CONNECTICUT YANKEE ATOMIC POWER COMPANY

HADDAM NECK PLANT
362 INJUN HOLLOW ROAD • EAST HAMPTON, CT 06424-3099

April 30, 2003

Docket No. 50-213
CY-03-046

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Haddam Neck Plant
Annual Radioactive Effluent Report

In accordance with the requirements of 10CFR50.36a and Technical Specifications, Section 6.7.3, a copy of the Annual Radioactive Effluent Report is included as Attachment 1. It covers the period of January through December 2002. This report includes a summary of the quantities of solid radioactive waste and liquid and gaseous effluents, as well as a summary of the assessment of maximum individual and population dose resulting from routine radioactive airborne and liquid effluents.

Additionally, this report is submitted to the Connecticut Department of Environmental Protection in accordance with Section 4(D) of the NPDES Permit (Permit ID: CT00003123).

Revision 15 of the Radiological Effluent Monitoring and Offsite Dose Calculation Manual (REMODCM) and a list of the associated changes are included as Attachment 2.

If you have any questions regarding this submittal, please call Mr. Gerry van Noordennen, Manager of Regulatory Affairs at (860) 267-3938.

Sincerely,

Noah W. Fetherston
Site Manager

Attachments: (1) Annual Radioactive Effluent Report
(2) Revision 15 to Radiological Effluent Monitoring and Offsite Dose Calculation Manual, and List of Changes

cc: H. J. Miller, NRC Region I Administrator
T. B. Smith, NRC Project Manager
R. R. Bellamy, Chief, Decommissioning and Laboratory Branch, NRC Region I
Dr. E. L. Wilds, Jr., Director, CT DEP Monitoring and Radiation Division
M. Rosenstein, US EPA, Region 1

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ANNUAL RADIOACTIVE EFFLUENT REPORT

HADDAM NECK STATION

RADIOLOGICAL EFFLUENT CONTROLS PROGRAM

JANUARY 1, 2002 - DECEMBER 31, 2002

DOCKET NO. 50-213
LICENSE NO. DPR-61

CONNECTICUT YANKEE ATOMIC POWER COMPANY
Haddam, Connecticut

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1.0 Introduction

As required by the Haddam Neck Plant Technical Specification Safety Manual (TSSM), Section 6.7.3, this Annual Radioactive Effluent Release Report for the year 2002 is submitted in accordance with 10 CFR 50.36a, "Technical Specifications on effluents from nuclear power reactors." A summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the Haddam Neck Facility is presented in this document. The material provided is consistent with the objectives outlined in the Radiological Effluent Monitoring and Offsite Dose Calculation Manual (REMODCM). The information submitted is formatted to the general outline 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."

Haddam Neck is currently in the process of decommissioning. In support of the decommissioning effort, radioactive liquid was processed and batch released from the Test and Temporary Tanks in 2002. The radwaste system utilized filters and demineralizers to process radioactive liquid prior to release to the environment. The RCA Yard Drain System is categorized as a continuous release liquid pathway. The major contributor to this release point during 2002 was rainwater collecting in the system catch basins. The collected liquid will cascade flow as a release to the environment. During this report period, an unplanned liquid release to the RCA Yard Drain System occurred in December 2002. This release is discussed in section 6.2.4.

As the decommissioning project creates new potential gaseous release pathways, baseline data will be collected and, if necessary, the release point will be added to the monitoring program. The Alternate Containment Access, Cable Vault, Containment Foyer, Tank Farm Tent and Terry Turbine are examples of miscellaneous pathways that are routinely monitored.

2.0 Summary

The radioactive effluent monitoring program for 2002 was conducted in accordance with Haddam Neck TSSM section 6.6.4. The results of the monitoring program indicate that the Haddam Neck Plant was successful in maintaining radioactive effluent releases to the environment as low as reasonably achievable.

A general overview of the radioactive gaseous releases to the environment during 2002 is summarized below:

- The total whole body dose due to gaseous radioactivity released was 2.95E-03 mrem. This is approximately 0.06% of the allowable limit.
- The maximum organ dose due to gaseous radioactivity was 6.37E-02 mrem. This is approximately 0.43% of the allowable limit.

- The calculated beta air dose due to noble gases was 0 mrad.
- The calculated gamma air dose due to noble gases was 0 mrad.
- The total gaseous tritium released was 1.53 curies.
- The total gaseous particulate activity released was 4.49E-05 curies.
- The total gaseous gross alpha activity released was 0 curies.
- The total gaseous Sr-90 activity released was 0 curies.

A general overview of the radioactive liquid releases to the environment during 2002 is summarized below:

- The total whole body dose due to liquid radioactivity released was 0.122 mrem. This is approximately 4.1% of the allowable limit.
- The maximum organ dose due to liquid radioactivity released was 0.192 mrem. This is approximately 1.9% of the allowable limit.
- The total volume of radioactive liquid processed and batch released was 230,040 gallons. The estimated total volume of radioactive liquid continuously released from the RCA Yard Drain System was 360,450 gallons.
- The total amount of radioactivity from liquids released to the environment was 2.15 curies.
- Of the total curies released, 2.13 were attributed to tritium and 0.02 curies from all other nuclides.

The effluent dose contributions for this report period are significantly less than regulatory limits and natural background dose contributions.

A review of the radioactive waste program showed 10,000 cubic meters of solid waste containing 3,030 curies of radioactivity was shipped offsite for processing or disposal.

3.0 Supplemental Information

3.1 Overview of the Radioactive Effluent Controls Program

This program conforms to 10 CFR 50.36a for the control of radioactive effluents and for maintaining the dose to MEMBERS OF THE PUBLIC from radioactive effluents as low as reasonably achievable. The program shall be contained in the REMODCM, shall be implemented by procedures, and shall include remedial actions to be taken whenever the program limits are exceeded. The program shall include the following elements:

a. Limitations on the functional capability of radioactive liquid and gaseous monitoring instrumentation, including surveillance tests and set point determinations, in accordance with the methodology described in the REMODCM;

b. Limitations on the concentrations of radioactive material released in liquid effluents to unrestricted areas, conforming to the pre-1994 concentration values in 10 CFR Part 20, Appendix B (to 20.1 to 20.602), Table II, Column 2;

c. Monitoring, sampling, and analysis of radioactive liquid and gaseous effluents in accordance with 10 CFR 20.106 and with the methodology and parameters described in the REMODCM;

d. Limitations on the annual and quarterly doses or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released from the facility to unrestricted areas, conforming to 10 CFR Part 50, Appendix I;

e. Determination of cumulative and projected dose contributions from radioactive effluents for the current calendar quarter and current calendar year in accordance with the methodology and parameters described in the REMODCM (performed at least every 92 days);

f. Limitations on the functional capability and use of the liquid and gaseous effluent treatment systems to ensure that appropriate portions of these systems are used to reduce releases of radioactivity when the projected doses in a period of 31 days would exceed 2% of the guidelines for the annual dose or dose commitment, conforming to 10 CFR Part 50, Appendix I;

g. Limitations on the dose rate resulting from radioactive material released in gaseous effluents from the site to areas at or beyond the SITE BOUNDARY shall be as follows;

   1. for noble gases: less than or equal to a dose rate of 500 mrem/yr to the total body and less than or equal to a dose of 3000 mrem/yr to the skin; and

   2. for tritium and all radionuclides in particulate form with half-lives greater than 8 days: less than or equal to a dose rate of 1500 mrem/yr. to any organ;

h. Limitations on the annual and quarterly air doses from noble gases released in gaseous effluents from the unit to areas beyond the SITE BOUNDARY, conforming to 10 CFR Part 50, Appendix I;

i. Limitations on the annual and quarterly doses to a MEMBER OF THE PUBLIC from tritium and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released from each facility to areas beyond the SITE BOUNDARY, conforming to 10 CFR Part 50, Appendix I; and

j. Limitations on the annual dose or dose commitment to any MEMBER OF THE PUBLIC at points beyond the SITE BOUNDARY due to releases of radioactivity and to radiation from uranium fuel cycle sources, conforming to 40 CFR Part 190.

3.2 Maximum Permissible Concentration

3.2.1 Gaseous Effluents

The applicable limits for gaseous effluents are expressed in terms of dose rate at the site boundary.

3.2.2 Liquid Effluents

The values specified in 10 CFR Part 20, Appendix B, Table 2, Column 2, (pre-1994 edition), were used as the limits for radioactive effluents released to unrestricted areas.

3.3 Measurements and Approximation of Total Activity

3.3.1 Gaseous Radioactive Effluents

Gaseous effluent release pathways were sampled and analyzed weekly for tritium and noble gas. Particulate release pathways were continuously sampled using air filters. The particulate filters were analyzed weekly for gamma radioactivity, monthly for gross alpha and gross beta activity. Particulate filters exhibiting a positive gross beta were saved for quarterly Sr-90 analysis. The results for radioactivity from gaseous effluents and the effluent flow rate were used to determine the total amount of activity released.

The following estimates for the uncertainty associated with gaseous sample analysis stem from a composite of variances in effluent flow rates, instrumentation tolerances and low level counting statistics.

Tritium	25%
Fission and Activation Products	25%
Gross Alpha, Sr-90	25%
Noble Gas	25%

3.3.2 Liquid Radioactive Effluents

Each batch release was sampled and analyzed for gamma emitting radionuclides prior to release. Composite samples were analyzed monthly for gross alpha and quarterly for Fe-55 and Sr-90. The results of the composite analyses from the previous month or quarter were used to estimate the quantities of these radionuclides in liquid effluents during the current month or quarter. The total radioactivity in liquid effluent releases was determined from the measured concentrations of each radionuclide present and the total volume of the effluent released during periods of discharge.

If required, the RCA Yard Drain continuous release pathway was sampled with an automatic composite sampler or by obtaining daily grab samples. Composites were analyzed each week for gamma emitting radionuclides and tritium. Analyses were performed to the minimum detection levels for environmental media. Composite samples were analyzed monthly for gross alpha and quarterly for Fe-55 and Sr-90. The results of the composite analyses from the previous month or quarter were used to estimate the quantities of these radionuclides in liquid effluents during the current month or quarter. The total radioactivity in liquid effluent releases was determined from the measured concentrations of each radionuclide present and the total volume of the effluent released during the period of discharge.

The following estimates for the uncertainty associated with liquid sample analysis stem from a composite of variances in effluent flow rates, instrumentation tolerances and low level counting statistics.

Tritium	25%
Fission and Activation Products	25%
Gross Alpha	25%
Sr-90, Fe-55	25%

3.4 Batch Releases

3.4.1 Airborne Effluents

None

3.4.2 Liquid Effluents

Number of Batches:	15
Total Time (min.):	3392
Maximum Time (min.):	286
Average Time (min.):	226
Minimum Time (min.):	190
Average dilution flow during releases:	Batch = 214 cfs
	Continuous = 34.5 cfs

3.5 Abnormal Releases

An unplanned liquid release occurred to the RCA Yard Drain System. Condition Report (03-005) was generated and is discussed in section 6.2.4.

4.0 Dose Calculation Methodology

4.1 Airborne Effluents

Maximum individual doses and population doses due to the release of noble gases and particulates were calculated using the computer program GASPAR II. GASPAR II is used by the staff of the NRC to perform environmental dose analyses for releases of radioactive effluents from nuclear power plants into the atmosphere. The program estimates radiation dose to individuals and population groups from inhalation, ingestion (terrestrial foods), and external-exposure (ground and plume) pathways. Additional information related to the GASPAR II program is in NUREG/CR-4653, "GASPAR II –Technical Reference and User Guide".

The values of average relative effluent concentration (χ/Q) and average relative deposition (D/Q) used in GASPAR II to determine population doses were generated using a meteorological computer code which implements the assumptions cited in Section C, NRC Regulatory Guide 1.111. These values were generated in 1999, the last year that real time data was collected. The χ/Q and D/Q values used in the GASPAR II program to determine maximum individual doses were obtained from Appendix F of the REMODCM. Separate values were used for the growing season (defined as April-December) and non-growing season (defined as January-March).

Continuous mixed mode releases from the Main Stack (175 ft) include the Reactor Containment, temporary tent enclosing the tank farm and the Primary Auxiliary Building Ventilation. The Spent Fuel Pool Spray Cooling, Spent Fuel Building Exhaust and other miscellaneous monitored release points are considered continuous ground level releases.

GASPAR II calculates the maximum individual and population doses to the whole body, GI-tract, bone, liver, kidney, thyroid, lung, and skin from each of the following pathways: direct exposure from the plume and ground deposition, inhalation, and ingestion of vegetation, cow's milk, and meat. The doses are calculated for adults, teenagers, children, and infants separately.

To determine compliance with 10CFR50, Appendix I, the maximum whole body dose to an individual only includes the external pathways (i.e. plume and ground exposure) while the maximum organ dose to an individual only includes the internal pathways (inhalation and ingestion). All applicable pathways were included for the population doses.

The off-site dose commitments from airborne effluents are presented in Table 1.

4.2 Liquid Effluents

Maximum individual and population doses from the release of radioactive liquid effluents were calculated using the computer program LADTAP II. LADTAP II is a NRC computer program, which performs environmental dose analyses for releases of radioactive effluents from nuclear power plants into surface waters. The program estimates radiation dose to individuals, population groups, and biota from ingestion (aquatic foods, water, and terrestrial irrigated foods) and external exposure (shoreline, swimming, and boating) pathways. Additional information relating to the LADTAP II program is in NUREG/CR-4013, "LADTAP II –Technical Reference and User Guide".

At Haddam Neck, the algae, drinking water, and irrigated food pathways do not exist; and therefore were not included in the totals. Doses are calculated for the whole body, skin, thyroid, GI-LLI, bone, liver, kidney, and lung. Calculations are performed separately for adults, teenagers, and children.

The off-site dose commitments from liquid effluents are presented in Table 2.

5.0 Evaluation of Results

5.1 Total Offsite Dose

The dose commitments calculated using the release data for this report period are compared to 10 CFR Part 50, Appendix I, in Table 3, and compared to 40 CFR Part 190 limits in Table 4.

The whole body and maximum organ total doses for each month in this report period are presented in Figure 9. The contributions shown were calculated using Method 1 in the REMODCM for gaseous and liquid contributions. As expected, the total dose increased in the months corresponding to larger volumes of liquid being released.

The effluent dose contributions for this report period are significantly less than regulatory limits and natural backgrounds dose contribution.

5.2 Gaseous Effluents

The total activity released from all gaseous effluent pathways is summarized in Table 5. Each pathway's contribution to the total activity released is shown in Tables 6-9. The figures described below were used to identify trends for this report period:

- The monthly maximum organ dose compared to the total year to date dose is presented in Figure 5. The calculations were performed using Method 1 in the REMODCM. The contribution for each month remained consistent throughout this report period.

- The tritium released for each month from the Main Stack pathway is presented in Figure 6. Periods of increased tritium releases correspond with variations in containment ventilation, and environmental conditions (changes in outside weather, temperature inversions, conditions in the Containment).
- The tritium released for each month from the Spent Fuel Building pathway is presented in Figure 7.
- The release rates (uCi/hr) for specific nuclides from the Spray Cooling System are shown in Figure 8. The release rates are consistent for this report period.

The monthly doses calculated using Method 1 in the REMODCM were conservatively higher than the calculations using GASPAR II for this report. The REMODCM includes adjustment factors for Method 1 that if used, would have corrected the monthly dose calculations to be within 22% of the doses calculated for this report (GASPAR II). This indicates the methodology currently used in the monthly calculations includes the necessary conservatism to ensure limitations are not exceeded.

5.3 Liquid Effluents

The total activity released from all liquid effluent pathways is summarized in Table 10. Each pathway's contribution to the total activity released is presented in Tables 11 and 12. The volume released from batch discharges during this report period are presented in Table 13. The figures described below were used to identify trends for this report period:

- The monthly whole body and maximum organ doses compared against the total year to date is presented in Figure 1. The calculations were performed using Method 1 in the REMODCM. As expected, the doses increase for the periods corresponding to large volumes of liquid waste being discharged.
- Specific contributions from individual nuclides released to the environment from batch discharges are presented in Figure 2. As expected, increases in radioactivity released corresponded to larger volumes of water being discharged.
- Specific contributions from individual nuclides released to the environment from the RCA Yard Drain System are presented in Figures 3 and 4. The major contributor to this release point is from rainfall that collects in the catch basins located in the RCA. A conservative estimate for the effluent volume is used in release calculations for this pathway.

The monthly doses calculated using Method 1 in the REMODCM were consistent with the calculations using LADTAP II for this report. The summed monthly doses calculated using Method 1 were within approximately 1% of the Whole Body and Maximum Organ calculations using LADTAPII for the year 2002. This indicates the methodology currently used in the monthly calculations includes the necessary conservatism to ensure limitations are not exceeded.

5.4 Solid Wastes

The quantities of radioactive material shipped offsite for processing or disposal are summarized in Table 14.

6.0 Related Information

6.1 Radiation Monitors Out of Service for Greater than Thirty Days.

None

6.2 Radioactive Effluent Condition Reports

6.2.1 The Spent Fuel Building Flow Rate Monitor (FIT-1104) was not calibrated within 18 months as required by the REMODCM. A procedure was developed and the flow rate monitor was calibrated. Three Condition Reports (02-0137, 02-0200 and 02-0203) were generated to resolve the lack of procedure, failed calibration and missed frequency for FIT-1104.

6.2.2 A discrepancy between Technical Specification 6.6.4.c and the REMODCM was identified. The Technical Specification references 10CFR20.1302 and the REMODCM references 10CFR20.106. Since Connecticut Yankee utilizes pre-1994 10CFR20 tables for the Maximum Permissible Concentrations allowed for release to the environment, the reference to 10CFR20.1302 was an error that occurred while processing Technical Specifications Amendment 195. A Condition Report (02-163) was generated in response to this finding and is being resolved by the Connecticut Yankee Licensing Department.

6.2.3 The monthly effluent dose was miscalculated for April 2002. The calculation was performed using a higher release rate than actually occurred. The calculation was corrected. A Condition Report (02-0262) was generated in response to the finding.

6.2.4 The demineralized water source being used for hydro lasing in the Reactor Cavity was radioactively contaminated. This resulted in an unplanned liquid release to the RCA Yard Drain System. The discharged liquid was collected in Yard Drain 6, a monitored liquid effluent release point in the REMODCM. The water supply to the hydro laser was from the Condensate Storage Tank (CST), which contained demineralized water at the start of the hydro lasing operations. A siphoning affect from the hydro laser hose located in the Reactor Cavity to the CST resulted in the CST becoming contaminated with Reactor Cavity liquid. A liquid dose calculation was performed for the release and included in the monthly effluent dose calculations for December 2002. A Condition Report (03-005) was generated in response to the CST contamination and the eventual unplanned release.

6.2.5 The 4th quarter 2002 Yard Drain 6 composite analysis for Fe-55 did not meet the required REMODCM LLD. An offsite vendor laboratory performed the analysis for Connecticut Yankee. Additional sample was shipped to the laboratory and the re-analysis for Fe-55 was below the REMODCM required LLD. A Condition Report (03-0143) was generated to document the re-analysis on the composite sample.

7.0 Bechtel Health Physics Technical Support Document

Bechtel Health Physics Technical Support Document, 24265-000-G65-GEHH-P0138, "Radioactivity Effluent Analysis for the Year 2002", was generated to document the calculations performed for this report. Site specific, environmental information and other input data that was necessary to complete this report are listed and discussed in the technical support document.

8.0 REMODCM Revisions in the Year 2002

Revision 15 to the REMODCM was issued June 11, 2002. A copy of revision 15 and the information to support the changes has been included with the submission of this annual report.

