological Environmental Monitoring Program (REMP) and the guidance provided in ANSI/HPS N13.37-2014 (see page 12).

The direct shine dose from the ISFSI to the Critical Receptor located at 4.6 miles in the SW sector was conservatively estimated at 4.18E-03 mrem. The doses from the gaseous and liquid radioactive effluents released from SGS Units 1 and Unit 2 and HCGS in 2017 resulted in a calculated total body and an organ dose of 8.51E-02 mrem and 3.99E-01mrem, respectively. The majority of dose was from the gaseous dose pathways from C-14. The total dose was calculated as 4.88E-01mrem, which was below the limits of 40 CFR 190 and 10 CFR 72.104. The results of this analysis are in Table 6.

Table 6

2017 Total Body and Organ Doses due to Liquid and Gaseous Effluents and Direct Shine ISFSI Dose to the Critical Receptor Located at 4.6 miles SW

Generating Station	Total Body Dose (mrem)		Critical Organ Dose (mrem)		ISFSI (mrem)
	Liquid	Gaseous*	Liquid	Gaseous*	
SGS Unit 1	2.31E-05	2.35E-02	2.64E-05	1.09E-01	
SGS Unit 2	4.33E-05	2.13E-02	1.05E-04	1.03E-01	
HCGS	8.65E-05	4.01E-02	2.12E-04	1.87E-01	
Total	1.53E-04	8.49E-02	3.43E-04	3.99E-01	
Total of Liquid and Gaseous (mrem)	**8.51E-02**		**3.99E-01**		**4.04E-03**
Total Dose (mrem)	**4.88E-01**				

* Includes C-14 dose.

3. Dose to Members of the Public Due to Activities Inside the Site Boundary

Members of the Public may receive up to a limit of 100 mrem Total Effective Dose Equivalent (TEDE) in a year in accordance with 10 CFR 20.1301. The TEDE dose is the combined organ Committed Dose Equivalent (CDE) and the Total Body Dose. The Total Body Dose includes the direct shine dose from the ISFSI pad. There are no liquid or airborne releases from the ISFSI. The dose from radioactive liquid and gaseous effluents to a Member of the Public performing activities inside the site boundary are to be calculated as required by ODCM 6.9.1.8 (SGS) and 6.9.1.7 (HCGS).

Two sets of TEDE doses were calculated to two different members of the public. The first TEDE dose calculation assumes that an adult emergency worker (i.e. National Guard, Police, etc.) was located at the site vehicle Security Checkpoint entrance. The second calculation was to an adult contract worker stationed at the sewage treatment plant (STP). Both sets of members of the public have assigned duties that do not involve exposure to radiation or to radioactive material. Neither group have Radiation Control Access. In addition exposure time was limited to 2000 hours in a year (0.25 occupancy).

The vehicle Security Checkpoint was located at 0.89 miles E from the gaseous release points for SGS Units 1 and 2 and 0.94 miles E from the HCGS and 1.18 miles from the ISFSI. The STP workers were located about 575 feet from the ISFSI pad.

The active exposure pathways at both locations were plume immersion, ground deposition and inhalation of airborne radioactivity in gaseous effluent. There was no liquid dose pathway to Members of the Public on site.

The 2016 atmospheric dispersion factors were imputed into the GASPAR computer program to calculate the gaseous effluent doses. For purposes of these calculations the gaseous doses for the STP worker used the highest site boundary sector doses located in the SW sector.

The calculated TEDE dose from gaseous effluents from the three reactors for each location was calculated by summing the total body and highest organ doses from SGS U1, SGS U2 and HCGS. The ISFSI dose was then added to each and then compared to the 10 CFR 20.1301 limit of 100 mrem. The results were as follows:

Table 7

Summary of TEDE doses to Members of the Public Due to Activities Inside the Site Boundary

Location	Operating Unit	CDE (Thyroid) mrem	Total Body Dose mrem	TEDE mrem	% of Limit (100 mrem) per 10 CFR 20.1301
Security Checkpoint	SGS U1	1.36E-03	1.36E-03		
	SGS U2	9.96E-04	9.96E-04		
	HCGS	1.31E-03	1.23E-03		
	ISFSI	N/A	1.51E-02		
	Total	3.67E-03	1.87E-02	2.24E-02	0.02%
STP	SGS U1	5.96E-02	5.96E-02		
	SGS U2	2.49E-02	2.49E-02		
	HCGS	1.88E-02	1.72E-02		
	ISFSI	N/A	1.80E+00		
	Total	1.03E-01	1.91E+00	2.01E+00	2.01%

The calculated doses were well below the 100 mrem limit of 10 CFR 20.1301.

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APPENDIX A-1

Effluent and Waste Disposal Summary, SGS Unit 1

List of Tables

TABLE 1A-1

LIQUID EFFLUENTS – SUMMATION OF ALL RELEASES

Facility: SGS Unit 1 Period: 2017

A. Fission & Activation Products	Unit	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total	Est. Total Error %
1. Total Release (not including tritium, gases & alpha)	Ci	1.03E-03	2.89E-04	1.49E-04	7.79E-04	2.25E-03	2.70E+01
2. Average diluted concentration during period	µCi/ml	2.15E-12	5.91E-13	2.92E-13	2.26E-12	1.23E-12	
3. Percent of applicable limit (ODCM 3.11.1(a) & (b))	Total Body % Organ %	See Table 2 on page 18					
B. Tritium							
1. Total List	Ci	1.35E+02	2.39E+02	3.19E+01	1.08E+02	5.14E+02	2.70E+01
2. Average diluted concentration during period	µCi/ml	2.83E-07	4.88E-07	6.23E-08	3.14E-07	2.82E-07	
3. Percent of applicable limit (ODCM 3.11.1(a) & (b))	Total Body % Organ %	See Table 2 on page 18					
C. Dissolved & Entrained Gases							
1. Total Release	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	2.70E+01
2. Average diluted concentration during period	µCi/ml	< LLD	< LLD	< LLD	< LLD	< LLD	
3. Percent of applicable limit (ODCM 3.11.1.1)	%	N/A	N/A	N/A	N/A	N/A	
D. Gross Alpha Activity							
Total Release	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	2.70E+01
E. Volume Of Waste Released (prior to dilution)	Liters	8.35E+07	7.40E+07	4.55E+07	4.52E+07	2.48E+08	
F. Volume Of Dilution Water Used During Period	Liters	4.78E+11	4.89E+11	5.11E+11	3.44E+11	1.82E+12	

N/A Not Applicable

TABLE 1B-1

LIQUID EFFLUENTS

Facility: SGS Unit 1 Period: 2017

Nuclides Released	Unit	Continuous Mode					Batch Mode				
		Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total
H-3	Ci	7.12E-01	7.60E-01	1.78E-01	8.86E-02		1.35E+02	2.38E+02	3.17E+01	1.08E+02	5.13E+02
Fission & Activation Products											
Na-24	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	6.47E-06	< LLD	< LLD	6.47E-06
Mn-54	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	1.76E-5	1.76E-05
Co-58	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	2.71E-04	1.13E-04	6.65E-05	5.67E-04	1.02E-03
Co-60	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	1.47E-04	5.44E-05	3.38E-05	1.36E-04	3.71E-04
Sb-124	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	1.97E-05	< LLD	< LLD	1.97E-05
Sb-125	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	5.98E-04	9.46E-05	4.91E-05	4.01E-05	7.82E-04
I-133	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	4.20E-07	< LLD	< LLD	4.20E-07
Cs-137	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	1.80E-05	1.80E-05
Cs-138	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	1.09E-05	< LLD	< LLD	< LLD	1.09E-05
Total for Period	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	1.03E-03	2.89E-04	1.49E-04	7.79E-04	2.25E-03
Dissolved and Entrained Noble Gases											
None	Ci										

Note: Only radionuclides with positive activity reported in this table.

TABLE 2A-1

GASEOUS EFFLUENTS – SUMMATION OF ALL RELEASES

Facility: SGS Unit 1 Period: 2017

A. Fission & Activation Gases	Unit	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total	Est. Total Error %
Total Release	Ci	2.77E-02	6.47E-04	2.33E-02	5.00E-02	1.02E-01	3.400E+01
Average release rate for the period	μCi/sec	3.56E-03	8.23E-05	2.93E-03	6.29E-03	3.22E-03	
Percent of limit (ODCM 3.11.2.2(a))	Gamma Air % Beta Air %	See Table 3 on page **Error! Bookmark not defined.**					
B. Iodine							
Total I-131	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	3.00E+01
Average release rate for the period	μCi/sec	N/A	N/A	N/A	N/A	N/A	
Percent of limit (ODCM 3.11.2.3(a))	%	*	*	*	*	*	
C. Particulates							
Particulates with half-lives > 8 days	Ci	< LLD	< LLD	< LLD	1.35E-05	1.35E-05	3.00E+01
Average release rate for the period	μCi/sec	N/A	N/A	N/A	1.70E-06	1.70E-06	
Percent of limit (ODCM 3.11.2.3(a))	%	*	*	*	*	*	
Gross alpha radioactivity	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	
D. Tritium							
Total Release	Ci	3.40E+01	9.63E+01	1.15E+02	9.07E+01	3.36E+02	3.10E+01
Average release rate for the period	μCi/sec	4.37E+00	1.23E+01	1.45E+01	1.14E+01	1.07E+01	
Percent of limit (ODCM 3.11.2.3(a))	%	*	*	*	*	*	
E. C-14							
Total Release	Ci	2.63E+00	2.63E+00	2.66E+00	2.66E+00	1.05E+01	N/A[a]
Average release rate for the period	μCi/sec	3.38E-01	3.35E-01	3.35E-01	3.35E-01	3.34E-01	
Percent of limit (ODCM 3.11.2.3(a))	%	*	*	*	*	*	
F. I-131, I-133, H-3 & Particulates > 8 day half-life							
Percent of limit (ODCM 3.11.2.3(a))	%	See Table 3 on page **Error! Bookmark not defined.**					
G. I-131, I-133, H-3, Particulates > 8 day half-life & C-14							
Percent of limit (ODCM 3.11.2.3(a))	%	See Table 3 on page **Error! Bookmark not defined.**					

N/A Not Applicable

* Iodine, Tritium, C-14, and Particulates were treated as a group. Although listed separately in the above table, the percent ODCM Limit is based on most limiting nuclide and organ dose for the group (even in cases when a sub-group member was not identified in effluents).

a. It is not necessary to calculate uncertainties for C-14 or to include C-14 uncertainty in any subsequent calculation of overall uncertainty. (Regulatory Guide 1.21 revision 2)

TABLE 2C-1

GASEOUS EFFLUENTS – GROUND LEVEL RELEASES

Facility: SGS Unit 1 Period: 2017

Nuclides Released	Unit	Continuous Mode					Batch Mode				
1.Fission gases		Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Ar-41	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	2.11E-02	3.69E-04	2.33E-02	1.18E-02	5.66E-02
Xe-133	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	6.37E-03	2.78E-04	< LLD	3.71E-02	4.37E-02
Xe-133m	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	3.00E-04	3.00E-04
Xe-135	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	2.19E-04	< LLD	< LLD	7.73E-04	9.92E-04
Total for Period	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	2.77E-02	6.47E-04	2.33E-02	5.00E-02	1.02E-01
2. Iodines											
None	Ci										
Total for Period	Ci										
3. Particulates											
Co-58	Ci	< LLD	< LLD	< LLD	1.30E-05	1.30E-05	< LLD	< LLD	< LLD	4.70E-07	4.70E-07
As-76	Ci	< LLD	5.00E-06	< LLD	< LLD	5.00E-06	< LLD	< LLD	< LLD	< LLD	< LLD
Total for Period	Ci	< LLD	5.00E-06	< LLD	< LLD	1.80E-05	< LLD	< LLD	< LLD	< LLD	4.70E-07
4. Tritium	Ci	3.36E+01	9.61E+01	1.15E+2	9.03E+01	3.35E+02	3.74E+01	2.51E-01	7.23E-01	4.28E-01	3.88E+01
5. C-14	Ci	2.63E+00	2.63E+00	2.66E+00	2.66E+00	1.05E+01	< LLD	< LLD	< LLD	< LLD	< LLD

Note: Only radionuclides with positive activity reported in this table.

TABLE 4A-1

SUMMARY SHEET FOR LIQUID RADIOACTIVE EFFLUENTS RELEASED IN A BATCH MODE

Facility: SGS Unit 1 Period: 2017

Liquid	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Number of Batch Releases	17	38	19	36	110
Total time period for batch releases (min)	7,179	15,894	2,556	26,241	51,870
Maximum time period for batch release (min)	586	9,050	459	2,537	9,050
Average time period for batch release (min)	422	418	135	729	472
Minimum time period for batch release (min)	254	16	30	30	16
Average stream flow during periods of release of effluents into a flowing stream (Lpm)	6.66E+07	3.08E+07	2.00E+08	5.79E+07	3.51E+07

TABLE 4B-1

SUMMARY SHEET FOR GASEOUS RADIOACTIVE EFFLUENTS RELEASED IN A BATCH MODE

Facility: SGS Unit 1 Period: 2017

Gaseous	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Number of Batch Releases	97	79	82	88	346
Total time period for batch releases (min)	9,216	7,163	7,541	25,622	49,542
Maximum time period for batch release (min)	245	165	409	4,350	4,350
Average time period for batch release (min)	95	91	92	291	143
Minimum time period for batch release (min)	40	4	36	25	4

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APPENDIX A-2

Effluent and Waste Disposal Summary, SGS Unit 2

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List of Tables

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TABLE 1A-2

LIQUID EFFLUENTS – SUMMATION OF ALL RELEASES

Facility: SGS Unit 2 Period: 2017

A. Fission & Activation Products	Unit	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total	Est. Total Error %
1. Total Release (not including tritium, gases & alpha)	Ci	1.40E-03	7.33E-03	1.75E-03	2.16E-03	1.26E-02	2.70E+01
2. Average diluted concentration during period	µCi/ml	2.80E-12	2.56E-11	3.34E-12	4.41E-12	6.98E-12	
3. Percent of applicable limit (ODCM 3.11.1(a) & (b))	Total Body %	See Table 2 on page 18					
	Organ %						
B. Tritium							
1. Total Release	Ci	1.22E+02	2.27E+02	6.59E+01	1.74E+02	5.89E+02	2.70E+01
2. Average diluted concentration during period	µCi/ml	2.43E-07	7.95E-07	1.26E-07	3.55E-07	3.25E-07	
3. Percent of applicable limit (ODCM 3.11.1(a) & (b))	Total Body %	See Table 2 on page 18					
	Organ %						
C. Dissolved & Entrained Gases							
1. Total Release	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	2.70E+01
2. Average diluted concentration during period	µCi/ml	< LLD	< LLD	< LLD	< LLD	< LLD	
3. Percent of applicable limit (ODCM 3.11.1.1)	%	N/A	N/A	N/A	N/A	N/A	
D. Gross Alpha Activity							
Total Release	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	2.70E+01
E. Volume Of Waste Released (prior to dilution)	Liters	4.98E+07	5.26E+07	2.67E+07	1.34E+07	1.43E+08	
F. Volume Of Dilution Water Used During Period	Liters	5.01E+11	2.86E+11	5.24E+11	4.91E+11	1.81E+12	

TABLE 1B-2

LIQUID EFFLUENTS

Facility: SGS Unit 2 Period: 2017

	Unit	Continuous Mode					Batch Mode				
		Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total
H-3	Ci	1.71E-02	3.40E-01	1.28E-02	4.87E-02	4.19E-01	1.22E+02	2.27E+02	6.59E+01	1.74E+02	5.89E+02
Fission and Activation Products											
Mn-54	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	1.17E-04	9.31E-06	< LLD	1.26E-04
Co-57	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	5.97E-06	1.19E-04	1.52E-05	< LLD	1.40E-04
Co-58	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	5.49E-04	4.30E-03	4.70E-04	1.85E-03	7.17E-03
Co-60	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	2.38E-04	2.75E-03	7.49E-04	1.54E-04	3.89E-03
Nb-95	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	4.43E-06	< LLD	< LLD	4.43E-06
Sn-117m	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	4.67E-06	< LLD	< LLD	4.67E-06
Sb-124	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	4.80E-05	< LLD	4.80E-05
Sb-125	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	5.44E-04	3.38E-05	4.17E-04	1.52E-04	1.15E-03
Cs-134	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	1.74E-05	< LLD	1.13E-05	< LLD	1.74E-05
Cs-137	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	4.62E-05	< LLD	3.06E-05	1.22E-05	8.90E-05
Total for Period	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	1.40E-03	7.33E-03	1.75E-03	2.16E-03	1.26E-02
Dissolved and Entrained Noble Gases											
None											
Total for Period	Ci										

Note: Only radionuclides with positive activity reported in this table.

TABLE 2A-2

GASEOUS EFFLUENTS – SUMMATION OF ALL RELEASES

Facility: SGS Unit 2 Period: 2017

A. Fission & Activation Gases	Unit	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total	Est. Total Error %
Total Release	Ci	4.91E-02	6.53E-02	5.22E-02	8.86E-02	2.55E-01	3.400E+01
Average release rate for the period	μCi/sec	6.32E-03	8.31E-03	6.57E-03	1.11E-02	8.07E-03	
Percent of limit (ODCM 3.11.2.2(a))	Gamma Air %	See Table 3 on page **Error! Bookmark not defined.**					
	Beta Air %						
B. Iodine							
Total Iodine – 131.	Ci	< LLD	7.04E-07	< LLD	< LLD	7.04E-07	3.00E+01
Average release rate for the period	μCi/sec	< LLD	8.95E-08	< LLD	< LLD	8.95E-08	
Percent of limit (ODCM 3.11.2.3(a))	%	*	*	*	*	*	
C. Particulates							
Particulates with half-lives > 8 days	Ci	< LLD	1.66E-04	< LLD	< LLD	1.66E-04	3.00E+01
Average release rate for the period	μCi/sec	< LLD	2.12E-05	< LLD	< LLD	2.12E-05	
Percent of limit (ODCM 3.11.2.3(a))	%	*	*	*	*	*	
Gross alpha radioactivity	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	
D. Tritium							
Total Release	Ci	8.84E+01	9.86E+01	1.78E+01	2.42E+01	2.29E+02	3.10E+01
Average release rate for the period	μCi/sec	1.14E+01	1.25E+01	2.25E+00	3.05E+00	7.24E+00	
Percent of limit (ODCM 3.11.2.3(a))	%	*	*	*	*	*	
E. C-14							
Total Release	Ci	2.48E+00	2.48E+00	2.51E+00	2.51E+00	9.96E+00	N/A[a]
Average release rate for the period	μCi/sec	3.19E-01	3.16E-01	3.16E-01	3.16E-01	3.15E-01	
Percent of limit (ODCM 3.11.2.3(a))	%	*	*	*	*	*	
F. I-131, I-133, H-3 & Particulates > 8 day half-life							
Percent of limit (ODCM 3.11.2.3(a))	%	See Table 3 on page **Error! Bookmark not defined.**					
G. I-131, I-133, H-3, Particulates > 8 day half-life & C-14							
Percent of limit (ODCM 3.11.2.3(a))	%	See Table 3 on page **Error! Bookmark not defined.**					

* Iodine, Tritium, C-14, and Particulates were treated as a group. Although listed separately in the above table, the percent ODCM Limit is based on most limiting nuclide and organ dose for the group (even in cases when a sub-group member was not identified in effluent).

a. It is not necessary to calculate uncertainties for C-14 or to include C-14 uncertainty in any subsequent calculation of overall uncertainty. (Regulatory Guide 1.21 revision 2)

TABLE 2C-2

GASEOUS EFFLUENTS – GROUND LEVEL RELEASES

Facility: SGS Unit 2 Period: 2017

Nuclides Released		Continuous Mode					Batch Mode				
1. Fission gases	**Unit**	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Total**	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Total**
Ar-41	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	4.42E-02	4.00E-03	3.47E-02	5.42E-02	9.30E-02
Kr-85m	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	2.00E-04	< LLD	< LLD	2.00E-04
Xe-133	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	4.89E-03	4.75E-02	1.76E-02	3.44E-02	1.04E-01
Xe-133m	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	2.98E-04	< LLD	< LLD	2.98E-04
Xe-135	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	8.76E-05	1.33E-02	< LLD	< LLD	5.75E-02
Total for Period	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	4.91E-02	6.53E-02	5.22E-02	8.86E-02	2.55E-01
2. Iodines											
I-131	Ci	< LLD	7.04E-07	< LLD	< LLD	7.04E-07	< LLD	< LLD	< LLD	< LLD	< LLD
I-132	Ci	< LLD	1.61E-06	< LLD	< LLD	1.61E-06	< LLD	< LLD	< LLD	< LLD	< LLD
Total for Period	Ci	< LLD	2.31E-06	< LLD	< LLD	2.31E-06	< LLD	< LLD	< LLD	< LLD	< LLD
3. Particulates											
Cr-51	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	1.06E-06	< LLD	< LLD	1.06E-06
Mn-54	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	2.22E-07	< LLD	< LLD	2.22E-07
Co-58	Ci	< LLD	2.67E-08	< LLD	< LLD	2.67E-08	< LLD	4.20E-07	< LLD	< LLD	4.20E-07
Co-60	Ci	< LLD	1.64E-08	< LLD	< LLD	1.64E-08	< LLD	1.65E-04	< LLD	< LLD	1.65E-04
Nb-95	Ci	< LLD	1.47E-08	< LLD	< LLD	1.47E-08	< LLD	< LLD	< LLD	< LLD	0.00E+00
Total for Period	Ci	< LLD	5.78E-08	< LLD	< LLD	5.78E-08	< LLD	1.66E-04	< LLD	< LLD	1.67E-04
4. Tritium	Ci	8.82E+01	9.83E+01	1.75E+01	2.40E+01	2.28E+02	2.08E-01	2.53E-01	3.21E-01	2.69E-01	1.05E+00
5. C-14	Ci	2.48E+00	2.48E+00	2.51E+00	2.51E+00	9.96E+00	< LLD	< LLD	< LLD	< LLD	< LLD

Note: Only radionuclides with positive activity reported in this table.

TABLE 3A-2
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
SOLID RADWASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL
(Not Irradiated Fuel)

Facility: SGS Units 1 and 2 Period: 2017

a. Waste Stream; Resins, Filters, and Evaporator Bottoms
Liquid Waste Processing Resin

Waste Class	Volume ft³	m³	Curies Shipped	% Error (Ci)
A	0	0	0.00E+00	+/-25%
B	0	0	0.00E+00	+/-25%
C	0	0	0.00E+00	+/-25%
All	0	0	0.00E+00	+/-25%

Major Nuclides for Above Table: Percent Cutoff 1%

Resins, Filters and Evaporator Bottoms Waste Class A		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A

Resins, Filters and Evaporator Bottoms Waste Class B		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A

Resins, Filters and Evaporator Bottoms Waste Class C		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A

Resins, Filters and Evaporator Bottoms Waste Class All		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A

N/A Not Applicable

TABLE 3A-2
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
SOLID RADWASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (continued)
(Not Irradiated Fuel)

b. Waste Stream; Dry Active Waste

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	2.76E+04	7.82E+02	9.31E-01	+/-25%
B	0	0	0	+/-25%
C	0	0	0	+/-25%
All	2.76E+04	7.82E+02	9.31E-01	+/-25%

Major Nuclides for Above Table: Percent Cutoff 1%

Dry Active Waste Waste Class A		
Nuclide Name	Percent Abundance	Curies
Mn-54	2.46%	2.29E-02
Fe-55	15.52%	1.44E-01
Co-58	31.42%	2.92E-01
Co-60	24.03%	2.24E-01
Ni-63	19.61%	1.83E-01
Sb-125	1.54%	1.43E-02
Cs-137	2.45%	2.28E-02

Dry Active Waste Waste Class B		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A

Dry Active Waste Waste Class C		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A

Dry Active Waste Waste Class All		
Nuclide Name	Percent Abundance	Curies
Mn-54	2.46%	2.29E-02
Fe-55	15.52%	1.44E-01
Co-58	31.42%	2.92E-01
Co-60	24.03%	2.24E-01
Ni-63	19.61%	1.83E-01
Sb-125	1.54%	1.43E-02
Cs-137	2.45%	2.28E-02

N/A Not Applicable

TABLE 3A-2
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
SOLID RADWASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (continued)
(Not Irradiated Fuel)

c. Waste Stream; Irradiated Components

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	0	0	0	+/-25%
B	0	0	0	+/-25%
C	0	0	0	+/-25%
All	0	0	0	+/-25%

Major Nuclides for Above Table: Percent Cutoff 1%

Irradiated Components Waste Class A		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A

Irradiated Components Waste Class B		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A

Irradiated Components Waste Class C		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A

Irradiated Components Waste Class All		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A

N/A Not Applicable

TABLE 3A-2
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
SOLID RADWASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (continued)

(Not Irradiated Fuel)

d. Waste Stream; Other Waste

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	0	0	0	+/-25%
B	0	0	0	+/-25%
C	0	0	0	+/-25%
All	0	0	0	+/-25%

Major Nuclides for Above Table: Percent Cutoff 1%

Other Waste Waste Class A		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Other Waste Waste Class B		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Other Waste Waste Class C		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Other Waste Waste Class All		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A

N/A Not Applicable

TABLE 3A-2
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
SOLID RADWASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (continued)

(Not Irradiated Fuel)

e. Waste Stream; Sum of All 4 Categories

Waste Class	Volume		Curies Shipped	% Error (Ci)
	ft^3	m^3		
A	2.76E+04	7.82E+02	9.31E-01	+/-25%
B	0	0	0	+/-25%
C	0	0	0	+/-25%
All	2.76E+04	7.82E+02	9.31E-01	+/-25%

Major Nuclides for Above Table: Percent Cutoff 1%

Waste Stream; Sum of All 4 Categories Waste Class A		
Nuclide Name	Percent Abundance	Curies
Mn-54	2.46%	2.29E-02
Fe-55	15.52%	1.44E-01
Co-58	31.42%	2.92E-01
Co-60	24.03%	2.24E-01
Ni-63	19.61%	1.83E-01
Sb-125	1.54%	1.43E-02
Cs-137	2.45%	2.28E-02
Waste Stream; Sum of All 4 Categories Waste Class B		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Waste Stream; Sum of All 4 Categories Waste Class C		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Waste Stream; Sum of All 4 Categories Waste Class All		
Nuclide Name	Percent Abundance	Curies
Mn-54	2.46%	2.29E-02
Fe-55	15.52%	1.44E-01
Co-58	31.42%	2.92E-01
Co-60	24.03%	2.24E-01
Ni-63	19.61%	1.83E-01
Sb-125	1.54%	1.43E-02
Cs-137	2.45%	2.28E-02

N/A Not Applicable

TABLE 3A-2
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
SOLID RADWASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (continued)

(Not Irradiated Fuel)

Number of Shipments	Mode Of Transportation	Destination
8	Hittman Transport Services, Inc.	Energy Solutions Services Inc. 1560 Bear Creek Road
1	Interstate Ventures	Energy Solutions Services Inc. 1560 Bear Creek Road
1	Tri State Motor Transit	Energy Solutions Services Inc. 1560 Bear Creek Road
3	Tri State Motor Transit.	UniTech Processing Facility. 2323 Zirconium Road

TABLE 4A-2

SUMMARY SHEET FOR LIQUID RADIOACTIVE EFFLUENTS RELEASED IN A BATCH MODE

Facility: SGS Unit 2 Period: 2017

Liquid	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Number of Batch Releases	11	60	15	13	99
Total time period for batch releases (min)	4,484	27,543	6,129	5,427	43,583
Maximum time period for batch release (min)	559	1,698	624	527	1,698
Average time period for batch release (min)	408	459	409	417	440
Minimum time period for batch release (min)	258	80	302	280	80
Average stream flow during periods of release of effluents into a flowing stream (Lpm)	1.12E+08	1.04E+07	8.71E+07	9.05E+07	4.16E+07

TABLE 4B-2

SUMMARY SHEET FOR GASEOUS RADIOACTIVE EFFLUENTS RELEASED IN A BATCH MODE

Facility: SGS Unit 2 Period: 2017

Gaseous	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Number of Batch Releases	208	100	88	159	555
Total time period for batch releases (min)	21,507	15,093	6,565	15,514	58,679
Maximum time period for batch release (min)	228	1,520	127	181	1,520
Average time period for batch release (min)	103	151	75	98	106
Minimum time period for batch release (min)	37	29	42	27	27

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APPENDIX A-3

Effluent and Waste Disposal Summary, HCGS

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List of Tables

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TABLE 1A-3

LIQUID EFFLUENTS – SUMMATION OF ALL RELEASES

Facility: HCGS

Period: 2017

A. Fission & Activation Products	Unit	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total	Est. Total Error %
1. Total Release (not including tritium, gases & alpha)	Ci	2.09E-04	1.84E-05	4.84E-04	1.31E-06	7.13E-04	2.70E+01
2. Average diluted concentration during period	μCi/ml	3.48E-11	2.22E-12	7.95E-11	2.37E-13	2.75E-11	
3. Percent of applicable limit (ODCM 3.11.1(a) & (b))	Total Body %	See Table 2 on page 18					
	Organ %						
B. Tritium							
1. Total Release	Ci	4.86E+00	4.01E+00	9.92E+00	2.11E+00	2.09E+01	2.70E+01
2. Average diluted concentration during period	μCi/ml	8.09E-07	4.84E-07	1.63E-06	3.81E-07	8.07E-07	
3. Percent of applicable limit (ODCM 3.11.1(a) & (b))	Total Body %	See Table 2 on page 18					
	Organ %						
C. Dissolved & Entrained Gases							
1. Total Release	Ci	1.22E-05	0.00E+00	0.00E+00	1.57E-06	1.37E-05	2.70E+01
2. Average diluted concentration during period	μCi/ml	2.02E-12	0.00E+00	0.00E+00	2.84E-13	5.30E-13	
3. Percent of applicable limit (ODCM 3.11.1.1)	%	See Table 2 on page 18					
D. Gross Alpha Activity							
Total Release	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	2.70E+01
E. Volume Of Waste Released (prior to dilution)	Liters	5.63E+06	1.24E+07	1.20E+07	7.15E+06	3.72E+07	
F. Volume Of Dilution Water Used During Period	Liters	6.01E+09	8.28E+09	6.09E+09	5.53E+09	2.59E+10	

TABLE 1B-3

LIQUID EFFLUENTS

Facility: HCGS | Period: 2017

		Continuous Mode					Batch Mode				
Nuclides Released	**Unit**	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Total**	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Total**
H-3	Ci	2.59E-01	2.65E+00	2.76E+00	1.04E+00	6.71E+00	4.60E+00	1.36E+00	7.17E+00	1.07E+00	1.42E+01
Fission and Activation Products											
Mn-54	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	1.85E-05	< LLD	8.55E-05	< LLD	1.04E-04
Co-58	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	5.82E-06	< LLD	1.72E-05	< LLD	2.31E-05
Co-60	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	1.85E-04	1.84E-05	3.64E-04	1.31E-06	5.69E-04
Zn-65	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	6.45E-06	< LLD	6.45E-06
Cs-137	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	< LLD	1.07E-05	< LLD	1.07E-05
Total for Period	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	2.09E-04	1.84E-05	4.84E-04	1.31E-06	7.13E-04
Dissolved and Entrained Noble Gases											
Xe-133	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	6.57E-06	< LLD	< LLD	< LLD	6.57E-06
Xe-135	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	5.59E-06	< LLD	< LLD	1.57E-06	7.16E-06
Total for Period	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	1.22E-05	< LLD	< LLD	1.57E-06	1.37E-05

Note: Only radionuclides with positive activity reported in this table.

TABLE 2A-3

GASEOUS EFFLUENTS – SUMMATION OF ALL RELEASES

Facility: HCGS Period: 2017

A. Fission & Activation Gases	Unit	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total	Est. Total Error %
Total Release	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	3.400E+01
Average release rate for the period	μCi/sec	< LLD	< LLD	< LLD	< LLD	< LLD	
Percent of limit (ODCM 3.11.2.2(a))	Gamma Air %	See Table 3 on page **Error! Bookmark not defined.**					
	Beta Air %						
B. Iodines and Halogens							
Total Release	Ci	5.66E-04	1.92E-03	1.75E-03	1.59E-03	5.83E-03	3.00E+01
Average release rate for the period	μCi/sec	7.28E-05	2.44E-04	2.21E-04	2.00E-04	1.85E-04	
Percent of limit (ODCM 3.11.2.3(a))	%	*	*	*	*	*	
C. Particulates							
Particulates with half-lives > 8 days	Ci	3.31E-04	7.49E-04	3.12E-04	6.75E-04	2.07E-03	3.00E+01
Average release rate for the period	μCi/sec	4.25E-05	9.53E-05	3.93E-05	8.49E-05	6.55E-05	
Percent of limit (ODCM 3.11.2.3(a))	%	*	*	*	*	*	
Gross alpha radioactivity	Ci	< LLD	< LLD	< LLD	< LLD	< LLD	
D. Tritium							
Total Release	Ci	9.81E+01	9.63E+01	1.08E+02	6.59E+01	3.69E+02	3.10E+01
Average release rate for the period	μCi/sec	1.26E+01	1.22E+01	1.36E+01	8.29E+00	1.17E+01	
Percent of limit (ODCM 3.11.2.3(a))	%	*	*	*	*	*	
E. C-14							
Total Release	Ci	4.53E+00	4.53E+00	4.58E+00	4.58E+00	1.82E+01	N/A
Average release rate for the period	μCi/sec	5.83E-01	5.77E-01	5.77E-01	5.77E-01	5.77E-02	
Percent of limit (ODCM 3.11.2.3(a))	%	*	*	*	*	*	
F. I-131, I-133, H-3 & Particulates > 8 day half-life							
Percent of limit (ODCM 3.11.2.3(a))	%	See Table 3 on page **Error! Bookmark not defined.**					
G. I-131, I-133, H-3, Particulates > 8 day half-life & C-14							
Percent of limit (ODCM 3.11.2.3(a))	%	See Table 3 on page **Error! Bookmark not defined.**					

* Iodine, Tritium, C-14, and Particulates were treated as a group. Although listed separately in the above table, the percent ODCM Limit is based on most limiting nuclide and organ dose for the group (even in cases when a sub-group member was not identified in effluent).

a. It is not necessary to calculate uncertainties for C-14 or to include C-14 uncertainty in any subsequent calculation of overall uncertainty. (Regulatory Guide 1.21 revision 2)

TABLE 2C-3

GASEOUS EFFLUENTS – GROUND LEVEL RELEASES

Facility: HCGS Period: 2017

Nuclides Released	Unit	Continuous Mode					Batch Mode				
1. Fission gases		**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Total**	**Qtr. 1**	**Qtr. 2**	**Qtr. 3**	**Qtr. 4**	**Total**
None											
Total for Period	Ci										
2. Iodines and Halogens											
I-131	Ci	1.17E-04	1.42E-04	1.63E-04	1.26E-04	5.48E-04	< LLD	< LLD	< LLD	< LLD	< LLD
I-133	Ci	4.49E-04	1.78E-03	1.59E-03	1.46E-03	5.28E-03	< LLD	< LLD	< LLD	< LLD	< LLD
Total for Period	Ci	5.66E-04	1.92E-03	1.75E-03	1.59E-03	5.83E-03	< LLD	< LLD	< LLD	< LLD	< LLD
3. Particulates											
Na-24	Ci	3.17E-04	7.49E-04	3.12E-04	6.75E-04	2.05E-03	< LLD	< LLD	< LLD	< LLD	< LLD
Co-60	Ci	1.34E-05	< LLD	< LLD	< LLD	1.34E-05	< LLD	< LLD	< LLD	< LLD	< LLD
Total for Period	Ci	3.31E-04	7.49E-04	3.12E-04	6.75E-04	2.07E-03	< LLD	< LLD	< LLD	< LLD	< LLD
4. Tritium	Ci	9.81E+01	9.63E+01	1.08E+02	6.59E+01	3.69E+02	< LLD	< LLD	< LLD	< LLD	< LLD
5. C-14	Ci	4.53E+00	4.53E+00	4.58E+00	4.58E+00	1.82E+01	< LLD	< LLD	< LLD	< LLD	< LLD

Note: Only radionuclides with positive activity reported in this table.

TABLE 3A-3
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
SOLID RADWASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL

(Not Irradiated Fuel)

Facility: HCGS Period: 2017

a. Waste Stream; Resins, Filters, and Evaporator Bottoms

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	1.03E+03	2.92E+01	1.14E+01	+/-25%
B	0	0	0	+/-25%
C	0	0	0	+/-25%
All	1.03E+03	2.92E+01	1.14E+01	+/-25%

Major Nuclides for Above Table: Percent Cutoff: 1%

Resins, Filters and Evaporator Bottoms Waste Class A		
Nuclide Name	Percent Abundance	Curies
H-3	1.89%	2.16E-01
C-14	17.15%	1.96E+00
Mn-54	2.97%	3.40E-01
Fe-55	34.27%	3.92E+00
Co-60	36.70%	4.20E+00
Ni-63	3.62%	4.14E-01
Zn-65	1.02%	1.16E-01
Cs-137	1.23%	1.41E-01
Resins, Filters and Evaporator Bottoms Waste Class B		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Resins, Filters and Evaporator Bottoms Waste Class C		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Resins, Filters and Evaporator Bottoms Waste Class All		
Nuclide Name	Percent Abundance	Curies
H-3	1.89%	2.16E-01
C-14	17.15%	1.96E+00
Mn-54	2.97%	3.40E-01
Fe-55	34.27%	3.92E+00
Co-60	36.70%	4.20E+00
Ni-63	3.62%	4.14E-01
Zn-65	1.02%	1.16E-01
Cs-137	1.23%	1.41E-01

N/A Not Applicable

TABLE 3A-3
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
SOLID RADWASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (continued)

(Not Irradiated Fuel)

b. Waste Stream; Dry Active Waste

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	4.89E+03	1.39E+02	7.65E+00	+/-25%
B	0	0	0	+/-25%
C	0	0	0	+/-25%
All	4.89E+03	1.39E+02	7.65E+00	+/-25%

Major Nuclides for Above Table: Percent Cutoff: 1%

Dry Active Waste Waste Class A		
Nuclide Name	Percent Abundance	Curies
Cr-51	2.06%	1.58E-01
Mn-54	8.06%	6.16E-01
Fe-55	36.31%	2.77E+00
Co-60	43.26%	3.30E+00
Zn-65	1.54%	1.17E-01
Zr-95	1.98%	1.52E-01
Nb-95	3.47%	2.65E-01
Dry Active Waste Waste Class B		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Dry Active Waste Waste Class C		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Dry Active Waste		
Waste Class All		
Nuclide Name	Percent Abundance	Curies
Cr-51	2.06%	1.58E-01
Mn-54	8.06%	6.16E-01
Fe-55	36.31%	2.77E+00
Co-60	43.26%	3.30E+00
Zn-65	1.54%	1.17E-01
Zr-95	1.98%	1.52E-01
Nb-95	3.47%	2.65E-01

N/A Not Applicable

TABLE 3A-3
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
SOLID RADWASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (continued)

(Not Irradiated Fuel)

c. Waste Stream; Irradiated Components

Waste Class	Volume ft³	Volume m³	Curies Shipped	% Error (Ci)
A	0	0	0	+/-25%
B	0	0	0	+/-25%
C	0	0	0	+/-25%
All	0	0	0	+/-25%

Major Nuclides for Above Table: Percent Cutoff: 1%

Irradiated Components Waste Class A		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Irradiated Components Waste Class B		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Irradiated Components Waste Class C		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Irradiated Components Waste Class All		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A

N/A Not Applicable

TABLE 3A-3
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
SOLID RADWASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (continued)

(Not Irradiated Fuel)

d. Waste Stream; Other Waste

Waste Class	Volume		Curies Shipped	% Error (Ci)
	ft^3	m^3		
A	3.33E+03	9.44E+01	6.18E-05	+/-25%
B	0	0	0	+/-25%
C	0	0	0	+/-25%
All	3.33E+03	9.44E+01	6.18E-05	+/-25%

Major Nuclides for Above Table: Percent Cutoff: 1%

Other Waste Waste Class A		
Nuclide Name	Percent Abundance	Curies
Mn-54	2.22%	1.38E-06
Fe-55	35.79%	2.21E-05
Co-60	60.61%	3.75E-05
Other Waste Waste Class B		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Other Waste Waste Class C		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Other Waste Waste Class All		
Nuclide Name	Percent Abundance	Curies
Mn-54	2.22%	1.38E-06
Fe-55	35.79%	2.21E-05
Co-60	60.61%	3.75E-05

N/A Not Applicable

TABLE 3A-3
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
SOLID RADWASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (continued)

(Not Irradiated Fuel)

e. Waste Stream; Sum of All 4 Categories

Waste Class	Volume ft^3	Volume m^3	Curies Shipped	% Error (Ci)
A	9.26E+03	2.62E+02	6.18E-05	+/-25%
B	0	0	0	+/-25%
C	0	0	0	+/-25%
All	9.26E+03	2.62E+02	6.18E-05	+/-25%

Major Nuclides for Above Table: Percent Cutoff: 1%

Sum of All 4 Categories Waste Class A		
Nuclide Name	Percent Abundance	Curies
H-3	1.13%	2.16E-01
C-14	10.28%	1.96E+00
Mn-54	5.01%	9.56E-01
Fe-55	35.09%	6.69E+00
Co-60	39.33%	7.50E+00
Ni-63	2.38%	4.54E-01
Zn-65	1.23%	2.34E-01
Nb-95	1.39%	2.65E-01
Waste Class B		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Waste Class C		
Nuclide Name	Percent Abundance	Curies
None	N/A	N/A
Sum of All 4 Categories Waste Class All		
Nuclide Name	Percent Abundance	Curies
H-3	1.13%	2.16E-01
C-14	10.28%	1.96E+00
Mn-54	5.01%	9.56E-01
Fe-55	35.09%	6.69E+00
Co-60	39.33%	7.50E+00
Ni-63	2.38%	4.54E-01
Zn-65	1.23%	2.34E-01
Nb-95	1.39%	2.65E-01

N/A Not Applicable

TABLE 3A-3
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
SOLID RADWASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (continued)

(Not Irradiated Fuel)

Number of Shipments	**Mode Of Transportation**	**Destination**
8	Hittman Transport Services, Inc.	Barnwell Disposal Facility Operated by Chem – Nuclear Systems, Inc.
1	Hittman Transport Services, Inc.	Energy Solutions – BCO Bear Creek Operations
10	R&R Trucking	Babcock Services, Inc. Oak Ridge Service Center

TABLE 4A-3

SUMMARY SHEET FOR LIQUID RADIOACTIVE EFFLUENTS RELEASED IN A BATCH MODE

Facility: HCGS Period: 2017

Liquid	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Number of Batch Releases	7	4	10	2	23
Total time period for batch releases (min)	482	252	708	133	1,580
Maximum time period for batch release (min)	85	79	83	83	85
Average time period for batch release (min)	69	63	71	67	69
Minimum time period for batch release (min)	47	49	34	50	34
Average stream flow during periods of release of effluents into a flowing stream (Lpm)	1.25E+07	3.29E+07	8.61E+06	4.16E+07	1.64E+07

TABLE 4B-3

SUMMARY SHEET FOR GASEOUS RADIOACTIVE EFFLUENTS RELEASED IN A BATCH MODE

Facility: HCGS Period: 2017

Gaseous	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Number of Batch Releases	0	0	0	0	0
Total time period for batch releases (min)	0	0	0	0	0
Maximum time period for batch release (min)	0	0	0	0	0
Average time period for batch release (min)	0	0	0	0	0
Minimum time period for batch release (min)	0	0	0	0	0

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APPENDIX B

Meteorological Data

Salem/Hope Creek Meteorological Tower

Joint Frequency Distribution of Wind Direction and Speed
All Stability Classes Total Hours and Frequency (%)

33 Ft. Wind Level

300 – 33 Ft. Delta Temperature

January – December 2017

SALEM / HOPE CREEK
JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND SPEED BY ATMOSPHERIC STABILITY CLASS
JANUARY - DECEMBER 2017
WIND LEVEL: 33 FT
DELTA T: (300-33 FT)
ALL STABILITY CLASSES
TOTAL HOURS

WIND DIRECTION (blowing from)		WIND SPEED GROUPS (m/sec)											
		< 0.5	0.5 - 1.0	1.1 - 1.5	1.6 - 2.0	2.1 - 3.0	3.1 - 4.0	4.1 - 5.0	5.1 - 6.0	6.1 - 8.0	8.1 - 10.0	> 10.0	Total
Degrees	Sect.												
348.75 - 11.25	N	0	9	31	43	150	169	96	54	31	2	1	586
11.25 - 33.75	NNE	0	11	37	58	148	136	68	39	21	1	1	520
33.75 - 56.25	NE	0	16	34	55	195	129	53	24	16	6	1	529
56.25 - 78.75	ENE	0	29	51	84	148	81	37	6	6	6	2	450
78.75 - 101.25	E	0	23	51	59	132	57	8	0	0	0	0	330
101.25 - 123.75	ESE	0	12	41	53	71	91	34	7	0	1	0	310
123.75 - 146.25	SE	0	14	28	35	116	158	168	126	114	26	0	785
146.25 - 168.75	SSE	0	2	24	43	125	105	74	80	70	24	1	548
168.75 - 191.25	S	0	6	27	36	95	75	80	70	50	12	0	451
191.25 - 213.75	SSW	0	6	24	41	112	108	80	64	71	25	0	531
213.75 - 236.25	SW	0	4	23	64	229	130	64	43	41	4	0	602
236.25 - 258.75	WSW	0	6	24	39	146	148	70	37	22	1	0	493
258.75 - 281.25	W	0	4	33	30	104	88	121	94	94	20	9	597
281.25 - 303.75	WNW	1	8	26	46	119	98	70	54	92	42	12	568
303.75 - 326.25	NW	0	9	23	41	152	146	103	103	145	18	11	751
326.25 - 348.75	NNW	0	10	29	38	148	157	97	54	55	14	1	603

Total 8,654

MISSING HOURS: 106
JOINT DATA RECOVERY: 98.8%

SALEM / HOPE CREEK
JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND SPEED BY ATMOSPHERIC STABILITY CLASS
JANUARY - DECEMBER 2017
WIND LEVEL: 33 FT
DELTA T: (300-33 FT)
ALL STABILITY CLASSES
FREQUENCY (%)

WIND DIRECTION (blowing from)		WIND SPEED GROUPS (m/sec)											
		< 0.5	0.5 - 1.0	1.1 - 1.5	1.6 - 2.0	2.1 - 3.0	3.1 - 4.0	4.1 - 5.0	5.1 - 6.0	6.1 - 8.0	8.1 - 10.0	> 10.0	Total
Degrees	Sect.												
348.75 - 11.25	N	0.000	0.104	0.358	0.497	1.733	1.953	1.109	0.624	0.358	0.023	0.012	6.77
11.25 - 33.75	NNE	0.000	0.127	0.428	0.670	1.710	1.572	0.786	0.451	0.243	0.012	0.012	6.01
33.75 - 56.25	NE	0.000	0.185	0.393	0.636	2.253	1.491	0.612	0.277	0.185	0.069	0.012	6.11
56.25 - 78.75	ENE	0.000	0.335	0.589	0.971	1.710	0.936	0.428	0.069	0.069	0.069	0.023	5.20
78.75 - 101.25	E	0.000	0.266	0.589	0.682	1.525	0.659	0.092	0.000	0.000	0.000	0.000	3.81
101.25 - 123.75	ESE	0.000	0.139	0.474	0.612	0.820	1.052	0.393	0.081	0.000	0.012	0.000	3.58
123.75 - 146.25	SE	0.000	0.162	0.324	0.404	1.340	1.826	1.941	1.456	1.317	0.300	0.000	9.07
146.25 - 168.75	SSE	0.000	0.023	0.277	0.497	1.444	1.213	0.855	0.924	0.809	0.277	0.012	6.33
168.75 - 191.25	S	0.000	0.069	0.312	0.416	1.098	0.867	0.924	0.809	0.578	0.139	0.000	5.21
191.25 - 213.75	SSW	0.000	0.069	0.277	0.474	1.294	1.248	0.924	0.740	0.820	0.289	0.000	6.14
213.75 - 236.25	SW	0.000	0.046	0.266	0.740	2.646	1.502	0.740	0.497	0.474	0.046	0.000	6.96
236.25 - 258.75	WSW	0.000	0.069	0.277	0.451	1.687	1.710	0.809	0.428	0.254	0.012	0.000	5.70
258.75 - 281.25	W	0.000	0.046	0.381	0.347	1.202	1.017	1.398	1.086	1.086	0.231	0.104	6.90
281.25 - 303.75	WNW	0.012	0.092	0.300	0.532	1.375	1.132	0.809	0.624	1.063	0.485	0.139	6.56
303.75 - 326.25	NW	0.000	0.104	0.266	0.474	1.756	1.687	1.190	1.190	1.676	0.208	0.127	8.68
326.25 - 348.75	NNW	0.000	0.116	0.335	0.439	1.710	1.814	1.121	0.624	0.636	0.162	0.012	6.97

Total 100.00

MISSING HOURS: 106
JOINT DATA RECOVERY: 98.8%

Salem and Hope Creek Ground Level Release

Dispersion (X/Q)

and

Deposition Factors (D/Q)

January – December 2017

SALEM GROUND LEVEL RELEASE DISPERSION (X/Q) AND DEPOSITION FACTORS(D/Q)

SPECIFIC POINTS OF INTEREST

Location	Direction From Site	Distance (MI)	X/Q (Sec/M^3) No Decay Undepleted	X/Q (Sec/M^3) No Decay Depleted	D/Q (1/M^2)
Site Boundary	S	0.17	1.30E-05	1.30E-05	7.20E-08
Site Boundary	SSW	0.13	2.20E-05	2.10E-05	9.40E-08
Site Boundary	SW	0.11	2.80E-05	2.70E-05	1.10E-07
Site Boundary	WSW	0.11	2.80E-05	2.70E-05	9.40E-08
Site Boundary	W	0.12	2.00E-05	1.90E-05	6.30E-08
Site Boundary	WNW	0.16	1.10E-05	1.10E-05	4.20E-08
Site Boundary	NW	0.28	7.10E-06	6.60E-06	4.30E-08
Site Boundary	NNW	0.68	1.00E-06	9.40E-07	7.60E-09
Site Boundary	N	0.83	6.60E-07	5.90E-07	4.40E-09
Site Boundary	NNE	0.89	6.90E-07	6.10E-07	4.60E-09
Site Boundary	NE	1.07	6.80E-07	6.00E-07	3.80E-09
Site Boundary	ENE	0.88	7.20E-07	6.40E-07	4.40E-09
Site Boundary	E	0.89	6.40E-07	5.60E-07	5.20E-09
Site Boundary	ESE	0.24	5.20E-06	4.90E-06	4.00E-08
Site Boundary	SE	0.15	1.50E-05	1.50E-05	1.10E-07
Site Boundary	SSE	0.15	1.40E-05	1.40E-05	8.60E-08
Dairy & Cattle	N	4.00	7.00E-08	5.40E-08	2.90E-10
Dairy & Cattle	N	5.70	4.20E-08	3.10E-08	1.50E-10
Dairy & Cattle	N	11.5	1.60E-08	1.00E-08	4.70E-11
Dairy & Cattle	NNE	4.20	7.60E-08	5.80E-08	3.10E-10
Dairy & Cattle	NNE	5.00	5.90E-08	4.40E-08	2.30E-10
Dairy & Cattle	NE	3.90	1.10E-07	8.40E-08	4.00E-10
Dairy & Cattle	NE	5.60	6.50E-08	4.80E-08	2.10E-10
Dairy & Cattle	ENE	3.90	8.70E-08	6.70E-08	3.30E-10
Dairy & Cattle	E	5.30	4.80E-08	3.50E-08	2.30E-10
Dairy & Cattle	ESE	5.90	4.60E-08	3.30E-08	1.80E-10
Dairy & Cattle	SE	9.50	2.90E-08	1.90E-08	1.10E-10
Dairy & Cattle	SSE	9.50	2.70E-08	1.80E-08	8.60E-11
Dairy & Cattle	S	5.20	7.00E-08	5.20E-08	2.30E-10
Dairy & Cattle	SSW	3.90	1.10E-07	8.50E-08	3.40E-10
Dairy & Cattle	SSW	8.30	3.90E-08	2.70E-08	9.20E-11

Location	Direction From Site	Distance (MI)	X/Q (Sec/M^3) No Decay Undepleted	X/Q (Sec/M^3) No Decay Depleted	D/Q (1/M^2)
Dairy & Cattle	SW	4.30	9.80E-08	7.50E-08	2.90E-10
Dairy & Cattle	SW	4.60	9.00E-08	6.80E-08	2.60E-10
Dairy & Cattle	WSW	4.40	9.50E-08	7.20E-08	2.40E-10
Dairy & Cattle	W	4.00	8.90E-08	6.90E-08	2.10E-10
Dairy & Cattle	W	4.90	6.70E-08	5.00E-08	1.50E-10
Dairy & Cattle	WNW	3.40	9.70E-08	7.60E-08	2.60E-10
Dairy & Cattle	WNW	8.50	2.70E-08	1.90E-08	5.30E-11
Dairy & Cattle	NW	3.70	1.50E-07	1.20E-07	5.70E-10
Dairy & Cattle	NNW	4.20	7.60E-08	5.80E-08	3.20E-10
Gardens	N	0.57	1.20E-06	1.00E-06	8.20E-09
Gardens	NNE	7.50	3.30E-08	2.30E-08	1.10E-10
Gardens	NE	5.60	6.50E-08	4.80E-08	2.10E-10
Gardens	ENE	5.00	6.10E-08	4.60E-08	2.10E-10
Gardens	E	6.00	4.00E-08	2.90E-08	1.80E-10
Gardens	ESE	6.30	4.20E-08	3.00E-08	1.60E-10
Gardens	SSW	3.90	1.10E-07	8.50E-08	3.40E-10
Gardens	SW	4.60	9.00E-08	6.80E-08	2.60E-10
Gardens	WSW	4.40	9.50E-08	7.20E-08	2.40E-10
Gardens	NW	0.58	2.20E-06	2.00E-06	1.40E-08
Gardens	NW	5.40	9.30E-08	6.90E-08	2.90E-10
Gardens	NNW	0.57	1.40E-06	1.20E-06	1.00E-08

VENT AND BUILDING PARAMETERS:

Release Height (Meters)	**0.00**	Rep. Wind Height (Meters)	**10.00**
Diameters (Meters)	**0.00**	Building Height (Meters)	**61.00**
Exit Velocity (Meters)	**0.00**	BLDG.MIN.CRS.SEC. AREA (Square Meters)	**3720.00**
		Heat Emission Rate (Cal/Sec)	**0.00**

HOPE CREEK GROUND LEVEL RELEASE DISPERSION (X/Q) AND DEPOSITION FACTORS(D/Q)

SPECIFIC POINTS OF INTEREST

LOCATION	DIRECTION FROM SITE	Distance (MI)	X/Q (Sec/M^3) No Decay Undepleted	X/Q (Sec/M^3) No Decay Depleted	D/Q (1/M^2)
SITE BOUNDARY	S	0.25	6.30E-06	6.00E-06	3.90E-08
SITE BOUNDARY	SSW	0.19	1.10E-05	1.00E-05	5.20E-08
SITE BOUNDARY	SW	0.17	1.30E-05	1.30E-05	6.20E-08
SITE BOUNDARY	WSW	0.17	1.30E-05	1.30E-05	5.30E-08
SITE BOUNDARY	W	0.18	9.90E-06	9.40E-06	3.60E-08
SITE BOUNDARY	WNW	0.22	6.20E-06	5.90E-06	2.60E-08
SITE BOUNDARY	NW	0.31	6.10E-06	5.70E-06	3.80E-08
SITE BOUNDARY	NNW	0.55	1.40E-06	1.30E-06	1.00E-08
SITE BOUNDARY	N	0.50	1.40E-06	1.30E-06	1.00E-08
SITE BOUNDARY	NNE	0.63	1.10E-06	1.00E-06	8.20E-09
SITE BOUNDARY	NE	0.74	1.10E-06	1.00E-06	7.10E-09
SITE BOUNDARY	ENE	0.94	6.50E-07	5.70E-07	3.90E-09
SITE BOUNDARY	E	0.94	5.80E-07	5.10E-07	4.70E-09
SITE BOUNDARY	ESE	0.75	8.90E-07	7.90E-07	6.60E-09
SITE BOUNDARY	SE	0.47	2.10E-06	1.90E-06	1.90E-08
SITE BOUNDARY	SSE	0.42	2.40E-06	2.20E-06	1.80E-08
DAIRY & CATTLE	N	4.00	7.00E-08	5.40E-08	2.90E-10
DAIRY & CATTLE	N	5.70	4.20E-08	3.10E-08	1.50E-10
DAIRY & CATTLE	N	11.50	1.60E-08	1.00E-08	4.70E-11
DAIRY & CATTLE	NNE	4.20	7.50E-08	5.80E-08	3.10E-10
DAIRY & CATTLE	NNE	5.00	5.90E-08	4.40E-08	2.30E-10
DAIRY & CATTLE	NE	3.90	1.10E-07	8.40E-08	4.00E-10
DAIRY & CATTLE	NE	5.60	6.50E-08	4.80E-08	2.10E-10
DAIRY & CATTLE	ENE	3.90	8.70E-08	6.70E-08	3.30E-10
DAIRY & CATTLE	E	5.30	4.80E-08	3.50E-08	2.30E-10
DAIRY & CATTLE	ESE	5.90	4.60E-08	3.30E-08	1.80E-10
DAIRY & CATTLE	SE	9.50	2.90E-08	1.90E-08	1.10E-10
DAIRY & CATTLE	SSE	9.50	2.70E-08	1.80E-08	8.60E-11
DAIRY & CATTLE	S	5.20	7.00E-08	5.20E-08	2.30E-10
DAIRY & CATTLE	SSW	3.90	1.10E-07	8.40E-08	3.40E-10
DAIRY & CATTLE	SSW	8.30	3.90E-08	2.70E-08	9.20E-11
DAIRY & CATTLE	SW	4.30	9.80E-08	7.50E-08	2.90E-10
DAIRY & CATTLE	SW	4.60	8.90E-08	6.70E-08	2.60E-10

LOCATION	DIRECTION FROM SITE	Distance (MI)	X/Q (Sec/M^3) No Decay Undepleted	X/Q (Sec/M^3) No Decay Depleted	D/Q (1/M^2)
DAIRY & CATTLE	WSW	4.40	9.40E-08	7.20E-08	2.40E-10
DAIRY & CATTLE	W	4.00	8.90E-08	6.80E-08	2.10E-10
DAIRY & CATTLE	W	4.90	6.70E-08	5.00E-08	1.50E-10
DAIRY & CATTLE	WNW	3.40	9.60E-08	7.50E-08	2.60E-10
DAIRY & CATTLE	WNW	8.50	2.70E-08	1.90E-08	5.30E-11
DAIRY & CATTLE	NW	3.70	1.50E-07	1.20E-07	5.70E-10
DAIRY & CATTLE	NNW	4.20	7.50E-08	5.80E-08	3.20E-10
GARDENS	N	0.57	1.20E-06	1.00E-06	8.20E-09
GARDENS	NNE	7.50	3.30E-08	2.30E-08	1.10E-10
GARDENS	NE	5.60	6.50E-08	4.80E-08	2.10E-10
GARDENS	ENE	5.00	6.10E-08	4.60E-08	2.10E-10
GARDENS	E	6.00	4.00E-08	2.90E-08	1.80E-10
GARDENS	ESE	6.30	4.20E-08	3.00E-08	1.60E-10
GARDENS	SSW	3.90	1.10E-07	8.40E-08	3.40E-10
GARDENS	SW	4.60	8.90E-08	6.70E-08	2.60E-10
GARDENS	WSW	4.40	9.40E-08	7.20E-08	2.40E-10
GARDENS	NW	0.58	2.20E-06	2.00E-06	1.40E-08
GARDENS	NW	5.40	9.30E-08	6.80E-08	2.90E-10
GARDENS	NNW	0.57	1.40E-06	1.20E-06	1.00E-08

VENT AND BUILDING PARAMETERS:			
Release Height (Meters)	**0.00**	Rep. Wind Height (Meters)	**10.0**
Diameters (Meters)	**0.00**	Building Height (Meters)	**61.8**
Exit Velocity (Meters)	**0.00**	BLDG.MIN.CRS.SEC.AREA (Square Meters)	**3819.0**
		Heat Emission Rate (Cal/Sec)	**0.0**

APPENDIX C

Maximum Permissible Concentration (MPC) Data

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The following radionuclide concentrations were obtained from 10 CFR 20 Appendix B, Table II, Column 2 as revised January 1, 1991.

Maximum Permissible Concentrations			
Element	**Isotope**	**Soluble Conc. (μCi/ml)**	**Insoluble Conc. (μCi/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
	Am-244	5E-3	5E-3
Antimony (51)	Sb-122	3E-5	3E-5
	Sb-124	2E-5	2E-5
	Sb-125	1E-4	1E-4
	Sb-126	3E-6	3E-6
Arsenic (33)	As-73	5E-4	5E-4
	As-74	5E-5	5E-5
	As-76	2E-5	2E-5
	As-77	8E-5	8E-5
Astatine (85)	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
	Br-83	3E-6	3E-6
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
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

Maximum Permissible Concentrations			
Element	Isotope	Soluble Conc. (μCi/ml)	Insoluble Conc. (μCi/ml)
	Cs-134m	6E-3	1E-3
	Cs-134	9E-6	4E-5
	Cs-135	1E-4	2E-4
	Cs-136	9E-5	6E-5
	Cs-137	2E-5	4E-5
Chlorine (17)	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
	Cm-249	2E-3	2E-3
Dysprosium (66)	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
Hydrogen (3)	H-3	3E-3	3E-3
Indium (49)	In-113m	1E-3	1E-3

Maximum Permissible Concentrations			
Element	Isotope	Soluble Conc. (µCi/ml)	Insoluble Conc. (µCi/ml)
	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-130	3E-6	3E-6
	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
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

Maximum Permissible Concentrations			
Element	**Isotope**	**Soluble Conc. (μCi/ml)**	**Insoluble Conc. (μCi/ml)**
Platinum (78)	Pt-191	1E-4	1E-4
	Pt-193m	1E-3	1E-3
	Pt-193	9E-4	2E-3
	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-103m	3E-6	3E-6
	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

Maximum Permissible Concentrations			
Element	**Isotope**	**Soluble Conc. (μCi/ml)**	**Insoluble Conc. (μCi/ml)**
	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
	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
	Te-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

Maximum Permissible Concentrations			
Element	**Isotope**	**Soluble Conc. (µCi/ml)**	**Insoluble Conc. (µCi/ml)**
	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
	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 radioactive 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 µCi/ml.

2. If the identity and concentration of each radionuclide were 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 D

2017 Radiological Groundwater Protection Program (RGPP) Report

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2017 Radiological Groundwater Protection Program (RGPP) Report

Results of the Integrated Tritium Management Program

With

2017 Radiological Groundwater Protection Program (RGPP)

And

2017 Monitoring Well and Remedial Action Work Plan

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I. Introduction

This report presents results of the 2017 groundwater monitoring activities performed by PSEG Nuclear at both the Hope Creek Generating Station (HCGS) and Salem Generating Station (SGS); collectively referred to as "the Station". Well locations at the Station are shown on Figures 1 and 2, respectively. To tie together the various groundwater monitoring programs at the Station, PSEG implemented the Integrated Tritium Management Program (ITMP) which integrates the following four broad programs:

- The Radiological Groundwater Protection Program (RGPP) is a program that was developed to ensure the timely detection of an unpermitted release of radioactive material;
- The Remedial Action Work Plan (RAWP) is a program that monitors the remediation of the historical release from the SGS Unit 1 Spent Fuel Pool;
- Investigation wells were installed as part of independent investigations into groundwater quality, that are not included as part of the RGPP or RAWP; and
- Early Site Permit (ESP) wells which are periphery wells that were installed outside of the protected area to support the potential licensing of a new nuclear plant.

Well construction details for the HCGS RGPP wells and SGS RGPP wells are presented on Tables 1 and 2, respectively. Well construction details for the wells that are not specifically part of the RGPP are presented on Table 3.

PSEG initiated the RGPP in 2006 to characterize groundwater at, and in the vicinity of, the Station with respect to historical releases of radionuclides and to provide the mechanism to detect such releases, if one were to occur. The RGPP is a voluntary program implemented by PSEG in conjunction with the nuclear industry initiatives and associated guidance (NEI 2007). The other key elements that comprise the RGPP and contribute to public safety are spill/leak prevention, effective remediation of spills and leaks, and effective stakeholder communication.

In 2002, PSEG operations personnel at SGS identified a release of tritiated water from the SGS Unit 1 Spent Fuel Pool to the environment. PSEG developed a RAWP to remediate the tritium in groundwater, which was reviewed by the United States Nuclear Regulatory Commission (USNRC) and approved by the New Jersey Department of Environmental Protection (NJDEP) Bureau of Nuclear Engineering (BNE). A Groundwater Recovery System (GRS) was installed to control the migration of groundwater in the shallow, water-bearing unit and to reduce the remaining mass of tritiated groundwater. The operation and performance of the GRS is documented in the Remedial Action Progress Reports (RAPRs) provided to the NRC and NJDEP BNE by PSEG. PSEG generates an effluent release permit for the residual tritium in groundwater discharging to the Delaware River. The permit values are included in the liquid effluent data reported earlier in this document.

The Station is located in a flat, largely undeveloped region of southern New Jersey, which is bordered to the west and south by the Delaware River and to the east and north by extensive marshlands. The Station obtains cooling water from the Delaware River.

The Station is underlain by over 1,000 feet of inter-layered sand, silt and clay. PSEG owns eight production/potable wells, which range in depth from 260 feet below ground surface (bgs) to 1,800 feet bgs. These wells are installed in deeper formations isolated by confining units beneath the Vincentown Formation.

The results from a computer based well search identified the nearest off-site permitted potable well is located approximately 3.5 miles away. Shallow groundwater and the Vincentown aquifer (the two most shallow water bearing units underlying the Station) flow toward and discharge to the Delaware River, thus reducing the potential that Station operations have or will influence off-site potable wells.

II. Radiological Groundwater Protection Program

This section of the annual report is prepared to summarize the status, activities, and groundwater analytical results collected in 2017 at the Site. This report also describes any changes made to the monitoring program during the 2017 reporting year.

1. Objectives of the Radiological Groundwater Protection Program

The long-term sampling program objectives are as follows:

- Identify suitable locations to monitor and evaluate potential impacts from Station operations before significant radiological impact to the environment or potential drinking water sources can occur.
- Refine the conceptual understanding of local hydrogeology and maintain current knowledge of potential flow paths on the surface and in groundwater beneath the Station.
- Evaluate systems, structures, components (SSCs) and work practices, which have the potential to release licensed radioactive material to the groundwater and develop strategies to mitigate potential releases to the environment.
- Perform routine groundwater monitoring and evaluate analytical results.
- Report any leaks, spills, or other detections with potential radiological significance to stakeholders in a timely manner.
- Take necessary corrective actions to protect groundwater resources.

2. Sample Collection

In 2006, the RGPP monitoring wells (Tables 1 and 2) were installed at the Station as part of site investigation activities. Details pertaining to these activities are documented in the Site Investigation Reports (Arcadis 2006A and 2006B). Groundwater samples are collected from all RGPP monitoring wells at least semi-annually, with additional monitoring conducted as appropriate. The groundwater sample collection schedule is adaptively managed to ensure that representative data are collected to provide the information necessary to evaluate groundwater quality conditions. Monitoring wells are sampled following the low-flow purging and sampling techniques in accordance with the Field Sampling Procedures Manual (NJDEP 2005). This methodology is consistent with protocols established in the RAWP.

3. New RGPP Wells

No new wells were added as part of the RGPP during 2017.

4. Sample Analysis

Groundwater samples collected from RGPP wells are analyzed for plant-related gamma emitting radionuclides (semi-annually), strontium (annually), iron 55 (biennially) and tritium (every sample) by an off-site radiochemical analytical laboratory.