Table 1
2002 Off-Site Dose Commitments from Airborne Effluents
Haddam Neck

CY	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Max Air	(mrad)	(mrad)	(mrad)	(mrad)
Beta	**0**	**0**	**0**	**0**
Gamma	**0**	**0**	**0**	**0**
Max Individual	(mrem)	(mrem)	(mrem)	(mrem)
Whole Body+	**0**	**9.31E-04**	**1.79E-03**	**2.29E-04**
Skin+	**8.62E-03**	**8.22E-03**	**9.29E-03**	**1.13E-02**
Thyroid	**8.62E-03**	**8.22E-03**	**9.29E-03**	**1.13E-02**
Max Organ++	**8.62E-03**	**1.76E-02**	**2.42E-02**	**1.32E-02**
Population	(person-rem)	(person-rem)	(person-rem)	(person-rem)
Whole Body	**9.75E-04**	**1.56E-03**	**2.71E-03**	**1.89E-03**
Skin	**9.75E-04**	**1.52E-03**	**2.66E-03**	**1.88E-03**
Thyroid	**9.75E-04**	**1.49E-03**	**2.59E-03**	**1.87E-03**
Max Organ++	**9.75E-04**	**1.67E-03**	**2.88E-03**	**1.91E-03**
Avg Individual	(mrem)	(mrem)	(mrem)	(mrem)
Whole Body	**2.54E-07**	**4.07E-07**	**7.06E-07**	**4.93E-07**
Skin	**2.54E-07**	**3.97E-07**	**6.93E-07**	**4.90E-07**
Thyroid	**2.54E-07**	**3.89E-07**	**6.75E-07**	**4.88E-07**
Max Organ++	**2.54E-07**	**4.36E-07**	**7.51E-07**	**4.98E-07**

+ External doses only

++ Maximum of the following organs: Bone, GI-LLI, Kidney, Liver, Lung, Thyroid

Table 2
2002 Off-Site Dose Commitments from Liquid Effluents
Haddam Neck

CY	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Max Individual	(mrem)	(mrem)	(mrem)	(mrem)
Whole Body	**0.00E+00**	**9.00E-03**	**2.13E-03**	**1.11E-01**
Thyroid	**0.00E+00**	**6.08E-04**	**4.46E-05**	**1.13E-03**
Max Organ	**0.00E+00**	**1.43E-02**	**3.41E-03**	**1.74E-01**
Population	(person-rem)	(person-rem)	(person-rem)	(person-rem)
Whole Body	**0.00E+00**	**1.53E-01**	**3.80E-02**	**2.00E+00**
Thyroid	**0.00E+00**	**4.09E-05**	**9.15E-06**	**2.09E-04**
Max Organ	**0.00E+00**	**2.95E-01**	**7.22E-02**	**3.70E+00**
Avg Individual	(mrem)	(mrem)	(mrem)	(mrem)
Whole Body	**0.00E+00**	**3.99E-05**	**9.91E-06**	**5.22E-04**
Thyroid	**0.00E+00**	**1.07E-08**	**2.39E-09**	**5.45E-08**
Max Organ	**0.00E+00**	**7.70E-05**	**1.88E-05**	**9.65E-04**

Table 3

<u>2002 Off-Site Dose Summary</u>
Haddam Neck

Airborne Effluents

Population Dose Commitments
(total person-rem within 50 miles)

Whole Body	Thyroid	Max Organ
7.13E-03	6.92E-03	7.43E-03

Max Individual Dose/Dose Commitments vs 10CFR50, Appendix I

	Whole Body (mrem)	Max Organ (mrem)	Skin (mrem)	Gamma Air Dose (mrad)	Beta Air Dose (mrad)
II.B and II.C Limits	*5*	*15*	*15*	*10*	*20*
Haddam Neck Total	2.95E-03	6.37E-02	3.74E-02	0	0

Liquid Effluents

Population Dose Commitments
(total person-rem within 50 miles)

Whole Body	Thyroid	Max Organ
2.19	2.59E-04	4.07

Max Individual Dose/Dose Commitments vs 10CFR50, Appendix I

	Whole Body (mrem)	Max Organ (mrem)
II.A Limits	*3*	*10*
Haddam Neck Total	1.22E-01	1.92E-01

Table 4

2002 Off-Site Dose Comparison
Haddam Neck

Max Individual Annual Dose vs 40CFR190 Limits

	Whole Body (mrem)	Any Organ (mrem)	Thyroid (mrem)
40CFR190 Limit	*25*	*25*	*75*
Airborne Effluents	2.95E-03	6.37E-02	3.74E-02
Liquid Effluents	1.22E-01	1.92E-01	1.78E-03
Haddam Neck Total	1.25E-01	2.55E-01	3.92E-02

Whole Body Dose from Haddam Neck Plant vs. Background Radiation

Sources of Background Radiation:

Cosmic	27
Cosmogenic	1
Terrestial (Atlantic and Gulf Coastal Plain)	16
Inhaled	200
In the Body	40

CT Resident Whole Body Dose from Background	**284 mrem**

CT Resident (within 50 miles) Whole Body Dose from Haddam Neck Plant Airborne and Liquid Effluents	**5.73E-04 mrem**

Maximum Individual (within 50 miles) Whole Body Dose from Haddam Neck Plant Airborne and Liquid Effluents	**1.25E-01 mrem**

Table 5

Haddam Neck

Airborne Effluents - Total Release Summary

	Units	2002				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
1. Total Activity Released	Ci	-	-	-	-	-
2. Average Release Rate	uCi/sec	-	-	-	-	-
B. Iodines						
1. Total Activity Released	Ci	-	-	-	-	-
2. Average Release Rate	uCi/sec	-	-	-	-	-
C. Particulates						
1. Total Activity Released	Ci	-	2.37E-05	1.75E-05	3.66E-06	4.49E-05
2. Average Release Rate	uCi/sec	-	3.01E-06	2.21E-06	4.61E-07	1.42E-06
D. Gross Alpha						
1. Total Activity Released	Ci	-	-	-	-	-
2. Average Release Rate	uCi/sec	-	-	-	-	-
E. Tritium						
1. Total Activity Released	Ci	3.14E-01	2.99E-01	4.99E-01	4.13E-01	1.53E+00
2. Average Release Rate	uCi/sec	4.04E-02	3.81E-02	6.28E-02	5.19E-02	4.84E-02

Table 6
Haddam Neck
Airborne Effluents - Mixed Mode Continous
Main Stack

Nuclides Released	Units	2002				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

A. Fission & Activation Gases

	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

B. Iodines

I-131	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

C. Particulates

Co-60	Ci	-	-	-	-	-
Cs-137	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

D. Gross Alpha

Gross Alpha	Ci	-	-	-	-	-

E. Tritium

H-3	Ci	-	-	1.77E-01	-	1.77E-01

- (For Fission & Act Gas) = Not Required to be analyzed.
- (For Iodine's) = Not Required to be analyzed.
- (For Particulates) = < Lower Limit of Detection as specified in the REMODCM
- (For Gross Alpha) = < Lower Limit of Detection as specified in the REMODCM

Table 7
Haddam Neck
Airborne Effluents - Ground Continuous
Spent Fuel Building Exhaust

Nuclides Released	Units	2002				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
B. Iodines						
I-131	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
C. Particulates						
Cs-137	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-
E. Tritium						
H-3	Ci	3.14E-01	2.99E-01	3.22E-01	4.13E-01	1.35E+00

- (For Fission & Act Gas) = < Lower Limit of Detection as specified in the REMODCM
- (For Iodine's) = Not Required to be analyzed
- (For Particulates) = < Lower Limit of Detection as specified in the REMODCM
- (For Gross Alpha) = < Lower Limit of Detection as specified in the REMODCM

Table 8
Haddam Neck
Airborne Effluents - Ground Continuous
Spent Fuel Spray Cooling

Nuclides Released	Units	2002				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

A. Fission & Activation Gases

	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

B. Iodines

I-131	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

C. Particulates

Fe-55	Ci	-	1.39E-05	-	1.43E-06	1.53E-05
Co-60	Ci	-	8.27E-07	3.21E-06	4.14E-07	4.45E-06
Cs-134	Ci	-	5.71E-07	1.02E-06	1.17E-07	1.71E-06
Cs-137	Ci	-	8.39E-06	1.33E-05	1.70E-06	2.34E-05
Total Activity	Ci	-	2.37E-05	1.75E-05	3.66E-06	4.49E-05

D. Gross Alpha

Gross Alpha	Ci	-	-	-	-	-

E. Tritium

H-3	Ci	-	1.73E-04	2.16E-04	3.17E-05	4.21E-04

- (For Fission & Act Gas) = Not Required to be analyzed.
- (For Iodine's) = Not Required to be analyzed.
- (For Particulates) = < Lower Limit of Detection as specified in the REMODCM
- (For Gross Alpha) = < Lower Limit of Detection as specified in the REMODCM

Table 9

Haddam Neck

Airborne Effluents - Ground Continuous

Miscellaneous potential release points

(Alternate Access, Containment Foyer, Cable Vault, Terry Turbine and Temporary Tank Farm Tent)

<< No Activity Detected >>

Nuclides Released	Units	2002				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
B. Iodines						
I-131	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
C. Particulates						
Co-60	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-
E. Tritium						
H-3	Ci	-	-	-	-	-

- (For Fission & Act Gas) = Not Required to be analyzed.
- (For Iodine's) = Not Required to be analyzed.
- (For Particulates) = < Lower Limit of Detection as specified in the REMODCM
- (For tritium) = Not Required to be analyzed.
- (For Gross Alpha) = < Lower Limit of Detection as specified in the REMODCM

Table 10
Haddam Neck
Liquid Effluents - Total Release Summary

	Units	2002				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission and Activation Products						
1. Total Activity Released	Ci	-	7.59E-03	7.51E-04	9.64E-03	1.80E-02
2. Average Period Diluted Activity	uCi/ml	-	2.87E-09	6.55E-10	1.84E-09	1.99E-09
B. Tritium						
1. Total Activity Released	Ci	-	3.44E-01	7.62E-02	1.71E+00	2.13E+00
2. Average Period Diluted Activity	uCi/ml	-	1.30E-07	6.65E-08	3.25E-07	2.35E-07
C. Dissolved and Entrained Gases						
1. Total Activity Released	Ci	-	-	-	-	-
2. Average Diluted Activity	uCi/ml	-	-	-	-	-
D. Gross Alpha						
1. Total Activity Released	Ci	-	1.87E-04	4.31E-05	-	2.30E-04
2. Average Diluted Activity	uCi/ml	-	7.06E-11	3.76E-11	-	2.54E-11
E. Volume						
1. Released Waste Volume	Liters	0.00E+00	2.58E+05	8.53E+04	1.34E+06	1.69E+06
2. Dilution Volume During Releases	Liters	0.00E+00	5.44E+08	1.80E+08	1.45E+09	2.17E+09
3. Dilution Volume During Period	Liters	0.00E+00	2.65E+09	1.15E+09	5.25E+09	9.05E+09

Table 11

Haddam Neck

Liquid Effluents - Batch

(Test and Temporary Tanks)

Nuclides Released	Units	2002				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Products						
Am-241	Ci	-	1.89E-04	9.61E-06	1.38E-05	2.12E-04
Co-60	Ci	-	3.36E-03	1.85E-04	2.30E-03	5.85E-03
Cs-134	Ci	-	8.65E-06	2.08E-06	1.62E-04	1.73E-04
Cs-137	Ci	-	5.07E-04	1.02E-04	6.74E-03	7.35E-03
Eu-154	Ci	-	8.85E-05	1.49E-05	-	1.03E-04
Fe-55	Ci	-	3.43E-03	4.33E-04	2.73E-04	4.14E-03
Sr-90	Ci	-	6.65E-06	4.41E-06	6.23E-06	1.73E-05
Total Activity	Ci	-	7.59E-03	7.51E-04	9.50E-03	1.78E-02
B. Tritium						
H-3	Ci	-	3.44E-01	7.62E-02	1.70E+00	2.12E+00
C. Dissolved & Entrained Gases						
	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
D. Gross Alpha						
Gross Alpha	Ci	-	1.87E-04	4.31E-05	-	2.30E-04

- (1st quarter) = Test Tanks were not released in 1st quarter, analysis not performed
- (For Fission & Act Products) = < Lower Limit of Detection as specified in the REMODCM
- (For Dissolved & Entrained Gases) = < Lower Limit of Detection as specified in the REMODCM
- (For Gross Alpha) = < Lower Limit of Detection as specified in the REMODCM

Table 12

Haddam Neck

Liquid Effluents - Continuous

(RCA Yard Drains)

Nuclides Released	Units	2002				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Products						
Sr-90	Ci	-	-	-	1.72E-06	1.72E-06
Co-60	Ci	-	-	-	1.40E-04	1.40E-04
Cs-137	Ci	-	-	4.64E-06	3.80E-06	8.44E-06
Total Activity	Ci	-	-	-	1.46E-04	1.50E-04
B. Tritium						
H-3	Ci	-	-	-	5.29E-03	5.29E-03
C. Dissolved & Entrained Gases						
[illegible]	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-

- (1st and 2nd quarters) = Analysis for Gamma and Tritium Activity were < Lower Limit of Detection as specified in the REMODCM
- (3rd and 4th quarters)
  - (For Fission & Act Products) = < Lower Limit of Detection as specified in the REMODCM
  - (For Dissolved & Entrained Gases) = Not Required to be analyzed
  - (For Gross Alpha) = < Lower Limit of Detection as specified in the REMODCM

Table 13
Monthly Liquid Release Volumes for the Test and Temporary Tanks during 2002

Month		***Volume Released (gallons)***
January		0
February		0
March		0
April		0
May		0
June		68,100
July		22,540
August		0
September		0
October		0
November		0
December		139,400
	YTD	***230,040***

Table 14
Haddam Neck
2002 Solid Waste and Irradiated Fuel Shipments

A. Solid Waste Shipped Offsite for Disposal and Estimates of Major Nuclides by Waste Class and Stream

1. Type of Waste

a. Waste Stream : Resins, Filters, and Evap Bottoms

Spent Fuel Pool Resin (3)	8-120 Cavity Filters	14-170 Insitu 2

Waste Class	Volume M^3	Curies Shipped	%Error (Ci)
A	1.24E+01	6.76E+01	+/-25%
B	0.00E+00	0.00E+00	-
C	5.66E+00	4.27E+02	+/-25%
All	**1.81E+01**	**4.94E+02**	**+/-25%**

b. Waste Stream : Dry Active Waste

Dry Active Waste 20'	DAW in Intermodal	DAW in B-25	Primary Piping Sea/Land
8-120 In-Situ cavity waste	FP/TRU in 20' S/L	14-170 In-Situ cavity waste	Cavity Waste in 20' S/L
RHR Hx in 40' S/L	Primary piping in B-25	FP/TRU in 20' Shield	FP/TRU in 40' S/L

Waste Class	Volume M^3	Curies Shipped	%Error (Ci)
A	9.95E+03	8.18E+00	+/-25%
B	0.00E+00	0.00E+00	-
C	7.14E+00	6.63E+02	+/-25%
All	**9.96E+03**	**6.71E+02**	**+/-25%**

Table 14

(continued)

c. Waste Stream : Irradiated Components

None

Waste Class	Volume M^3	Curies Shipped	% Error (Ci)
A	0.00E+00	0.00E+00	-
B	0.00E+00	0.00E+00	-
C	0.00E+00	0.00E+00	-
All	**0.00E+00**	**0.00E+00**	**-**

d. Waste Stream : Other Waste

Garnet #9
Garnet HIC #4
WDB Preheater
Oil Bin / Six Pack
14-170 Insitu 2

Waste Class	Volume M^3	Curies Shipped	% Error (Ci)
A	3.61E+01	7.67E+01	+/-25%
B	2.78E+01	1.78E+03	+/-25%
C	0.00E+00	0.00E+00	+/-25%
All	**6.39E+01**	**1.86E+03**	**+/-25%**

e. Waste Stream : Sum of all 4 Waste Streams

Waste Class	Volume M^3	Curies Shipped	% Error (Ci)
A	1.00E+04	1.53E+02	+/-25%
B	2.78E+01	1.78E+03	+/-25%
C	1.28E+01	1.09E+03	+/-25%
All	**1.00E+04**	**3.03E+03**	**+/-25%**

Table 14

(continued)

2. Estimate of Major Nuclide Composition (by waste stream)

	Composition in % for each waste stream					Total
Nuclide	**a.**	**b.**	**c.**	**d.**	**e.**	**Curies**
H-3	1.367%	0.001%	0.000%	0.003%	0.225%	6.82E+00
C-14	0.004%	0.014%	0.000%	0.012%	0.011%	3.33E-01
Mn-54	0.051%	0.452%	0.000%	0.447%	0.383%	1.16E+01
Fe-55	13.477%	45.012%	0.000%	45.507%	40.166%	1.22E+03
Co-57	0.000%	0.000%	0.000%	0.000%	0.000%	2.75E-04
Co-60	14.687%	44.619%	0.000%	46.014%	40.588%	1.23E+03
Ni-59	0.016%	0.052%	0.000%	0.050%	0.045%	1.36E+00
Ni-63	5.093%	9.653%	0.000%	7.937%	7.853%	2.38E+02
Sr-89	0.000%	0.000%	0.000%	0.000%	0.000%	1.58E-05
Sr-90	0.169%	0.070%	0.000%	0.020%	0.056%	1.69E+00
Nb-94	0.000%	0.000%	0.000%	0.000%	0.000%	4.82E-03
Tc-99	0.000%	0.001%	0.000%	0.000%	0.000%	4.38E-03
Sb-125	0.000%	0.000%	0.000%	0.000%	0.000%	3.06E-05
I-129	0.000%	0.000%	0.000%	0.000%	0.000%	5.32E-03
Cs-134	0.001%	0.011%	0.000%	0.001%	0.003%	9.90E-02
Cs-137	64.827%	0.070%	0.000%	0.004%	10.606%	3.21E+02
Ce-144	0.298%	0.019%	0.000%	0.002%	0.054%	1.63E+00
Eu-154	0.000%	0.000%	0.000%	0.000%	0.000%	1.66E-03
Np-237	0.000%	0.000%	0.000%	0.000%	0.000%	6.60E-06
Pu-238	0.002%	0.002%	0.000%	0.000%	0.001%	2.57E-02
Pu-239	0.000%	0.000%	0.000%	0.000%	0.000%	2.82E-03
Pu-240	0.000%	0.000%	0.000%	0.000%	0.000%	1.82E-03
Pu-241	0.000%	0.017%	0.000%	0.001%	0.005%	1.38E-01
Am-241	0.004%	0.001%	0.000%	0.000%	0.001%	3.10E-02
Cm-242	0.000%	0.000%	0.000%	0.000%	0.000%	7.76E-04
Cm-243	0.002%	0.003%	0.000%	0.001%	0.001%	4.20E-02
Cm-244	0.002%	0.003%	0.000%	0.001%	0.001%	4.03E-02

Table 14

(continued)

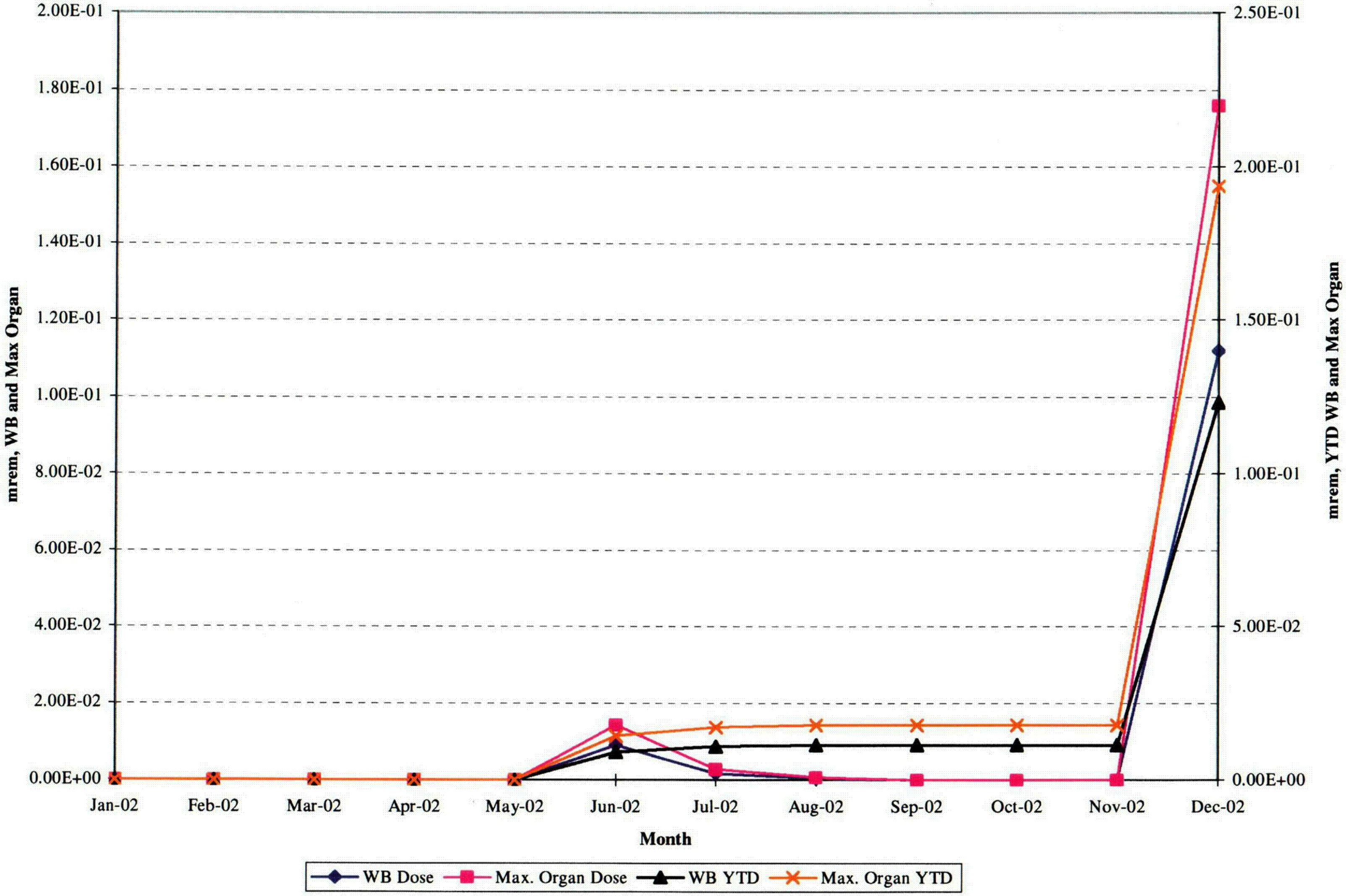
3. Solid Waste Disposition

Mode of Transportation	No. Shipments	Destination
Hittman Transport	27	Barnwell Waste Management Facility
Hittman Transport	7	Envirocare of Utah, Inc.
Hittman Transport	38	GTS Duratek, Inc. (BCO)
Hittman Transport	169	GTS Duratek, Inc. (GR)