The samples are maintained under chain of custody procedures throughout sample handling, screening, shipping and laboratory analysis process. Samples are submitted to the respective Station's onsite chemistry laboratory for radiological analysis screening prior to shipment to Teledyne Brown Engineering (TBE) located in Knoxville, Tennessee, for radiological analysis. Analytical laboratories are subject to internal quality assurance programs and inter-laboratory cross-check programs. Station personnel review and evaluate analytical data obtained from the laboratory.

5. Data Evaluation

Analytical results are reviewed for adverse trends or anomalies. Investigations and corrective action program notifications (CAP) are made as required by program procedures. The radiological data collected since the inception of the RGPP program is the basis for the baseline statistical evaluation to which current operational data are compared. Several factors are important in the interpretation and evaluation of the radiological data:

A. Detection limits

The Offsite Dose Calculation Manual (ODCM) specifies detection capabilities for each isotope that may be produced by the Station. While the detection capability for tritium specified in the ODCM is 3,000 picocuries per liter (pCi/L) in water, RGPP tritium analyses are performed to a lower value of 200 pCi/L. Lower values for LLDs are used to be consistent with the state of New Jersey where PSEG conducts split samples with the state. Each well has a statistically derived action level. When an action level is exceeded, PSEG may increase monitoring frequency and evaluates potential sources of the elevated tritium. Relevant groundwater evaluation criteria are listed in Table 4.

B. Laboratory Measurements Uncertainty

Statistically, the value of a measurement is expressed as a range with a stated level of confidence. PSEG is required to report results with a 95% level of confidence.

Analytical uncertainties are reported at the 95% confidence level in this report and are consistent with the methodologies used to report data in the AREOR.

6. RGPP Data Quality

Groundwater samples consist of at least four aliquots. One of the aliquots is submitted to the respective Site's on-site chemistry laboratory for initial screening, which includes tritium and gamma spectroscopy analysis. The second aliquot is sent to TBE for tritium analysis. In accordance with NJDEP request, the third aliquot is submitted for split sample analysis to GEL Laboratories located in Charleston, South Carolina. The fourth aliquot is held as a back-up, "retained" sample until all the analytical results are received and determined to be valid.

All radionuclide results are compared to the following limitations defined as part of the RGPP:

- Internal Administrative Control Limits are defined within the RGPP procedures. They are developed based on a statistical analysis of the historical baseline concentrations of tritium in each specific well and are used to identify tritium concentrations that warrant further investigation for that specific well. Solely exceeding an Administrative Control Limit does not initiate external communication, unless the external reporting limit is also exceeded.

- The Courtesy Communication Limit is a tritium concentration, below regulatory requirements, based on agreements with NJDEP-BNE, USNRC and other stakeholders ensuring the stakeholders are cognizant of potential issues. If a confirmed tritium result, collected from a RGPP well, exceeds the Courtesy Communication Limit of 3,000 pCi/L, PSEG provides a courtesy communication by telephone no later than the end of the next business day to NJDEP-BNE. The NRC Site Resident is also informed. This is not a regulatory required communication.

- Voluntary Communication Limits are those concentrations of radionuclides that require voluntary communication and reporting to regulators and/or stakeholders based on NEI 07-07, the ODCMs, and Site procedures.

III. Discussion

The locations of the RGPP monitoring wells located at HCGS and SGS are depicted on Figures 1 and 2, respectively. Additionally, well construction details for the HCGS RGPP wells and SGS RGPP wells are presented on Tables 1 and 2, respectively. The relevant radiological parameters used to evaluate the groundwater analytical results are provided in Table 4. The groundwater tritium analytical results for HCGS and SGS are shown on Tables 5 and 6, respectively.

1. Groundwater Results - RGPP

Groundwater samples were collected from all RGPP monitoring wells during 2017 in accordance with the Station and PSEG's Laboratory and Testing Services (LTS) procedures for the RGPP. Sample results are discussed below.

A. HCGS RGPP Wells

Tritium analytical results for groundwater samples collected during 2017 from HCGS RGPP monitoring wells are summarized below and are presented in Table 5.

- Tritium was not detected in groundwater samples collected from 7 of the 13 HCGS RGPP wells (wells BH, BL, BP, BQ, BR, BS, and BT).
- Well BI: Tritium was not detected in samples collected in January, August, and November 2016. Tritium was detected in the sample collected in May 2017 at a concentration of 329 pCi/L. Well BI is located west of the reactor containment and is a sentinel (source) well for facilities and buried piping.
- Well BJ: Tritium concentrations detected in well BJ ranged from 1,350 pCi/L (July 2017) to 2,100 pCi/L (December 2017) and averaged 1,675 pCi/L, during 2017. Well BJ is located near the HCGS main permitted gaseous effluent vent (i.e., south plant vent).
- Well BK: Tritium was not detected in the sample collected in November 2017. Tritium was detected in the sample collected in May 2017 at a concentration of 501 pCi/L. Well BK is located due west of the reactor containment and functions as a perimeter well.

- Well BM: Tritium was not detected in the sample collected in February 2017. Tritium was detected at concentrations ranging from 299 pCi/L (November 2017) to 423 pCi/L (December 2017). Well BM is located west of the abandoned Unit 2 reactor building and is a sentinel (source) well for facilities and buried piping.
- Well BN: Tritium concentrations detected in well BN ranged from 538 pCi/L (August 2017) to 937 pCi/L (May 2017) and averaged 763 pCi/L. Well BN is located northeast of the Materials Control Center and is a sentinel (source) well for the Auxiliary Boiler building and buried piping.
- Well BO: Tritium was not detected in samples taken in February, September, October, and November. Detected concentrations ranged from 214 pCi/L (December 2017) to 820 pCi/L (May 2017). Well BO is located northeast of the Materials Control Center and is a sentinel (source) well for the Auxiliary Boiler building and buried piping.
- There were no analytical results for which a Courtesy Communication (greater than 3,000 pCi/L tritium) was required as part of the HCGS RGPP.

With the exception of tritium, no plant-related radionuclides were detected in any HCGS RGPP well sampled in 2017.

B. <u>SGS RGPP Wells</u>

Tritium analytical results for groundwater samples collected during 2017 from SGS RGPP monitoring wells are summarized below and are presented on Table 6.

- Tritium was not detected in groundwater samples collected from 6 of the 13 SGS RGPP wells (wells BA, BB, BF, BU, T, and Y).
- Well AL was sampled in May and November 2017, with results of 417 pCi/L and 381 pCi/L respectively. Well AL is located south of the SGS Unit 1 reactor building and is a sentinel (source) well.
- Well BC: Tritium was detected at concentrations ranging from 381 pCi/L (February 2017) to 2,210 pCi/L (July 2017) and averaged 1,239 pCi/L. Well BC is a sentinel (source)/perimeter well located southwest of Facilities, Refueling Water Storage Tank, Auxiliary Feedwater Storage Tank and Primary Water Storage Tank (RAP) tanks and piping.
- Well BD: Tritium was detected at concentrations ranging from 380 pCi/L (September 2017) to 724 pCi/L (May 2017) and averaged 537 pCi/L. Well BD is located to the west of SGS Unit 2 reactor building and is a sentinel (source) well for Facilities, RAP tanks, and piping.
- Well BE: Tritium was not detected in samples collected in February, and November 2017. Tritium was detected at concentrations of 403 pCi/L

(May 2017) and 207 pCi/L (August 2017). Well BE is located to the west of SGS Unit 2 reactor building and is a perimeter well.

- Well BG: Tritium was not detected in the samples collected in February, August, and November 2017. Tritium was detected at a concentration of 242 pCi/L (May 2017). Well BG is located northwest of SGS Unit 2 reactor building and is a perimeter well.
- Well U: Tritium was detected at concentrations ranging from 206 pCi/L (November 2017) to 350 pCi/L (May 2017). Well U is located north of SGS Unit 2 reactor building and is a sentinel (source) well for the House Heating Boilers.
- Well Z: Tritium was detected at concentrations ranging from 3017 pCi/L (November 2017) to 1153 pCi/L (May 2017) and averaged 537 pCi/L. Well Z is located west of the SGS Unit 1 & 2 reactor buildings and is a perimeter well.
- There were no analytical results for which a Courtesy Communication (greater than 3,000 pCi/L tritium) was required as part of the SGS RGPP.

With the exception of tritium, no plant-related gamma emitters or other plant related radionuclides were detected during 2017 in any SGS RGPP wells.

2. Mass Flux Estimation of Tritium to the Delaware River

PSEG uses transect methods to calculate the mass flux of tritium to the Delaware River in the shallow, water bearing unit and the deeper basal sand unit and Vincentown Formation. To calculate the mass flux, the tritium concentration was conservatively estimated using the average concentration detected in monitoring wells located nearest to the Delaware River during each quarter. During 2017, the mass flux within the shallow, water bearing unit and deeper groundwater was estimated to be 0.011 Ci and 0.007 Ci, respectively. Therefore, the total potential estimated mass flux of tritium in groundwater reaching the Delaware River during 2017 was 0.017 Ci.

The calculated mass flux of 0.017 Ci (total of four quarterly estimates) was included in the Station's liquid effluent discharge and reported in the data tables of the ARERR.

3. Investigations

A. Groundwater Monitoring Well Data (Non-RGPP)

As previously discussed, PSEG Nuclear monitors a series of wells located at the Site. The ITMP is comprised of the RGPP wells, the RAWP wells, the ESP wells and a series of monitoring wells that were installed to investigate groundwater quality, but are not included as part of the RGPP or RAWP. Well construction details and tritium analytical results for the wells described above that are not specifically part of the RGPP are presented on Table 3 and Table 7, respectively.

B. SGS Service Water Return Header Isolation Valve Project Dewatering Activities

PSEG operated a dewatering system from August 2014 through November 2014, July 2015 through June 2016, March 23, 2017 through May 12, 2017, and October 4, 2017 through November 14, 2017 to remove groundwater from an excavation where the Service Water return header joins the Circulating Water Return line. Dewatering was performed to maintain excavation integrity in addition to ensure suitable working conditions during project activities.

Specifically, during 2017, PSEG operated the dewatering system from March 23, 2017 through May 12 and October 4, 2017 through November 14, 2017. Dewatering occurred 24 hours a day and utilized sump pumps from within the excavation. Collectively, the dewatering activities removed anywhere between 20 gallons per minute (gpm) and 60 gpm of groundwater from the shallow, water-bearing unit.

SGS Chemistry collected samples of the recovered groundwater for tritium and gamma analysis. When tritium was detected, liquid effluent release permits were generated.

During the dewatering period of March 23, 2017 through May 12, 2017 there was no tritium detected. PSEG estimated 1.4 gallons of water were removed through dewatering activities during this period.

During the dewatering period of October 4, 2017 through November 14, 2017 tritium detections ranged from non-detect (<1,670 pCi/L) to 3,750 pCi/L. PSEG estimated 1.2 million gallons of water and 0.012 Ci of tritium were removed through dewatering activities during this period.

Gamma emitting isotopes were not detected in any of the 2017 dewatering groundwater samples.

C. Focused Remediation at Well AC

On April 3, 2017, PSEG resumed the focused remediation at well AC by purging on average 525 gallons of groundwater per week. PSEG temporarily suspended focused remediation activities on October 5, 2017 to eliminate potential complications caused by freezing weather conditions. Purged groundwater was transferred to the non-radiological liquid waste basin for release through the PSEG permitted liquid effluent outfall. During 2017 focused remediation activities, a total of approximately 14,175 gallons were purged and approximately 0.00281 curies of tritium were removed from groundwater.

D. Well AF-V Installation

After installation and well development in November 2016, Well AF-V was first sampled on January 4, 2017. The monthly results for 2017 are provided in Table 7. In summary, tritium detections ranged between 228 pCi/L (February 2017) and 425 pCi/L (January 2017). Further, tritium was not detected in April, May, and July through December 2017.

E. Past Spills and Leaks: Impacts to Groundwater

In 2017, there were no known active unmonitored or unevaluated releases into the groundwater at the Station.

As part of the installation of service water isolation valves, tritium was detected intermittently in the dewatering effluent associated with the excavation during the period October 4, 2017 through November 14, 2017. Conservative effluent release permits were created to capture the tritium released and the associated dose impacts. The results of these permits are contained in the release totals earlier in the report.

In conclusion, PSEG has not detected an unmonitored release of radionuclides to the environment from the 2017 operation of the Site.

IV. RGPP 2018 Status

The RGPP long-term sampling program will be modified as required to meet the RGPP objectives. Baseline sampling and analysis of groundwater is planned to continue on the following schedule:

- Tritium will be analyzed at least semi-annually each calendar year to a detection capability less than or equal to 200 pCi/L;
- Plant-related gamma emitters will be analyzed semi-annually to the environmental detection limits specified in the ODCM;
- RGPP monitoring well sample frequency will be adjusted as needed based on analytical results.

V. References

1. Arcadis, 2004. Remedial Investigation Work Plan. PSEG Nuclear LLC. Salem Generating Station, Hancocks Bridge, New Jersey.
2. Arcadis, 2006A. Site Investigation Report July 2006. PSEG Nuclear LLC. Hope Creek Generating Station, Hancock's Bridge, New Jersey.
3. Arcadis, 2006B. Site Investigation Report July 2006. PSEG Nuclear LLC. Salem Generating Station, Hancock's Bridge, New Jersey.
4. Arcadis, 2013. Revised Salem Unit 2 Remedial Investigation Work Plan Addendum. PSEG Nuclear LLC. December 2013.
5. Arcadis, 2014. Remedial Action Work Plan Addendum. PSEG Nuclear LLC. Salem, Hancock's Bridge, New Jersey. April 10, 2014.
6. Arcadis, 2016. Well AF-V Installation Work Plan. PSEG Nuclear LLC.
7. NEI, 2007. NEI 07-07, Industry Groundwater Protection Initiative – Final Guidance Document, Nuclear Energy Institute, Washington, DC, June 2007.

Table 1. RGPP Well Construction Details, HCGS

Well ID	Installation Date	Construction Details	Diameter (inches)	Total Depth (feet bgs)	Monitoring Interval (feet bgs)	MP Elevation (feet RPD)	MP Elevation (feet amsl)	Monitoring Purpose	Source Targets
Well BH	May-06	Sch-40 PVC	4	37.0	27.0 - 37.0	101.16	11.24	Perimeter	NA
Well BI	May-06	Sch-40 PVC	4	37.0	27.0 - 37.0	103.07	13.15	Source	Facilities; Piping
Well BJ	May-06	Sch-40 PVC	4	38.0	28.0 - 38.0	102.97	13.05	Source	Condensate Storage & Transfer; Facilities; Piping
Well BK	May-06	Sch-40 PVC	4	38.5	28.5 - 38.5	101.42	11.50	Perimeter	NA
Well BL	May-06	Sch-40 PVC	4	37.0	27.0 - 37.0	102.69	12.77	Perimeter	NA
Well BM	May-06	Sch-40 PVC	4	37.5	27.5 - 37.5	102.75	12.83	Source	Facilities; Piping
Well BN	May-06	Sch-40 PVC	4	12.5	7.5 - 12.5	102.64	12.72	Source	Auxiliary Boiler Building; Piping
Well BO	May-06	Sch-40 PVC	4	35.0	25.0 - 35.0	97.98	8.06	Perimeter/Source	Building Sewage
Well BP	May-06	Sch-40 PVC	4	38.0	28.0 - 38.0	99.06	9.14	Perimeter/Source	Building Sewage
Well BQ	May-06	Sch-40 PVC	4	42.0	32.0 - 42.0	105.62	15.70	Source	Auxiliary Boiler Building; Dry Cask Storage Building; Piping
Well BR	May-06	Sch-40 PVC	4	40.5	30.5 - 40.5	104.28	14.36	Perimeter/Source	Piping; Dry Cask Storage Building
Well BS	May-06	Sch-40 PVC	4	35.0	25.0 - 35.0	100.55	10.63	Upgradient	NA
Well BT	May-06	Sch-40 PVC	4	38.5	28.5 - 38.5	99.60	9.68	Upgradient	NA

Notes:

MP Measuring Point

bgs Below ground surface

RPD Relative to plant datum

amsl Above mean sea level (NAVD 1988)

NA Not applicable

Table 2. RGPP Well Construction Details, SGS

Well ID	Installation Date	Construction Details	Diameter (inches)	Total Depth (feet bgs)	Monitoring Interval (feet bgs)	MP Elevation (feet RPD)	MP Elevation (feet amsl)	Monitoring Purpose	Source Targets
Well T	Jun-03	Sch-40 PVC	2	31.2	21.2 - 31.2	104.13	14.21	Source	Facilities; House Heating Boiler
Well U[1]	May-03	Sch-40 PVC	2	32.2	27.2 - 32.2	101.46	11.54	Source	Facilities; House Heating Boiler
Well Y	Sep-03	Sch-40 PVC	2	37.0	27.0 - 37.0	101.81	11.89	Perimeter	NA
Well Z	Sep-03	Sch-40 PVC	2	37.5	27.5 - 37.5	101.86	11.94	Perimeter	NA
Well AL	Jan-04	Sch-40 PVC	2	25.3	15.3 - 25.3	99.13	9.21	Perimeter	NA
Well BA	May-06	Sch-40 PVC	4	39.5	29.5 - 39.5	101.07	11.15	Perimeter	NA
Well BB[1]	May-06	Sch-40 PVC	4	47.0	37.0 - 47.0	102.18	12.26	Perimeter	NA
Well BC	May-06	Sch-40 PVC	4	38.0	28.0 - 38.0	98.78	8.86	Source / Perimeter	Facilities; RAP Tanks; Piping
Well BD	May-06	Sch-40 PVC	4	40.5	30.5 - 40.5	98.78	8.86	Source	Facilities; RAP Tanks; Piping
Well BE	May-06	Sch-40 PVC	4	37.0	27.0 - 37.0	98.31	8.39	Perimeter	NA
Well BF[1]	May-06	Sch-40 PVC	4	42.0	32.0 - 42.0	101.45	11.53	Perimeter	NA
Well BG[1]	May-06	Sch-40 PVC	4	37.0	27.0 - 37.0	103.34	13.42	Perimeter	NA
Well BU	May-06	Sch-40 PVC	4	36.0	26.0 - 36.0	100.16	10.24	Upgradient	NA

Notes:

MP Measuring Point

bgs Below ground surface

RPD Relative to plant datum

amsl Above mean sea level (NAVD 1988)

NA Not applicable

1 Monitoring wells U, BB, BF, and BG were surveyed in July/August 2013 following retrofitting or repair activities.

Table 3. Well Construction Details, Investigation and Monitoring Wells

Well ID	Installation Date	Construction Details	Diameter (inches)	Total Depth (feet bgs)	Monitoring Interval (feet bgs)	Monitored Hydrogeologic Unit	MP Elevation (feet RPD)	MP Elevation (feet amsl)
Well K	Feb-03	Sch-40 PVC	2	80.0	70.0 - 80.0	Vincentown[1]	102.00	12.08
Well L	Jan-03	Sch-40 PVC	2	80.0	70.0 - 80.0	Vincentown[1]	101.46	11.54
Well M	May-03	Sch-40 PVC	1	20.0	10.0 - 20.0	Cofferdam[2]	102.17	12.25
Well N	Jan-03	Sch-40 PVC	2	20.0	10.0 - 20.0	Cofferdam[2]	101.65	11.73
Well O	Jan-03	Sch-40 PVC	2	20.0	10.0 - 20.0	Cofferdam[2]	101.33	11.41
Well P	Mar-03	Sch-40 PVC	2	80.0	70.0 - 80.0	Vincentown[1]	101.13	11.21
Well Q	Mar-03	Sch-40 PVC	2	80.0	70.0 - 80.0	Vincentown[1]	106.59	16.67
Well EOW-4L	Jan-09	Sch-40 PVC	2	120.2	110.2-120.2	Vincentown[1]	112.23	22.31
Well R	Jun-03	Sch-40 PVC	1	19.0	9.0 - 19.0	Cofferdam[2]	102.35	12.43
Well S[4]	May-03	Sch-40 PVC	2	34.7	24.7 - 34.7	Shallow[3]	99.04	9.12
Well S-V	May-14	Sch-40 PVC	4	85.0	75.0 - 85.0	Vincentown[1]	101.00	11.08
Well V[6]	Jun-03	Sch-40 PVC	2	79.5	69.5 - 79.5	Vincentown[1]	101.72	11.80
Well W[6]	Jun-03	Sch-40 PVC	2	35.0	25.0 - 35.0	Shallow[3]	98.49	8.57
Well AA[4]	Sep-03	Sch-40 PVC	2	36.0	26.0 - 36.0	Shallow[3]	99.07	9.15
Well AA-V	May-13	Sch-40 PVC	2	85.0	75.0 - 85.0	Vincentown[1]	100.80	10.88
Well AB[4]	Oct-03	Sch-40 PVC	2	42.0	32.0- 42.0	Shallow[3]	98.93	9.01
Well AC[4]	Sep-03	Sch-40 PVC	2	24.0	14.0 - 24.0	Cofferdam[2]	98.77	8.85
Well AD[4]	Oct-03	Sch-40 PVC	6	43.0	33.0 - 43.0	Shallow[3]	98.99	9.07
Well AE	Oct-03	Sch-40 PVC	2	27.5	17.5 - 27.5	Cofferdam[2]	101.54	11.62
Well AF	Oct-03	Sch-40 PVC	2	45.0	35.0 - 45.0	Shallow[3]	101.61	11.69
Well AF-V	Nov-16	Sch-40 PVC	4	91.0	71.0 - 91.0	Vincentown[1]	101.38	11.46
Well AG-Shallow	Feb-04	Sch-40 PVC	1	24.2	14.2 - 24.2	Shallow[3]	99.29	9.37
Well AG-Deep	Feb-04	Sch-40 PVC	1	40.0	30.0 - 40.0	Shallow[3]	99.20	9.28
Well AH-Shallow	Feb-04	Sch-40 PVC	1	24.5	14.5 - 24.5	Shallow[3]	102.58	12.66

Table 3. Well Construction Details, Investigation and Monitoring Wells

Well ID	Installation Date	Construction Details	Diameter (inches)	Total Depth (feet bgs)	Monitoring Interval (feet bgs)	Monitored Hydrogeologic Unit	MP Elevation (feet RPD)	MP Elevation (feet amsl)
Well AH-Deep	Feb-04	Sch-40 PVC	1	40.0	30.0 - 40.0	Shallow[3]	102.70	12.78
Well AI	Jan-04	Sch-40 PVC	4	22.0	12.0 - 22.0	Cofferdam[2]	98.79	8.87
Well AJ	Jan-04	Sch-40 PVC	4	35.3	15.3 - 35.3	Shallow[3]	98.85	8.93
Well AM	Jan-04	Sch-40 PVC	4	20.9	10.9 - 20.9	Cofferdam[2]	98.55	8.63
Well AN	Jun-04	Sch-40 PVC	4	25.0	10.0 - 25.0	Cofferdam[2]	98.76	8.84
Well AO	Jun-04	Sch-40 PVC	4	21.0	11.0 - 21.0	Cofferdam[2]	98.82	8.90
Well AP	Jun-04	Sch-40 PVC	4	40.0	15.0 - 40.0	Shallow[3]	98.65	8.73
Well AQ[5]	Jun-04	Sch-40 PVC	4	45.0	20.0 - 45.0	Shallow[3]	99.05	9.13
Well AR	Jun-04	Sch-40 PVC	4	43.0	18.0 - 43.0	Shallow[3]	99.22	9.30
Well AS	Jun-04	Sch-40 PVC	4	41.5	16.5 - 41.5	Shallow[3]	99.44	9.52
Well AT	Jun-04	Sch-40 PVC	4	44.0	19.0 - 44.0	Shallow[3]	99.25	9.33
Well BW[6]	Dec-06	Sch-40 PVC	1	10.0	5.0 - 10.0	Shallow[3]	101.62	11.70
Well BX[6]	Dec-06	Sch-40 PVC	1	10.0	5.0 - 10.0	Shallow[3]	101.79	11.87
Well BY	Nov-10	Sch-40 PVC	4	40.0	35.0 - 40.0	Shallow[3]	103.36	13.44
Well BZ	Nov-10	Sch-40 PVC	4	36.0	31.0 - 36.0	Shallow[3]	104.29	14.37
Well CA[6]	Dec-06	Sch-40 PVC	4	38.0	28.0 - 38.0	Shallow[3]	101.96	12.04
Well CB[7]	Dec-06	Sch-40 PVC	2	80.0	70.0 - 80.0	Vincentown[1]	98.98	9.06
Well DA[6]	Nov-10	Sch-40 PVC	4	17.0	12.0 - 17.0	Cofferdam[2]	99.04	9.12
Well DB	Nov-10	Sch-40 PVC	4	21.0	16.0 - 21.0	Cofferdam[2]	101.69	11.77
Well DC	Nov-10	Sch-40 PVC	4	22.0	17.0 - 22.0	Cofferdam[2]	100.90	10.98
Well DD	Nov-10	Sch-40 PVC	4	19.0	14.0 - 19.0	Cofferdam[2]	101.23	11.31
Well DE	Nov-10	Sch-40 PVC	4	18.0	13.0 - 18.0	Cofferdam[2]	101.43	11.51
Well DF	Nov-10	Sch-40 PVC	4	19.0	14.0 - 19.0	Cofferdam[2]	101.32	11.40

Table 3. Well Construction Details, Investigation and Monitoring Wells

Well ID	Installation Date	Construction Details	Diameter (inches)	Total Depth (feet bgs)	Monitoring Interval (feet bgs)	Monitored Hydrogeologic Unit	MP Elevation (feet RPD)	MP Elevation (feet amsl)
Well DG	Nov-10	Sch-40 PVC	2	13.5	11.5 - 13.5	Cofferdam[2]	98.98	9.06
Well DH	Oct-10	Sch-40 PVC	4	21.0	16.0 - 21.0	Cofferdam[2]	101.54	11.62
Well DI	Oct-10	Sch-40 PVC	4	18.0	13.0 - 18.0	Cofferdam[2]	101.64	11.72
Well DJ	Oct-10	Sch-40 PVC	2	11.0	6.0 - 11.0	Cofferdam[2]	99.03	9.11

Notes:

MP Measuring point

bgs Below ground surface

RPD Relative to plant datum

amsl Above mean sea level (NAVD 1988)

1 Monitoring well is screened in the Vincentown Formation.

2 Monitoring well is screened in the shallow, water-bearing unit at a location within the limits of the cofferdam.

3 Monitoring well is screened in the shallow, water-bearing unit at a location outside the limits of the cofferdam.

4 The surface completions of Monitoring Wells S, AA, AB, AC, and AD were converted from above-grade to flush-grade in February 2004.

5 Monitoring well AQ was abandoned in November 2016.

6 Monitoring wells BW, BX, CA, DA, V, and W were surveyed in July/August 2013 following retrofitting or repair activities.

7 Monitoring well CB was abandoned in May 2013

Table 4. Relevant Groundwater Evaluation Criteria, SGS and HCGS

Isotope	RGPP LLD (pCi/L)	PSEG Reporting Level (pCi/L)
Tritium	200	30,000
Total Strontium	2	8
Mn-54	15	1,000
Fe-59	30	400
Co-60	15	300
Zn-65	30	300
Nb-95	15	400
Zr-95	15	400
Cs-134	15	30
Cs-137	18	50
Ba-140	60	200
La-140	15	200

Notes:

LLD Lower Limit of Detection

pCi/L Picocuries per liter

Table 5. Tritium Analytical Results, HCGS RGPP Wells

Well ID	Sample Date	Tritium Result (pCi/L)
Well BH	02/07/17	< 198
Well BH	05/10/17	< 187
Well BH	08/11/17	< 173
Well BH	11/07/17	< 177
Well BI	02/07/17	< 200
Well BI	05/09/17	**329**
Well BI	08/14/17	< 171
Well BI	11/07/17	< 173
Well BJ	02/10/17	**1,610**
Well BJ	05/09/17	**1,900**
Well BJ	07/20/17	**1,350**
Well BJ	08/14/17	**1,690**
Well BJ	09/07/17	**1,630**
Well BJ	10/04/17	**1,470**
Well BJ	11/06/17	**1,650**
Well BJ	12/05/17	**2,100**
Well BK	05/10/17	**501**
Well BK	11/07/17	< 175
Well BL	05/09/17	< 184
Well BL	11/07/17	< 175
Well BM	02/07/17	< 197
Well BM	05/09/17	**328**
Well BM	07/20/17	**391**
Well BM	08/11/17	**358**
Well BM	09/06/17	**355**
Well BM	10/04/17	**305**
Well BM	11/06/17	**299**
Well BM	12/05/17	**423**

Table 5. Tritium Analytical Results, HCGS RGPP Wells (cont.)

Well ID	Sample Date	Tritium Result (pCi/L)
Well BN	02/08/17	**601**
Well BN	05/08/17	**937**
Well BN	06/12/17	**887**
Well BN	07/10/17	**751**
Well BN	08/10/17	**538**
Well BN	09/08/17	**786**
Well BN	10/04/17	**666**
Well BN	11/06/17	**799**
Well BN	12/04/17	**899**
Well BO	02/08/17	< 191
Well BO	05/08/17	**820**
Well BO	06/12/17	**353**
Well BO	07/10/17	**324**
Well BO	08/10/17	**514**
Well BO	09/08/17	< 185
Well BO	10/04/17	< 183
Well BO	11/07/17	< 178
Well BO	12/04/17	**214**
Well BP	05/08/17	< 193
Well BP	11/06/17	< 195
Well BQ	02/08/17	< 190
Well BQ	05/09/17	< 189
Well BQ	07/14/17	< 192
Well BQ	11/08/17	< 198
Well BR	05/08/17	< 194
Well BR	11/06/17	< 195
Well BS	05/09/17	< 183
Well BS	11/07/17	< 194
Well BT	05/03/17	< 199
Well BT	11/06/17	< 195

Notes:

pCi/L Picocuries per liter

< Tritium not detected above indicated concentration

214 Bolded values indicate tritium was detected

Table 6. Tritium Analytical Results, SGS RGPP Wells

Well ID	Sample Date	Tritium Result (pCi/L)
Well AL	05/01/17	**417**
Well AL	11/10/17	**381**
Well BA	05/04/17	< 188
Well BA	11/09/17	< 196
Well BB	05/04/17	< 191
Well BB	11/09/17	< 196
Well BC	02/08/17	**381**
Well BC	05/03/17	**1,760**
Well BC	07/19/17	**2,210**
Well BC	08/10/17	**1,360**
Well BC	09/07/17	**1,110**
Well BC	10/02/17	**1,300**
Well BC	11/10/17	**895**
Well BC	12/05/17	**894**
Well BD	02/06/17	**513**
Well BD	05/02/17	**724**
Well BD	07/13/17	**541**
Well BD	08/09/17	**640**
Well BD	09/05/17	**380**
Well BD	10/03/17	**519**
Well BD	11/08/17	**403**
Well BD	12/06/17	**577**
Well BE	02/07/17	< 189
Well BE	05/03/17	**403**
Well BE	08/14/17	**207**
Well BE	11/08/17	< 194

Table 6. Tritium Analytical Results, SGS RGPP Wells (cont.)

Well ID	Sample Date	Tritium Result (pCi/L)
Well BF	05/03/17	< 185
Well BF	11/10/17	< 195
Well BG	02/10/17	< 190
Well BG	05/10/17	**242**
Well BG	08/14/17	< 190
Well BG	11/08/17	< 195
Well BU	05/03/17	< 180
Well BU	11/06/17	< 195
Well T	02/07/17	< 188
Well T	05/10/17	< 189
Well T	08/14/17	< 188
Well T	11/09/17	< 194
Well U	02/07/17	**289**
Well U	05/03/17	**350**
Well U	08/14/17	**253**
Well U	11/09/17	**206**
Well Y	05/04/17	< 188
Well Y	11/09/17	< 195
Well Z	05/04/17	**1,153**
Well Z	07/19/17	**433**
Well Z	08/10/17	**498**
Well Z	09/07/17	**379**
Well Z	10/02/17	**441**
Well Z	11/09/17	**317**

Notes:

pCi/L — Picocuries per liter

< — Tritium not detected above indicated concentration

214 — Bolded values indicate tritium was detected

Table 7
Tritium Analytical Results, Investigation & Monitoring Wells

Well ID	Sample Date	Tritium Result (pCi/L)
Well AA	01/11/17	**761**
Well AA	07/06/17	**1,240**
Well AA-V	01/12/17	**3,730**
Well AA-V	02/08/17	**2,150**
Well AA-V	03/06/17	**1,380**
Well AA-V	04/07/17	**1,130**
Well AA-V	05/01/17	**2,700**
Well AA-V	06/07/17	**425**
Well AA-V	07/06/17	**450**
Well AA-V	08/07/17	**603**
Well AA-V	09/07/17	**460**
Well AA-V	10/05/17	**219**
Well AA-V	11/09/17	**232**
Well AA-V	12/06/17	< 186
Well AB	01/12/17	**10,800**
Well AB	02/16/17	**6,250**
Well AB	03/07/17	**7,010**
Well AB	04/03/17	**19,500**
Well AB	05/04/17	**17,100**
Well AB	06/05/17	**15,100**
Well AB	07/07/17	**12,100**
Well AB	08/07/17	**11,700**
Well AB	09/05/17	**15,000**
Well AB	12/04/17	**12,400**
Well AC	01/05/17	**39,000**
Well AC	02/06/17	**35,500**
Well AC	03/09/17	**30,000**
Well AC	04/07/17	**64,600**
Well AC	05/04/17	**47,100**
Well AC	06/05/17	**42,700**
Well AC	07/07/17	**51,100**
Well AC	08/10/17	**50,900**
Well AC	09/06/17	**38,600**
Well AC	10/05/17	**46,300**
Well AC	11/08/17	**54,800**
Well AC	12/06/17	**43,300**

Table 7
Tritium Analytical Results, Investigation & Monitoring Wells (cont.)

Well ID	Sample Date	Tritium Result (pCi/L)
Well AC-MT*	04/07/17	**64,600**
Well AC-MT*	05/04/17	**47,100**
Well AC-MT*	06/05/17	**42,700**
Well AC-MT*	07/07/17	**51,100**
Well AC-MT*	08/10/17	**50,900**
Well AC-MT*	09/06/17	**38,600**
Well AC-MT*	10/05/17	**46,300**
Well AD	01/12/17	**12,400**
Well AD	02/16/17	**13,400**
Well AD	03/07/17	**14,500**
Well AD	04/03/17	**14,000**
Well AD	05/04/17	**3,590**
Well AD	06/05/17	**13,900**
Well AD	07/07/17	**10,900**
Well AD	08/07/17	**12,200**
Well AD	09/05/17	**12,100**
Well AD	11/07/17	**12,200**
Well AD	12/04/17	**13,100**
Well AE	01/06/17	**11,500**
Well AE	04/04/17	**14,100**
Well AE	07/12/17	**6,860**
Well AE	10/02/17	**5,840**
Well AF	01/04/17	< 197
Well AF	07/19/17	**397**
Well AF-V**	01/04/17	**394** **425** < 196 < 191
Well AF-V	02/10/17	**228**
Well AF-V	03/06/17	**403**
Well AF-V	04/05/17	< 191
Well AF-V	05/01/17	< 187
Well AF-V	06/05/17	**337**
Well AF-V	07/12/17	< 195
Well AF-V	08/09/17	< 172
Well AF-V	09/07/17	< 176
Well AF-V	10/06/17	< 186
Well AF-V	11/09/17	< 196
Well AF-V	12/06/17	< 188

Table 7
Tritium Analytical Results, Investigation & Monitoring Wells (cont.)

Well ID	Sample Date	Tritium Result (pCi/L)
Well AG-D	01/06/17	**898**
Well AG-D	07/11/17	**1,580**
Well AG-S	01/06/17	**858**
Well AG-S	07/11/17	**567**
Well AH-D	01/04/17	**1,010**
Well AH-D	07/20/17	**542**
Well AH-S	01/04/17	**1,880**
Well AH-S	07/20/17	**4,890**
Well AH-S	10/02/17	**347**
Well AI	01/04/17	**4,460**
Well AI	07/12/17	**2,980**
Well AJ	01/12/17	**7,890**
Well AJ	02/16/17	**12,700**
Well AJ	03/07/17	**16,500**
Well AJ	04/03/17	**12,700**
Well AJ	05/04/17	**6,310**
Well AJ	06/05/17	**13,200**
Well AJ	07/07/17	**7,420**
Well AJ	09/08/17	**3,460**
Well AJ	11/07/17	**3,810**
Well AJ	12/04/17	**19,100**
Well AL	05/01/17	**417**
Well AL	11/10/17	**381**
Well AM	01/05/17	**7,660**
Well AM	02/06/17	**9,850**
Well AM	03/09/17	**7,770**
Well AM	04/03/17	**5,730**
Well AM	05/02/17	**5,750**
Well AM	06/07/17	**7,050**
Well AM	07/13/17	**19,000**
Well AM	08/09/17	**12,000**
Well AM	09/05/17	**8,600**
Well AM	10/03/17	**8,870**
Well AM	11/08/17	**7,740**
Well AM	12/06/17	**7,790**

Table 7. Tritium Analytical Results, Investigation & Monitoring Wells (cont.)

Well ID	Sample Date	Tritium Result (pCi/L)
Well AN	01/12/17	**10,600**
Well AN	02/16/17	**14,100**
Well AN	03/07/17	**17,700**
Well AN	04/03/17	**19,700**
Well AN	05/04/17	**16,500**
Well AN	06/05/17	**18,900**
Well AN	07/07/17	**14,600**
Well AN	08/07/17	**6,170**
Well AN	09/05/17	**20,700**
Well AN	12/06/17	**23,300**
Well AP	01/06/17	**1,190**
Well AP	07/11/17	**1,800**
Well AR	01/10/17	**3,870**
Well AR	04/05/17	**8,340**
Well AR	07/10/17	**4,740**
Well AR	10/05/17	**5,340**
Well AS	01/10/17	**16,100**
Well AS	07/12/17	**17,400**
Well AT	01/12/17	**2,420**
Well AT	02/16/17	**2,150**
Well AT	03/07/17	**1,840**
Well AT	04/03/17	**2,450**
Well AT	05/04/17	**2,020**
Well AT	06/05/17	**1,980**
Well AT	07/07/17	**2,090**
Well AT	08/07/17	**2,330**
Well AT	09/05/17	**1,840**
Well AT	11/07/17	**1,700**
Well AT	12/04/17	**1,760**
Well BA	05/04/17	< 188
Well BA	11/09/17	< 196
Well BB	05/04/17	< 191
Well BB	11/09/17	< 196

Table 7. Tritium Analytical Results, Investigation & Monitoring Wells (cont.)

Well ID	Sample Date	Tritium Result (pCi/L)
Well BC	02/08/17	**381**
Well BC	05/03/17	**1,760**
Well BC	07/19/17	**2,210**
Well BC	08/10/17	**1,360**
Well BC	09/07/17	**1,110**
Well BC	10/02/17	**1,300**
Well BC	11/10/17	**895**
Well BC	12/05/17	**894**
Well BD	02/06/17	**513**
Well BD	05/02/17	**724**
Well BD	07/13/17	**541**
Well BD	08/09/17	**640**
Well BD	09/05/17	**380**
Well BD	10/03/17	**519**
Well BD	11/08/17	**403**
Well BD	12/06/17	**577**
Well BE	02/07/17	< 189
Well BE	05/03/17	**403**
Well BE	08/14/17	**207**
Well BE	11/08/17	< 194
Well BF	05/03/17	< 185
Well BF	11/10/17	< 195
Well BG	02/10/17	< 190
Well BG	05/10/17	**242**
Well BG	08/14/17	< 190
Well BG	11/08/17	< 195
Well BH	02/07/17	< 198
Well BH	05/10/17	< 187
Well BH	08/11/17	< 173
Well BH	11/07/17	< 177
Well BI	02/07/17	< 200
Well BI	05/09/17	**329**
Well BI	08/14/17	< 171
Well BI	11/07/17	< 173

Table 7. Tritium Analytical Results, Investigation & Monitoring Wells (cont.)

Well ID	Sample Date	Tritium Result (pCi/L)
Well BJ	02/10/17	**1,610**
Well BJ	05/09/17	**1,900**
Well BJ	07/20/17	**1,350**
Well BJ	08/14/17	**1,690**
Well BJ	09/07/17	**1,630**
Well BJ	10/04/17	**1,470**
Well BJ	11/06/17	**1,650**
Well BJ	12/05/17	**2,100**
Well BK	05/10/17	**501**
Well BK	11/07/17	< 175
Well BL	05/09/17	< 184
Well BL	11/07/17	< 175
Well BM	02/07/17	< 197
Well BM	05/09/17	**328**
Well BM	07/20/17	**391**
Well BM	08/11/17	**358**
Well BM	09/06/17	**355**
Well BM	10/04/17	**305**
Well BM	11/06/17	**299**
Well BM	12/05/17	**423**
Well BN	02/08/17	**601**
Well BN	05/08/17	**937**
Well BN	06/12/17	**887**
Well BN	07/10/17	**751**
Well BN	08/10/17	**538**
Well BN	09/08/17	**786**
Well BN	10/04/17	**666**
Well BN	11/06/17	**799**
Well BN	12/04/17	**899**
Well BO	02/08/17	< 191
Well BO	05/08/17	**820**
Well BO	06/12/17	**353**
Well BO	07/10/17	**324**
Well BO	08/10/17	**514**
Well BO	09/08/17	< 185
Well BO	10/04/17	< 183
Well BO	11/07/17	< 178
Well BO	12/04/17	**214**

Table 7. Tritium Analytical Results, Investigation & Monitoring Wells (cont.)

Well ID	Sample Date	Tritium Result (pCi/L)
Well BP	05/08/17	< 193
Well BP	11/06/17	< 195
Well BQ	02/08/17	< 190
Well BQ	05/09/17	< 189
Well BQ	07/14/17	< 192
Well BQ	11/08/17	< 198
Well BR	05/08/17	< 194
Well BR	11/06/17	< 195
Well BS	05/09/17	< 183
Well BS	11/07/17	< 194
Well BT	05/03/17	< 199
Well BT	11/06/17	< 195
Well BU	05/03/17	< 180
Well BU	11/06/17	< 195
Well BW	05/04/17	**922**
Well BW	11/09/17	**813**
Well BX	05/04/17	**921**
Well BX	11/09/17	**1,560**
Well BY	01/11/17	**13,900**
Well BY	02/10/17	**23,000**
Well BY	03/07/17	**29,900**
Well BY	04/04/17	**36,000**
Well BY	05/04/17	**33,500**
Well BY	06/06/17	**37,300**
Well BY	07/14/17	**29,100**
Well BY	08/10/17	**27,900**
Well BY	09/06/17	**24,600**
Well BY	10/04/17	**19,800**
Well BY	11/06/17	**23,500**
Well BY	12/05/17	**19,000**
Well BZ	05/04/17	**937**
Well BZ	11/06/17	**4,300**
Well CA	01/06/17	**1,580**
Well CA	07/05/17	**2,100**

Table 7. Tritium Analytical Results, Investigation & Monitoring Wells (cont.)

Well ID	Sample Date	Tritium Result (pCi/L)
Well DA	01/11/17	**2,190**
Well DA	04/04/17	**3,100**
Well DA	07/19/17	**5,360**
Well DA	10/02/17	**3,930**
Well DA	11/08/17	**3,920**
Well DB	01/05/17	**3,890**
Well DB	04/03/17	**4,250**
Well DB	07/13/17	**4,690**
Well DB	10/03/17	**4,470**
Well DC	01/05/17	**1,540**
Well DC	07/13/17	**2,240**
Well DD	01/05/17	**8,650**
Well DD	04/03/17	**7,010**
Well DD	07/13/17	**6,720**
Well DD	10/03/17	**7,730**
Well DE	01/05/17	**13,500**
Well DE	02/06/17	**11,700**
Well DE	03/09/17	**12,000**
Well DE	04/03/17	**11,100**
Well DE	05/02/17	**11,800**
Well DE	06/07/17	**11,500**
Well DE	07/13/17	**11,100**
Well DE	08/09/17	**10,800**
Well DE	09/05/17	**12,700**
Well DE	10/03/17	**12,300**
Well DE	11/08/17	**12,300**
Well DE	12/06/17	**12,100**
Well DF	01/05/17	**1,370**
Well DF	07/13/17	**1,470**
Well DG	01/05/17	**2,710**
Well DG	04/04/17	**2,720**
Well DG	07/13/17	**3,350**
Well DG	10/05/17	**3,250**
Well DH	01/06/17	**8,650**
Well DH	04/05/17	**9,360**
Well DH	07/05/17	**11,400**
Well DH	10/05/17	**9,140**

Table 7. Tritium Analytical Results, Investigation & Monitoring Wells (cont.)

Well ID	Sample Date	Tritium Result (pCi/L)
Well DI	01/06/17	**2,690**
Well DI	04/05/17	**3,110**
Well DI	07/05/17	**2,400**
Well DI	10/05/17	**2,020**
Well DJ	01/06/17	**798**
Well DJ	07/05/17	**1,250**
EOW-4L †	02/13/17	< 192
EOW-4L †	07/10/17	< 183
Well K	01/10/17	< 193
Well K	07/11/17	< 188
Well L	01/11/17	< 191
Well L	07/19/17	< 193
Well M	01/05/17	**5,840**
Well M	04/04/17	**7,350**
Well M	07/20/17	**6,220**
Well M	10/03/17	**5,590**
Well N	01/05/17	**8,440**
Well N	04/03/17	**10,800**
Well N	07/13/17	**18,100**
Well N	10/03/17	**13,200**
Well O	01/06/17	**26,700**
Well O	02/06/17	**19,000**
Well O	03/06/17	**15,500**
Well O	04/04/17	**19,800**
Well O	05/01/17	**13,300**
Well O	06/05/17	**7,850**
Well O	07/12/17	**3,710**
Well O	08/10/17	**6,570**
Well O	09/05/17	**5,550**
Well O	10/02/17	**2,240**
Well O	11/10/17	**13,800**
Well O	12/05/17	**8,020**
Well P	01/10/17	< 196
Well P	07/19/17	< 196
Well Q	01/11/17	< 193

Table 7. Tritium Analytical Results, Investigation & Monitoring Wells (cont.)

Well ID	Sample Date	Tritium Result (pCi/L)
Well R	01/11/17	**3,540**
Well R	07/20/17	**3,440**
Well S	01/12/17	**6,730**
Well S	02/16/17	**1,830**
Well S	03/07/17	**15,200**
Well S	04/03/17	**2,160**
Well S	05/04/17	**5,740**
Well S	06/05/17	**396**
Well S	07/07/17	**1,710**
Well S	08/07/17	**4,560**
Well S	09/05/17	**11,300**
Well S	11/07/17	**6,720**
Well S	12/04/17	**7,240**
Well S-V	01/06/17	**5,430**
Well S-V	02/08/17	**4,960**
Well S-V	03/06/17	**1,750**
Well S-V	04/05/17	**1,380**
Well S-V	05/01/17	**1,080**
Well S-V	06/06/17	**691**
Well S-V	07/05/17	**878**
Well S-V	08/09/17	**878**
Well S-V	09/07/17	**1,020**
Well S-V	10/06/17	**1,150**
Well S-V	11/10/17	**280**
Well S-V	12/05/17	**1,280**
Well T	02/07/17	< 188
Well T	05/10/17	< 189
Well T	08/14/17	< 188
Well T	11/09/17	< 194
Well U	02/07/17	**289**
Well U	05/03/17	**350**
Well U	08/14/17	**253**
Well U	11/09/17	**206**
Well V	01/10/17	**214**
Well V	07/11/17	**212**
Well W	01/04/17	**2,880**
Well W	04/04/17	**4,130**
Well W	07/12/17	**4,420**
Well W	10/04/17	**4,210**

Table 7. Tritium Analytical Results, Investigation & Monitoring Wells (cont.)

Well ID	Sample Date	Tritium Result (pCi/L)
Well Y	05/04/17	< 188
Well Y	11/09/17	< 195
Well Z	05/04/17	**1,153**
Well Z	07/19/17	**433**
Well Z	08/10/17	**498**
Well Z	09/07/17	**379**
Well Z	10/02/17	**441**
Well Z	11/09/17	**317**

Notes:

pCi/L	Picocuries per liter
*	AC-MT samples are collected from a mobile water tank during purge activities associated with well AC.
**	On January 4, 2017, groundwater low-flow stratification sampling was conducted at well AF-V at four depth intervals (75, 80, 85, and 90 feet below ground surface) to vertically stratify the well screen.
†	EOW-4L is presented as supplemental data for Well Q
<	Tritium not detected above indicated concentration
214	Bolded values indicate tritium was detected
20,000	Tritium was detected above the New Jersey Department of Environmental Protection (NJDEP) Class II-A Groundwater Quality Standard (GWQS) of 20,000 pCi/L.

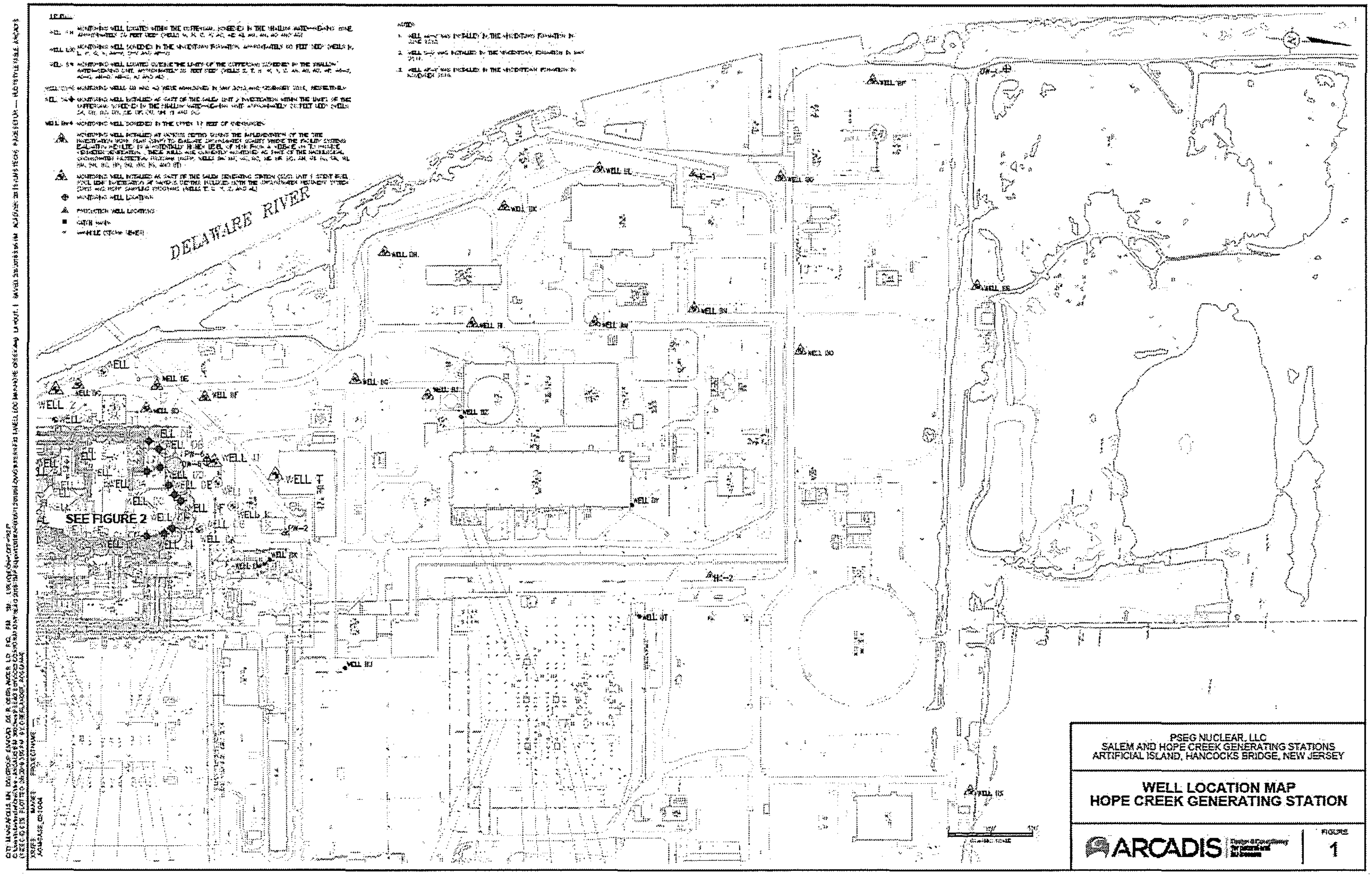

Figure 1. Well Location Map, Hope Creek Generating Station

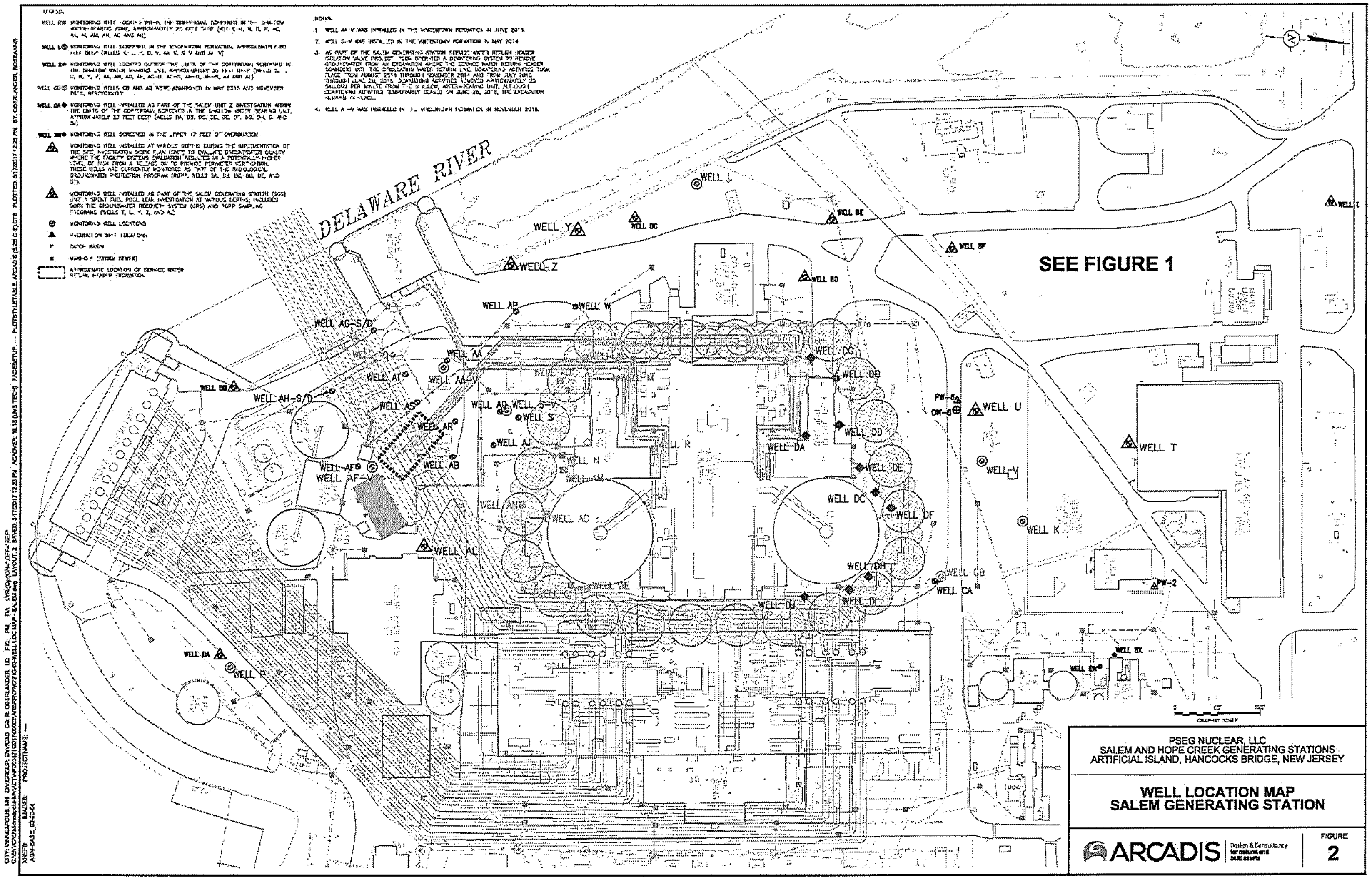

Figure 2. Well Location Map, Salem Generating Stat

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Enclosure 2

Revision 28 of Salem and Hope Creek Generating Stations'

Offsite Dose Calculation Manual

Supplement to the 2017 PSEG Nuclear Annual Radiological Effluent Release Report (ARERR)

Hope Creek ODCM Revision 28

Effective Date: 9/7/2017

(Revision Summary starts on page 2 of ODCM)

Salem ODCM Revision 28

Effective Date: 9/7/2017

(Revision Summary starts on page 3 of ODCM)

OFFSITE DOSE CALCULATION MANUAL

FOR

PSEG NUCLEAR LLC

HOPE CREEK GENERATING STATION

Revision 28

Prepared by:	Rick M. Heathwaite Hope Creek ODCM Coordinator	7/24/17 Date
Accepted by:	Shelly Kugler Hope Creek Chemistry Manager	7/31/17 Date
Accepted by:	Steve Poorman Hope Creek PORC Chairman	9/5/17 Date
	Meeting #: H2017-06	
Approved by:	Casulli Edward Hope Creek Plant Manager	9/7/17 Date

Revision Summary

This revision is effective after review and acceptance by the PORC and the approval and dated signature of the Plant General Manager.

Item No.	(old) Rev. 27 page No.	(new) Rev. 28 page No.	Description of Change	Type of Change
1	10	12	Defined date range for "new" 10 CFR Part 20 and "old" 10 CFR Part 20. Justification: Provided clarity for time period when the "new" 10 CFR Part 20 and "old" 10 CFR Part 20 were effective.	Editorial
2	22	25	Included 3 asterisks (***) on item 3.b to connect to Action 112. Justification: Need to add note for Action 112 for releases when service water by-pass is in service. (70175347/020)	Technical
3	23	26	Added note with 3 asterisks (***) to define action. Justification: Defined actions to take when liquid releases are being made when cooling tower is out of service and releases are using service water by-pass for dilution. (70175347/020)	Technical
4	40	40	The heading for the column, Lower Limit of Detection, on Table 4.11.2.1.2-1 was revised to include the proper units. The column had a typographical error. Justification: the units displayed in revision 27 on Table 4.11.2.1.2-1 were □Ci/ml, the units should be μCi/ml.	Editorial
5	40	40	Table 4.11.2.1.2-1. Updated item "D". Item D was changed from "All Release types as listed in A and B above" to "All Release types as listed in B and C above". Removed Item A. Justification: Item A, the Offgas Treatment System item was removed from the table as this is not a release point and is monitored by the North Plant Vent. Item A is now listed as "Not Used". Item D was revised to indicate it's applicable to only Items B and C. Item B is the containment purge and has unique and special sampling requirements prior to release due to the potential for releases into primary containment that may need to be accounted for as a batch release. This specification only applies to effluent release points which are the North Plant Vent, South Plant Vent, and the FRVS.	Editorial

Item No.	(old) Rev. 27 page No.	(new) Rev. 28 page No.	Description of Change	Type of Change
6	50	51	Updated Table 3.12.1-1, Radiological Environmental Monitoring Program, heading to remove the asterisk (*) and remove the item referenced by the asterisk (*) at the bottom of the page. Justification: The Item referenced by the asterisk (*) is a generic statement from NUREG-1302 to aid in the initial development of site specific environmental monitoring programs. The statement is no longer needed in the ODCM since the program is already established.	Editorial
7	50	51	Updated Table 3.12.1-1, item 1, third paragraph, to reflect current conditions. The outer ring of TLDs is in the 5 to 11 km range. Justifications The dosimeters were not relocated. The dosimeter sample location range was changed in ODCM Revision 27 because (6 to 8 km) is the range in NUREG-1302. NUREG-1302 also acknowledges that sample locations vary from site to site. Due to plant location, some of the ideal locations are not accessible or are over the water so alternate locations which are accessible were selected in the (5 to 11 km) range. This is not a change to the program but restores previously specified range of Revision 26. (70175881/010)	Editorial
8	52	53	Updated Table 3.12.1-1, Item 3.a, "Sampling Collection Frequency" from "Grab sample monthly" to "Grab sample semi-monthly and composited". Justification: the frequency was increased from monthly to semi-monthly and the sample composited for gamma analysis in order to collect a more representative surface water sample. (70152838/010)	Technical

Item No.	(old) Rev. 27 page No.	(new) Rev. 28 page No.	Description of Change	Type of Change
9	58-59	57-58	Corrected typographical error on Table 3.12.1-2. Corrected column heading "Airborne Particulate or Gases (pCi/m3)" to "Airborne Particulate or Gases (pCi/m^3)". Added note 1 to bottom of Tables 3.12.1-2 and 4.12.1-1 explaining that the H-3 and I-131 LLD/reporting values were used due to no drinking water exposure pathway. Justification: Corrected the exponent in the units for the Airborne column in Tables 3.12.1-2 and 4.12.1-1 to superscript. Note 1 for Table 3.12.1-2 explains why limit value is 30,000 pCi/L instead of 20,000 pCi/L and in Table 4.12.1-1 why LLD value is 3,000 instead of 2,000 pCi/L for H-3 as listed in NUREG-1302. Also explains why limit value is 20 pCi/L instead of 2 pCi/L and why LLD value is 15 pCi/L instead of 1 pCi/L for I-131 as listed in NUREG-1302. NUREG-1302 has notes allowing these higher values if no drinking water pathway exists. (70199487/010)	Editorial
10	63	60	Inserted a note, annotated with two asterisks (**), to ensure that receptors are on land instead of over water. Justification: The use of real receptors provides an actual dose to real pathways instead of hypothetical dose to hypothetical pathways. NUREG-0133 indicates that actual pathways should be used. (80113172/0490)	Editorial
11	66	63	Inserted information from WGE explaining rationale for time used to obtain particulate and iodine samples from gaseous release points. Justification: WGE in order 70177022/050 explained the acceptability of the specified time used to establish sampling when samplers are out service. Explanation of the time used at Hope Creek was requested to be inserted in the BASES by NRC.	Editorial

Item No.	(old) Rev. 27 page No.	(new) Rev. 28 page No.	Description of Change	Type of Change
12	70	67	Inserted a note to ensure that receptors are over land instead of water. Justification: The use of real receptors provides an actual dose to real pathways instead of hypothetical dose to hypothetical pathways. NUREG-0133 indicates that actual pathways should be used. (80113172/0490)	Editorial
13	91	90	Inserted a note to explain that as an extra measure of conservatism, there is a 25 percent reduction factor applied to the default setpoints. There is also a note explaining that the EALs are based on actual monitor readings not alarm setpoints. Justification: This item provides an explanation of the existing conditions in the ODCM and why the calculated setpoint is different from the default setpoint listed in the ODCM. (70179192/020)	Editorial
14	99	98	In Section 3.3, inserted “Revision 2” with Regulatory Guide 1.21 to indicate which revision of Regulatory Guide 1.21 is referenced for doses due to C-14 releases. Justification: This is consistent with the description contained in Section 3.3.1 for the estimation of C-14 annual releases. This is an editorial change.	Editorial
15	101	102	Updated Drawing to include service water bypass and label cooling tower blowdown line. Justification: Reflects current release pathways. (70175347/020)	Editorial
16	103	104	Adjusted Table 1-1 Column widths to proper size to contain existing information. Justification: Editorial change, columns not sized properly to hold all information. Change bars were not used for marking this editorial change.	Editorial
17	110	111	Reformatted Table 2-2. Updated Ci actual value description to include appropriate reference. Included Calculated Setpoint for RMS points and updated comment for clarification. Justification: Default setpoints were not changed, updated for clarification information only.	Editorial

Item No.	(old) Rev. 27 page No.	(new) Rev. 28 page No.	Description of Change	Type of Change
18	111	112	Updated Table 2-3, Item 3.11.2.3 to correct location. Correct location is 4.6 miles SW. Previous location was described incorrectly as 4.9 miles West. Changed the case of miles to lower case. Justification: Based on Land Use Census data the existing location was previously described incorrectly.	Editorial
19	112 through 122	113 through 123	Adjusted all columns in Table 2-4 so that numbers would fit. No data was changed. Justification: The numbers did not fit properly in the existing column widths and in some cases were not being fully displayed or printed thereby giving false indication of the number to use. This was an editorial change and no data was revised. Change bars not included since data was not altered.	Editorial
20	140	140	Changed the column 3 and 4 headings in the first table in Table C-1 to reflect the actual nomenclature as the descriptions found in the formulas. No data was changed. Reformatted the data into a table format. Table C-1 columns 3 and 4 of the Noble Gases –Air table were incorrectly labeled. The column headings were updated to reflect the same nomenclature as descriptions found in the formulas. Justification: equations C.1, C.2, C.3, and C.4 in Appendix C, "Determination of Effective Dose Factors" were used to correct the incorrect table headings. Table headings were corrected to agree with formulas and calculations.	Editorial
21	146	146-147	Updated sampling location descriptions to refer to new maps since there are now three maps instead of two as in revision 27. Appendix E Sample Designation page was completely revised. Justifications: New Sampling Locations Maps were made. Third map showing sampling location beyond 10 miles was added. Due to sampling location changes, new maps are required to show locations and station codes. Third map added for ease of reading. Appendix E Sample Designation changes were made to improve clarity and correct editorial items. Revision bars not used for this change	Editorial

Item No.	(old) Rev. 27 page No.	(new) Rev. 28 page No.	Description of Change	Type of Change
22	142 through 150	148 through 153	Table E-1, REMP Sample Locations, was updated to reflect current sample locations, add latitude and longitude information and to clarify ambiguous abbreviations. Justification: All sample locations were reviewed to ensure compliance with the requirements of ODCM Table 3.12.1-1, Radiological Environmental Monitoring Program. Sample locations were updated to reflect the actual current locations in the field. Latitude and longitudes were added to each sample location to ensure ease of location identification. Some location descriptions were improved to provide clarity. This rewrite corrects editorial items identified in review of 2014 ARERR. Revision bars not used for this change so individual changes could be marked.	Editorial
23	149	152	Table E-1.F, Water Sediment Locations (ESS), changed 6S2 to 6A1. Justification: 6S2 is already defined as an IDM location. ESS locations are beyond site boundary because they are over water so the ESS location was renamed 6A1.	Technical
24	150	153	Table E-1.I, Food Product Locations (FPL, FPV), 7S2 location added. 16S2 location name corrected to 15S2. Justification: 7S2 is a new location for FPL/FPV located next to the 7S2 air sampler. Also, the FPL/FPV location identified as 16S2 in Revision 27 of the ODCM was a typing error and should have been identified as 15S2. (70166150/030)	Technical
25	153-154	155-157	New Sampling Locations Maps were made. Third map showing sampling location beyond 10 miles was added. Revision bars not used for this change. Justification: Due to sampling location changes, new maps are required to show locations and station codes. Third map added for ease of reading.	Technical
26	156	159	Updated the description used in Appendix F to describe Table F-1, Maximum Permissible Concentrations. The description was updated to reflect the revision date of 10 CFR 20. Added a clarifying statement that this revision of 10 CFR 20 is referred to as the "old" 10 CFR 20. Justification: These were editorial changes only with no changes to existing data in the data tables. (70166487/010)	Editorial

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HOPE CREEK NUCLEAR GENERATING STATION
OFFSITE DOSE CALCULATION MANUAL

INTRODUCTION

The Hope Creek Offsite Dose Calculation Manual (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 and the Radiological Environmental Monitoring Programs required by Technical Specifications 6.8.4
- Descriptions of the information that should be included in the Annual Radiological Environmental Operating Report and the Annual Radioactive Effluent Release Report required by Technical Specifications 6.9.1.6 and 6.9.1.7, respectively.

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 list and graphical description of the specific sample locations for the radiological environmental monitoring program (REMP), and the liquid and gaseous waste treatment systems.

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

SECTION 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 OPERABILITY 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 OPERABILITY including alarm and/or trip functions.

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

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."