B. Irradiated Fuel Shipments (disposition)

NONE

Figure 1
Liquid Dose 2002
Haddam Neck



C01

Figure 2
Test or Temporary Tank Activity Released 2002
Haddam Neck

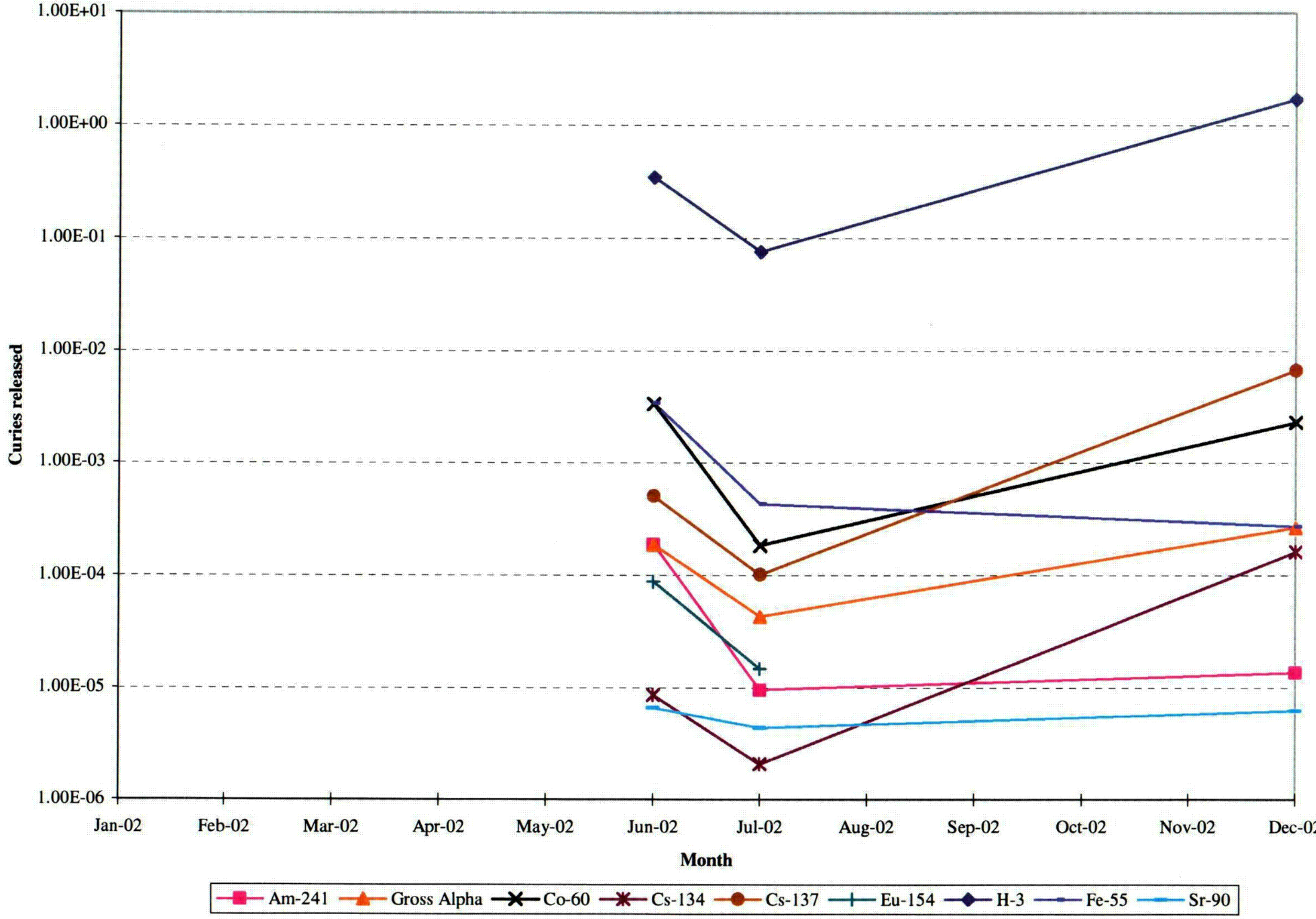


Figure 3
RCA Yard Drain Co-60, Sr-90 and Cs-137Activity Released 2002
Haddam Neck

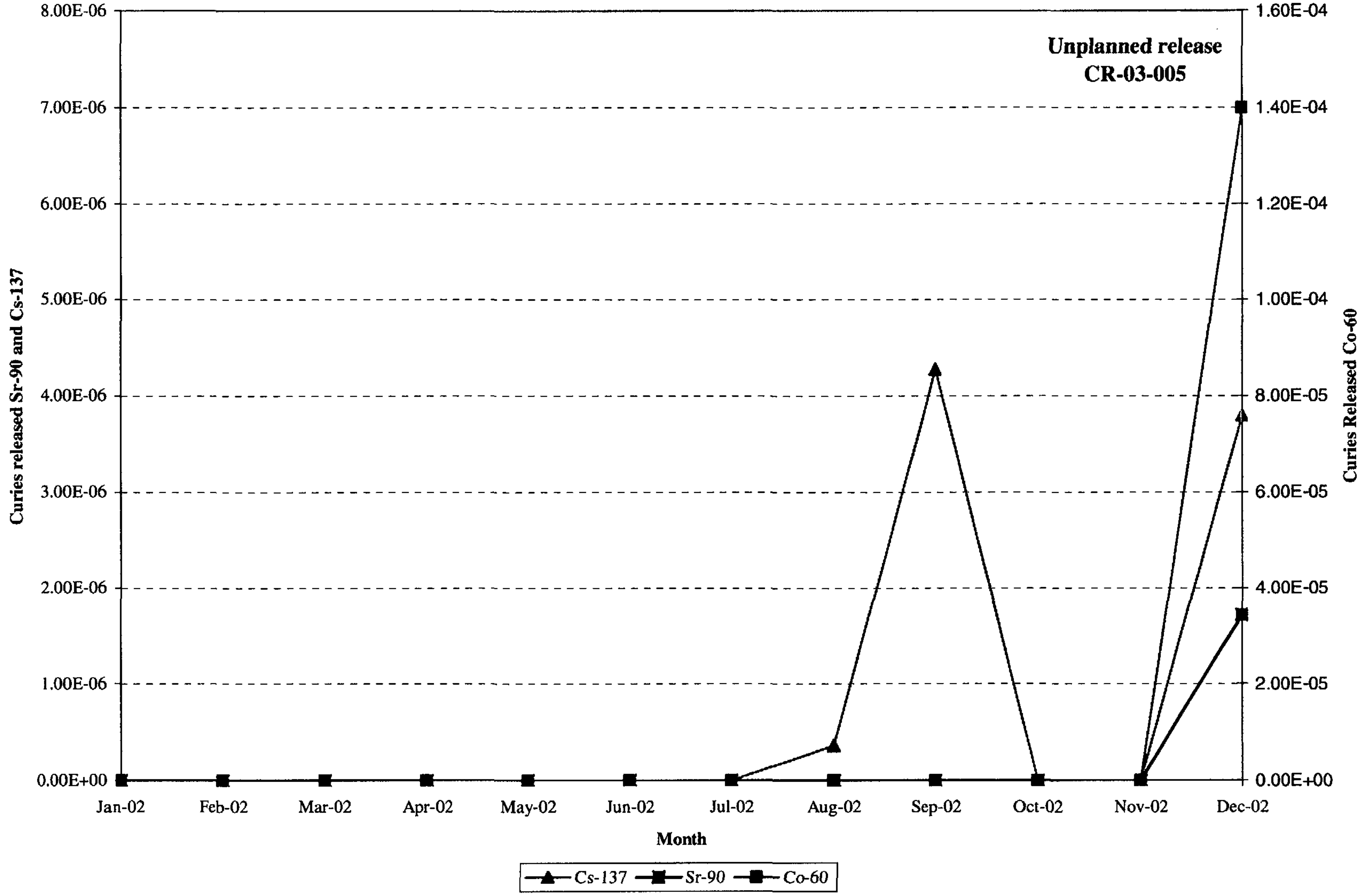


Figure 4
RCA Yard Drain Tritium Activity Released 2002
Haddam Neck

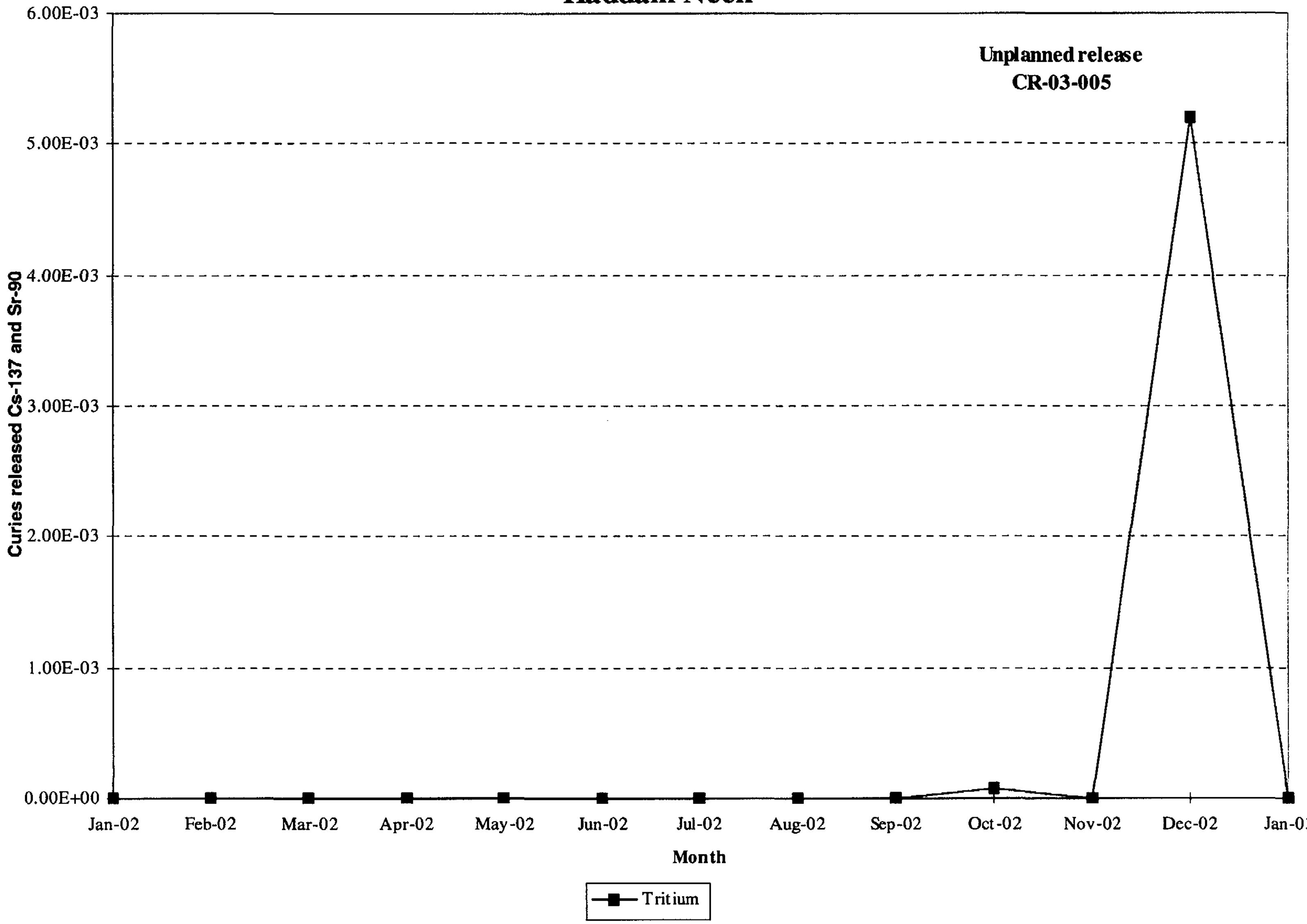
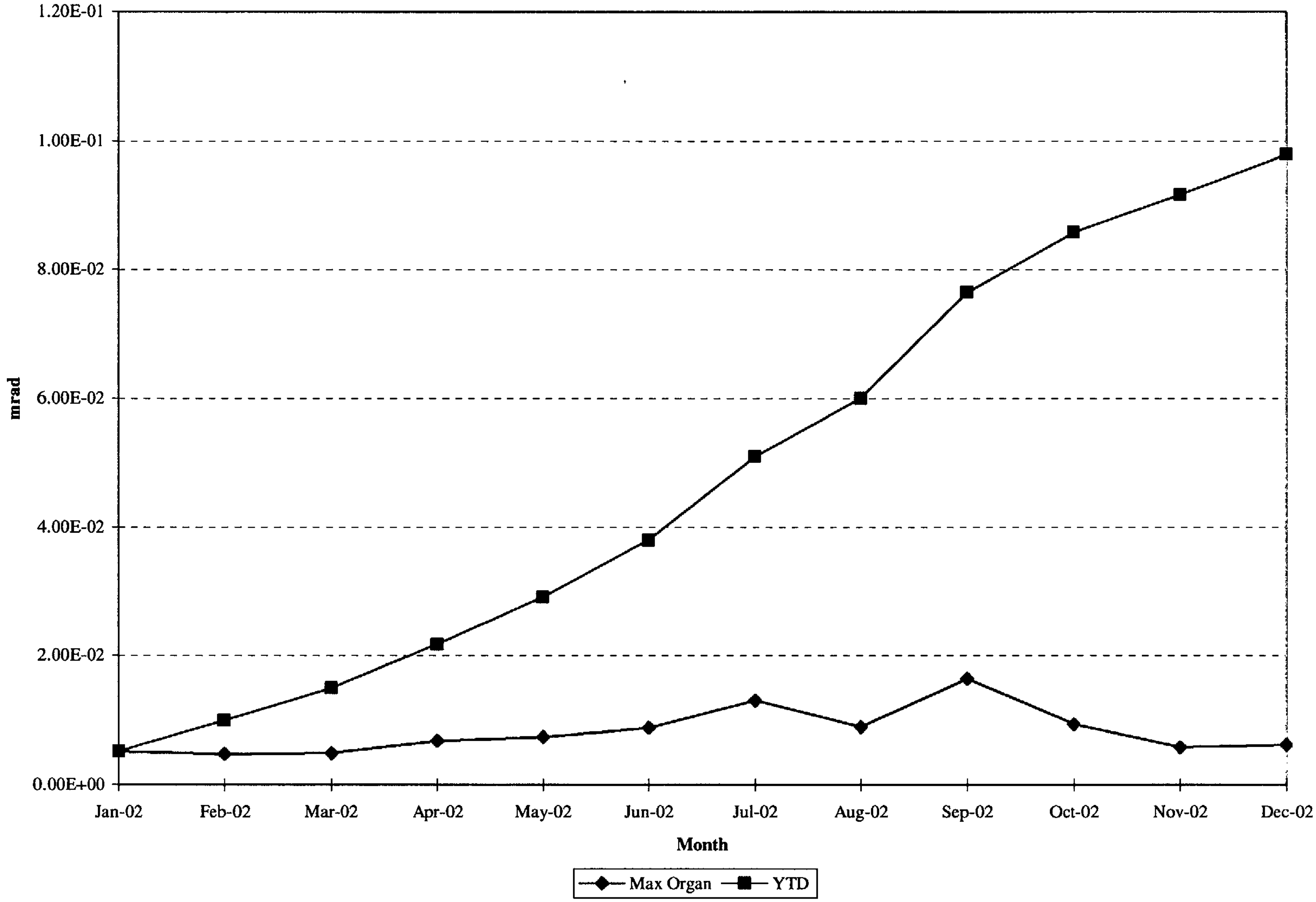


Figure 5
Gaseous Effluent Dose 2002
Haddam Neck



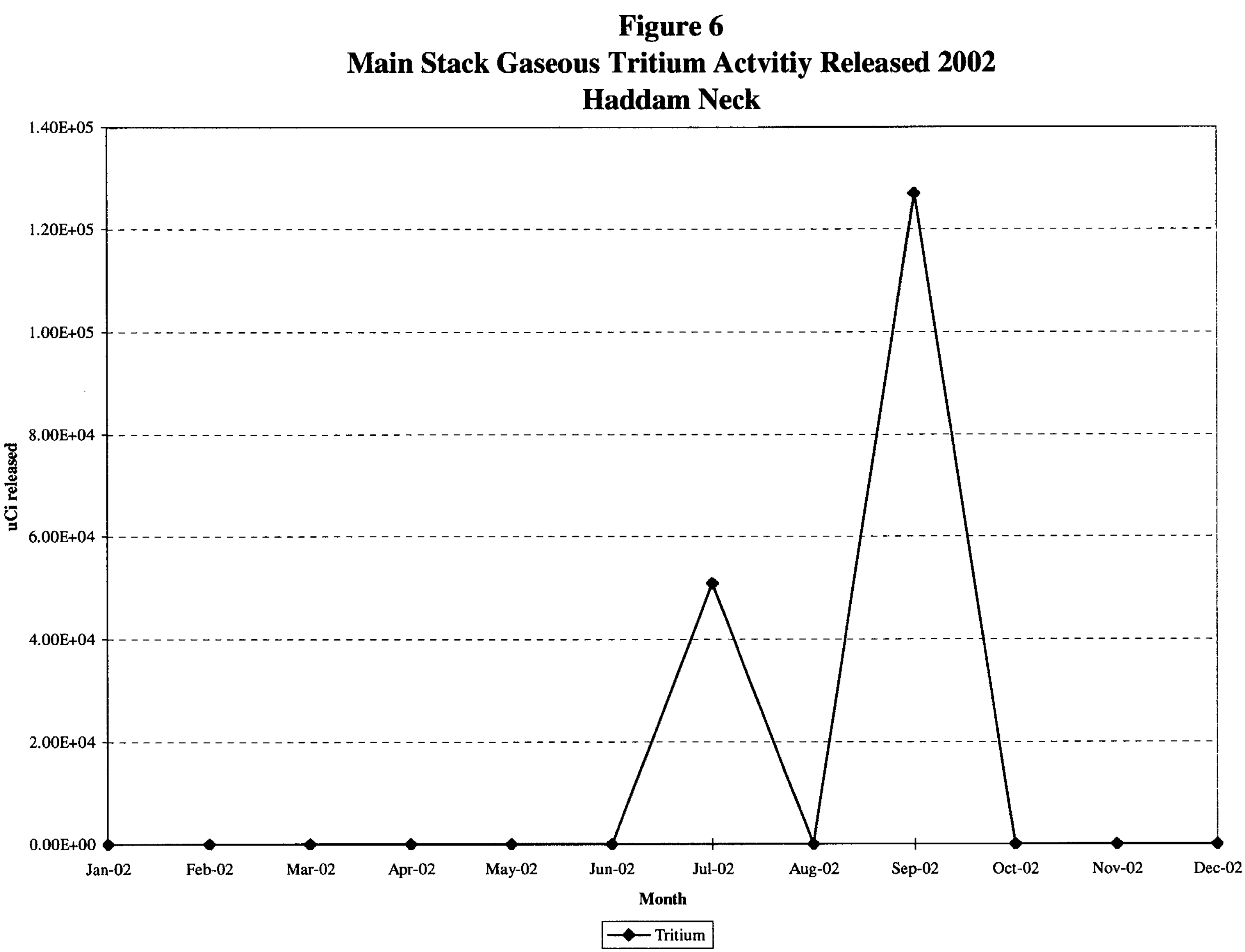


Figure 6
Main Stack Gaseous Tritium Actvitiy Released 2002
Haddam Neck
1.40E+05
1.20E+05
1.00E+05
8.00E+04
6.00E+04
4.00E+04
2.00E+04
0.00E+00
uCi released
Jan-02
Feb-02
Mar-02
Apr-02
May-02
Jun-02
Jul-02
Aug-02
Sep-02
Oct-02
Nov-02
Dec-02
Month
Tritium