1.7 FREQUENCY NOTATION

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

1.8 MEMBER(S) OF THE PUBLIC

MEMBER(S) OF THE PUBLIC shall include all persons who are not occupationally associated with the plant. This category does not include employees of the licensee, its contractors, or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational or other purposes not associated with the plant

1.9 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.

1.10 OFFSITE DOSE CALCULATION MANUAL (ODCM)

The OFFSITE DOSE CALCULATION MANUAL (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, and in the conduct of the radiological environmental monitoring program. The ODCM shall also contain (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs required by Technical Specification Section 6.8.4 and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating Report and the Annual Radioactive Effluent Release Reports required by Technical Specification Sections 6.9.1.6 and 6.9.1.7, respectively.

1.11 OPERABLE - OPERABILITY

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).

1.12 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.

1.13 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.

1.14 RATED THERMAL POWER

RATED THERMAL POWER shall be a total reactor core heat transfer rate to the reactor coolant of 3840 MWT.

1.15 REPORTABLE EVENT

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

1.16 SITE BOUNDARY

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

1.17 SOURCE CHECK

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

1.18 THERMAL POWER

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

1.19 UNRESTRICTED AREA

An UNRESTRICTED AREA shall be any area at or beyond the SITE BOUNDARY, access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, or any area within the SITE BOUNDARY used for residential quarters or for industrial, commercial, institutional, and/or recreational purposes.

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

1.21 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.

TABLE 1.1: SURVEILLANCE FREQUENCY NOTATION

NOTATION	FREQUENCY
S	At least once per 12 hours
D	At least once per 24 hours
W	At least once per 7 days
M	At least once per 31 days
Q	At least once per 92 days
SA	At least once per 184 days
A	At least once per 366 days
R	At least once per 18 months (550 days)
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

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.

PART I

RADIOLOGICAL EFFLUENT CONTROLS

SECTION 3.0 AND 4.0

CONTROLS

AND

SURVEILLANCE REQUIREMENTS

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 OPERATIONAL CONDITIONS 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 an OPERATIONAL CONDITION in which the CONTROL does not apply by placing it, as applicable, in:

1. At least STARTUP within the next 6 hours,
2. At least HOT SHUTDOWN within the following 6 hours, and
3. At least COLD SHUTDOWN 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 OPERATIONAL CONDITION 4 or 5.

3.0.4 Entry into an OPERATIONAL CONDITIONS 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 an OPERATIONAL CONDITION 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 OPERATIONAL CONDITIONS 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 inoperable to comply with ACTIONS may be returned to service under administrative control solely to perform testing to demonstrate its OPERABILITY or the OPERABILITY 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 OPERABILITY.

4.0 SURVEILLANCE REQUIREMENTS

4.0.1 Surveillance Requirements shall be met during the OPERATIONAL CONDITIONS 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 OPERABILITY requirements for a CONTROL. The time limits of the ACTION requirements are applicable at the time it is identified that a Surveillance Requirement has not been performed. 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 inoperable equipment.

4.0.4 Entry into an OPERATIONAL CONDITION 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 OPERATIONAL CONDITIONS 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 6.8.4.g.1, the radioactive liquid effluent monitoring instrumentation channels shown in Table 3.3.7.10-1 shall be OPERABLE with their Alarm/Trip setpoints set to ensure that the limits of CONTROL 3.11.1.1 are not exceeded. The Alarm/Trip setpoints of these channels shall be determined 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 inoperable, or change the setpoint so it is acceptably conservative.

b. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 3.3.7.10-1. Exert best efforts to return the instrument to OPERABLE status within 30 days and, if unsuccessful, explain in the next Radioactive Effluent Release report why the inoperability was not corrected in a timely manner.

c. 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 OPERABLE 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

TABLE 3.3.7.10-1: RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	ACTION
1. Radioactivity Monitors Providing Alarm and Automatic Termination of Release		
a. Liquid Radwaste Discharge Line to the Cooling Tower Blowdown Line	1	110
b. Turbine Building Circulating Water Dewatering Sump Discharge Line to the Cooling Tower*	1	110
2. Radioactivity Monitors Providing Alarm but not Providing Automatic Termination of Release		
a. Cooling Tower Blowdown Effluent	1	111
3. Flow Rate Measurement Devices		
a. Liquid Radwaste Discharge Line to the Cooling Tower Blowdown Line	1	112
b. Cooling Tower Blowdown Weir***	1	112
c. Turbine Building Circulating Water Dewatering Sump Discharge Line**	N/A	N/A

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

ACTION 110 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that prior to initiating a release:

a. At least two independent samples are analyzed in accordance with 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 111 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that, at least once per 12 hours, grab samples are collected and analyzed for 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 OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 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.

** 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 OPERABLE for the flow rate measurement device is less than required by the Minimum Channels OPERABLE requirement. Effluent releases via this pathway may continue provided the flow rate is estimated at least once per 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.

TABLE 4.3.7.10-1: 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

TABLE 4.3.7.10-1: RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS – TABLE NOTATIONS (Continued)

(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 6.8.4.g.1, the radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.3.7.11-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of 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 inoperable, or change the setpoint so it is acceptably conservative.

b. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 3.3.7.11-1. Exert best efforts to return the instrument to OPERABLE status within 30 days and, if unsuccessful, explain in the next Radioactive Effluent Release Report pursuant to CONTROL 6.9.1.7 why this inoperability was not corrected in a timely manner.

c. 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 OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4.3.7.11-1.

TABLE 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	*	123
b. Iodine Sampler	1	*	125
c. Particulate Sampler	1	*	125
d. Flow Rate Monitor	1	*	122
e. Sampler Flow Rate Monitor	1	*	122
3. South Plant Vent Monitoring System			
a. Noble Gas Activity Monitor	1	*	123
b. Iodine Sampler	1	*	125
c. Particulate Sampler	1	*	125
d. Flow Rate Monitor	1	*	122
e. Sampler Flow Rate Monitor	1	*	122
4. North Plant Vent Monitoring System			
a. Noble Gas Activity Monitor	1	*	123
b. Iodine Sampler	1	*	125
c. Particulate Sampler	1	*	125
d. Flow Rate Monitor	1	*	122
e. Sampler Flow Rate Monitor	1	*	122

* At all times

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

ACTION 122 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours. Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 123 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided 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 OPERABLE less than required by the Minimum Channels OPERABLE 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.

TABLE 4.3.7.11-1: 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	R	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	*

* At all times

TABLE 4.3.7.11-1: RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS – TABLE NOTATIONS (Continued)

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that the control room alarm annunciation occurs if any of the following conditions exist:

a. 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 6.8.4.g.2 and 3, the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (See Figure 5.1.1.1-1) 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.

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

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[(a)] (uCi/ml)
A. Batch Waste 1) Release[(b)] Sample Tanks	P Each Batch	P Each Batch	Principal Gamma Emitters[(c)]	$5x10^{-7}$
			I-131	$1x10^{-6}$
2) Turbine Building Circulating Water Dewatering Sump when released in Batch Mode*	P One Batch/M	M	Dissolved and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
	P Each Batch	M Composite[(d)]	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	P Each Batch	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*	N/A	M Composite	Principal Gamma Emitters[(c)]	$5x10^{-7}$
			I-131	$1x10^{-6}$
	W** Grab Sample	M	Dissolved and Entrained Gases	$1x10^{-5}$
	NA	M Composite [(d)]	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	NA	Q Composite [(d)]	Sr-89, Sr-90	$5x10^{-8}$

TABLE 4.11.1.1.1-1: RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM – TABLE NOTATIONS (Continued)

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

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

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

WHERE: LLD is the "a priori" lower limit of detection as defined above, as microcuries per unit mass or volume,

4.66 is the statistical factor from NUREG 1302

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

E is the counting efficiency, as counts per disintegration,

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

2.22E6 is the number of disintegrations per minute per microcurie,

Y is the fractional radiochemical yield, when applicable,

λ is the radioactive decay constant for the particular radionuclide (sec-1), and

Δt for plant effluents is the elapsed time between midpoint of sample collection and time of counting (sec).

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

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

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

(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 x 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 6.9.1.7.

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

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

* 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.

** The grab sample from the Turbine Building Circulating Water Dewatering Sump for dissolved and entrained noble gases is required monthly from the composite sampler.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.1.2 DOSE

CONTROLS

3.11.1.2 In accordance with Hope Creek Technical Specifications 6.8.4.g.4 and 5, the dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each reactor unit, to UNRESTRICTED AREAS (see Figure 5.1.1-1) 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 Technical Specification 6.9.2, 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 RADIOACTIVE EFFLUENTS

3/4.11.1.3 LIQUID WASTE TREATMENT SYSTEM

CONTROLS

3.11.1.3 In accordance with the Hope Creek Technical Specifications 6.8.4.g.6, the liquid radwaste treatment system shall be OPERABLE 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 5.1.1-1) 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 Technical Specification 6.9.2, a Special Report that includes the following information:

   1. Explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability,

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

   3. Summary description of action(s) taken to prevent a recurrence.

b. The provisions of 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 OPERABLE by meeting CONTROLS 3.11.1.1 and 3.11.1.2.

3/4.11 RADIOACTIVE EFFLUENTS

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 6.8.4.g.3 and 7, the dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY (see Figure 5.1.1-1) 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.

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

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)]	P Each PURGE[(c)]	Principal Gamma Emitters[(b)]	$1x10^{-4}$
	Grab Sample	P	H-3 (oxide)	$1x10^{-6}$
C. North Plant Vent South Plant Vent FRVS [(g)]	M[(c), (d)] Grab Sample	M[(c)]	Principal Gamma Emitters[(b)]	$1x10^{-4}$
			H-3 (oxide)	$1x10^{-6}$
D. All Release Types as listed in B and C above	Continuous[(e)]	W[(f)] Charcoal Sample	I-131	$1x10^{-12}$
	Continuous[(e)]	W[(f)] Particulate Sample	Principal Gamma Emitters[(b)]	$1x10^{-11}$
	Continuous[(e)]	M Composite Particulate Sample	Gross Alpha	$1x10^{-11}$
	Continuous[(e)]	Q Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$
	Continuous[(e)]	Noble Gas Monitor	Noble Gasses Gross Beta or Gamma	$1x10^{-6}$

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

(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 6.9.1.7.

(c) Sampling and analysis shall also be performed following shutdown, startup or a THERMAL POWER change exceeding 15% of RATED THERMAL POWER within 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 required when FRVS Vent Fan(s) is in service for greater than 2 hours.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.2.2 DOSE - NOBLE GASES

CONTROLS

3.11.2.2 In accordance with the Hope Creek Technical Specification 6.8.4.g.5 and 8, the air dose due to noble gases released in gaseous effluents, from each reactor unit, to areas at and beyond the SITE BOUNDARY (see Figure 5.1.1-1) 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 Technical Specification 6.9.2, 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 RADIOACTIVE 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 6.8.4.g.5 and 9, 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 5.1.1-1) 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 RADIOACTIVE EFFLUENTS

3/4.11.2.4 GASEOUS RADWASTE TREATMENT

CONTROLS

3.11.2.4 In accordance with Hope Creek Technical Specifications 6.8.4.g.6, 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 Technical Specification 6.9.2, a Special Report that includes the following information:

   1. Identification of any inoperable equipment or subsystems, and the reason for the inoperability,

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

   3. Summary description of action(s) taken to prevent a recurrence.

b. The provisions of 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 RADIOACTIVE EFFLUENTS

3/4.11.2.5VENTILATION EXHAUST TREATMENT

CONTROLS

3.11.2.5 In accordance with Hope Creek Technical Specifications 6.8.4.g.6, the VENTILATION EXHAUST TREATMENT SYSTEM for the Reactor Building and the Service and Radwaste Building shall be OPERABLE 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 5.1.1-1), 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 Technical Specification 6.9.2, a Special Report that includes the following information:

   1. Identification of any inoperable equipment or subsystems, and the reason for the inoperability,

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

   3. Summary description of action(s) taken to prevent a recurrence.

b. The provisions of 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 EXAUST TREATMENT SYSTEM shall be considered OPERABLE by meeting CONTROLS 3.11.2.1, 3.11.2.2, and 3.11.2.3.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.2.8VENTING 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.*

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.

SURVEILLAINCE 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.

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

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.4 TOTAL DOSE

CONTROLS

3.11.4 In accordance with Hope Creek Technical Specification s 6.8.4.g.11, 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 Technical Specification 6.9.2, 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.

3/4.11 RADIOACTIVE EFFLUENTS (Continued)

3/4.11.4 TOTAL DOSE

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.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.1 MONITORING PROGRAM

CONTROLS

3.12.1. In accordance with Hope Creek Technical Specifications 6.8.4.h.1, the radiological environmental monitoring program shall be conducted as specified in Table 3.12.1-1.

APPLICABILITY: At all times.

ACTION:

a. With the radiological environmental monitoring program not being conducted as specified in Table 3.12.1-1, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report required by Technical Specification 6.9.1.6, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

b. With the level of radioactivity as the result of plant effluents in an environmental sampling medium at a specified location exceeding the reporting levels of Table 3.12.1-2 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose* to a MEMBER OF THE PUBLIC is less than the calendar year limits of CONTROLS 3.11.1.2, 3.11.2.2, and 3.11.2.3. When more than one of the radionuclides in Table 3.12.1-2 are detected in the sampling medium, this report shall be submitted if:

$$\frac{concentration(1)}{reporting\ Level\ (1)} + \frac{concentration\ (2)}{reporting\ Level\ (2)} + \geq 1.0$$

When radionuclides other than those in Table 3.12.1-2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose* to a MEMBER OF THE PUBLIC from all radionuclides is equal to or greater than the calendar year limits of CONTROLS 3.11.1.2, 3.11.2.2, and 3.11.2.3. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report pursuant to CONTROL 6.9.1.6.

* The methodology used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING (Continued)

3/4.12.1 MONITORING PROGRAM

ACTION: (Continued)

c. With milk or fresh leafy vegetable samples unavailable from one or more of the sample locations required by Table 3.12.1-1, identify specific locations for obtaining replacement samples and add them to the radiological environmental monitoring program within 30 days. The specific locations from which samples were unavailable may then be deleted from the monitoring program. Pursuant to CONTROL 6.9.1.7, identify the cause of the unavailability of samples and the new location(s) for obtaining replacement samples in the next Radioactive Effluent Release Report pursuant to CONTROL 6.9.1.7 and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

d. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.1 The radiological environmental monitoring samples shall be collected pursuant to Table 3.12.1-1 from the specific locations given in the table and figure(s) in the ODCM, and shall be analyzed pursuant to the requirements of Table 3.12.1-1, and the detection capabilities required by Table 4.12.1-1.

TABLE 3.12.1-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS(1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
1. Directed Radiation(2)	Fifty eight routine monitoring stations with two or more dosimeters placed as follows: An inner ring of stations one in each land based meteorological sector in the general area of the SITE BOUNDARY; An outer ring of stations, one in each land-based meteorological sector in the 5 to 11 km range from the site; and The balance of the stations to be placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control stations.	Quarterly	Gamma dose quarterly

TABLE 3.12.1-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (Continued)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
2. Airborne			
Radioiodine and Particulates	Samples from 5[3] locations:	Continuous sampler operation with sample collection weekly or more frequently if required by dust loading.	Radioiodine Canister I-131 analysis weekly.
	Three samples from close to the SITE BOUNDARY location, in different sectors, of the highest calculated annual average ground level D/Q		Particulate Sampler Gross beta radioactivity analysis following filter change [4];
	One sample from the vicinity of a community having a highest calculated annual average ground-level D/Q; and		Gamma isotopic analysis[5] of composites (by location) quarterly.
	One sample from a control location, as for example 15-30 km distant and in the least prevalent wind direction.		

TABLE 3.12.1-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (Continued)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
3. Waterborne			
a. Surface[6]	One sample upstream. One sample downstream One sample outfall One sample cross-stream	Grab sample semi-monthly.	Composite for gamma isotopic analysis [5] monthly. Composite for tritium analysis quarterly.
b. Ground	Samples from one or two sources only if likely to be affected[8].	Monthly	Gamma isotopic analysis[5] monthly and tritium analysis quarterly.
c. Drinking[11]	One sample of the nearest water supply affected by its discharge	Composite sample over two-week period[7] when I-131 analysis is performed; monthly composite otherwise.	I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than 1 mrem per year[8]. Composite for gross beta and gamma isotopic analysis[5] monthly Composite for tritium analysis quarterly
d. Sediment	One sample downstream area One sample cross-stream area One sample from outfall area One sample from upstream area A control location One sample from shoreline area	Semi-annually	Gamma isotopic analysis[5] semiannually

TABLE 3.12.1-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (Continued)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS(1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
4. Ingestion			
a. Milk	Samples from milking animals in three locations within 5 km distance having the highest dose potential. If there are none, then, one sample from milking animals in each of three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per yr(9). One sample from milking animals at a control location 15 to 30 km distant.	Semimonthly when animals are on pasture, monthly at other time.	Gamma isotopic (5) and I-131 analysis semi-monthly when animals are on pasture; monthly at other times.
b. Fish and Invertebrates	One sample of each commercially and recreationally important species in vicinity of plant discharge area. One sample of same species in area not influenced by plant discharge.	Sample in season, or semiannually if they are not seasonal.	Gamma isotopic analysis(5) on edible portions.
c. Food Products	One sample of each principal class of food products from any area that is irrigated by water in which liquid plant wastes have been discharged.	At time of harvest. (10)	Gamma isotopic analysis (5) on edible portion.
	Samples of three different kinds of broad leaf grown nearest each of two different offsite locations of highest predicted annual ground level D/Q if milk sampling is not performed.	Monthly during growing season.	Gamma isotopic analysis (5) on edible portion.
	One sample of each similar broadleaf vegetation grown 15 to 30 km distant in the least prevalent wind direction of milk sampling is not performed.	Monthly during growing season.	Gamma isotopic analysis (5) on edible portion.

TABLE 3.12.1-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM - TABLE NOTATIONS (Continued)

(1) Specific parameters of distance and direction sector from the midpoint of a line between the center of the Salem units 1 & 2 containment domes and additional description where pertinent, shall be provided for each and every sample location in Table 3.12.1-1 in a table and figure(s) in the ODCM. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978, and to Reg. Guide 4.8 as amended by Radiological Assessment Branch Technical Position, Revision 1, November 1979. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to circumstances such as hazardous conditions, seasonal unavailability and malfunction of automatic sampling equipment. If specimens are unobtainable due to sampling equipment malfunction, effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to CONTROL 6.9.1.6. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable specific alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the Radiological Environmental Monitoring Program given in the ODCM. Pursuant to CONTROL 6.9.1.7, submit in the next Radioactive Effluent Release Report documentation for a change in the ODCM including revised figure(s) and table for the ODCM reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples for the pathway and justifying the selection of the new location(s) for obtaining samples.

(2) One or more instruments, such as pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a passive dosimeter (PD) a device meeting the criteria of ANSI N545 is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used for measuring direct radiation. The frequency of analysis or readout for dosimetry systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading. The 40 stations is not an absolute number. The number of direct radiation monitoring stations may be reduced according to geographical limitations; e.g., at an ocean site, some sectors will be over water so that the number of dosimeters may be reduced accordingly.

(3) There are four additional air sample locations – a "duplicate" air sampler at location 5S2, 5D1, 1F1 and 2F6 which are maintained for their historical data.

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

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

(6) The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. The "downstream" sample shall be taken in an area beyond but near the mixing zone. "Upstream" samples in an estuary must be taken far enough upstream to be beyond the plant influence. Saltwater shall be sampled only when the receiving water is utilized for recreational activities.

TABLE 3.12.1-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM - TABLE NOTATIONS (Continued)

(7) A composite sample is one in which the quantity (aliquot) of liquid sampled is proportional to the quantity of flowing liquid and in which the method of sampling employed results in a specimen that is representative of the liquid flow. In this program composite sample aliquots shall be collected at time intervals that are very short relative to the compositing period in order to assure obtaining a representative sample.

(8) Groundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

(9) The dose shall be calculated for the maximum organ and age group using the methodology and parameters in the ODCM. There are no farms that meet the 5 km requirement and it is unlikely that any releases from the site will approach the 1 mrem criteria at 5 to 8 km. Milk samples will be taken (owner obliging) within 8 km and other management audit samples within 16 km. Broad leaf vegetation (within 8 km) shall be taken to meet this pathway.

(10) If harvest occurs more than once a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuberous and root food products. The Delaware River at the location of Salem and Hope Creek Nuclear Power Plants is a brackish water source. No irrigation of food products is performed using water in the vicinity from which liquid plant wastes have been discharged. However, 12 management audit food samples are collected from various locations.

(11) No groundwater samples are required as liquid effluents discharged from Salem and Hope Creek Generating Stations do not directly affect this pathway. However for management audit, one raw and one treated ground water sample from the nearest unaffected water supply is required.

TABLE 3.12.1-2: REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

REPORTING LEVELS

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

Note 1: No drinking water exposure pathway exists on site. If a drinking water pathway existed, then the water reporting level would be 20,000 pCi/L for H-3 and 2 pCi/L for I-131.

TABLE 4.12.1-1: DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS[(1), (2)] LOWER LIMITS OF DETECTION (LLD)[(3)]

Analysis	Water (pCi/L)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/Kg wet)	Milk (pCi/L)	Food Products (pCi/Kg, wet)	Sediment (pCi/Kg, dry)
Gross Beta	4	0.01				
H-3	3000[1]					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131	15[1]	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15			15		

Note 1: No drinking water exposure pathway exists on site. If a drinking water pathway existed, then the water LLD would be 2,000 pCi/L for H-3 and 1 pCi/L for I-131.

TABLE 4.12.1-1: DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS[(1), (2)] LOWER LIMITS OF DETECTION (LLD)[(3)] – TABLE NOTATIONS (Continued)

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

(2) Required detection capabilities for dosimeters used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13.

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

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

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

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

4.66 is the statistical factor from NUREG 1302,

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

E is the counting efficiency, as counts per disintegration,

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

2.22 is the number of disintegrations per minute per picocurie,

Y is the fractional radiochemical yield, when applicable,

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

Δt for environmental samples is the elapsed time between sample collection, or end of the sample collection period, and time of counting (sec).

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

For low count rates a value of 2.71 may be added to the numerator.

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. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report pursuant to CONTROL 6.9.1.6.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.2 LAND USE CENSUS

CONTROLS

3.12.2 In accordance with the Hope Creek Technical Specifications 6.8.4.h.2, a land use census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors of the nearest milk animal, the nearest residence and the nearest garden* of greater than 50 m^2 (500 ft^2) producing broad leaf vegetation. [For elevated releases as defined in Regulatory Guide 1.111, Revision 1, July 1977, the Land Use Census shall also identify within a distance of 5 km (3 miles) the locations in each of the 16 meteorological sectors of all milk animals and all gardens of greater than 50 m2 producing broad leaf vegetation.]

APPLICABILITY: At all times.

ACTION:

a. With a land use census identifying a location(s) that yields a calculated dose or dose commitment greater than the values currently being calculated in CONTROL 4.11.2.3, identify the new location(s) in the next Radioactive Effluent Release Report, pursuant to CONTROL 6.9.1.7.

b. With a land use census identifying a location(s) ** that yields a calculated dose or dose commitment (via the same exposure pathway) 20 percent greater than at a location from which samples are currently being obtained in accordance with CONTROL 3.12.1, add the new location(s) to the radiological environmental monitoring program within 30 days. The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from this monitoring program after October 31 of the year in which this land use census was conducted. Pursuant to CONTROL 6.9.1.7, identify the new location(s) in the next Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

c. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.2 The land use census shall be conducted during the growing season at least once per 12 months using that information that will provide the best results, such as by a door-to-door survey, visual survey, aerial survey, or by consulting local agriculture authorities. The results of the land use census shall be included in the Annual Radiological Environmental Operating Report pursuant to CONTROL 6.9.1.6.

* Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the SITE BOUNDARY in each of two different direction sectors with the highest predicted D/Q's in lieu of the garden census. CONTROLS for broadleaf vegetation sampling in Table 3.12.1-1, Part 4.c shall be followed, including analysis of control samples.

** New receptor locations must be on land and not over water to be considered in dose calculations.

3.4/12 RADIOLOGICAL ENVIRONMENTAL MONITORING (Continued)

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

CONTROLS

3.12.3 In accordance with Hope Creek Technical Specifications 6.8.4.h.3, analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program that has been approved by the Commission, that correspond to samples required by Table 3.12.1-1.

APPLICABILITY: At all times.

ACTION:

a. With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report pursuant to CONTROL 6.9.1.6.

b. The provisions of CONTROLS 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.3 The Interlaboratory Comparison Program shall be described in the ODCM. A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report pursuant to CONTROL 6.9.1.6.

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.

3/4.3 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 OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

3/4.3.7.11 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

The radioactive gaseous effluent 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 OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

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 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 inoperable 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 control room indication of either process flow or sample flow is lost, then ACTION 122 allows a condition to continue as long as 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.

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

3/4.11.1.1 CONCENTRATION

This CONTROL is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than the concentration levels specified in (pre 1994) 10 CFR Part 20, Appendix B, Table II, Column 2. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in 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 RADIOACTIVE EFFLUENTS (Continued)

3/4.11.1.2DOSE

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.

3/4.11.1.3LIQUID RADWASTE TREATMENT

The OPERABILITY 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.

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.1DOSE 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).

3/4.11.2.2DOSE – 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.

3/4.11.2.3DOSE – 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 UNRERSTRICTED 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.

3/4.11.2.4
and
3/4.11.2.5 GASEOUS RADWASTE TREATMENT AND VENTILATION EXHAUST TREATMENT

The OPERABILITY of the GASEOUS RADWASTE TREATMENT SYSTEM and the VENTILATION EXHAUST TREAMENT 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 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.

3/4.12 RADIOLOGICAL ENVIORNMENTAL MONITORING

3/4.12.1 MONITORING PROGRAM

The radiological environmental monitoring program required by this CONTROL provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Reg. Guide 4.8 as amended by Radiological Assessment Branch Position on Environmental Monitoring, Revision 1, and November 1979. The initially specified monitoring program will be effective for at least the first three years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 4.12.1-1 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Detailed discussion of the LLD, and other detection limits can be found in 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).

3/4.12.2 LAND USE CENSUS

This CONTROL is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the radiological environmental monitoring program are made if required by the results of this census. The best information from the door-to-door survey, from aerial survey, from visual survey or consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than $50 m^2$ provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/year) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made: 1) 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and 2) a vegetation yield of 2 kg/m^2.

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

The requirement for participation in an approved Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

SECTION 5.0

DESIGN FEATURES

5.0 DESIGN FEATURES

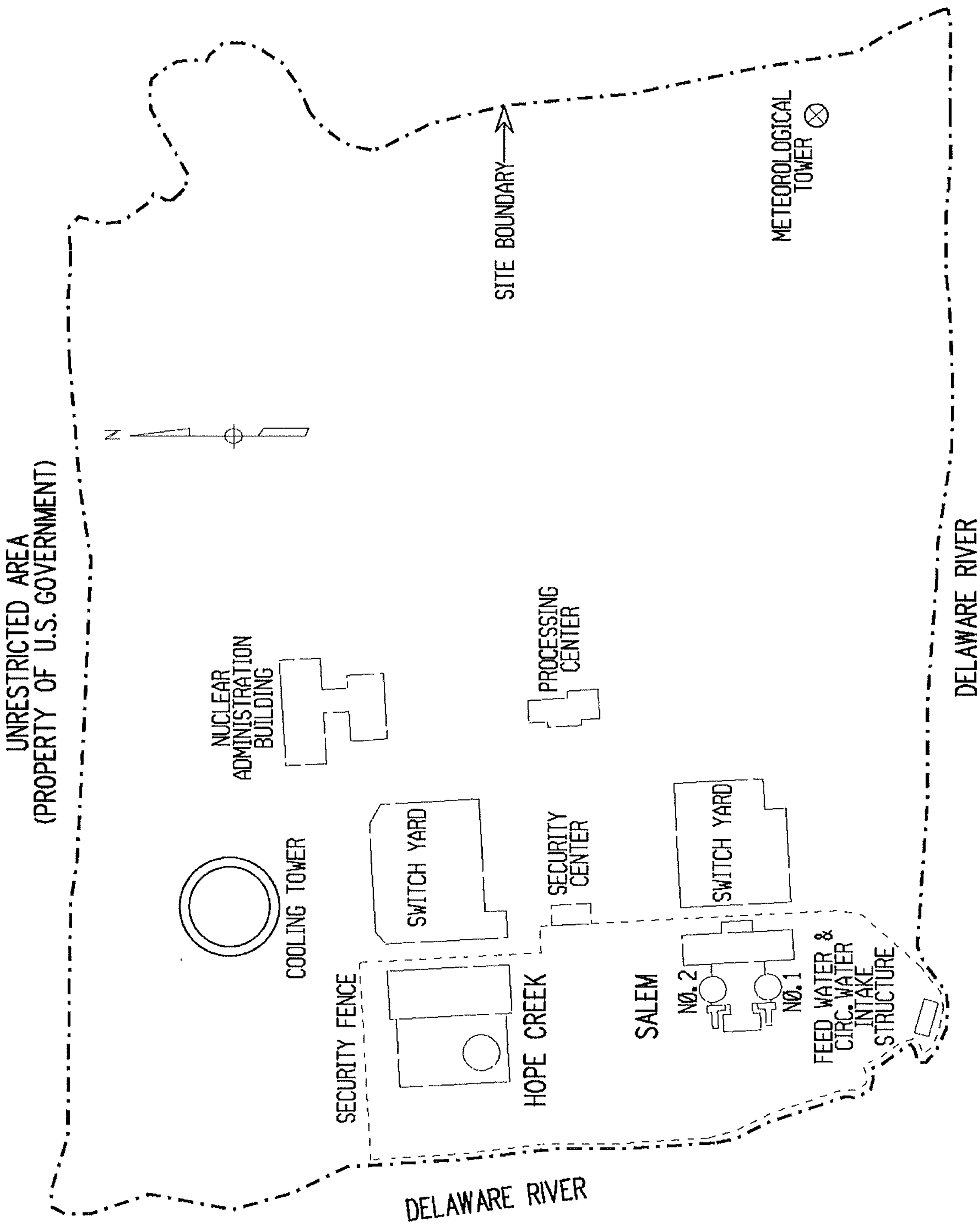
(Provided FOR INFORMATION ONLY. Technical Specifications Section 5.0 is controlling.)

5.1 SITE

MAP DEFINING UNRESTRICTED AREAS AND SITE BOUNDARY FOR RADIOACTIVE GASEOUS AND LIQUID EFFLUENTS

5.1.1 Information regarding radioactive gaseous and liquid effluents which will allow identification of structures and release points as well as definition of UNRESTRICTED AREAS within the SITE BOUNDARY that are accessible to MEMBERS OF THE PUBLIC, shall be as shown in Figure 5.1.1-1.

FIGURE 5.1.1-1: AREA PLOT PLAN OF SITE



6.0 ADMINISTRATIVE CONTROLS

6.9.1.6 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

In accordance with Hope Creek Technical Specifications 6.9.1.6, The Annual Radiological Environmental Operating Report* covering the operation of the unit during the previous calendar year, shall be submitted prior to May 1 of each year.

The Annual Radiological Environmental Operating Reports shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies, with operational controls (as appropriate), and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of land use censuses required by CONTROL 3.12.2. If harmful effects or evidence of irreversible damage are detected by the monitoring, the report shall provide an analysis of the problem and a planned course of action to alleviate the problem.

The Annual Radiological Environmental Operating Reports shall include summarized and tabulated results in the format of Reg. Guide 4.8 as amended by Radiological Assessment Branch Technical Position, Revision 1, November 1979, for all of the radiological environmental samples taken during the report period pursuant to the table and figures in the environmental radiation section of the ODCM. Deviations from the sampling program identified in CONTROL 3.12.1 shall be reported. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following: a summary description of the radiological environmental monitoring program; at least two legible maps, one covering sampling locations near the SITE BOUNDARY and a second covering the more distant locations, all keyed to a table giving distances and directions from midpoint of a line between the center of the Salem units 1& 2 containment domes; the results of licensee participation in the Interlaboratory Comparison Program, as required by CONTROL 3.12.3 and discussion of all analyses in which the LLD required by Table 4.12.1-1 was not achieved.

The report shall also include the results of specific activity analysis in which the primary coolant exceeded the limits of Technical Specification 3.4.5. The following information shall be included: (1) Reactor power history starting 48 hours prior to the first sample in which the limit was exceeded; (2) Results of the last isotopic analysis for radioiodine performed prior to exceeding the limit, results of analysis while limit was exceeded and results of one analysis after the radioiodine activity was reduced to less than the limit. Each result should include date and time of sampling and the radioiodine concentrations; (3) Clean-up system flow history starting 48 hours prior to the first sample in which the limit was exceeded; (4) Graph of the I-131 per gram as a function of time for the duration of the specific activity of the steady-state level; and (5) The time duration when the specific activity of the primary coolant exceeded the limit.

* A single submittal may be made for a multiple unit site. The submittal should combine those sections that are common to all units at the site.

6.9.1.7 RADIOACTIVE EFFLUENT RELEASE REPORT

In accordance with Hope Creek Technical Specifications 6.9.1.7, The Annual Radioactive Effluent Release Report* 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 Radioactive Effluent Release Report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit as outlined in Regulatory Guide 1.21. "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof.

The Radioactive Effluent Release Report 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 5.1.1-1) 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 Radioactive Effluent Release Report 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).

The Radioactive Effluent Release Report 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 Radioactive Effluent Release Reports 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 Radioactive Effluent Release Report * 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 Radioactive Effluent Release Report 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 CONTROL 3.12.2. for dose calculations or environmental monitoring.

* 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.

6.15 MAJOR CHANGES TO RADIOACTIVE LIQUID, GASEOUS AND SOLID WASTE TREATMENT SYSTEMS

6.15.1 LICENSEE INITIATED MAJOR CHANGES TO THE RADIOACTIVE WASTE SYSTEM (LIQUID, GASEOUS AND SOLID)

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.

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 Radiation Monitoring Instrumentation and 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 Technical Specifications 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 waterboxes 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.

1.2 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 μCi/ml for dissolved or entrained noble gases). The following equation (adopted from NUREG-0133) must be satisfied to meet the liquid effluent restrictions:

$$c \leq \frac{C\,(F+f)}{f} \tag{1.1}$$

Where:

- C = The effluent concentration limit of CONTROL 3.11.1.1 implementing the 10 CFR 20 MPC (Appendix F) for the site, in μCi/ml.
- c = The setpoint, in μCi/ml, of the radioactivity monitor measuring the radioactivity concentration in the effluent line prior to dilution and subsequent release; the setpoint, represents a value which, if exceeded, would result in concentrations exceeding the limits of 10 CFR 20 in the UNRESTRICTED AREA.
- f = The flow rate at the radiation monitor location, in volume per unit time, but the same units as F, below.
- F = The dilution water flow rate as measured prior to the release point, in volume per unit time.

[Note that if no dilution is provided, $c \leq C$. Also, note that when (F) is large compared to (f), then (F + f) = F.]

1.2.1 Liquid Effluent Monitors

*The setpoints for the liquid effluent monitors at the Hope Creek Generating Station are determined by the following equation:

$$SP \leq \frac{MCP_e * CTBD * [1 - CF]}{RR} + bkg \qquad \textbf{(1.2)}$$

with:

$$MPC_e = \sum_i C_i\ (gamma)\ /\ \sum_i \frac{C_i}{MPC_i}\ (gamma) \qquad \textbf{(1.3)}$$

Where:

	SP	=	Alarm setpoint corresponding to the maximum allowable release rate (μCi/ml).
	MPC_e	=	An effective MPC value for the mixture of radionuclides in the effluent stream, (μCi/ml).
	C_i	=	The concentration of radionuclide in the liquid effluent (μCi/ml).
	MPC_i	=	The MPC value corresponding to radionuclide i from (Appendix F) 10 CFR 20, Appendix B, Table II, Column 2 (μCi/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 (μCi/ml).
	CF	=	Correction factor to account for non-gamma emitting nuclides and radiation monitor inaccuracies.

The radioactivity monitor setpoint equation (1.2) 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.

1.2.2 Conservative Default Values

Conservative alarm setpoints for liquid radwaste radiation monitors may be determined through the use of 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 4.09E-05 μCi/ml for radwaste releases (Refer to Appendix A for justification);

b. Substitutions of the Cooling-Tower Blowdown discharge rate with the minimum average flow, in gal/min; and,

c. Substitutions of the effluent release rate with the highest allowed rate, in gal/min.

d. Substitution of a 0.8 correction factor (CF) to account for monitor inaccuracies and non-gamma emitting radionuclides.

The use of the conservative alarm setpoint, or a setpoint below the conservative value, is acceptable provided that the value used is at least as conservative as the release specific setpoint calculated in accordance with Equation 1.2 above. Procedural controls exist to verify the setpoint utilized is at or below what is required.

1.3 <u>Liquid Effluent Concentration Limits - 10 CFR 20</u>

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 µCi/ml. Release rates are controlled and radiation monitor alarm setpoints are established as addressed above to ensure that these concentration limits are not exceeded. However, in the event any liquid release results in an alarm setpoint being exceeded, an evaluation of compliance with the concentration limits of CONTROL 3.11.1.1 may be performed using the following equation:

$$\frac{C_i}{MPC_i} * \frac{RR}{CTBD + RR} \leq 1 \qquad \textbf{(1.4)}$$

Where:

C_i = Actual concentration of radionuclide i as measured in the undiluted liquid effluent (µCi/ml).

MPC_i = The MPC value corresponding to radionuclide i from 10 CFR 20, Appendix B, Table II, Column 2 (Appendix F) (µCi/ml).

= 2E-04 µCi/ml for dissolved or entrained noble gases.

RR = The actual liquid effluent release rate (gal/min)

CTBD = The actual Cooling-Tower Blowdown discharge at the time of release (gal/min).

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.

$$D_o = \frac{8.35E-04 * VOL}{CTBD} * \sum_i C_i * A_{io}$$

(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 µCi/ml).
C_i	=	Average concentration of radionuclide i, in undiluted liquid effluent representative of volume VOL (µCi/ml).
VOL	=	Volume of liquid effluent released (gal).
CTBD	=	Average Cooling-Tower Blowdown discharge rate during release period (gal/min).
8.35E-04	=	Conversion factor (1.67E-2 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:

$$A_{io} = 1.14E+05\ [(UI * BI_i) + (UF * BF_i)]\ Df_{io}$$

(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 µCi/ml).
1.14E+05	=	Conversion factor (pCi/µCi * ml/kg per hr/yr).
UI	=	Adult invertebrate consumption (5 kg/yr).
Bi_i	=	Bioaccumulation factor for radionuclide i in invertebrates from Table 1-3 (pCi/kg per pCi/1).
UF	=	Adult fish consumption (21 kg/yr).
Bf_i	=	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.

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.)

<u>Total Body</u>

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

<u>Maximum Organ</u>

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

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 (μCi/ml).
VOL	=	Volume of liquid effluent released (gal).
CTBD	=	Average Cooling-Tower Blowdown discharge rate during release period (gal/min).
1.94E+02	=	Conversion factor (1.67E-2 hr/min), the conservative total body ingestion dose commitment factor (Zn-65 = 2.32E+5 mrem/hr per μCi/ml), and the near field dilution factor of 0.05. (See Appendix B)
5.28E+02	=	Conversion factor (1.67E-2 hr/min), the conservative maximum organ ingestion dose commitment factor (Fe-59, GI-LLI – 6.32E+5 mrem/hr per μCi/ml), and the near field dilution factor of 0.05 (See Appendix B).

1.5 <u>Liquid Effluent Dose Projections</u>

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:

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

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

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 current calendar quarter at the end of the release.

31d = The number of days of concern.

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:

1. 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.

2. 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.

3. 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 Figures 2-1 and 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 equation:

$$FRAC = [\,4.72E+02 * {}^{X}/_{Q} * VF * \sum_i (C_i * K_i)\,] \,/\, 500 \qquad \textbf{(2.1)}$$

$$FRAC = [\,4.72E+02 * {}^{X}/_{Q} * VF * \sum_i (C_i * (L_i + 1.1M_i))\,] \,/\, 3000 \qquad \textbf{(2.2)}$$

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/m^3).
VF	=	Ventilation system flow rate for the applicable release point and monitor (ft^3/min).
C_i	=	Concentration of noble gas radionuclide i as determined by radioanalysis of grab sample (uCi/cm^3)
K_i	=	Total body dose conversion factor for noble gas radionuclide i (mrem/yr per μCi/m^3), from Table 2-1
L_i	=	Beta skin dose conversion factor for noble gas radionuclide i (mrem/yr per μCi/m^3), from Table 2-1
M_i	=	Gamma air dose conversion factor for noble gas radionuclide i (mrad/yr per μCi/m^3), from Table 2-1
1.1	=	mrem skin dose per mrad gamma air dose (mrem/mrad)
4.72E+02	=	Conversion factor (cm^3/ft^3 * min/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:

$$SP \leq [\, AF * \sum_i C_i \,/\, FRAC \,] + bkg$$

(2.3)

Where:

	SP	=	Alarm setpoint corresponding to the maximum allowable release rate (μCi/cc).
	FRAC	=	Highest fraction of the allowable release rate as determined in equation (2.2).
	bkg	=	Background of the monitor (μCi/cc).
	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 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.la 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:

$$D_{tb} = {}^{X}/_{Q} * \sum_{i} (K_i * Q_i) \tag{2.4}$$

$$D_s = {}^{X}/_{Q} * \sum_{i} ((L_i + 1.1M_i) * Q_i) \tag{2.5}$$

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/m^3).
	Q_i	=	Average release rate of radionuclide i over the release period under evaluation (μCi/sec).
	K_i	=	Total body dose conversion factor for noble gas radionuclide i (mrem/yr per μCi/m^3), from Table 2-1.
	L_i	=	Beta skin dose conversion factor for noble gas radionuclide i (mrad/yr per μCi/m^3), from Table 2-1.
	M_i	=	Gamma air dose conversion factor for noble gas radionuclide i (mrad/yr per μCi/m^3, from Table 2-1.
	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:

$$D_o = {}^{X}/_{Q} * \sum_i (R_{io} * Q_i) \qquad \textbf{(2.6)}$$

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/m^3).

R_{io} = Dose parameter for radionuclide i (mrem/yr per μCi/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 (μCi/sec).

By substituting 1500 mrem/yr for D_o and solving for Q, 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 -- Ri = 1.62E+07 mrem/yr per μCi/m^3), the allowable release rate for I-131 is 34.7 μCi/sec. 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 17.4 μCi/sec. For a 7-day period, which is the nominal sampling and analysis frequency for I-131, the cumulative release is 10.5 Ci.

Therefore, as long as the I-131 release in any 7-day period do not exceed 10.5 Ci, 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:

$$D_\gamma = 3.17E-08 * \chi/Q * \sum_i (M_i * Q_i) \qquad \textbf{(2.7)}$$

$$D_\beta = 3.17E-08 * \chi/Q * \sum_i (N_i * Q_i) \qquad \textbf{(2.8)}$$

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/m^3).
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 μCi/m^3, from Table 2-1.
N_i	=	Air dose factor due to beta emissions from noble gas radionuclide i (mrad/yr per μCi/m^3, Table 2-1).
3.17E-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).

$$D_\gamma = \frac{3.17E-8}{0.50} * {}^{\chi}/_{Q} * M_{eff} * \sum_i Q_i \qquad \textbf{(2.9)}$$

$$D_\beta = \frac{3.17E-8}{0.50} * {}^{\chi}/_{Q} * N_{eff} * \sum_i Q_i \qquad \textbf{(2.10)}$$

Where:

M_{eff}	=	8.1E+03, effective gamma-air dose factor (mrad/yr per µCi/m3).
N_{eff}	=	8.5E+03, effective beta-air dose factor (mrad/yr per µCi/m3).
Q_i	=	Cumulative release for all noble gas radionuclides (µCi).
0.50	=	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:

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

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 μCi/m^3 or m^2 - mrem/yr per μCi/sec) and organ o from Table 2-4 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.

1. For milk and vegetation exposure pathways: A six month fresh vegetation and grazing season (May through Oct) = 0.5

2. For inhalation and ground plane exposure pathways: = 1.0

For evaluating the maximum exposed individual, the infant age group is controlling for the milk pathway. 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):

$$D_{\max o} = 3.17E-08 * W * SF_p * R_{I-131} * \sum_i Q_i \tag{2.12}$$

Where:

$D_{\max o}$ = Maximum organ dose (mrem).

R_{I-131} = I-131 dose parameter for the thyroid for the identifie controlling pathway.
= 1.05E+12, infant thyroid dose parameter with the cow-milk pathway controlling (m^2 - mrem/yr per μCi/sec).

W = D/Q for radioiodine, 2.87E-10 1/m^2.

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.

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 (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 mrad 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 projection are performed at least once per 31-days by the following equations:

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

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

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

Where:

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).
	D_{bp}	=	Beta air dose projection for current 31-day period (mrad).
	D_b	=	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.
	31d	=	The number of days of concern.

3.0 **SPECIAL DOSE ANALYSIS**

3.1 Doses Due to Activities Inside the Site Boundary

In accordance with Technical Specification 6.9.1.7, the Radioactive Effluent Release Report (RERR) 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 year meteorological data.

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

The Radioactive Effluent Release Report (RERR) 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 6.9.1.7 (RERR) 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 or the actual pathways and locations as identified by the land use census (CONTROL 3/4.12.1) 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.

3.3 <u>Doses due to Carbon 14 in Gaseous Effluent</u>

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.

3.3.1 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.

3.3.2 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.

4.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

4.1 Sampling Program

The operational phase of the Radiological Environmental Monitoring Program (REMP) is conducted in accordance with the requirements of CONTROL 3.12. The objectives of the program are:

- To determine whether any significant increases occur in the concentration of radionuclides in the critical pathways of exposure in the vicinity of Artificial Island;
- To determine if the operation of the Hope Creek Generating Station has resulted in any increase in the inventory of long lived radionuclides in the environment;
- To detect any changes in the ambient gamma radiation levels; and
- To verify that HCGS operations have no detrimental effects on the health and safety of the public or on the environment.

The sampling requirements (type of samples, collection frequency and analysis) and sample locations are presented in Appendix E.

NOTE: No public drinking water samples or irrigation water samples are taken as these pathways are not directly affected by liquid effluents discharged from Hope Creek Generating Station.

4.2 Interlaboratory Comparison Program

CONTROL 3.12.3 requires analyses be performed on radioactive material supplied as part of an Interlaboratory Comparison. Participation in an approved Interlaboratory Comparison Program provides a check on the preciseness of measurements of radioactive materials in environmental samples. A summary of the Interlaboratory Comparison Program results will be provided in the Annual Radiological Environmental Operating Report pursuant to CONTROLS 6.9.1.7.

5.0 HCGS EXPLOSIVE GAS MONITORING PROGRAM

The Hope Creek Explosive Gas Monitoring program was moved within the Hope Creek Technical Specifications to section 6.8.4.d. This was performed in Technical Specification Amendment 91. Details of the Hope Creek Explosive Gas Monitoring program are maintained in station implementing procedures and are controlled by the 50.59 safety evaluation and procedure processes.

FIGURE 1-1: LIQUID RADWASTE TREATMENT AND MONITORING SYSTEM

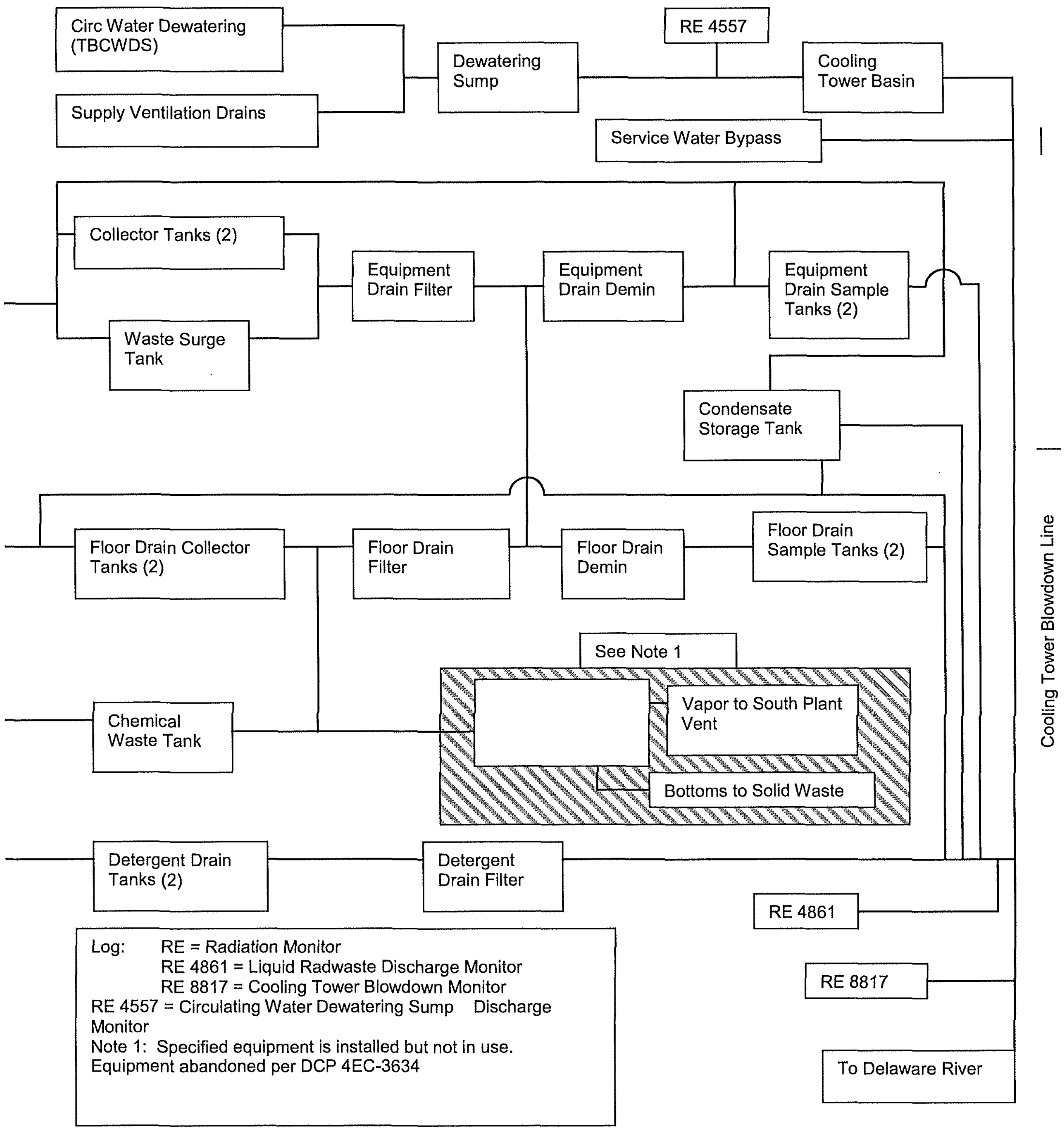


FIGURE 1-2: SOLID RADWASTE PROCESSING SYSTEM

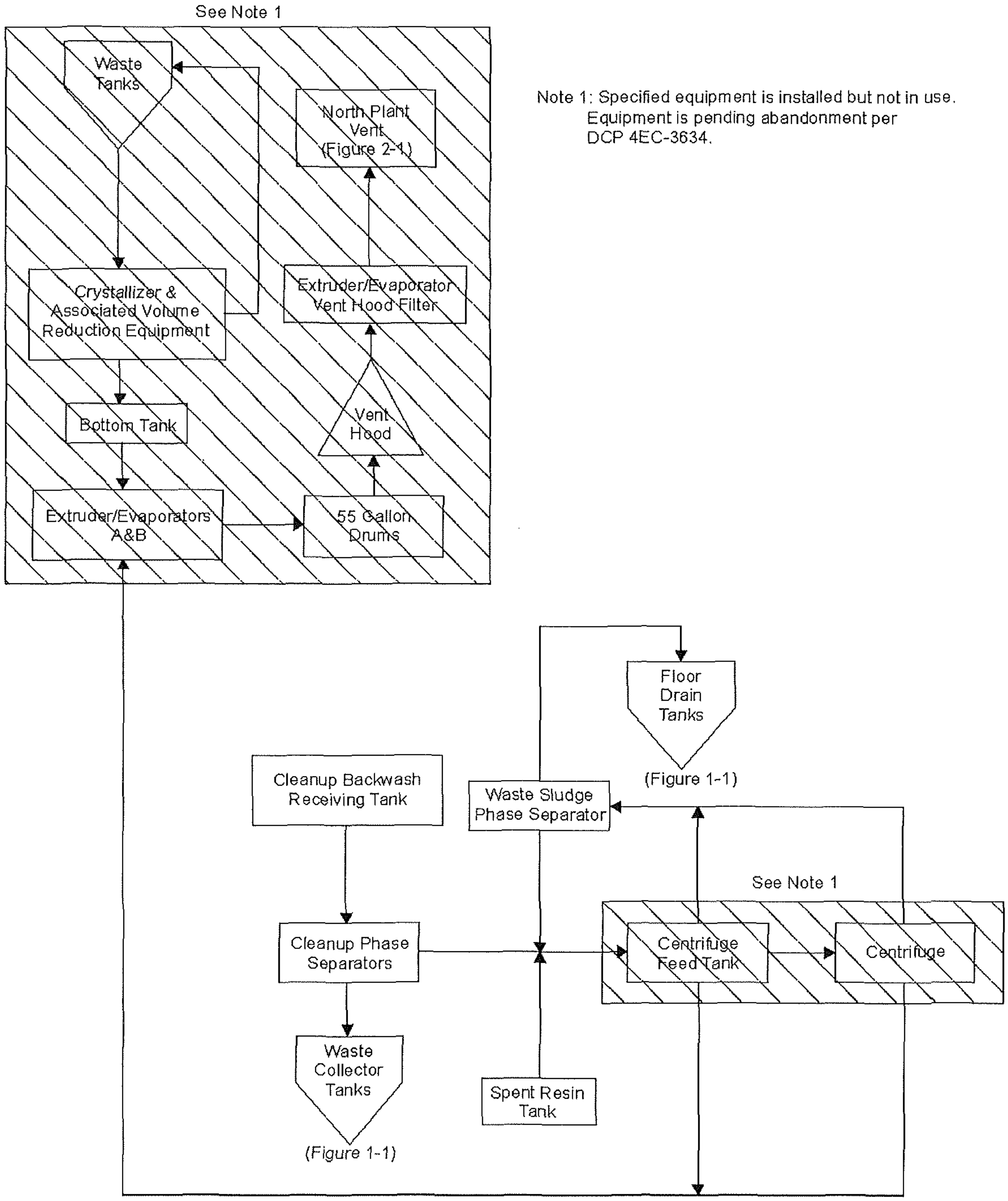


TABLE 1-1: PARAMETERS FOR LIQUID ALARM SETPOINT DETERMINATION

Parameter	Actual Value	Default Value	Units	Comments
MPCe	Calc	4.09E-05*	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 1300	gpm or gpm (CST)	Determined prior to release, release rate can be adjusted for CONTROL compliance
	Estimated	100	gpm (TBCW)	Maximum flow rate with both pumps running (50 gpm each)
SP (Setpoints)				
A) RE4861	Calc	5.58E-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	8.18E-06	µCi/ml	
RE4557	Calc	2.40E-06	µCi/ml	Maximum alarm setpoint continuous release; more conservative value may be established by plant procedure
B) RE4861	Calc	7.55E-05	µCi/ml	These setpoints are for condensate storage tank releases
RE8817	Calc	8.18E-06	µCi/ml	

* See Appendix A for basis

TABLE 1-2: SITE RELATED INGESTION DOSE COMMITMENT FACTOR, A_{io} (FISH AND INVERTEBRATE CONSUMPTION)

(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	2.82E-1	2.82E-1	2.82E-1	2.82E-1	2.82E-1	2.82E-1
C-14	1.45E+4	2.90E+3	2.90E+3	2.90E+3	2.90E+3	2.90E+3	2.90E+3
Na-24	4.57E-1	4.57E-1	4.57E-1	4.57E-1	4.57E-1	4.57E-1	4.57E-1
P-32	4.69E+6	2.91E+5	1.81E+5	-	-	-	5.27E+5
Cr-51	-	-	5.58E+0	3.34E+0	1.23E+0	7.40E+0	1.40E+3
Mn-54	-	7.06E+3	1.35E+3	-	2.10E+3	-	2.16E+4
Mn-56	-	1.78E+2	3.15E+1	-	2.26E+2	-	5.67E+3
Fe-55	5.11E+4	3.53E+4	8.23E+3	-	-	1.97E+4	2.03E+4
Fe-59	8.06E+4	1.90E+5	7.27E+4	-	-	5.30E+4	6.32E+5
Co-57	-	1.42E+2	2.36E+2	-	-	-	3.59E+3
Co-58	-	6.03E+2	1.35E+3	-	-	-	1.22E+4
Co-60	-	1.73E+3	3.82E+3	-	-	-	3.25E+4
Ni-63	4.96E+4	3.44E+3	1.67E+3	-	-	-	7.18E+2
Ni-65	2.02E+2	2.62E+1	1.20E+1	-	-	-	6.65E+2
Cu-64	-	2.14E+2	1.01E+2	-	5.40E+2	-	1.83E+4
Zn-65	1.61E+5	5.13E+5	2.32E+5	-	3.43E+5	-	3.23E+5
Zn-69m	5.66E+3	1.36E+4	1.24E+3	-	8.22E+3	-	8.29E+5
As-76	4.38E+2	1.16E+3	5.14E+3	3.42E+2	1.39E+3	3.58E+2	4.30E+4
Br-82	-	-	4.07E+0	-	-	-	4.67E+0
Br-83	-	-	7.25E-2	-	-	-	1.04E-1
Br-84	-	-	9.39E-2	-	-	-	7.37E-7
Br-85	-	-	3.86E-3	-	-	-	-
Rb-86	-	6.24E+2	2.91E+2	-	-	-	1.23E+2
Rb-88	-	1.79E+0	9.49E-1	-	-	-	2.47E-11
Rb-89	-	1.19E+0	8.34E-1	-	-	-	6.89E-14
Sr-89	4.99E+3	-	1.43E+2	-	-	-	8.00E+2
Sr-90	1.23E+5	-	3.01E+4	-	-	-	3.55E+3
Sr-91	9.18E+1	-	3.71E+0	-	-	-	4.37E+2
Sr-92	3.48E+1	-	1.51E+0	-	-	-	6.90E+2
Y-90	6.06E+0	-	1.63E-1	-	-	-	6.42E+4
Y-91m	5.73E-2	-	2.22E-3	-	-	-	1.68E-1
Y-91	8.88E+1	-	2.37E+0	-	-	-	4.89E+4
Y-92	5.32E-1	-	1.56E-2	-	-	-	9.32E+3
Y-93	1.69E+0	-	4.66E-2	-	-	-	5.35E+4
Zr-95	1.59E+1	5.11E+0	3.46E+0	-	8.02E+0	-	1.62E+4
Zr-97	8.81E-1	1.78E-1	8.13E-2	-	2.68E-1	-	5.51E+4
Nb-95	4.47E+2	2.49E+2	1.34E+2	-	2.46E+2	-	1.51E+6
Nb-97	3.75E+0	9.49E-1	3.46E-1	-	1.11E+0	-	3.50E+3
Mo-99	-	1.28E+2	2.43E+1	-	2.89E+2	-	2.96E+2
Tc-99m	1.30E-2	3.66E-2	4.66E-1	-	5.56E-1	1.79E-2	2.17E+1
Tc-101	1.33E-2	1.92E-2	1.88E-1	-	3.46E-1	9.81E-3	5.77E-14

TABLE 1-2: SITE RELATED INGESTION DOSE COMMITMENT FACTOR, A_{io} (FISH AND INVERTEBRATE CONSUMPTION) (Continued)

(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	1.07E+2	-	4.60E+1	-	4.07E+2	-	1.25E+4
Ru-105	8.89E+0	-	3.51E+0	-	1.15E+2	-	5.44E+3
Ru-106	1.59E+3	-	2.01E+2	-	3.06E+3	-	1.03E+5
Ag-110m	1.56E+3	1.45E+3	8.60E+2	-	2.85E+3	-	5.91E+5
Sb-122	1.98E+1	4.55E-1	6.82E+0	3.06E-1	-	1.19E+1	7.51E+3
Sb-124	2.77E+2	5.23E+0	1.10E+2	6.71E-1	-	2.15E+2	7.86E+3
Sb-125	1.77E+2	1.98E+0	4.21E+1	1.80E-1	-	1.36E+2	1.95E+3
Sb-126	1.14E+2	2.31E+0	4.10E+1	6.96E-1	-	6.97E+1	9.29E+3
Te-125m	2.17E+2	7.86E+1	2.91E+1	6.52E+1	8.82E+2	-	8.66E+2
Te-127m	5.48E+2	1.96E+2	6.68E+1	1.40E+2	2.23E+3	-	1.84E+3
Te-127	8.90E+0	3.20E+0	1.93E+0	6.60E+0	3.63E+1	-	7.03E+2
Te-129m	9.31E+2	3.47E+2	1.47E+2	3.20E+2	3.89E+3	-	4.69E+3
Te-129	2.54E+0	9.55E-1	6.19E-1	1.95E+0	1.07E+1	-	1.92E+0
Te-131m	1.40E+2	6.85E+1	5.71E+1	1.08E+2	6.94E+2	-	6.80E+3
Te-131	1.59E+0	6.66E-1	5.03E-1	1.31E+0	6.99E+0	-	2.26E-1
Te-132	2.04E+2	1.32E+2	1.24E+2	1.46E+2	1.27E+3	-	6.24E+3
I-130	3.96E+1	1.17E+2	4.61E+1	9.91E+3	1.82E+2	-	1.01E+2
I-131	2.18E+2	3.12E+2	1.79E+2	1.02E+5	5.35E+2	-	8.23E+1
I-132	1.06E+1	2.85E+1	9.96E+0	9.96E+2	4.54E+1	-	5.35E+0
I-133	7.45E+1	1.30E+2	3.95E+1	1.90E+4	2.26E+2	-	1.16E+2
I-134	5.56E+0	1.51E+1	5.40E+0	2.62E+2	2.40E+1	-	1.32E-2
I-135	2.32E+1	6.08E+1	2.24E+1	4.01E+3	9.75E+1	-	6.87E+1
Cs-134	6.84E+3	1.63E+4	1.33E+4	-	5.27E+3	1.75E+3	2.85E+2
Cs-136	7.16E+2	2.83E+3	2.04E+3	-	1.57E+3	2.16E+2	3.21E+2
Cs-137	8.77E+3	1.20E+4	7.85E+3	-	4.07E+3	1.35E+3	2.32E+2
Cs-138	6.07E+0	1.20E+1	5.94E+0	-	8.81E+0	8.70E-1	5.12E-5
Ba-139	7.85E+0	5.59E-3	2.30E-1	-	5.23E-3	3.17E-3	1.39E+1
Ba-140	1.64E+3	2.06E+0	1.08E+2	-	7.02E-1	1.18E+0	3.38E+3
Ba-141	3.81E+0	2.88E-3	1.29E-1	-	2.68E-3	1.63E-3	1.80E-9
Ba-142	1.72E+0	1.77E-3	1.08E-1	-	1.50E-3	1.00E-3	2.43E-18
La-140	1.57E+0	7.94E-1	2.10E-1	-	-	-	5.83E+4
La-142	8.06E-2	3.67E-2	9.13E-3	-	-	-	2.68E+2
Ce-141	3.43E+0	2.32E+0	2.63E-1	-	1.08E+0	-	8.86E+3
Ce-143	6.04E-1	4.46E+2	4.94E-2	-	1.97E-1	-	1.67E+4
Ce-144	1.79E+2	7.47E+1	9.59E+0	-	4.43E+1	-	6.04E+4
Pr-143	5.79E+0	2.32E+0	2.87E-1	-	1.34E+0	-	2.54E+4
Pr-144	1.90E-2	7.87E-3	9.64E-4	-	4.44E-3	-	2.73E-9
Nd-147	3.96E+0	4.58E+0	2.74E-1	-	2.68E+0	-	2.20E+4
W-187	9.16E+0	7.66E+0	2.68E+0	-	-	-	2.51E+3
Np-239	3.53E-2	3.47E-3	1.91E-3	-	1.08E-2	-	7.11E+2

TABLE 1-3: BIOACCUMULATION FACTORS

(pCi/kg per pCi/liter)*

ELEMENT	SALTWATER FISH	SALTWATER INVERTEBRATES
H	9.0E-01	9.3E-01
C	1.8E+03	1.4E+03
Na	6.7E-02	1.9E-01
P	3.0E+03	3.0E+04
Cr	4.0E+02	2.0E+03
Mn	5.5E+02	4.0E+02
Fe	3.0E+03	2.0E+04
Co	1.0E+02	1.0E+03
Ni	1.0E+02	2.5E+02
Cu	6.7E+02	1.7E+03
Zn	2.0E+03	5.0E+04
Br	1.5E-02	3.1E+00
Rb	8.3E+00	1.7E+01
Sr	2.0E+00	2.0E+01
Y	2.5E+01	1.0E+03
Zr	2.0E+02	8.0E+01
Nb	3.0E+04	1.0E+02
Mo	1.0E+01	1.0E+01
Tc	1.0E+01	5.0E+01
Ru	3.0E+00	1.0E+03
Rh	1.0E+01	2.0E+03
Ag	3.3E+03	3.3E+03
Sb	4.0E+01	5.4E+00
Te	1.0E+01	1.0E+02
I	1.0E+01	5.0E+01
Cs	4.0E+01	2.5E+01
Ba	1.0E+01	1.0E+02
La	2.5E+01	1.0E+03
Ce	1.0E+01	6.0E+02
Pr	2.5E+01	1.0E+03
Nd	2.5E+01	1.0E+03
W	3.0E+01	3.0E+01
Np	1.0E+01	1.0E+01
As	3.3E+02	3.3E+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

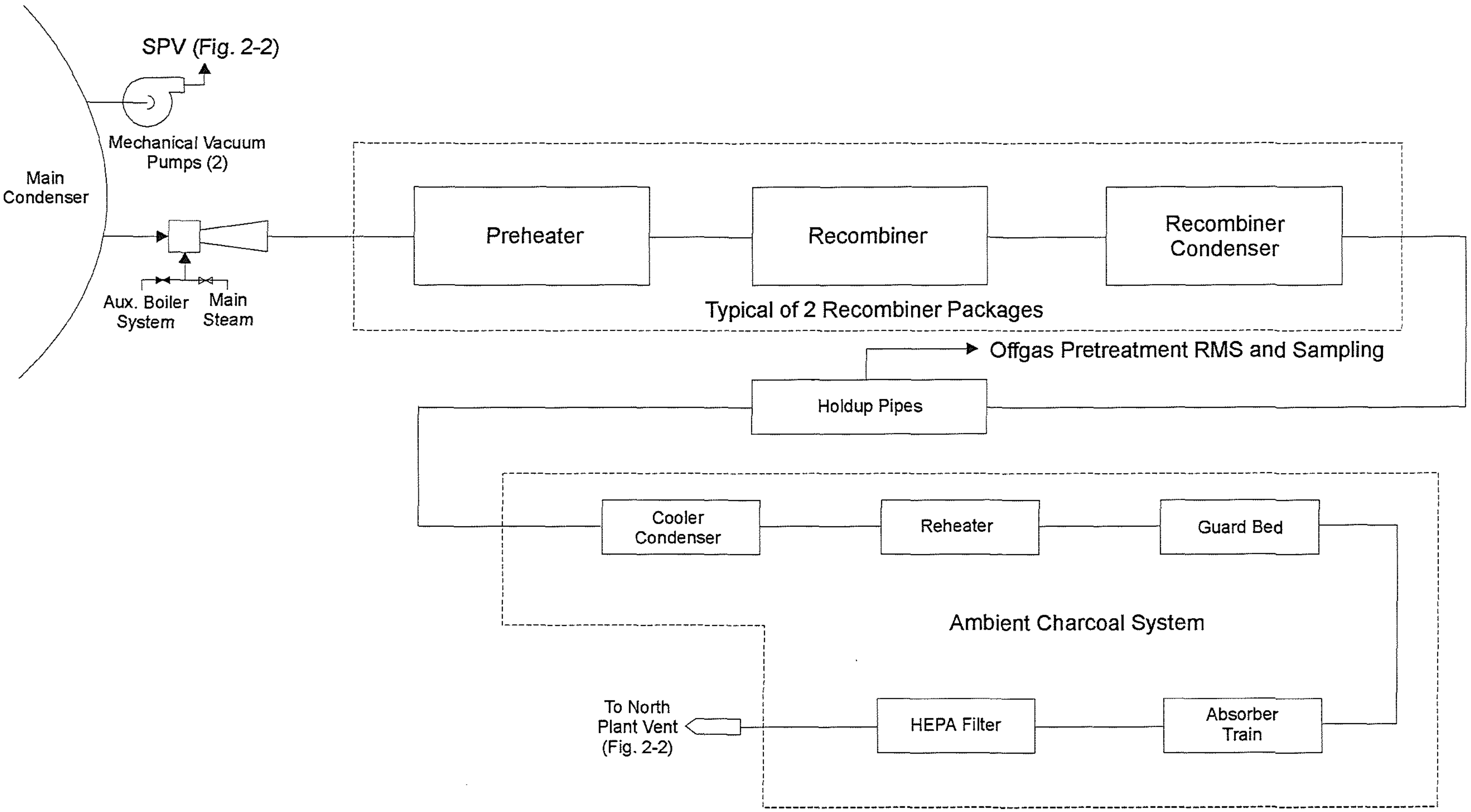
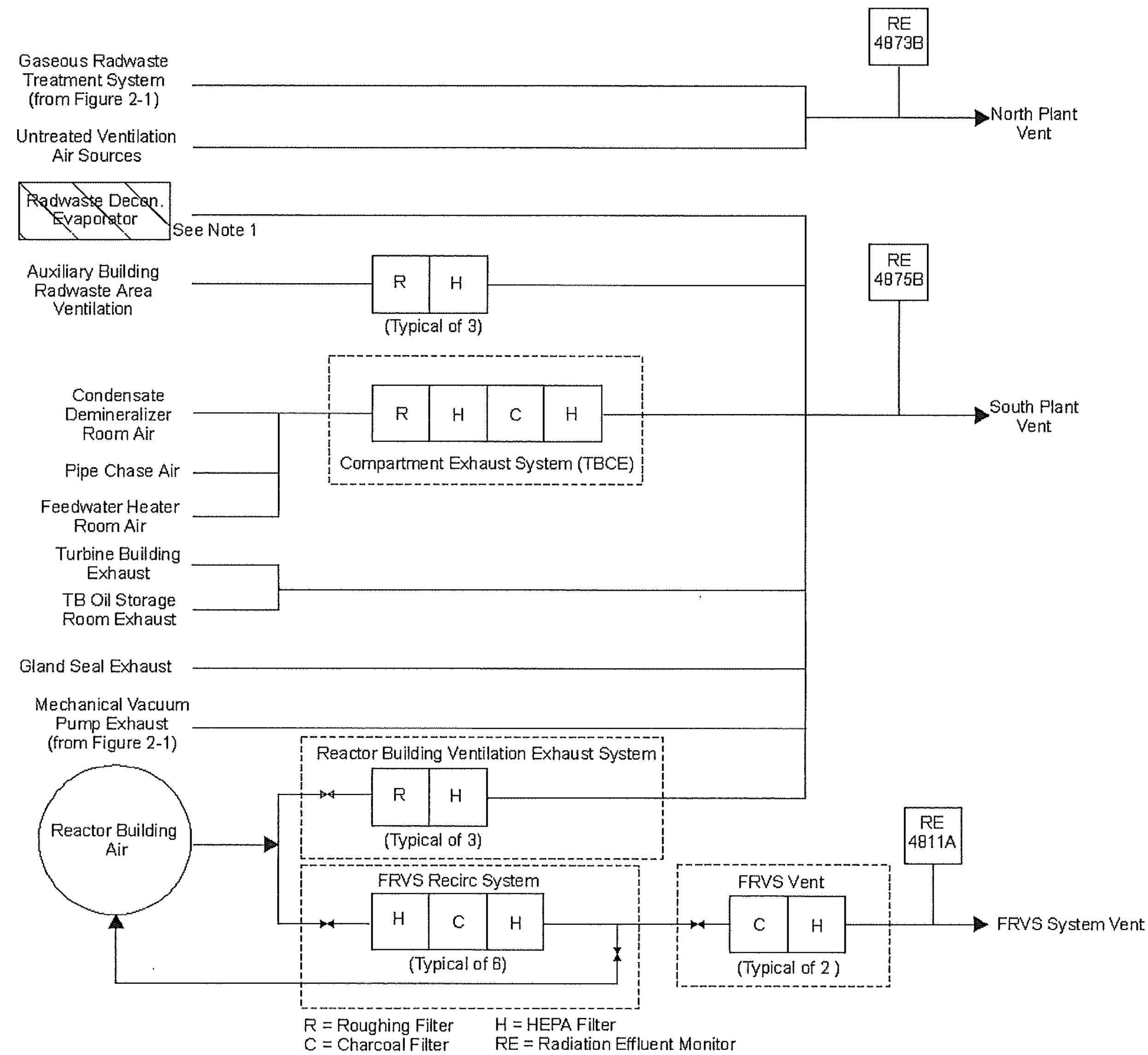


FIGURE 2-2: VENTILATION EXHAUST TREATMENT SYSTEM



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

TABLE 2-1: DOSE FACTORS FOR NOBLE GASES

Radionuclide	Total Body Dose Factor Ki (mrem/yr per μCi/m3)	Skin Dose Factor Li (mrem/yr per μCi/m3)	Gamma Air Dose Factor Mi (mrad/yr per μCi/m3)	Beta Air Dose Factor Ni (mrad/yr per μCi/m3
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 2-2: PARAMETERS FOR GASEOUS ALARM SETPOINT DETERMINATION

Parameter	Actual Value	Default Value	Units	Comments
X/Q	Calculated	2.14E-6	sec/m^3	From FSAR Table 2.3-31, 0.5 mile, N
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
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
C_i	Measured or Distribution from ANSI N237-1976[1]	N/A	μCi/cm^3	Normally derived from ANSI N237-1976
K_i	Nuclide Specific	N/A Specific	mrem/yr per μCi/m^3	Table 2-1
L_i	Nuclide Specific	N/A	mrem/yr per μCi/m^3	Table 2-1
M_i	Nuclide Specific	N/A	mrad/yr per μCi/m^3	Table 2-1
Setpoints	**Calculated Setpoint**	**Default Setpoint**		
NPV (RE 4873B)	3.03E-4	2.43E-4	μCi/cc	As an additional measure of conservatism, the default setpoints are set approximately 25% lower than the calculated setpoints.
SPV (RE 4875B)	2.89E-5	2.31E-5	μCi/cc	
FRVS (RE 4811A)	7.06E-4	5.65E-4	μCi/cc	

[1] See Section 2.2.2

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

ODCM Control	Location	Pathway(s)	Age Group	(sec/m3)	(1/m2)
3.11.2.1a	Site Boundary 0.5 miles, N*	Noble Gases direct exposure	N/A	2.14 E-06	N/A
3.11.2.1b	Site Boundary 0.5 miles, N*	Inhalation and ground plane	Child	2.14 E-06	N/A
3.11.2.2	Site Boundary 0.5 miles, N*	Gamma-Air Beta-Air	N/A	2.14 E-06	N/A
3.11.2.3	Residence/Dairy - 4.9 miles, W**	Milk, ground plane and inhalation	Infant	7.2 E-08	2.87 E-10
3.11.2.3	Residence/Garden/Beef 4.6 miles SW**	Ground Plane, inhalation, garden produce, meat ingestion	Child	8.0E-08	2.4E-10

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

** Location and distance are determined from the performance of the annual land use census as required by ODCM CONTROL 3.12.2.