Figure 7
Spent Fuel Building Gaseous Tritium Released 2002
Haddam Neck

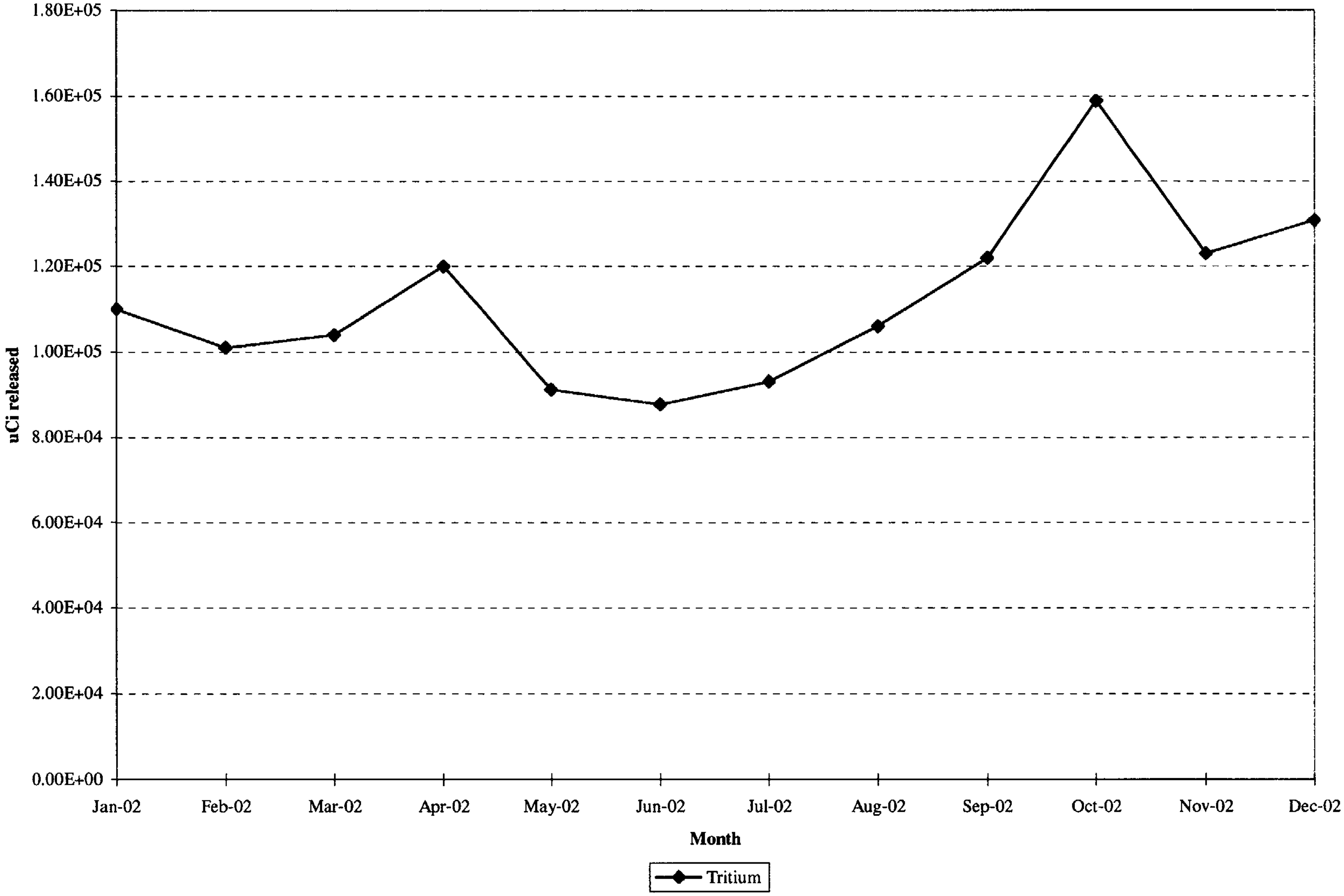
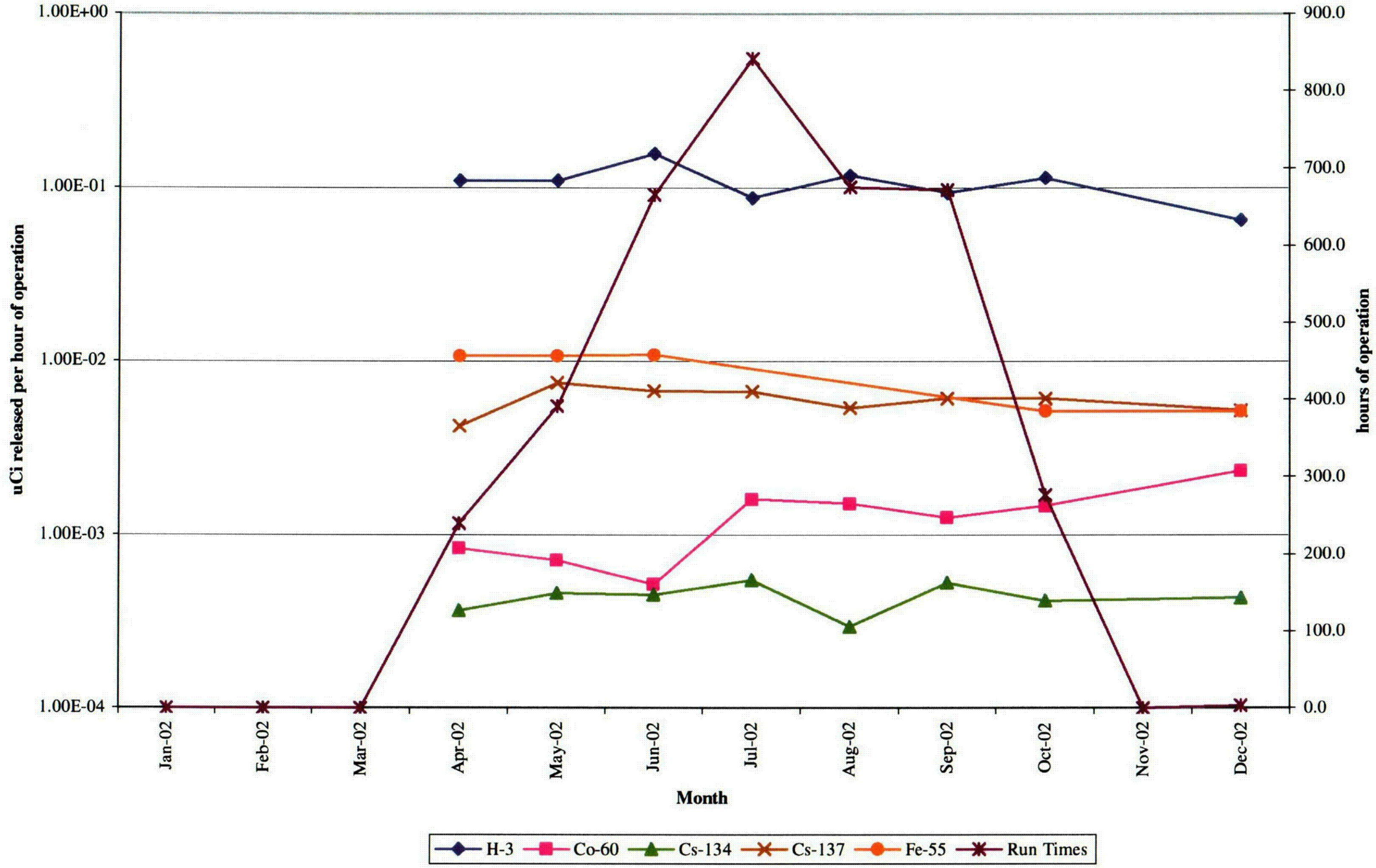
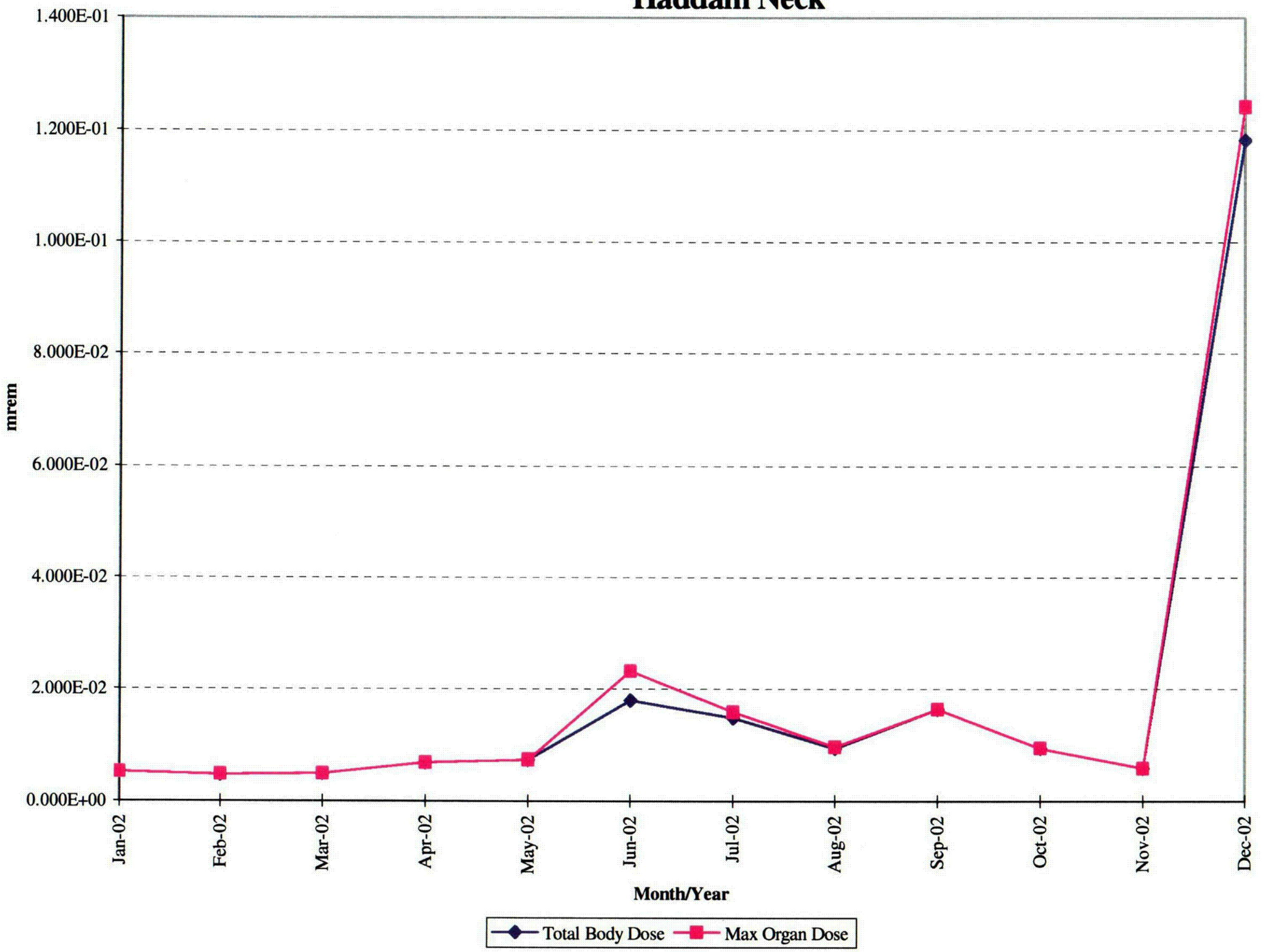


Figure 8
Spray Cooling Release Rates During 2002 System Operation (uCi/hr)
Haddam Neck



C03

Figure 9
Total Dose 2002 for 40 CFR Part 190
Haddam Neck



C04

Docket No. 50-213
CY-03-046

Attachment 2

Haddam Neck Plant
Revision 15 to Radiological Effluent Monitoring
And Offsite Dose Calculation Manual
And List of Changes

List of Changes Documented in Revision 15 to Haddam Neck REM/ODCM

Section No.	Section Title	Page No.	Description of Change & Reason
			REMM CHANGES
Table of Contents	D.2, D. 3/4	TOC 1 of 2	**Description of Change:** Renumber pages to be consistent with section page numbers in the manual. **Basis for Change**: Table of Content page manual numbers did not match section page numbers in the manual.
Table of Contents	H.2	TOC 2 of 2	**Description of Change:** Added new Figure H.2 to list of figures **Basis for Change:** List new figure in Table of Contents
Various	Editorial Corrections	Various	**Description of Changes** Removal of extra spaces between words throughout document. **Basis for Change:** Clean up document
A.2	Responsibilities	A-2	**Description of Change:** Changed title of Unit Director to Unit Manager. Changed sentence "All Changes to this manual shall be reviewed by the Plant Operations Review Committee prior to implementation.." to "All changes to this manual shall be *independently* reviewed *and approved by the Unit Manager* prior to implementation." **Basis for Change:** This change to Unit Manager is in accordance with changes described in Technical Specification Amendment No. 196, approved by the NRC on 12/4/2001. The change to independent review and Unit Manager approval was used to more accurately reflect the Technical Specifications requirement in section 6.5.1 and 6.5.2..
B. 1	Definitions	B-1	**Description of Change:** In Revision 14 to the REM/ODCM, the basis and justification for removing the word "ANALOG" was provided. However, removal of the word "ANALOG" for 2 of 3 uses was inadvertently overlooked in this paragraph. It has been removed here in Rev. 15. **Basis for Change:** From Rev 14, Change 00-03; Delete "ANALOG" from the definition. This description does not reflect the equipment in place, which utilizes digital signals & outputs.

List of Changes Documented in Revision 15 to Haddam Neck REM/ODCM

Section No.	Section Title	Page No.	Description of Change & Reason
Table B.1	Frequency Notation	B-4	**Description of Change:** Footnote to Surveillance "Frequency Notation" was included in Revision 14 to the REMODCM. This change was not re-routed procedurally for formal documented review and is added here to document the procedurally required review (ACP1.2-2.48). **Basis for Change:** This 25% extension to surveillances was, and still is, in the Technical Specifications. When RETS was cut and pasted into the REMODCM in Rev 12, this 25% extension was inadvertently omitted. It was restored in revision 14.
Table C-1.A	Radioactive Liquid Waste Sampling & Analysis Program	C-2	**Description of Change:** Deleted LLD for Ce-144 (T1/2 = 284 days). Created new superscript and notation "i" which defines the requirements for temporary tank discharges. Deleted superscript and notation "f". **Basis for Change:** There is no longer a source term for Ce-144. Ce-144 was not detected in the recent operating years prior to shutdown, or in effluents since permanent shutdown in 1996. Since shutdown, any remaining Ce-144 present (but not detected) in effluent streams has gone through 7.0 half lives and is now less than 0.2 % of its original activity level at shutdown.
Table C-1.A	Radioactive Liquid Waste Sampling & Analysis Program	C-2, C-4	**Description of Change:** Deleted Waste Test Tank, Waste Neutralization Tank, and Waste Transfer (NPDES) Sump and added temporary tanks. **Basis for Change:** WTT, WNT, & WT (NPDES) Sump Systems have been removed from service/abandoned/ removed; Temporary Tanks have been added and require the same level of monitoring. Temporary tanks must meet the same requirements as the Recycle Test Tanks discharges. Removed notation and superscript (f) since Gross Alpha, Sr-90 and Fe-55 must be done on all composites.

List of Changes Documented in Revision 15 to Haddam Neck REM/ODCM

Section No.	Section Title	Page No.	Description of Change & Reason
Table C-1.B	Radioactive Liquid Waste Sampling & Analysis Program	C-2, C-4	**Description of Change:** Removed superscript "g" from strontium 90, iron 55, & alpha, and deleted footnote "g" from table notations. **Basis for Change:** Mix of nuclides used previously to trigger Sr-90, Fe-55 and/or alpha analysis does not apply anymore with the bulk of water discharged via this pathway representing groundwater under decommissioning conditions. This change is more conservative requiring Sr-90 & Fe-55 analysis quarterly, and alpha monthly, regardless of the concentration of gamma emitters.
Table C-1.B	Radioactive Liquid Waste Sampling & Analysis Program	C-2	**Description of Change:** Lowered LLDs for gamma emitters, tritium, gross alpha , Sr-90 and Fe-55 to more conservative values for yard drain 6. Inserted superscript "b" to weekly, monthly and quarterly composites. **Basis for Change:** This change is more conservative requiring lower LLDs. These nuclides can be routinely detected down to these values. Notation "b" defines a composite sample.
Table C-1 Notations	Radioactive Liquid Waste Sampling & Analysis Program	C-3	**Description of Change:** Added notation to "e" that "Sampling at Yard Drain #6 (catch basin 11) is only required when the Mat Sump is operating." **Basis for Change:** As decommissioning has progressed, flow through this system normally occurs when the Mat Sump is running; at other times there is little or not enough flow to collect either a grab or composite sample. WNT and NPDES sump were deleted as these have been removed from service.
Table C-1 Notations	Radioactive Liquid Waste Sampling & Analysis Program	C-4	**Description of Change:** Removed reference to Waste Test Tanks and added Temporary Tanks. Removed reference to Waste Neutralizing Tanks and NPDES sump and gamma level trigger of 5E-7 uCi/ml for performing these analyses. **Basis for Change:** These systems have been removed from service. Temporary Tanks have been added to service.

List of Changes Documented in Revision 15 to Haddam Neck REM/ODCM

Section No.	Section Title	Page No.	Description of Change & Reason
C.2	Liquid Radioactive Waste Treatment	C-5	**Description of Change:** Added a qualifying statement for Figure H-2. **Basis for Change**: Plant is undergoing decommissioning, configuration of liquid radwaste system will change due to demolition of tanks and use of temporary tanks. Figure H-2 will be updated if required each revision of the REMODCM.
Table C.3.3	Radioactive Liquid Effluent Monitoring Instrumentation	C-12	**Description of Change:** Deleted Waste Test Tanks. Renumbered Action 48 to 47. Renumber pages to be consistent with section page numbers in the manual. **Basis for Change**: Waste Test Tanks are no longer used and are abandoned. Keep Table in numerical sequence.
Table C.3.3	Action Statements	C-13	**Description of Change:** Renumbered Action 48 to 47. Minor rewording of Action 46.b. **Basis for Change:** Clarity/enhancement. Renumbered to follow sequential order.
Table C.4.3	Radioactive Liquid Effluent Monitoring Instrumentation Surv. Requirements	C-14	**Description of Change**: Deleted Waste Test Tanks. Renumbered number 3 to 2 Flow Rate Measurement. Added note (5) to instrument 1. **Basis for Change**: Waste Test Tanks no longer used and are abandoned. Keep Table in numerical sequence. Notation (5) was added to "Table Notation" in Rev. 14, but not in Table C.4.3 itself. This is corrected here.
Table C.4.3	Table Notations	C-15	**Description of Change**: Deleted "in the Primary Auxiliary Building". **Basis for Change**: As decommissioning progresses location of monitor may change.
Table D-1 Notations	Radioactive Gaseous Waste Sampling and Analysis Program	D-2, 3	**Description of Change:** Added notation "i" to Spent Fuel Building Exhaust; Main Stack and Misc. Points for quarterly particulate composites Sr-90 analysis has to be performed only if Gross Beta is identified. Basis for Change: If there is no gross beta present in the sample than there is no Sr-90 present.

List of Changes Documented in Revision 15 to Haddam Neck REM/ODCM

Section No.	Section Title	Page No.	Description of Change & Reason
Table D-1	Table Notations	D-4	**Description of Change:** Eliminate reference to Ce-144 **Basis for Change:** There is no longer a source term for Ce-144 on site. Ce-144 was not detected in the recent operating years prior to shutdown, or in effluents since permanent shutdown in 1996. Since shutdown, any remaining Ce-144 present (but not detected) in effluent streams has gone through 7.0 half lives and is now less than 0.2 % of its original activity level at shutdown.
Table D-1 Table of Notation	Radioactive Gaseous Waste Sampling and Analysis Program	D-4	**Description of Change:** Added notation "i" Sr-90 analysis only required if Gross Beta is identified". Deleted last sentence of notation "h" which identified specific HP (CYHP 0029 & 99-108) documents. **Basis for Change:** If there is no gross beta present in the sample than there is no Sr-90 present. These two documents are only two of many documents that are used to perform radiological evaluations.
Table D.3.4	Radioactive Gaseous Effluent Monitoring Instrumentation	D-14	**Description of Change:** Deleted LCO type statement regarding recording of flow rates when chart recorder was not functioning.. **Basis for Change:** REMODCM Rev. 14 contains a superscript and notation (e.g., 1, 2) that were not properly reviewed prior to implementation of Rev. 14, CR-00-0600 was written to document this issue. These actions are no longer needed since they are identified in the action statements. They are being removed from Rev. 15 which will complete corrective actions for this CR.

List of Changes Documented in Revision 15 to Haddam Neck REM/ODCM

Section No.	Section Title	Page No.	Description of Change & Reason
Table E-1, 3.b	Vegetation – Broad Leaf Vegetation	E-3	**Description of Change:** "Broad Leaf Vegetation" - shall be sampled from three locations (one control, two indicator sample locations), monthly during the growing season (April - December), with gamma isotopic on each sample. The control is taken from the same location as that for "Fruits and Vegetables" at 13C. **Basis for Change**: Program clarification. Broad Leaf Vegetation sampling is modified to mirror NUREG 1301 and called out to replace the milk sampling. Conforms to NUREG-1301. Clarified wording as Rev 14 listed three locations in this table, but two in Appendix G of the ODCM – three is required by NUREG-1301. Three have been collected consistently as part of the program.
Table E-1, 4.	Milk	E-3	**Description of Change:** Deleted requirement to analyze for Sr-89 (T1/2=50.5 days). Added notation "**" to bottom of page provides clarification for obtaining milk samples between 0 and 5 miles from the main stack. **Basis for Change:** Sr-89 analysis was removed from all other sections in previous revisions due to its short half-life, lack of source terms since permanent shutdown in 1996, and no detectable levels in effluent samples. This clarification wording comes directly out of Reg Guide 1301 Table 3.12-1, 4 Ingestion, Milk.
Table E-1, 5.	Well Water	E-3	**Description of Change:** Changed sample type description from "composite" to "sample". **Basis for Change:** Sample collected have always been grab samples vs. composite. Missed incorrect wording in previous revisions. Each sample is analyzed following collection to facilitate trending.

List of Changes Documented in Revision 15 to Haddam Neck REM/ODCM

Section No.	Section Title	Page No.	Description of Change & Reason
Table E-1, 7.	River Water	E-3	**Description of Change:** Changed control sample collection frequency from six consecutive weeklies, to six consecutive grab samples collected biweekly. **Basis for Change:** This change provides more sampling flexibility, and a sample collection period that more closely mirrors the collection frequency for the indicator sample at location 28I. It permits synchronization with all remaining off site sample collection on a biweekly frequency. Weekly sample collection supported detection of short-lived activity during operation (I-131, I-133, Co-58, for example). Following permanent shutdown, the source terms for these diminished and these have not been detected in plant effluents.
Figure H-1	Exclusion Area Boundary and Site Boundary for Liquid and Gaseous Effluents	H-1	**Description of Change:** Changed "Private Property" near Salmon Cove in the Unrestricted area to "Former Schmidt Property" **Basis for Change:** Document change in ownership.
Figure H-2	Liquid Waste Treatment System	H-2	**Description of Change:** Added simplified diagram of Liquid Radwaste Treatment System. **Basis For Change:** Enhancement encouraged by NRC.
		ODCM CHANGES	
Table of Contents	Appendices, Appendix C	T of C-3	**Description of Change:** Added "(OR EQUIVALENT)" to Appendix C Title "LIQUID DOSE CALCULATIONS – LADTAP". **Basis for Change:** To clarify that any liquid dose code or method that implements the guidance provided in Reg. Guide 1.109 may be used to calculate quarterly and annual doses resulting from liquid effluents released to unrestricted areas.
E E1	Table of Contents Recycle Test Tank Discharge Line Monitor	TOC-1, E-1	**Description of Change & Reason:** Deleted "Waste Tanks from these sections. **Basis for Change:** These tanks are no longer used and have been abandoned.

List of Changes Documented in Revision 15 to Haddam Neck REM/ODCM

Section No.	Section Title	Page No.	Description of Change & Reason
B.	Responsibilities	B-1	**Description of Change:** Change Unit Director to Unit Manager. Changed "reviewed by Plant Operations Review Committee prior to implementation", to "independently and approved by the Unit Manager prior to implementation". **Basis for Change:** To ensure REMODCM consistent with Amendment 196 to the CY Technical Specifications, Approved by the NRC 12/4/01. Minor rewording to more accurately describe the review process in terms of Technical Specification requirements in section 6.5.
C.	Liquid Dose Calculations	C-1	**Description of Change:** Added requirement to maintain circulation water flow following a tank release until 125 million gallons of river water is discharged following termination of the release. **Basis for Change:** For batch releases, ensures constant flow rate dilution water flow remains in place long enough that liquid dose model assumptions are valid.
C.2	Method 2	C-2	**Description of Change:** Deleted reference to RAB Procedure on Liquid Dose Calculations. **Basis for Change:** Millstone's Rad Assessment Branch (RAB) no longer provides the service of performing the CY dose assessment calculation. RAB has revised the procedures and deleted all references to CY.
C.3	Quarterly Dose Calculations for Annual Radioactive Effluent Report	C-2	**Description of Change:** Change clarifies the acceptable use of "equivalent" dose calculation methods, or codes, for the quarterly and annual doses, that implement the guidance in Regulatory Guide 1.109, Rev. 1. **Basis for Change:** Permits the use of other, NRC sanctioned codes that meet R.G. 1.109 criteria for dose calculations.