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, INHALATION PATHWAY DOSE FACTORS

ADULT (mrem/yr per µCi/m^3)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.26E+3	1.26E+3	1.26E+3	1.26E+3	1.26E+3	1.26E+3
C-14	1.82E+4	3.41E+3	3.41E+3	3.41E+3	3.41E+3	3.41E+3	3.41E+3
P-32	1.32E+6	7.71E+4	-	-	-	8.64E+4	5.01E+4
Cr-51	-	-	5.95E+1	2.28E+1	1.44E+4	3.32E+3	1.00E+2
Mn-54	-	3.96E+4	-	9.84E+3	1.40E+6	7.74E+4	6.30E+3
Fe-55	2.46E+4	1.70E+4	-	-	7.21E+4	6.03E+3	3.94E+3
Fe-59	1.18E+4	2.78E+4	-	-	1.02E+6	1.88E+5	1.06E+4
Co-57	-	6.92E+2	-	-	3.70E+5	3.14E+4	6.71E+2
Co-58	-	1.58E+3	-	-	9.28E+5	1.06E+5	2.07E+3
Co-60	-	1.15E+4	-	-	5.97E+6	2.85E+5	1.48E+4
Ni-63	4.32E+5	3.14E+4	-	-	1.78E+5	1.34E+4	1.45E+4
Zn-65	3.24E+4	1.03E+5	-	6.90E+4	8.64E+5	5.34E+4	4.66E+4
Rb-86	-	1.35E+5	-	-	-	1.66E+4	5.90E+4
Sr-89	3.04E+5	-	-	-	1.40E+6	3.50E+5	8.72E+3
Sr-90	9.92E+7	-	-	-	9.60E+6	7.22E+5	6.10E+6
Y-91	4.62E+5	-	-	-	1.70E+6	3.85E+5	1.24E+4
Zr-95	1.07E+5	3.44E+4	-	5.42E+4	1.77E+6	1.50E+5	2.33E+4
Nb-95	1.41E+4	7.82E+3	-	7.74E+3	5.05E+5	1.04E+5	4.21E+3
Ru-103	1.53E+3	-	-	5.83E+3	5.05E+5	1.10E+5	6.58E+2
Ru-106	6.91E+4	-	-	1.34E+5	9.36E+6	9.12E+5	8.72E+3
Ag-110m	1.08E+4	1.00E+4	-	1.97E+4	4.63E+6	3.02E+5	5.94E+3
Sb-124	3.12E+4	5.89E+2	7.55E+1	-	2.48E+6	4.06E+5	1.24E+4
Sb-125	5.34E+4	5.95E+2	5.40E+1	-	1.74E+6	1.01E+5	1.26E+4
Te-125m	3.42E+3	1.58E+3	1.05E+3	1.24E+4	3.14E+5	7.06E+4	4.67E+2
Te-127m	1.26E+4	5.77E+3	3.29E+3	4.58E+4	9.60E+5	1.50E+5	1.57E+3
Te-129m	9.76E+3	4.67E+3	3.44E+3	3.66E+4	1.16E+6	3.83E+5	1.58E+3
I-131	2.52E+4	3.58E+4	1.19E+7	6.13E+4	-	6.28E+3	2.05E+4
I-132	1.16E+3	3.26E+3	1.14E+5	5.18E+3	-	4.06E+2	1.16E+3
I-133	8.64E+3	1.48E+4	2.15E+6	2.58E+4	-	8.88E+3	4.52E+3
I-134	6.44E+2	1.73E+3	2.98E+4	2.75E+3	-	1.01E+0	6.15E+2
I-135	2.68E+3	6.98E+3	4.48E+5	1.11E+4	-	5.25E+3	2.57E+3
Cs-134	3.73E+5	8.48E+5	-	2.87E+5	9.76E+4	1.04E+4	7.28E+5
Cs-136	3.90E+4	1.46E+5	-	8.56E+4	1.20E+4	1.17E+4	1.10E+5
Cs-137	4.78E+5	6.21E+5	-	2.22E+5	7.52E+4	8.40E+3	4.28E+5
Ba-140	3.90E+4	4.90E+1	-	1.67E+1	1.27E+6	2.18E+5	2.57E+3
Ce-141	1.99E+4	1.35E+4	-	6.26E+3	3.62E+5	1.20E+5	1.53E+3
Ce-144	3.43E+6	1.43E+6	-	8.48E+5	7.78E+6	8.16E+5	1.84E+5
Pr-143	9.36E+3	3.75E+3	-	2.16E+3	2.81E+5	2.00E+5	4.64E+2
Nd-147	5.27E+3	6.10E+3	-	3.56E+3	2.21E+5	1.73E+5	3.65E+2

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, INHALATION PATHWAY DOSE FACTORS (Continued)

TEENAGER (mrem/yr per μCi/m³)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.27E+3	1.27E+3	1.27E+3	1.27E+3	1.27E+3	1.27E+3
C-14	2.60E+4	4.87E+3	4.87E+3	4.87E+3	4.87E+3	4.87E+3	4.87E+3
P-32	1.89E+6	1.10E+5	-	-	-	9.28E+4	7.16E+4
Cr-51	-	-	7.50E+1	3.07E+1	2.10E+4	3.00E+3	1.35E+2
Mn-54	-	5.11E+4	-	1.27E+4	1.98E+6	6.68E+4	8.40E+3
Fe-55	3.34E+4	2.38E+4	-	-	1.24E+5	6.39E+3	5.54E+3
Fe-59	1.59E+4	3.70E+4	-	-	1.53E+6	1.78E+5	1.43E+4
Co-57	-	6.92E+2	-	-	5.86E+5	3.14E+4	9.20E+2
Co-58	-	2.07E+3	-	-	1.34E+6	9.52E+4	2.78E+3
Co-60	-	1.51E+4	-	-	8.72E+6	2.59E+5	1.98E+4
Ni-63	5.80E+5	4.34E+4	-	-	3.07E+5	1.42E+4	1.98E+4
Zn-65	3.86E+4	1.34E+5	-	8.64E+4	1.24E+6	4.66E+4	6.24E+4
Rb-86	-	1.90E+5	-	-	-	1.77E+4	8.40E+4
Sr-89	4.34E+5	-	-	-	2.42E+6	3.71E+5	1.25E+4
Sr-90	1.08E+8	-	-	-	1.65E+7	7.65E+5	6.68E+6
Y-91	6.61E+5	-	-	-	2.94E+6	4.09E+5	1.77E+4
Zr-95	1.46E+5	4.58E+4	-	6.74E+4	2.69E+6	1.49E+5	3.15E+4
Nb-95	1.86E+4	1.03E+4	-	1.00E+4	7.51E+5	9.68E+4	5.66E+3
Ru-103	2.10E+3	-	-	7.43E+3	7.83E+5	1.09E+5	8.96E+2
Ru-106	9.84E+4	-	-	1.90E+5	1.61E+7	9.60E+5	1.24E+4
Ag-110m	1.38E+4	1.31E+4	-	2.50E+4	6.75E+6	2.73E+5	7.99E+3
Sb-124	4.30E+4	7.94E+2	9.76E+1	-	3.85E+6	3.98E+5	1.68E+4
Sb-125	7.38E+4	8.08E+2	7.04E+1	-	2.74E+6	9.92E+4	1.72E+4
Te-125m	4.88E+3	2.24E+3	1.40E+3	-	5.36E+5	7.50E+4	6.67E+2
Te-127m	1.80E+4	8.16E+3	4.38E+3	6.54E+4	1.66E+6	1.59E+5	2.18E+3
Te-129m	1.39E+4	6.58E+3	4.58E+3	5.19E+4	1.98E+6	4.05E+5	2.25E+3
I-131	3.54E+4	4.91E+4	1.46E+7	8.40E+4	-	6.49E+3	2.64E+4
I-132	1.59E+3	4.38E+3	1.51E+5	6.92E+3	-	1.27E+3	1.58E+3
I-133	1.22E+4	2.05E+4	2.92E+6	3.59E+4	-	1.03E+4	6.22E+3
I-134	8.88E+2	2.32E+3	3.95E+4	3.66E+3	-	2.04E+1	8.40E+2
I-135	3.70E+3	9.44E+3	6.21E+5	1.49E+4	-	6.95E+3	3.49E+3
Cs-134	5.02E+5	1.13E+6	-	3.75E+5	1.46E+5	9.76E+3	5.49E+5
Cs-136	5.15E+4	1.94E+5	-	1.10E+5	1.78E+4	1.09E+4	1.37E+5
Cs-137	6.70E+5	8.48E+5	-	3.04E+5	1.21E+5	8.48E+3	3.11E+5
Ba-140	5.47E+4	6.70E+1	-	2.28E+1	2.03E+6	2.29E+5	3.52E+3
Ce-141	2.84E+4	1.90E+4	-	8.88E+3	6.14E+5	1.26E+5	2.17E+3
Ce-144	4.89E+6	2.02E+6	-	1.21E+6	1.34E+7	8.64E+5	2.62E+5
Pr-143	1.34E+4	5.31E+3	-	3.09E+3	4.83E+5	2.14E+5	6.62E+2
Nd-147	7.86E+3	8.56E+3	-	5.02E+3	3.72E+5	1.82E+5	5.13E+2

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, INHALATION PATHWAY DOSE FACTORS (Continued)

CHILD (mrem/yr per µCi/m^3)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.12E+3	1.12E+3	1.12E+3	1.12E+3	1.12E+3	1.12E+3
C-14	3.59E+4	6.73E+3	6.73E+3	6.73E+3	6.73E+3	6.73E+3	6.73E+3
P-32	2.60E+6	1.14E+5	-	-	-	4.22E+4	9.88E+4
Cr-51	-	-	8.55E+1	2.43E+1	1.70E+4	1.08E+3	1.54E+2
Mn-54	-	4.29E+4	-	1.00E+4	1.58E+6	2.29E+4	9.51E+3
Fe-55	4.74E+4	2.52E+4	-	-	1.11E+5	2.87E+3	7.77E+3
Fe-59	2.07E+4	3.34E+4	-	-	1.27E+6	7.07E+4	1.67E+4
Co-57	-	9.03E+2	-	-	5.07E+5	1.32E+4	1.07E+3
Co-58	-	1.77E+3	-	-	1.11E+6	3.44E+4	3.16E+3
Co-60	-	1.31E+4	-	-	7.07E+6	9.62E+4	2.26E+4
Ni-63	8.21E+5	4.63E+4	-	-	2.75E+5	6.33E+3	2.80E+4
Zn-65	4.26E+4	1.13E+5	-	7.14E+4	9.95E+5	1.63E+4	7.03E+4
Rb-86	-	1.98E+5	-	-		7.99E+3	1.14E+5
Sr-89	5.99E+5	-	-	-	2.16E+6	1.67E+5	1.72E+4
Sr-90	1.01E+8	-	-	-	1.48E+7	3.43E+5	6.44E+6
Y-91	9.14E+5	-	-	-	2.63E+6	1.84E+5	2.44E+4
Zr-95	1.90E+5	4.18E+4	-	5.96E+4	2.23E+6	6.11E+4	3.70E+4
Nb-95	2.35E+4	9.18E+3	-	8.62E+3	6.14E+5	3.70E+4	6.55E+3
Ru-103	2.79E+3	-	-	7.03E+3	6.62E+5	4.48E+4	1.07E+3
Ru-106	1.36E+5	-	-	1.84E+5	1.43E+7	4.29E+5	1.69E+4
Ag-110m	1.69E+4	1.14E+4	-	2.12E+4	5.48E+6	1.00E+5	9.14E+3
Sb-124	5.74E+4	7.40E+2	1.26E+2	-	3.24E+6	1.64E+5	2.00E+4
Sb-125	9.84E+4	7.59E+2	9.10E+1	-	2.32E+6	4.03E+4	2.07E+4
Te-125m	6.73E+3	2.33E+3	1.92E+3	-	4.77E+5	3.38E+4	9.14E+2
Te-127m	2.49E+4	8.55E+3	6.07E+3	6.36E+4	1.48E+6	7.14E+4	3.02E+3
Te-129m	1.92E+4	6.85E+3	6.33E+3	5.03E+4	1.76E+6	1.82E+5	3.04E+3
I-131	4.81E+4	4.81E+4	1.62E+7	7.88E+4	-	2.84E+3	2.73E+4
I-132	2.12E+3	4.07E+3	1.94E+5	6.25E+3	-	3.22E+3	1.88E+3
I-133	1.66E+4	2.03E+4	3.85E+6	3.38E+4	-	5.48E+3	7.70E+3
I-134	1.17E+3	2.16E+3	5.07E+4	3.30E+3	-	9.55E+2	9.95E+2
I-135	4.92E+3	8.73E+3	7.92E+5	1.34E+4	-	4.44E+3	4.14E+3
Cs-134	6.51E+5	1.01E+6	-	3.30E+5	1.21E+5	3.85E+3	2.25E+5
Cs-136	6.51E+4	1.71E+5	-	9.55E+4	1.45E+4	4.18E+3	1.16E+5
Cs-137	9.07E+5	8.25E+5	-	2.82E+5	1.04E+5	3.62E+3	1.28E+5
Ba-140	7.40E+4	6.48E+1	-	2.11E+1	1.74E+6	1.02E+5	4.33E+3
Ce-141	3.92E+4	1.95E+4	-	8.55E+3	5.44E+5	5.66E+4	2.90E+3
Ce-144	6.77E+6	2.12E+6	-	1.17E+6	1.20E+7	3.89E+5	3.61E+5
Pr-143	1.85E+4	5.55E+3	-	3.00E+3	4.33E+5	9.73E+4	9.14E+2
Nd-147	1.08E+4	8.73E+3	-	4.81E+3	3.28E+5	8.21E+4	6.81E+2

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, INHALATION PATHWAY DOSE FACTORS (Continued)

INFANT (mrem/yr per μCi/m³)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	6.47E+2	6.47E+2	6.47E+2	6.47E+2	6.47E+2	6.47E+2
C-14	2.65E+4	5.31E+3	5.31E+3	5.31E+3	5.31E+3	5.31E+3	5.31E+3
P-32	2.03E+6	1.12E+5	-	-	-	1.61E+4	7.74E+4
Cr-51	-	-	5.75E+1	1.32E+1	1.28E+4	3.57E+2	8.95E+1
Mn-54	-	2.53E+4	-	4.98E+3	1.00E+6	7.06E+3	4.98E+3
Fe-55	1.97E+4	1.17E+4	-	-	8.69E+4	1.09E+3	3.33E+3
Fe-59	1.36E+4	2.35E+4	-	-	1.02E+6	2.48E+4	9.48E+3
Co-57	-	6.51E+2	-	-	3.79E+5	4.86E+3	6.41E+2
Co-58	-	1.22E+3	-	-	7.77E+5	1.11E+4	1.82E+3
Co-60	-	8.02E+3	-	-	4.51E+6	3.19E+4	1.18E+4
Ni-63	3.39E+5	2.04E+4	-	-	2.09E+5	2.42E+3	1.16E+4
Zn-65	1.93E+4	6.26E+4	-	3.25E+4	6.47E+5	5.14E+4	3.11E+4
Rb-86	-	1.90E+5	-	-	-	3.04E+3	8.82E+4
Sr-89	3.98E+5	-	-	-	2.03E+6	6.40E+4	1.14E+4
Sr-90	4.09E+7	-	-	-	1.12E+7	1.31E+5	2.59E+6
Y-91	5.88E+5	-	-	-	2.45E+6	7.03E+4	1.57E+4
Zr-95	1.15E+5	2.79E+4	-	3.11E+4	1.75E+6	2.17E+4	2.03E+4
Nb-95	1.57E+4	6.43E+3	-	4.72E+3	4.79E+5	1.27E+4	3.78E+3
Ru-103	2.02E+3	-	-	4.24E+3	5.52E+5	1.61E+4	6.79E+2
Ru-106	8.68E+4	-	-	1.07E+5	1.16E+7	1.64E+5	1.09E+4
Ag-110m	9.98E+3	7.22E+3	-	1.09E+4	3.67E+6	3.30E+4	5.00E+3
Sb-124	3.79E+4	5.56E+2	1.01E+2	-	2.65E+6	5.91E+4	1.20E+4
Sb-125	5.17E+4	4.77E+2	6.23E+1	-	1.64E+6	1.47E+4	1.09E+4
Te-125m	4.76E+3	1.99E+3	1.62E+3	-	4.47E+5	1.29E+4	6.58E+2
Te-127m	1.67E+4	6.90E+3	4.87E+3	3.75E+4	1.31E+6	2.73E+4	2.07E+3
Te-129m	1.41E+4	6.09E+3	5.47E+3	3.18E+4	1.68E+6	6.90E+4	2.23E+3
I-131	3.79E+4	4.44E+4	1.48E+7	5.18E+4	-	1.06E+3	1.96E+4
I-132	1.69E+3	3.54E+3	1.69E+5	3.95E+5	-	1.90E+3	1.26E+3
I-133	1.32E+4	1.92E+4	3.56E+6	2.24E+4	-	2.61E+3	5.60E+3
I-134	9.21E+2	1.88E+3	4.45E+4	2.09E+3	-	1.29E+3	6.65E+2
I-135	3.86E+3	7.60E+3	6.96E+5	8.47E+3	-	1.83E+3	2.77E+3
Cs-134	3.96E+5	7.03E+5	-	1.90E+5	7.97E+4	1.33E+3	7.45E+4
Cs-136	4.83E+4	1.35E+5	-	5.64E+4	1.18E+4	1.43E+3	5.29E+4
Cs-137	5.49E+5	6.12E+5	-	1.72E+5	7.13E+4	1.33E+3	4.55E+4
Ba-140	5.60E+4	5.60E+1	-	1.34E+1	1.60E+6	3.84E+4	2.90E+3
Ce-141	2.77E+4	1.67E+4	-	5.25E+3	5.17E+5	2.16E+4	1.99E+3
Ce-144	3.19E+6	1.21E+6	-	5.38E+5	9.84E+6	1.48E+5	1.76E+5
Pr-143	1.40E+4	5.24E+3	-	1.97E+3	4.33E+5	3.72E+4	6.99E+2
Nd-147	7.94E+3	8.13E+3	-	3.15E+3	3.22E+5	3.12E+4	5.00E+2

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, GRASS-COW-MILK PATHWAY DOSE FACTORS (Continued)

ADULT (mrem/yr per μCi/m^3) FOR H-3 AND C-14
(m^2 * mrem/yr per μCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	7.63E+2	7.63E+2	7.63E+2	7.63E+2	7.63E+2	7.63E+2
C-14	3.63E+5	7.26E+4	7.26E+4	7.26E+4	7.26E+4	7.26E+4	7.26E+4
P-32	1.71E+10	1.06E+9	-	-	-	1.92E+9	6.60E+8
Cr-51	-	-	1.71E+4	6.30E+3	3.80E+4	7.20E+6	2.86E+4
Mn-54	-	8.40E+6	-	2.50E+6	-	2.57E+7	1.60E+6
Fe-55	2.51E+7	1.73E+7	-	-	9.67E+6	9.95E+6	4.04E+6
Fe-59	2.98E+7	7.00E+7	-	-	1.95E+7	2.33E+8	2.68E+7
Co-57	-	1.28E+6	-	-	-	3.25E+7	2.13E+6
Co-58	-	4.72E+6	-	-	-	9.57E+7	1.06E+7
Co-60	-	1.64E+7	-	-	-	3.08E+8	3.62E+7
Ni-63	6.73E+9	4.66E+8	-	-	-	9.73E+7	2.26E+8
Zn-65	1.37E+9	4.36E+9	-	2.92E+9	-	2.75E+9	1.97E+9
Rb-86	-	2.59E+9	-	-	-	5.11E+8	1.21E+9
Sr-89	1.45E+9	-	-	-	-	2.33E+8	4.16E+7
Sr-90	4.68E+10	-	-	-	-	1.35E+9	1.15E+10
Y-91	8.60E+3	-	-	-	-	4.73E+6	2.30E+2
Zr-95	9.46E+2	3.03E+2	-	4.76E+2	-	9.62E+5	2.05E+2
Nb-95	8.25E+4	4.59E+4	-	4.54E+4	-	2.79E+8	2.47E+4
Ru-103	1.02E+3	-	-	3.89E+3	-	1.19E+5	4.39E+2
Ru-106	2.04E+4	-	-	3.94E+4	-	1.32E+6	2.58E+3
Ag-110m	5.83E+7	5.39E+7	-	1.06E+8	-	2.20E+10	3.20E+7
Sb-124	2.57E+7	4.86E+5	6.24E+4	-	2.00E+7	7.31E+8	1.02E+7
Sb-125	2.04E+7	2.28E+5	2.08E+4	-	1.58E+7	2.25E+8	4.86E+6
Te-125m	1.63E+7	5.90E+6	4.90E+6	6.63E+7	-	6.50E+7	2.18E+6
Te-127m	4.58E+7	1.64E+7	1.17E+7	1.86E+8	-	1.54E+8	5.58E+6
Te-129m	6.04E+7	2.25E+7	2.08E+7	2.52E+8	-	3.04E+8	9.57E+6
I-131	2.96E+8	4.24E+8	1.39E+11	7.27E+8	-	1.12E+8	2.43E+8
I-132	1.64E-1	4.37E-1	1.53E+1	6.97E-1	-	8.22E-2	1.53E-1
I-133	3.97E+6	6.90E+6	1.01E+9	1.20E+7	-	6.20E+6	2.10E+6
I-134	-	-	-	-	-	-	-
I-135	1.39E+4	3.63E+4	2.40E+6	5.83E+4	-	4.10E+4	1.34E+4
Cs-134	5.65E+9	1.34E+10	-	4.35E+9	1.44E+9	2.35E+8	1.10E+10
Cs-136	2.61E+8	1.03E+9	-	5.74E+8	7.87E+7	1.17E+8	7.42E+8
Cs-137	7.38E+9	1.01E+10	-	3.43E+9	1.14E+9	1.95E+8	6.61E+9
Ba-140	2.69E+7	3.38E+4	-	1.15E+4	1.93E+4	5.54E+7	1.76E+6
Ce-141	4.84E+3	3.27E+3	-	1.52E+3	-	1.25E+7	3.71E+2
Ce-144	3.58E+5	1.50E+5	-	8.87E+4	-	1.21E+8	1.92E+4
Pr-143	1.59E+2	6.37E+1	-	3.68E+1	-	6.96E+5	7.88E+0
Nd-147	9.42E+1	1.09E+2	-	6.37E+1	-	5.23E+5	6.52E+0

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, GRASS-COW-MILK PATHWAY DOSE FACTORS (Continued)

TEENAGER (mrem/yr per μCi/m³) FOR H-3 AND C-14
(m² * mrem/yr per μCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	9.94E+2	9.94E+2	9.94E+2	9.94E+2	9.94E+2	9.94E+2
C-14	6.70E+5	1.34E+5	1.34E+5	1.34E+5	1.34E+5	1.34E+5	1.34E+5
P-32	3.15E+10	1.95E+9	-	-	-	2.65E+9	1.22E+9
Cr-51	-	-	2.78E+4	1.10E+4	7.13E+4	8.40E+6	5.00E+4
Mn-54	-	1.40E+7	-	4.17E+6	-	2.87E+7	2.78E+6
Fe-55	4.45E+7	3.16E+7	-	-	2.00E+7	1.37E+7	7.36E+6
Fe-59	5.20E+7	1.21E+8	-	-	3.82E+7	2.87E+8	4.68E+7
Co-57	-	2.25E+6	-	-	-	4.19E+7	3.76E+6
Co-58	-	7.95E+6	-	-	-	1.10E+8	1.83E+7
Co-60	-	2.78E+7	-	-	-	3.62E+8	6.26E+7
Ni-63	1.18E+10	8.35E+8	-	-	-	1.33E+8	4.01E+8
Zn-65	2.11E+9	7.31E+9	-	4.68E+9	-	3.10E+9	3.41E+9
Rb-86	-	4.73E+9	-	-	-	7.00E+8	2.22E+9
Sr-89	2.67E+9	-	-	-	-	3.18E+8	7.66E+7
Sr-90	9.92E+7	-	-	-	9.60E+6	7.22E+5	6.10E+6
Y-91	1.58E+4	-	-	-	-	6.48E+6	4.24E+2
Zr-95	1.65E+3	5.22E+2	-	7.67E+2	-	1.20E+6	3.59E+2
Nb-95	1.41E+5	7.80E+4	-	7.57E+4	-	3.34E+8	4.30E+4
Ru-103	1.81E+3	-	-	6.40E+3	-	1.52E+5	7.75E+2
Ru-106	3.75E+4	-	-	7.23E+4	-	1.80E+6	4.73E+3
Ag-110m	9.63E+7	9.11E+7	-	1.74E+8	-	2.56E+10	5.54E+7
Sb-124	4.59E+7	8.46E+5	1.04E+5	-	4.01E+7	9.25E+8	1.79E+7
Sb-125	3.65E+7	3.99E+5	3.49E+4	-	3.21E+7	2.84E+8	8.54E+6
Te-125m	3.00E+7	1.08E+7	8.39E+6	-	-	8.86E+7	4.02E+6
Te-127m	8.44E+7	2.99E+7	2.01E+7	3.42E+8	-	2.10E+8	1.00E+7
Te-129m	1.11E+8	4.10E+7	3.57E+7	4.62E+8	-	4.15E+8	1.75E+7
I-131	5.38E+8	7.53E+8	2.20E+11	1.30E+9	-	1.49E+8	4.04E+8
I-132	2.90E-1	7.59E-1	2.56E+1	1.20E+0	-	3.31E-1	2.72E-1
I-133	7.24E+6	1.23E+7	1.72E+9	2.15E+7	-	9.30E+6	3.75E+6
I-134	-	-	-	-	-	-	-
I-135	2.47E+4	6.35E+4	4.08E+6	1.00E+5	-	7.03E+4	2.35E+4
Cs-134	9.81E+9	2.31E+10	-	7.34E+9	2.80E+9	2.87E+8	1.07E+10
Cs-136	4.45E+8	1.75E+9	-	9.53E+8	1.50E+8	1.41E+8	1.18E+9
Cs-137	1.34E+10	1.78E+10	-	6.06E+9	2.35E+9	2.53E+8	6.20E+9
Ba-140	4.85E+7	5.95E+4	-	2.02E+4	4.00E+4	7.49E+7	3.13E+6
Ce-141	8.87E+3	1.35E+4	-	2.79E+3	-	1.69E+7	6.81E+2
Ce-144	6.58E+5	2.72E+5	-	1.63E+5	-	1.66E+8	3.54E+4
Pr-143	2.92E+2	1.17E+2	-	6.77E+1	-	9.61E+5	1.45E+1
Nd-147	1.81E+2	1.97E+2	-	1.16E+2	-	7.11E+5	1.18E+1

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, GRASS-COW-MILK PATHWAY DOSE FACTORS (Continued)

CHILD (mrem/yr per μCi/m^3) FOR H-3 AND C-14
(m^2 * mrem/yr per μCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.57E+3	1.57E+3	1.57E+3	1.57E+3	1.57E+3	1.57E+3
C-14	1.65E+6	3.29E+5	3.29E+5	3.29E+5	3.29E+5	3.29E+5	3.29E+5
P-32	7.77E+10	3.64E+9	-	-	-	2.15E+9	3.00E+9
Cr-51	-	-	5.66E+4	1.55E+4	1.03E+5	5.41E+6	1.02E+5
Mn-54	-	2.09E+7	-	5.87E+6	-	1.76E+7	5.58E+6
Fe-55	1.12E+8	5.93E+7	-	-	3.35E+7	1.10E+7	1.84E+7
Fe-59	1.20E+8	1.95E+8	-	-	5.65E+7	2.03E+8	9.71E+7
Co-57	-	3.84E+6	-	-	-	3.14E+7	7.77E+6
Co-58	-	1.21E+7	-	-	-	7.08E+7	3.72E+7
Co-60	-	4.32E+7	-	-	-	2.39E+8	1.27E+8
Ni-63	2.96E+10	1.59E+9	-	-	-	1.07E+8	1.01E+9
Zn-65	4.13E+9	1.10E+10	-	6.94E+9	-	1.93E+9	6.85E+9
Rb-86	-	8.77E+9	-	-	-	5.64E+8	5.39E+9
Sr-89	6.62E+9	-	-	-	-	2.56E+8	1.89E+8
Sr-90	1.12E+11	-	-	-	-	1.51E+9	2.83E+10
Y-91	3.91E+4	-	-	-	-	5.21E+6	1.04E+3
Zr-95	3.84E+3	8.45E+2	-	1.21E+3	-	8.81E+5	7.52E+2
Nb-95	3.18E+5	1.24E+5	-	1.16E+5	-	2.29E+8	8.84E+4
Ru-103	4.29E+3	-	-	1.08E+4	-	1.11E+5	1.65E+3
Ru-106	9.24E+4	-	-	1.25E+5	-	1.44E+6	1.15E+4
Ag-110m	2.09E+8	1.41E+8	-	2.63E+8	-	1.68E+10	1.13E+8
Sb-124	1.09E+8	1.41E+8	2.40E+5	-	6.03E+7	6.79E+8	3.81E+7
Sb-125	8.70E+7	1.41E+6	8.06E+4	-	4.85E+7	2.08E+8	1.82E+7
Te-125m	7.38E+7	2.00E+7	2.07E+7	-	-	7.12E+7	9.84E+6
Te-127m	2.08E+8	5.60E+7	4.97E+7	5.93E+8	-	1.68E+8	2.47E+7
Te-129m	2.72E+8	7.61E+7	8.78E+7	8.00E+8	-	3.32E+8	4.23E+7
I-131	1.30E+9	1.31E+9	4.34E+11	2.15E+9	-	1.17E+8	7.46E+8
I-132	6.86E-1	1.26E+0	5.85E+1	1.93E+0	-	1.48E+0	5.80E-1
I-133	1.76E+7	2.18E+7	4.04E+9	3.63E+7	-	8.77E+6	8.23E+6
I-134	-	-	-	-	-	-	-
I-135	5.84E+4	1.05E+5	9.30E+6	1.61E+5	-	8.00E+4	4.97E+4
Cs-134	2.26E+10	3.71E+10	-	1.15E+10	4.13E+9	2.00E+8	7.83E+9
Cs-136	1.00E+9	2.76E+9	-	1.47E+9	2.19E+8	9.70E+7	1.79E+9
Cs-137	3.22E+10	3.09E+10	-	1.01E+10	3.62E+9	1.93E+8	4.55E+9
Ba-140	1.17E+8	1.03E+5	-	3.34E+4	6.12E+4	5.94E+7	6.84E+6
Ce-141	2.19E+4	1.09E+4	-	4.78E+3	-	1.36E+7	1.62E+3
Ce-144	1.62E+6	5.09E+5	-	2.82E+5	-	1.33E+8	8.66E+4
Pr-143	7.23E+2	2.17E+2	-	1.17E+2	-	7.80E+5	3.59E+1
Nd-147	4.45E+2	3.60E+2	-	1.98E+2	-	5.71E+5	2.79E+1

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, GRASS-COW-MILK PATHWAY DOSE FACTORS (Continued)

INFANT (mrem/yr per µCi/m³) FOR H-3 AND C-14
(m² * mrem/yr per µCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	2.38E+3	2.38E+3	2.38E+3	2.38E+3	2.38E+3	2.38E+3
C-14	3.23E+6	6.89E+5	6.89E+5	6.89E+5	6.89E+5	6.89E+5	6.89E+5
P-32	1.60E+11	9.42E+9	-	-	-	2.17E+9	6.21E+9
Cr-51	-	-	1.05E+5	2.30E+4	2.05E+5	4.71E+6	1.61E+5
Mn-54	-	3.89E+7	-	8.63E+6	-	1.43E+7	8.83E+6
Fe-55	1.35E+8	8.72E+7	-	-	4.27E+7	1.11E+7	2.33E+7
Fe-59	2.25E+8	3.93E+8	-	-	1.16E+8	1.88E+8	1.55E+8
Co-57	-	8.95E+6	-	-	-	3.05E+7	1.46E+7
Co-58	-	2.43E+7	-	-	-	6.05E+7	6.06E+7
Co-60	-	8.81E+7	-	-	-	2.10E+8	2.08E+8
Ni-63	3.49E+10	2.16E+9	-	-	-	1.07E+8	1.21E+9
Zn-65	5.55E+9	1.90E+10	-	9.23E+9	-	1.61E+10	8.78E+9
Rb-86	-	2.22E+10	-	-	-	5.69E+8	1.10E+10
Sr-89	1.26E+10	-	-	-	-	2.59E+8	3.61E+8
Sr-90	1.22E+11	-	-	-	-	1.52E+9	3.10E+10
Y-91	7.33E+4	-	-	-	-	5.26E+6	1.95E+3
Zr-95	6.83E+3	1.66E+3	-	1.79E+3	-	8.28E+5	1.18E+3
Nb-95	5.93E+5	2.44E+5	-	1.75E+5	-	2.06E+8	1.41E+5
Ru-103	8.69E+3	-	-	1.81E+4	-	1.06E+5	2.91E+3
Ru-106	1.90E+5	-	-	2.25E+5	-	1.44E+6	2.38E+4
Ag-110m	3.86E+8	2.82E+8	-	4.03E+8	-	1.46E+10	1.86E+8
Sb-124	2.09E+8	3.08E+6	5.56E+5	-	1.31E+8	6.46E+8	6.49E+7
Sb-125	1.49E+8	1.45E+6	1.87E+5	-	9.38E+7	1.99E+8	3.07E+7
Te-125m	1.51E+8	5.04E+7	5.07E+7	-	-	7.18E+7	2.04E+7
Te-127m	4.21E+8	1.40E+8	1.22E+8	1.04E+9	-	1.70E+8	5.10E+7
Te-129m	5.59E+8	1.92E+8	2.15E+8	1.40E+9	-	3.34E+8	8.62E+7
I-131	2.72E+9	3.21E+9	1.05E+12	3.75E+9	-	1.15E+8	1.41E+9
I-132	1.42E+0	2.89E+0	1.35E+2	3.22E+0	-	2.34E+0	1.03E+0
I-133	3.72E+7	5.41E+7	9.84E+9	6.36E+7	-	9.16E+6	1.58E+7
I-134	-	-	1.01E-9	-	-	-	-
I-135	1.21E+5	2.41E+5	2.16E+7	2.69E+5	-	8.74E+4	8.80E+4
Cs-134	3.65E+10	6.80E+10	-	1.75E+10	7.18E+9	1.85E+8	6.87E+9
Cs-136	1.96E+9	5.77E+9	-	2.30E+9	4.70E+8	8.76E+7	2.15E+9
Cs-137	5.15E+10	6.02E+10	-	1.62E+10	6.55E+9	1.88E+8	4.27E+9
Ba-140	2.41E+8	2.41E+5	-	5.73E+4	1.48E+5	5.92E+7	1.24E+7
Ce-141	4.33E+4	2.64E+4	-	8.15E+3	-	1.37E+7	3.11E+3
Ce-144	2.33E+6	9.52E+5	-	3.85E+5	-	1.33E+8	1.30E+5
Pr-143	1.49E+3	5.59E+2	-	2.08E+2	-	7.89E+5	7.41E+1
Nd-147	8.82E+2	9.06E+2	-	3.49E+2	-	5.74E+5	5.55E+1

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, VEGETATION PATHWAY DOSE FACTORS (Continued)

ADULT (mrem/yr per µCi/m³) FOR H-3 AND C-14
(m² * mrem/yr per µCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	2.26E+3	2.26E+3	2.26E+3	2.26E+3	2.26E+3	2.26E+3
C-14	8.97E+5	1.79E+5	1.79E+5	1.79E+5	1.79E+5	1.79E+5	1.79E+5
P-32	1.40E+9	8.73E+7	-	-	-	1.58E+8	5.42E+7
Cr-51	-	-	2.79E+4	1.03E+4	6.19E+4	1.17E+7	4.66E+4
Mn-54	-	3.11E+8	-	9.27E+7	-	9.54E+8	5.94E+7
Fe-55	2.09E+8	1.45E+8	-	-	8.06E+7	8.29E+7	3.37E+7
Fe-59	1.27E+8	2.99E+8	-	-	8.35E+7	9.96E+8	1.14E+8
Co-57	-	1.17E+7	-	-	-	2.97E+8	1.95E+7
Co-58	-	3.09E+7	-	-	-	6.26E+8	6.92E+7
Co-60	-	1.67E+8	-	-	-	3.14E+9	3.69E+8
Ni-63	1.04E+10	7.21E+8	-	-	-	1.50E+8	3.49E+8
Zn-65	3.17E+8	1.01E+9	-	6.75E+8	-	6.36E+8	4.56E+8
Rb-86	-	2.19E+8	-	-	-	4.32E+7	1.02E+8
Sr-89	9.96E+9	-	-	-	-	1.60E+9	2.86E+8
Sr-90	6.05E+11	-	-	-	-	1.75E+10	1.48E+10
Y-91	5.13E+6	-	-	-	-	2.82E+9	1.37E+5
Zr-95	1.19E+6	3.81E+5	-	5.97E+5	-	1.21E+9	2.58E+5
Nb-95	1.42E+5	7.91E+4	-	7.81E+4	-	4.80E+8	4.25E+4
Ru-103	4.80E+6	-	-	1.83E+7	-	5.61E+8	2.07E+6
Ru-106	1.93E+8	-	-	3.72E+8	-	1.25E+10	2.44E+7
Ag-110m	1.06E+7	9.76E+6	-	1.92E+7	-	3.98E+9	5.80E+6
Sb-124	1.04E+8	1.96E+6	2.52E+5	-	8.08E+7	2.95E+9	4.11E+7
Sb-125	1.36E+8	1.52E+6	1.39E+5	-	1.05E+8	1.50E+9	3.25E+7
Te-125m	9.66E+7	3.50E+7	2.90E+7	3.93E+8	-	3.86E+8	1.29E+7
Te-127m	3.49E+8	1.25E+8	8.92E+7	1.42E+9	-	1.17E+9	4.26E+7
Te-129m	2.55E+8	9.50E+7	8.75E+7	1.06E+9	-	1.28E+9	4.03E+7
I-131	8.09E+7	1.16E+8	3.79E+10	1.98E+8	-	3.05E+7	6.63E+7
I-132	5.74E+1	1.54E+2	5.38E+3	2.45E+2	-	2.89E+1	5.38E+1
I-133	2.12E+6	3.69E+6	5.42E+8	6.44E+6	-	3.31E+6	1.12E+6
I-134	1.06E-4	2.88E-4	5.00E-3	4.59E-4	-	2.51E-7	1.03E-4
I-135	4.08E+4	1.07E+5	7.04E+6	1.71E+5	-	1.21E+5	3.94E+4
Cs-134	4.66E+9	1.11E+10	-	3.59E+9	1.19E+9	1.94E+8	9.07E+9
Cs-136	4.20E+7	1.66E+8	-	9.24E+7	1.27E+7	1.89E+7	1.19E+8
Cs-137	6.36E+9	8.70E+9	-	2.95E+9	9.81E+8	1.68E+8	5.70E+9
Ba-140	1.29E+8	1.62E+5	-	5.49E+4	9.25E+4	2.65E+8	8.43E+6
Ce-141	1.96E+5	1.33E+5	-	6.17E+4	-	5.08E+8	1.51E+4
Ce-144	3.29E+7	1.38E+7	-	8.16E+6	-	1.11E+10	1.77E+6
Pr-143	6.34E+4	2.54E+4	-	1.47E+4	-	2.78E+8	3.14E+3
Nd-147	3.34E+4	3.86E+4	-	2.25E+4	-	1.85E+8	2.31E+3

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, VEGETATION PATHWAY DOSE FACTORS (Continued)

TEENAGER (mrem/yr per μCi/m^3) FOR H-3 AND C-14
(m^2 * mrem/yr per μCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	2.59E+3	2.59E+3	2.59E+3	2.59E+3	2.59E+3	2.59E+3
C-14	1.45E+6	2.91E+5	2.91E+5	2.91E+5	2.91E+5	2.91E+5	2.91E+5
P-32	1.61E+9	9.96E+7	-	-	-	1.35E+8	6.23E+7
Cr-51	-	-	3.44E+4	1.36E+4	8.85E+4	1.04E+7	6.20E+4
Mn-54	-	4.52E+8	-	1.35E+8	-	9.27E+8	8.97E+7
Fe-55	3.25E+8	2.31E+8	-	-	1.46E+8	9.98E+7	5.38E+7
Fe-59	1.81E+8	4.22E+8	-	-	1.33E+8	9.98E+8	1.63E+8
Co-57	-	1.79E+7	-	-	-	3.34E+8	3.00E+7
Co-58	-	4.38E+7	-	-	-	6.04E+8	1.01E+8
Co-60	-	2.49E+8	-	-	-	3.24E+9	5.60E+8
Ni-63	1.61E+10	1.13E+9	-	-	-	1.81E+8	5.45E+8
Zn-65	4.24E+8	1.47E+9	-	9.41E+8	-	6.23E+8	6.86E+8
Rb-86	-	2.73E+8	-	-	-	4.O5E+7	1.28E+8
Sr-89	1.51E+10	-	-	-	-	1.80E+9	4.33E+8
Sr-90	7.51E+11	-	-	-	-	2.11E+10	1.85E+11
Y-91	7.87E+6	-	-	-	-	3.23E+9	2.11E+5
Zr-95	1.74E+6	5.49E+5	-	8.07E+5	-	1.27E+9	3.78E+5
Nb-95	1.92E+5	1.06E+5	-	1.03E+5	-	4.55E+8	5.86E+4
Ru-103	6.87E+6	-	-	2.42E+7	-	5.74E+8	2.94E+6
Ru-106	3.09E+8	-	-	5.97E+8	-	1.48E+10	3.90E+7
Ag-110m	1.52E+7	1.44E+7	-	2.74E+7	-	4.04E+9	8.74E+6
Sb-124	1.55E+8	2.85E+6	3.51E+5	-	1.35E+8	3.11E+9	6.03E+7
Sb-125	2.14E+8	2.34E+6	2.04E+5	-	1.88E+8	1.66E+9	5.00E+7
Te-125m	1.48E+8	5.34E+7	4.14E+7	-	-	4.37E+8	1.98E+7
Te-127m	5.51E+8	1.96E+8	1.31E+8	2.24E+9	-	1.37E+9	6.56E+7
Te-129m	3.67E+8	1.36E+8	1.18E+8	1.54E+9	-	1.38E+9	5.81E+7
I-131	7.70E+7	1.08E+8	3.14E+10	1.85E+8	-	2.13E+7	5.79E+7
I-132	5.18E+1	1.36E+2	4.57E+3	2.14E+2	-	5.91E+1	4.87E+1
I-133	1.97E+6	3.34E+6	4.66E+8	5.86E+6	-	2.53E+6	1.02E+6
I-134	9.59E-5	2.54E-4	4.24E-3	4.01E-4	-	3.35E-6	9.13E-5
I-135	3.68E+4	9.48E+4	6.10E+6	1.50E+5	-	1.05E+5	3.52E+4
Cs-134	7.09E+9	1.67E+10	-	5.30E+9	2.02E+9	2.08E+8	7.74E+9
Cs-136	4.29E+7	1.69E+8	-	9.19E+7	1.45E+7	1.36E+7	1.13E+8
Cs-137	1.01E+10	1.35E+10	-	4.59E+9	1.78E+9	1.92E+8	4.69E+9
Ba-140	1.38E+8	1.69E+5	-	5.75E+4	1.14E+5	2.13E+8	8.91E+6
Ce-141	2.82E+5	1.88E+5	-	8.86E+4	-	5.38E+8	2.16E+4
Ce-144	5.27E+7	2.18E+7	-	1.30E+7	-	1.33E+10	2.83E+6
Pr-143	7.12E+4	2.84E+4	-	1.65E+4	-	2.34E+8	3.55E+3
Nd-147	3.63E+4	3.94E+4	-	2.32E+4	-	1.42E+8	2.36E+3

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, VEGETATION PATHWAY DOSE FACTORS (Continued)

CHILD (mrem/yr per µCi/m³) FOR H-3 AND C-14
(m² * mrem/yr per µCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	4.01E+3	4.01E+3	4.01E+3	4.01E+3	4.01E+3	4.01E+3
C-14	3.50E+6	7.01E+5	7.01E+5	7.01E+5	7.01E+5	7.01E+5	7.01E+5
P-32	3.37E+9	1.58E+8	-	-	-	9.30E+7	1.30E+8
Cr-51	-	-	6.54E+4	1.79E+4	1.19E+5	6.25E+6	1.18E+5
Mn-54	-	6.61E+8	-	1.85E+8	-	5.55E+8	1.76E+8
Fe-55	8.00E+8	4.24E+8	-	-	2.40E+8	7.86E+7	1.31E+8
Fe-59	4.01E+8	6.49E+8	-	-	1.88E+8	6.76E+8	3.23E+8
Co-57	-	2.99E+7	-	-	-	2.45E+8	6.04E+7
Co-58	-	6.47E+7	-	-	-	3.77E+8	1.98E+8
Co-60	-	3.78E+8	-	-	-	2.10E+9	1.12E+9
Ni-63	3.95E+10	2.11E+9	-	-	-	1.42E+8	1.34E+9
Zn-65	8.12E+8	2.16E+9	-	1.36E+9	-	3.80E+8	1.35E+9
Rb-86	-	4.52E+8	-	-	-	2.91E+7	2.78E+8
Sr-89	3.59E+10	-	-	-	-	1.39E+9	1.03E+9
Sr-90	1.24E+12	-	-	-	-	1.67E+10	3.15E+11
Y-91	1.87E+7	-	-	-	-	2.49E+9	5.01E+5
Zr-95	3.90E+6	8.58E+5	-	1.23E+6	-	8.95E+8	7.64E+5
Nb-95	4.10E+5	1.59E+5	-	1.50E+5	-	2.95E+8	1.14E+5
Ru-103	1.55E+7	-	-	3.89E+7	-	3.99E+8	5.94E+6
Ru-106	7.45E+8	-	-	1.01E+9	-	1.16E+10	9.30E+7
Ag-110m	3.22E+7	2.17E+7	-	4.05E+7	-	2.58E+9	1.74E+7
Sb-124	3.52E+8	4.57E+6	7.78E+5	-	1.96E+8	2.20E+9	1.23E+8
Sb-125	4.99E+8	3.85E+6	4.62E+5	-	2.78E+8	1.19E+9	1.05E+8
Te-125m	3.51E+8	9.50E+7	9.84E+7	-	-	3.38E+8	4.67E+7
Te-127m	1.32E+9	3.56E+8	3.16E+8	3.77E+9	-	1.07E+9	1.57E+8
Te-129m	8.54E+8	2.39E+8	2.75E+8	2.51E+9	-	1.04E+9	1.33E+8
I-131	1.43E+8	1.44E+8	4.76E+10	2.36E+8	-	1.28E+7	8.18E+7
I-132	9.20E+1	1.69E+2	7.84E+3	2.59E+2	-	1.99E+2	7.77E+1
I-133	3.59E+6	4.44E+6	8.25E+8	7.40E+6	-	1.79E+6	1.68E+6
I-134	1.70E-4	3.16E-4	7.28E-3	4.84E-4	-	2.10E-4	1.46E-4
I-135	6.54E+4	1.18E+5	1.04E+7	1.81E+5	-	8.98E+4	5.57E+4
Cs-134	1.60E+10	2.63E+10	-	8.14E+9	2.92E+9	1.42E+8	5.54E+9
Cs-136	8.06E+7	2.22E+8	-	1.18E+8	1.76E+7	7.79E+6	1.43E+8
Cs-137	2.39E+10	2.29E+10	-	7.46E+9	2.68E+9	1.43E+8	3.38E+9
Ba-140	2.77E+8	2.43E+5	-	7.90E+4	1.45E+5	1.40E+8	1.62E+7
Ce-141	6.35E+5	3.26E+5	-	1.43E+5	-	4.07E+8	4.84E+4
Ce-144	1.27E+8	3.98E+7	-	2.21E+7	-	1.04E+10	6.78E+6
Pr-143	1.48E+5	4.46E+4	-	2.41E+4	-	1.60E+8	7.37E+3
Nd-147	7.16E+4	5.80E+4	-	3.18E+4	-	9.18E+7	4.49E+3

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, GROUND PLANE PATHWAY DOSE FACTORS (Continued)

(m^2 * mrem/yr per μCi/sec)

Nuclide	Any Organ
H-3	-
C-14	-
P-32	-
Cr-51	4.68E+6
Mn-54	1.34E+9
Fe-55	-
Fe-59	2.75E+8
Co-58	3.82E+8
Co-60	2.16E+10
Ni-63	-
Zn-65	7.45E+8
Rb-86	8.98E+6
Sr-89	2.16E+4
Sr-90	-
Y-91	1.08E+6
Zr-95	2.48E+8
Nb-95	1.36E+8
Ru-103	1.09E+8
Ru-106	4.21E+8
Ag-110m	3.47E+9
Te-125m	1.55E+6
Te-127m	9.17E+4
Te-129m	2.00E+7
I-131	1.72E+7
I-132	1.24E+6
I-133	2.47E+6
I-134	4.49E+5
I-135	2.56E+6
Cs-134	6.75E+9
Cs-136	1.49E+8
Cs-137	1.04E+10
Ba-140	2.05E+7
Ce-141	1.36E+7
Ce-144	6.95E+7
Pr-143	-
Nd-147	8.40E+6

APPENDIX A

EVALUATION OF DEFAULT MPC VALUES

FOR LIQUID EFFLUENTS

APPENDIX A: EVALUATION OF DEFAULT MPC VALUE 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 concentration of radioactive material at the discharge point does not exceed the MPC value of 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 the individual monitor.

In order to limit the need for routinely having to re-establish the alarm setpoints as a function of changing radionuclide distributions, a default alarm setpoint can be established. This default setpoint can be based on an evaluation of the radionuclide distribution from the 1997 to 1999 release data of the liquid effluents from Hope Creek and the effective MPC value for this distribution.

The effective MPC value for a radionuclide distribution is calculated by the equation:

$$MPC_e = \sum_i C_i \ (gamma) \ / \ \sum_i \frac{C_i}{MPC_i} \ (gamma) \tag{A.1}$$

Where:

	MPC_e	=	An effective MPC value for a mixture of radionuclides (μCi/ml)
	C_i	=	Concentration of radionuclide i in the mixture
	MPC_i	=	The 10 CFR 20, Appendix B, Table II, Column II MPC value for radionuclide i (μCi/ml) Appendix F

Considering the average effective MPC values from 1997 thru 1999 releases it is reasonable to select an MPC value of 4.09E-5 μCi/ml as typical of liquid radwaste discharges. This value will be reviewed and adjusted as necessary based on the distribution history of effluents from Hope Creek. Using the value of 4.09E-5 μCi/ml to calculate the default alarm setpoint, results in a setpoint that:

1. Will not require frequent re-adjustment due to minor variations in the nuclide distribution which are typical of routine plant operations, and;

2. Will provide for a liquid radwaste discharge rate (as evaluated for each batch release) that is compatible with plant operations (Refer to Table 1-1).

1.0 DEFAULT SETPOINT DETERMINATION

Conservative alarm setpoints can be determined through the use of default parameters. Table 1-1 summarizes all current default values in use for Hope Creek.

A. Liquid Radwaste Monitor (RE4861)

$$SP \leq \frac{MPC_e * CTBD * [1 - CF]}{RR} + bkg \qquad \textbf{(1.2)}$$

Default values from Table 1-1:

Where:
- MPC_e = 4.09E-5 μCi/ml
- CTBD = 12000 gpm
- RR = 176 gpm (LRW)
- Bkg = 0 μCi/ml
- CF = 0.8

$$SP \leq \frac{4.09E\text{-}5 * 12000 * 0.2}{176} + 0$$

$$\underline{SP < 5.58E\text{-}4\ \mu Ci/ml}$$

Correction Factor:

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

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.

Nuclide	MPC (μCi/ml)	Activity (μCi/ml)	Activity / MPC
H-3	3E-3	1.0E-1	33.3
Fe-55	8E-4	4.7E-4	0.59
Sr-89	3E-6	1.6E-6	0.53
Sr-90	3E-7	2.0E-8	0.07
Total			34.5

The values in the table above represent the historical maximum reactor coolant values for non-gamma emitting nuclides (H3 is an assumed maximum). Reactor coolant values were chosen to represent the maximum concentration of non-gamma emitting radionuclides that could be released from Hope Creek station in liquid effluent. The activity values in the table 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 Activity / MPC fraction and the minimum dilution factor as follows:

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:

Overall Correction Factor = 0.3 + 0.5 = 0.8

B. <u>Cooling Tower Blowdown Radiation Monitor (RE8817)</u>

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.

$$SP \leq MPC_g * 0.2$$

$$SP \leq 4.09E{-}5\ \mu Ci/ml * 0.2$$

$$\underline{\mathbf{SP \leq 8.18E{-}6\ \mu Ci/ml (RE8817)}}$$

C. <u>Turbine Building Circulating Water Dewatering Sump Radiation Monitor (RE4557)</u>

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 pumps discharge 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 μCi/ml based on a postulated release of reactor steam into the sump. Using the MPCe determined for Liquid Radwaste and Cooling Tower Blowdown monitors, a more conservative maximum default value for batch releases can be determined:

$$SP \leq \frac{MPC_e * CTBD * [1 - CF]}{RR} + bkg \qquad \textbf{(1.2)}$$

Default values from Table 1-1:

Where:	MPC_e	=	4.09E-5 μCi/ml
	CTBD	=	12000 gpm
	RR	=	100 gpm
	Bkg	=	0 μCi/ml
	CF	=	0.8

$$SP \leq \frac{4.09E\text{-}5 * 12000 * 0.2}{100} + 0$$

$$\underline{SP < 9.82E\text{-}4\ \mu Ci/ml\ (batch\ releases\ only)}$$

For continuous releases, the maximum setpoint should be less than 2.4E-6 μCi/ml above background to limit dose consequences from this pathway. (4HE-0241, CVF-98-0002)

D. 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 unexpected activity. Default setpoints are determined for potential releases of the CST.

a. Liquid Radwaste Monitor (RE4861)

$$SP \leq \frac{MPC_e * CTBD * [1 - CF]}{RR} + bkg \qquad \textbf{(1.2)}$$

Default values from Table 1-1:

Where:

Where:	MPC_e	=	4.09E-5 μCi/ml
	CTBD	=	12000 gpm
	RR	=	1300 gpm
	Bkg	=	0 μCi/ml
	CF	=	0.8

$$SP \leq \frac{4.09E{-}5 * 12000 * 0.2}{1300} + 0$$

$$\underline{SP < 7.55E{-}5\ \mu Ci/ml (RE4861)}$$

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.

$$SP \leq MPC_e * 0.2$$

$$SP \leq 4.09E{-}5\ \mu Ci/ml * 0.2$$

$$\underline{SP < 8.18E{-}6\ \mu Ci/ml (RE8817)}$$

TABLE A-1: CALCULATION OF EFFECTIVE MPC - HOPE CREEK

NUCLIDE	MPC	1997 ACTIVITY RELEASED (Ci)	1998 ACTIVITY RELEASED (Ci)	1999 ACTIVITY RELEASED (Ci)
Cr-51	2.00E-03	7.44E-03	2.37E-02	1.66E-02
Mn-54	1.00E-04	1.74E-02	7.48E-03	6.87E-02
Mn-56	1.00E-04	N/D	N/D	9.36E-06
Co-58	9.00E-05	5.68E-04	7.67E-04	3.30E-03
Co-60	3.00E-05	7.05E-03	6.78E-03	2.05E-02
Na-24	3.00E-05	N/D	7.02E-02	1.01E-03
Cs-137	2.00E-05	2.84E-06	1.03E-06	2.23E-04
Zn-65	1.00E-04	1.29E-03	1.39E-03	3.37E-03
Zn-69m	6.00E-05	1.58E-05	N/D	2.64E-04
Fe-59	5.00E-05	2.65E-03	1.62E-04	1.72E-02
As-76	2.00E-05	7.70E-05	N/D	9.94E-05
Nb-95	1.00E-04	N/D	N/D	1.69E-04
Mo-99	4.00E-05	9.56E-05	N/D	N/D
Zr-95	6.00E-05	N/D	N/D	4.08E-05
Tc-99m	3.00E-03	1.29E-04	2.05E-04	3.35E-04
Ru-105	1.00E-04	N/D	N/D	4.45E-05
Ag-110m	3.00E-05	4.85E-05	1.36E-05	3.88E-04
Sb-124	2.00E-05	N/D	N/D	4.63E-05
Cs-134	9.00E-06	N/D	N/D	7.13E-05
I-133	1.00E-06	N/D	3.11E-05	N/D
La-140	2.00E-05	N/D	N/D	4.82E-06
H-3	3.00E-03	1.24E+01	2.76E+01	2.95E+01
Fe-55	8.00E-04	2.28E-01	6.40E-03	2.83E-02
Sr-89	3.00E-06	8.56E-03	1.34E-05	3.29E-05
Total Curies (Gamma)		3.68E-02	1.11E-01	1.32E-01
SUM (Ci/MPCi) (Gamma)		4.93E+02	2.71E+03	1.87E+03
SUM (Ci/MPCi) (Non-Gamma)		7.27E+03	9.21E+03	9.88E+03
MPCe (µCi/ml)		7.45E-05	4.09E-05	7.03E-05

N/D Not detected

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 μCi/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 μCi/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:

<u>Total Body</u>

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

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 μCi/ml)

VOL = Volume of liquid effluent released (gal)

C_i = Total concentration of all radionuclides (μCi/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

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

$$D_{tb} = \frac{1.94E + 02 * VOL * C_i}{CTBD}$$

(B.2)

Maximum Organ

$$D_{\max} = 8.35\text{E} - 4 * \text{VOL} * A_{i\,GI-LLI} * \sum_i C_i \;/\; CTBD$$

(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 μCi/ml).

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

$$D_{\max} = 5.28\text{E} + 2 * \text{VOL} * \sum_i C_i \;/\; CTBD$$

(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.

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

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

Overview

The evaluation of doses due to releases of radioactive material to the atmosphere can be simplified by the use of 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., Keff, Meff, or Neff 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:

$$K_{ef}f = \sum_i (K_i * f_i) \tag{C.1}$$

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.

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

Where:

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

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

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.

$$N_{eff} = \sum_i (N_i * f_i)$$

(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.

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 by the use of 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:

$$D_\gamma = \frac{3.17E-08}{0.50} * {}^{\chi}/_{Q} * M_{eff} * \sum_i Q_i$$

(C.5)

$$D_\beta = \frac{3.17E-08}{0.50} * {}^{\chi}/_{Q} * N_{eff} * \sum_i Q_i$$

(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/m^3)

M_{eff} = 8.1E3, effective gamma-air dose factor (mrad/yr per $\mu Ci/m^3$)

N_{eff} = 8.5E3, effective beta-air dose factor (mrad/yr per $\mu Ci/m^3$)

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:

$$D_\gamma = 5.14E-4 * {}^{\chi}/_{Q} * \sum_i Q_i \tag{C.7}$$

$$D_\beta = 5.39E-4 * {}^{\chi}/_{Q} * \sum_i Q_i \tag{C.8}$$

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.

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

Radionuclide	f_i	Total Body Dose Factor (K_{eff}) (mrem/yr per µCi/m^3)	Total Skin Dose Factor (L + 1.1 M_{eff}) (mrem/yr per µCi/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

Noble Gases - Air

Radionuclide	f_i	Gamma Air Dose Factor (M_{eff}) (mrad/yr per µCi/m^3)	Beta Air Dose Factor (N_{eff}) (mrad/yr per µCi/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

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

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 m^2*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:

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

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^2mrem/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 radionuclides has a higher dose parameter for any organ via any pathway than I-131 for the thyroid via the milk pathway.

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 (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

Samples are identified by a three part code. 1) The first two letters are the program identification code. Because of the proximity of the Salem and Hope Creek Stations, a common environmental surveillance program is conducted. The identification code "SA," has been applied to Salem and Hope Creek Stations. 2) The next three letters are the media sampled.