List of Changes Documented in Revision 15 to Haddam Neck REM/ODCM

Section No.	Section Title	Page No.	Description of Change & Reason
D.	Gaseous Dose Calculation	D-1	**Description of Change:** Inserted a reference to Appendix E, which was missing. **Basis for Change:** Appendix E used for calculating max individual dose.
G.	References	Page G-1	**Description of Change:** Deleted three references from this section. **Basis for Change:** Equipment/instruments have been abandoned, the REMODCM no longer uses them.
Appendix E	Gaseous Dose Calculations – GASPAR-2 (Or Equivalent)	App E-1	**Description of Change:** Clarification regarding the criteria of equivalent codes and specifically identifying the need to conform to the guidance in R.G. 1.109. **Basis for Change:** Clarification
Appendix G	Environmental Monitoring Program, Sampling Locations	APP G-1	**Description of Change:** Added broad leaf vegetation to sampling locations 6-I; 17-C; 18-I. Clarified the name of sampling station 16-C. Typo corrected sampling location 2-l, it was listed as 2-1. **Basis for Change:** Land use census determined there are no reliable dairy farms within five miles of the plant. Substituted broad leaf vegetation in lieu of dairy products. Former location listed as state highway dept East Haddam, actual location of the well is inside East Haddam Town Office Building. This is the correct sample location number 2-I (Indicator Location).

Radiological Effluent Monitoring
&
Offsite Dose Calculation Manual

REMODCM

RADIOLOGICAL EFFLUENT

MONITORING MANUAL

JUN 11 2002

SECTION I

RADIOLOGICAL EFFLUENT MONITORING MANUAL

For The

HADDAM NECK PLANT

Docket No. 50-213

HADDAM NECK PLANT

RADIOLOGICAL EFFLUENT MONITORING MANUAL

TABLE OF CONTENTS

A. INTRODUCTION AND RESPONSIBILITIES

A.1 Introduction

The purpose of this manual is to provide the sampling and analysis programs that provide input to the ODCM for calculating liquid and gaseous effluent concentrations and offsite doses. Guidelines are provided for operating RADIOACTIVE WASTE TREATMENT SYSTEMS in order that offsite doses are kept As-Low-As-Reasonably Achievable (ALARA).

The Radiological Environmental Monitoring Program outlined within this manual provides confirmation that the measurable concentrations of radioactive material released as a result of operations at the Haddam Neck Plant are not higher than expected.

In addition, this manual outlines the information required for submittal to the NRC in both the Annual Radiological Environmental Operating Report and the Annual Radioactive Effluent Report.

A.2 Responsibilities

All changes to this manual shall be independently reviewed and approved by the Unit Manager prior to implementation.

All changes and their rationale shall be documented in the Annual Radioactive Effluent Report in accordance with the administrative controls of Technical Specification 6.6.3.

It shall be the responsibility of the Unit Manager to ensure that this manual is used in the implementation of the Radiological Effluent Monitoring, Radioactive Effluent Controls, and the Radiological Environmental Monitoring Programs. The Unit Manager shall ensure that the REMODCM is maintained and controlled in accordance with Technical Specification 6.6.3.

B. DEFINITIONS

The defined terms of this section appear in capitalized type and are applicable throughout the REMODCM.

B.1 ACTION

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

B.2 **CHANNEL OPERATIONAL TEST**

A CHANNEL OPERATIONAL TEST shall be the injection of a simulated signal into the channel as close to the sensor as practicable to verify OPERABILITY of alarm, interlock and/or trip functions. The CHANNEL OPERATIONAL TEST shall include adjustments, as necessary, of the alarm, interlock and/or Trip Setpoints such that the Setpoints are within the required range and accuracy.

B.3 CHANNEL CALIBRATION

A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel such that it responds within the required range and accuracy to known values of input. The CHANNEL CALIBRATION shall encompass the entire channel including the sensors and alarm, interlock and/or trip functions, and may be performed by any series of sequential, overlapping or total channel steps such that the entire channel is calibrated.

B.4 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.

B.5 FREQUENCY NOTATION

The FREQUENCY NOTATION specified for the performance of Surveillance Requirements shall correspond to the intervals defined in Table B.1.

B.6 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.

B.7 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).

B.8 RADIOACTIVE WASTE TREATMENT SYSTEMS

RADIOACTIVE WASTE TREATMENT SYSTEMS are those liquid, gaseous and solid waste systems which are required to maintain control over radioactive material in order to meet the Controls set forth in the REMODCM.

B.9 RADIOLOGICAL EFFLUENT MONITORING AND OFFSITE DOSE CALCULATION MANUAL (REMODCM)

A RADIOLOGICAL EFFLUENT MONITORING MANUAL (REMM) shall be a manual containing the site and environmental sampling and analysis programs for measurements of radiation and radioactive materials in those exposure pathways and for those radionuclides which lead to the highest potential radiation exposures to individuals from station operation. An OFFSITE DOSE CALCULATION MANUAL (ODCM) shall be a manual containing the methodology and parameters to be used in the calculation of offsite doses due to radioactive gaseous and liquid effluents and in the calculation of gaseous and liquid effluent monitoring instrumentation Alarm/Trip Setpoints. Requirements of the REMODCM are provided in Technical Specification 6.6.3.

B.10 SITE BOUNDARY

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

B.11 SOURCE CHECK

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

B.12 ALL APPLICABLE LIQUID RADIOACTIVE WASTE TREATMENT SYSTEMS

ALL APPLICABLE LIQUID RADIOACTIVE WASTE TREATMENT SYSTEMS is defined as that equipment applicable to any waste stream responsible for greater than ten percent (10%) of the total projected dose. The liquid radioactive waste treatment system equipment at the Haddam Neck Plant consists of: portable demineralizer, waste liquid polishing demineralizer, borated waste ion demineralizer, and boron recovery polishing demineralizer.

B.13 <u>ALL APPLICABLE GASEOUS RADIOACTIVE WASTE TREATMENTS SYSTEMS</u>

ALL APPLICABLE GASEOUS RADIOACTIVE WASTE TREATMENT SYSTEMS is defined as that equipment applicable to a waste stream responsible for greater than ten percent 10% of the total projected dose. The gaseous radioactive waste treatment equipment at the Haddam Neck Plant consists of ventilation system HEPA.

TABLE B.1

*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.
B	At least once per 14 days (biweekly)
M	At least once per 31 days.
Q	At least once per 92 days.
SA	At least once per 184 days.
R	At least once per 18 months.
P	Prior to each release.
N.A.	Not applicable.

*Each surveillance requirement shall be performed/completed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified interval

C. LIQUID EFFLUENTS

C.1 Liquid Effluents Sampling and Analysis Program

Radioactive liquid wastes shall be sampled and analyzed in accordance with the program specified in Table C-1 for the Haddam Neck Plant. The results of the radioactive analyses shall be input to the methodology of the ODCM to assure that the concentrations at the point of release are maintained within the Controls of the REMODCM.

Table C-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection[a] (LLD) (μCi/cc)
A. Batch Release[h] *From these sources:* Recycle Test Tank Temporary Tanks[i]	Prior to Each Batch Release	Prior to Each Batch Release	Principal Gamma Emitters[d]	5.00E-07
		Monthly Composite[b,c]	Gross Alpha H-3	1.00E-07 1.00E-05
		Quarterly Composite[b,c]	Sr-90 Fe-55	5.00E-08 1.00E-06
B. Continuous Release *From these sources:* Yard Drain #6 (Catch Basin 11)	Daily Grab Sample[e]	Weekly Composite[b,c]	Principal Gamma Emitters[d] H-3	3.00E-08 2.00E-06
		Monthly Composite[b,c]	Gross Alpha	5.00E-08
		Quarterly Composite[b,c]	Sr-90 Fe-55	3.00E-09 5.00E-07

TABLE C-1
(Continued)

TABLE NOTATIONS

a. The lower limit of detection (LLD) is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66S_b}{E \cdot V \cdot (2.22E+06) \cdot Y \cdot \exp(-\lambda \Delta t)}$$

where:

LLD is the lower limit of detection as defined above (microcuries per unit volume)

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

E is the counting efficiency (counts per transformation)

V is the sample size (volume)

2.22E+06 is the number of transformations per minute per microcurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide

Δt is the elapsed time between sample collection (or midpoint of sample collection) and time of counting.

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 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 which is representative of the liquid released.

c. Prior to analysis, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluents released.

d. The principal gamma emitters for which the LLD specification will apply are exclusively the following nuclides: Mn-54, Co-60, Zn-65, Cs-134 and Cs-137. This does not mean that only these nuclides are to be reported. Other nuclides that are identified shall be reported. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level. When unusual circumstances result in an a priori LLD being higher than required, the reasons shall be documented in the Annual Radioactive Effluent Report.

e. A grab sample will be obtained daily at least five (5) days per week. A composite sampler may be used in lieu of the daily grab sample for Yard Drain #6. Grab samples or composite sampler operation at yard Drain 6 (catch basin 11) is only required when the Mat Sump is operating.

h. Prior to sampling, each batch shall be isolated; at least two tank volumes shall be recirculated or equivalent mixing provided.

i. Releases can be made from other sources (e.g., temporary tanks) as long as these have met the programmatic requirements including, but not limited to monitoring through R-22 setpoints and release rate determination action statements, etc.

C.2 Liquid Radioactive Waste Treatment

Monthly doses due to liquid effluents to unrestricted areas shall be projected at least once per 31 days only if one or ALL APPLICABLE LIQUID RADIOACTIVE WASTE TREATMENT SYSTEMS will not be routinely operated. When the projected monthly dose due to liquid effluents exceeds 0.06 mrem to the total body or 0.2 mrem to any organ, ALL APPLICABLE LIQUID RADIOACTIVE WASTE TREATMENT SYSTEMS will be operated.

With 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 Subsection F.3, a special report that includes the following information:

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

b. Actions taken to restore the inoperable equipment to OPERABLE status; and

c. Summary description of actions taken to prevent a recurrence.

Figure H-2, "Liquid Radwaste System" represents how the liquid radwaste system is configured at the time of this revision. Since the plant is undergoing decommissioning, tanks will be abandoned and dismantled. Temporary tanks may be used to replace them. This will not require a change to this figure (REMODCM) prior to use of these. This figure will be updated, if required, to reflect the current configuration of the liquid radwaste system, each time the REMODCM is revised.

C.3/4 LIQUID EFFLUENT CONTROLS AND SURVEILLANCE REQUIREMENTS

CONCENTRATION

CONTROLS

C.3.1 The concentration of radioactive material released from the site (see Figure H-1) shall not exceed the concentrations specified in 10 CFR Part 20, Appendix B, Table II, Column 2.

APPLICABILITY: At all times.

ACTION:

With the concentration of radioactive material released from the site exceeding the above limits, restore the concentration to within the above limits within 15 minutes.

SURVEILLANCE REQUIREMENTS

C.4.1.1 Radioactive liquid wastes shall be sampled and analyzed in accordance with the sampling and analysis program specified in Section I of the REMODCM.

C.4.1.2 The results of the radioactive analysis shall be used in accordance with the methods of Section II of the REMODCM to assure that the concentration of the point of release are maintained within the limits of Control C.3.1.

RADIOACTIVE EFFLUENTS

BASIS

C.3/4 LIQUID EFFLUENTS

C.3/4.1 CONCENTRATION

This Control is provided to ensure that the concentration of radioactive materials released in liquid waste effluents from the site will be less than the concentration levels specified in 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 outside the site 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 20.106(e) to the population.

RADIOACTIVE EFFLUENTS

DOSE, LIQUIDS

CONTROLS

C.3.2 The dose or dose commitment to any MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released from the site (see Figure H-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 Control F.3, a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce the releases of radioactive materials in liquid effluents during the remainder of the current calendar quarter and during the remainder of the calendar year so that the cumulative dose or dose commitment to any MEMBER OF THE PUBLIC from such release during the calendar year is within 3 mrem to the total body and 10 mrem to any organ.

SURVEILANCE REQUIREMENTS

C.4.2.1 Cumulative dose contributions for the current calendar quarter and current calendar year from liquid effluents shall be determined in accordance with Section II of the REMODCM once every 31 days.

C.4.2.2 Relative accuracy or conservatisms of the calculations shall be confirmed by performance of the Radiological Environmental Monitoring Program as detailed in Section I of the REMODCM.

RADIOACTIVE EFFLUENTS

BASIS

C.3/4 LIQUID EFFLUENTS

C.3/4.2 DOSE, LIQUIDS

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 Limiting Condition for Operation 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". The dose calculation methodology and parameters in the REMODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I is to 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 REMODCM 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 Purpose of Implementing Appendix I," April 1977.

INSTRUMENTATION

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

C.3.3 The radioactive liquid effluent monitoring instrumentation channels shown in Table C.3.3 shall be OPERABLE with applicable Alarm/Trip Setpoints set to ensure that the limits of Control C.3.1 are not exceeded. The Alarm/Trip Setpoints shall be determined in accordance with methodology and parameters described in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: At all times*.

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 Alarm/Trip Setpoint so it is acceptably conservative.

b. With the number of channels less than the minimum channels OPERABLE requirement, take the ACTION shown in Table C.3.3. Exert best efforts to restore the inoperable monitor to OPERABLE status within 30 days, and, if unsuccessful, explain in the next Annual Effluent Report why the inoperability was not corrected in a timely manner. Releases need not be terminated after 30 days provided the specified actions are continued.

SURVEILLANCE REQUIREMENTS

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

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* At all times means that channel shall be OPERABLE and in service on a continuous, uninterrupted basis, except that outages of monitoring channels are permitted for a maximum of 12 hours each time for the purpose of maintenance and performance of required tests, checks, calibrations or sampling.

INSTRUMENTATION

BASES

C.3/4.3RADIOACTIVE 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.

TABLE C.3.3

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM # OPERABLE	ACTION
1. GROSS RADIOACTIVITY MONITORS PROVIDING AUTOMATIC TERMINATION OF RELEASE		
a. Recycle Test Tank Discharge Line	1	46
2. FLOW RATE MEASUREMENT		
a. Recycle Test Tank Discharge Line	1	47
b. Discharge Canal	*	N.A.

* Discharge canal flow is determined by the number of pumps running.

TABLE C.3.3
(Continued)

ACTION STATEMENTS

ACTION 46 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirements, effluent releases may continue provided that best efforts are made to repair the instrument and that prior to initiating a release:

a. At least two independent samples of the tank to be discharged are analyzed in accordance with Control C.4.1.1, and;

b. A second individual independently verifies the original release rate calculations and discharge valving.

ACTION 47 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument and that the flow rate is estimated once per 4 hours during actual releases. Pump performance curves generated insitu may be used to estimate flow.

TABLE C.4.3

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE(5)				
a. Recycle Test Tank Discharge Line	D(1)	P	R(2)	Q(3)
2. FLOW RATE MEASUREMENT				
a. Recycle Test Tank Discharge Line	D(1)	N.A.	R	N.A.
b. Discharge Canal	D(4)	N.A.	N.A.	N.A.

TABLE C.4.3
(Continued)

TABLE NOTATIONS

(1) CHANNEL CHECK need only be performed daily when discharges are made from this pathway. The CHANNEL CHECK should be done when the discharge is in process.

(2) CHANNEL CALIBRATION shall be performed using a known radioactive liquid or solid source whose strength is determined by a detector which has been calibrated to an NIST source. The radioactive source shall be in a known, reproducible geometry.

(3) The CHANNEL OPERATIONAL TEST shall also demonstrate that control room or local (see (5) below) alarm annunciation occurs if any of the following conditions exist:

1. Instrument indicates measured levels above the alarm/trip setpoint.†
2. Instrument indicates a downscale failure or circuit failure.
3. Instrument controls not set in operate mode.

(4) Pump status should be checked at least once per 24 hours for the purpose of determining flow rate.

(5) A responsible individual (preferably an operator) shall be present and within audible range of the local alarm (to monitor the alarm function) during Test Tank Discharges.

† Automatic isolation shall also be demonstrated annually for the test tank discharge monitor line.

D. GASEOUS EFFLUENTS

D.1 Gaseous Effluents Sampling and Analysis Program

Radioactive gaseous wastes shall be sampled and analyzed in accordance with the program specified in Table D-1 for the Haddam Neck Plant. The results of the radioactive analyses shall be input to the methodology of the ODCM to assure that the offsite dose rates are maintained within the Controls of the REMODCM.

TABLE D-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/cc)
A. Spent Fuel Pool Spray Cooling	Weekly	Weekly Liquid Grab	Principal Gamma Emitters[c] H-3	3.00E-08 2.00E-06
		Monthly Liquid Composite[f,g]	Gross Alpha	1.00E-07
		Quarterly Liquid Composite[f,g]	Sr-90 Fe-55	5.00E-08 1.00E-06
B. Containment Purge	Prior to Each Purge[d]	Prior to Each Purge	H-3	1.00E-06
C. Spent Fuel Building Exhaust	Weekly	Weekly Gaseous Grab	Kr-85 H-3	1.00E-04 1.00E-06
	Continuous[b]	Weekly Particulate[e]	Principal Gamma Emitters[c]	1.00E-11
		Monthly Particulate Composite	Gross Alpha	1.00E-11
		Quarterly Particulate Composite	Sr-90[i]	1.00E-11
		Noble Gas Monitor	Noble Gas Gross Activity	1.00E-06

TABLE D-1
(Continued)

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[a] (μCi/cc)
D. Main Stack	Weekly	Weekly Gaseous Grab	H-3	1.00E-06
	Continuous[b]	Weekly Particulate[e]	Principal Gamma Emitters[c]	1.00E-11
		Monthly Particulate Composite	Gross Alpha	1.00E-11
		Quarterly Particulate Composite	Sr-90[i]	1.00E-11
E. Miscellaneous Points[h] For example: • Alternate Containment Access • Tented Enclosures	Continuous[b]	Weekly Particulate[e]	Principal Gamma Emitters[c]	1.00E-11
		Monthly Particulate Composite	Gross Alpha	1.00E-11
		Quarterly Particulate Composite	Sr-90[i]	1.00E-11

Table D-1
(Continued)

TABLE NOTATIONS

a. The lower limit of detection (LLD) is defined in Table Notations of Table C-1.

b. 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 REMODCM.

c. The principal gamma emitters for which the LLD specification will apply are exclusively the following radionuclides: Mn-54, Co-60, Zn-65, Cs-134, and Cs-137. The list does not mean that only these nuclides are to be detected and reported. Other nuclides, which are identified, shall be reported. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD. When unusual circumstances result in an a priori (before the fact) LLD being higher than required, the reasons shall be documented in the Annual Radioactive Effluent Report.

d. Sample prior to purge will be obtained from the charging floor (refueling floor). Only required if reactor cavity is flooded.

   Sample results from the charging floor will be used to account for gaseous radioactivity released for the first 12 hours; after 12 hours, the radioactivity released will be accounted for from the Main Stack.

e. Samples shall be changed at least once per 7 days and analyses completed within 48 hours. The LLDs may be increased by a factor of 10 if sample collection is for less than 24 hours.

f. A composite sample is one in which the quantity of liquid sampled is proportional to system operational time and in which the method of sampling employed results in a specimen which is representative of the liquid released.

g. Prior to analysis, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluents released.

h. Release points included in this category are added if the radiological evaluation of the job or building indicates a potential for significant airborne radioactivity. This evaluation shall be performed in accordance with applicable radiological engineering programs.

i. Sr-90 analysis only required if Gross Beta is identified.

D.2 Gaseous Radioactive Waste Treatment

Monthly doses due to gaseous effluents to unrestricted areas shall be projected at least once per 31 days only if one or ALL APPLICABLE GASEOUS RADIOACTIVE WASTE TREATMENT SYSTEMS will not be routinely operated. When the projected monthly dose due to gaseous effluents exceeds 0.2 mrad for gamma radiation, 0.4 mrad for beta radiation or 0.3 mrem to any organ due to gaseous particulate effluents, ALL APPLICABLE GASEOUS RADIOACTIVE WASTE TREATMENT SYSTEMS will be operated.

With radioactive gaseous waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission, within 30 days, pursuant to Subsection F.3, a special report that includes the following information:

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

b. Actions taken to restore the inoperable equipment to OPERABLE status; and

c. Summary description of actions taken to prevent a recurrence.

D.3/4 GASEOUS EFFLUENT CONTROLS AND SURVEILLANCE REQUIREMENTS

DOSE RATE

CONTROLS

D.3.1 The dose rate, at any time, offsite (see Figure H-1) due to radioactive materials released in gaseous effluents from the site shall be limited to the following values:

a. The dose rate limit for noble gases shall be 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. The dose rate limit due to inhalation for tritium and for all radioactive materials in particulate form with half-lives greater than 8 days shall be 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, decrease the release rate within 15 minutes to comply with the limit(s) given in Control D.3.1.

SURVEILLANCE REQUIREMENTS

D.4.1.1 The release rate, at any time, of noble gases in gaseous effluents shall be controlled by the offsite dose rate as established above in Control D.3.1. The corresponding release rate shall be determined in accordance with the methodology of Section II of the REMODCM.

D.4.1.2 The noble gas effluent monitors of Control D.3.4 shall be used to control release rates to limit offsite doses within the values established in Control D.3.1.

D.4.1.3 The release rate of radioactive materials in gaseous effluents shall be determined by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Section I of the REMODCM (Table D-1). The corresponding dose rate shall be determined using the methodology and parameters given in the ODCM (Section II of the REMODCM).

RADIOACTIVE EFFLUENTS

BASES

D.3/4 GASEOUS EFFLUENTS

D.3/4.1 DOSE RATE

This Control is provided to ensure that the dose rate at anytime from gaseous effluents from the site will be within the annual dose limits of 10 CFR Part 20 for all areas offsite. The annual dose limits are the doses associated with the concentrations of 10 CFR Part 20, Appendix B, Table II. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of an individual offsite to annual average concentrations exceeding the limits specified in Appendix B, Table II of 10 CFR Part 20 (10 CFR 20.106(b)). For individuals who may at times be within the SITE BOUNDARY, the occupancy of that individual will be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the SITE BOUNDARY. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to an individual 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/year to the skin. These release rate limits also restrict, at all times, the corresponding thyroid or other organ dose rate above background to a child to less than or equal to 1500 mrem/year from inhalation.

RADIOACTIVE EFFLUENTS

DOSE, NOBLE GASES

CONTROLS

D.3.2 The air dose offsite (see Figure H-1) due to noble gases released in gaseous effluents shall be limited to the following:

a. During any calendar quarter, to 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 to 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 Control F.3, a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce the releases of radioactive noble gases in gaseous effluents during the remainder of the current calendar quarter and during the remainder of the calendar year so that the cumulative dose during the calendar year is within 10 mrad for gamma radiation and 20 mrad for beta radiation.

SURVEILLANCE REQUIREMENTS

D.4.2.1 Cumulative dose contributions for the current calendar quarter and current calendar year for noble gases shall be determined in accordance with Section II of the REMODCM once every 31 days.

D.4.2.2 Relative accuracy or conservatism of the calculations shall be confirmed by performance of the Radiological Environmental Monitoring Program as detailed in Section I of the REMODCM.

RADIOACTIVE EFFLUENTS

BASES

D.3/4 GASEOUS EFFLUENTS

D.3/4.2DOSE, NOBLE GASES

This Control is provided to implement the requirements of Sections II.B., III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition for Operation 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 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 conform with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of an individual through the 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, "Calculational 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 1.111, "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 the SITE BOUNDARY are based upon utilizing successively more realistic dose calculational methodologies. More realistic dose calculational methods are used whenever simplified calculations indicate a dose approaching a substantial portion of the regulatory limits.

RADIOACTIVE EFFLUENTS

DOSE, RADIOACTIVE MATERIAL IN PARTICULATE FORM AND RADIONUCLIDES OTHER THAN NOBLE GASES

CONTROLS

D.3.3 The dose to any MEMBER OF THE PUBLIC from tritium and radioactive materials in particulate form with half lives greater than 8 days in gaseous effluents released offsite (see Figure H-1) shall be limited to the following:

a. During any calendar quarter to less than or equal to 7.5 mrem to any organ;

b. During any calendar year to less than or equal to 15 mrem to any organ.

APPLICABILITY: At all times.

ACTION:

a. With the calculated dose from the release of radionuclides, radioactive materials in particulate form, or radionuclides other than noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Control F.3, a Special Report which identifies the cause(s) for exceeding the limit and defines the corrective actions to be taken to reduce the releases during the remainder of the current calendar quarter and during the remainder of the calendar year so that the cumulative dose or dose commitment to any MEMBER OF THE PUBLIC from such releases during the calendar year is within 15 mrem to any organ.

SURVEILLANCE REQUIREMENTS

D.4.3.1 Cumulative dose contributions for the current calendar quarter and current calendar year shall be determined in accordance with Section II of the REMODCM once every 31 days.

D.4.3.2 Relative accuracy or conservatism of the calculations shall be confirmed by performance of the Radiological Environmental Monitoring Program as detailed in the REMODCM.

RADIOACTIVE EFFLUENTS

BASES

D.3/4.3 DOSE, RADIOACTIVE MATERIAL IN PARTICULATE FORM AND RADIONUCLIDES OTHER THAN NOBLE GASES

This Control is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Conditions for Operation 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 materials in gaseous effluents will be kept "as low as is reasonably achievable." The ODCM calculational methods specified in the surveillance requirements implement the requirements in Section III.A of Appendix I that conformance with the guides for Appendix I be shown by calculational procedures based on models and data such that the actual exposure of an individual 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, "Calculating of Annual Dose to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 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 I, July 1977. The release rate Controls for radioactive material in particulate form and radionuclides other than noble gases are dependent on the existing radionuclide pathways to man. The pathways which are examined in the development of these calculations are:

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.

INSTRUMENTATION

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

D.3.4 The radioactive gaseous effluent monitoring instrumentation channels shown in Table D.3.4 shall be OPERABLE with applicable Alarm Setpoints set to ensure that the limits of Control D.3.1 are not exceeded. The setpoints shall be determined in accordance with the methodology and parameters as described in the ODCM.

APPLICABILITY: At all times‡

ACTION:

a. With a radioactive gaseous effluent monitoring instrumentation channel Alarm 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 Alarm Setpoint so it is acceptably conservative.

b. With the number of channels less than the minimum channels OPERABLE requirement, take the ACTION shown in Table D.3.4. Exert best efforts to restore the inoperable monitor to OPERABLE status within 30 days and, if unsuccessful, explain in the next Annual Effluent Report why the inoperability was not corrected in a timely manner. Releases need not be terminated after 30 days provided the specified actions are continued.

SURVEILLANCE REQUIREMENT

D.4.4 Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and ANALOG CHANNEL OPERATIONAL TEST operations at the frequencies shown in Table D.4.4.

‡ At all times means that the channel shall be operable and in service on a continuous basis, except that outages are permitted for a maximum of 12 hours each time for the purpose of maintenance and performance of required tests, checks, calibrations.

INSTRUMENTATION

BASES

D.3/4.4RADIOACTIVE 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 REMODCM 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.

TABLE D.3.4

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	ACTION
1. SPENT FUEL BUILDING EXHAUST MONITOR		
a. Noble Gas Activity Monitor Providing Alarm	1	50
b. Particulate Sampler	1	51
c. Stack Flow Rate Monitor	1	52
d. Sample Flow Rate Monitor	1	52
2. MAIN STACK MONITOR		
a. Particulate Sampler	1	51
b. Stack Flow Rate Monitor	1	52
c. Sample Flow Rate Monitor	1	52

TABLE D.3.4
(Continued)

ACTION STATEMENTS

ACTION 50 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument and grab samples are taken at least once per 12 hours and these samples are analyzed for radioactivity within 24 hours.

ACTION 51 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument and that samples are continuously collected with auxiliary sampling equipment for periods of seven (7) days and analyzed for principal gamma emitters with half lives greater than 8 days within 48 hours after the end of the sampling period. Auxiliary sampling shall be established within 12 hours of declaring the channel inoperable.

ACTION 52 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided that the best efforts are made to repair the instrument and that the flow rate is estimated once per 4 hours.

TABLE D.4.4

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. SPENT FUEL BUILDING EXHAUST MONITOR				
a. Noble Gas Activity Monitor	D(1)	M	R(2)	Q(3)
b. Particulate Sampler	W	N.A.	N.A.	N.A.
c. Stack Flow Rate Monitor	D(1)	N.A.	R	N.A.
d. Sample Flow Rate Monitor	D	N.A.	R	N.A.
2. MAIN STACK MONITOR				
a. Particulate Sampler	W	N.A.	N.A.	N.A.
b. Stack Flow Rate Monitor	D(1)	N.A.	R	N.A.
c. Sample Flow Rate Monitor	D	N.A.	R	N.A.

TABLE D.4.4
(Continued)

TABLE NOTATIONS

(1) CHANNEL CHECK daily when releases exist via this pathway.

(2) Calibration shall be performed using a known source whose strength is determined by a detector which has been calibrated to an NIST source. These sources shall be in a known, reproducible geometry.

(3) 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 above the Alarm Setpoint.

b. Instrument indicates a downscale failure or circuit failure.

c. Instrument controls not set in operate mode.

E. RADIOLOGICAL ENVIRONMENTAL MONITORING

E.1 Sampling and Analysis

The radiological sampling and analyses provide measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides which lead to the highest potential radiation exposures of individuals resulting from plant operation. This monitoring program 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 modeling of the environmental exposure pathways. Program changes may be made based on operational experience.

The sampling and analyses shall be conducted as specified in Table E-1 for the locations shown in Appendix G of the ODCM. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment or other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, every 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 Section F.1. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice (excluding milk) at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathways in question and appropriate substitutions made within 30 days in the Radiological Environmental Monitoring Program.

If the Land Use Census identifies milking animals within 8 km (5 miles) from the site, milk sampling shall be initiated as follows:

- Samples from milking animals shall be collected from 3 indictor locations within 5 km (3 miles) from the site at the locations calculated to have the highest dose potential.
- If no milking animals are located within 5 km (3 miles), then samples from milking animals shall be collected from 3 indicator locations between 5 to 8 km (3 to 5 miles) from the site at locations calculated to exceed 1 mrem per year. (The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.
- If any samples of milking animals are collected, 1 control sample shall be collected from milking animals at a location 15 km to 30 km (10 to 18 miles) from the site and in the least prevalent wind direction.

Any and all changes to milking animal sample locations shall be documented in the Annual Radiological Environmental Operating Report which is submitted to the U.S. Nuclear Regulatory Commission prior to May 1 of each year.

Changes to sampling locations shall be identified in a revised table and figure(s) in Appendix G of the ODCM.

If the level of radioactivity in an environmental sampling medium at one or more of the locations specified in Table E-1 exceeds the report levels of Table E-2 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days from the end of the affected calendar quarter, a Special Report which includes an evaluation of any release conditions, environmental factors or other aspects which caused the limits of Table E-2 to be exceeded. When more than one of the radionuclides in Table E-2 are detected in the sampling medium, this report shall be submitted if:

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

When radionuclides other than those in Table E-2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose to an individual is equal to or greater than the appropriate calendar year limit of the REMODCM. 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.

The detection capabilities required by Table E-3 are state-of-the-art 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. All analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified and described in the Annual Radiological Environmental Operating Report.

TABLE E-1

HADDAM NECK RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
1. Gamma Dose – Environmental TLD	14	Quarterly	Gamma Dose - Quarterly
2. Airborne Particulate	5	Continuous sampler - biweekly filter change§	Gross Beta - Biweekly§ Gamma Spectrum - Quarterly on composite (by location), and on individual sample if gross beta is greater than 10 times the mean of the biweekly control station's gross beta results.
3a. Vegetation – Fruits and Vegetables	2	One sample near middle and one near end of growing season	Gamma Isotopic on each sample
3b. Vegetation – Broad Leaf Vegetation, in lieu of milk	**3**	Monthly during growing season (April - December)	Broad Leaf Vegetation at each of the two indicator and one control locations, when available. Gamma Isotopic on each sample
4. Milk	4	Monthly, if required **	Gamma Isotopic on each sample - Monthly, if required** Sr-90 - Quarterly, if required **
5. Well Water	2	Quarterly	Gamma Isotopic, and Tritium on each sample
6. Bottom Sediment	3	Semiannual	Gamma Isotopic
7. River Water	2	Quarterly Sample - Indicator is Continuous Composite; Control is Composite of Six Consecutive Grab Samples collected biweekly.	Quarterly - Gamma Isotopic and Tritium of continuous indicator and control grab composites.
8. Fish (edible portion) - bullheads and, when available, Perch or other edible fish	3	Semiannual	Gamma Isotopic - Semiannual
9. Shellfish	2	Semiannual	Gamma Isotopic - Semiannual

§ More frequent filter replacement may be necessary, depending on filter media loading. Gross beta analysis frequency shall follow the frequency of the filter replacement.

** Milk sampling and analysis is only required if the conditions specified in NUREG 1301, Table 3.12-1, are met (Samples are collected from milking animals in three locations within 3 miles when, and if, milking animals are identified in the annual Land Use Census. If no milking animals are found within 3 miles, then samples from milking animals in one location between 3 and 5 miles are collected if the projected dose from milk consumption exceeds 1 mrem/year via this pathway). The Land Use Census looks for and documents (when found) the presence of milk animals within 5 miles annually.

TABLE E-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

Analysis	**Water** (pCi/l)	**Airborne Particulate or Gas** (pCi/m^3)	**Fish** (pCi/kg, wet)	**Milk** (pCi/l)	**Vegetables** (pCi/kg, wet)	**Shellfish** (pCi/kg, wet)
H-3	2.00E+04					
Mn-54	1.00E+03		3.00E+04			1.40E+05
Co-60	3.00E+02		1.00E+04			5.00E+04
Zn-65	3.00E+02		2.00E+04			8.00E+04
Cs-134	3.00E+01	1.00E+01	1.00E+03	6.00E+01	1.00E+03	5.00E+03
Cs-137	5.00E+01	2.00E+01	2.00E+03	7.00E+01	2.00E+03	8.00E+03

TABLE E-3

MAXIMUM VALUES FOR LOWER LIMITS OF DETECTION (LLD)[a]

Analysis	**Water** (pCi/l)	**Airborne Particulate or Gas** (pCi/m^3)	**Fish** (pCi/kg, wet)	**Milk** (pCi/l)	**Food Products** (pCi/kg, wet)	**Sediment** (pCi/kg, dry)
Gross Beta		1.00E-02				
H-3	2.00E+03					
Mn-54	1.50E+01		1.30E+02			
Co-60	1.50E+01		1.30E+02			1.50E+02
Zn-65	3.00E+01		2.60E+02			
Cs-134	1.50E+01	5.00E-02	1.30E+02	1.50E+01	6.00E+01	1.50E+02
Cs-137	1.80E+01	6.00E-02	1.50E+02	1.80E+01	8.00E+01	1.80E+02

TABLE E-3
(Continued)

TABLE NOTATIONS

a. The lower limit of detection (LLD) is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

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

where:

LLD is the lower limit of detection as defined above (microcuries per unit volume)

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

E is the counting efficiency (counts per transformation)

V is the sample size (volume)

2.22 is the number of transformations per minute per picocurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide

Δt is the elapsed time between sample collection (or midpoint of sample collection) and time of counting.

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, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified and described in the Annual Radiological Environmental Operating Report.

E.2 Land Use Census

The land use census ensures that changes in the use of unrestricted areas are identified and that modifications to the monitoring program are made if required by the results of this census. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50.

The Land Use Census shall be conducted and shall identify the location of the nearest resident, the nearest milk animal, and the nearest garden[††] of greater than 50 m^2 (500 ft^2) producing broad leaf vegetation in each of the 16 meteorological sectors within a distance of 8 km (5 miles).

- The validity of the Land Use Census shall be conducted at least once per calendar year by either a door-to-door survey, aerial survey, consulting local agriculture authorities, or any combination of these methods.

- With a Land Use Census identifying a location(s) which yields a calculated dose or dose commitment greater than the doses currently being calculated in the off-site dose models, make the appropriate changes in the sample locations used.

- With a Land Use Census identifying a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with Section E.1, add the new location(s) within 30 days. The sample location(s), excluding the control 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 the Land Use Census is conducted.

- With a Land Use Census identifying milking animals within 8 km (5 miles) from the site, initiate sampling for milk in accordance with Section E.1 within 30 days.

Sample location changes shall be noted in the Annual Radiological Environmental Operating Report.

[††] Broad leaf vegetation (a composite of at least 3 different kinds of vegetation) may be sampled at the SITE BOUNDARY in each of 2 different direction sectors with high D/Q in lieu of a garden census.

E.3 Interlaboratory Comparison Program

The 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 a quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid.

Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program. 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.

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.

F. REPORT CONTENT

F.1 Annual Radiological Environmental Operating Report

The Annual Radioactive Environmental Operating Report shall include summaries, interpretations and statistical evaluation of the results of the radiological environmental surveillance activities for the report period, including a comparison with the previous environmental surveillance reports and an assessment of the observed impacts of the plant operation on the environment. The report shall also include the results of the land use census required by Section E.2 of this manual. If levels of radioactivity are detected that result in calculated doses greater than 10 CFR Part 50 Appendix I Guidelines, the report shall provide an analysis of the cause and a planned course of action to alleviate the cause.

The report shall include a summary table of all radiological environmental samples, which shall include the following information for each pathway sampled, and each type of analysis:

a. Total number of analyses performed at indicator locations;

b. Total number of analyses performed at control locations;

c. Lower limit of detection (LLD);

d. Mean and range of all indicator locations together;

e. Mean and average of all control locations together;

f. Name, distance and direction from discharge, mean and range for the location with the highest annual mean (indicator or control); and

g. Number of nonroutine reported measurements as defined in these specifications.

In the event that some 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 in the next annual report.

The report shall also include a map of sampling locations keyed to a table giving distances and directions from the discharge; the report shall also include a summary of the Interlaboratory Comparison Data required by Section E.3 of this manual.

F.2 Annual Radioactive Effluent Report

The Annual Radioactive Effluent Report (ARER) shall include quarterly quantities of and an annual summary of radioactive liquid and gaseous effluents released from the unit in the Regulatory Guide 1.21 (Rev 1, 06/74) format. Radiation dose assessments for these effluents shall be provided in accordance with 10 CFR Part 50.36a and the REMODCM. An annual assessment of the radiation dose from the site to the most likely exposed MEMBER OF THE PUBLIC shall be included to demonstrate conformance with 40 CFR Part 190. Doses shall be calculated in accordance with the OFFSITE DOSE CALCULATION MANUAL. The ARER shall be submitted by May 1 of each year for the period covering the previous calendar year.

The ARER shall include a summary of each type of solid radioactive waste shipped offsite for burial or final disposal during the report period and shall include the following information for each type:

a. Type of waste (e.g., spent resin, compacted dry waste, irradiated components, etc.);

b. Solidification agent (e.g., cement);

c. Total curies;

d. Total volume and typical container volumes;

e. Principal radionuclides (those greater than 10% of total activity); and

f. Types of containers used (e.g., LSA, Type A, etc.).

The ARER shall include the following information for each abnormal release of radioactive liquid and gaseous effluents from the site to unrestricted areas:

a. Description of the events and equipment involved;

b. Causes for the abnormal release;

c. Actions taken to prevent recurrence; and

d. Consequences of the abnormal release.

Changes to the RADIOLOGICAL EFFLUENT MONITORING AND OFFSITE DOSE CALCULATION MANUAL (REMODCM) shall be submitted to the NRC as appropriate, as part of or concurrent with the ARER for the period in which the changes were made.

F.3 SPECIAL REPORTS

Special reports shall be submitted to the U.S. Nuclear Regulatory Commission, Document Control Desk, Washington, D.C. 20555, with a copy to the appropriate Regional Office of the NRC, within the time period specified for each report.

G. TOTAL DOSE

G.1 Total Dose from All Sources

In addition to the dose limitations specified in sections C & D of the REMM, 40 CFR 190 limits the total dose to an individual from all sources (liquid effluents, gaseous effluents, and direct dose from fixed sources) to less than or equal to 25 mrem per year to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem per year.

G.2 Compliance with 40CFR190 Limits

The following sources should be considered in determining the total dose to a real individual from uranium fuel cycle sources:

a. CY gaseous doses from all release pathways.

b. CY liquid doses from all release pathways.

c. CY direct dose from the site (see Section D.5 in the ODCM).

d. Since all other uranium fuel cycle sources are greater than 20 miles away, they need not be considered.

G.3/4 TOTAL DOSE CONTROLS AND SURVEILLANCE REQUIREMENTS

CONTROLS

G.3 The dose or dose commitment from the site to a MEMBER OF THE PUBLIC is limited to less than or equal to 25 mrem to the total body or any organ (except the thyroid, which is limited to less than or equal to 75 mrem) over a period of 12 consecutive months.

APPLICABILITY: At all times.

ACTION:

With the calculated dose from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Specification C.3.2, D.3.2, or D.3.3, prepare and submit a Special Report to Commission pursuant to Control F.3 and limit the subsequent releases such that the dose or dose commitment from the site to any MEMBER OF THE PUBLIC is limited to less than or equal to 25 mrem to the total body or any organ (except thyroid, which is limited to less than or equal to 75 mrem) over 12 consecutive months. This Special Report shall include an analysis which demonstrates that radiation exposures from the site to any MEMBER OF THE PUBLIC (including all effluent pathways and direct radiation) are less than the 40 CFR Part 190 Standard. If the estimated doses exceed the above limits, the special report shall include a request for a variance in accordance with the provisions of 40 CFR Part 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

SURVEILLANCE REQUIREMENTS

G.4 Cumulative dose contributions from liquid and gaseous effluents and direct radiation shall be determined in Specifications C.4.2.1, D.4.2.1 and D.4.3.1 and in accordance with Section II of the REMODCM once per 31 days.

BASES

G.3/4 TOTAL DOSE

This specification is provided to meet the reporting requirements of 40 CFR Part 190. For the purposes of the Special Report, it may be assumed that the dose commitment to any MEMBER OF THE PUBLIC from other 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 5 miles must be considered.