- AIO = Air Iodine
- APT = Air Particulates
- ECH = Hard Shell Blue Crab
- ESF = Edible Fish
- ESS = Sediment
- FPL = Green Leaf Vegetables
- FPV = Vegetables (Various)
- GAM = Game (Muskrat)
- IDM = Immersion Dose (TLD)
- MLK = Milk
- PWR – Potable Water (Raw)
- PWT = Potable Water (Treated)
- SOL - Soil
- SWA = Surface Water
- VGT = Fodder Crops (Various)
- WWA = Well Water

3) The last three or four symbols are a location code based on direction and distance from a standard reference point. The reference point is located at midpoint between the center of the Salem Unit 1 and Salem Unit 2 containments. Of these, the first one or two represent each of the sixteen angular sectors of 22.5 degrees centered about the reactor site. Sector one is divided evenly by the north axis and other sectors are numbered in a clockwise direction as follows:

- 1 = N
- 2 = NNE
- 3 = NE
- 4 = ENE
- 5 = E
- 6 = ESE
- 7 = SE
- 8 = SSE
- 9 = S
- 10 = SSW
- 11 = SW
- 12 = WSW
- 13 = W
- 14 = WNW
- 15 = NW
- 16 = NNW

The next digit is a letter which represents the radial distance from the plant:

- S = On-site location
- A = 0-1 miles off-site
- B = 1-2 miles off-site
- C = 2-3 miles off-site
- D = 3-4 miles off-site
- E = 4-5 miles off-site
- F = 5-10 miles off-site
- G = 10-20 miles off-site
- H = > 20 miles off-site

The last number is the station numerical designation within each sector and zone; e.g., 1,2,3, etc. For example, the designation SA-WWA-3E1 would indicate a sample in the Salem and Hope Creek program (SA), consisting of well water (WWA), which had been collected in sector number 3, centered at 45 degrees (north east) with respect to the midpoijntmidpoint between Salem 1 and 2 containments at a radial distance of 4 to 5 miles off-site, (therefore, radial distance E). The number 1 indicates that this is sampling station number 1 in that particular sector.

SAMPLING LOCATIONS

All sampling locations and specific information about the individual locations are given here in Table E-1. Maps E-1, E-2 and E-3 show the locations of sampling stations with respect to the site. Not all stations in Table E-1 are required sample locations. Some of the stations identified in Table E-1 are used for management audit samples. Minimum sampling requirements are specified in Table 3.12-1.

TABLE E-1: REMP SAMPLE LOCATIONS

STATION CODE	STATION LOCATION*	LATITUDE	LONGITUDE
		Decimal Degrees	Decimal Degrees
A. Direct Radiation Monitoring Locations (IDM)			
1S1	0.56 mi. N	39.47103333	-75.53698333
2S2	0.42 mi. NNE	39.4685	-75.53318333
2S4	0.61 mi. NNE; in the equipment laydown area	39.47071667	-75.53075
3S1	0.61 mi. NE	39.46901667	-75.52796667
4S1	0.63 mi ENE; access road near intersection to TB-02	39.46705	-75.52573333
5S1	0.89 mi. E; site access road	39.46113333	-75.51978333
6S2	0.24 mi. ESE; area around helicopter pad	39.46198333	-75.53186667
7S1	0.14 mi. SE	39.46168333	-75.53411667
8S1	0.15mi. SSE; fuel oil storage	39.46138333	-75.53428333
9S1	0.18mi. S; fuel oil storage	39.4606	-75.53485
10S1	0.09 mi. SSW; circulating water building.	39.46166667	-75.536
11S1	0.08 mi. SW; service water building.	39.46198333	-75.53708333
12S1	0.06 mi. WSW; outside security fence	39.4626	-75.53726667
13S1	0.09 mi. W; outside security fence	39.46335	-75.53778333
14S1	0.16 mi. NNW; outside security fence	39.46476667	-75.53796667
15S1	0.54 mi. NW; near river and barge slip	39.46935	-75.54208333
15S2	0.57 mi NW, near Hope Creek barge slip	39.46988333	-75.54216667
16S1	0.56 mi. NNW; on road near fuel oil storage tank	39.47033333	-75.54046667
16S2	0.58 mi. NNW; near security firing range	39.47125	-75.5381
16S3	0.87 mi NNW, Consolidated Spoils Facility	39.47451667	-75.54283333
4D2	3.97 mi. ENE; Alloway Creek Neck Road	39.4882	-75.46958333
5D1	3.50 mi. E; local farm	39.47326667	-75.47223333
10D1	3.89 mi. SSW; Taylor's Bridge Spur	39.41021667	-75.56221667
14D1	3.43 mi. WNW; Bay View, Delaware	39.48766667	-75.59201667

TABLE E-1: REMP SAMPLE LOCATIONS (Continued)

STATION CODE	STATION LOCATION*	LATITUDE	LONGITUDE
		Decimal Degrees	**Decimal Degrees**
A. Direct Radiation Monitoring Locations (IDM) (Continued)			
15D1	3.87 mi. NW; Rt 9, Augustine Beach, Delaware	39.50208333	-75.588
2E1	4.43 mi. NNE; local farm	39.523	-75.50713333
3E1	4.13 mi. NE; local farm	39.50163333	-75.47743333
11E2	4.97 mi. SW; Route 9	39.40546667	-75.59243333
12E1	4.40 mi. WSW; Thomas Landing	39.4477	-75.61613333
13E1	4.07 mi. W; Diehl House Lab	39.46648333	-75.61225
16E1	4.05 mi. NNW; Port Penn	39.5127	-75.57633333
1F1	5.73 mi. N; Fort Elfsborg	39.54488333	-75.51873333
2F2	8.51 mi. NNE; Salem Substation	39.5748	-75.46938333
2F5	7.29 mi. NNE; Salem High School	39.55746667	-75.47523333
2F6	7.45 mi. NNE; PSEG EERC Salem New Jersey	39.56188333	-75.48031667
3F2	5.10 mi. NE; Hancocks Bridge, New Jersey Municipal Building	39.50683333	-75.45963333
3F3	8.66 mi. NE; Quinton Township Elementary School New Jersey	39.5436	-75.41225
4F2	5.98 mi. ENE; Mays Lane, Harmersville, New Jersey	39.49921667	-75.4346
5F1	6.40 mi. E; Canton, New Jersey	39.47266667	-75.41718333
6F1	6.46 mi. ESE; Stow Neck Road	39.43993333	-75.41913333
7F2	8.96 mi. SE; Bayside, New Jersey	39.38285	-75.40435
8F1	9.61 mi. SE; Woodland Beach, Delaware	39.33221667	-75.47438333
9F1	5.49 mi. S; off Route 9, Delaware	39.38403333	-75.54916667
10F2	5.73 mi. SSW; Route 9, Delaware	39.3839	-75.5692
11F1	5.97 mi. SW; Taylors Bridge, Delaware	39.41276667	-75.6272
12F2	9.35 mi. WSW; Townsend Elementary School, Delaware	39.3963	-75.68851667

TABLE E-1: REMP SAMPLE LOCATIONS (Continued)

STATION CODE	STATION LOCATION*	LATITUDE	LONGITUDE
		Decimal Degrees	Decimal Degrees
A. Direct Radiation Monitoring Locations (IDM) (Continued)			
13F2	6.44 mi. W; Odessa, Delaware	39.45495	-75.6562
13F3	9.26 mi. W; Redding Middle School, Middletown, Delaware	39.45358333	-75.70905
13F4	9.80 mi. W; Middletown, Delaware	39.44761667	-75.71851667
14F2	6.62 mi. WNW; Route 13 and Boyds Corner Road	39.49965	-75.6507
15F3	5.39 mi. NW	39.51645	-75.60976667
16F2	8.06 mi. NNW; Delaware City Public School	39.5719	-75.59048333
1G3	18.99 mi. N; N. Church Street Wilmington, Delaware	39.73811667	-75.54186667
3G1	16.58 mi. NE; local farm	39.59855	-75.28006667
10G1	11.53 mi. SSW; Smyrna, Delaware	39.30371667	-75.60158333
14G1	13.38 mi. WNW; Route 286, Bethel Church Road., Delaware	39.5215	-75.77491667
16G1	15.09 mi. NNW; Wilmington Airport	39.67728333	-75.59283333
3H1	32.76 mi. NE; National Park, New Jersey	39.85998333	-75.19933333
B. Air Sampling Locations (AIO,APT)			
5S1	0.89 mi. E; site access road	39.46113333	-75.51978333
5S2	0.90 mi. E; site access road (duplicate sample)	39.46086667	-75.51968333
7S2	0.20 mi. SE; old Salem parking lot	39.46171667	-75.53255
15S2	0.57 mi. NW, near Hope Creek barge slip	39.46988333	-75.54216667
5D1	3.50 mi. E; local farm	39.47326667	-75.47223333
16E1	4.05 mi. NNW; Port Penn	39.5127	-75.57633333
1F1	5.73 mi. N; Fort Elfsborg	39.54488333	-75.51873333
2F6	7.45 mi. NNE; PSEG EERC Salem New Jersey	39.56188333	-75.48031667
14G1	13.38 mi. WNW; Route 286, Bethel Church Road, Delaware	39.5215	-75.77491667

TABLE E-1: REMP SAMPLE LOCATIONS (Continued)

STATION CODE	STATION LOCATION*	LATITUDE	LONGITUDE
		Decimal Degrees	**Decimal Degrees**
C. Surface Water Locations (SWA) - Delaware River			
11A1	0.19 mi. SW; Salem outfall area	39.46051135	-75.53809583
11A1a	Alternate 0.15 SE; barge slip area	39.461667	-75.53375
12C1	1.81 mi. WSW; West bank of Delaware River	39.45366667	-75.568
12C1a	Alternate 3.71 mi. WSW at the tip of Augustine Beach Boat Ramp	39.50472222	-75.58
7E1	4.42 mi. SE; 1.0 mi. west of Mad Horse Creek	39.418	-75.47733333
7E1a	Alternate 9.27 mi SE end of Bayside Road	39.37616667	-75.404
1F2	7.28 mi. N; midpoint of Delaware River	39.56783333	-75.55166667
16F1	6.89 mi. NNW; C&D Canal	39.55916667	-75.57083333
16F1a	Alternate 6.52 mi. NNW; tip of C&D Canal	39.55566667	-75.55933333
D. Ground Water Locations (WWA)			
3E1	4.13 mi. NE; local farm	39.50163333	-75.47743333
No groundwater samples are required as liquid effluents discharged from Hope Creek and Salem Generating Stations do not directly affect this pathway. However, this location (3E1) is being monitored as a management audit sample			
E. Drinking Water Locations (PWR, PWT)			
2F3	7.85 mi NNE, City of Salem Water and Sewage Dept.	39.55666667	-75.453
No public drinking water samples or irrigation water samples are required as these pathways are not directly affected by liquid effluents discharged from Hope Creek and Salem Generating Stations. However, this location (2F3) is being monitored as a management audit sample			

TABLE E-1: REMP SAMPLE LOCATIONS (Continued)

STATION CODE	STATION LOCATION*	LATITUDE	LONGITUDE
		Decimal Degrees	Decimal Degrees
F. Water Sediment Locations (ESS)			
11A1	0.19 mi. SW; Salem outfall area	39.46051135	-75.53809583
15A1	0.65 mi. NW; Hope Creek outfall area	39.4709	-75.5434
16A1	0.64 mi. NNW; south storm drain outfall	39.47066667	-75.543
12C1	1.81 mi. WSW; West bank of Delaware River	39.45366667	-75.568
7E1	4.42 mi. SE; 1.0 mi. west of Mad Horse Creek	39.418	-75.47733333
16F1	6.89 mi. NNW; C&D Canal	39.55916667	-75.57083333
6A1	0.27 mi. ESE; near shoreline	39.461135	-75.531853
G. Milk Sampling Locations (MLK)			
2G3	11.85 mi. NNE, local farm	39.6035	-75.40883333
3G1	16.58 mi. NE; local farm	39.59855	-75.28006667
13E3	4.62 mi W, local farm	39.45283333	-75.62166667
14F4	8.04 mi. WNW; local farm	39.50733333	-75.67533333
H. Fish and Invertebrate Locations (ESF, ECH)			
11A1	0.19 mi. SW; Salem outfall area	39.46051135	-75.53809583
12C1	1.81 mi. WSW; West bank of Delaware River	39.45366667	-75.568
7E1	4.42 mi. SE; 1.0 mi. west of Mad Horse Creek	39.418	-75.47733333

TABLE E-1: REMP SAMPLE LOCATIONS (Continued)

STATION CODE	STATION LOCATION*	LATITUDE	LONGITUDE
		Decimal Degrees	Decimal Degrees
I. Food Product Locations (FPL, FPV)			
1S1	0.56 mi. N	39.47103333	-75.53698333
7S2	0.20 mi. SE; old Salem parking lot	39.46171667	-75.53255
15S2	0.57 mi. NW, near Hope Creek barge slip	39.46988333	-75.54216667
16S1	0.56 mi. NNW; on road near fuel oil storage tank	39.47033333	-75.54046667
10D1	3.89 mi. SSW; Taylor's Bridge Spur	39.41021667	-75.56221667
The Delaware River at the location of Salem and Hope Creek Nuclear Power Plants is a brackish water source. No irrigation of food products is performed using water in the vicinity from which liquid plant wastes have been discharged. However, 12 management audit food samples are collected from various locations			
*All distances and directions for the Station Locations are referenced to the midpoint between the two Salem units' containments. The WGS 84 coordinates for this site center point location are: Latitude N 39° - 27' – 46.5" and Longitude W 75° - 32' – 10.6".			

SAMPLES COLLECTION AND ANALYSIS

SAMPLE	COLLECTION METHOD	ANALYSIS
Air Particulate	Continuous low volume air sampler. Sample collected every week along with the filter change.	Gross Beta analysis on each weekly sample. Gamma spectrometry shall be performed if gross beta exceeds10 times the yearly mean of the control station value. Samples shall be analyzed 24 hrs or more after collection to allow for radon and thorium daughter decay. Gamma isotopic analysis on quarterly composites.
Air Iodine	A TEDA impregnated charcoal cartridge is connected to air particulate air sampler and is collected weekly at filter change.	Iodine 131 analysis are performed on each weekly sample.
Crab and Fish	Two batch samples are sealed in a plastic bag or jar and frozen semi-annually or when in season.	Gamma isotopic analysis of edible port ion on collection.
Sediment	A sediment sample is taken semi-annually.	Gamma isotopic analysis semi-annually.
Direct	2 PD's will be collected from each location quarterly.	Gamma dose quarterly.
Milk	Sample of fresh milk is collected for each farm semi-monthly when cows are in pasture, monthly at other times.	Gamma isotopic analysis and I-131analysis on each sample on collection.
Water (Potable, Surface)	monthly providing winter icing Sample to be collected conditions allow.	Gamma isotopic monthly H-3 on quarterly surface sample, monthly on ground water sample.

FIGURE E-1: ON-SITE SAMPLING LOCATIONS – LOCATIONS 0 TO 1 MILE

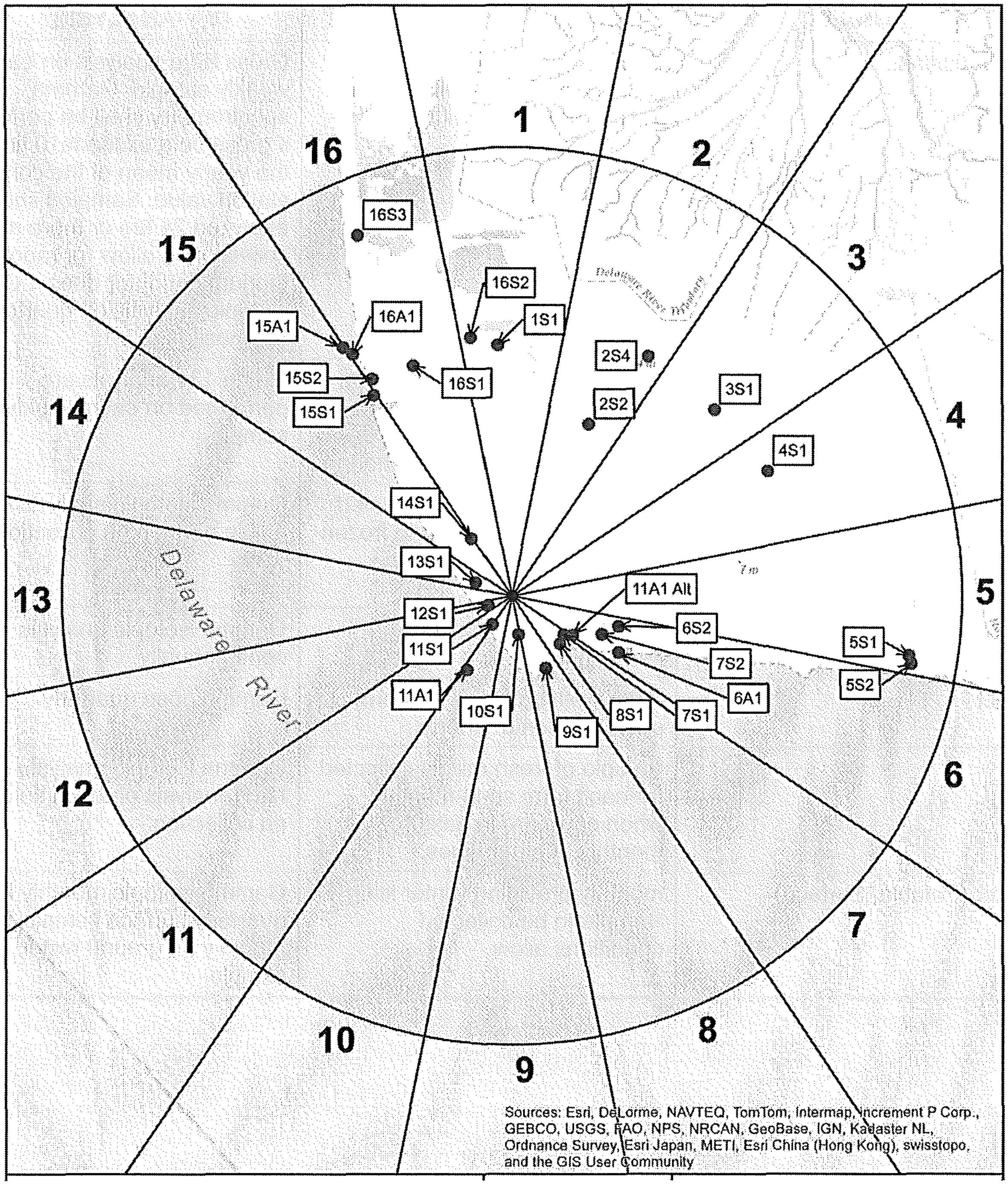


FIGURE E-2: OFF-SITE SAMPLING LOCATIONS – LOCATIONS 1 TO 10 MILES

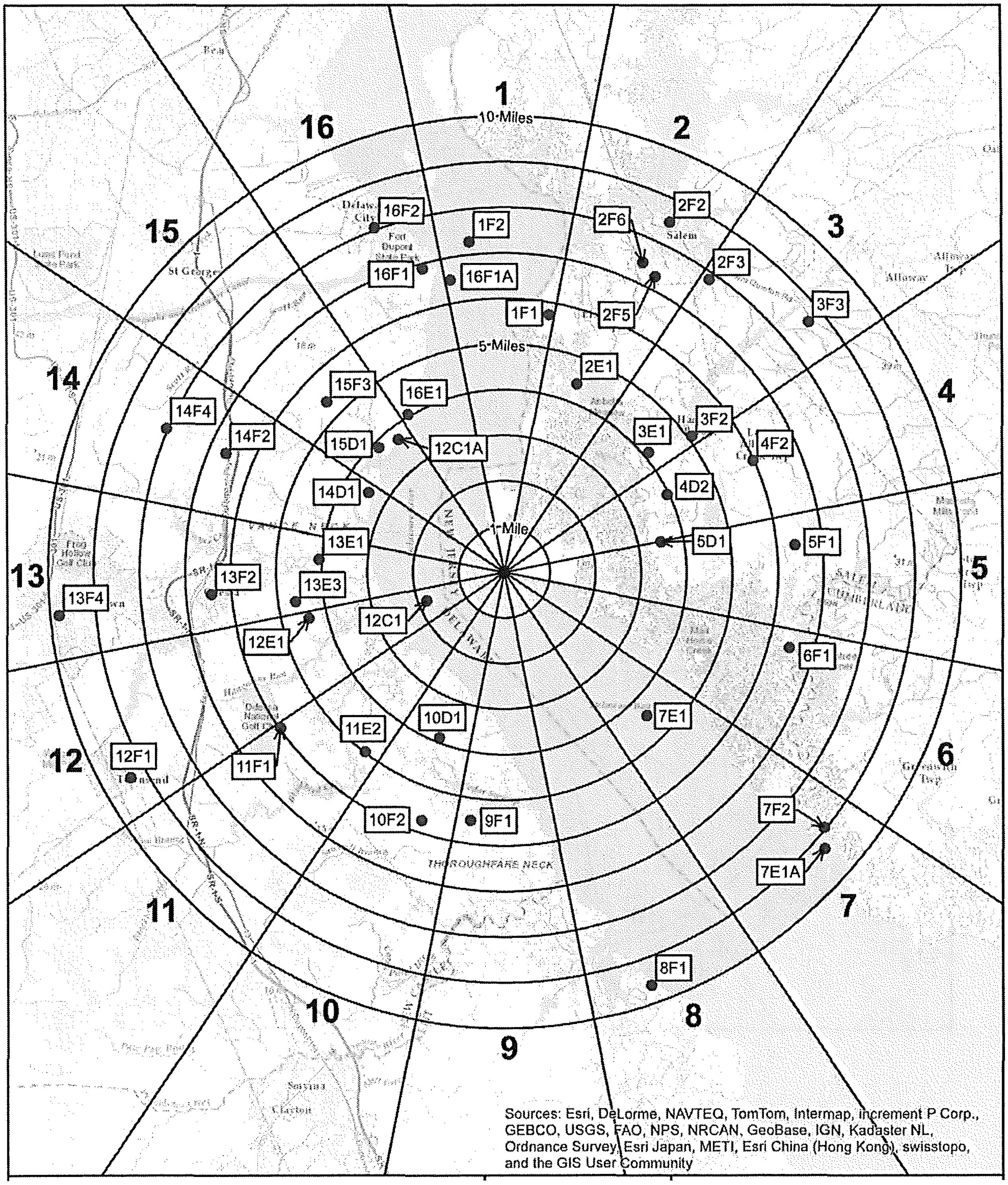
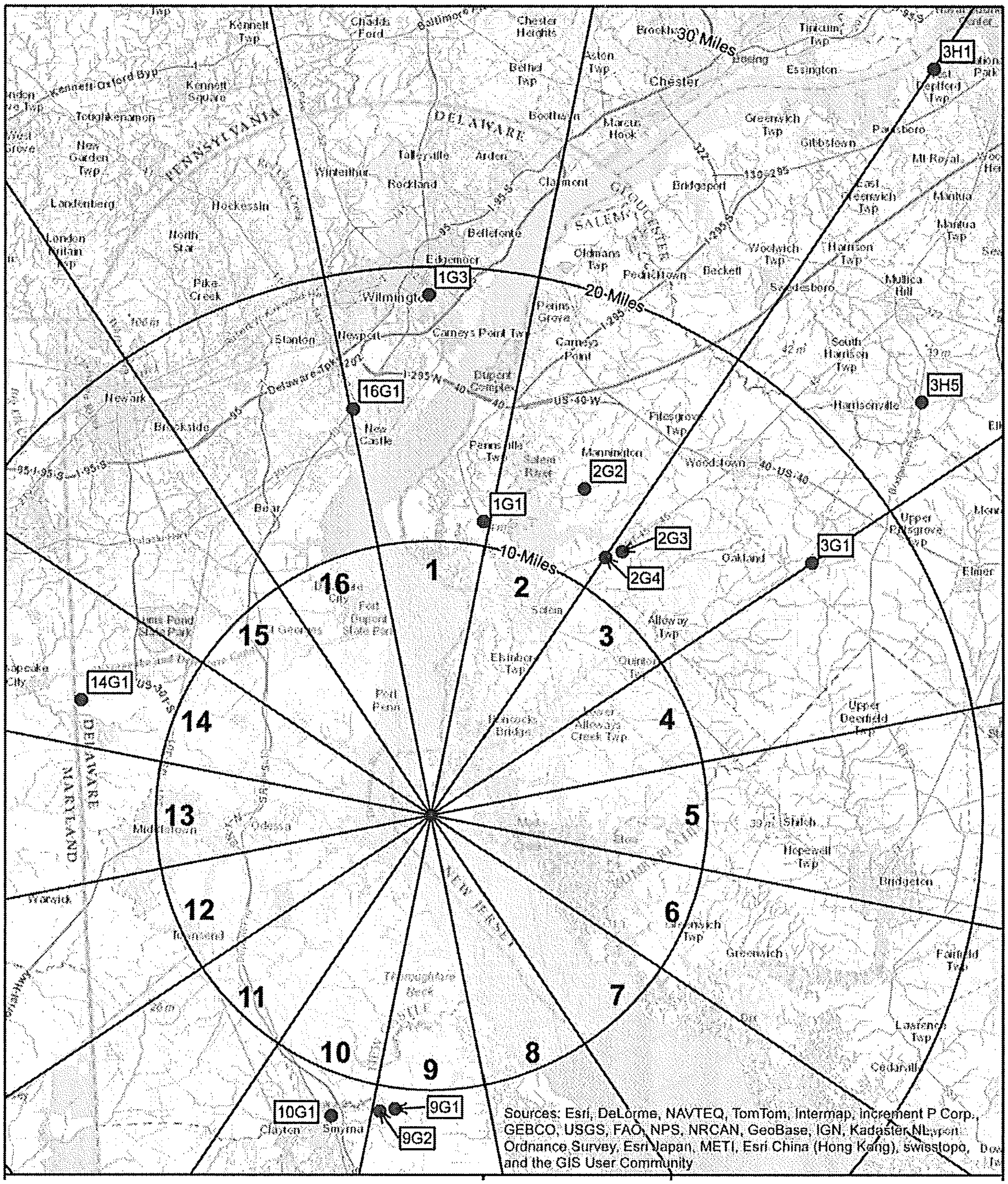


FIGURE E-3: OFF-SITE SAMPLING LOCATIONS



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, 1998 and referred to as the "old" 10 CFR 20.

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS

Element	Isotope	Soluble Conc (μCi/ml)	Insoluble Conc. (μCi/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
	Am-244	5E-3	5E-3
Antimony (51)	Sb-122	3E-5	3E-5
	Sb-124	2E-5	2E-5
	Sb-125	1E-4	1E-4
	Sb-126	3E-6	3E-6
Arsenic (33)	As-73	5E-4	5E-4
	As-74	5E-5	5E-5
	As-76	2E-5	2E-5
	As-77	8E-5	8E-5
Astatine (85)	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

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS (Continued)

Element	Isotope	Soluble Conc. (μCi/ml)	Insoluble Conc. (μCi/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
	Cs-137	2E-5	4E-5
Chlorine (17)	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
	Cm-249	2E-3	2E-3
Dysprosium (66)	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

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS (Continued)

Element	Isotope	Soluble Conc. (μCi/ml)	Insoluble Conc. (μCi/ml)
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
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

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS (Continued)

Element	Isotope	Soluble Conc. (μCi/ml)	Insoluble Conc. (μCi/ml)
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
	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

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS (Continued)

Element	Isotope	Soluble Conc. (μCi/ml)	Insoluble Conc. (μCi/ml)
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
	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

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS (Continued)

Element	Isotope	Soluble Conc. (μCi/ml)	Insoluble Conc. (μCi/ml)
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

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS (Continued)

Element	Isotope	Soluble Conc. (μCi/ml)	Insoluble Conc. (μCi/ml)
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
	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 radio-nuclide 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 radio-nuclide 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 μCi/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").

OFFSITE DOSE CALCULATION MANUAL

FOR

PSEG NUCLEAR LLC

SALEM GENERATING STATION

Revision 28

Prepared By:	Richard H. Cary ODCM Coordinator	12/13/2016 Date
Reviewed by:	Mark Pyle Salem Chemistry Manager	1/19/17 Date
SQR	Ryan Gallagher Reviewed by	12/28/17 Date
Accepted by:	Patrick Martino PORC Chairman	1/25/17 Date
	Meeting #: S2017-002	
Approved by:	Plant Manager	9/18/17 Date

Revision Summary:

All of the items indicated below are considered implemented on the date the Plant Manager signs the cover page indicating approval of revision 28 to the Salem ODCM.

Item No.	Rev. 27 Page No.	Rev. 28 Page No.	Description of Change	Type of Change
1	20 26	26 32	In 3/4.3.3.8 and 4/3.3.9 Action d was deleted. **Justification:** Action d was added in Revision 27 although the reporting requirements are already in Action b so has caused confusion. Restoring to NUREG 1301 wording is for clarification only and is an editorial change.	Editorial
2	27	33	Edited monitor numbers in Table 3.3-13: Radioactive Gaseous Effluent Monitoring Instrumentation per markup in DCP #80057583. **Justification:** DCP #80057583 removed some Unit 1 and Unit 2 R45 skids components. (80057583/450).	Technical
3	27 28	35	TABLE 3.3-13: Moved note ## so it is after note # in the Table Notations. **Justification:** Editorial to place note ## after note #.	Editorial
4	31	38	Added note to Control 3.11.1.1, "Since the MPC values were removed from 10 CFR 20 effective 1/1/94, the MPC values are provided as Appendix F to the ODCM". **Justification:** This addition did not change the intent or technical content. It was performed to add clarity and consistency within this document. (70166487/10)	Editorial
5	32	39 41	In Table 4.11-1.1 added Groundwater Remediation as a new Batch Liquid Release Type and added note "f" to Table 4.11-1 Table Notations. **Justification:** Groundwater onsite contains small amounts of tritium due to a historical leak from the Salem Unit 1 Spent Fuel Pool. During the remediation process, some groundwater is pumped to a tank and then batch released using similar methodology to other batch releases and is treated as a Radioactive Liquid Release. This change customizes the Liquid Release Type to be plant specific as per NUREG-1301. (70162733/010)	Technical

6	32	39 41	In TABLE 4.11-1/.B added note "g" to Steam Generator Blowdown. Note "g" also added to TABLE 4.11-1 Table Notations to reference Section 1.5 of the ODCM for better explanation of blowdown flow path since Steam Generator Blowdown is normally routed to the condenser and not directly to the environment. **Justification:** This only attempts to clarify and does not change technical information. Steam Generator Blowdown may be sampled directly or after processing but before release to the environment. See section 1.5 in Part II – Calculational Methodologies for further clarification (70162733/010)	Editorial
7	32	39 41	In Table 4.11-1.1 added Groundwater Remediation as a new Continuous Liquid Release Type and added note "h" to Table 4.11-1 Table Notations. **Justification:** Groundwater onsite contains small amounts of tritium due to a historical leak from the Salem Unit 1 Spent Fuel Pool. During the remediation process, some groundwater is continuously pumped to the Non-Rad Waste Basin where it is sampled by a compositor and is treated as a Radioactive Liquid Release. This change customizes the Liquid Release Type to be plant specific as per NUREG-1301. (70162733/010)	Technical
8	33	40	Corrected LLD delta time definition in Table 4.11-1: Radioactive Liquid Waste Sampling and Analysis Program to reflect REC program LLD. **Justification:** Table 4.11-1 incorrectly defined delta time using definition for REMP counting. Corrected to agree with NUREG-1301. (70166487/010)	Editorial
9	34	40	Moved note from bottom of Table 4.11-1 about Ce-144 LLD to notation c. **Justification:** Note moved into notation "c" is editorial.	Editorial
10	36	43	Clarified Controls 3.11.1.3 to state the 92-day dose projection required by the Technical Specifications (TS) 6.8.4.g.6 is being satisfied by performing 31-day dose projections. **Justification:** 92-day dose projection was previously removed from ODCM and replaced with 31-day dose projection. 92-day remains in TS. This change only adds a note saying the 31-day performance is more conservative than the 92-days allowed by TS. (70166444/010)	Editorial

11	38 39	45 46	Table 4.11-2: Added Containment Equipment Hatch as a Gaseous Release Type. Added notes "h" and "i" to Table 4.11-2 Table Notations to clarify when monitoring is needed and when analysis for hard-to-detects is required. **Justification:** Containment Equipment Hatch is opened during outages and may have outward flow of gases. Addition to this table acknowledges this and gives direction to perform monitoring when hatch is open. (70171791/030)	Technical
12	41	48	In Control 3.11.2.3, I-133 is being added. **Justification:** I-133 is currently included in the dose calculations performed by effluents software but was left out of previous ODCM revision. I-133 being added will also agree with NUREG-1301, Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactor.	Editorial
13	42	49	Clarified Controls 3.11.2.4 to state the 92-day dose projection required by the Technical Specifications, TS, 6.8.4.g.6 is being satisfied by performing 31-day dose projections. **Justification:** 92-day dose projection was previously removed from ODCM and replaced with 31-day dose projection. 92-day remains in TS. This change only adds a note saying the 31-day performance is more conservative than the 92-days allowed by TS. (70166444/010)	Editorial
14	46	53	Changed distance for outer ring dosimeter sample locations in Table 3.12-1.1 from (6 to 8 km) to (5 to 11 km) to reflect plant specific information. **Justification:** The dosimeters were not relocated. The dosimeter sample location range was changed in ODCM Revision 27 because (6 to 8 km) is the range in NUREG-1301. NUREG-1301 also acknowledges that sample locations vary from site to site. Due to plant location, some of the ideal locations are not accessible or are over the water so alternate locations which are accessible were selected in the (5 to 11 km) range. This is not a change to the program but restores previously specified range of Revision 26. (70175881/010)	Editorial
15	46	53	Note below Table 3.12-1 deleted. **Justification:** Note came from NUREG 1301 and concerned customizing table to the local site. This was performed when program was setup.	Editorial

16	47	54	Clarify gamma isotopic analysis is performed on particulate sample composite in Type and Frequency of Analysis column of Table 3.12-1.2. **Justification:** It was not clear during review of document which analyses were for iodine sample and which were for particulate sample. This revision complies with NUREG-1301. This is not a change in practice, this is an editorial change.	Editorial
17	48	55	Changed sampling and collection frequency and type of analysis for Surface Waterborne samples in Table 3.12-1.3.a. **Justification:** Sampling frequency was increased from monthly to semi-monthly. Specified the analysis will be performed on a composited sample; the frequency of sample analysis was not changed. This aligns program more closely agree with NUREG-1301. (70152838/010)	Technical
18	51	58	Edited Table Notation (3) in Table 3.12-1 to identify sample location 5S2 as a duplicate sample location. **Justification:** The purpose of sample location 5S2 was unclear. This is an editorial change. (70169329/020)	Editorial
19	53 54	60 61 62	Added note (1) to bottom of Table 3.12-2 and of Table 4.12-1 explaining these H-3 and I-131 LLD values were used due to no drinking water exposure pathway. **Justification:** Explains why limit value is 30,000 pCi/L instead of 20,000 pCi/L and why LLD value is 3,000 pCi/L instead of 2,000 pCi/L for H-3 as listed in NUREG-1301. Also explains why limit value is 20 pCi/L instead of 2 pCi/L and why LLD value is 15 pCi/L instead of 1 pCi/L for I-131 as listed in NUREG-1301. NUREG-1301 has notes allowing these higher values if no drinking water pathway exists. (70199487/010)	Editorial
20	54	61	In Table 4.12-1 changed LLD for I-131 from 10 to 15. **Justification:** Changed to agree with NUREG-1301 guidance which says "If no drinking water pathway exists, a value of 15 pCi/L may be used.	Technical
21	57	64	Removed reference to elevated release from Control 3.12.2. **Justification:** No elevated release exists at Salem and reference clutters text and adds to confusion. This is an editorial change.	Editorial

22	57	64	Inserted note ** in actions a. and b. for Control 3.12.2 to specify that receptor locations must be on land and not over water. **Justification:** The use of a real receptor provides an actual dose to real pathways instead of hypothetical dose to hypothetical pathways. NUREG-0133 indicates that actual pathways should be used. (80113172/490)	Editorial
23	62 63	68 69	Edited monitor numbers in Bases Section 4/3.3.9 on Unit 1 and Unit 2 Instrument Description Tables per markup in DCP #80057583. **Justification:** DCP #80057583 removed some Unit 1 and Unit 2 R45 skids components. (80057583/450)	Technical
24	66	74	Inserted a note in Bases Section 3/4.11.2.3 to specify that receptor locations must be on land and not over water. **Justification:** The use of real receptors provides an actual dose to real pathways instead of hypothetical dose to hypothetical pathways. NUREG-0133 indicates that actual pathways should be used. (80113172/490)	Editorial
25	72	81	Inserted header page for section 6.0 **Justification:** Editorial	Editorial
26	82	96	Section 1.6: Added equations and supporting definitions for liquid 31 day dose projection. **Justification:** Dose projection equations were left out of ODCM revision 27 when 92-day dose projection was replaced by 31-day dose projection. (70166444/010)	Technical
27	92	108	Section 2.7: Added equations and supporting definitions for gaseous 31 day dose projection. **Justification:** Dose projection equations left out of ODCM revision 27 when 92-day dose projection was replaced by 31-day dose projection. (70166444/010)	Technical
28	96 97 98	113 114 115	Figures 1-1, 1-2, and 1-3 edited line connections so they reached tanks and repositioned some lines and verbiage for clarity. No technical changes. Revision bars not used on these charts. **Justification:** Editorial change.	Editorial
29	99	116	Comments in Table 1-1.1 for 1-R18, 1-R19(A,B,C,D) and 1-R13(A,B) Sensitivities and Setpoints were edited to correct references. **Justification:** Engineering Calculations which replaced the previous document were performed for DCP 80019351.	Editorial
30	100	117	Comments in Table 1-1.2 for 2-R18, 2-R19(A,B,C,D), 2-R13(A,B) and R37 Sensitivities and Setpoints were edited to	Editorial

			correct references. **Justification:** Engineering Calculations which replaced the previous document were performed due to component upgrades. Those references were updated in this revision.	
31	107	124	Comments in Table 2-2.1 for 1-R-12A and 1-R-41 Sensitivities and Setpoints were changed to reference the correct calculations which control the setpoints. **Justification:** Calculations were performed as Engineering Documents SC-RM004 in 2005 and SC-RM002 in 2007. These setpoints are conservative and setpoints were not specified in revision 27 of the ODCM.	Editorial
32	108	125	Comments in Table 2-2.2 for 2-R-12A and 2-R-41 Sensitivities and Setpoints were changed to reference the correct calculations which control the setpoints. **Justification:** Calculations were performed as Engineering Documents SC-RM004 in 2005 and SC-RM002 in 2007. These setpoints are conservative and setpoints were not specified in revision 27 of the ODCM.	Editorial
33	142	159 160	Appendix E Sample Designation page was completely revised. **Justification:** The rewrite is editorial for clarity. This rewrite corrects editorial items identified in review of 2014 ARERR.	Editorial
34	143 to 146	161 to 166	Appendix E Table E-1 was reformatted, Latitude and Longitude values were added, and station locations were corrected for accuracy and for clarification as needed. Revision bars not used for this change so other individual changes could be marked. **Justification:** GPS coordinates and distances can now be determined more accurately. Latitude and Longitude values are not required for this table but enhance the ability to locate sample stations. Some Station Locations descriptions were outdated.	Technical
35	144	163	Table E-1.B, Air Sample Locations, changed 7S1 to 7S2. **Justification:** This is a new air sampler location and 7S1 is a previously defined Direct Radiation Monitoring Location (IDM). (70166150/030)	Technical
36	145	165	Table E-1.F, Water Sediment Locations (ESS), changed 6S2 to 6A1. **Justification:** 6S2 is already defined as an IDM location. ESS locations are beyond site boundary because they are over water so the ESS location was renamed 6A1.	Technical
37	146	166	Table E-1.I, Food Product Locations (FPL, FPV), 7S2 location added. 16S2 location name corrected to 15S2.	Technical

			Justification: 7S2 is a new location for FPL/FPV located next to the 7S2 air sampler. Also, the FPL/FPV location identified as 16S2 in Revision 27 of the ODCM was a typing error and should have been identified as 15S2. (70166150/030)	
38	148	167	On Sample Collection and Analysis table the "Water (potable, surface) sample was divided into two entries. **Justification:** The separation was made to add clarity to this line item. This is an editorial change.	Editorial
39	149 150	168 169 170	New Sampling Locations Maps were made. Third map showing sampling location beyond 10 miles was added. Revision bars not used for this change. **Justification:** Due to sampling location changes, new maps are required to show locations and station codes. Third map added for ease of reading.	Technical
40	152	172	In Appendix F title, corrected effective date of 10 CFR 20 revision used for MPC values from 10 CFR 20 Appendix B, Table II, Column 2. Added a clarifying statement that this revision of 10 CFR 20 is referred to as the "old" 10 CFR 20. **Justification:** The date was not correct for the revision of 10 CFR 20. This was an editorial change only. (70166487/10)	Editorial
41	ALL	ALL	Corrections were made throughout on capitalization, formatting, spelling, and other clerical items. Font changed to Arial 12 except where larger or smaller type was appropriate or needed. **Justification:** These did not change the intent or technical content. They were performed to add clarity and consistency and to correct typos.	Editorial
42	ALL	ALL	Added "old" and "new" in front of 10 CFR 20 references to specify whether referring to pre-1994 revision or post-1994 revision. Standardized spaces in 10 CFR xx. **Justification:** These did not change the intent or technical content. They were performed to specify whether referring to pre-1994 revision or post-1994 revision. This adds clarity and consistency and is an editorial change. (70166487/10)	Editorial

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SALEM NUCLEAR GENERATING STATION
OFFSITE DOSE CALCULATION MANUAL

INTRODUCTION

The Salem Offsite Dose Calculation Manual (ODCM) is a supporting document to the Salem Units 1 and 2 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 and the Radiological Environmental Monitoring Programs required by Technical Specifications 6.8.4
- Descriptions of the information that should be included in the Annual Radiological Environmental Operating Report and the Annual Radioactive Effluent Release Report required by Technical Specifications 6.9.1.7 and 6.9.1.8, respectively.

Part II describes 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 list and graphical description of the specific sample locations for the radiological environmental monitoring program (REMP), and the liquid and gaseous waste treatment systems.

Revisions to the ODCM shall be made in accordance with the Technical Specifications Section 6.14.

The current licensing basis applies Maximum Permissible Concentrations (MPCs) for radioactive liquid effluent concentration limits. Since the MPC values were removed from 10 CFR 20 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 Nos. 234 and 215, letters between the Nuclear Management and Resources Council (NUMARC) concerning the differences between the "old" 10 CFR 20 and the "new" 10 CFR 20 allowed continued use of the instantaneous release limits (MPCs). The NUMARC letter of April 28, 1993, concluded that the RETS referencing 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 20 was effective January 1, 1994. Versions of 10 CFR 20 prior to January 1, 1994 are considered the "old" 10 CFR Part 20.

PART I - RADIOLOGICAL EFFLUENT CONTROLS

SECTION 1.0

DEFINITIONS

1.0 DEFINED TERMS

The DEFINED TERMS of this section 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 the injection of a simulated signal into the channel as close to the primary sensor as practicable to verify OPERABILITY including alarm and/or trip functions.

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 Federal Guidance Report No. 11 (FGR 11), "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion".

1.7 FREQUENCY NOTATION

The FREQUENCY NOTATION specified for the performance of Surveillance Requirements shall correspond to the intervals defined in Table 1.2.

1.8 GASEOUS RADWASTE TREATMENT SYSTEM

A GASEOUS RADWASTE TREATMENT SYSTEM is any system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system offgases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

1.9 MEMBER(S) OF THE PUBLIC

MEMBER(S) OF THE PUBLIC shall include all persons who are not occupationally associated with the plant. This category does not include employees of the licensee, its contractors, or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational or other purposes not associated with the plant.

1.10 OFFSITE DOSE CALCULATION MANUAL (ODCM)

The OFFSITE DOSE CALCULATION MANUAL (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, and in the conduct of the environmental radiological monitoring program. The ODCM shall also contain (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs required by Technical Specification Section 6.8.4 and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and the Radioactive Effluent Release Reports required by Technical Specification Sections 6.9.1.7 and 6.9.1.8, respectively.

1.11 OPERABLE - OPERABILITY

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, normal or emergency electrical power source, cooling and seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component or device to perform its specified safety function(s) are also capable of performing their related support function(s).

1.12 OPERATIONAL MODE - MODE

An OPERATIONAL MODE (i.e., MODE) shall correspond to any one inclusive combination of core reactivity condition, power level and average reactor coolant temperature specified in Table 1.1.

1.13 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.

1.14 RATED THERMAL POWER

RATED THERMAL POWER shall be a total reactor core heat transfer rate to the reactor coolant of 3459 MWt.

1.15 REPORTABLE EVENT

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

1.16 SITE BOUNDARY

The SITE BOUNDARY shall be that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee, as shown in Figure 5.1-3.

1.17 SOURCE CHECK

SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to either (a) an external source of increased radioactivity, or (b) an internal source of radioactivity (keep-alive source), or (c) an equivalent electronic source check.

1.18 THERMAL POWER

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

1.19 UNRESTRICTED AREA

An UNRESTRICTED AREA shall be any area at or beyond the SITE BOUNDARY, access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, or any area within the SITE BOUNDARY used for residential quarters or industrial, commercial, institutional, and/or recreational purposes.

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

1.21 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.

1.22 WASTE GAS HOLDUP SYSTEM

A WASTE GAS HOLDUP SYSTEM shall be any system designed and installed to reduce radioactive gaseous effluents by collecting Reactor Coolant System offgases from the Reactor Coolant System and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

TABLE 1.1: OPERATIONAL MODES

MODE	REACTIVITY CONDITION, K_{eff}	THERMAL POWER*	AVERAGE COOLANT TEMPERATURE
1. Power Operation	> 0.99	> 5%	> 350°F
2. Startup	> 0.99	≤ 5%	≥ 350°F
3. Hot Standby	< 0.99	0	≥ 350°F
4. Hot Shutdown	< 0.99	0	350°F > T_{avg} > 200°F
5. Cold Shutdown	< 0.99	0	≤ 200°F
6. Refueling**	≤ 0.95	0	≤ 140°F

* Excluding decay heat.

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

TABLE 1.2: 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 6 months
R	At least once per 18 months
S/U	Prior to each reactor startup
P	Prior to each release
N.A.	Not Applicable

SECTIONS 3.0 AND 4.0

CONTROLS

AND

SURVEILLANCE REQUIREMENTS

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 OPERATIONAL MODES or other conditions specified therein; except that upon failure to meet the CONTROL, the associated ACTION requirements shall be met.

3.0.2 Noncompliance with a CONTROL shall exist when the requirements of the CONTROLS 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 a MODE in which the CONTROL does not apply by placing it, as applicable, in:

1. At least HOT STANDBY within the next 6 hours,
2. At least HOT SHUTDOWN within the following 6 hours, and
3. At least COLD SHUTDOWN 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 MODE 5 or 6.

3.0.4 Entry into an OPERATIONAL MODE or other specified condition:

a. Shall not be made when the conditions of the CONTROL are not met and the associated ACTION requires a shutdown if they are not met within a specified time interval.

b. 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 OPERATIONAL MODES as required to comply with ACTION requirements. Exceptions to these requirements are stated in the individual CONTROLS.

4.0 SURVEILLANCE REQUIREMENTS

4.0.1 Surveillance Requirements shall be met during the OPERATIONAL 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 specification 4.0.2, shall constitute a failure to meet the OPERABILITY requirements for a CONTROL. The time limits of the ACTION requirements are applicable at the time it is identified that a Surveillance Requirement has not been performed. 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 inoperable equipment.

4.0.4 Entry into an OPERATIONAL MODE or other specified condition shall not be made unless the Surveillance Requirement(s) associated with the CONTROL has been performed within the stated surveillance interval or as otherwise specified. This provision shall not prevent passage through or to OPERATIONAL MODES as required to comply with ACTION requirements.

3/4.3 INSTRUMENTATION

3/4.3.3.8 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

3.3.3.8 In accordance with Salem Units 1 and 2 Technical Specifications 6.8.4.g.1, the radioactive liquid effluent monitoring instrumentation channels shown in Table 3.3-12 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of CONTROL 3.11.1.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: 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, without delay suspend the release of radioactive liquid effluents monitored by the affected channel or declare the channel inoperable or change the setpoint so it is acceptably conservative.

b. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 3.3-12. Exert best efforts to return the instrument to OPERABLE status within 30 days and, if unsuccessful, explain in the next radioactive effluent release report why the inoperability was not corrected in a timely manner.

c. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.3.3.8 Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4.3-12.

TABLE 3.3-12: RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	ACTION
1. Gross Radioactivity Monitors Providing Automatic Termination of Release		
a. Liquid Radwaste Effluent Line	1 **(1R18, 2R18)**	26
b. Steam Generator Blowdown Line	4 **(1R19A-D, 2R19A-D)**	27
2. Gross Radioactivity Monitors not Providing Automatic Termination of Release		
a. Containment Fan Coolers – Service Water Line Discharge	2 (Unit 1) **(1R13A, B)** 2 (Unit 2) **(2R13A, B)**	28
b. Chemical Waste Basin	1 **(R37)**	31
3. Flow Rate Measurement Devices		
a. Liquid Radwaste Effluent Line	1 **(1FR1064, 2FR1064)**	29
b. Steam Generator Blowdown Line	4 **(1FA-3178, -3180, -3182, -3184, 2FA-3178, -3180, -3182, -3184)**	29

TABLE 3.3-12: RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION – TABLE NOTATION (Continued)

ACTION 26 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases may continue provided that prior to initiating a release:

a. At least two independent samples are analyzed in accordance with CONTROL 4.11.1.1.1, 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 27 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided grab samples are analyzed for principal gamma emitters, I-131, and dissolved and entrained gases at the lower limits of detection required in ODCM CONTROL Table 4.11-1.B, and the ODCM Surveillance Requirement 4.11.1.1.2 is performed:

a. At least once per 8 hours when the specific activity of the secondary coolant is greater than 0.01 microcuries/gram DOSE EQUIVALENT I-131, or
b. At least once per 24 hours when the specific activity of the secondary coolant is less than or equal to 0.01 microcuries/gram DOSE EQUIVALENT I-131.

ACTION 28 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that:

a. At least once per 8 hours, local monitor readouts for the affected channels are verified to be below their alarm setpoints, or
b. With a Service Water System leak (inside containment) on the Containment Fan Coil Unit associated with the inoperable monitor either:
    1. At least once per 8 hours, grab samples are to be collected and analyzed for principal gamma emitters, I-131, and dissolved and entrained gases at the lower limits of detection specified in ODCM CONTROL Table 4.11-1.B, and the ODCM Surveillance Requirement 4.11.1.1.2 is performed, or
    2. Isolate the release pathway.
c. With no identified service water leakage (inside containment) on the Containment Fan Coil Unit associated with the inoperable monitor, at least once per 24 hours, collect grab samples and analyze for principal gamma emitters, I-131, and dissolved and entrained gases at the lower limits of detection specified in ODCM CONTROL Table 4.11-1.B, and the ODCM Surveillance Requirement 4.11.1.1.2 is performed.

TABLE 3.3-12: RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION – TABLE NOTATION (Continued)

ACTION 29 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves may be used to estimate flow.

ACTION 31 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that grab sampling is conducted in accordance with the following table:

FREQUENCY	CONDITION
1 per week	During normal operation (all MODES)
1 per day	During operation with an identified primary to secondary leak on either Salem Unit

The grab samples shall be analyzed for principal gamma emitters, I-131, and dissolved and entrained gases at the lower limits of detection specified in ODCM CONTROL Table 4.11-1.B, and the ODCM Surveillance Requirement 4.11.1.1.2 shall be performed.

TABLE 4.3-12: RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. Gross Radioactive Monitors Providing Alarm and Automatic Termination of Release				
a. Liquid Radwaste Effluent Line	D	P#	R(3)	Q(1)
b. Steam Generator Blowdown Line	D	M	R(3)	Q(1)
2. Gross Radioactivity Monitors Providing Alarm but not Providing Automatic Termination of Release				
a. Containment Fan Coolers – Service Water Line Discharge	D	M	R(3)	Q(2)
b. Chemical Waste Basin Line	D	M	R(3)	Q(5)
3. Flow Rate Measurement Devices				
a. Liquid Radwaste Effluent Line	D(4)	N.A.	R	N.A.
b. Steam Generator Blowdown Line	D(4)	N.A.	R	N.A.

TABLE 4.3-12: RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS – TABLE NOTATIONS (Continued)

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that automatic isolation of this pathway and Control Room alarm annunciation occurs if any of the following conditions exist:

a. Instrument indicates measured levels at or above the alarm/trip setpoint.

b. Circuit failure. (Loss of Power)

c. Control Room 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.

b. Circuit failure. (Loss of Power)

c. Control Room Instrument indicates a downscale failure.

d. Instrument controls not set in operate mode. (On instruments equipped with operate mode switches only **{Unit 1}**).

(3) The initial CHANNEL CALIBRATION was performed using appropriate liquid or gaseous calibration sources obtained from reputable suppliers. The activity of the calibration sources were reconfirmed using a multi-channel analyzer which was calibrated using one or more NBS (now NIST) standards.

(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) 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.

b. Circuit failure. (Loss of Power)

The R18's channels off-line channels which requires periodic decontamination. Any count rate indication above 10,000 cpm constitutes a SOURCE CHECK for compliance purposes.

3/4.3 INSTRUMENTATION

3/4.3.3.9 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

3.3.3.9 In accordance with Salem Units 1 and 2 Technical Specifications 6.8.4.g.1, the radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.3-13 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of CONTROL 3.11.2.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the ODCM.

APPLICABILITY: As shown in Table 3.3-13

ACTION:

a. With a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above CONTROL, without delay suspend the release of radioactive gaseous effluents monitored by the affected channel or declare the channel inoperable or change the setpoint so it is acceptably conservative.

b. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 3.3-13. Exert best efforts to return the instrument to OPERABLE status within 30 days and, if unsuccessful, explain in the next radioactive effluent release report why the inoperability was not corrected in a timely manner.

c. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.3.3.9 Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4.3-13.

TABLE 3.3-13: RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
1. Waste Gas Holdup System			
a. Noble Gas Activity Monitor – Providing Alarm and Automatic Termination of Release	1 **(1R41A&D, 2R41A&D)**	*	31
2. Containment Purge			
a. Noble Gas Activity Monitor	1 **(1R12A or 1R41A&D, 2R12A or 2R41A&D) #**	**	34
3. Containment Pressure – Vacuum Relief			
a. Noble Gas Activity Monitor	1 **(1R12A or 1R41A&D 2R12A or 2R41A & D) #**	**	37
4. Plant Vent Header System ##			
a. Noble Gas Activity Monitor	1 **(1R41A&D, 2R41A&D)**	*	33
b. Iodine Sampler	1 **(1RME4, 5 or 1RME50, 51, 2RME4, 5 or 2RME50, 51)**	*	36
c. Particulate Sampler	1 **(1RME4, 5 or 1RME50, 51, 2RME4, 5 or 2RME50, 51)**	*	36
d. Process Flow Rate Monitor (stack)	1 **(1RM-1FA8603, 2RM-2FA8603)**	*	32
e. Sampler Flow Rate Monitor	1 **(1RM-1FA17079 or S1RM-1YD20697, 2RM-2FA17079 or S2RM-2YD20697)**	*	32

TABLE 3.3-13: RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION – TABLE NOTATION (Continued)

ACTION 31 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, the contents of the tank(s) may be released to the environment provided that prior to initiating the release:

a. At least two independent samples of the tank's contents are analyzed, and

b. At least two technically qualified members of the Facility Staff independently verify the release rate calculations and discharge valving lineup;

Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 32 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours.

ACTION 33 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided grab samples are taken at least once per 8 hours and these samples are analyzed for gaseous principal gamma emitters at the lower limits of detection required in ODCM CONTROL TABLE 4.11-2.A, B, or C within 24 hours. Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 34 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, immediately suspend PURGING of radioactive effluents via this pathway.

ACTION 36 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that within 4 hours samples are continuously collected with auxiliary sampling equipment as required in Table 4.11-2.

TABLE 3.3-13: RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION – TABLE NOTATION (Continued)

ACTION 37 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, Containment Pressure Reliefs may be performed provided that prior to initiating the release:

a. At least two independent samples of containment are analyzed, and

b. At least two technically qualified members of the Facility Staff independently verify the release rate calculations.

Otherwise, suspend release of radioactive effluents via this pathway.

* At all times, other than when the line is valved out and locked.

** During Containment Purges or Containment Pressure - Vacuum Relief

APPLICABILITY:

- Modes 1-6, R41A/D Monitors providing Alarm and Automatic Termination of Release, or
- Modes 1-5, R12A Monitor providing Alarm and Automatic Termination of Release, or
- Mode 6, R12A Monitor providing Alarm only (Automatic Termination of Release is not required).
- During Mode Undefined (Defueled) operation, containment purge is reclassified as a building ventilation process stream monitored by the PLANT VENT HEADER SYSTEM.

During movement of irradiated fuel within containment with the Containment Equipment Hatch OPEN, only R41A/D can be credited for MINIMUM CHANNEL OPERABLE.

During movement of irradiated fuel within containment with the Containment Equipment Hatch CLOSED, R41A/D or R12A may be credited for MINIMUM CHANNEL OPERABLE.

The following process streams are routed to the plant vent where they are effectively monitored by the instruments described:

a. Condenser Air Removal System

b. Auxiliary Building Ventilation System

c. Fuel Handling Building Ventilation System

d. Radwaste Area Ventilation System

e. Containment Purges & Pressure-Vacuum Relief

TABLE 4.3-13: RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	MODES IN WHICH SURVEILLANCE REQUIRED
1. Waste Gas Holdup System					
a. Noble Gas Activity Monitor – Providing Alarm and Automatic Termination of Release	P	P	R(3)	Q(1)	*
2. Containment Purge and Pressure – Vacuum Relief					
a. Noble Gas Activity Monitor	P	P	R(3)	Q(1)	*
3. Plant Vent Header System					
a. Noble Gas Activity Monitor	D	M	R(3)	Q(2)	*
b. Iodine Sampler	W	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W	N.A.	N.A.	N.A.	*
d. Process Flow Rate Monitor (stack)	D	N.A.	R	N.A.	*
e. Sampler Flow Rate Monitor	W	N.A.	R	N.A.	*

The following process streams are routed to the plant vent where they are effectively monitored by the instruments described:

a. Condenser Air Removal System
b. Auxiliary Building Ventilation System
c. Fuel Handling Building Ventilation System
d. Radwaste Area Ventilation System
e. Containment Purges & Pressure-Vacuum Relief

TABLE 4.3-13: RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS – TABLE NOTATIONS (Continued)

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that automatic isolation of this pathway and Control Room alarm annunciation occurs if any of the following conditions exist:

a. Instrument indicates measured levels above the alarm/trip setpoint.

b. Circuit failure. (Loss of Power)

c. Control Room Instrument indicates a downscale failure. (Alarm Only)

(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.

b. Circuit failure. (Loss of Power)

c. Control Room Instrument indicates a downscale failure.

(3) The initial CHANNEL CALIBRATION was performed using appropriate liquid or gaseous calibration sources obtained from reputable suppliers. The activity of the calibration sources were reconfirmed using a multi-channel analyzer which was calibrated using one or more NBS (now NIST) standards.

* At all times.

** During Containment Purges or Containment Pressure - Vacuum Relief

SURVEILLANCE REQUIREMENT

– Modes 1-6, R41A/D Monitors providing Alarm and Automatic Termination of Release
– Modes 1-5, R12A Monitors providing Alarm and Automatic Termination of Release
– Mode 6, R12A Monitors providing Alarm only (Automatic Termination of Release is not required).
– During Mode Undefined (Defueled) operation, containment purge is reclassified as a building ventilation process stream monitored by the PLANT VENT HEADER SYSTEM.

During movement of irradiated fuel within containment with the Containment Equipment Hatch OPEN, only R41A/D can be credited for MINIMUM CHANNEL OPERABLE.

During movement of irradiated fuel within containment with the Containment Equipment Hatch CLOSED, R41A/D or R12A may be credited for MINIMUM CHANNEL OPERABLE.

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 Salem Units 1 and 2 Technical Specifications 6.8.4.g. 2 and 3, the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (See Figure 5.1-3) shall be limited to the concentrations specified in the "old" 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 2E-4 uCi/ml.

APPLICABILITY: At all times.

ACTION:

With the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeding the above limits, without delay restore the concentration to within the above limits.

SURVEILLANCE REQUIREMENTS

4.11.1.1.1 Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analyses program in Table 4.11-1.

4.11.1.1.2 The results of the radioactivity analyses shall be used in accordance with the ODCM to assure that the concentrations at the point of release are maintained within the limits of CONTROL 3.11.1.1.

* Since the MPC values were removed from 10 CFR 20 effective 1/1/94, the MPC values are provided as Appendix F to the ODCM.

TABLE 4.11-1: RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[(a)] (uCi/ml)
A. Batch Waste Release 1. Tanks[b] 2. Groundwater Remediation Batch [f]	P Each Batch	P Each Batch	Principal Gamma Emitters[c]	$5x10^{-7}$
			I-131	$1x10^{-6}$
	P One Batch/M	M	Dissolve and Entrained Gases (Gamma Emitters)	$1x10^{-5}$
	P Each Batch	M Composite[d]	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	P Each Batch	Q Composite[d]	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$
B Continuous Releases[e] 1. Steam Generator Blowdown[g] 2. Ground Water Remediation Continuous [h]	W Grab Sample	W	Principal Gamma Emitters[c]	$5x10^{-7}$
			I-131	$1x10^{-6}$
	M Grab Sample	M	Dissolved and Entrained Gases	$1x10^{-5}$
	W Grab Sample	M Composite[d]	H-3	$1x10^{-5}$
			Gross Alpha	$1x10^{-7}$
	W Grab Sample	Q Composite[d]	Sr-89, Sr-90	$5x10^{-8}$
			Fe-55	$1x10^{-6}$

TABLE 4.11-1: RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM – TABLE NOTATION (Continued)

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

For a particular measurement system (which may include radiochemical separation):

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

WHERE: LLD is the "a priori" lower limit of detection as defined above (as microcuries per unit mass or volume)

4.66 is the statistical factor from NUREG 1301

S_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)

E is the counting efficiency (as counts per disintegration)

V is the sample size (in units of mass or volume)

2.22E6 is the number of disintegrations per minute per microcurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide (sec^{-1})

Δt is the elapsed time between the midpoint of sample collection and time of counting (sec)

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

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

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

c. The principal gamma emitters for which the LLD CONTROL applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. Ce-144 is also included, but with an LLD of 2×10^{-6}. This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

TABLE 4.11-1: RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM – TABLE NOTATION (Continued)

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 wastes of a non-discrete volume, e.g., from a volume of a system that has an input flow during the continuous release.

f. Groundwater Remediation Batch refers to pumping groundwater to a tank, isolating the tank, then processing as a batch release.

g. *Steam Generator Blowdown may be sampled directly or after processing but before* release to the environment. See section 1.5 in PART II – CALCULATIONAL METHODOLOGIES for further clarification.

h. Groundwater Remediation Continuous refers to pumping of groundwater to Non-rad Waste Basin and releasing in a continuous mode.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.1.2 DOSE

CONTROLS

3.11.1.2 In accordance with Salem Units 1 and 2 Technical Specifications 6.8.4.g.4 and 5, the dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each reactor unit, to UNRESTRICTED AREAS (see Figure 5.1-3) shall be limited:

a. During any calendar quarter to less than or equal to 1.5 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 Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

b. The provisions of CONTROL 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.1.2 Cumulative dose contributions from liquid effluents shall be determined in accordance with the ODCM at least once per 31 days.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.1.3 LIQUID RADWASTE TREATMENT

CONTROLS

3.11.1.3 In accordance with the Salem Units 1 and 2 Technical Specifications 6.8.4.g.6, the Liquid Radwaste Treatment System shall be OPERABLE and appropriate portions of the system used to reduce releases of radioactivity when the projected doses due to the liquid effluent, from each unit, to UNRESTRICTED AREAS (see Figure 5.1-3) would exceed 0.06 mrem to the total body or 0.2 mrem to any organ in a 31 day period. *

* Values of 0.06 mrem and 0.2 mrem in 31 day period come from NUREG-1301 and are more conservative than the 92-day requirement of Technical Specifications 6.8.4.g.6.

APPLICABILITY: At all times.

ACTION:

a. With the radioactive liquid waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that includes the following information:

   1. Explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability.

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

   3. Summary description of action(s) taken to prevent a recurrence.

b. The provisions of CONTROL 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.1.3 Doses due to liquid releases shall be projected at least once per 31 days in accordance with the ODCM.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.1 DOSE RATE

CONTROLS

3.11.2.1 In accordance with the Salem Units 1 and 2 Technical Specifications 6.8.4.g.3 and 7, the dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY (see Figure 5.1-3) 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, for iodine 133, for 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:

With the dose rate(s) exceeding the above limits, without delay restore the release rate to within the above limit(s).

SURVEILLANCE REQUIREMENTS

4.11.2.1.1 The dose rate due to noble gases in gaseous effluents shall be determined continuously to be within the above limits in accordance with 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 ODCM by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 4.11-2.

TABLE 4.11-2: RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[a] (uCi/mL)
A. Waste Gas Storage Tank	P Each Tank Grab Sample	P Each Tank	Principal Gamma Emitters[b]	$1x10^{-4}$
B. Containment PURGE	P Each PURGE Grab Sample	P Each PURGE	Principal Gamma Emitters[b]	$1x10^{-4}$
			H-3	$1x10^{-6}$
C. Plant Vent	M[c,d,e] Grab Sample	M[c]	Principal Gamma Emitters[b]	$1x10^{-4}$
			H-3	$1x10^{-6}$
D. All Release Types as Listed in A, B, and C Above	Continuous[f]	W[g] Charcoal Sample	I-131	$1x10^{-12}$
	Continuous[f]	W[g] Particulate Sample	Principal Gamma Emitters[b] (I-131, Others)	$1x10^{-11}$
	Continuous[f]	M Composite Particulate Sample	Gross Alpha	$1x10^{-11}$
	Continuous[f]	Q Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$
	Continuous[f]	Noble Gas Monitor	Noble Gasses Gross Beta or Gamma	$1x10^{-6}$
E. Containment Hatch when open during outages[h]	Continuous	D Charcoal Sample	I-131	$1x10^{-11}$
	Continuous	D Particulate Sample[i]	Principal Gamma Emitters[b]	$1x10^{-10}$
	D Grab Sample	D	Principal Gamma Emitters[b]	$1x10^{-4}$
			H-3	$1x10^{-6}$
	Continuous	Once per release period or Q	Gross Alpha Sr-89, Sr-90	$1x10^{-10}$

TABLE 4.11-2: RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM – TABLE NOTATION (Continued)

a. The LLD is defined in Table 4.11.1

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, Xe-138 for gaseous emissions and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141 and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

c. Sampling and analysis shall also be performed following shutdown, startup or a THERMAL POWER change that, within one hour, exceeds 15 percent of RATED THERMAL POWER unless:

   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 activity 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 24 hours when the refueling canal is flooded.

e. Tritium grab samples shall be taken at least once per 7 days from the ventilation exhaust from the spent fuel pool area whenever spent fuel is in the spent fuel pool.

f. 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.

g. 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 that, within one hour, exceeds 15 percent of RATED THERMAL POWER 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.

h. With the Containment Equipment Hatch OPEN, the air near the opening is monitored to estimate dose to public from any potential release.

i. The composite of all particulate filters collected when releases were being made through the Containment Hatch are to be analyzed for gross alpha, strontium-89, and strontium-90 at a LLD of no more than $1x10^{-10}$ uCi/mL at the end of the outage or Quarterly (92 day interval) from date of first opening until date of last closing.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.2.2 DOSE - NOBLE GASES

CONTROLS

3.11.2.2 In accordance with the Salem Units 1 and 2 Technical Specification 6.8.4.g.5 and 8, the air dose due to noble gases released in gaseous effluents, from each reactor unit, from the site areas and beyond the SITE BOUNDARY (see Figure 5.1-3) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 5 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 Technical Specification 6.9.2, 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 shall be determined in accordance with the ODCM at least once per 31 days.

3/4.11 RADIOACTIVE 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 the Salem Units 1 and 2 Technical Specification 6.8.4.g.5 and 9, 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, from the site to areas at and beyond the SITE BOUNDARY (see Figure 5.1-3) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 7.5 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 air 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 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

4.11.2.3 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 ODCM at least once per 31 days.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.2.4 GASEOUS RADWASTE TREATMENT

CONTROLS

3.11.2.4 In accordance with the Salem Units 1 and 2 Technical Specifications 6.8.4.g.6, the GASEOUS RADWASTE TREATMENT SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM shall be OPERABLE and appropriate portions of these systems shall be used to reduce releases of radioactivity when the projected doses due to gaseous effluent releases, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure 5.1-3), in a 92-day period would exceed a suitable fraction of allowable dose. This 92-day requirement is satisfied by performing dose projections every 31 days and determining if they would exceed the limits listed below from NUREG-1301:

- 0.2 mrad in air from gamma radiation, or
- 0.4 mrad in air from beta radiation, or
- 0.3 mrad to any organ to a MEMBER OF THE PUBLIC

APPLICABILITY: At all times.

ACTION:

a. With gaseous waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that includes the following information:

   1. Explanation of why gaseous radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability.

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

   3. Summary description of action(s) taken to prevent a recurrence.

b. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.11.2.4 Doses due to gaseous releases from the site shall be projected at least once per 31 days in accordance with the ODCM.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.4 TOTAL DOSE

CONTROLS

3.11.4 In accordance with Salem Units 1 and 2 Technical Specifications 6.8.4.g.11, 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 CONTROL 3.11.1.2a, 3.11.1.2b, 3.11.2.2a, 3.11.2.2b, 3.11.2.3a, or 3.11.2.3b, calculations should be made including direct radiation contributions from the reactor units and from outside storage tanks to determine whether the limits of this CONTROL have been exceeded. If such is the case, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, 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 20.405c, shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits, and if the release condition resulting in violation of 40 CFR Part 190 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 3.11.1.2, 3.11.2.2, 3.11.2.3, and in accordance with the ODCM.

4.11.4.2 Cumulative dose contributions from direct radiation from the reactor units and from radwaste storage shall be determined in accordance with the ODCM.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.1 MONITORING PROGRAM

CONTROLS

3.12.1. In accordance with Salem Units 1 and 2 Technical Specifications 6.8.4.h.1, the radiological environmental monitoring program shall be conducted as specified in Table 3.12-1.

APPLICABILITY: At all times.

ACTION:

a. With the radiological environmental monitoring program not being conducted as specified in Table 3.12-1, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report required by Technical Specification 6.9.1.7, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

b. With the level of radioactivity as the result of plant effluents in an environmental sampling medium at a specified location exceeding the reporting levels of Table 3.12-2 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days, pursuant to Technical Specification 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose* to a MEMBER OF THE PUBLIC is less than the calendar year limits of CONTROLS 3.11.1.2, 3.11.2.2, and 3.11.2.3. When more than one of the radionuclides in Table 3.12-2 are detected in the sampling medium, this report shall be submitted if:

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

When radionuclides other than those in Table 3.12-2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose* to a MEMBER OF THE PUBLIC from all radionuclides is equal to or greater than the calendar year limits of CONTROLS 3.11.1.2, 3.11.2.2, and 3.11.2.3. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report pursuant to CONTROL 6.9.1.7.

* The methodology used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.1 MONITORING PROGRAM

CONTROLS

ACTION: (Continued)

c. With milk or fresh leafy vegetable samples unavailable from one or more of the sample locations required by Table 3.12-1, identify specific locations for obtaining replacement samples and add them to the radiological environmental monitoring program within 30 days. The specific locations from which samples were unavailable may then be deleted from the monitoring program.

   Pursuant to Technical Specification 6.9.1.8, identify the cause of the unavailability of samples and the new location(s) for obtaining replacement samples in the next Radioactive Effluent Release Report. Include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

d. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.1 The radiological environmental monitoring samples shall be collected pursuant to Table 3.12-1 from the specific locations given in the table and figure(s) in the ODCM, and shall be analyzed pursuant to the requirements of Table 3.12-1, and the detection capabilities required by Table 4.12-1.

TABLE 3.12-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS(1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
1. Direct Radiation(2)	Fifty eight routine monitoring stations with two or more dosimeters placed as follows: An inner ring of stations one in each land based meteorological sector in the general area of the SITE BOUNDARY; An outer ring of stations, one in each land-based meteorological sector in the 5 to 11 km range from the site; and The balance of the stations to be placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control stations.	Quarterly	Gamma dose quarterly

TABLE 3.12-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (Continued)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS(1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
2. AIRBORNE Radioiodine and Particulates	Samples from 5(3) locations: Three samples from close to the SITE BOUNDARY location, in different sectors, of the highest calculated annual average ground level D/Q. One sample from the vicinity of a community having a highest calculated annual average ground-level D/Q; and One sample from a control location, as for example 15-30 km distant and in the least prevalent wind direction.	Continuous sampler operation with sample collection weekly or more frequently if required by dust loading	Radioiodine Canister I-131 analysis weekly. Particulate Sampler Gross beta radioactivity analysis following filter change(4). AND Gamma isotopic analysis(5) of particulate composites (by location) quarterly.

TABLE 3.12-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (Continued)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS(1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
3. WATERBORNE			
a. Surface(6)	One sample upstream One sample downstream One sample outfall One sample cross-stream	Grab sample semi-monthly	Composite for gamma isotopic analysis(5) monthly. Composite for tritium analysis quarterly.
b. Ground	Samples from one or two sources only if likely to be affected(8).	Monthly	Gamma isotopic analysis(5) monthly and tritium analysis quarterly.
c. Drinking(11)	One sample of the nearest water supply affected by its discharge	Composite sample over two-week period(7) when I-131 analysis is performed; monthly composite otherwise	I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than 1 mrem per year(9). Composite for gross beta and gamma isotopic analysis(5) monthly Composite for tritium analysis quarterly
d. Sediment	One sample from downstream area One sample from cross-stream area One sample from outfall area One sample from upstream area One sample from a control location One sample from shoreline location	Semiannually	Gamma isotopic analysis(5) semiannually

TABLE 3.12-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (Continued)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
4. INGESTION			
a. Milk	Samples from milking animals in three locations within 5 km distance having the highest dose potential. If there are none, then one sample from milking animals in each of three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per yr[9]. One sample from milking animals at a control location 15 to 30 km distant.	Semi-monthly when animals are on pasture, monthly at other time	Gamma isotopic[5] and I-131 analysis semi-monthly when animals are on pasture; monthly at other times.
b. Fish and Invertebrates	One sample of each commercially and recreationally important species in vicinity of plant discharge area. One sample of same species in area not influenced by plant discharge.	Sample in season, or semiannually if they are not seasonal	Gamma isotopic analysis[5] on edible portions.

TABLE 3.12-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (Continued)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS [(1)]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
c. Food Products	One sample of each principal class of food products from any area that is irrigated by water in which liquid plant wastes have been discharged	At time of harvest[(10)]	Gamma isotopic analysis [(5)] on edible portion.
	Samples of three different kinds of broad leaf grown nearest each of two different offsite locations of highest predicted annual ground level D/Q if milk sampling is not performed.	Monthly during growing season	Gamma isotopic analysis[(5)] on edible portion.
	One sample of each similar broadleaf vegetation grown 15 to 30 km distant in the least prevalent wind direction if milk sampling is not performed.	Monthly during growing season	Gamma isotopic analysis [(5)] on edible portion.

TABLE 3.12-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM – TABLE NOTATION (Continued)

(1) Specific parameters of distance and direction sector from the midpoint of a line between the center of the Salem Units 1 & 2 containment domes, and additional description where pertinent, shall be provided for each and every sample location in Table 3.12-1 in a table and figure(s) in the ODCM. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978, and to Reg. Guide 4.8 as amended by Radiological Assessment Branch Technical Position, Revision 1, November 1979. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to circumstances such as hazardous conditions, seasonal unavailability and malfunction of automatic sampling equipment. If specimens are unobtainable due to sampling equipment malfunction, effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to CONTROL 6.9.1.7. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable specific alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the Radiological Environmental Monitoring Program given in the ODCM. Pursuant to CONTROL 6.9.1.8, submit in the next Radioactive Effluent Release Report documentation for a change in the ODCM including revised figure(s) and table for the ODCM reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples for the pathway and justifying the selection of the new location(s) for obtaining samples.

(2) One or more instruments, such as pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a Passive Dosimeter (PD), a device meeting the criteria of ANSI N545 is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used for measuring direct radiation. The frequency of analysis or readout will depend upon the characteristics of the specific dosimetry system used and should be selected to obtain optimum dose information with minimal fading. The number of direct radiation monitoring stations may be reduced according to geographical limitations; e.g., at an ocean site, some sectors will be over water so that the number of dosimeters may be reduced accordingly.

(3) There are four additional air sample locations – one "duplicate" air sampler at location 5S2 plus locations 5D1, 1F1 and 2F6 which are maintained for their historical data.

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

TABLE 3.12-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM – TABLE NOTATION (Continued)

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

(6) The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. The "downstream" sample shall be taken in an area beyond but near the mixing zone. "Upstream" samples in an estuary must be taken far enough upstream to be beyond the plant influence. Saltwater shall be sampled only when the receiving water is utilized for recreational activities.

(7) A composite sample is one which the quantity (aliquot) of liquid sampled is proportional to the quantity of flowing liquid and in which the method of sampling employed results in a specimen that is representative of the liquid flow. In this program composite sample aliquots shall be collected at time intervals that are very short relative to the compositing period in order to assure obtaining a representative sample.

(8) Groundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

(9) The dose shall be calculated for the maximum organ and age group using the methodology and parameters in the ODCM. There are no farms that meet the 5 km requirement and it is unlikely that any releases from the site will approach the 1 mrem criteria at 5 to 8 km. Milk samples will be taken (owner obliging) within 8 km and other management audit samples within 16 km. Broad leaf vegetation (within 8 km) shall be taken to meet this pathway.

(10) If harvest occurs more than once a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuberous and root food products. The Delaware River at the location of Salem and Hope Creek Nuclear Power Plants is a brackish water source. No irrigation of food products is performed using water in the vicinity from which liquid plant wastes have been discharged. However, 12 management audit food samples are collected from various locations.

(11) No groundwater samples are required as liquid effluents discharged from Salem and Hope Creek Generating Stations do not directly affect this pathway. However for management audit, one raw and one treated ground water sample from the nearest unaffected water supply is required.

TABLE 3.12-2: REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Analysis	Water (pCi/L)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/Kg, wet)	Milk (pCi/L)	Food Products (pCi/Kg, wet)
H-3	3×10^4 (1)				
Mn-54	1×10^3		3×10^4		
Fe-59	4×10^2		1×10^4		
Co-58	1×10^3		3×10^4		
Co-60	3×10^2		1×10^4		
Zn-65	3×10^2		2×10^4		
Zr-Nb-95	4×10^2				
I-131	20 (1)	0.9		3	1×10^2
Cs-134	30	10	1×10^3	60	1×10^3
Cs-137	50	20	2×10^3	70	2×10^3
Ba-La-140	2×10^2			3×10^2	

1. No drinking water exposure path exists on site. If a drinking water pathway existed, then the water reporting level would be 20,000 pCi/L for H-3 and 2 pCi/L for I-131.

TABLE 4.12-1: DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS(1), (2)

LOWER LIMITS OF DETECTION (LLD) (4)

Analysis	Water (pCi/L)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/Kg, wet)	Milk (pCi/L)	Food Products (pCi/Kg, wet)	Sediment (pCi/kg, dry)
Gross Beta	4	1×10^{-2}				
H-3	3000 (3)					
Mn-54	15		130			
Fe-59	30		260			
Co-58,60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131	15 (3)	7×10^{-2}		1	60	
Cs-134	15	5×10^{-2}	130	15	60	150
Cs-137	18	6×10^{-2}	150	18	80	180
Ba-La-140	15			15		

TABLE 4.12-1: DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS – TABLE NOTATIONS

(1) This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report pursuant to CONTROL 6.9.1.7.

(2) Required detection capabilities for dosimeters used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13.

(3) No drinking water exposure pathway exists on site. If drinking water pathway existed, then the water LLD would be 2,000 pCi/L for H-3 and 1 pCi/L for I-131.

TABLE 4.12-1: DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS – TABLE NOTATIONS

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

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

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

WHERE: LLD is the "a priori" lower limit of detection as defined above (as picocuries per unit mass or volume)

4.66 is the statistical factor from NUREG 1301

S_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)

E is the counting efficiency (as counts per disintegration)

V is the sample size (in units of mass or volume)

2.22 is the number of disintegrations per minute per picocurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide (sec^{-1})

Δt for environmental samples is the elapsed time between sample collection (or end of the sample collection period) and time of counting

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

For low count rates a value of 2.71 may be added to the numerator

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. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report pursuant to CONTROL 6.9.1.7.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.2 LAND USE CENSUS

CONTROLS

3.12.2 In accordance with the Salem Units 1 and 2 Technical Specifications 6.8.4.h.2, a land use census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors of the nearest milk animal, the nearest residence and the nearest garden* of greater than 50 m^2 (500 ft^2) producing broad leaf vegetation.

APPLICABILITY: At all times.

ACTION:

a. With a land use census identifying a location(s)** that yields a calculated dose or dose commitment greater than the values currently being calculated in CONTROL 4.11.2.3, identify the new location(s) in the next Radioactive Effluent Release Report, pursuant to CONTROL 6.9.1.8.

b. With a land use census identifying a location(s)** that yields a calculated dose or dose commitment (via the same exposure pathway) 20 percent greater than at a location from which samples are currently being obtained in accordance with CONTROL 3.12.1, add the new location(s) to the radiological environmental monitoring program within 30 days. The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from this monitoring program after October 31 of the year in which this land use census was conducted. Pursuant to CONTROL 6.9.1.8, identify the new location(s) in the next Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

c. The provisions of CONTROLS 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.2 The land use census shall be conducted during the growing season at least once per 12 months using that information that will provide the best results, such as by a door-to-door survey, visual survey, aerial survey, or by consulting local agriculture authorities. The results of the land use census shall be included in the Annual Radiological Environmental Operating Report pursuant to CONTROL 6.9.1.7.

* Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the SITE BOUNDARY in each of two different direction sectors with the highest predicted D/Q in lieu of the garden census. CONTROLS for broadleaf vegetation sampling in Table 3.12-1.4c shall be followed, including analysis of control samples.

** New receptor locations must be on land and not over water to be considered in dose calculations.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

CONTROLS

3.12.3 In accordance with Salem Units 1 and 2 Technical Specifications 6.8.4.h.3, analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program that has been approved by the Commission, that correspond to samples required by Table 3.12-1.

APPLICABILITY: At all times.

ACTION:

a. With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report pursuant to CONTROL 6.9.1.7.

b. The provisions of CONTROLS 3.0.3 and 3.0.4. are not applicable.

SURVEILLANCE REQUIREMENTS

4.12.3 The Interlaboratory Comparison Program shall be described in the ODCM. A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report pursuant to CONTROL 6.9.1.7.

BASES

FOR

SECTIONS 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.

3/4.3 INSTRUMENTATION

3/4.3.3.8 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

BASES

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 procedures in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of the "old" 10 CFR Part 20 (ODCM Appendix F). The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

CROSS REFERENCE - TABLES 3.3-12 and 4.3-12

Unit 1 T/S Table Item No.	Instrument Description	Acceptable RMS Channels
1a	Liquid Radwaste Effluent Line Gross Activity	1R18
1b	Steam Generator Blowdown Line Gross Activity	1R19A, B, C, and D(1)
2a	Containment Fan Coolers Service Water Line Discharge Gross Activity	1R13A and B(1)

Unit 2 T/S Table Item No.	Instrument Description	Acceptable RMS Channels
1a	Liquid Radwaste Effluent Line Gross Activity	2R18
1b	Steam Generator Blowdown Line Gross Activity	2R19A,B,C, and D(1)
2a	Containment Fan Coolers - Service Water Line Discharge Gross Activity	2R13A and B(1)
2b	Chemical Waste Basin Line Gross Activity	R37

(1) The channels listed are required to be operable to meet a single operable channel for the ODCM's "Minimum Channels Operable" requirement.

3/4.3 INSTRUMENTATION

3/4.3.3.9 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

BASES

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 procedures in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of the "old" 10 CFR Part 20 (ODCM Appendix F). The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

CROSS REFERENCE - TABLES 3.3-13 and 4.3-13

Unit 1 T/S Table Item No.	Instrument Description	Acceptable RMS Channels
1a	Waste Gas Holdup System Noble Gas Activity	1R41A and D(1)(2)
2a	Containment Purge and Pressure - Vacuum Relief Noble Gas Activity	1R12A or 1R41A and D(1)(2)
3a	Plant Vent Header System Noble Gas Activity	1R41A and D(1)(2)
3b	Plant Vent Header System Iodine Sampler (3)	1RME 4, 5 (1R41) or 1RME50, 51 (1R45)
3c	Plant Vent Header System Particulate Sampler (3)	1RME 4, 5 (1R41) or 1 RME50, 51 (1R45)

(1) The channels listed are required to be operable to meet a single operable channel for the ODCM's Minimum Channels Operable" requirement.

(2) 1R41D is the setpoint channel. 1R41A is the measurement channel.

(3) Laboratory analysis of the sampler filters ensures that the limits of ODCM CONTROL 3.11.2.1 are not exceeded. Alarm/trip setpoints do not apply to these passive components.

3/ 4.3 INSTRUMENTATION

3/4.3.3.9 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION (Continued)

BASES

Unit 2 T/S Table Item No.	Instrument Description	Acceptable RMS Channels
1a	Waste Gas Holdup System Noble Gas Activity	2R41A and D(1)(2)
2a	Containment Purge and Pressure - Vacuum Relief Noble Gas Activity	2R12A or 2R41A and D(1)(2)
3a	Plant Vent Header System Noble Gas Activity	2R41A and D(1)(2)
3b	Plant Vent Header System Iodine Sampler (3)	RME 4, 5 (2R41) or 2RME50, 51 (2R45)
3c	Plant Vent Header System Particulate Sampler (3)	2RME 4, 5 (2R41) or 2RME50, 51 (2R45)

(1) The channels listed are required to be operable to meet a single operable channel for the ODCM's "Minimum Channels Operable" requirement.

(2) 2R41D is the setpoint channel. 2R41A is the measurement channel.

(3) Laboratory analysis of the sampler filters ensures that the limits of ODCM CONTROL 3.11.2.1 are not exceeded. Alarm/trip setpoints do not apply to these passive components.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.1 LIQUID EFFLUENTS

BASES

3/4.11.1.1 CONCENTRATION

The CONTROL is provided to ensure that the concentration of radioactive materials released in liquid waste effluents will be less than the concentration levels specified in the "old" 10 CFR Part 20, Appendix B Table II, Column 2 (ODCM Appendix F). 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).

3/4.11.1.2 DOSE

This CONTROL is provided to implement the requirements of Sections II.A, III.A, and IV.A of Appendix I. 10 CFR Part 50. The CONTROL implements the guides set forth in Section II.A of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents will be kept "as low as 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 calculations 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 LIQUID EFFLUENTS (Continued)

BASES

3/4.11.1.2 DOSE (Continued)

The CONTROL applies to the release of liquid effluents from each reactor at the site. For units with shared radwaste treatment systems, the liquid effluents from the shared system are proportioned among the units sharing that system.

3/4.11.1.3 LIQUID RADWASTE TREATMENT

The requirement that the appropriate portions of this system be used, when specified, provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable". This CONTROL implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.0 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. The annual dose limits are the doses associated with the concentrations of the "old" 10 CFR Part 20, Appendix B, Table II, Column 1 (ODCM Appendix F). These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a MEMBER OF THE PUBLIC either within or outside the SITE BOUNDARY, to annual average concentrations exceeding the limits specified in the "old" 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 whole body and 3000 mrem/year to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a child via the inhalation pathway to less than or equal to 1500 mrem/year.

This CONTROL applies to the release of gaseous effluents from all reactors at the site.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.2 GASEOUS EFFLUENTS (Continued)

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 calculations 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 I, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," Revision 1, July 1977. The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

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 CONTROL 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 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 methods for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 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 dose 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.

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.2 GASEOUS EFFLUENTS (Continued)

3/4.11.2.3 DOSE - IODINE-131, IODINE 133, TRITIUM, AND RADIONUCLIDES IN PARTICULATE FORM (Continued)

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 that any new receptor locations must be on land and not over water to be considered in dose calculations.

3/4.11.2.4 GASEOUS RADWASTE TREATMENT SYSTEM

The requirement that the appropriate portions of this system 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 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objectives given in Section II.0 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 RADIOACTIVE EFFLUENTS

3/4.11.4 TOTAL DOSE

BASES

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 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 and 3.11.2. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

BASES

3/4.12.1 MONITORING PROGRAM

The radiological environmental monitoring program required by this CONTROL provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. The initial specified monitoring program will be effective for at least the first three years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of lower limits of detection (LLDs). The LLDs required by Table 4.12-1 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Detailed discussion of the LLD, and other detection limits, can be found in 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.

3/4.12.2 LAND USE CENSUS

This CONTROL is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the radiological environmental monitoring program are made if required by the results of this census. The best information from the door-to-door survey, aerial survey or consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than $50m^2$ provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 Kg/year) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made: 1) 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and 2) yield of 2 kg/m2.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING (Continued)

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

This requirement for participation in an Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

SECTION 5.0

DESIGN FEATURES

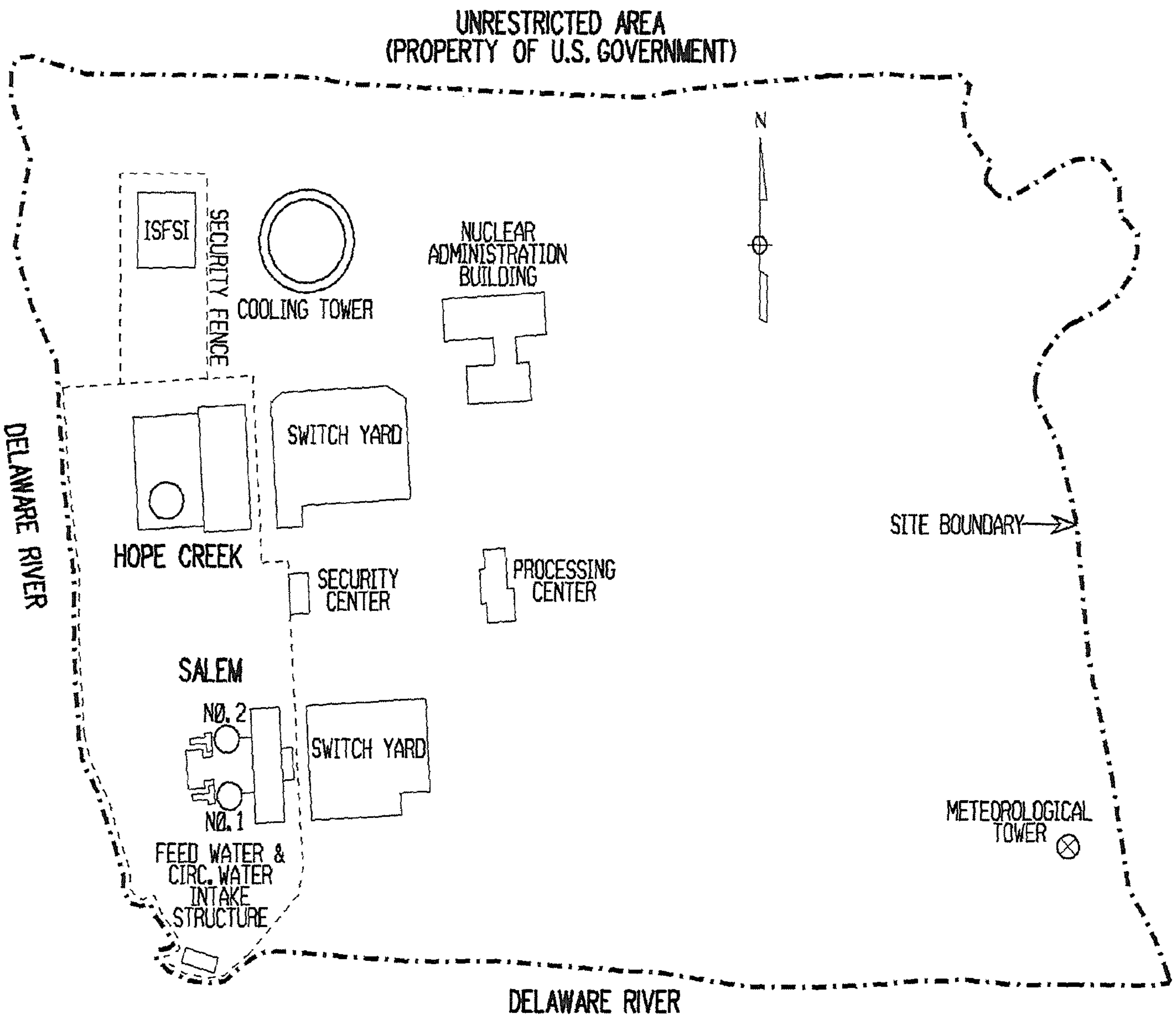
5.0 DESIGN FEATURES

5.1 SITE

5.1.3 UNRESTRICTED AREAS FOR RADIOACTIVE GASEOUS AND LIQUID EFFLUENTS

UNRESTRICTED AREAS within the SITE BOUNDARY that are accessible to MEMBERS OF THE PUBLIC, shall be as shown in Figure 5.1-3. (Provided FOR INFORMATION ONLY. Technical Specifications Section 5.0 is controlling.)

FIGURE 5.1-3: AREA PLOT PLAN OF SITE



SECTION 6.0

ADMINISTRATIVE CONTROLS

6.0 ADMINISTRATIVE CONTROLS

6.9.1.7 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

6.9.1.7 In accordance with Salem Units 1 and 2 Technical Specifications 6.9.1.7, The Annual Radiological Environmental Operating Report* covering the operation of the unit during the previous calendar year shall be submitted prior to May 1 of each year.

The Annual Radiological Environmental Operating Reports shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies with operational controls (as appropriate), and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of land use censuses required by CONTROL 3.12.2. The Annual Radiological Environmental Operating Reports shall include the results of analysis of all radiological environmental samples and of all measurements taken during the period pursuant to the Table and Figures in the environmental radiation section of the ODCM; as well as summarized and tabulated results of locations specified in these analyses and measurements in the format of the table in Reg. Guide 4.8 as amended by Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following: a summary description of the radiological environmental monitoring program; at least two legible maps, one covering sampling locations near the SITE BOUNDARY and a second covering the more distant locations, all keyed to a table giving distances and directions from the midpoint of a line between the centers of Salem Units 1 & 2 containment domes; the results of licensee participation in the Interlaboratory Comparison Program, required by CONTROL 3.12.1; and discussion of all analyses in which the LLD required by Table 4.12-1 was not achievable.

6.9.1.8 RADIOACTIVE EFFLUENT RELEASE REPORT

6.9.1.8 In accordance with Salem Units 1 and 2 Technical Specifications 6.9.1.8, The Annual Radiological Effluent Release Report* covering the operation of the unit during the previous calendar year shall be submitted prior to May 1 of each year and in accordance with the requirements of 10 CFR 50.36a.

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* 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.

6.9.1.8 RADIOACTIVE EFFLUENT RELEASE REPORT (Continued)

The Radioactive Effluent Release Report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit as outlined in Regulatory Guide 1.21. "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof.

The Radioactive Effluent Release Report 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 on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), 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 5.1-3) 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.

The Radioactive Effluent Release Report 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).

The Radioactive Effluent Release Report 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 or MRS. Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in Regulatory Guide 1.109, Rev. 1, October 1977.

6.9.1.8 RADIOACTIVE EFFLUENT RELEASE REPORT (Continued)

The Radioactive Effluent Release Reports 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. Source of waste and processing employed (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 Radioactive Effluent Release Report 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 Radioactive Effluent Release Report 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 CONTROL 3.12.2. for dose calculations or environmental monitoring.

6.15 MAJOR CHANGES TO RADIOACTIVE LIQUID, GASEOUS AND SOLID WASTE TREATMENT SYSTEMS

6.15.1 Licensee initiated major changes to the radioactive waste system (liquid, gaseous and solid):

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 10 CFR50.59;

   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;

6.15 MAJOR CHANGES TO RADIOACTIVE LIQUID, GASEOUS AND SOLID WASTE TREATMENT SYSTEMS (Continued)

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.

2. Shall become effective upon review and acceptance by the PORC.

PART II – CALCULATIONAL METHODOLOGIES

1.0 **LIQUID EFFLUENTS**

1.1 Radiation Monitoring Instrumentation and Controls

The liquid effluent monitoring instrumentation and controls at Salem for controlling and monitoring normal radioactive material releases in accordance with the Salem Technical Specifications 6.8.4.g and ODCM CONTROLS are summarized as follows:

1. Alarm (and Automatic Termination) - 1R18 (Unit 1) and 2R18 (Unit 2) provide the alarm and automatic termination of liquid radioactive material releases as required by ODCM CONTROL 3.3.3.8.

   1R19A, B, C, and D provide the alarm and isolation function for the Unit 1 steam generator blowdown lines. 2R19A, B, C, and D provide this function for Unit 2.

2. Alarm (only) - The alarm functions for the Service Water System are provided by the radiation monitors on the Containment Fan Cooler discharges (1R13A and B for Unit 1 and 2R13A and B for Unit 2).

   Releases from the secondary system are routed through the Chemical Waste Basin where the effluent is monitored (with an alarm function) by R37 prior to release to the environment.

Liquid radioactive release flow diagrams with the applicable, associated radiation monitoring instrumentation and controls are presented as Figures 1-1 and 1-2 for Units 1 and 2, respectively. The Liquid Radioactive Waste System is presented in Figure 1-3.

1.2 Liquid Effluent Monitor Setpoint Determination

Per the requirements of ODCM CONTROL 3.3.3.8, alarm setpoints shall be established for the liquid effluent monitoring instrumentation to ensure that the release concentration limits of ODCM 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 the "old" 10 CFR 20, Appendix B, Table II, Column 2, (ODCM Appendix F) for radionuclides and 2×10^{-4} uCi/ml for dissolved or entrained noble gases).

The following equation* must be satisfied to meet the liquid effluent restrictions:

$$c \leq \frac{C(F + f)}{f} \qquad \textbf{(1.1)}$$

WHERE: C = The effluent concentration limit of ODCM CONTROL 3.11.1.1 (ODCM Appendix F) for the site, in uCi/ml. This implements the "old" 10 CFR 20 MPC values.

c = The setpoint, in uCi/ml, of the radioactivity monitor measuring the radioactivity concentration in the effluent line prior to dilution and subsequent release; the setpoint, represents a value which, if exceeded, would result in concentrations exceeding the limits of the "old" 10 CFR 20 (ODCM Appendix F) in the UNRESTRICTED AREA.

f = The flow rate at the radiation monitor location, in volume per unit time, but in the same units as F, below.

F = The dilution water flow rate as measured prior to the release point, in volume per unit time

[Note that if no dilution is provided, c < C. Also, note that when (F) is large compared to (f), then (F + f) = F.]

* Adapted from NUREG-0133

1.2.1 Liquid Effluent Monitors (Radwaste, Steam Generator Blowdown, Chemical Waste Basin and Service Water

The setpoints for the liquid effluent monitors at the Salem Nuclear Generating Station are determined by the following equations:

$$SP \leq \left[\frac{MPCe * SEN * CW * CF * AF}{RR} \right] + bkg \qquad \textbf{(1.2)}$$

with:

$$MPCe = \frac{\sum_i C_i \ (gamma\ only)}{\sum_i \frac{C_i}{MPC_i} \ (gamma\ only)} \qquad \textbf{(1.3)}$$

WHERE:

SP	=	Alarm setpoint corresponding to the maximum allowable release rate (cpm).
MPCe	=	An effective MPC value for the mixture of gamma emitting radionuclides in the effluent stream (uCi/ml).
C_i	=	The concentration of radionuclide i in the undiluted liquid effluents (uCi/ml).
MPC_i	=	The MPC value corresponding to radionuclide i from the "old" 10 CFR 20, Appendix B, Table II, Column 2, (ODCM Appendix F) (uCi/ml).
SEN	=	The sensitivity value to which the monitor is calibrated (cpm per uCi/ml).
CW	=	The circulating water flow rate (dilution water flow) at the time of release (gal/min).
RR	=	The liquid effluent release rate (gal/min).
bkg	=	The background of the monitor (cpm).
CF	=	Correction factor to account for non-gamma emitting nuclides in setpoint calculations.
AF	=	An allocation factor applicable for steam generator blowdown.

The radioactivity monitor setpoint equation (1.2) remains valid during outages when the circulating water dilution is potentially at its lowest value. Reduction of the waste stream flow (RR) may be necessary during these periods to meet the discharge criteria. However, in order to maximize the available plant discharge dilution and thereby minimize the potential offsite doses, batch releases from either Unit 1 or Unit 2 may be routed to either the Unit 1 or Unit 2 Circulating Water System discharge. Procedural restrictions prevent simultaneous batch releases from either a single unit or both units into a single Circulating Water System discharge.

1.2.2 Conservative Default Values

Conservative alarm setpoints may be determined through the use of default parameters. Tables 1-1.1 and 1-1.2 summarize all current default values in use for Salem Unit 1 and Unit 2, respectively. They are based upon the following:

a. Substitution of the effective MPC value with a default value of 6.05-6 uCi/ml (Unit 1) and 4.81E-6 uCi/ml (Unit 2). (Refer to Appendix A for justification);

b. For additional conservatism*, substitution of the I-131 MPC value of 3-7 uCi/ml for the R19 Steam Generator Blowdown monitors, the R37 Chemical Waste Basin monitor and the R13 Service Water monitors;

c. For conservatism, use of an allocation factor of 0.5 for the Steam Generator Blowdown monitors to limit consequences of potential simultaneous primary-to-secondary leaks in two steam generators.** The allocation factor equals 1.0 for all liquid effluent setpoints;

d. Substitutions of the operational circulating water flow with the lowest flow, in gal/min;***

e. Substitutions of the effluent release rate with the highest allowed rate, in gal/min; and,

f. Substitution of a Correction factor of 0.75 to account for non-gamma emitting nuclides.

For batch liquid releases a fixed alarm setpoint is established for the 1R18 and 2R18 monitors and the release rate is controlled to ensure the inequality of equation 1.1 is maintained. With this approach, values selected for the parameters in the setpoint calculation (e.g., Table 1-1.1 and Table 1-1.2) should be any set of reasonable values that provide a setpoint value reasonably above anticipated monitor response, plus background, so as not to yield spurious alarms. The release rate is controlled to ensure compliance with the requirements of ODCM CONTROL 3.3.3.8.

* Based upon the potential for I-131 to be present in the secondary and service water systems, the use of the default effective MPC (MPCe) value as derived in Appendix A may be non-conservative for the 1R19 and 2R19 SGBD monitors, the R37 Chemical Waste Basin monitor and the R13 Service Water monitors.

** Setpoints using the Allocation Factor of 0.5 become invalid if primary-to-secondary leaks are identified in more than two steam generators simultaneously.

*** The Containment Fan Coil Unit Discharge to Service Water Line is routed to the opposite Unit's Circulating Water System discharge. Therefore, during periods when circulating water pumps are out of service, such as during refueling outages, the default setpoints of the other Unit's R13 radiation monitors are not valid.

Calculations, as performed by Engineering, to establish the actual fixed setpoints for use in the plant, incorporate uncertainties and instrument drift. These factors will cause the actual installed instrument setpoint to be at a lower (conservative) value. However, for batch releases, when the rate is controlled, these uncertainties and drift should not be included in the evaluation of acceptable release rate, since this could cause a non-conservative correction, i.e., a higher allowable release rate. Therefore, for 1R18 and 2R18 monitors, the setpoint value used for calculating the allowable release rate should be that value prior to correction for uncertainty and drift.

1.3 Liquid Effluent Concentration Limits - 10 CFR 20

ODCM CONTROL 3.11.1.1 limits the concentration of radioactive material in liquid effluents (after dilution in the Circulating Water System) to less than the concentrations as specified in the "old" 10 CFR 20, Appendix B, Table II, Column 2, (ODCM Appendix F) for radionuclides other than noble gases. Noble gases are limited to a diluted concentration of 2E-4 uCi/ml.

Release rates are controlled and radiation monitor alarm setpoints are established as addressed above to ensure that these concentration limits are not exceeded. However, in the event any liquid release results in an alarm setpoint being exceeded, an evaluation of compliance with the concentration limits of ODCM CONTROL 3.11.1.1 may be performed using the following equation:

$$\sum_i \left(\frac{C_i}{MPC_i} * \frac{RR}{CW + RR} \right) \leq 1 \qquad (1.4)$$

WHERE: C_i = *Actual concentration of radionuclide i as measured in the* undiluted liquid effluent (uCi/ml).

MPC = The MPC value corresponding to radionuclide i from the "old" 10 CFR 20, Appendix B, Table II, Column 2 (uCi/ml) [ODCM Appendix F].

= 2E-4 uCi/ml for dissolved or entrained noble gases.

RR = The actual liquid effluent release rate (gal/min).

CW = The actual circulating water flow rate (dilution water flow) at the time of the release (gal/min).

1.4 Liquid Effluent Dose Calculation - 10 CFR 50

1.4.1 MEMBER OF THE PUBLIC Dose - Liquid Effluents

ODCM CONTROL 3.11.1.2 limits the dose or dose commitment to MEMBERS OF THE PUBLIC from radioactive materials in liquid effluents from each unit of the Salem Nuclear Generating Station to:

- during any calendar quarter;
  ≤ 1.5 mrem to total body per unit
  ≤ 5.0 mrem to any organ per unit
- during any calendar year;
  ≤ 3.0 mrem to total body per unit
  ≤ 10.0 mrem to any organ per unit.

Per the surveillance requirements of ODCM CONTROL 4.11.1.2, the following calculational methods shall be used for determining the dose or dose commitment due to the liquid radioactive effluents from Salem:

$$D_o = \frac{1.67\text{E}-02 * VOL}{CW} * \sum_i \left(C_i * A_{io} \right) \qquad \textbf{(1.5)}$$

WHERE:

D_o	=	Dose or dose commitment to organ o (mrem). Total body dose can also be calculated using site-related total body dose commitment factor.
A_{io}	=	Site-related ingestion dose commitment factor to the total body or any organ o for radionuclide i (mrem/hr per uCi/ml).
C_i	=	Average concentration of radionuclide i, in undiluted liquid effluent representative of the volume VOL (uCi/ml).
VOL	=	Volume of liquid effluent released (gal)
CW	=	Average circulating water discharge rate during release period (gal/min)
1.672	=	Conversion factor (hr/min)

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

$$A_{io} = 1.14E + 05 * [(UI * BI_i) + (UF * BF_i)] * DF \quad \textbf{(1.6)}$$

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 uCi/ml).

UI = Adult invertebrate consumption (5 kg/yr).

BI_i = Bioaccumulation factor for radionuclide i in invertebrates from Table 1-3 (uCi/g per uCi/L).

UF = Adult fish consumption (21 Kg/yr).

BF_i = Bioaccumulation factor for radionuclide i in fish from Table 1-3 (uCi/g per uCi/l).

DF_{io} = Dose conversion factor for nuclide i for adults in pre-selected organ, o, from Table E-11 of Regulatory Guide 1.109 (mrem/uCi).

1.14E+05 = Conversion factor (pCi/uCi * ml/kg per hr/yr).

The radionuclides included in the periodic dose assessment per the requirements of ODCM 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 ODCM CONTROL 3/4.11.1.1, Table 4.11-1.

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 ODCM CONTROL Table 4.11-1.

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 ODCM CONTROL 3.11.1.2. (Refer to Appendix B for the derivation and justification for this simplified method.)

<u>Total Body</u>

$$D_{tb} = \frac{1.21E+03 * VOL}{CW} * \sum_i C_i \qquad (1.7)$$

<u>Maximum Organ</u>

$$D_{max} = \frac{2.52E+04 * VOL}{CW} * \sum_i C_i \qquad (1.8)$$

WHERE:

C_i	=	Average concentration of radionuclide i, in undiluted liquid effluent representative of the volume VOL (uCi/ml).
VOL	=	Volume of liquid effluent released (gal).
CW	=	Average circulating water discharge rate during release period (gal/min).
D_{tb}	=	Conservatively evaluated total body dose (mrem).
D_{max}	=	Conservatively evaluated maximum organ dose (mrem).
1.21E+03	=	Conversion factor (hr/min) and the total body dose conversion factor for Fe-59 = 7.27E+04 mrem/hr per uCi/ml.
2.52E+04	=	Conversion factor (hr/min) and the conservative maximum organ dose conversion factor for Nb-95 = 1.51E+06 mrem/hr per uCi/ml for GI-LLI.

1.5 <u>Secondary Side Radioactive Liquid Effluents and Dose Calculations During Primary to Secondary Leakage</u>

During periods of primary-to-secondary leakage (i.e., steam generator tube leaks), radioactive material will be transmitted from the primary system to the secondary system. The potential exists for the release of radioactive material to the off-site environment (Delaware River) via secondary system discharges. Potential releases are controlled/monitored by the Steam Generator Blowdown monitors (R19) and the Chemical Waste Basin monitor (R37).

However to ensure compliance with the regulatory limits on radioactive material releases, it may be desirable to account for potential releases from the secondary system during periods of primary-to-secondary leakage. Any potentially significant releases will be via the Chemical Waste Basin with the major source of activity being the Steam Generator Blowdown.

With identified radioactive material levels in the secondary system, appropriate samples should be collected and analyzed for the principal gamma emitting radionuclides. Based on the identified radioactive material levels and the volume of water discharged, the resulting environmental doses may be calculated based on equation (1.5).

Because the release rate from the secondary system is indirect (e.g., SG blowdown is normally routed to condenser where the condensate clean-up system will remove much of the radioactive material), samples should be collected from the release point (i.e., Chemical Waste Basin) for quantifying the radioactive material releases. However, for conservatism and ease of controlling and quantifying all potential release paths, it is prudent to sample the SG blowdown and to assume all radioactive material is released directly to the environment via the Chemical Waste Basin. This approach while not exact is conservative and ensures timely analysis for regulatory compliance. Accounting for radioactive material retention of the condensate clean-up system ion exchange resins may be needed to more accurately account for actual releases.

In addition to the secondary releases described in this section, the Salem Ground Water Remediation System also can potentially discharge radioactive material to the Chemical Waste Basin. To ensure regulatory compliance, the releases are monitored by Radiation Monitor R37. Samples are also collected, and analyzed for radionuclides. Based on the identified radioactive material levels and the volume of water discharged, the resulting environmental doses may be calculated based on equation (1.5).

1.6 Liquid Effluent Dose Projections

ODCM 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 monthly 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 is the ion exchange system as delineated in Figure 1-3. Alternately, the waste evaporator as presented in the Salem FSAR has processing capabilities meeting the NRC ALARA design requirements and may be used in conjunction or in lieu of the ion exchange system for waste processing requirements in accordance with ODCM CONTROL 3.11.1.3. These processing requirements are applicable to each unit individually. Exceeding the projected dose requiring processing prior to release for one unit does not in itself dictate processing requirements for the other unit.

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

$$D_{tbp} = (D_{tb}/d) \; * 31 \, days \qquad \textbf{(1.9)}$$

$$D_{maxp} = (D_{max}/d) \; * 31 \, days \qquad \textbf{(1.10)}$$

WHERE:

D_{tbp}	=	The total body dose projection for current calendar quarter (mrem).
D_{tb}	=	The total body dose to date for current calendar quarter as determined by Equation 1.5 or 1.7 (mrem).
D_{maxp}	=	The maximum organ dose projection for current calendar quarter (mrem).
D_{max}	=	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 to date for current calendar quarter.
31d	=	The number of days for the projection.

2.0 GASEOUS EFFLUENTS

2.1 Radiation Monitoring Instrumentation and Controls

The gaseous effluent monitoring instrumentation and controls at Salem for controlling and monitoring normal radioactive material releases in accordance with the Technical Specifications 6.8.4.g and ODCM CONTROLS are summarized as follows:

1. Waste Gas Holdup System

   The vent header gases are collected by the waste gas holdup system. Gases may be recycled to provide cover gas for the CVCS hold-up tank or held in the waste gas tanks for decay prior to release. Waste gas decay tanks are batch released after sampling and analysis. The tanks are discharged via the Plant Vent. 1-R41D provides noble gas monitoring and automatic isolation of waste gas decay tank releases for Unit 1. This function is provided by 2-R41D for Unit 2.

2. Containment Purge and Pressure/Vacuum Relief

   Containment purges and pressure/vacuum reliefs are released to the atmosphere via the respective unit Plant Vent. Noble gas monitoring and auto isolation function are provided by 1-R41D for Unit 1 and 2-R41D for Unit 2. Additionally, in accordance with ODCM CONTROL 3.3.3.9, Table 3.3-13, 1-R12A and 2-R12A may be used to provide the containment monitoring and automatic isolation function during purge and pressure/vacuum reliefs (*).

3. Plant Vent

   The Plant Vent for each respective unit receives discharges from the waste gas hold-up system, condenser evacuation system, containment purge and pressure/vacuum reliefs, and the Auxiliary Building ventilation. Effluents are monitored by R41D, a flow through gross activity monitor (for noble gas monitoring). Radioiodine and particulate sampling capabilities are provided by charcoal cartridge and filter medium samplers. Additionally, back-up sampling capability for radioiodine and particulates is provided at the 1-R45 and 2-R45 sampling skids. Plant Vent flow rate is measured and as a back-up may be determined empirically as a function of fan operation (fan curves). Sampler flow rates are determined by flow rate instrumentation (e.g., venturi rotameter).

* The R12A monitor in Mode 6 provides containment monitoring and alarm functions without automatic isolation

Gaseous radioactive effluent flow diagrams with the applicable, associated radiation monitoring instrumentation and controls are presented in Figures 2-1. A simplified diagram of the Gaseous radioactive waste disposal system is provided in Figure 2-2.

2.2 Gaseous Effluent Monitor Setpoint Determination

2.2.1 Containment and Plant Vent Monitor

Per the requirements of ODCM CONTROL 3.3.3.9, 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 ODCM 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., grab sample of the Containment atmosphere, waste gas decay tank, or Plant Vent), 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 Specification 3.11.2.1, by the equation:

$$FRAC = \left[4.72\mathrm{E}+02 * \chi/Q * VF * \sum_i (C_i * K_i) \right] / 500 \qquad \textbf{(2.1)}$$

$$FRAC = \left[4.72\mathrm{E}+02 * \chi/Q * VF * \sum_i (C_i * (L_i + 1.1 M_i)) \right] / 3000 \qquad \textbf{(2.2)}$$

WHERE:

FRAC	=	Fraction of the allowable release rate based on the identified radionuclide concentrations and the release flow rate.
χ/Q	=	Annual average meteorological dispersion to the controlling. site boundary location (sec/m^3)
VF	=	Ventilation system flow rate for the applicable release point and monitor (ft^3/min).
C_i	=	Concentration of noble gas radionuclide i as determined by radioanalysis of grab sample (uCi/cm^3).
K_i	=	Total body dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m^3 from Table 2-1).
L_i	=	Beta skin dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m^3 from Table 2-1).
M_i	=	Gamma air dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m^3 from Table 2-1).
1.1	=	mrem skin dose per mrad gamma air dose (mrem/mrad).
500	=	Total body dose rate limit (mrem/yr).
3000	=	Skin dose rate limit (mrem/yr).
4.72 E+02	=	Conversion factor (cm^3/ft^3 * min/sec).

Based on the more limiting FRAC (i.e., higher value) as determined above, the alarm setpoints for the applicable monitors (R41D and/or R12A) may be calculated by the equation:

$$SP = \left[AF * \frac{\sum_i C_i * SEN}{FRAC} \right] + bkg \tag{2.3}$$

WHERE:

SP	=	Alarm setpoint corresponding to the maximum allowable release rate (cpm).
SEN	=	Monitor sensitivity (cpm per uCi/cm^3).
bkg	=	Background of the monitor (cpm).
AF	=	Administrative allocation factor for the specific monitor and type release, which corresponds to the fraction of the total allowable release rate that is administratively allocated to the release.

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 ODCM CONTROL 3.11.2.1). Normally, the combined AF value for Salem Units 1 and 2 is equal to 0.5 (0.25 per unit), with the remainder 0.5 allocated to Hope Creek. Any increase in AF above 0.5 for the Salem Nuclear Generating Station will be coordinated with the Hope Creek 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 2-2.1 and 2-2.2 for Units 1 and 2, respectively. These values are based upon:

- the maximum ventilation (or purge) flow rate;
- a radionuclide distribution comprised of 95% Xe-133, 2% Xe-135, 1% Xe-133m, 1% Kr-88 and 1% Kr-85; and
- an administrative allocation factor of 0.25 to conservatively ensure that any simultaneous releases from Salem Units 1 and 2 do not exceed the maximum allowable release rate. For this radionuclide distribution, the alarm setpoint based on the total body dose rate is more restrictive than the corresponding setpoint based on the skin dose rate.

a. Adopted from ANSI N237-1976/ANS-18.1, Source Term Specifications, Table 6.

2.3 Gaseous Effluent Instantaneous Dose Rate Calculations - 10 CFR 20

2.3.1 Boundary Dose Rate - Noble Gases

ODCM CONTROL 3.11.2.1.a 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 being exceeded, an evaluation of the SITE BOUNDARY dose rate resulting from the release shall be performed using the following equations:

$$D_{tb} = \chi/Q * \sum_i (K_i * Q_i) \quad \textbf{(2.4)}$$

and

$$D_s = \chi/Q * \sum_i ((L_i + 1.1M_i) * Q_i) \quad \textbf{(2.5)}$$

WHERE:

D_{tb}	=	Total body dose rate (mrem/yr).
D_s	=	Skin dose rate (mrem/yr).
χ/Q	=	Atmospheric dispersion to the controlling SITE BOUNDARY location (sec/m^3).
Q_i	=	Average release rate of radionuclide i over the release period under evaluation (uCi/sec).
K_i	=	Total body dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m^3, from Table 2-1).
L_i	=	Beta skin dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m^3, from Table 2-1).
M_i	=	Gamma air dose conversion factor for noble gas radionuclide i (mrad/yr per uCi/m^3, from Table 2-1).
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 ODCM CONTROL 3.11.2.1a, following any release 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 limits of ODCM CONTROL 3.11.2.1.a. 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 ODCM CONTROL 3.11.2.1.a.

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

ODCM CONTROL 3.11.2.1.b limits the dose rate to $\leq$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:

$$D_o = \chi/Q * \sum_i (R_{io} * Q_i) \quad \textbf{(2.6)}$$

WHERE: D_o = Average organ dose rate over the sampling time period (mrem/yr).

χ/Q = Atmospheric dispersion to the controlling SITE BOUNDARY location for the inhalation pathway (sec/m^3).

R_{io} = Dose parameter for radionuclide i (mrem/yr per uCi/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-13l, I-133, tritium or other radionuclide in particulate form with half-life greater than 8 days (uCi/sec).

By substituting 1500 mrem/yr for D_o and solving for Q, 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_{io} = 1.62E+07 mrem/yr per uCi/m^3), the allowable release rate for I-131 is 42 uCi/sec. Reducing this release rate by a factor of 4 to account for potential dose contributions from other radioactive particulate material and other release points (e.g., Hope Creek), the corresponding release rate allocated to each of the Salem units is 10.5 uCi/sec.

For a 7 day period, which is the nominal sampling and analysis frequency for I-131, the cumulative release is 6.3 Ci. Therefore, as long as the I-131 releases in any 7 day period do not exceed 6.3 Ci, no additional analyses are needed for verifying compliance with the ODCM 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

ODCM CONTROL 3.11.2.2 requires a periodic assessment of releases of noble gases to evaluate compliance with the quarterly dose limits of $\leq$5 mrad, gamma-air and $\leq$10 mrad, beta-air and the calendar year limits $\leq$10 mrad, gamma-air and $\leq$20 mrad, beta-air. The limits are applicable separately to each unit and are not combined site limits. The following equations shall be used to calculate the gamma-air and beta-air doses:

$$D\gamma = 3.17\text{E-}08 * \chi/Q * \sum_i (M_i * Q_i) \qquad \textbf{(2.7)}$$

and

$$D\beta = 3.17\text{E-}08 * \chi/Q * \sum_i (N_i * Q_i) \qquad \textbf{(2.8)}$$

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).
χ/Q	=	Atmospheric dispersion to the controlling SITE BOUNDARY location (sec/m^3).
Q_i	=	Cumulative release of noble gas radionuclide i over the period of interest (uCi) where uCi = (uCi/cc)*(cc released) or (uCi/sec)*(sec released).
M_i	=	Air dose factor due to gamma emissions from noble gas radionuclide i (mrad/yr per uCi/m^3, from Table 2-1).
N_i	=	Air dose factor due to beta emissions from noble gas radionuclide i (mrad/yr per uCi/m^3, Table 2-1).
3.17E-8	=	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 ODCM CONTROL 3.11.2.2. (Refer to Appendix C for the derivation and justification for this simplified method and for values of M_{eff}, and N_{eff}.)

$$D\gamma = \frac{3.17\text{E-}08}{0.50} * \chi/Q * M_{eff} * \sum_i Q_i \qquad \textbf{(2.9)}$$

and

$$D\beta = \frac{3.17\text{E-}08}{0.50} * \chi/Q * N_{eff} * \sum_i Q_i \qquad \textbf{(2.10)}$$

WHERE: M_{eff} = 5.3E+02, effective gamma-air dose factor (mrad/yr per uCi/m^3).

N_{eff} = 1.1E+03, effective beta-air dose factor (mrad/yr per uCi/m^3).

Q_i = Cumulative release for all noble gas radionuclides (uCi), where uCi = (uCi/cc) * (cc released) or (uCi/sec) * (sec released).

0.50 = 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 requirements of ODCM 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 <15 mrem to any organ. The following equation shall be used to evaluate the maximum organ dose due to releases of I-131, I-133, tritium and particulates with half-lives greater than 8 days:

$$D_{aop} = 3.17\text{E-}08 * W * SF_p * \sum_i \left(R_{iop} * Q_i\right) \quad \textbf{(2.11)}$$

WHERE:

D_{aop} = Dose or dose commitment via all pathways p and controlling 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.

χ/Q = Atmospheric dispersion for inhalation pathway, C-14, and H-3 dose contribution via other pathways (sec/m^3).

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

R_{iop} = Dose factor for radionuclide i (mrem/yr per uCi/m^3) or (m^2 - mrem/yr per uCi/sec) and organ o from Table 2-4 for each age group and the applicable pathway p as identified in Table 2-3. Values for R_{iop} 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, tritium, or radioactive material in particulate form with half-life greater than 8 days (uCi).

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

1. For milk and vegetation exposure pathways: A six month fresh vegetation and grazing season (May through October) = 0.5
2. For inhalation and ground plane exposure pathways: = 1.0

For evaluating the maximum exposed individual, only the controlling pathways and age group as identified in Table 2-3 need be evaluated for compliance with ODCM 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, tritium, 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 ODCM CONTROL 3.11.2.3 (refer to Appendix D for the derivation and justification of this simplified method).

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

WHERE: D_{max} = Maximum organ dose (mrem).

R_{I-131} = I-131 dose parameter for the thyroid for the identified controlling pathway.

= 1.05E+12, infant thyroid dose parameter with the grass-cow-milk pathway controlling (m^2 - mrem/yr per uCi/sec).

W = D/Q for radioiodine, 2.1-10 $1/m^2$.

Q_i = Cumulative release over the period of interest for radionuclide i - I-131, tritium, or radioactive material in particulate from with half-life greater than 8 days (uCi).

The dose should be evaluated based on the predetermined controlling pathways as identified in Table 2-3. If more limiting exposure pathways are determined to exist in the surrounding environment of Salem by the annual land-use census, Table 2-3 will be revised as specified in ODCM CONTROL 3.12.2.

2.6 Secondary Side Radioactive Gaseous Effluents and Dose Calculations

During periods of primary to secondary leakage, minor levels of radioactive material may be released via the secondary system to the atmosphere. Non-condensables (e.g., noble gases) will be predominately released via the condenser evacuation system and will be monitored and quantified by the routine plant vent monitoring and sampling system and procedures (e.g., R15 on condenser evacuation, R41D on plant vent, and the plant vent particulate and charcoal samplers).

However, if the Steam Generator blowdown is routed directly to the Chemical Waste Basin (via the SG blowdown flash tank) instead of being recycled through the condenser, it may be desirable to account for the potential atmospheric releases of radioiodines and particulates from the flash tank vent (i.e., releases due to moisture carry over). Since this pathway is not sampled or monitored, it is necessary to calculate potential releases.

Based on the guidance in NRC NUREG-0133, the releases of the radioiodines and particulates shall be calculated by the equation:

$$Q_i = C_i * R_{sgb} * F_{ft} * (1 - SQ_{ftv}) \quad \textbf{(2.13)}$$

WHERE: Q_i = The release rate of radionuclide, i, from the steam generator flash tank vent (uCi/sec).

C_i = The concentration of radionuclide, i, in the secondary coolant water averaged over not more than one week (uCi/ml).

R_{sgb} = The steam generator blowdown rate to the flash tank (ml/sec).

F_{ft} = The fraction of blowdown flashed in the tank determined from a heat balance taken around the flash tank at the applicable reactor power level.

SQ_{ftv} = The measured steam quality in the flash tank vent; or an assumed value of 0.85, based on NUREG-0017.

Tritium releases via the steam flashing may also be quantified using the above equation with the assumption of a steam quality (SQ_{ftv}) equal to 0. Since the H-3 will be associated with the water molecules, it is not necessary to account for the moisture carry-over which is the transport media for the radioiodines and particulates.

Based on the design and operating conditions at Salem, the fraction of blowdown converted to steam (F_{ft}) is approximately 0.48. The equation simplifies to the following:

$$Q_i = 0.072 * C_i * R_{sgb} \quad \textbf{(2.14)}$$

For H-3, the simplified equation is:

$$Q_i = 0.48 * C_i * R_{sgb} \quad \textbf{(2.15)}$$

Also during reactor shutdown operations with a radioactively contaminated secondary system, radioactive material may be released to the atmosphere via the atmospheric reliefs (PORV) and the safety reliefs on the main steam lines and via the steam driven auxiliary feed pump exhaust. The evaluation of the radioactive material concentration in the steam relative to that in the steam generator water is based on the guidance of NUREG-0017, Revision 1. The partitioning factors for the radioiodines is 0.01 and is 0.005 for all other particulate radioactive material. The resulting equation for quantifying releases via the atmospheric steam releases is:

$$Q_{ij} = 0.13 * \left(C_{ij} * SF_j\right) * PF_i \quad \textbf{(2.16)}$$

WHERE:

Q_{ij}	=	Release rate of radionuclide i via pathway j, (uCi/sec).
C_{ij}	=	Concentration of radionuclide i, in pathway j, (uCi/ml).
SF_j	=	Steam flow for release pathway j.
	=	400,000 lb/hr per PORV.
	=	850,000 lb/hr per safety relief valve.
	=	62,500 lb/hr for auxiliary feed pump exhaust.
PF_i	=	Partitioning factor, ratio of concentration in steam to that in the water in the steam generator.
	=	0.01 for radioiodines.
	=	0.005 for all other particulates.
	=	1.0 for H-3.
0.13	=	Conversion factor - [(hr*ml) / (sec*lb)].

Any significant releases of noble gases via the atmospheric steam releases can be quantified in accordance with the calculation methods of the Salem Emergency Plan Implementation Procedure.

Alternately, the quantification of the release rate and cumulative releases may be based on secondary samples. The measured radionuclide concentration in the secondary system may be used for quantifying the noble gases, radioiodine and particulate releases.

NOTE: The expected mode of operation would be to isolate the effected steam generator, thereby reducing the potential releases during the shutdown/cooldown process. Use of the above calculation methods should consider actual operating conditions and release mechanisms.

The calculated quantities of radioactive materials may be used as inputs to the equation (2.11) or (2.12) to calculate offsite doses for demonstrating compliance with the Technical Specifications 6.8.4.g and the ODCM CONTROLS.

2.7 Gaseous Effluent Dose Projection

ODCM CONTROL 3.11.2.4 requires that the GASEOUS RADWASTE TREATMENT SYSTEM and VENTILATION EXHAUST TREATMENT SYSTEM be used to reduce radioactive material levels prior to discharge when projected doses exceed one-half the annual design objective rate in any calendar month, i.e., exceeding:

- 0.2 mrad in air from gamma radiation, or
- 0.4 mrad in air from beta radiation or,
- 0.3 mrad to any organ to a MEMBER OF THE PUBLIC.

The applicable gaseous processing systems for maintaining radioactive material releases ALARA are the Auxiliary Building normal ventilation system (filtration systems # 1, 2 and 3) and the Waste Gas Decay Tanks as delineated in Figures 2-1 and 2-2. Dose projections are performed at least once per 31 days by the following equations:

$$D_{gp} = (D_g/d) * 31d \quad \textbf{(2.17)}$$

$$D_{dp} = (D_d/d) * 31d \quad \textbf{(2.18)}$$

$$D_{maxp} = (D_{max}/d) * 31d \quad \textbf{(2.14)}$$

WHERE:

D_{gp} = Gamma air dose projection for current 31-day period (mrad).

D_g = Max gamma air dose to date for current calendar quarter as determined by equation (2.7) or (2.9) (mrad).

D_{bp} = Beta air dose projection for current 31-day period (mrad).

D_b = 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.

31d = The number of days for the projection.

3.0 SPECIAL DOSE ANALYSES

3.1 Doses Due To Activities Inside the SITE BOUNDARY

In accordance with ODCM CONTROL 6.9.1.8, the Radioactive Effluent Release Report (RERR) 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 year meteorological data.

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

The Radioactive Effluent Release Report (RERR) 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 sources (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 Nuclear Generating Station and the Hope Creek Nuclear 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 Hope Creek Nuclear Generating Station will be estimated based on the methods as presented in the Hope Creek Offsite Dose Calculation Manual (HCGS ODCM).

As appropriate for demonstrating/evaluating compliance with the limits of ODCM 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 ODCM CONTROL 3/4.11.4 and the reporting requirements of 6.9.1.8 (RERR), dose calculations for the Salem Nuclear Generating Station should be performed using the controlling pathways and locations of Table 2-3 and the calculation methods contained within this ODCM. If more limiting exposure pathways are determined to exist in the surrounding environment of Salem by the annual land-use census, Table 2-3 will be revised as specified in ODCM CONTROL 3.12.2.

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., PD, 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 Salem 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 where the direct exposure contribution is potentially significant, on-site measurements, off-site measurements and/or calculation techniques will be used for determination of dose for assessing 40 CFR 190 or 10 CFR 72.104 compliance.

3.3 <u>Doses Due to Carbon 14 in Gaseous Effluents</u>

Because gaseous effluent releases from a pressurized water reactor (PWR), such as the Salem Generating Station, can contain significant quantities of C-14 (i.e., approximately 5 to 7.3 curies annually – Regulatory Guide 1.21 rev 2), 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 Salem Generating Station.

3.3.1 Estimation of Carbon 14 in Annual Releases

The methodology for estimating the quantity C-14 released annually from the Salem 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.

3.3.2 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.

4.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

4.1 Sampling Program

The operational phase of the Radiological Environmental Monitoring Program (REMP) is conducted in accordance with the requirements of ODCM CONTROL 3.12. The objectives of the program are:

- To determine whether any significant increases occur in the concentration of radionuclides in the critical pathways of exposure in the vicinity of Artificial Island;
- To determine if the operation of the Salem Nuclear Generating Stations has resulted in any increase in the inventory of long lived radionuclides in the environment;
- To detect any changes in the ambient gamma radiation levels; and
- To verify that SNGS operations have no detrimental effects on the health and safety of the public or on the environment.

The sampling requirements (type of samples*, collection frequency and analysis) and sample locations are presented in Appendix E.

*NOTE: No public drinking water samples or irrigation water samples are required as these pathways are not directly affected by liquid effluents discharged from Salem Generating Station.

4.2 Interlaboratory Comparison Program

ODCM CONTROL 3.12.3 requires analyses be performed on radioactive material supplied as part of an Interlaboratory Comparison Program. Participation in an approved Interlaboratory Comparison Program provides a check on the precision and accuracy of measurements of radioactive materials in environmental samples.

A summary of the Interlaboratory Comparison Program results will be provided in the Annual Radiological Environmental Operating Report pursuant to ODCM CONTROL 6.9.1.7.