Exclusion Area Boundary and Site Boundary for Liquid and Gaseous Effluents

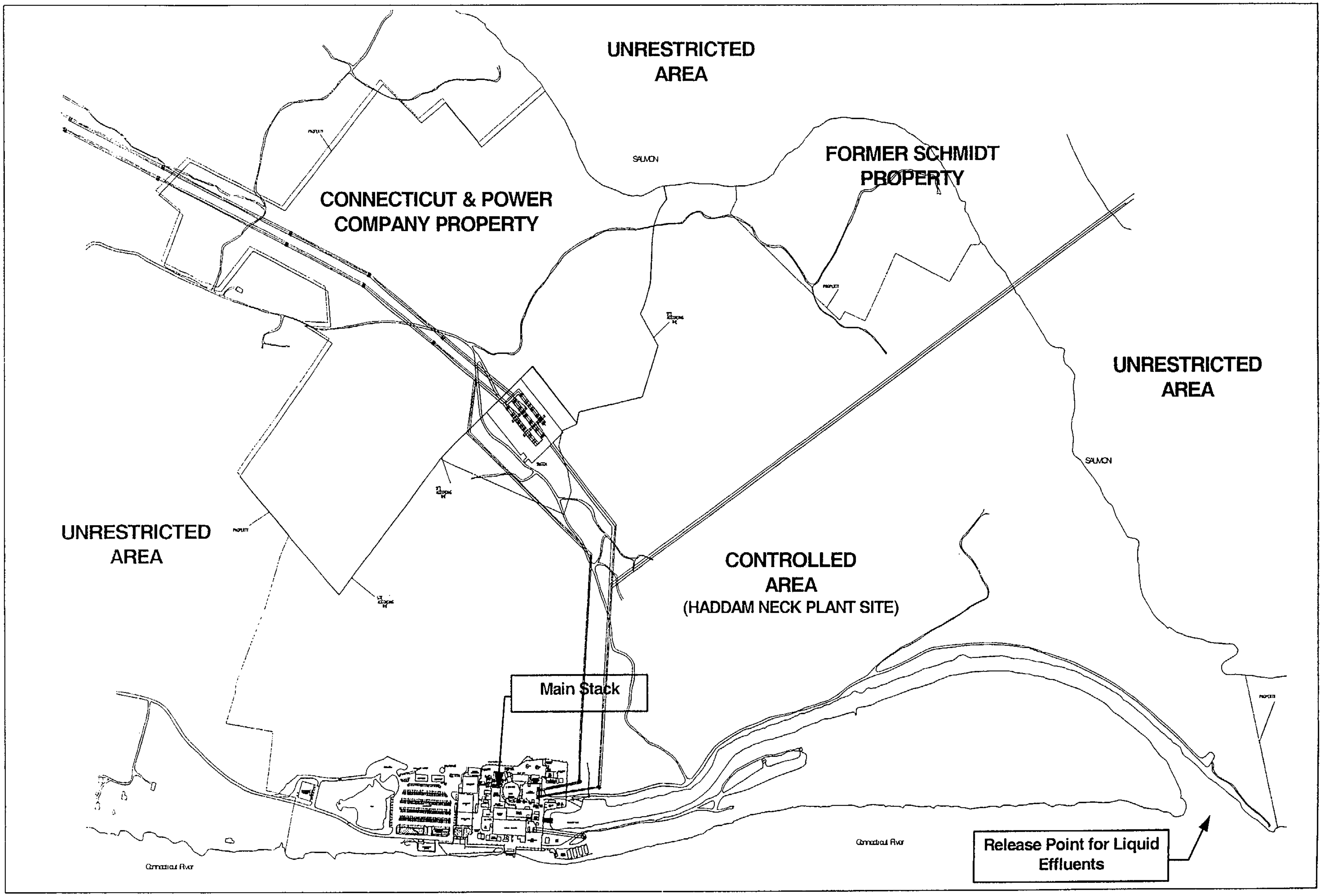
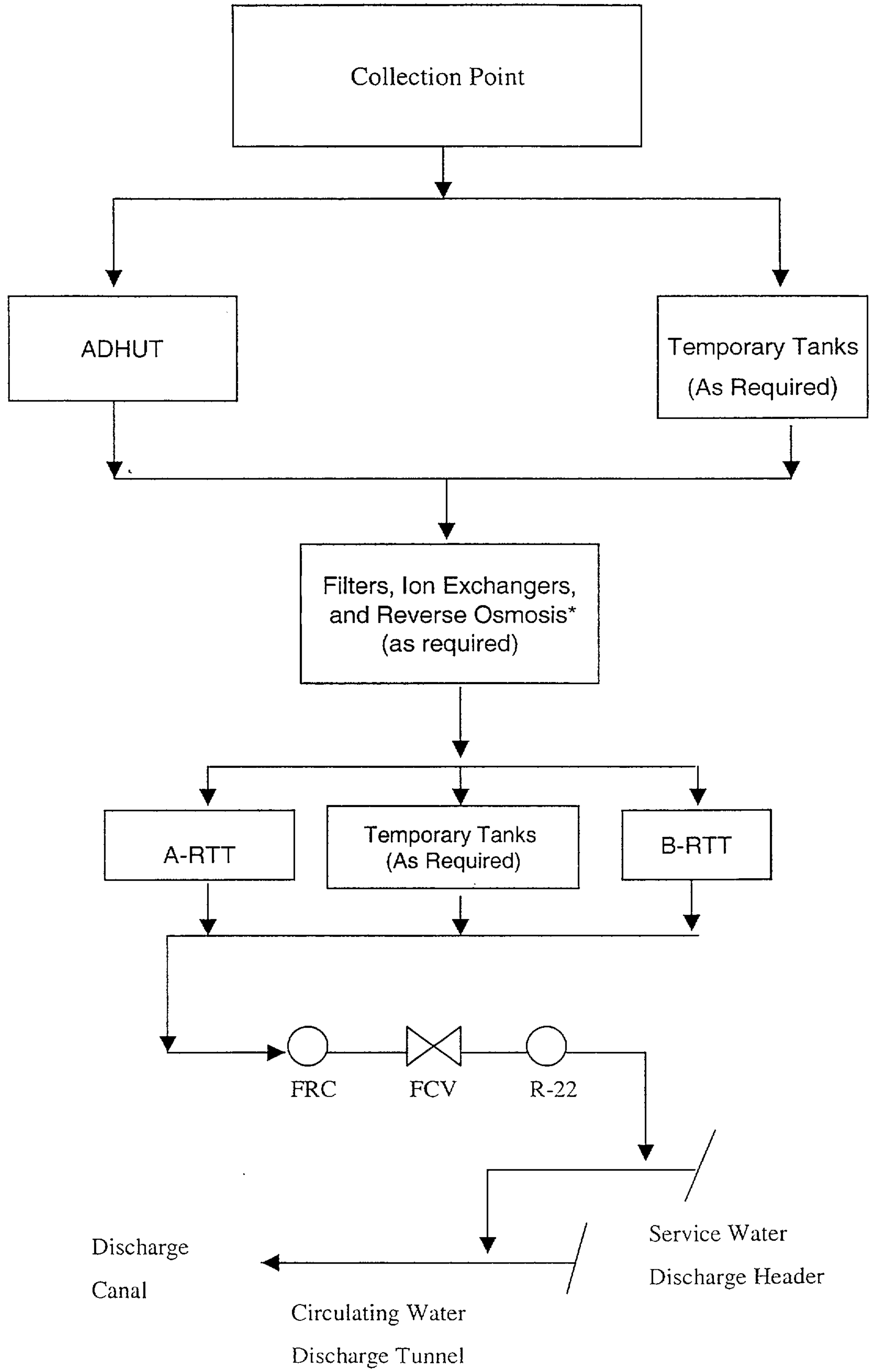


Figure H-2 Liquid Radwaste System



FRC – Flow Controller

FCV – Flow Control Valve

*Process requires written CT DEP Approval

OFFSITE DOSE

CALCUATION MANUAL

JUN 11 2002

SECTION II

OFFSITE DOSE CALCULATION MANUAL

For The

HADDAM NECK PLANT

Docket No. 50-213

HADDAM NECK PLANT

OFFSITE DOSE CALCULATION MANUAL

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APPENDICES

A. INTRODUCTION

Technical Specification 6.6.3, Radiological Effluent Monitoring and Offsite Dose Calculation Manual (REMODCM), requires that Section II contain the Offsite Dose Calculation Manual. This manual shall describe the methodology and parameters to be used in the following:

1. Calculation of offsite doses due to radioactive gaseous and liquid effluents.

2. Calculation of gaseous and liquid effluent monitoring instrumentation alarm/trip setpoints consistent with the applicable limiting conditions of operation contained in Part I of the REMODCM.

This manual contains the methods to be used in performance of the Control surveillance requirements in Part I of the REMODCM but does not include the procedures and forms needed to document compliance with the surveillance requirements.

In some sections, several methods may exist to perform the required Control. Generally, the methods are listed in order of simplicity and conservatism (i.e. Method 1 being the most simple and most conservative). If a limit is approached, then more detailed calculations need to be performed. A more detailed calculation may be used at any time in lieu of a more simple method.

B. RESPONSIBILITIES

All changes to this manual shall be independently reviewed and approved by the Unit Manager prior to implementation.

It is the responsibility of the Unit Manager to ensure compliance with all the requirements of this manual.

C. LIQUID DOSE CALCULATIONS

Liquid dose calculations are performed once every 31 days to comply with Controls C.3.2 and G.3 of Part I of this manual. The basis for the Method 1 used to calculate liquid dose is explained in Appendix B. The methods described below use source terms totaled by similar dilution flows. For example; if, during a period, there were releases at flows of 3,000 gpm and 189,000 gpm, then dose calculations must be performed for each different dilution flow and then summed to calculate the total doses. Initial circulation water (CW) dilution flow must be maintained for batch discharges until 125 million gallons of river water is discharged following termination of the release.

(Note: Method 2 can be used at any time in lieu of Method 1.)

C.1 Method 1

a. Monthly

Method 1 is used primarily for calculating monthly liquid doses; however, it can also be used for any release period if both the radionuclide activities and dilution flow are for that same period.

Step 1

Determine the total activity (*Ci*) of each nuclide released with the same dilution flow (ft^3/sec).

Step 2

Determine the maximum total body and maximum organ doses by using the following calculation logic:

(a) For each nuclide from Step 1 that is in Appendix A, calculate its age-organ dose contribution (e.g. Adult Thyroid) by dividing its activity (*Ci*) by the dilution flow (ft^3/sec) and then multiplying that result by each of the age-organ dose conversion factors (DCFs) from Appendix A (3 ages x 7 organs = 21 DCFs per nuclide).

(b) Sum all individual nuclide age-organ dose contributions by age-organ (e.g. Adult Thyroid) for all the nuclides in Step 1.

(c) Select the maximum summed total body dose for Adult, Teen and Child as the whole body dose. Likewise, select the maximum summed organ dose for Adult, Teen and Child as the maximum organ dose.

Repeat Steps 1 and 2 for each different dilution flow, as required.

Step 3

Sum the whole body doses for each different dilution flow to derive the total whole body dose. Likewise, sum the maximum organ doses for each different dilution flow to derive the total maximum organ dose.

b. **Quarterly and Annually**

Quarterly total body and maximum organ liquid doses are calculated by summing the appropriate monthly total body and maximum organ doses, respectively. Likewise, annual total body and maximum organ liquid doses are calculated by summing the appropriate quarterly total body and maximum organ doses, respectively.

Control C.3.2 of Part I of this manual specifies the following limitations and actions for liquid effluent doses:

> The dose or dose commitment to any MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released from site shall be limited:
>
> > 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
> >
> > 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.
>
> 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 Subsection F.3 of the REMM, a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce the releases of radioactive materials in liquid effluents during the remainder of the current calendar quarter and during the remainder of the current calendar year so that the cumulative dose or dose commitment to any MEMBER OF THE PUBLIC from such release during the calendar year is within 3 mrem to the total body and 10 mrem to any organ.

If the quarterly or annual liquid doses exceed, or are expected to exceed, the limits cited above, then Method 2 is to be used to refine liquid doses.

C.2 Method 2

This method uses the methodology of NRC Regulatory Guide 1.109 (Rev 1) to calculate liquid effluent doses. The use of this model and its associated input parameters are discussed in Appendix C.

By design, Method 2 is to be used to calculate quarterly and annual liquid effluent doses for the Annual Radioactive Effluent Report; however, Method 2 should be used whenever Method 1 is determined to be inadequate or inappropriate. Method 2 can be used at any time in lieu of Method 1.

C.3 Quarterly Dose Calculations for Annual Radioactive Effluent Report

Detailed quarterly dose calculations required for the Annual Radioactive Effluent Report shall be done using the NRC computer code LADTAP II, i.e. Method 2, or an equivalent code implementing the guidance in Regulatory Guide 1.109, Rev. 1. The use of this model and its associated input parameters are discussed in Appendix C.

D. GASEOUS DOSE CALCULATIONS

The determination of doses from radioactive gaseous effluents to the maximum off-site receptor are typically divided into two methods representing different levels of conservatism. All hand calculation approaches discussed below (i.e., Method 1) provide simplified, conservative operational tools to ensure that effluent releases are not likely to cause quarterly and annual off-site dose or dose rate limits to be exceeded. Site specific dose factors used in Method 1 are based on long-term historical on-site meteorological dispersion estimates as described in Appendix H, options and parameters that may be used are summarized in Appendix E. In cases where additional analyses can justify a more accurate determination of dose, a Method 2 approach is also listed. Method 2 provides for a more detailed calculation using accepted computer models along with historical atmospheric dispersion parameters, to demonstrate regulatory compliance. Method 2 can be used whenever the Method 1 estimation approaches a regulatory limit, or if a more refined dose estimate is desired. Method 2 is also used for preparation of the Annual Radioactive Effluent Report that includes the quarterly and annual dose impacts for all effluents recorded discharged to the atmosphere during the year of record.

D.1. Site Dose Rate Limits ("Instantaneous")

The Technical Specifications requires that the instantaneous off-site dose rate from noble gas (Kr-85 is the only remaining isotope) released to the atmosphere be limited not exceed 500 mrem/year at any time to the whole body or 3000 mrem/year to the skin from the external cloud. With the abandonment of the Waste Gas Decay System and isolation of the Spent Fuel Building ventilation from the plant stack, noble gas release potential is associated only with ground level sources.

For tritium and particulates (half-lives > 8 days), the inhalation pathway critical organ dose rate shall not exceed 1500 mrem/year at any time.

a. Total Body Dose Rate Due to Kr-85

The total body dose rate limit (500 mrem/yr) applies to the combination of all concurrent ground level sources on site.

For **ground-level** releases (i.e., all releases points other than the plant stack), the total body dose rate is:

$$\dot{D}_{tb(g)} = 309 * \dot{Q}_g * DFB$$

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

where:

$\dot{Q}_g$ = Total release rate (µCi/second) to the environment of Kr-85 via ground-level release pathways.

309 = Site specific total body dose rate conversion constant for ground level releases (see Appendix H for derivation).

DFB = Total body dose factor from Appendix H, Table H-1 = 1.61E-5 mrem-m^3/pCi-yr.

b. **Skin Dose Rate Due to Kr-85**

The skin dose rate limit (3000 mrem/yr) applies to the combination of all concurrent ground level sources.

For **ground-level** release points (i.e., all releases other than the plant stack), the skin dose rate:

$$\dot{D}_{skin(g)} = \dot{Q}_g * DF'_g .$$

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

where:

$\dot{Q}_g$ = The total release rate (μCi/second) of Kr-85 from all ground-level release points.

DF'_g = The combined skin dose rate factor from Appendix H, Table H-1 = 4.20 E-1 mrem-sec/μCi-yr.

c. **Site Release Rate Limits For Noble Gas ("Instantaneous")**

The site noble gas dose rate limits (500 mrem/yr total body and 3000 mrem/yr skin) apply to the combination of concurrent effluents from all releases points, and are directly related to the radioactivity release rates measured for each discharge point. By limiting gaseous release rates to within values which correlate to the above dose rate limits, assurance is provided that the site effluent control dose rate limits are not exceeded. Since the only remaining noble gas isotope is Kr-85, the above dose rate equations and site dose rate limits show that the skin dose is the limiting exposure pathway.

The instantaneous noble gas release rate limit from the site shall be:

$$\frac{Q_g}{7,143} \leq 1$$

where:

Q_g = Kr-85 release rate from all ground level sources (μCi/sec).

7,143 = The Kr-85 release rate (μCi/sec) from the ground-level sources equivalent to a skin dose rate of 3000 mrem/year.

As long as the above is less than or equal to 1, the dose rate from Kr-85 will be less than or equal to 3000 mrem/yr to the skin (and 500 mrem/yr to the total body).

d. **Critical Organ Dose Rate from Particulates and Tritium**

The critical organ rate limit (1500 mrem/yr) applies to the combination of the plant stack releases and all concurrent ground level sources. It includes particulates with half lives greater than 8 days, and tritium (Iodine-131 and 133 have been removed from the potential source term due to decay). Results of gross alpha analyses shall be considered as Am-241 for dose calculations. Dose rates from all concurrent ground sources and the plant stack are determined independently, and then summed to obtain the overall critical organ dose rate.

(1) Method 1

For **elevated** (mixed mode) releases from the plant stack, the critical organ dose rate to the maximum off-site receptor is determined as follows:

$$\dot{D}_{co(e)} = \sum_i (\dot{Q} * DFG'_{ico(e)})$$

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

where:

$\dot{D}_{co(e)}$ = The off-site critical organ dose rate (mrem/yr) due to particulates and tritium from plant stack releases;

$\dot{Q}_i$ = The release rate (μCi/second) of radionuclide "i" (i.e., total activity measured of radionuclide "i" averaged over the time period for which the filter sample collector was in the effluent stream (plant stack).

$DFG'_{ico(e)}$ = The site-specific critical organ dose rate factor for an elevated (plant stack) release (see Appendix D, Table D-5) $\left(\frac{mrem-\sec}{\mu Ci-yr}\right)$.

For ground-level releases (i.e., all releases point other than the plant stack), the critical organ dose rate to the maximum off-site receptor is determined as follows:

$$\dot{D}_{co(g)} = \sum_i (\dot{Q} * DFG'_{ico(g)})$$

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

where:

$\dot{D}_{co(g)}$ = The off-site critical organ dose rate (mrem/yr) due to particulates and tritium from a ground-level release.

$\dot{Q}_i$ = The release rate (μCi/second) of radionuclide "i".

$DFG'_{ico(g)}$ = The site-specific critical organ dose rate factor for a ground-level release (i.e., all releases other than from the plant stack) (see Appendix D, Table D-5) $\left(\frac{mrem - \sec}{\mu Ci - yr}\right)$.

Note: For ground-level releases from other than a Temporary Tent Exhaust, the ground-level DFG values may be decreased, if desired, by multiplying them by a correction factor applicable to the specific ground-level release point being evaluated. The correction factors are listed in Appendix D, Table D.4.

(2) Method 2

If necessary, determine the maximum organ dose rate for the identified mix of particulates utilizing the GASPAR code (or equivalent code model that implements Regulatory Guide 1.109, Rev. 1 dose equations and maximum individual assumptions) to estimate the dose rate from tritium and particulates with half-lives greater than 8 days. For the identified radionuclide mix, dose rates by critical organ and age group should be assessed to determine the limiting organ dose rate at the maximum exposure point offsite.

D.2 10CFR50 Appendix I Limits (Noble Gases)

Effluent controls limit the off-site air dose from noble gases released in gaseous effluents to 5 mrad gamma, and 10 mrad beta for a calendar quarter (10 and 20 mrad gamma and beta, respectively, per calendar year). Effluent dose calculations are calculated at least once every 31 days. This part of the ODCM provides the calculation methodology for determining air doses from noble gases.

a. **Gamma Air Dose Due to Kr-85**

For **ground-level** releases (i.e., all release points other than the plant stack), the gamma air dose is calculated:

$$D^{\gamma}_{air(g)} = (9.8E-06) * Q_g * DF^{\gamma}$$
$$(mrad) = \left(\frac{pCi-yr}{\mu Ci - m^3}\right) * (\mu Ci) * \left(\frac{mrad - m^3}{pCi - yr}\right)$$

where:

Q_g = Total quantity of Kr-85 (µCi) released from the ground-level release points (all release points other than the plant stack) during the period of interest.

9.8E-6 = Site specific gamma air dose conversion constant for ground level releases. See Appendix H for derivation.

DF^{γ} = Gamma air dose factor for a uniform semi-infinite cloud of Kr-85 from Appendix H, Table H-1 = 1.72 E-5 mrad-m^3/pCi-yr.

b. **Beta Air Dose Due to Kr-85**

For **ground-level** release points (i.e., all release points other than the plant stack), the beta air dose is calculated:

$$D^{\beta}_{air(g)} = (9.8E-06) * (Q_g) * (DF^{\beta})$$
$$(mrad) = \left(\frac{pCi-yr}{\mu Ci - m^3}\right) * (\mu Ci) * \left(\frac{mrad - m^3}{pCi - yr}\right)$$

where:

DF^{β} = Beta air dose factors for a uniform semi-infinite cloud of Kr-85 from Appendix H, Table H-1 = 1.95 E-3 mrad-m^3/pCi-yr.

9.8E-6 = Site specific beta air dose conversion constant for ground level releases. See Appendix H for derivation.

Q_g = Quantity of Kr-85 (µCi) released from the ground-level release points during the period of interest.

c. **Annual Air Dose Due to Kr-85**

Determine D_{YAG} and D_{YAB} which equals the gamma air dose and beta air dose for the calendar year as follows:

$$D_{YAG} = \sum D_{QAG} \text{ and } D_{YAB} = \sum D_{QAB}$$

where the sum is over the first quarter through the present quarter doses.

The following should be used as D_{QAG} and D_{QAB}:

(1) If the detailed quarterly dose calculations required per Section D.5 for the Annual Radioactive Effluent Report are complete for any calendar quarter, use those results.

(2) If the detailed calculations are not complete for a particular quarter, use the results as determined above in Section D.2.a and b.

D.3. 10CFR50 Appendix I Limits (Particulates and Tritium)

Effluent control requirements limit the off-site dose to a critical organ from tritium and particulates with half-lives greater than 8 days released in gaseous effluents to 7.5 mrem for a calendar quarter and 15 mrem per calendar year. These dose limits apply to the combination of plant stack and all concurrent ground level sources. (Iodine-131 and 133 have been removed from the potential sources term due to radioactive decay.) Effluent dose calculations are performed at least once every 31 days. This part of the ODCM provides the calculation methodology for determining critical organ doses from atmospheric releases of tritium and particulates. Results of gross alpha analyses shall be considered as Am-241 for dose calculations.

a. **Critical Organ Doses**

(1) Method 1a

For an elevated (mixed mode) release from the plant stack, the critical organ dose during a release period of interest (such as 31 days, quarterly, etc.) at the postulated maximum off-site receptor location can be calculated from:

$$D_{co(e)} = \sum_i \left(Q_{i(e)} * DFG_{ico(e)} \right)$$

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

where:

$Q_{i(e)}$ = The total activity in μCi of radionuclide "i" released to the atmosphere from the elevated release point (plant stack) during the period of interest.