FIGURE 1-1: LIQUID RELEASE FLOWPATH UNIT 1

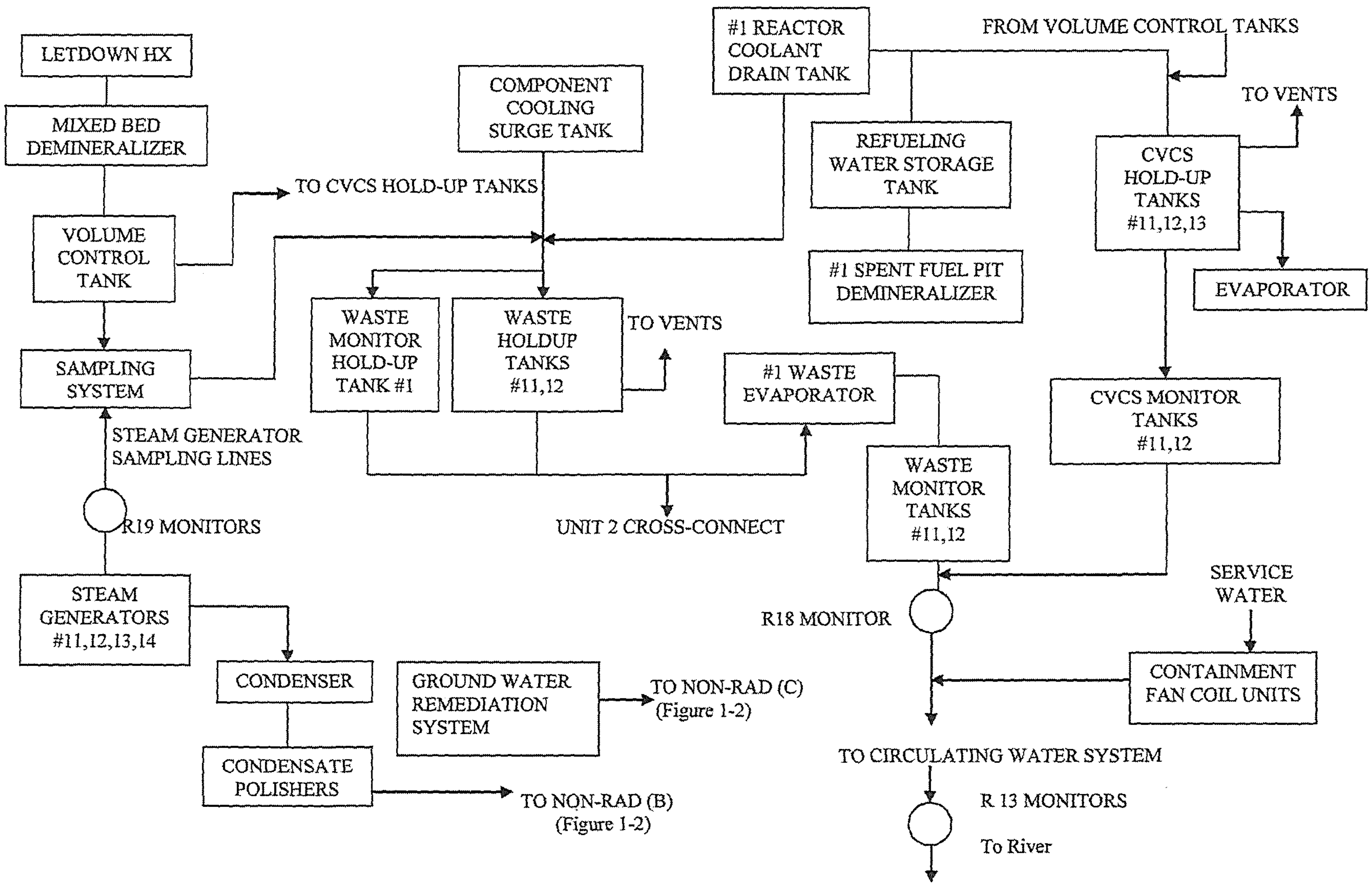


FIGURE 1-2: LIQUID RELEASE FLOWPATH UNIT 2

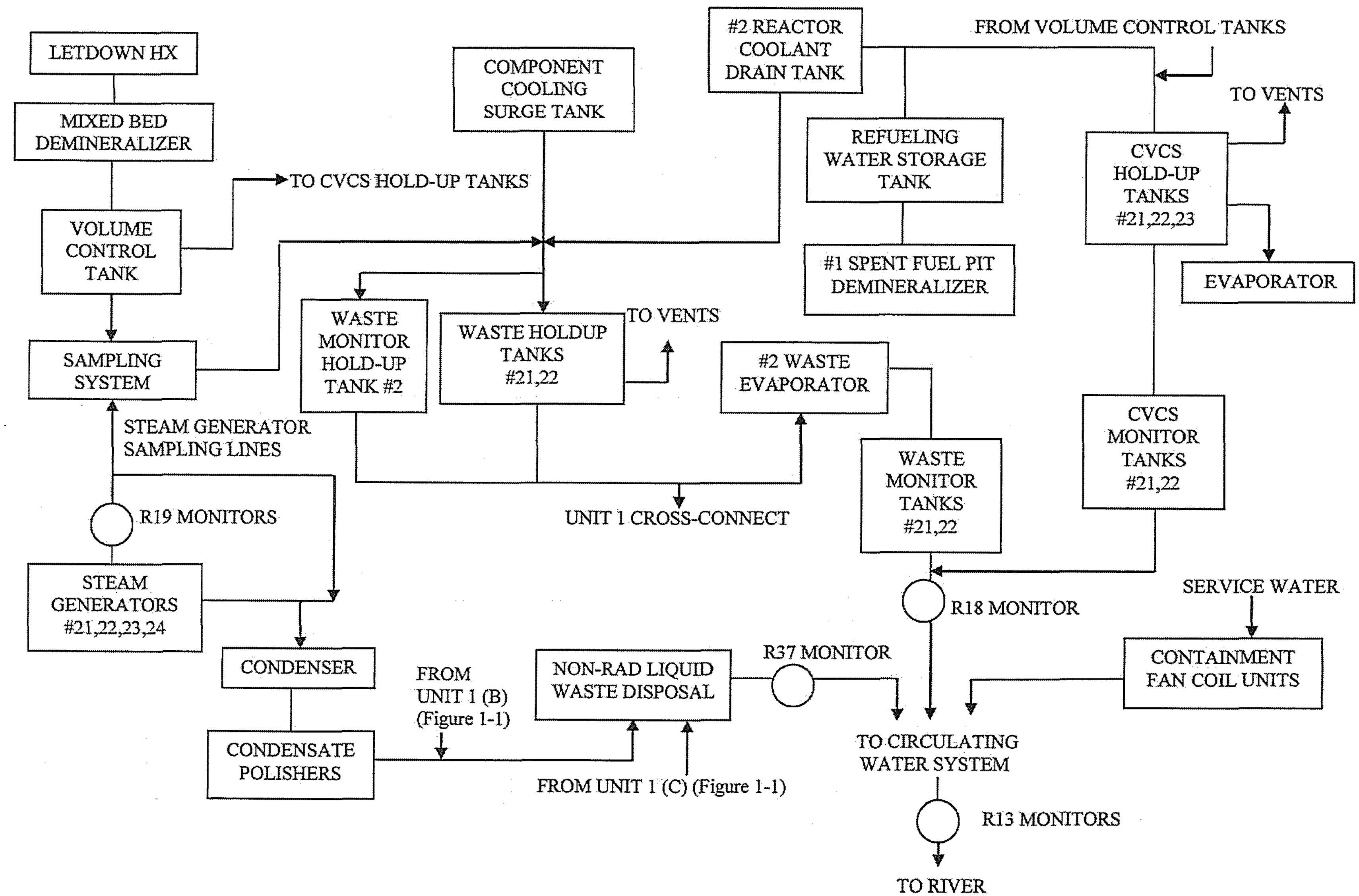


FIGURE 1-3: LIQUID RADIOACTIVE WASTE SYSTE

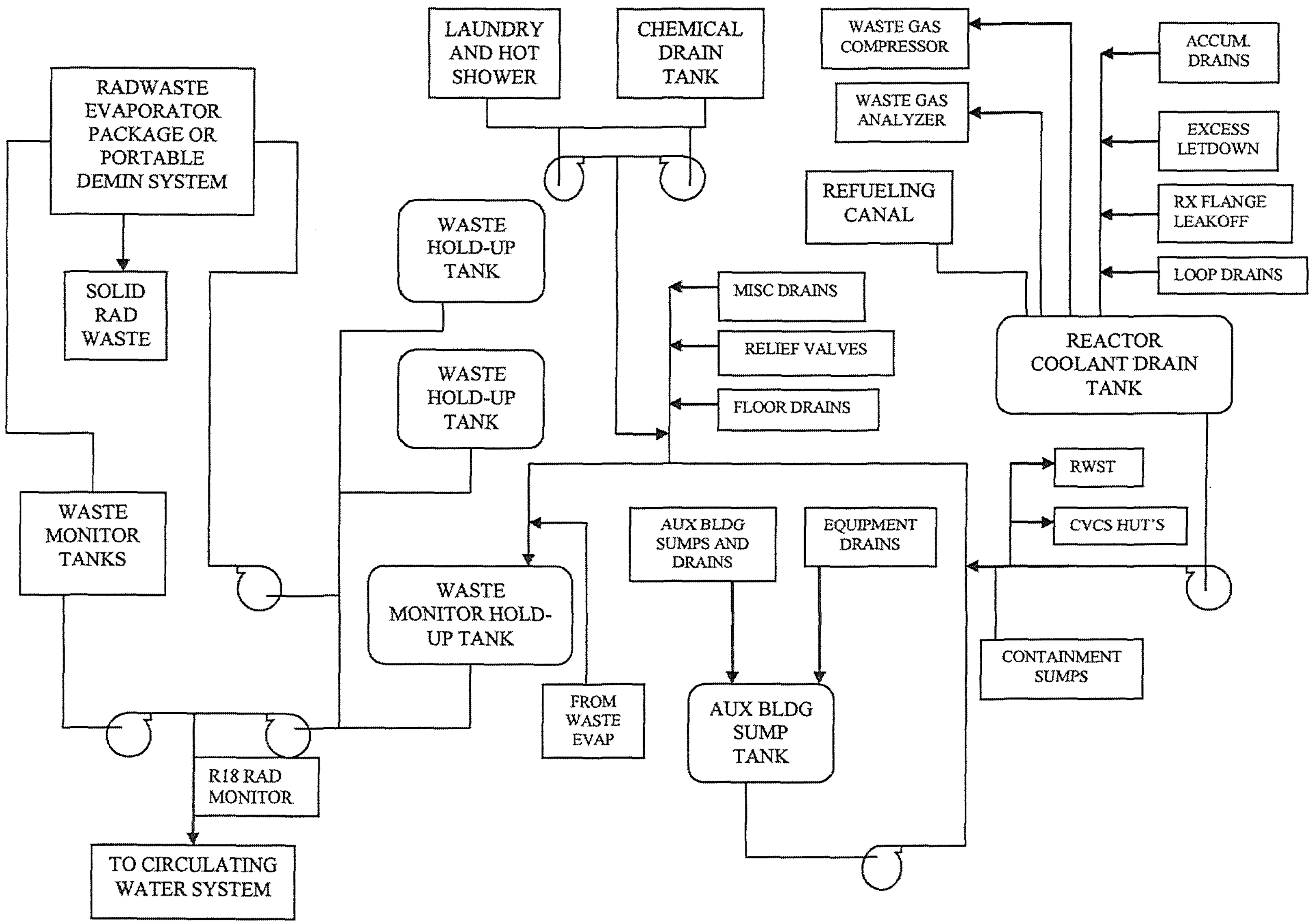


TABLE 1-1.1: PARAMETERS FOR LIQUID ALARM SETPOINT DETERMINATIONS - UNIT 1

Parameter	Actual Value	Default Value	Units	Comments
MPC_e	Calculated	6.05E-06*	uCi/ml	Calculated for each batch to be released.
MPC I-131	3.0E-07	N.A.	uCi/ml	I-131 MPC conservatively used for SG blowdown and Service Water monitor setpoints.
C_i	Measured	N.A.	uCi/ml	Taken from gamma spectral analysis of liquid effluent.
MPC_i	as determined	N.A.	uCi/ml	Taken from old 10 CFR 20, Appendix B, Table II, Col 2 (ODCM Appendix F).
Sensitivity 1-R18 1-R19 (A,B,C,D) 1-R13 (A and B)	as determined	N.A.	cpm per uCi/ml	Monitor sensitivities are controlled under the following calculations: S-1-RM-SC-4335 S-1-RM-SC-1626 SC-RM021-01
CW	as determined	1.00E+05	gpm	Circulating water system – single CW pump ***
RR 1-R18 1-R19 1-R13	as determined	 120 250 1.00 E +05	gpm	Determined prior to release; release rate can be adjusted for ODCM CONTROL compliance Steam Generator blowdown rate per Generator Circulating Water System, single CW pump ***
Setpoint 1-R18 1-R19 (A,B,C,D)** 1-R13 (A and B)**	Calculated	N.A.	cpm	Monitor setpoints are controlled under the following calculations: S-1-RM-SC-4335 S-1-RM-SC-1626 SC-RM021-01
Correction Factor (Non-Gamma)	as determined	0.75	Unitless	Default parameter to account for non-gamma emitting nuclides.
Allocation Factor 1-R19	0.5	0.5	Unitless	Conservatism factor to preclude exceeding MPC limit in the case of simultaneous primary-to-secondary leaks at both Salem Units,

* Refer to Appendix A for derivation.

** The MPC value of I-131 (3E-07 uCi/ml) has been used for derivation of R19 Steam Generator Blowdown and R13 Service Water monitor setpoints as discussed in Section 1.2.2.

*** During periods when Unit 2 Circulators are out of service, the CW flow for 1-R13 monitors is zero. See Section 1.2.2.

TABLE 1-1.2: PARAMETERS FOR LIQUID ALARM SETPOINT DETERMINATIONS - UNIT 2

Parameter	Actual Value	Default Value	Units	Comments
MPC_e	Calculated	4.81E-06*	uCi/ml	Calculated for each batch to be released.
MPC I-131	3.0E-07	N.A.	uCi/ml	I-131 MPC conservatively used for SG blowdown, Service Water and Chemical Waste Basin monitor setpoints.
C_i	Measured	N.A.	uCi/ml	Taken from gamma spectral analysis of liquid effluent.
MPC_i	as determined	N.A.	uCi/ml	Taken from old 10 CFR 20, Appendix B, Table II, Col. 2 (ODCM Appendix F)
Sensitivity 2-R18 2R19(A,B,C,D) 2-R13(A and B) R37	as determined	N.A.	cpm per uCi/ml	Monitor sensitivities are controlled under the following calculations: S-2-RM-SC-4335 SC-RM002-08 SC-RM021-02 S-2-RM-SC-9864
CW	as determined	1.0E+05	gpm	Circulating Water System, single CW pump ***
RR 2-R18 2-R19 2-R13 R37	as determined	120 250 1.0E+05 1200	gpm	Determined prior to release; release rate can be adjusted for ODCM CONTROL Compliance Steam Generator Blowdown rate per Generator Circulating Water System, single CW Pump Chemical Waste Basin discharge
Setpoint 2-R18 2R19(A,B,C,D)** 2-R13(A and B)** R37 **	Calculated	N.A.	cpm	Monitor setpoints are controlled under the following calculations: S-2-RM-SC-4335 SC-RM002-08 SC-RM021-02 S-2-RM-SC-9864
Correction Factor (Non-Gamma)	as determined	0.75	Unitless	Default parameter to account for non-gamma emitting nuclides.
Allocation Factor 2-R19	0.5	0.5	Unitless	Conservatism factor to preclude exceeding MPC limit in the case of simultaneous primary-to-secondary leaks at both Salem Units

* Refer to Appendix A for derivation.

** The MPC value of I-131 (3E-7 uCi/ml) has been used for derivation of the R13, R19 and R37 monitor setpoints as discussed in Section 1.2.2.

*** During periods when Unit 1 Circulators are out of service, the CW flow for 2-R13 monitors is zero. See Section 1.2.2.

TABLE 1-2: SITE RELATED INGESTION DOSE COMMITMENT FACTOR, A_{io} (FISH AND INVERTEBRATE CONSUMPTION) (mrem/hr per uCi/ml)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	2.82E-1	2.82E-1	2.82E-1	2.82E-1	2.82E-1	2.82E-1
C-14	1.45E+4	2.90E+3	2.90E+3	2.90E+3	2.90E+3	2.90E+3	2.90E+3
Na-24	4.57E-1	4.57E-1	4.57E-1	4.57E-1	4.57E-1	4.57E-1	4.57E-1
P-32	4.69E+6	2.91E+5	1.81E+5	-	-	-	5.27E+5
Cr-51	-	-	5.58E+0	3.34E+0	1.23E+0	7.40E+0	1.40E+3
Mn-54	-	7.06E+3	1.35E+3	-	2.10E+3	-	2.16E+4
Mn-56	-	1.78E+2	3.15E+1	-	2.26E+2	-	5.67E+3
Fe-55	5.11E+4	3.53E+4	8.23E+3	-	-	1.97E+4	2.03E+4
Fe-59	8.06E+4	1.90E+5	7.27E+4	-	-	5.30E+4	6.32E+5
Co-57	-	1.42E+2	2.36E+2	-	-	-	3.59E+3
Co-58	-	6.03E+2	1.35E+3	-	-	-	1.22E+4
Co-60	-	1.73E+3	3.82E+3	-	-	-	3.25E+4
Ni-63	4.96E+4	3.44E+3	1.67E+3	-	-	-	7.18E+2
Ni-65	2.02E+2	2.62E+1	1.20E+1	-	-	-	6.65E+2
Cu-64	-	2.14E+2	1.01E+2	-	5.40E+2	-	1.83E+4
Zn-65	1.61E+5	5.13E+5	2.32E+5	-	3.43E+5	-	3.23E+5
Zn-69m	5.66E+3	1.36E+4	1.24E+3	-	8.22E+3	-	8.29E+5
As-76	4.38E+2	1.16E+3	5.14E+3	3.42E+2	1.39E+3	3.58E+2	4.30E+4
Br-82	-	-	4.07E+0	-	-	-	4.67E+0
Br-83	-	-	7.25E-2	-	-	-	1.04E-1
Br-84	-	-	9.39E-2	-	-	-	7.37E-7
Br-85	-	-	3.86E-3	-	-	-	-
Rb-86	-	6.24E+2	2.91E+2	-	-	-	1.23E+2
Rb-88	-	1.79E+0	9.49E-1	-	-	-	2.47E-11
Rb-89	-	1.19E+0	8.34E-1	-	-	-	6.89E-14
Sr-89	4.99E+3	-	1.43E+2	-	-	-	8.00E+2
Sr-90	1.23E+5	-	3.01E+4	-	-	-	3.55E+3
Sr-91	9.18E+1	-	3.71E+0	-	-	-	4.37E+2
Sr-92	3.48E+1	-	1.51E+0	-	-	-	6.90E+2
Y-90	6.06E+0	-	1.63E-1	-	-	-	6.42E+4
Y-91m	5.73E-2	-	2.22E-3	-	-	-	1.68E-1
Y-91	8.88E+1	-	2.37E+0	-	-	-	4.89E+4
Y-92	5.32E-1	-	1.56E-2	-	-	-	9.32E+3
Y-93	1.69E+0	-	4.66E-2	-	-	-	5.35E+4
Zr-95	1.59E+1	5.11E+0	3.46E+0	-	8.02E+0	-	1.62E+4
Zr-97	8.81E-1	1.78E-1	8.13E-2	-	2.68E-1	-	5.51E+4
Nb-95	4.47E+2	2.49E+2	1.34E+2	-	2.46E+2	-	1.51E+6
Nb-97	3.75E+0	9.49E-1	3.46E-1	-	1.11E+0	-	3.50E+3
Mo-99	-	1.28E+2	2.43E+1	-	2.89E+2	-	2.96E+2
Tc-99m	1.30E-2	3.66E-2	4.66E-1	-	5.56E-1	1.79E-2	2.17E+1
Tc-101	1.33E-2	1.92E-2	1.88E-1	-	3.46E-1	9.81E-3	5.77E-14

TABLE 1-2: SITE RELATED INGESTION DOSE COMMITMENT FACTOR, A_{io} (FISH AND INVERTEBRATE CONSUMPTION) (mrem/hr per uCi/ml) (Continued)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	1.07E+2	-	4.60E+1	-	4.07E+2	-	1.25E+4
Ru-105	8.89E+0	-	3.51E+0	-	1.15E+2	-	5.44E+3
Ru-106	1.59E+3	-	2.01E+2	-	3.06E+3	-	1.03E+5
Ag-110m	1.56E+3	1.45E+3	8.60E+2	-	2.85E+3	-	5.91E+5
Sb-122	1.98E+1	4.55E-1	6.82E+0	3.06E-1	-	1.19E+1	7.51E+3
Sb-124	2.77E+2	5.23E+0	1.10E+2	6.71E-1	-	2.15E+2	7.86E+3
Sb-125	1.77E+2	1.98E+0	4.21E+1	1.80E-1	-	1.36E+2	1.95E+3
Sb-126	1.14E+2	2.31E+0	4.10E+1	6.96E-1	-	6.97E+1	9.29E+3
Te-125m	2.17E+2	7.86E+1	2.91E+1	6.52E+1	8.82E+2	-	8.66E+2
Te-127m	5.48E+2	1.96E+2	6.68E+1	1.40E+2	2.23E+3	-	1.84E+3
Te-127	8.90E+0	3.20E+0	1.93E+0	6.60E+0	3.63E+1	-	7.03E+2
Te-129m	9.31E+2	3.47E+2	1.47E+2	3.20E+2	3.89E+3	-	4.69E+3
Te-129	2.54E+0	9.55E-1	6.19E-1	1.95E+0	1.07E+1	-	1.92E+0
Te-131m	1.40E+2	6.85E+1	5.71E+1	1.08E+2	6.94E+2	-	6.80E+3
Te-131	1.59E+0	6.66E-1	5.03E-1	1.31E+0	6.99E+0	-	2.26E-1
Te-132	2.04E+2	1.32E+2	1.24E+2	1.46E+2	1.27E+3	-	6.24E+3
I-130	3.96E+1	1.17E+2	4.61E+1	9.91E+3	1.82E+2	-	1.01E+2
I-131	2.18E+2	3.12E+2	1.79E+2	1.02E+5	5.35E+2	-	8.23E+1
I-132	1.06E+1	2.85E+1	9.96E+0	9.96E+2	4.54E+1	-	5.35E+0
I-133	7.45E+1	1.30E+2	3.95E+1	1.90E+4	2.26E+2	-	1.16E+2
I-134	5.56E+0	1.51E+1	5.40E+0	2.62E+2	2.40E+1	-	1.32E-2
I-135	2.32E+1	6.08E+1	2.24E+1	4.01E+3	9.75E+1	-	6.87E+1
Cs-134	6.84E+3	1.63E+4	1.33E+4	-	5.27E+3	1.75E+3	2.85E+2
Cs-136	7.16E+2	2.83E+3	2.04E+3	-	1.57E+3	2.16E+2	3.21E+2
Cs-137	8.77E+3	1.20E+4	7.85E+3	-	4.07E+3	1.35E+3	2.32E+2
Cs-138	6.07E+0	1.20E+1	5.94E+0	-	8.81E+0	8.70E-1	5.12E-5
Ba-139	7.85E+0	5.59E-3	2.30E-1	-	5.23E-3	3.17E-3	1.39E+1
Ba-140	1.64E+3	2.06E+0	1.08E+2	-	7.02E-1	1.18E+0	3.38E+3
Ba-141	3.81E+0	2.88E-3	1.29E-1	-	2.68E-3	1.63E-3	1.80E-9
Ba-142	1.72E+0	1.77E-3	1.08E-1	-	1.50E-3	1.00E-3	2.43E-18
La-140	1.57E+0	7.94E-1	2.10E-1	-	-	-	5.83E+4
La-142	8.06E-2	3.67E-2	9.13E-3	-	-	-	2.68E+2
Ce-141	3.43E+0	2.32E+0	2.63E-1	-	1.08E+0	-	8.86E+3
Ce-143	6.04E-1	4.46E+2	4.94E-2	-	1.97E-1	-	1.67E+4
Ce-144	1.79E+2	7.47E+1	9.59E+0	-	4.43E+1	-	6.04E+4
Pr-143	5.79E+0	2.32E+0	2.87E-1	-	1.34E+0	-	2.54E+4
Pr-144	1.90E-2	7.87E-3	9.64E-4	-	4.44E-3	-	2.73E-9
Nd-147	3.96E+0	4.58E+0	2.74E-1	-	2.68E+0	-	2.20E+4
W-187	9.16E+0	7.66E+0	2.68E+0	-	-	-	2.51E+3
Np-239	3.53E-2	3.47E-3	1.91E-3	-	1.08E-2	-	7.11E+2

TABLE 1-3: BIOACCUMULATION FACTORS (pCi/kg per pCi/liter)*

ELEMENT	SALTWATER FISH	SALTWATER INVERTEBRATES
H	9.0E-01	9.3E-01
C	1.8E+03	1.4E+03
Na	6.7E-02	1.9E-01
P	3.0E+03	3.0E+04
Cr	4.0E+02	2.0E+03
Mn	5.5E+02	4.0E+02
Fe	3.0E+03	2.0E+04
Co	1.0E+02	1.0E+03
Ni	1.0E+02	2.5E+02
Cu	6.7E+02	1.7E+03
Zn	2.0E+03	5.0E+04
As	3.3E+02	3.3E+02
Br	1.5E-02	3.1E+00
Rb	8.3E+00	1.7E+01
Sr	2.0E+00	2.0E+01
Y	2.5E+01	1.0E+03
Zr	2.0E+02	8.0E+01
Nb	3.0E+04	1.0E+02
Mo	1.0E+01	1.0E+01
Tc	1.0E+01	5.0E+01
Ru	3.0E+00	1.0E+03
Rh	1.0E+01	2.0E+03
Ag	3.3E+03	3.3E+03
Sb	4.0E+01	5.4E+00
Te	1.0E+01	1.0E+02
I	1.0E+01	5.0E+01
Cs	4.0E+01	2.5E+01
Ba	1.0E+01	1.0E+02
La	2.5E+01	1.0E+03
Ce	1.0E+01	6.0E+02
Pr	2.5E+01	1.0E+03
Nd	2.5E+01	1.0E+03
W	3.0E+01	3.0E+01
Np	1.0E+01	1.0E+01

* 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: SALEM VENTILATION EXHAUST SYSTEMS AND EFFLUENT MONITOR INTERFACES

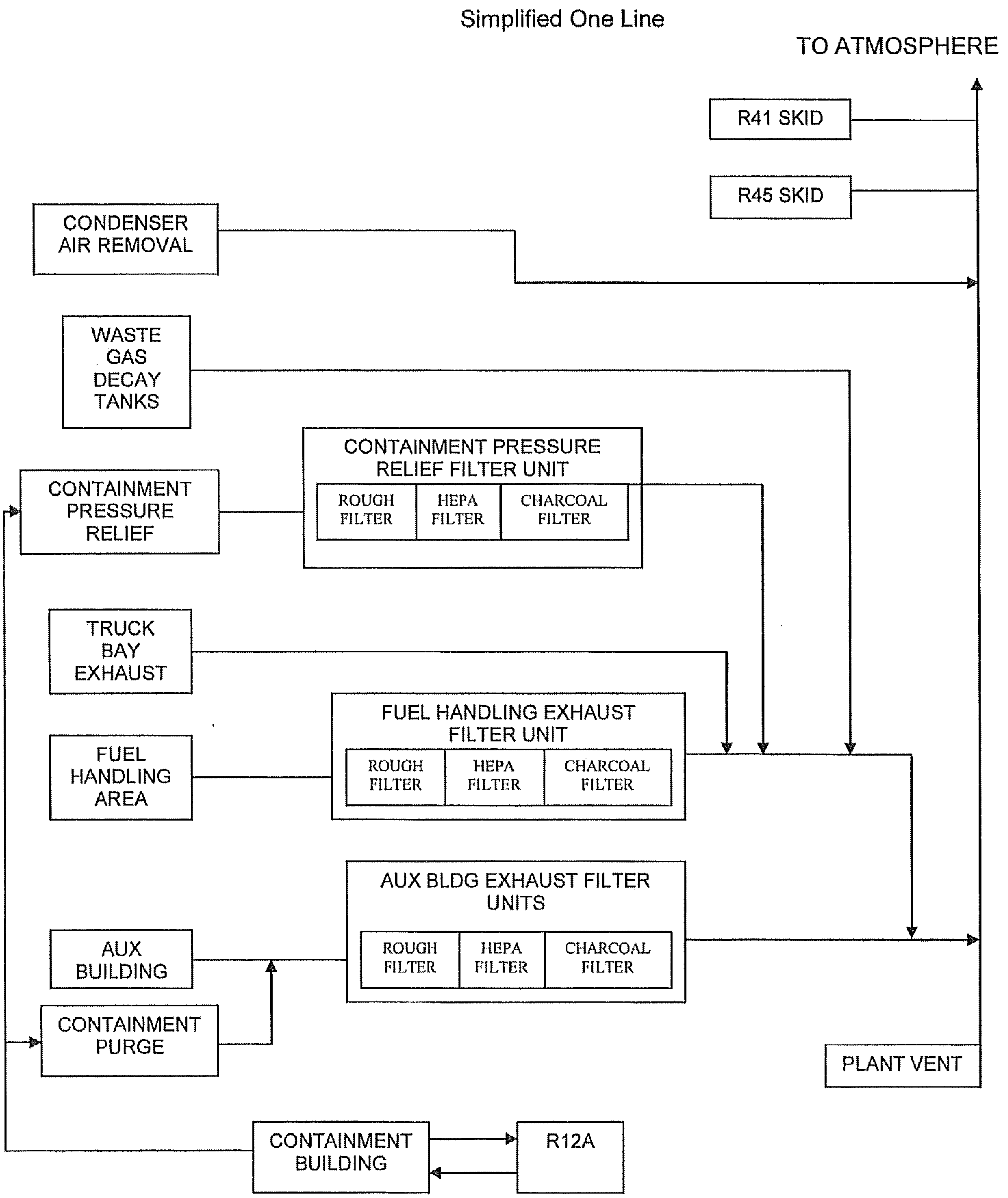


FIGURE 2-2: GASEOUS RADIOACTIVE WASTE DISPOAL SYSTEM

Simplified One Line

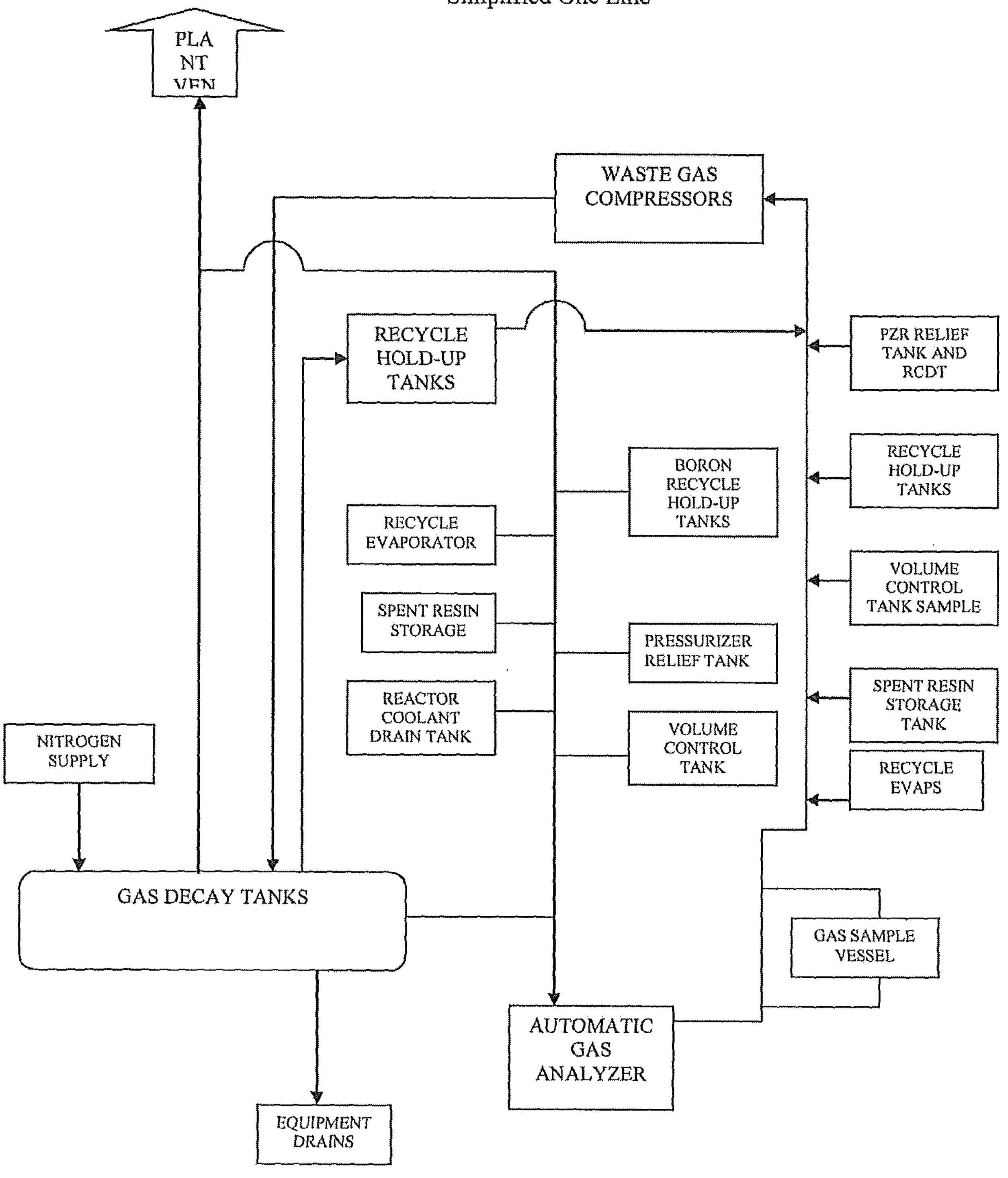


TABLE 2-1: DOSE FACTORS FOR NOBLE GASES

Radionuclide	Total Body Dose Factor Ki (mrem/yr per uCi /m3)	Skin Dose Factor Li (mrem/yr per uCi/m3)	Gamma Air Dose Factor Mi (mrad/yr per uCi/m3)	Beta Air Dose Factor Ni (mrad/yr per uCi/m3)
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 2-2.1: PARAMETERS FOR GASEOUS ALARM SETPOINT DETERMINATIONS – UNIT 1

Parameter	Actual Value	Default Value	Units	Comments
X/Q	calculated	2.2E-06	sec/m^3	USNRC Salem Safety Evaluation, Sup 3
VF (Plant Vent) (Cont Purge)	as measured or fan curves	 1.30E+05 3.50E+04	ft^3/min	Plant Vent - normal operation Containment Purge
AF	coordinated	0.25	N.A	Administrative allocation factor with HCGS to ensure combined releases do not exceed release rate limit for site.
C_i	measured	N.A	uCi/cm^3	Taken from gamma spectral analysis of gaseous effluent
K_i	nuclide specific	N.A	mrem/yr per uCi/m^3	Values from Table 2-1
L_i	nuclide specific	N.A	mrem/yr per uCi/m^3	Values from Table 2-1
M_i	nuclide specific	N.A	mrem/yr per uCi/m^3	Values from Table 2-1
Sensitivities 1-R41 1-R12A	as determined	N.A	cpm per uCi/m^3 or cpm per uCi/cc	Monitor sensitivities are controlled under the following calculations: SC-RM004-01 (1-R41) SC-RM020-01 (1-R12A)
Setpoint 1-R41D 1-R12A **	 2.00E+04 1.15E+05	 2.00E+04 1.15E+05	 uCi/sec uCi/sec	Monitor setpoints are controlled under the following calculations: SC-RM004-01 (1-R41) SC-RM020-01 (1-R12A)

** Automatic Isolation function is applicable in all MODES except MODE 6.

TABLE 2-2.2: PARAMETERS FOR GASEOUS ALARM SETPOINT DETERMINATIONS – UNIT 2

Parameter	Actual Value	Default Value	Units	Comments
X/Q	Calculated	2.2E-6	sec/m^3	USNRC Salem Safety Evaluation, Sup 3
VF Plant Vent Cont. Purge	as measured or fan curves	 1.30E+05 3.50E+04	ft^3/min	 Plant Vent – normal operation Containment Purge
AF	Coordinated with HCGS	0.25	N.A.	Administrative allocation factor to ensure combined releases do not exceed release rate for site.
C_I	Measured	N.A.	uCi/cm^3	Taken from gamma spectral analysis of gaseous effluent
K_I	Nuclide specific	N.A.	mrem/yr per uCi/m^3	Values from Table 2-1
L_I	Nuclide specific	N.A.	mrem/yr per uCi/m^3	Values from Table 2-1
M_I	Nuclide specific	N.A.	mrem/yr per uCi/m^3	Values from Table 2-1
Sensitivities 2-R41 2-R12A	as determined	N.A.	cpm per uCi/m^3 or cpm per uCi/cc	Monitor sensitivities are controlled under the following calculations: SC-RM004-02 (2-R41) SC-RM002-03 (2-R12A)
Setpoint 2-R41D 2-R12A **	 2.00E+04 1.15E+05	 2.00E+04 1.15E+05	 uCi/sec uCi/sec	Monitor setpoints are controlled under the following calculations: SC-RM004-02 (2-R41) SC-RM002-03 (2-R12A)

** Automatic Isolation function is applicable in all MODES except MODE 6.

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

ODCM Control	Location	Pathway(s)	Controlling Age Group	Atmospheric Dispersion X/Q (sec/m^3)	Atmospheric Dispersion D/Q (1/m^2)
3.11.2.1a	Site Boundary (0.83 mile, N)	Noble Gases direct exposure	N.A.	2.2 E-06	N.A.
3.11.2.1b	Site Boundary (0.83 mile, N)	Inhalation and ground plane	Child	2.2 E-06	N.A.
3.11.2.2	Site Boundary (0.83 mile, N)	Gamma-Air Beta-Air	N.A.	2.2 E-06	N.A.
3.11.2.3	Residence/Dairy** (4.9 miles, W)	Milk, ground plane and inhalation	Infant	5.4E-08	2.1 E-10
3.11.2.3	Residence/Garden/ Beef (4.6 mi, SW)**	Ground plane, inhalation, garden produce, meat ingestion	Child	8.0 E-8	2.4 E-10

* The identified controlling locations, pathways and atmospheric dispersion are from the Safety Evaluation Report, Supplement No. 3, for the Salem Nuclear Generating Station, Unit 2 (NUREG-0157, December 1978).

** Location and distance are determined from the performance of the annual land use census as required by ODCM CONTROL 3.12.2.

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, INHALATION PATHWAY DOSE FACTORS

ADULT (mrem/yr per uCi/m^3)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.26E+3	1.26E+3	1.26E+3	1.26E+3	1.26E+3	1.26E+3
C-14	1.82E+4	3.41E+3	3.41E+3	3.41E+3	3.41E+3	3.41E+3	3.41E+3
P-32	1.32E+6	7.71E+4	-	-	-	8.64E+4	5.01E+4
Cr-51	-	-	5.95E+1	2.28E+1	1.44E+4	3.32E+3	1.00E+2
Mn-54	-	3.96E+4	-	9.84E+3	1.40E+6	7.74E+4	6.30E+3
Fe-55	2.46E+4	1.70E+4	-	-	7.21E+4	6.03E+3	3.94E+3
Fe-59	1.18E+4	2.78E+4	-	-	1.02E+6	1.88E+5	1.06E+4
Co-57	-	6.92E+2	-	-	3.70E+5	3.14E+4	6.71E+2
Co-58	-	1.58E+3	-	-	9.28E+5	1.06E+5	2.07E+3
Co-60	-	1.15E+4	-	-	5.97E+6	2.85E+5	1.48E+4
Ni-63	4.32E+5	3.14E+4	-	-	1.78E+5	1.34E+4	1.45E+4
Zn-65	3.24E+4	1.03E+5	-	6.90E+4	8.64E+5	5.34E+4	4.66E+4
Rb-86	-	1.35E+5	-	-	-	1.66E+4	5.90E+4
Sr-89	3.04E+5	-	-	-	1.40E+6	3.50E+5	8.72E+3
Sr-90	9.92E+7	-	-	-	9.60E+6	7.22E+5	6.10E+6
Y-91	4.62E+5	-	-	-	1.70E+6	3.85E+5	1.24E+4
Zr-95	1.07E+5	3.44E+4	-	5.42E+4	1.77E+6	1.50E+5	2.33E+4
Nb-95	1.41E+4	7.82E+3	-	7.74E+3	5.05E+5	1.04E+5	4.21E+3
Ru-103	1.53E+3	-	-	5.83E+3	5.05E+5	1.10E+5	6.58E+2
Ru-106	6.91E+4	-	-	1.34E+5	9.36E+6	9.12E+5	8.72E+3
Ag-110m	1.08E+4	1.00E+4	-	1.97E+4	4.63E+6	3.02E+5	5.94E+3
Sb-124	3.12E+4	5.89E+2	7.55E+1	-	2.48E+6	4.06E+5	1.24E+4
Sb-125	5.34E+4	5.95E+2	5.40E+1	-	1.74E+6	1.01E+5	1.26E+4
Te-125m	3.42E+3	1.58E+3	1.05E+3	1.24E+4	3.14E+5	7.06E+4	4.67E+2
Te-127m	1.26E+4	5.77E+3	3.29E+3	4.58E+4	9.60E+5	1.50E+5	1.57E+3
Te-129m	9.76E+3	4.67E+3	3.44E+3	3.66E+4	1.16E+6	3.83E+5	1.58E+3
I-131	2.52E+4	3.58E+4	1.19E+7	6.13E+4	-	6.28E+3	2.05E+4
I-132	1.16E+3	3.26E+3	1.14E+5	5.18E+3	-	4.06E+2	1.16E+3
I-133	8.64E+3	1.48E+4	2.15E+6	2.58E+4	-	8.88E+3	4.52E+3
I-134	6.44E+2	1.73E+3	2.98E+4	2.75E+3	-	1.01E+0	6.15E+2
I-135	2.68E+3	6.98E+3	4.48E+5	1.11E+4	-	5.25E+3	2.57E+3
Cs-134	3.73E+5	8.48E+5	-	2.87E+5	9.76E+4	1.04E+4	7.28E+5
Cs-136	3.90E+4	1.46E+5	-	8.56E+4	1.20E+4	1.17E+4	1.10E+5
Cs-137	4.78E+5	6.21E+5	-	2.22E+5	7.52E+4	8.40E+3	4.28E+5
Ba-140	3.90E+4	4.90E+1	-	1.67E+1	1.27E+6	2.18E+5	2.57E+3
Ce-141	1.99E+4	1.35E+4	-	6.26E+3	3.62E+5	1.20E+5	1.53E+3
Ce-144	3.43E+6	1.43E+6	-	8.48E+5	7.78E+6	8.16E+5	1.84E+5
Pr-143	9.36E+3	3.75E+3	-	2.16E+3	2.81E+5	2.00E+5	4.64E+2
Nd-147	5.27E+3	6.10E+3	-	3.56E+3	2.21E+5	1.73E+5	3.65E+2

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES R(io), INHALATION PATHWAY DOSE FACTORS (Continued)

TEENAGER (mrem/yr per uCi/m^3)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.27E+3	1.27E+3	1.27E+3	1.27E+3	1.27E+3	1.27E+3
C-14	2.60E+4	4.87E+3	4.87E+3	4.87E+3	4.87E+3	4.87E+3	4.87E+3
P-32	1.89E+6	1.10E+5	-	-	-	9.28E+4	7.16E+4
Cr-51	-	-	7.50E+1	3.07E+1	2.10E+4	3.00E+3	1.35E+2
Mn-54	-	5.11E+4	-	1.27E+4	1.98E+6	6.68E+4	8.40E+3
Fe-55	3.34E+4	2.38E+4	-	-	1.24E+5	6.39E+3	5.54E+3
Fe-59	1.59E+4	3.70E+4	-	-	1.53E+6	1.78E+5	1.43E+4
Co-57	-	6.92E+2	-	-	5.86E+5	3.14E+4	9.20E+2
Co-58	-	2.07E+3	-	-	1.34E+6	9.52E+4	2.78E+3
Co-60	-	1.51E+4	-	-	8.72E+6	2.59E+5	1.98E+4
Ni-63	5.80E+5	4.34E+4	-	-	3.07E+5	1.42E+4	1.98E+4
Zn-65	3.86E+4	1.34E+5	-	8.64E+4	1.24E+6	4.66E+4	6.24E+4
Rb-86	-	1.90E+5	-	-	-	1.77E+4	8.40E+4
Sr-89	4.34E+5	-	-	-	2.42E+6	3.71E+5	1.25E+4
Sr-90	1.08E+8	-	-	-	1.65E+7	7.65E+5	6.68E+6
Y-91	6.61E+5	-	-	-	2.94E+6	4.09E+5	1.77E+4
Zr-95	1.46E+5	4.58E+4	-	6.74E+4	2.69E+6	1.49E+5	3.15E+4
Nb-95	1.86E+4	1.03E+4	-	1.00E+4	7.51E+5	9.68E+4	5.66E+3
Ru-103	2.10E+3	-	-	7.43E+3	7.83E+5	1.09E+5	8.96E+2
Ru-106	9.84E+4	-	-	1.90E+5	1.61E+7	9.60E+5	1.24E+4
Ag-110m	1.38E+4	1.31E+4	-	2.50E+4	6.75E+6	2.73E+5	7.99E+3
Sb-124	4.30E+4	7.94E+2	9.76E+1	-	3.85E+6	3.98E+5	1.68E+4
Sb-125	7.38E+4	8.08E+2	7.04E+1	-	2.74E+6	9.92E+4	1.72E+4
Te-125m	4.88E+3	2.24E+3	1.40E+3	-	5.36E+5	7.50E+4	6.67E+2
Te-127m	1.80E+4	8.16E+3	4.38E+3	6.54E+4	1.66E+6	1.59E+5	2.18E+3
Te-129m	1.39E+4	6.58E+3	4.58E+3	5.19E+4	1.98E+6	4.05E+5	2.25E+3
I-131	3.54E+4	4.91E+4	1.46E+7	8.40E+4	-	6.49E+3	2.64E+4
I-132	1.59E+3	4.38E+3	1.51E+5	6.92E+3	-	1.27E+3	1.58E+3
I-133	1.22E+4	2.05E+4	2.92E+6	3.59E+4	-	1.03E+4	6.22E+3
I-134	8.88E+2	2.32E+3	3.95E+4	3.66E+3	-	2.04E+1	8.40E+2
I-135	3.70E+3	9.44E+3	6.21E+5	1.49E+4	-	6.95E+3	3.49E+3
Cs-134	5.02E+5	1.13E+6	-	3.75E+5	1.46E+5	9.76E+3	5.49E+5
Cs-136	5.15E+4	1.94E+5	-	1.10E+5	1.78E+4	1.09E+4	1.37E+5
Cs-137	6.70E+5	8.48E+5	-	3.04E+5	1.21E+5	8.48E+3	3.11E+5
Ba-140	5.47E+4	6.70E+1	-	2.28E+1	2.03E+6	2.29E+5	3.52E+3
Ce-141	2.84E+4	1.90E+4	-	8.88E+3	6.14E+5	1.26E+5	2.17E+3
Ce-144	4.89E+6	2.02E+6	-	1.21E+6	1.34E+7	8.64E+5	2.62E+5
Pr-143	1.34E+4	5.31E+3	-	3.09E+3	4.83E+5	2.14E+5	6.62E+2
Nd-147	7.86E+3	8.56E+3	-	5.02E+3	3.72E+5	1.82E+5	5.13E+2

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES R($_{io}$), INHALATION PATHWAY DOSE FACTORS (Continued)

CHILD (mrem/yr per uCi/m^3)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.12E+3	1.12E+3	1.12E+3	1.12E+3	1.12E+3	1.12E+3
C-14	3.59E+4	6.73E+3	6.73E+3	6.73E+3	6.73E+3	6.73E+3	6.73E+3
P-32	2.60E+6	1.14E+5	-	-	-	4.22E+4	9.88E+4
Cr-51	-	-	8.55E+1	2.43E+1	1.70E+4	1.08E+3	1.54E+2
Mn-54	-	4.29E+4	-	1.00E+4	1.58E+6	2.29E+4	9.51E+3
Fe-55	4.74E+4	2.52E+4	-	-	1.11E+5	2.87E+3	7.77E+3
Fe-59	2.07E+4	3.34E+4	-	-	1.27E+6	7.07E+4	1.67E+4
Co-57	-	9.03E+2	-	-	5.07E+5	1.32E+4	1.07E+3
Co-58	-	1.77E+3	-	-	1.11E+6	3.44E+4	3.16E+3
Co-60	-	1.31E+4	-	-	7.07E+6	9.62E+4	2.26E+4
Ni-63	8.21E+5	4.63E+4	-	-	2.75E+5	6.33E+3	2.80E+4
Zn-65	4.26E+4	1.13E+5	-	7.14E+4	9.95E+5	1.63E+4	7.03E+4
Rb-86	-	1.98E+5	-	-		7.99E+3	1.14E+5
Sr-89	5.99E+5	-	-	-	2.16E+6	1.67E+5	1.72E+4
Sr-90	1.01E+8	-	-	-	1.48E+7	3.43E+5	6.44E+6
Y-91	9.14E+5	-	-	-	2.63E+6	1.84E+5	2.44E+4
Zr-95	1.90E+5	4.18E+4	-	5.96E+4	2.23E+6	6.11E+4	3.70E+4
Nb-95	2.35E+4	9.18E+3	-	8.62E+3	6.14E+5	3.70E+4	6.55E+3
Ru-103	2.79E+3	-	-	7.03E+3	6.62E+5	4.48E+4	1.07E+3
Ru-106	1.36E+5	-	-	1.84E+5	1.43E+7	4.29E+5	1.69E+4
Ag-110m	1.69E+4	1.14E+4	-	2.12E+4	5.48E+6	1.00E+5	9.14E+3
Sb-124	5.74E+4	7.40E+2	1.26E+2	-	3.24E+6	1.64E+5	2.00E+4
Sb-125	9.84E+4	7.59E+2	9.10E+1	-	2.32E+6	4.03E+4	2.07E+4
Te-125m	6.73E+3	2.33E+3	1.92E+3	-	4.77E+5	3.38E+4	9.14E+2
Te-127m	2.49E+4	8.55E+3	6.07E+3	6.36E+4	1.48E+6	7.14E+4	3.02E+3
Te-129m	1.92E+4	6.85E+3	6.33E+3	5.03E+4	1.76E+6	1.82E+5	3.04E+3
I-131	4.81E+4	4.81E+4	1.62E+7	7.88E+4	-	2.84E+3	2.73E+4
I-132	2.12E+3	4.07E+3	1.94E+5	6.25E+3	-	3.22E+3	1.88E+3
I-133	1.66E+4	2.03E+4	3.85E+6	3.38E+4	-	5.48E+3	7.70E+3
I-134	1.17E+3	2.16E+3	5.07E+4	3.30E+3	-	9.55E+2	9.95E+2
I-135	4.92E+3	8.73E+3	7.92E+5	1.34E+4	-	4.44E+3	4.14E+3
Cs-134	6.51E+5	1.01E+6	-	3.30E+5	1.21E+5	3.85E+3	2.25E+5
Cs-136	6.51E+4	1.71E+5	-	9.55E+4	1.45E+4	4.18E+3	1.16E+5
Cs-137	9.07E+5	8.25E+5	-	2.82E+5	1.04E+5	3.62E+3	1.28E+5
Ba-140	7.40E+4	6.48E+1	-	2.11E+1	1.74E+6	1.02E+5	4.33E+3
Ce-141	3.92E+4	1.95E+4	-	8.55E+3	5.44E+5	5.66E+4	2.90E+3
Ce-144	6.77E+6	2.12E+6	-	1.17E+6	1.20E+7	3.89E+5	3.61E+5
Pr-143	1.85E+4	5.55E+3	-	3.00E+3	4.33E+5	9.73E+4	9.14E+2
Nd-147	1.08E+4	8.73E+3	-	4.81E+3	3.28E+5	8.21E+4	6.81E+2

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES R$_{(io)}$, INHALATION PATHWAY DOSE FACTORS (Continued)

INFANT (mrem/yr per uCi/m^3)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	6.47E+2	6.47E+2	6.47E+2	6.47E+2	6.47E+2	6.47E+2
C-14	2.65E+4	5.31E+3	5.31E+3	5.31E+3	5.31E+3	5.31E+3	5.31E+3
P-32	2.03E+6	1.12E+5	-	-	-	1.61E+4	7.74E+4
Cr-51	-	-	5.75E+1	1.32E+1	1.28E+4	3.57E+2	8.95E+1
Mn-54	-	2.53E+4	-	4.98E+3	1.00E+6	7.06E+3	4.98E+3
Fe-55	1.97E+4	1.17E+4	-	-	8.69E+4	1.09E+3	3.33E+3
Fe-59	1.36E+4	2.35E+4	-	-	1.02E+6	2.48E+4	9.48E+3
Co-57	-	6.51E+2	-	-	3.79E+5	4.86E+3	6.41E+2
Co-58	-	1.22E+3	-	-	7.77E+5	1.11E+4	1.82E+3
Co-60	-	8.02E+3	-	-	4.51E+6	3.19E+4	1.18E+4
Ni-63	3.39E+5	2.04E+4	-	-	2.09E+5	2.42E+3	1.16E+4
Zn-65	1.93E+4	6.26E+4	-	3.25E+4	6.47E+5	5.14E+4	3.11E+4
Rb-86	-	1.90E+5	-	-	-	3.04E+3	8.82E+4
Sr-89	3.98E+5	-	-	-	2.03E+6	6.40E+4	1.14E+4
Sr-90	4.09E+7	-	-	-	1.12E+7	1.31E+5	2.59E+6
Y-91	5.88E+5	-	-	-	2.45E+6	7.03E+4	1.57E+4
Zr-95	1.15E+5	2.79E+4	-	3.11E+4	1.75E+6	2.17E+4	2.03E+4
Nb-95	1.57E+4	6.43E+3	-	4.72E+3	4.79E+5	1.27E+4	3.78E+3
Ru-103	2.02E+3	-	-	4.24E+3	5.52E+5	1.61E+4	6.79E+2
Ru-106	8.68E+4	-	-	1.07E+5	1.16E+7	1.64E+5	1.09E+4
Ag-110m	9.98E+3	7.22E+3	-	1.09E+4	3.67E+6	3.30E+4	5.00E+3
Sb-124	3.79E+4	5.56E+2	1.01E+2	-	2.65E+6	5.91E+4	1.20E+4
Sb-125	5.17E+4	4.77E+2	6.23E+1	-	1.64E+6	1.47E+4	1.09E+4
Te-125m	4.76E+3	1.99E+3	1.62E+3	-	4.47E+5	1.29E+4	6.58E+2
Te-127m	1.67E+4	6.90E+3	4.87E+3	3.75E+4	1.31E+6	2.73E+4	2.07E+3
Te-129m	1.41E+4	6.09E+3	5.47E+3	3.18E+4	1.68E+6	6.90E+4	2.23E+3
I-131	3.79E+4	4.44E+4	1.48E+7	5.18E+4	-	1.06E+3	1.96E+4
I-132	1.69E+3	3.54E+3	1.69E+5	3.95E+5	-	1.90E+3	1.26E+3
I-133	1.32E+4	1.92E+4	3.56E+6	2.24E+4	-	2.61E+3	5.60E+3
I-134	9.21E+2	1.88E+3	4.45E+4	2.09E+3	-	1.29E+3	6.65E+2
I-135	3.86E+3	7.60E+3	6.96E+5	8.47E+3	-	1.83E+3	2.77E+3
Cs-134	3.96E+5	7.03E+5	-	1.90E+5	7.97E+4	1.33E+3	7.45E+4
Cs-136	4.83E+4	1.35E+5	-	5.64E+4	1.18E+4	1.43E+3	5.29E+4
Cs-137	5.49E+5	6.12E+5	-	1.72E+5	7.13E+4	1.33E+3	4.55E+4
Ba-140	5.60E+4	5.60E+1	-	1.34E+1	1.60E+6	3.84E+4	2.90E+3
Ce-141	2.77E+4	1.67E+4	-	5.25E+3	5.17E+5	2.16E+4	1.99E+3
Ce-144	3.19E+6	1.21E+6	-	5.38E+5	9.84E+6	1.48E+5	1.76E+5
Pr-143	1.40E+4	5.24E+3	-	1.97E+3	4.33E+5	3.72E+4	6.99E+2
Nd-147	7.94E+3	8.13E+3	-	3.15E+3	3.22E+5	3.12E+4	5.00E+2

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES R(io), GRASS-COW-MILK PATHWAY DOSE FACTORS (Continued)

ADULT (mrem/yr per uCi/m^3) FOR H-3 AND C-14
(m^2 * mrem/yr per uCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	7.63E+2	7.63E+2	7.63E+2	7.63E+2	7.63E+2	7.63E+2
C-14	3.63E+5	7.26E+4	7.26E+4	7.26E+4	7.26E+4	7.26E+4	7.26E+4
P-32	1.71E+10	1.06E+9	-	-	-	1.92E+9	6.60E+8
Cr-51	-	-	1.71E+4	6.30E+3	3.80E+4	7.20E+6	2.86E+4
Mn-54	-	8.40E+6	-	2.50E+6	-	2.57E+7	1.60E+6
Fe-55	2.51E+7	1.73E+7	-	-	9.67E+6	9.95E+6	4.04E+6
Fe-59	2.98E+7	7.00E+7	-	-	1.95E+7	2.33E+8	2.68E+7
Co-57	-	1.28E+6	-	-	-	3.25E+7	2.13E+6
Co-58	-	4.72E+6	-	-	-	9.57E+7	1.06E+7
Co-60	-	1.64E+7	-	-	-	3.08E+8	3.62E+7
Ni-63	6.73E+9	4.66E+8	-	-	-	9.73E+7	2.26E+8
Zn-65	1.37E+9	4.36E+9	-	2.92E+9	-	2.75E+9	1.97E+9
Rb-86	-	2.59E+9	-	-	-	5.11E+8	1.21E+9
Sr-89	1.45E+9	-	-	-	-	2.33E+8	4.16E+7
Sr-90	4.68E+10	-	-	-	-	1.35E+9	1.15E+10
Y-91	8.60E+3	-	-	-	-	4.73E+6	2.30E+2
Zr-95	9.46E+2	3.03E+2	-	4.76E+2	-	9.62E+5	2.05E+2
Nb-95	8.25E+4	4.59E+4	-	4.54E+4	-	2.79E+8	2.47E+4
Ru-103	1.02E+3	-	-	3.89E+3	-	1.19E+5	4.39E+2
Ru-106	2.04E+4	-	-	3.94E+4	-	1.32E+6	2.58E+3
Ag-110m	5.83E+7	5.39E+7	-	1.06E+8	-	2.20E+10	3.20E+7
Sb-124	2.57E+7	4.86E+5	6.24E+4	-	2.00E+7	7.31E+8	1.02E+7
Sb-125	2.04E+7	2.28E+5	2.08E+4	-	1.58E+7	2.25E+8	4.86E+6
Te-125m	1.63E+7	5.90E+6	4.90E+6	6.63E+7	-	6.50E+7	2.18E+6
Te-127m	4.58E+7	1.64E+7	1.17E+7	1.86E+8	-	1.54E+8	5.58E+6
Te-129m	6.04E+7	2.25E+7	2.08E+7	2.52E+8	-	3.04E+8	9.57E+6
I-131	2.96E+8	4.24E+8	1.39E+11	7.27E+8	-	1.12E+8	2.43E+8
I-132	1.64E-1	4.37E-1	1.53E+1	6.97E-1	-	8.22E-2	1.53E-1
I-133	3.97E+6	6.90E+6	1.01E+9	1.20E+7	-	6.20E+6	2.10E+6
I-134	-	-	-	-	-	-	-
I-135	1.39E+4	3.63E+4	2.40E+6	5.83E+4	-	4.10E+4	1.34E+4
Cs-134	5.65E+9	1.34E+10	-	4.35E+9	1.44E+9	2.35E+8	1.10E+10
Cs-136	2.61E+8	1.03E+9	-	5.74E+8	7.87E+7	1.17E+8	7.42E+8
Cs-137	7.38E+9	1.01E+10	-	3.43E+9	1.14E+9	1.95E+8	6.61E+9
Ba-140	2.69E+7	3.38E+4	-	1.15E+4	1.93E+4	5.54E+7	1.76E+6
Ce-141	4.84E+3	3.27E+3	-	1.52E+3	-	1.25E+7	3.71E+2
Ce-144	3.58E+5	1.50E+5	-	8.87E+4	-	1.21E+8	1.92E+4
Pr-143	1.59E+2	6.37E+1	-	3.68E+1	-	6.96E+5	7.88E+0
Nd-147	9.42E+1	1.09E+2	-	6.37E+1	-	5.23E+5	6.52E+0

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES R(io), GRASS-COW-MILK PATHWAY DOSE FACTORS (Continued)

TEENAGER (mrem/yr per uCi/m^3) FOR H-3 AND C-14
(m^2 * mrem/yr per uCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	9.94E+2	9.94E+2	9.94E+2	9.94E+2	9.94E+2	9.94E+2
C-14	6.70E+5	1.34E+5	1.34E+5	1.34E+5	1.34E+5	1.34E+5	1.34E+5
P-32	3.15E+10	1.95E+9	-	-	-	2.65E+9	1.22E+9
Cr-51	-	-	2.78E+4	1.10E+4	7.13E+4	8.40E+6	5.00E+4
Mn-54	-	1.40E+7	-	4.17E+6	-	2.87E+7	2.78E+6
Fe-55	4.45E+7	3.16E+7	-	-	2.00E	1.37E+7	7.36E+6
Fe-59	5.20E+7	1.21E+8	-	-	3.82E+7	2.87E+8	4.68E+7
Co-57	-	2.25E+6	-	-	-	4.19E+7	3.76E+6
Co-58	-	7.95E+6	-	-	-	1.10E+8	1.83E+7
Co-60	-	2.78E+7	-	-	-	3.62E+8	6.26E+7
Ni-63	1.18E+10	8.35E+8	-	-	-	1.33E+8	4.01E+8
Zn-65	2.11E+9	7.31E+9	-	4.68E+9	-	3.10E+9	3.41E+9
Rb-86	-	4.73E+9	-	-	-	7.00E+8	2.22E+9
Sr-89	2.67E+9	-	-	-	-	3.18E+8	7.66E+7
Sr-90	9.92E+7	-	-	-	9.60E+6	7.22E+5	6.10E+6
Y-91	1.58E+4	-	-	-	-	6.48E+6	4.24E+2
Zr-95	1.65E+3	5.22E+2	-	7.67E+2	-	1.20E+6	3.59E+2
Nb-95	1.41E+5	7.80E+4	-	7.57E+4	-	3.34E+8	4.30E+4
Ru-103	1.81E+3	-	-	6.40E+3	-	1.52E+5	7.75E+2
Ru-106	3.75E+4	-	-	7.23E+4	-	1.80E+6	4.73E+3
Ag-110m	9.63E+7	9.11E+7	-	1.74E+8	-	2.56E+10	5.54E+7
Sb-124	4.59E+7	8.46E+5	1.04E+5	-	4.01E+7	9.25E+8	1.79E+7
Sb-125	3.65E+7	3.99E+5	3.49E+4	-	3.21E+7	2.84E+8	8.54E+6
Te-125m	3.00E+7	1.08E+7	8.39E+6	-	-	8.86E+7	4.02E+6
Te-127m	8.44E+7	2.99E+7	2.01E+7	3.42E+8	-	2.10E+8	1.00E+7
Te-129m	1.11E+8	4.10E+7	3.57E+7	4.62E+8	-	4.15E+8	1.75E+7
I-131	5.38E+8	7.53E+8	2.20E+11	1.30E+9	-	1.49E+8	4.04E+8
I-132	2.90E-1	7.59E-1	2.56E+1	1.20E+0	-	3.31E-1	2.72E-1
I-133	7.24E+6	1.23E+7	1.72E+9	2.15E+7	-	9.30E+6	3.75E+6
I-134	-	-	-	-	-	-	-
I-135	2.47E+4	6.35E+4	4.08E+6	1.00E+5	-	7.03E+4	2.35E+4
Cs-134	9.81E+9	2.31E+10	-	7.34E+9	2.80E+9	2.87E+8	1.07E+10
Cs-136	4.45E+8	1.75E+9	-	9.53E+8	1.50E+8	1.41E+8	1.18E+9
Cs-137	1.34E+10	1.78E+10	-	6.06E+9	2.35E+9	2.53E+8	6.20E+9
Ba-140	4.85E+7	5.95E+4	-	2.02E+4	4.00E+4	7.49E+7	3.13E+6
Ce-141	8.87E+3	1.35E+4	-	2.79E+3	-	1.69E+7	6.81E+2
Ce-144	6.58E+5	2.72E+5	-	1.63E+5	-	1.66E+8	3.54E+4
Pr-143	2.92E+2	1.17E+2	-	6.77E+1	-	9.61E+5	1.45E+1
Nd-147	1.81E+2	1.97E+2	-	1.16E+2	-	7.11E+5	1.18E+1

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, GRASS-COW-MILK PATHWAY DOSE FACTORS (Continued)

CHILD (mrem/yr per uCi/m^3) FOR H-3 AND C-14
(m^2 * mrem/yr per uCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.57E+3	1.57E+3	1.57E+3	1.57E+3	1.57E+3	1.57E+3
C-14	1.65E+6	3.29E+5	3.29E+5	3.29E+5	3.29E+5	3.29E+5	3.29E+5
P-32	7.77E+10	3.64E+9	-	-	-	2.15E+9	3.00E+9
Cr-51	-	-	5.66E+4	1.55E+4	1.03E+5	5.41E+6	1.02E+5
Mn-54	-	2.09E+7	-	5.87E+6	-	1.76E+7	5.58E+6
Fe-55	1.12E+8	5.93E+7	-	-	3.35E+7	1.10E+7	1.84E+7
Fe-59	1.20E+8	1.95E+8	-	-	5.65E+7	2.03E+8	9.71E+7
Co-57	-	3.84E+6	-	-	-	3.14E+7	7.77E+6
Co-58	-	1.21E+7	-	-	-	7.08E+7	3.72E+7
Co-60	-	4.32E+7	-	-	-	2.39E+8	1.27E+8
Ni-63	2.96E+10	1.59E+9	-	-	-	1.07E+8	1.01E+9
Zn-65	4.13E+9	1.10E+10	-	6.94E+9	-	1.93E+9	6.85E+9
Rb-86	-	8.77E+9	-	-	-	5.64E+8	5.39E+9
Sr-89	6.62E+9	-	-	-	-	2.56E+8	1.89E+8
Sr-90	1.12E+11	-	-	-	-	1.51E+9	2.83E+10
Y-91	3.91E+4	-	-	-	-	5.21E+6	1.04E+3
Zr-95	3.84E+3	8.45E+2	-	1.21E+3	-	8.81E+5	7.52E+2
Nb-95	3.18E+5	1.24E+5	-	1.16E+5	-	2.29E+8	8.84E+4
Ru-103	4.29E+3	-	-	1.08E+4	-	1.11E+5	1.65E+3
Ru-106	9.24E+4	-	-	1.25E+5	-	1.44E+6	1.15E+4
Ag-110m	2.09E+8	1.41E+8	-	2.63E+8	-	1.68E+10	1.13E+8
Sb-124	1.09E+8	1.41E+8	2.40E+5	-	6.03E+7	6.79E+8	3.81E+7
Sb-125	8.70E+7	1.41E+6	8.06E+4	-	4.85E+7	2.08E+8	1.82E+7
Te-125m	7.38E+7	2.00E+7	2.07E+7	-	-	7.12E+7	9.84E+6
Te-127m	2.08E+8	5.60E+7	4.97E+7	5.93E+8	-	1.68E+8	2.47E+7
Te-129m	2.72E+8	7.61E+7	8.78E+7	8.00E+8	-	3.32E+8	4.23E+7
I-131	1.30E+9	1.31E+9	4.34E+11	2.15E+9	-	1.17E+8	7.46E+8
I-132	6.86E-1	1.26E+0	5.85E+1	1.93E+0	-	1.48E+0	5.80E-1
I-133	1.76E+7	2.18E+7	4.04E+9	3.63E+7	-	8.77E+6	8.23E+6
I-134	-	-	-	-	-	-	-
I-135	5.84E+4	1.05E+5	9.30E+6	1.61E+5	-	8.00E+4	4.97E+4
Cs-134	2.26E+10	3.71E+10	-	1.15E+10	4.13E+9	2.00E+8	7.83E+9
Cs-136	1.00E+9	2.76E+9	-	1.47E+9	2.19E+8	9.70E+7	1.79E+9
Cs-137	3.22E+10	3.09E+10	-	1.01E+10	3.62E+9	1.93E+8	4.55E+9
Ba-140	1.17E+8	1.03E+5	-	3.34E+4	6.12E+4	5.94E+7	6.84E+6
Ce-141	2.19E+4	1.09E+4	-	4.78E+3	-	1.36E+7	1.62E+3
Ce-144	1.62E+6	5.09E+5	-	2.82E+5	-	1.33E+8	8.66E+4
Pr-143	7.23E+2	2.17E+2	-	1.17E+2	-	7.80E+5	3.59E+1
Nd-147	4.45E+2	3.60E+2	-	1.98E+2	-	5.71E+5	2.79E+1

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, GRASS-COW-MILK PATHWAY DOSE FACTORS (Continued)

INFANT (mrem/yr per uCi/m^3) FOR H-3 AND C-14
(m^2 * mrem/yr per uCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	2.38E+3	2.38E+3	2.38E+3	2.38E+3	2.38E+3	2.38E+3
C-14	3.23E+6	6.89E+5	6.89E+5	6.89E+5	6.89E+5	6.89E+5	6.89E+5
P-32	1.60E+11	9.42E+9	-	-	-	2.17E+9	6.21E+9
Cr-51	-	-	1.05E+5	2.30E+4	2.05E+5	4.71E+6	1.61E+5
Mn-54	-	3.89E+7	-	8.63E+6	-	1.43E+7	8.83E+6
Fe-55	1.35E+8	8.72E+7	-	-	4.27E+7	1.11E+7	2.33E+7
Fe-59	2.25E+8	3.93E+8	-	-	1.16E+8	1.88E+8	1.55E+8
Co-57	-	8.95E+6	-	-	-	3.05E+7	1.46E+7
Co-58	-	2.43E+7	-	-	-	6.05E+7	6.06E+7
Co-60	-	8.81E+7	-	-	-	2.10E+8	2.08E+8
Ni-63	3.49E+10	2.16E+9	-	-	-	1.07E+8	1.21E+9
Zn-65	5.55E+9	1.90E+10	-	9.23E+9	-	1.61E+10	8.78E+9
Rb-86	-	2.22E+10	-	-	-	5.69E+8	1.10E+10
Sr-89	1.26E+10	-	-	-	-	2.59E+8	3.61E+8
Sr-90	1.22E+11	-	-	-	-	1.52E+9	3.10E+10
Y-91	7.33E+4	-	-	-	-	5.26E+6	1.95E+3
Zr-95	6.83E+3	1.66E+3	-	1.79E+3	-	8.28E+5	1.18E+3
Nb-95	5.93E+5	2.44E+5	-	1.75E+5	-	2.06E+8	1.41E+5
Ru-103	8.69E+3	-	-	1.81E+4	-	1.06E+5	2.91E+3
Ru-106	1.90E+5	-	-	2.25E+5	-	1.44E+6	2.38E+4
Ag-110m	3.86E+8	2.82E+8	-	4.03E+8	-	1.46E+10	1.86E+8
Sb-124	2.09E+8	3.08E+6	5.56E+5	-	1.31E+8	6.46E+8	6.49E+7
Sb-125	1.49E+8	1.45E+6	1.87E+5	-	9.38E+7	1.99E+8	3.07E+7
Te-125m	1.51E+8	5.04E+7	5.07E+7	-	-	7.18E+7	2.04E+7
Te-127m	4.21E+8	1.40E+8	1.22E+8	1.04E+9	-	1.70E+8	5.10E+7
Te-129m	5.59E+8	1.92E+8	2.15E+8	1.40E+9	-	3.34E+8	8.62E+7
I-131	2.72E+9	3.21E+9	1.05E+12	3.75E+9	-	1.15E+8	1.41E+9
I-132	1.42E+0	2.89E+0	1.35E+2	3.22E+0	-	2.34E+0	1.03E+0
I-133	3.72E+7	5.41E+7	9.84E+9	6.36E+7	-	9.16E+6	1.58E+7
I-134	-	-	1.01E-9	-	-	-	-
I-135	1.21E+5	2.41E+5	2.16E+7	2.69E+5	-	8.74E+4	8.80E+4
Cs-134	3.65E+10	6.80E+10	-	1.75E+10	7.18E+9	1.85E+8	6.87E+9
Cs-136	1.96E+9	5.77E+9	-	2.30E+9	4.70E+8	8.76E+7	2.15E+9
Cs-137	5.15E+10	6.02E+10	-	1.62E+10	6.55E+9	1.88E+8	4.27E+9
Ba-140	2.41E+8	2.41E+5	-	5.73E+4	1.48E+5	5.92E+7	1.24E+7
Ce-141	4.33E+4	2.64E+4	-	8.15E+3	-	1.37E+7	3.11E+3
Ce-144	2.33E+6	9.52E+5	-	3.85E+5	-	1.33E+8	1.30E+5
Pr-143	1.49E+3	5.59E+2	-	2.08E+2	-	7.89E+5	7.41E+1
Nd-147	8.82E+2	9.06E+2	-	3.49E+2	-	5.74E+5	5.55E+1

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES R(io), VEGETATION PATHWAY DOSE FACTORS (Continued)

ADULT (mrem/yr per uCi/m^3) FOR H-3 AND C-14
(m^2 * mrem/yr per uCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	2.26E+3	2.26E+3	2.26E+3	2.26E+3	2.26E+3	2.26E+3
C-14	8.97E+5	1.79E+5	1.79E+5	1.79E+5	1.79E+5	1.79E+5	1.79E+5
P-32	1.40E+9	8.73E+7	-	-	-	1.58E+8	5.42E+7
Cr-51	-	-	2.79E+4	1.03E+4	6.19E+4	1.17E+7	4.66E+4
Mn-54	-	3.11E+8	-	9.27E+7	-	9.54E+8	5.94E+7
Fe-55	2.09E+8	1.45E+8	-	-	8.06E+7	8.29E+7	3.37E+7
Fe-59	1.27E+8	2.99E+8	-	-	8.35E+7	9.96E+8	1.14E+8
Co-57	-	1.17E+7	-	-	-	2.97E+8	1.95E+7
Co-58	-	3.09E+7	-	-	-	6.26E+8	6.92E+7
Co-60	-	1.67E+8	-	-	-	3.14E+9	3.69E+8
Ni-63	1.04E+10	7.21E+8	-	-	-	1.50E+8	3.49E+8
Zn-65	3.17E+8	1.01E+9	-	6.75E+8	-	6.36E+8	4.56E+8
Rb-86	-	2.19E+8	-	-	-	4.32E+7	1.02E+8
Sr-89	9.96E+9	-	-	-	-	1.60E+9	2.86E+8
Sr-90	6.05E+11	-	-	-	-	1.75E+10	1.48E+10
Y-91	5.13E+6	-	-	-	-	2.82E+9	1.37E+5
Zr-95	1.19E+6	3.81E+5	-	5.97E+5	-	1.21E+9	2.58E+5
Nb-95	1.42E+5	7.91E+4	-	7.81E+4	-	4.80E+8	4.25E+4
Ru-103	4.80E+6	-	-	1.83E+7	-	5.61E+8	2.07E+6
Ru-106	1.93E+8	-	-	3.72E+8	-	1.25E+10	2.44E+7
Ag-110m	1.06E+7	9.76E+6	-	1.92E+7	-	3.98E+9	5.80E+6
Sb-124	1.04E+8	1.96E+6	2.52E+5	-	8.08E+7	2.95E+9	4.11E+7
Sb-125	1.36E+8	1.52E+6	1.39E+5	-	1.05E+8	1.50E+9	3.25E+7
Te-125m	9.66E+7	3.50E+7	2.90E+7	3.93E+8	-	3.86E+8	1.29E+7
Te-127m	3.49E+8	1.25E+8	8.92E+7	1.42E+9	-	1.17E+9	4.26E+7
Te-129m	2.55E+8	9.50E+7	8.75E+7	1.06E+9	-	1.28E+9	4.03E+7
I-131	8.09E+7	1.16E+8	3.79E+10	1.98E+8	-	3.05E+7	6.63E+7
I-132	5.74E+1	1.54E+2	5.38E+3	2.45E+2	-	2.89E+1	5.38E+1
I-133	2.12E+6	3.69E+6	5.42E+8	6.44E+6	-	3.31E+6	1.12E+6
I-134	1.06E-4	2.88E-4	5.00E-3	4.59E-4	-	2.51E-7	1.03E-4
I-135	4.08E+4	1.07E+5	7.04E+6	1.71E+5	-	1.21E+5	3.94E+4
Cs-134	4.66E+9	1.11E+10	-	3.59E+9	1.19E+9	1.94E+8	9.07E+9
Cs-136	4.20E+7	1.66E+8	-	9.24E+7	1.27E+7	1.89E+7	1.19E+8
Cs-137	6.36E+9	8.70E+9	-	2.95E+9	9.81E+8	1.68E+8	5.70E+9
Ba-140	1.29E+8	1.62E+5	-	5.49E+4	9.25E+4	2.65E+8	8.43E+6
Ce-141	1.96E+5	1.33E+5	-	6.17E+4	-	5.08E+8	1.51E+4
Ce-144	3.29E+7	1.38E+7	-	8.16E+6	-	1.11E+10	1.77E+6
Pr-143	6.34E+4	2.54E+4	-	1.47E+4	-	2.78E+8	3.14E+3
Nd-147	3.34E+4	3.86E+4	-	2.25E+4	-	1.85E+8	2.31E+3

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES $R_{(io)}$, VEGETATION PATHWAY DOSE FACTORS (Continued)

TEENAGER (mrem/yr per uCi/m^3) FOR H-3 AND C-14
(m^2 * mrem/yr per uCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	2.59E+3	2.59E+3	2.59E+3	2.59E+3	2.59E+3	2.59E+3
C-14	1.45E+6	2.91E+5	2.91E+5	2.91E+5	2.91E+5	2.91E+5	2.91E+5
P-32	1.61E+9	9.96E+7	-	-	-	1.35E+8	6.23E+7
Cr-51	-	-	3.44E+4	1.36E+4	8.85E+4	1.04E+7	6.20E+4
Mn-54	-	4.52E+8	-	1.35E+8	-	9.27E+8	8.97E+7
Fe-55	3.25E+8	2.31E+8	-	-	1.46E+8	9.98E+7	5.38E+7
Fe-59	1.81E+8	4.22E+8	-	-	1.33E+8	9.98E+8	1.63E+8
Co-57	-	1.79E+7	-	-	-	3.34E+8	3.00E+7
Co-58	-	4.38E+7	-	-	-	6.04E+8	1.01E+8
Co-60	-	2.49E+8	-	-	-	3.24E+9	5.60E+8
Ni-63	1.61E+10	1.13E+9	-	-	-	1.81E+8	5.45E+8
Zn-65	4.24E+8	1.47E+9	-	9.41E+8	-	6.23E+8	6.86E+8
Rb-86	-	2.73E+8	-	-	-	4.O5E+7	1.28E+8
Sr-89	1.51E+10	-	-	-	-	1.80E+9	4.33E+8
Sr-90	7.51E+11	-	-	-	-	2.11E+10	1.85E+11
Y-91	7.87E+6	-	-	-	-	3.23E+9	2.11E+5
Zr-95	1.74E+6	5.49E+5	-	8.07E+5	-	1.27E+9	3.78E+5
Nb-95	1.92E+5	1.06E+5	-	1.03E+5	-	4.55E+8	5.86E+4
Ru-103	6.87E+6	-	-	2.42E+7	-	5.74E+8	2.94E+6
Ru-106	3.09E+8	-	-	5.97E+8	-	1.48E+10	3.90E+7
Ag-110m	1.52E+7	1.44E+7	-	2.74E+7	-	4.04E+9	8.74E+6
Sb-124	1.55E+8	2.85E+6	3.51E+5	-	1.35E+8	3.11E+9	6.03E+7
Sb-125	2.14E+8	2.34E+6	2.04E+5	-	1.88E+8	1.66E+9	5.00E+7
Te-125m	1.48E+8	5.34E+7	4.14E+7	-	-	4.37E+8	1.98E+7
Te-127m	5.51E+8	1.96E+8	1.31E+8	2.24E+9	-	1.37E+9	6.56E+7
Te-129m	3.67E+8	1.36E+8	1.18E+8	1.54E+9	-	1.38E+9	5.81E+7
I-131	7.70E+7	1.08E+8	3.14E+10	1.85E+8	-	2.13E+7	5.79E+7
I-132	5.18E+1	1.36E+2	4.57E+3	2.14E+2	-	5.91E+1	4.87E+1
I-133	1.97E+6	3.34E+6	4.66E+8	5.86E+6	-	2.53E+6	1.02E+6
I-134	9.59E-5	2.54E-4	4.24E-3	4.01E-4	-	3.35E-6	9.13E-5
I-135	3.68E+4	9.48E+4	6.10E+6	1.50E+5	-	1.05E+5	3.52E+4
Cs-134	7.09E+9	1.67E+10	-	5.30E+9	2.02E+9	2.08E+8	7.74E+9
Cs-136	4.29E+7	1.69E+8	-	9.19E+7	1.45E+7	1.36E+7	1.13E+8
Cs-137	1.01E+10	1.35E+10	-	4.59E+9	1.78E+9	1.92E+8	4.69E+9
Ba-140	1.38E+8	1.69E+5	-	5.75E+4	1.14E+5	2.13E+8	8.91E+6
Ce-141	2.82E+5	1.88E+5	-	8.86E+4	-	5.38E+8	2.16E+4
Ce-144	5.27E+7	2.18E+7	-	1.30E+7	-	1.33E+10	2.83E+6
Pr-143	7.12E+4	2.84E+4	-	1.65E+4	-	2.34E+8	3.55E+3
Nd-147	3.63E+4	3.94E+4	-	2.32E+4	-	1.42E+8	2.36E+3

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES R(io), VEGETATION PATHWAY DOSE FACTORS (Continued)

CHILD (mrem/yr per uCi/m^3) FOR H-3 AND C-14
(m^2 * mrem/yr per uCi/sec) FOR OTHERS

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	4.01E+3	4.01E+3	4.01E+3	4.01E+3	4.01E+3	4.01E+3
C-14	3.50E+6	7.01E+5	7.01E+5	7.01E+5	7.01E+5	7.01E+5	7.01E+5
P-32	3.37E+9	1.58E+8	-	-	-	9.30E+7	1.30E+8
Cr-51	-	-	6.54E+4	1.79E+4	1.19E+5	6.25E+6	1.18E+5
Mn-54	-	6.61E+8	-	1.85E+8	-	5.55E+8	1.76E+8
Fe-55	8.00E+8	4.24E+8	-	-	2.40E+8	7.86E+7	1.31E+8
Fe-59	4.01E+8	6.49E+8	-	-	1.88E+8	6.76E+8	3.23E+8
Co-57	-	2.99E+7	-	-	-	2.45E+8	6.04E+7
Co-58	-	6.47E+7	-	-	-	3.77E+8	1.98E+8
Co-60	-	3.78E+8	-	-	-	2.10E+9	1.12E+9
Ni-63	3.95E+10	2.11E+9	-	-	-	1.42E+8	1.34E+9
Zn-65	8.12E+8	2.16E+9	-	1.36E+9	-	3.80E+8	1.35E+9
Rb-86	-	4.52E+8	-	-	-	2.91E+7	2.78E+8
Sr-89	3.59E+10	-	-	-	-	1.39E+9	1.03E+9
Sr-90	1.24E+12	-	-	-	-	1.67E+10	3.15E+11
Y-91	1.87E+7	-	-	-	-	2.49E+9	5.01E+5
Zr-95	3.90E+6	8.58E+5	-	1.23E+6	-	8.95E+8	7.64E+5
Nb-95	4.10E+5	1.59E+5	-	1.50E+5	-	2.95E+8	1.14E+5
Ru-103	1.55E+7	-	-	3.89E+7	-	3.99E+8	5.94E+6
Ru-106	7.45E+8	-	-	1.01E+9	-	1.16E+10	9.30E+7
Ag-110m	3.22E+7	2.17E+7	-	4.05E+7	-	2.58E+9	1.74E+7
Sb-124	3.52E+8	4.57E+6	7.78E+5	-	1.96E+8	2.20E+9	1.23E+8
Sb-125	4.99E+8	3.85E+6	4.62E+5	-	2.78E+8	1.19E+9	1.05E+8
Te-125m	3.51E+8	9.50E+7	9.84E+7	-	-	3.38E+8	4.67E+7
Te-127m	1.32E+9	3.56E+8	3.16E+8	3.77E+9	-	1.07E+9	1.57E+8
Te-129m	8.54E+8	2.39E+8	2.75E+8	2.51E+9	-	1.04E+9	1.33E+8
I-131	1.43E+8	1.44E+8	4.76E+10	2.36E+8	-	1.28E+7	8.18E+7
I-132	9.20E+1	1.69E+2	7.84E+3	2.59E+2	-	1.99E+2	7.77E+1
I-133	3.59E+6	4.44E+6	8.25E+8	7.40E+6	-	1.79E+6	1.68E+6
I-134	1.70E-4	3.16E-4	7.28E-3	4.84E-4	-	2.10E-4	1.46E-4
I-135	6.54E+4	1.18E+5	1.04E+7	1.81E+5	-	8.98E+4	5.57E+4
Cs-134	1.60E+10	2.63E+10	-	8.14E+9	2.92E+9	1.42E+8	5.54E+9
Cs-136	8.06E+7	2.22E+8	-	1.18E+8	1.76E+7	7.79E+6	1.43E+8
Cs-137	2.39E+10	2.29E+10	-	7.46E+9	2.68E+9	1.43E+8	3.38E+9
Ba-140	2.77E+8	2.43E+5	-	7.90E+4	1.45E+5	1.40E+8	1.62E+7
Ce-141	6.35E+5	3.26E+5	-	1.43E+5	-	4.07E+8	4.84E+4
Ce-144	1.27E+8	3.98E+7	-	2.21E+7	-	1.04E+10	6.78E+6
Pr-143	1.48E+5	4.46E+4	-	2.41E+4	-	1.60E+8	7.37E+3
Nd-147	7.16E+4	5.80E+4	-	3.18E+4	-	9.18E+7	4.49E+3

TABLE 2-4: PATHWAY DOSE FACTORS – ATMOSPHERIC RELEASES R(io), GROUND PLANE PATHWAY DOSE FACTORS (Continued)

(m^2 * mrem/yr per uCi/sec)

Nuclide	Any Organ
H-3	-
C-14	-
P-32	-
Cr-51	4.68E+6
Mn-54	1.34E+9
Fe-55	-
Fe-59	2.75E+8
Co-58	3.82E+8
Co-60	2.16E+10
Ni-63	-
Zn-65	7.45E+8
Rb-86	8.98E+6
Sr-89	2.16E+4
Sr-90	-
Y-91	1.08E+6
Zr-95	2.48E+8
Nb-95	1.36E+8
Ru-103	1.09E+8
Ru-106	4.21E+8
Ag-110m	3.47E+9
Te-125m	1.55E+6
Te-127m	9.17E+4
Te-129m	2.00E+7
I-131	1.72E+7
I-132	1.24E+6
I-133	2.47E+6
I-134	4.49E+5
I-135	2.56E+6
Cs-134	6.75E+9
Cs-136	1.49E+8
Cs-137	1.04E+10
Ba-140	2.05E+7
Ce-141	1.36E+7
Ce-144	6.95E+7
Pr-143	-
Nd-147	8.40E+6

APPENDIX A

EVALUATION OF DEFAULT PARAMETERS

FOR LIQUID EFFLUENTS

APPENDIX A: EVALUATION OF DEFAULT PARAMETERS FOR LIQUID EFFLUENTS

A. Effective Maximum Permissible Concentration (MPC_e)

In accordance with the requirements of ODCM CONTROL 3.3.3.8 the radioactive liquid effluent monitors shall be operable with alarm setpoints established to ensure that the concentration of radioactive material at the discharge point does not exceed the MPC value of the "old" 10 CFR 20, Appendix B, Table II, Column 2, (ODCM Appendix F). The determination of allowable radionuclide concentration and corresponding alarm setpoint is a function of the individual radionuclide distribution and corresponding MPC values.

In order to limit the need for routinely having to re-establish the alarm setpoints as a function of changing radionuclide distributions, a default alarm setpoint can be established. This default setpoint can be based on an evaluation of the radionuclide distribution of the liquid effluents from Salem and the effective MPC value for this distribution.

The effective MPC value for a radionuclide distribution is calculated by the equation:

$$MPC_e = \frac{\sum_i C_i \ (gamma)}{\sum_i \frac{C_i}{MPC_i} \ (gamma)}$$

WHERE: MPC_e = An effective MPC value for a mixture of gamma emitting radionuclides (uCi/ml).

C_i = Concentration of radionuclide i in the mixture.

MPC_i = The "old" 10 CFR 20, Appendix B, Table II, Column 2 MPC value for radionuclide i (ODCM Appendix F) (uCi/ml).

The equation for determining the liquid effluent setpoints (Section 1.2.1, equation 1.2) is based on a multiplication of the effective MPC times the monitor sensitivity. Considering the average effective MPC value for the years 1993, 1994, and 1998, it is reasonable to select an MPCe value of 6.05E-06 uCi/ml for Unit 1 and 4.81E-06 uCi/ml for Unit 2 as typical of liquid radwaste discharges.

B. Correction Factor

The type of radiation detector used to monitor radioactive releases is not capable of detecting non-gamma emitting radionuclides such as H-3, Fe-55, Sr-89, and Sr-90, as required by ODCM CONTROL 3.11.1.1. A conservative default safety factor can be determined to account for non-gamma emitting radionuclides. Non-gamma emitting radionuclides are analyzed at Salem station on a monthly basis from a composite sample of liquid releases.

Nuclide	MPC (uCi/ml)	Activity (uCi/ml)	Activity/MPC
H-3	3E-3	5.2E-1	173.3
Fe-55	8E-4	2.5E-3	3.1
Sr-89	3E-6	2.0E-5	6.7
Sr-90	3E-7	7.2E-7	2.4
Total			185.5

The values in the table above represent the maximum reactor coolant values for non-gamma emitting nuclides in 1994 for Unit 1 and 2. Reactor coolant values were chosen to represent the maximum concentration of non-gamma emitting nuclides that could be released from Salem Station. The activity values in the table will be diluted by a minimum factor of 800 prior to release. The minimum dilution factor is obtained by using the minimum circulating water flowrate of 100,000 gpm and the maximum release rate of 120 gpm.

A conservative non-gamma factor for non-gamma emitting nuclides can be obtained using the highest Activity/MPC fraction and the minimum dilution factor as follows:

Non-Gamma Factor = 185.5 / 800 = 0.23 (Rounded up to 0.25)

Correction Factor = 1 - 0.25 = 0.75

C. Default setpoint determination:

Using the information and parameters described above a default setpoint can be calculated for Unit 1 and 2 liquid radwaste disposal process radiation monitors (R18).

Using these values to calculate the default R18 alarm setpoint value, results in a setpoint that:

1. Will not require frequent re-adjustment due to minor variations in the nuclide distribution which are typical of routine plant operations, and

2. Will provide for a liquid radwaste discharge rate (as evaluated for each batch release) that is compatible with plant operations (refer to Tables 1-1.1 and 1-1.2).

TABLE A-1: CALCULATION OF EFFECTIVE MPC - UNIT 1

		Activity Released (Ci)		
NUCLIDE	**MPC* (uCi/ml)**	**1993 CURIES**	**1994 CURIES**	**1998 CURIES**
BE-7	2.00E-03	8.88E-04	ND	ND
NA-24	3.00E-05	6.68E-04	1.62E-04	1.00E-04
CR-51	2.00E-03	5.38E-03	2.02E-03	ND
MN-54	1.00E-04	3.52E-02	1.37E-02	7.16E-04
MN-56	1.00E-04	ND	ND	0.00E+00
FE-59	5.00E-05	4.76E-04	4.84E-03	ND
CO-57	4.00E-04	1.03E-02	3.10E-03	1.78E-05
CO-58	9.00E-05	1.71E+00	6.47E-01	3.39E-02
CO-60	3.00E-05	3.04E-01	1.10E-01	2.42E-02
ZR-95	6.00E-05	3.29E-03	7.13E-04	ND
NB-95	1.00E-04	5.78E-03	1.28E-03	ND
NB-97	9.00E-04	1.27E-03	1.07E-03	4.90E-05
TC-99M	3.00E-03	2.66E-04	ND	ND
SR-89	3.00E-06	ND	ND	2.18E-04
SR-92	6.00E-05	ND	7.32E-06	ND
MO-99	4.00E-05	1.76E-04	1.76E-04	ND
AG-110m	3.00E-05	1.19E-02	1.10E-02	6.58E-05
SN-113	8.00E-05	7.88E-05	4.91E-05	ND
SB-122	3.00E-05	1.21E-03	5.35E-04	1.12E-03
SB-124	2.00E-05	2.08E-02	1.75E-02	1.73E-02
SB-125	1.00E-04	9.04E-02	8.23E-02	3.56E-02
SB-126	3.00E-06	ND	6.18E-05	2.23E-04
I-131	3.00E-07	1.27E-01	1.82E-02	2.32E-03
I-133	1.00E-06	2.16E-03	1.88E-04	8.32E-06
I-134	2.00E-05	ND	3.63E-04	ND
CE-141	9.00E-05	ND	4.24E-05	ND
CE-143	4.00E-05	5.42E-05	ND	ND
CS-134	9.00E-06	3.54E-01	6.46E-01	2.49E-02
CS-136	6.00E-05	3.61E-03	1.59E-03	ND
CS-137	2.00E-05	4.53E-01	8.54E-01	7.51E-02
CS-138	3.00E-06	4.15E-06	1.35E-04	ND
BA-140	2.00E-05	ND	8.62E-05	ND
LA-140	2.00E-05	2.12E-04	1.86E-04	ND
RU-105	1.00E-04	2.21E-04	1.35E-04	ND
RU-106	1.00E-05	ND	1.03E-03	ND
ZN-65	1.00E-04	6.72E-04	ND	ND
Total Ci	Gamma	**3.14E+00**	**2.42E+00**	**2.16E-01**
MPCe	(uCi/ml)	**6.05E-06**	**1.28E-05**	**1.28E-05**

* MPC value for unrestricted area from the "old" 10 CFR 20, Appendix B, Table II, Column 2, [ODCM Appendix F].

ND - not detected.

TABLE A-2: CALCULATION OF EFFECTIVE MPC - UNIT 2

		Activity Released (Ci)		
NUCLIDE	**MPC* (uCi/ml)**	**1993 CURIES**	**1994 CURIES**	**1998 CURIES**
BE-7	2.00E-03	1.59E-03	2.88E-04	ND
NA-24	3.00E-05	1.05E-03	5.77E-05	7.39E-05
CR-51	2.00E-03	4.39E-03	1.55E-03	1.14E-04
MN-54	1.00E-04	3.73E-02	1.37E-02	7.54E-04
MN-56	1.00E-04	ND	ND	4.66E-05
FE-59	5.00E-05	4.83E-04	3.25E-03	ND
CO-57	4.00E-04	1.17E-02	3.24E-03	ND
CO-58	9.00E-05	1.75E+00	6.60E-01	4.52E-02
CO-60	3.00E-05	3.47E-01	1.03E-01	2.12E-02
ZR-95	6.00E-05	2.34E-03	3.22E-04	ND
NB-95	1.00E-04	3.97E-03	1.11E-03	ND
NB-97	9.00E-04	1.46E-03	1.10E-03	4.22E-05
TC-99M	3.00E-03	3.77E-04	ND	2.35E-06
SR-89	3.00E-06	ND	ND	2.71E-04
SR-92	6.00E-05	ND	1.43E-05	ND
MO-99	4.00E-05	ND	ND	ND
AG-110m	3.00E-05	1.03E-02	1.34E-02	ND
SN-113	8.00E-05	7.45E-05	ND	ND
SB-122	3.00E-05	1.20E-03	ND	6.37E-04
SB-124	2.00E-05	3.77E-02	9.82E-03	1.44E-02
SB-125	1.00E-04	1.35E-01	6.03E-02	1.88E-02
SB-126	3.00E-06	3.51E-04	ND	1.97E-04
I-131	3.00E-07	1.87E-01	7.98E-03	3.14E-03
I-132	8.00E-06	8.72E-05	ND	1.68E-04
I-134	2.00E-05	2.39E-04	1.85E-04	ND
CE-141	9.00E-05	ND	2.87E-05	ND
CE-143	4.00E-05	ND	ND	ND
CS-134	9.00E-06	4.57E-01	6.44E-01	2.64E-02
CS-136	6.00E-05	4.82E-03	1.51E-03	ND
CS-137	2.00E-05	5.70E-01	8.54E-01	7.97E-02
CS-138	3.00E-06	ND	ND	4.90E-05
BA-140	2.00E-05	ND	ND	ND
LA-140	2.00E-05	2.03E-03	1.11E-04	ND
RU-105	1.00E-04	4.07E-05	ND	ND
RU-106	1.00E-05	ND	4.38E-04	ND
ZN-65	1.00E-04	1.59E-04	ND	ND
W-187	6.00E-05	ND	7.98E-05	ND
Total Ci	Gamma	**3.57E+00**	**2.38E+00**	**2.31E-01**
MPCe	(uCi/ml)	**4.81E-06**	**1.55E-05**	**1.12E-05**

* MPC value for unrestricted area from the "old" 10 CFR 20, Appendix B, Table II, Column 2, [ODCM Appendix F].
ND = not detected.

APPENDIX B

TECHNICAL BASIS FOR SIMPLIFIED DOSE CALCULATIONS

LIQUID RADIOACTIVE EFFLUENT

APPENDIX B: TECHNICAL BASIS FOR SIMPLIFIED DOSE CALCULATIONS - LIQUID EFFLUENTS

The radioactive liquid effluents for the years 1993, 1994, and 1998 were evaluated to determine the dose contribution of the radionuclide distribution. These were the most recent years of full power operation for both Units. 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 ODCM CONTROL 3.11.1.2.

For the radionuclide distribution of effluents from Salem, the controlling organ is typically the GI-LLI. The calculated GI-LLI dose is predominately a function of the Fe-55, Co-58, Co-60, Fe-59 and Ag-110m releases. The radionuclides, Cs-134 and Cs-137 contribute the large majority of the calculated total body dose. The results of the evaluation for 1993, 1994, and 1998 are presented in Table B-1 and Table B-2.

For purposes of simplifying the details of the dose calculational 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 Nb-95 dose conversion factor (1.51 E+06 mrem/hr per uCi/ml, GI-LLI). By this approach, the maximum organ dose will be overestimated since this nuclide has the highest organ dose factor of all the radionuclides evaluated.

For the total body calculation, the Fe-59 dose factor (7.27E+04 mrem/hr per uCi/ml, total body) is the highest among the identified dominant nuclides. For evaluating compliance with the dose limits of ODCM CONTROL 3.11.1.2, the following simplified equations may be used:

<u>Total Body</u>

$$D_{tb} = \frac{1.67\text{E-}02 * VOL}{CW} * A_{Fe-59,TB} * \sum_i C_i \qquad \textbf{(B.1)}$$

WHERE:

D_{tb}	=	Dose to the total body (mrem).
$A_{Fe\text{-}59,TB}$	=	7.27E+04, total body ingestion dose conversion factor for Fe-59 (mrem/hr per uCi/ml).
VOL	=	Volume of liquid effluent released (gal).
C_i	=	Total concentration of all radionuclides (uCi/ml).
CW	=	Average circulating water discharge rate during release period(gal/min).
1.67E-02	=	Conversion factor (hr/min).

Substituting the value for the Fe-59 total body dose conversion factor, the equation simplifies to:

$$D_{tb} = \frac{1.21\mathrm{E}+03 * VOL}{CW} * \sum_i C_i \qquad \textbf{(B.2)}$$

<u>Maximum Organ</u>

$$D_{\max} = \frac{1.67\mathrm{E}-02 * VOL}{CW} * A_{Nb-95,GI-LLI} * \sum_i C_i \qquad \textbf{(B.3)}$$

WHERE: D_{max} = Maximum organ dose (mrem).

$A_{Nb-95,GI-LLI}$= 1.51E+06, Gi-LLI ingestion dose conversion factor for Nb-95 (mrem/hr per uCi/ml)

Substituting the value for $A_{Nb-95,GI-LLI}$ the equation simplifies to:

$$D_{\max} = \frac{2.52\mathrm{E}+04 * VOL}{CW} * \sum_i C_i \qquad \textbf{(B.4)}$$

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. The average annual tritium release from each Salem Unit is approximately 350 curies. The calculated total body dose from such a release is 2.4E-03 mrem/yr via the fish and invertebrate ingestion pathways. This amounts to 0.08% of the design limit dose of 3 mrem/yr. Furthermore, the release of tritium is a function of operating time and power level and is essentially unrelated to radwaste system operation.

TABLE B-1: ADULT DOSE CONTRIBUTIONS - FISH AND INVERTEBRATE PATHWAYS – UNIT 1

Nuclide	Release (Ci)			T.Body Dose Fraction			GI-LLI Dose Fraction			Liver Dose Fraction		
	1994	1993	1998	1994	1993	1998	1994	1993	1998	1994	1993	1998
Mn-54	1.32E-2	3.51E-2	7.16E-4	*	*	*	0.03	0.02	*	*	0.02	*
Fe-55	1.49E-1	6.40E-2	8.39E-2	0.07	0.04	0.37	0.12	0.03	0.52	0.19	0.14	0.67
Fe-59	4.84E-3	4.77E-4	ND	0.02	*	*	0.12	0.01	*	0.03	0.01	*
Co-58	6.47E-1	1.71E+0	3.39E-2	0.05	0.18	0.02	0.31	0.51	0.13	0.01	0.07	*
Co-60	1.10E-1	3.04E-1	2.42E-2	0.02	0.09	0.05	0.14	0.24	0.24	*	0.03	0.01
Zn-65	ND	6.72E-4	ND	*	0.01	*	*	0.01	*	*	0.02	*
Nb-95	1.28E-3	5.78E-3	ND	*	*	*	*	0.01	*	*	*	*
Ag-110m	1.10E-2	1.19E-2	6.58E-5	*	*	*	0.26	0.17	0.01	*	*	*
Sb-124	1.75E-2	2.58E-2	1.73E-2	*	*	*	*	*	0.04	*	*	*
Sb-125	8.23E-2	9.04E-2	3.56E-2	*	*	*	*	*	0.02	*	*	*
Cs-134	6.46E-1	3.54E-1	2.49E-2	0.47	0.38	0.18	*	*	*	0.38	0.37	0.09
Cs-137	8.54E-1	4.53E-1	7.51E-2	0.37	0.28	0.32	*	*	*	0.37	0.35	0.20
Total	2.53E+0	3.21E+0	3.31E-1									

* Less than 0.01

ND = not detected

TABLE B-2: ADULT DOSE CONTRIBUTIONS - FISH AND INVERTEBRATE PATHWAYS - UNIT 2

Nuclide	Release (Ci)			T.Body Dose Fraction			GI-LLI Dose Fraction			Liver Dose Fraction		
	1994	1993	1998	1994	1993	1998	1994	1993	1998	1994	1993	1998
Mn-54	1.37E-2	3.73E-2	7.54E-4	*	*	*	0.01	0.02	*	*	0.01	*
Fe-55	1.38E-1	6.61E-2	1.64E-2	0.06	0.04	0.10	0.10	0.03	0.18	0.18	0.12	0.27
Fe-59	3.25E-3	4.82E-4	ND	0.01	*	*	0.08	0.01	*	0.02	*	*
Co-58	6.60E-1	1.75E+0	4.52E-2	0.05	0.16	0.04	0.29	0.51	0.29	0.01	0.06	0.01
Co-60	1.03E-1	3.47E-1	2.12E-2	0.02	0.09	0.06	0.12	0.27	0.37	0.01	0.03	0.02
Zn-65	ND	1.59E-4	ND	*	*	*	*	*	*	*	*	*
Nb-95	1.11E-3	3.97E-3	ND	*	*	*	0.06	0.01	*	*	*	*
Ag-110m	1.34E-2	1.03E-2	ND	*	*	*	0.31	0.14	*	*	*	*
Sb-124	9.82E-3	3.77E-2	1.44E-2	*	*	*	*	0.01	0.06	*	*	*
Sb-125	6.03E-2	1.35E-1	1.88E-2	*	*	*	*	0.01	0.02	*	*	*
Cs-134	6.44E-1	4.58E-1	2.64E-2	0.48	0.41	0.26	0.01	*	*	0.39	0.40	0.20
Cs-137	8.54E-1	5.70E-1	7.97E-2	0.37	0.30	0.46	*	*	*	0.38	0.36	0.45
Total	2.48E+0	3.65E+0	2.23E-1									

* Less than 0.01
ND = not detected

APPENDIX C

TECHNICAL BASES FOR EFFECTIVE DOSE FACTORS

GASEOUS RADIOACTIVE EFFLUENT

APPENDIX C: TECHNICAL BASES FOR EFFECTIVE DOSE FACTORS - GASEOUS EFFLUENTS

A. Overview

The evaluation of doses due to releases of radioactive material to the atmosphere can be simplified by the use of effective dose transfer factors instead of using dose factors which are radionuclide specific.

These effective factors, which can be based on typical radionuclide distributions of releases, can be applied to the total radioactivity released to approximate the dose in the environment (i.e., instead of having to perform individual radionuclide dose analyses only a single multiplication (K_{eff}, M_{eff} or N_{eff}) times the total quantity of radioactive material released would be needed).

This approach provides a reasonable estimate of the actual dose while eliminating the need for a detailed calculational technique.

B. Determination of Effective Dose Factors

Effective dose transfer factors are calculated by the following equations:

$$K_{eff} = \sum_i (K_i * f_i) \qquad \textbf{(C.1)}$$

WHERE: K_{eff} = The effective total body dose 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.

$$(L_i + 1.1M_i)_{eff} = \sum_i \left[(L_i + 1.1M_i) * f\right] \qquad \textbf{(C.2)}$$

WHERE: $(L + 1.1\ M)_{eff}$ = The effective skin dose factor due to beta and gamma emissions from all noble gases released.

$(L_i + 1.1\ M_i)$ = The skin dose factor due to beta and gamma emissions from each noble gas radionuclide i released.

$$M_{eff} = \sum_i (M_i * f_i) \qquad \textbf{(C.3)}$$

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.

$$N_{eff} = \sum_i (N_i * f_i) \qquad \textbf{(C.4)}$$

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 Salem have been maintained to such negligible quantities that the inherent variability in the data makes any meaningful evaluations difficult.

Therefore, in order to provide a reasonable basis for the derivation of the effective noble gas dose factors, the primary coolant source term from ANSI N237-1976/ANS-18.1, "Source Term Specifications," has been used as representing a typical distribution. The effective dose factors as derived are presented in Table C-1.

C. Application

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

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

$$D\gamma = \frac{3.17\text{E-}08}{0.50} * \chi/Q * M_{eff} * \sum_i Q_i \quad \textbf{(C.5)}$$

and

$$D\beta = \frac{3.17\text{E-}08}{0.50} * \chi/Q * N_{eff} * \sum_i Q_i \quad \textbf{(C.6)}$$

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/m^3).

M_{eff} = 5.3E+02, effective gamma-air dose factor (mrad/yr per uCi/m^3).

N_{eff} = 1.1E+03, effective beta-air dose factor (mrad/yr per uCi/m^3).

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

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 calculational equations simplify to:

$$D_\gamma = 3.5\text{E-}05 * \chi/Q * \sum_i Q_i \quad \textbf{(C.7)}$$

and

$$D\beta = 7.0\text{E-}05 * \chi/Q * \sum_i Q_i \quad \textbf{(C.8)}$$

The effective dose factors are used on a very 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.

TABLE C-1: EFFECTIVE DOSE FACTORS NOBLE

Total Body and Skin Dose

Radionuclide	f_i*	Total Body Effective Dose Factor (K_{eff}) (mrem/yr per uCi/m^3)	Skin Effective Dose Factor ($L + 1.1\ M_{eff}$) (mrem/yr per uCi/m^3)
Kr-83m	0.01	--	1.4E+01
Kr-88	0.01	1.5E+02	1.9E+02
Xe-133m	0.01	2.5E+00	1.4E+01
Xe-133	0.95	2.8E+02	6.6E+02
Xe-135	0.02	3.6E+01	7.9E+01
Total		4.7E+02	9.6E+02

Noble Gases - Air

Radionuclide	f_i	Gamma Air Effective Dose Factor (M_{eff}) (mrad/yr per uCi/m^3)	Beta Air Effective Dose Factor (N_{eff}) (mrad/yr per uCi/m^3)
Kr-85	0.01	--	2.0E+01
Kr-88	0.01	1.5E+02	2.9E+01
Xe-133m	0.01	3.3E+00	1.5E+01
Xe-133	0.95	3.4E+02	1.0E+03
Xe-135	0.02	3.8E+01	4.9E+01
Total		5.3E+02	1.1E+03

* Based on Noble gas distribution from ANSI N237-1976/ANSI-18.1, "Source Term Specifications."

APPENDIX D

TECHNICAL BASIS FOR SIMPLIFIED DOSE CALCULATION

GASEOUS RADIOACTIVE EFFLUENT

APPENDIX D: TECHNICAL BASIS FOR SIMPLIFIED DOSE CALCULATION - GASEOUS EFFLUENTS

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 ODCM 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 for 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 (1.05E12 m^2 mrem/yr per uCi/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 ODCM CONTROL 3.11.2.3, the following simplified equation may be used:

$$D_{max} = 3.17\text{E-}08 * W * R_{I-131} * \sum_i Q_i$$

WHERE:

D_{max}	=	Maximum organ dose (mrem).
W	=	Atmospheric dispersion parameters 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 (m^{-2}).
Q_i	=	Cumulative release over the period of interest for radioiodines and particulates.
3.17E-8	=	Conversion factor (yr/sec).
R_{I-131}	=	I-131 dose parameter for the thyroid for the identified controlling pathway.
	=	1.05E+12 (m^2 mrem/yr per uCi/sec), infant thyroid dose parameter with the grass-cow-milk pathway controlling.

The ground plane exposure and inhalation pathways need not be considered when the above simplified calculation 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 (see Table D-1).

The dose should be evaluated based on the predetermined controlling pathways as identified in Table 2-3. If more limiting pathways in the surrounding environment of Salem are identified by the annual land use census, Table 2-3 will be revised as specified in ODCM CONTROL 3.12.2.

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

PATHWAY

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

FRACTION OF DOSE CONTRIBUTION BY PATHWAY

Pathway	f
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 DESIGNATION

Samples locations are identified by a three part code. 1) The first two letters are the program identification code. Because of the proximity of the Salem and Hope Creek Stations, a common environmental surveillance program is conducted. The identification code, "SA", has been applied to Salem and Hope Creek stations. 2) The next three letters identify the media sampled.

AIO = Air Iodine	IDM = Immersion Dose (TLD)
APT = Air Particulate	MLK = Milk
ECH = Hard Shell Blue Crab	PWR = Potable Water (Raw)
ESF = Edible Fish	PWT = Potable Water (Treated)
ESS = Sediment	SOL = Soil
FPL = Green Leaf Vegetables	SWA = Surface Water
FPV = Vegetables (Various)	VGT = Fodder Crops (Various)
GAM = Game (Muskrat)	WWA= Well Water

3) The last three or four symbols are a location code based on direction and distance from a standard reference point. The reference point is located at the midpoint between the center of the Salem Unit 1 and Salem Unit 2 containments. Of these, the first one or two represent each of the sixteen angular sectors of 22.5 degrees centered about the reactor site. Sector one is divided evenly by the north axis and other sectors are numbered in a clockwise direction as follows:

1 = N	5 = E	9 = S	13 = W
2 = NNE	6 = ESE	10 = SSW	14 = WNW
3 = NE	7 = SE	11 = SW	15 = NW
4 = ENE	8 = SSE	12 = WSW	16= NNW

The next digit is a letter which represents the radial distance from the reference point:

S = On-site location	E = 4-5 miles off-site
A = 0-1 miles off-site	F = 5-10 miles off-site
B = 1-2 miles off-site	G = 10-20 miles off-site
C = 2-3 miles off-site	H = >20 miles off-site
D = 3-4 miles off-site	

The last number is the station numerical designation within each sector and zone; e.g. 1,2,3,...etc. For example, the designation SA-WWA-3E1 would indicate a sample in the Salem and Hope Creek program (SA) consisting of well water (WWA) which was collected in sector number 3, centered at 45 degrees (north east) with respect to the midpoint between Salem 1 and 2 containments at a radial distance of 4 to 5 miles offsite, (therefore, radial distance E). The number 1 indicates that this is sampling station number 1 in that particular sector.

SAMPLING LOCATIONS

All sampling locations and specific information about the individual locations are given here in Table E-1. Maps E-1, E-2, and E-3 show the locations of sampling stations with respect to the site. Not all stations in Table E-1 are required sample locations. Some of the stations identified in Table E-1 are used for management audit samples. Minimum sampling requirements are specified in Table 3.12-1.

TABLE E-1: REMP SAMPLE LOCATIONS

STATION CODE	STATION LOCATION*	LATITUDE	LONGITUDE
		Decimal Degrees	Decimal Degrees
A. Direct Radiation Monitoring Locations (IDM)			
1S1	0.56 mi. N	39.47103333	-75.53698333
2S2	0.42 mi. NNE	39.4685	-75.53318333
2S4	0.61 mi. NNE; in the equipment laydown area	39.47071667	-75.53075
3S1	0.61 mi. NE	39.46901667	-75.52796667
4S1	0.63 mi ENE; access road near intersection to TB-02	39.46705	-75.52573333
5S1	0.89 mi. E; site access road	39.46113333	-75.51978333
6S2	0.24 mi. ESE; area around helicopter pad	39.46198333	-75.53186667
7S1	0.14 mi. SE	39.46168333	-75.53411667
8S1	0.15mi. SSE; fuel oil storage	39.46138333	-75.53428333
9S1	0.18mi. S; fuel oil storage	39.4606	-75.53485
10S1	0.09 mi. SSW; circulating water building.	39.46166667	-75.536
11S1	0.08 mi. SW; service water building.	39.46198333	-75.53708333
12S1	0.06 mi. WSW; outside security fence	39.4626	-75.53726667
13S1	0.09 mi. W; outside security fence	39.46335	-75.53778333
14S1	0.16 mi. NNW; outside security fence	39.46476667	-75.53796667
15S1	0.54 mi. NW; near river and barge slip	39.46935	-75.54208333
15S2	0.57 mi NW, near Hope Creek barge slip	39.46988333	-75.54216667
16S1	0.56 mi. NNW; on road near fuel oil storage tank	39.47033333	-75.54046667
16S2	0.58 mi. NNW; near security firing range	39.47125	-75.5381
16S3	0.87 mi NNW, Consolidated Spoils Facility	39.47451667	-75.54283333
4D2	3.97 mi. ENE; Alloway Creek Neck Road	39.4882	-75.46958333
5D1	3.50 mi. E; local farm	39.47326667	-75.47223333
10D1	3.89 mi. SSW; Taylor's Bridge Spur	39.41021667	-75.56221667
14D1	3.43 mi. WNW; Bay View, Delaware	39.48766667	-75.59201667

TABLE E-1: REMP SAMPLE LOCATIONS (Continued)

STATION CODE	STATION LOCATION*	LATITUDE	LONGITUDE
		Decimal Degrees	Decimal Degrees
A. Direct Radiation Monitoring Locations (IDM) (Continued)			
15D1	3.87 mi. NW; Rt 9, Augustine Beach, Delaware	39.50208333	-75.588
2E1	4.43 mi. NNE; local farm	39.523	-75.50713333
3E1	4.13 mi. NE; local farm	39.50163333	-75.47743333
11E2	4.97 mi. SW; Route 9	39.40546667	-75.59243333
12E1	4.40 mi. WSW; Thomas Landing	39.4477	-75.61613333
13E1	4.07 mi. W; Diehl House Lab	39.46648333	-75.61225
16E1	4.05 mi. NNW; Port Penn	39.5127	-75.57633333
1F1	5.73 mi. N; Fort Elfsborg	39.54488333	-75.51873333
2F2	8.51 mi. NNE; Salem Substation	39.5748	-75.46938333
2F5	7.29 mi. NNE; Salem High School	39.55746667	-75.47523333
2F6	7.45 mi. NNE; PSEG EERC Salem New Jersey	39.56188333	-75.48031667
3F2	5.10 mi. NE; Hancocks Bridge, New Jersey Municipal Building	39.50683333	-75.45963333
3F3	8.66 mi. NE; Quinton Township Elementary School New Jersey	39.5436	-75.41225
4F2	5.98 mi. ENE; Mays Lane, Harmersville, New Jersey	39.49921667	-75.4346
5F1	6.40 mi. E; Canton, New Jersey	39.47266667	-75.41718333
6F1	6.46 mi. ESE; Stow Neck Road	39.43993333	-75.41913333
7F2	8.96 mi. SE; Bayside, New Jersey	39.38285	-75.40435
8F1	9.61 mi. SE; Woodland Beach, Delaware	39.33221667	-75.47438333
9F1	5.49 mi. S; off Route 9, Delaware	39.38403333	-75.54916667
10F2	5.73 mi. SSW; Route 9, Delaware	39.3839	-75.5692
11F1	5.97 mi. SW; Taylors Bridge, Delaware	39.41276667	-75.6272
12F2	9.35 mi. WSW; Townsend Elementary School, Delaware	39.3963	-75.68851667

TABLE E-1: REMP SAMPLE LOCATIONS (Continued)

STATION CODE	STATION LOCATION*	LATITUDE	LONGITUDE
		Decimal Degrees	**Decimal Degrees**
A. Direct Radiation Monitoring Locations (IDM) (Continued)			
13F2	6.44 mi. W; Odessa, Delaware	39.45495	-75.6562
13F3	9.26 mi. W; Redding Middle School, Middletown, Delaware	39.45358333	-75.70905
13F4	9.80 mi. W; Middletown, Delaware	39.44761667	-75.71851667
14F2	6.62 mi. WNW; Route 13 and Boyds Corner Road	39.49965	-75.6507
15F3	5.39 mi. NW	39.51645	-75.60976667
16F2	8.06 mi. NNW; Delaware City Public School	39.5719	-75.59048333
1G3	18.99 mi. N; N. Church Street Wilmington, Delaware	39.73811667	-75.54186667
3G1	16.58 mi. NE; local farm	39.59855	-75.28006667
10G1	11.53 mi. SSW; Smyrna, Delaware	39.30371667	-75.60158333
14G1	13.38 mi. WNW; Route 286, Bethel Church Road., Delaware	39.5215	-75.77491667
16G1	15.09 mi. NNW; Wilmington Airport	39.67728333	-75.59283333
3H1	32.76 mi. NE; National Park, New Jersey	39.85998333	-75.19933333
B. Air Sampling Locations (AIO,APT)			
5S1	0.89 mi. E; site access road	39.46113333	-75.51978333
5S2	0.90 mi. E; site access road (duplicate sample)	39.46086667	-75.51968333
7S2	0.20 mi. SE; old Salem parking lot	39.46171667	-75.53255
15S2	0.57 mi. NW, near Hope Creek barge slip	39.46988333	-75.54216667
5D1	3.50 mi. E; local farm	39.47326667	-75.47223333
16E1	4.05 mi. NNW; Port Penn	39.5127	-75.57633333
1F1	5.73 mi. N; Fort Elfsborg	39.54488333	-75.51873333
2F6	7.45 mi. NNE; PSEG EERC Salem New Jersey	39.56188333	-75.48031667
14G1	13.38 mi. WNW; Route 286, Bethel Church Road, Delaware	39.5215	-75.77491667

TABLE E-1: REMP SAMPLE LOCATIONS (Continued)

STATION CODE	STATION LOCATION*	LATITUDE	LONGITUDE
		Decimal Degrees	Decimal Degrees
C. Surface Water Locations (SWA) - Delaware River			
11A1	0.19 mi. SW; Salem outfall area	39.46051135	-75.53809583
11A1a	Alternate 0.15 SE; barge slip area	39.461667	-75.53375
12C1	1.81 mi. WSW; West bank of Delaware River	39.45366667	-75.568
12C1a	Alternate 3.71 mi. WSW at the tip of Augustine Beach Boat Ramp	39.50472222	-75.58
7E1	4.42 mi. SE; 1.0 mi. west of Mad Horse Creek	39.418	-75.47733333
7E1a	Alternate 9.27 mi SE end of Bayside Road	39.37616667	-75.404
1F2	7.28 mi. N; midpoint of Delaware River	39.56783333	-75.55166667
16F1	6.89 mi. NNW; C&D Canal	39.55916667	-75.57083333
16F1a	Alternate 6.52 mi. NNW; tip of C&D Canal	39.55566667	-75.55933333
D. Ground Water Locations (WWA)			
3E1	4.13 mi. NE; local farm	39.50163333	-75.47743333
No groundwater samples are required as liquid effluents discharged from Hope Creek and Salem Generating Stations do not directly affect this pathway. However, this location (3E1) is being monitored as a management audit sample			
E. Drinking Water Locations (PWR, PWT)			
2F3	7.85 mi NNE, City of Salem Water and Sewage Dept.	39.55666667	-75.453
No public drinking water samples or irrigation water samples are required as these pathways are not directly affected by liquid effluents discharged from Hope Creek and Salem Generating Stations. However, this location (2F3) is being monitored as a management audit sample			

TABLE E-1: REMP SAMPLE LOCATIONS (Continued)

STATION CODE	STATION LOCATION*	LATITUDE	LONGITUDE
		Decimal Degrees	**Decimal Degrees**
F. Water Sediment Locations (ESS)			
11A1	0.19 mi. SW; Salem outfall area	39.46051135	-75.53809583
15A1	0.65 mi. NW; Hope Creek outfall area	39.4709	-75.5434
16A1	0.64 mi. NNW; south storm drain outfall	39.47066667	-75.543
12C1	1.81 mi. WSW; West bank of Delaware River	39.45366667	-75.568
7E1	4.42 mi. SE; 1.0 mi. west of Mad Horse Creek	39.418	-75.47733333
16F1	6.89 mi. NNW; C&D Canal	39.55916667	-75.57083333
6A1	0.27 mi. ESE; near shoreline	39.461135	-75.531853
G. Milk Sampling Locations (MLK)			
2G3	11.85 mi. NNE, local farm	39.6035	-75.40883333
3G1	16.58 mi. NE; local farm	39.59855	-75.28006667
13E3	4.62 mi W, local farm	39.45283333	-75.62166667
14F4	8.04 mi. WNW; local farm	39.50733333	-75.67533333
H. Fish and Invertebrate Locations (ESF, ECH)			
11A1	0.19 mi. SW; Salem outfall area	39.46051135	-75.53809583
12C1	1.81 mi. WSW; West bank of Delaware River	39.45366667	-75.568
7E1	4.42 mi. SE; 1.0 mi. west of Mad Horse Creek	39.418	-75.47733333

TABLE E-1: REMP SAMPLE LOCATIONS (Continued)

STATION CODE	STATION LOCATION*	LATITUDE	LONGITUDE
		Decimal Degrees	Decimal Degrees
I. Food Product Locations (FPL, FPV)			
1S1	0.56 mi. N	39.47103333	-75.53698333
7S2	0.20 mi. SE; old Salem parking lot	39.46171667	-75.53255
15S2	0.57 mi. NW, near Hope Creek barge slip	39.46988333	-75.54216667
16S1	0.56 mi. NNW; on road near fuel oil storage tank	39.47033333	-75.54046667
10D1	3.89 mi. SSW; Taylor's Bridge Spur	39.41021667	-75.56221667
The Delaware River at the location of Salem and Hope Creek Nuclear Power Plants is a brackish water source. No irrigation of food products is performed using water in the vicinity from which liquid plant wastes have been discharged. However, 12 management audit food samples are collected from various locations			
*All distances and directions for the Station Locations are referenced to the midpoint between the two Salem units' containments. The WGS 84 coordinates for this site center point location are: Latitude N 39° - 27' – 46.5" and Longitude W 75° - 32' – 10.6".			

TABLE E-2: SAMPLES COLLECTION AND ANALYSIS

SAMPLE	COLLECTION METHOD	ANALYSIS
Air Particulate	Continuous low volume air sampler. Sample collected every week along with the filter change.	Gross Beta analysis on each weekly sample. Gamma spectrometry shall be performed if gross beta exceeds10 times the yearly mean of the control station value. Samples shall be analyzed 24 hours or more after collection to allow for radon and thorium daughter decay. Gamma isotopic analysis on quarterly composites.
Air Iodine	A TEDA impregnated charcoal cartridge is connected to air particulate air sampler and is collected weekly at filter change.	Iodine 131 analysis are performed on each weekly sample.
Crab and Fish	Two batch samples are sealed in a plastic bag or jar and frozen semi-annually or when in season.	Gamma isotopic analysis of edible portion on collection.
Sediment	A sediment sample is taken semi-annually.	Gamma isotopic analysis semi-annually.
Direct	2 PD's will be collected from each location quarterly.	Gamma dose quarterly.
Milk	Sample of fresh milk is collected for each farm semi-monthly when cows are in pasture, monthly at other times.	Gamma isotopic analysis and I-131analysis on each sample on collection.
Water (Potable)	Sample to be collected monthly.	Gamma isotopic monthly and H-3 monthly
Water (Surface)	Sample to be collected semi-monthly providing winter icing conditions allow.	Gamma isotopic on monthly composite and H-3 on quarterly composite.

FIGURE E-1: ON-SITE SAMPLING LOCATIONS - LOCATIONS 0 TO 1 MILE

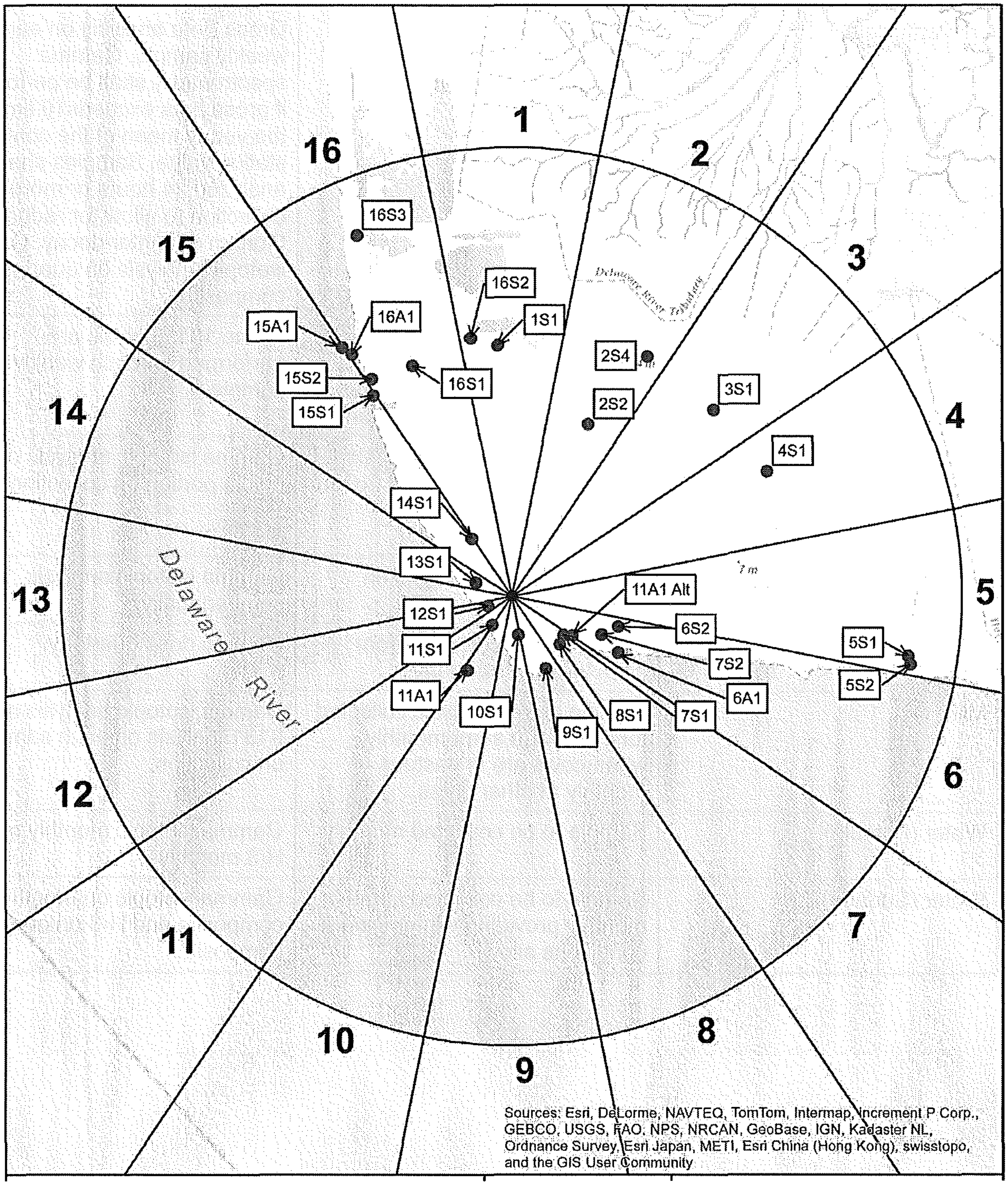


FIGURE E-2: OFF-SITE SAMPLING LOCATIONS - LOCATIONS 1 TO 10 MILES

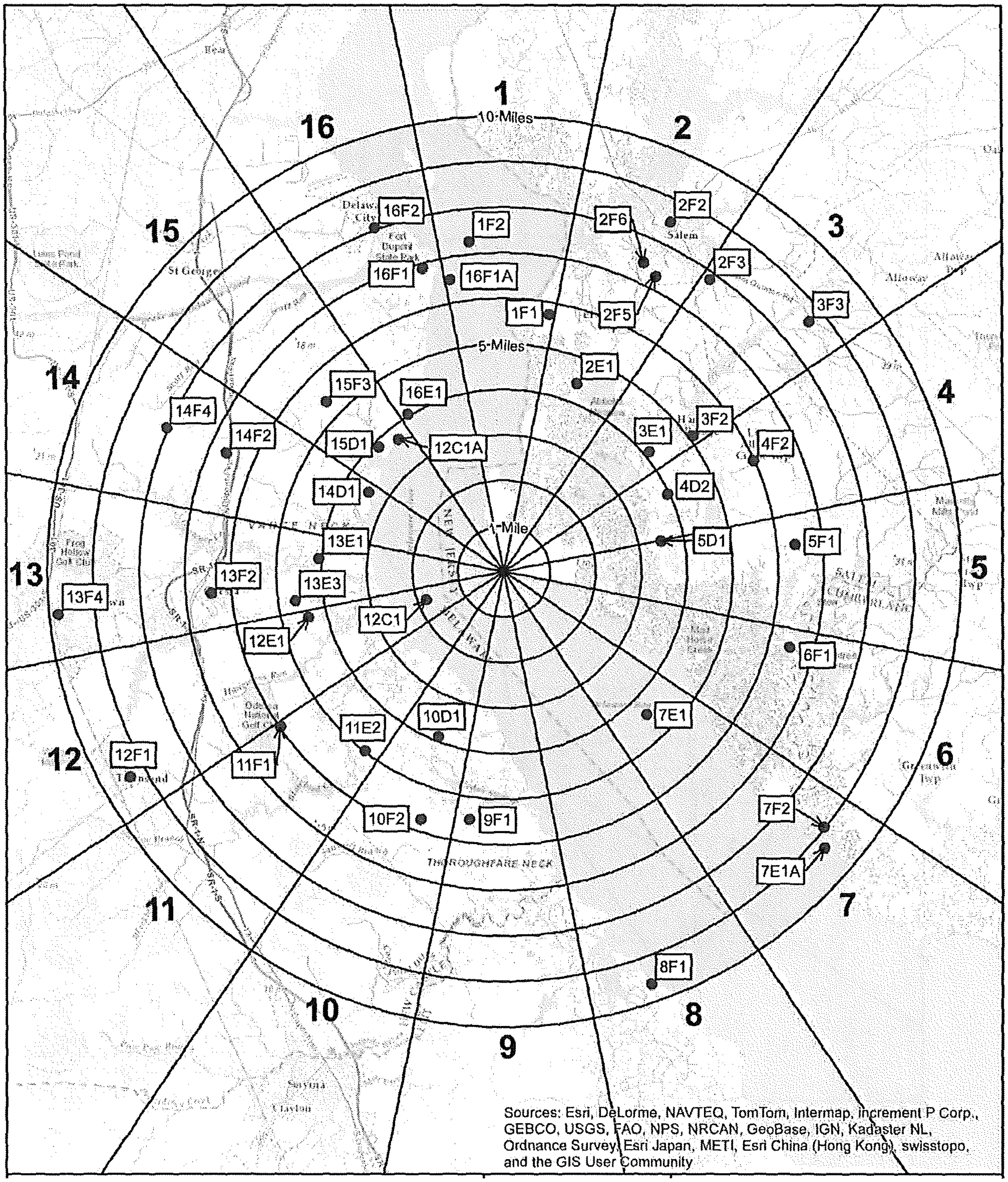
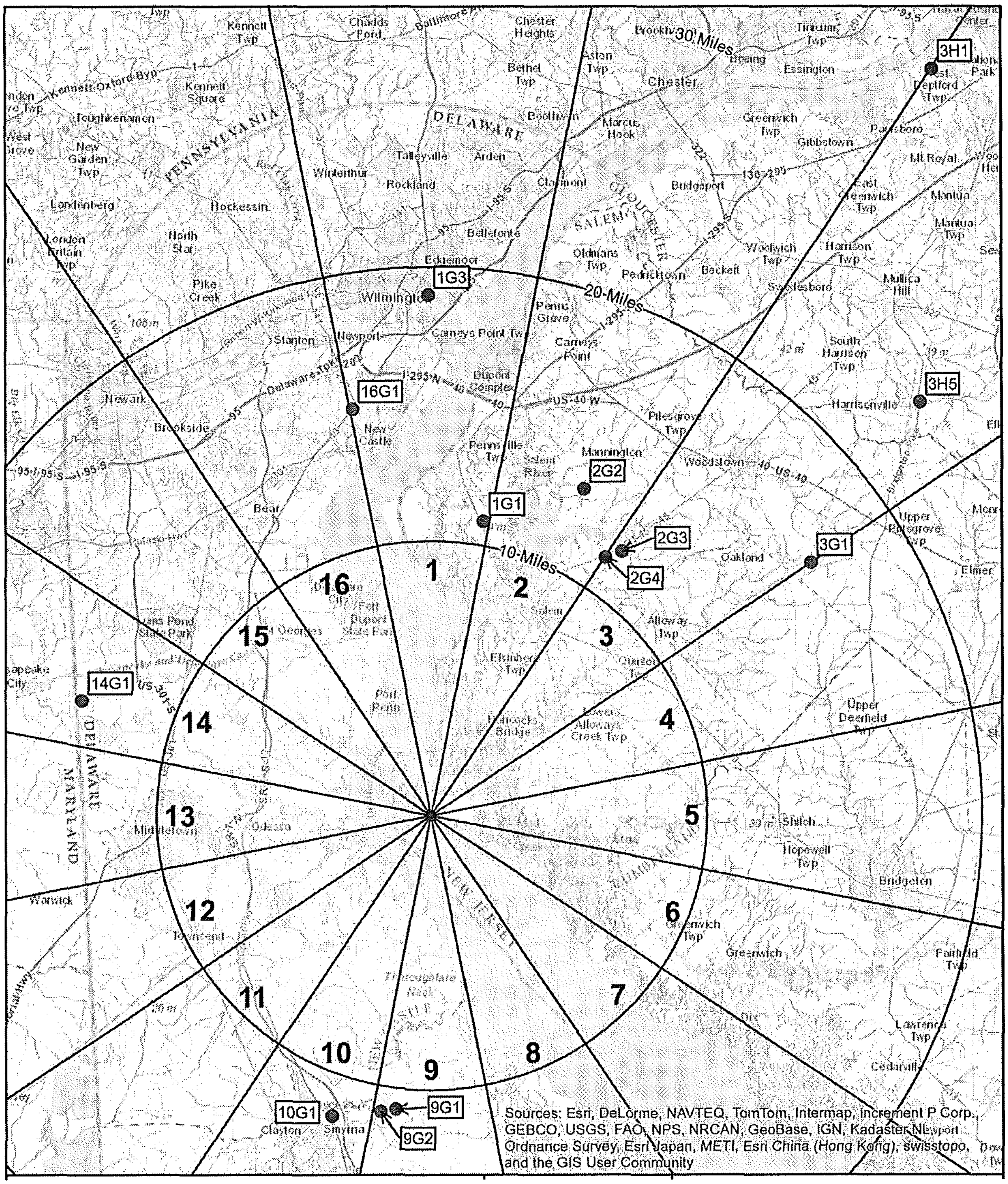


FIGURE E-3: OFF-SITE SAMPLING LOCATIONS - LOCATIONS GREATER THAN 10 MILES



APPENDIX F

MAXIMUM PERMISSIBLE CONCENTRATIONS

LIQUID EFFLUENTS

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

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

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS

Element	Isotope	Soluble Conc. (uCi/ml)	Insoluble Conc. (uCi/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
	Am-244	5E-3	5E-3
Antimony (51)	Sb-122	3E-5	3E-5
	Sb-124	2E-5	2E-5
	Sb-125	1E-4	1E-4
	Sb-126	3E-6	3E-6
Arsenic (33)	As-73	5E-4	5E-4
	As-74	5E-5	5E-5
	As-76	2E-5	2E-5
	As-77	8E-5	8E-5
Astatine (85)	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
	Br-83	3E-6	3E-6
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

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS (CONTINUED)

Element	Isotope	Soluble Conc. (uCi/ml)	Insoluble Conc. (uCi/ml)
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
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
	Cs-137	2E-5	4E-5
Chlorine (17)	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
	Cm-249	2E-3	2E-3
Dysprosium (66)	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

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS (CONTINUED)

Element	Isotope	Soluble Conc. (uCi/ml)	Insoluble Conc. (uCi/ml)
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
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-130	3E-6	3E-6
	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
Lead (82)	Pb-203	4E-4	4E-4
	Pb-210	1E-7	2E-4
	Pb-212	2E-5	2E-5

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS (CONTINUED)

Element	Isotope	Soluble Conc. (uCi/ml)	Insoluble Conc. (uCi/ml)
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
	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

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS (CONTINUED)

Element	Isotope	Soluble Conc. (uCi/ml)	Insoluble Conc. (uCi/ml)
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-103m	3E-6	3E-6
	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

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS (CONTINUED)

Element	Isotope	Soluble Conc. (uCi/ml)	Insoluble Conc. (uCi/ml)
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
	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
	Te-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

TABLE F-1: MAXIMUM PERMISSIBLE CONCENTRATIONS (CONTINUED)

Element	Isotope	Soluble Conc. (uCi/ml)	Insoluble Conc. (uCi/ml)
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
	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 radio-nuclide 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 radio- nuclide not listed above, which decays by alpha emission or spontaneous fission.		3E-8	3E-8

1. If the identity of any radionuclide is not known, the limiting values for purposes of this table shall be: 3E-8 uCi/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").