$DFG_{ico(e)}$ = The site-specific critical organ dose factor for radionuclide "i" and the elevated release point, based on the age group and organ with the largest dose factor (see Appendix D, Table D-6).

For **ground-level** releases (i.e., all release points other than the plant stack) the critical organ dose during a release period of interest (such as 31 days, quarterly, etc) at the postulated maximum off-site receptor location is calculated:

$$D_{co(g)} = \sum_i \left(Q_{i(g)} * DFG_{ico(g)}\right)$$

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

where:

$Q_{i(g)}$ = The total activity in μCi of radionuclide "i" released to the atmosphere from ground-level release points during the period of interest.

$DFG_{ico(g)}$ = The site-specific critical organ dose factor for radionuclide "i" and ground-level release points, based on the age group and organ with the largest dose factor (see Appendix D, Table D-6).

> Note: For ground-level releases from other than a Temporary Tent Exhaust, the ground-level DFG values may be decreased, if desired, by multiplying them by a correction factor applicable to the specific ground-level release point being evaluated. The correction factors are listed in Appendix D, Table D.4.

(2) Method 1b (For ground level releases only)

With the elimination of the waste gas system operation as a batch mode release source, an additional dose equation has been provided for the situations where routine discharges are impacted with an identifiable short duration release of particulate radioactivity, such as the breakthrough of activity on a temporary HEPA filter used during dismantlement activities. The time-adjusted X/Q value provides additional conservatism to the dose calculation by substituting a short-term X/Q estimate for the standard annual average value (ground-level releases only). The time-adjusted Method 1 dose equation for Particulate and Tritium releases is:

$$D_{co(g)} = 9.86 * t^{-.252} * \sum_i \left(Q_{i(g)} * DFG_{ico(g)}\right)$$

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

where:

D_{co} = The maximum critical organ dose from particulates and tritium accounting for single event short duration discrete release.

9.86 = The ratio of the 1 hour depleted X/Q (2.89E-03 sec/m3) at the maximum receptor location to the long term average (growing season) depleted X/Q (2.93E-04 sec/m3).

$t^{-0.252}$ = A unitless adjustment factor to account for a release with a total duration of "t" hours.

Q_i = The total activity in µCi of radionuclide "i" released to the atmosphere during the short term period of interest.

DFG_{ico} = The site-specific critical organ dose factor for radionuclide "i", based on the age group and organ with the largest dose factor (see Appendix D, Table D.6).

Note: For ground-level releases from other than a Temporary Tent Exhaust, the ground-level DFG values may be decreased, if desired, by multiplying them by a correction factor applicable to the specific ground-level release point being evaluated. The correction factors are listed in Appendix D, Table D.4.

(3) Method 2

The maximum critical organ dose can be calculated utilizing the GASPAR code (or equivalent code model that implements Regulatory Guide 1.109, Rev. 1 dose equations and maximum individual assumptions) to estimate the dose from tritium and particulates with half-lives greater than 8 days. The dose to the critical organ and age group should be assessed using the most recent land use census data to identify which exposure pathways need to be considered at actual receptor locations. Doses from vegetation consumption can be neglected during the 1st and 4th quarters and the doses from milk consumption can be neglected during the first quarter since winter conditions eliminate the out door growing of vegetation during these time frames.

b. **Estimation of Annual Critical Organ Dose**

The determination of the annual (calendar year) critical organ dose, D_{YO}, from tritium and particulates released in gaseous effluents is the sum over the first quarter to the present quarter doses to the maximum organ.

c. **Annual Organ Dose Limit**

Determine D_{YO} which is the maximum organ dose for the calendar year, as follows:

$D_{YO} = \Sigma D_{QMO}$ where the sum is over the first quarter through the present quarter doses to the maximum organ.

D.4 Quarterly Dose Calculations for Annual Radioactive Effluent Report

Detailed quarterly dose calculations required for the Annual Radioactive Effluent Report shall be done using the computer code GASPAR (or equivalent code implementing Regulatory Guide 1.109, Rev. 1).

D.5 Compliance with 40CFR190 Limits

The following sources should be considered in determining the total dose to a real individual from uranium fuel cycle sources:

a. CY gaseous effluents (doses calculated in Section D above).

b. CY liquid effluents (doses calculated in Section C above).

c. CY direct radiation from the site. Based on ERC-16103-ER-99-012, direct dose will not be routinely included in the dose assessment. An evaluation of the direct dose aspect will be discussed in the Annual Environmental Operating Report. This evaluation will include the dose recorded on control TLDs and TLDs located near residents.

d. Since all other uranium fuel cycle sources are greater than 20 miles away, they need not be considered.

E. LIQUID EFFLUENT INSTRUMENTATION SETPOINTS

Control C.3.3 of Part I of this manual requires that the radioactive liquid effluent instrumentation in Table C.3.3 have alarm setpoints in order to ensure that the limits of Control C.3.1 are not exceeded. Control C.3.1 of Part I of this manual requires that the concentration of radioactive material released from the site shall not exceed the concentrations specified in 10 CFR Part 20, Appendix B, Table II, Column 2. Connecticut Yankee uses MPC values obtained from 10 CFR Part 20 revision prior to Jan 1, 1994.

E.1 Recycle Test Tank Discharge Line Monitor (R-22)

The Recycle Test Tank effluent monitor provides alarm and automatic termination of release prior to exceeding the concentration limits. Normally the setpoint for R-22 is at twice the gamma activity in the tank to be released. This verifies that the sample results used in release calculations were from a homogenous mixture.

The alarm/trip setpoint is determined prior to each batch release taking into account current values for each variable parameter. The following steps are used in determining the monitor setpoint:

Step 1

Determine the maximum allowable discharge flow (F_{max}) in gpm, at which the test tank can be released.

$$F_{max} = \frac{F_d}{\sum_i \frac{C_i}{MPC_i}}$$

where:

F_d = The actual or conservative estimate of the flow out of the discharge canal (gpm). The flow for 1 Circulating Water pump is 93,000 gpm and the flow for the Service Water system is set at 3,000 gpm.

C_i = Activity concentration of each radionuclide "i" (uCi/ml) determined to be in the test tank. This includes gross alpha, Tritium, Fe-55 and Sr-90 either measured or estimated from the most recent composite sample analysis.

MPC_i = The concentration limit (uCi/ml) above background at the point of discharge to the environment for radionuclides "i", taken from 10 CFR Part 20 Appendix B, Table II, Column 2. For Gross Alpha use the MPC for Am-241.

Step 2

The selection of the actual discharge flow rate (F_m) from the test tanks compared to the maximum allowable discharge rate F_{max} must satisfy the following:

$$F_m \leq F_{max} \times AF$$

where: AF = Administrative limiting factor for the maximum allowable discharge rate (usually between 0.1 and 0.7). This factor is conservative and will account for ongoing releases from other sources and the presence of beta emitters that cannot be detected by the radiation monitor.

If $F_{max} \times AF > F_m$, then reduce discharge flow rate, increase dilution flow or reprocess tank to lower activity levels.

Step 3

Determine the monitor response (R_m) in cpm corresponding to two times the total concentration of gamma emitters.

$$R_m = 2 \times E \times A_{gam}$$

where: E = Current monitor efficiency (cpm per μCi/ml)

A_{gam} = Total concentration of gamma emitters in the tank (μCi/ml). If isotopic analysis of tank does not identify gamma emitters use 5E-07 μCi/ml (LLD requirement) for A_{gam}.

Step 4

Determine the limiting monitor response (R_{lim}) in cpm. The limiting monitor response is the calculated alarm setpoint at which an administrative MPC concentration limit would be exceeded.

$$R_{lim} = E \times A_{mpc} \times (F_d / F_m)$$

where: A_{mpc} = Administrative MPC associated with assumed worse case mix of nuclides in accordance with 10 CFR 20 Appendix B, Footnotes.

Step 5

Determine test tank discharge monitor alarm setpoint (S) in cpm, where
B = Background count rate of monitor (cpm).

If $R_m + B > R_{lim}$, Then reduce discharge flow rate, increase dilution flow or reprocess tank to lower activity levels.

If $2 \times B > R_{lim}$, Then decontaminate monitor

If $R_{lim} > R_m + B$ Then If $R_m > B$, Then $S = R_m + B$

Else $S = 2 \times B$

At no time can the monitor setpoint (S) be greater than R_{lim}.

F. GASEOUS MONITOR SETPOINTS

F.1 Spent Fuel Building Noble Gas Activity Monitor (R-1)

As discussed in D.1.c, Site Release Limits for Noble Gas ("Instantaneous"), the skin dose rate of 3000 mrem/year is the limiting value. With the fuel stored in the Spent Fuel Building with an independent ventilation system, the only source of noble gas release is the Spent Fuel Building which is continuously monitored by the R-1 noble gas activity monitor. The SFB noble gas monitor will be set to alarm before the release rate exceeds 1% of this limit.

$$\text{R-1 Setpoint} = \frac{7143 * 0.01 * 60 * 5E7}{9000 * 1.2 * 2.83E4} = 7.00\text{E2 cpm}$$

Where: 7143 = the Kr-85 release rate (μCi/sec) from the ground-level sources equivalent to a skin dose rate of 3000 mrem/year (see Section D.1.c).

0.01 = 1% factor applied to the dose rate limit.

60 = seconds per minute conversion factor.

5E7 = conservative radiation monitor efficiency for Kr-85 (cpm/μCi/cc).

9000 cfm = nominal Spent Fuel Building ventilation flow rate.

1.2 = a conservative factor applied to the ventilation flow rate.

2.83E4 = cubic centimeters per cubic foot conversion factor.

G. REFERENCES

1. Health Physics Technical Support Document, CY-HP-0029, HEPA Units Environmental Release Evaluation

2. CY Memorandum HP-99-108, Justification To Eliminate HEPA Unit Exhaust Airborne Radioactivity Sampling Based On Work Location Contamination Levels.

3. CY Calculation REMODCM-01686-SY-00, Connecticut Yankee Haddam Neck Plant ODCM, Atmospheric Dispersion Factors.

4. CY Calculation REMODCM-01687-SY-00, Connecticut Yankee Haddam Neck Plant ODCM, Terrain Data.

5. CY Calculation REMODCM-01688-SY-00, CY Defueled State- ODCM Dose Conversion Factors for Gaseous Releases.

6. CY Calculation REMODCM-01689-SY-00, Connecticut Yankee Method 1 Dose Equations for ODCM Revision 13.

7. Northeast Utilities Service Company Document Transmittal CY-DE-DT-0021-97, Spent Fuel Island, Resorcon Inc. Operating Manual

8. ERC 16103-ER-99-0011, Input Data for Offsite Dose Calculation

9. DCR CY-98-042, Spent Fuel Building Ventilation.

10. ERC-16103-ER-99-012, Basis for 40CFR190 Doses Used to Implement CY REMM/ODCM.

11. ERC 16103-ER-00-0004, "Technical Basis Document, Radiological Environmental Monitoring Program Reduction", Revision 1, Dated 6/12/2000

APPENDIX A

SECTION C.1 - METHOD 1 DOSE CONVERSION FACTORS

LADTAP II Age-Organ Dose Conversion Factors (mrem/yr per Ci/ft3/sec)
[For Activity = 1 Curie; Dilution Flow = 1 cfs]

NUCLIDE	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
ADULT							
Ag-110m	5.66E+00	5.66E+00	5.66E+00	5.65E+00	5.67E+00	5.65E+00	8.91E+00
Am-241	4.44E+02	4.15E+02	3.25E+01	7.48E-01	2.40E+02	7.48E-01	4.43E+01
Ce-144	1.24E-01	1.17E-01	1.13E-01	1.12E-01	1.15E-01	1.12E-01	3.98E+00
Co-57	3.02E-01	5.07E-01	6.43E-01	3.02E-01	3.02E-01	3.02E-01	5.51E+00
Co-58	8.00E-01	1.67E+00	2.74E+00	8.00E-01	8.00E-01	8.00E-01	1.84E+01
Co-60	3.16E+01	3.41E+01	3.71E+01	3.16E+01	3.16E+01	3.16E+01	7.88E+01
Cs-134	2.93E+03	6.96E+03	5.69E+03	1.02E+01	2.26E+03	7.57E+02	1.32E+02
Cs-137	3.76E+03	5.14E+03	3.37E+03	1.50E+01	1.75E+03	5.93E+02	1.14E+02
Eu-152	2.19E+01	2.18E+01	2.18E+01	2.17E+01	2.19E+01	2.17E+01	3.68E+01
Eu-154	1.96E+01	1.93E+01	1.92E+01	1.92E+01	1.94E+01	1.92E+01	5.14E+01
Eu-155	7.29E-01	6.85E-01	6.83E-01	6.78E-01	7.11E-01	6.78E-01	6.32E+00
Fe-55	6.46E+00	4.46E+00	1.04E+00	9.02E-06	9.02E-06	2.49E+00	2.56E+00
H-3	0.00E+00	2.22E-03	2.22E-03	2.22E-03	2.22E-03	2.22E-03	2.22E-03
Mn-54	2.20E+00	4.51E+01	1.04E+01	2.20E+00	1.50E+01	2.20E+00	1.33E+02
Np-239	3.61E-02	3.59E-02	3.59E-02	3.59E-02	3.59E-02	3.59E-02	4.19E+00
Ru-106	1.25E+00	6.07E-01	6.89E-01	6.07E-01	1.85E+00	6.07E-01	4.24E+01
Sb-124	1.43E+00	1.37E+00	1.40E+00	1.37E+00	1.37E+00	1.42E+00	3.22E+00
Sb-125	3.52E+00	3.47E+00	3.48E+00	3.47E+00	3.47E+00	3.51E+00	3.94E+00
Sn-125	5.45E+02	1.10E+01	2.48E+01	9.12E+00	2.85E-02	2.85E-02	6.80E+03
Sr-89	2.14E+02	6.79E-04	6.14E+00	6.79E-04	6.79E-04	6.79E-04	3.43E+01
Sr-90	5.34E+03	7.61E-05	1.31E+03	7.61E-05	7.61E-05	7.61E-05	1.54E+02
Zn-65	2.28E+02	7.23E+02	3.27E+02	1.23E+00	4.84E+02	1.23E+00	4.56E+02
TEEN							
Ag-110m	5.66E+00	5.66E+00	5.66E+00	5.65E+00	5.67E+00	5.65E+00	7.89E+00
Am-241	3.58E+02	3.38E+02	2.65E+01	7.48E-01	1.94E+02	7.48E-01	3.60E+01
Ce-144	1.25E-01	1.17E-01	1.13E-01	1.12E-01	1.15E-01	1.12E-01	3.24E+00
Co-57	3.02E-01	5.15E-01	6.58E-01	3.02E-01	3.02E-01	3.02E-01	4.27E+00
Co-58	8.00E-01	1.66E+00	2.78E+00	8.00E-01	8.00E-01	8.00E-01	1.27E+01
Co-60	3.16E+01	3.41E+01	3.72E+01	3.16E+01	3.16E+01	3.16E+01	6.43E+01
Cs-134	3.00E+03	7.06E+03	3.28E+03	1.02E+01	2.25E+03	8.65E+02	9.79E+01
Cs-137	4.03E+03	5.35E+03	1.87E+03	1.50E+01	1.83E+03	7.20E+02	9.09E+01
Eu-152	2.18E+01	2.18E+01	2.18E+01	2.17E+01	2.19E+01	2.17E+01	3.15E+01
Eu-154	1.96E+01	1.93E+01	1.92E+01	1.92E+01	1.94E+01	1.92E+01	4.33E+01
Eu-155	7.56E-01	6.86E-01	6.83E-01	6.78E-01	7.08E-01	6.78E-01	4.38E+01
Fe-55	6.76E+00	4.79E+00	1.12E+00	9.02E-06	9.02E-06	3.04E+00	2.08E+00
H-3	0.00E+00	1.71E-03	1.71E-03	1.71E-03	1.71E-03	1.71E-03	1.71E-03
Mn-54	2.20E+00	4.44E+01	1.06E+01	2.20E+00	1.48E+01	2.20E+00	8.87E+01
Np-239	3.61E-02	3.59E-02	3.59E-02	3.59E-02	3.59E-02	3.59E-02	3.56E+00
Ru-106	1.31E+00	6.07E-01	6.95E-01	6.07E-01	1.96E+00	6.07E-01	3.42E+01
Sb-124	1.44E+00	1.37E+00	1.40E+00	1.37E+00	1.37E+00	1.43E+00	2.75E+00
Sb-125	3.52E+00	3.47E+00	3.48E+00	3.47E+00	3.47E+00	3.51E+00	3.82E+00
Sn-125	5.93E+02	1.18E+01	2.68E+01	9.30E+00	2.85E-02	2.85E-02	5.58E+03
Sr-89	2.33E+02	6.79E-04	6.67E+00	6.79E-04	6.79E-04	6.79E-04	2.77E+01
Sr-90	4.46E+03	7.61E-05	1.10E+03	7.61E-05	7.61E-05	7.61E-05	1.25E+02
Zn-65	2.07E+02	7.15E+02	3.34E+02	1.23E+00	4.58E+02	1.23E+00	3.04E+02
CHILD							
Ag-110m	3.17E+00	3.17E+00	3.17E+00	3.17E+00	3.18E+00	3.17E+00	3.93E+00
Am-241	2.63E+02	2.26E+02	2.01E+01	4.19E-01	1.21E+02	4.19E-01	1.52E+01
Ce-144	7.89E-02	6.79E-02	6.37E-02	6.28E-02	6.56E-02	6.28E-02	1.37E+00
Co-57	1.69E-01	3.59E-01	5.53E-01	1.69E-01	1.69E-01	1.69E-01	1.72E+00
Co-58	4.48E-01	1.14E+00	2.55E+00	4.48E-01	4.48E-01	4.48E-01	4.46E+00
Co-60	1.77E+01	1.97E+01	2.37E+01	1.77E+01	1.77E+01	1.77E+01	2.90E+01
Cs-134	3.62E+03	5.93E+03	1.26E+03	5.73E+00	1.84E+03	6.64E+02	3.77E+01
Cs-137	5.06E+03	4.84E+03	7.22E+02	8.38E+00	1.58E+03	5.75E+02	3.86E+01
Eu-152	1.23E+01	1.22E+01	1.22E+01	1.22E+01	1.23E+01	1.22E+01	1.57E+01
Eu-154	1.12E+01	1.08E+01	1.08E+01	1.08E+01	1.09E+01	1.08E+01	2.00E+01
Eu-155	4.73E-01	3.86E-01	3.85E-01	3.80E-01	4.05E-01	3.80E-01	1.71E+01
Fe-55	8.87E+00	4.71E+00	1.46E+00	5.05E-06	5.05E-06	2.66E+00	8.72E-01
H-3	0.00E+00	1.41E-03	1.41E-03	1.41E-03	1.41E-03	1.41E-03	1.41E-03
Mn-54	1.23E+00	3.42E+01	1.00E+01	1.23E+00	1.05E+01	1.23E+00	2.89E+01
Np-239	2.04E-02	2.01E-02	2.01E-02	2.01E-02	2.01E-02	2.01E-02	1.61E+00
Ru-106	1.24E+00	3.40E-01	4.52E-01	3.40E-01	1.56E+00	3.40E-01	1.44E+01
Sb-124	8.51E-01	7.68E-01	7.96E-01	7.67E-01	7.67E-01	8.14E-01	1.30E+00
Sb-125	2.00E+00	1.95E+00	1.96E+00	1.95E+00	1.95E+00	1.98E+00	2.08E+00
Sn-125	7.63E+02	1.15E+01	3.42E+01	1.19E+01	1.60E-02	1.60E-02	2.36E+03
Sr-89	3.01E+02	3.80E-04	8.61E+00	3.80E-04	3.80E-04	3.80E-04	1.17E+01
Sr-90	3.94E+03	4.26E-05	9.98E+02	4.26E-05	4.26E-05	4.26E-05	5.30E+01
Zn-65	2.12E+02	5.63E+02	3.50E+02	6.87E-01	3.55E+02	6.87E-01	9.94E+01

APPENDIX B

SECTION C.1 - METHOD 1 DOSE CONVERSION FACTORS BASIS

Refer to memorandum RB-98-069, subject: Verification of the PCLADTAP.xlt Excel Spreadsheet in Support of the Proposed New CY REMODCM Method 1 Calculation for Liquid Effluent Doses, March 27, 1998 for the Method 1 liquid effluent dose calculation basis.

The basis substantiates the use of: (1) dilution flow, (2) radionuclide activities and (3) "composite" radionuclide age-organ dose conversion factors (DCFs) (derived from the NRC LADTAP II software program which conforms to Regulatory Guide 1.109) to calculate age-organ doses. These "composite" DCFs include the contributions from all pathways (including pathway age usage's and radionuclide age-organ DCFs) and LADTAP II site-specific parameters, and are acceptable because LADTAP II is used for Method 2.

APPENDIX C

LIQUID DOSE CALCULATIONS – LADTAP (OR EQUIVALENT)

The LADTAP codes were written by the NRC to compute doses from liquid releases. The actual model used in LADTAP II which performs calculations in accordance with Regulatory Guide 1.109, Revision 1.

For calculating the maximum individual dose from Haddam Neck, the following options and parameters are used:

1. Real time, measured dilution flow

2. Fresh water site, no re-concentration

3. Shorewidth factor = 0.1 for discharge canal

4. No dilution for maximum individual pathways

5. One-hour discharge transit time – approximate time to reach ½ canal length

6. Regulatory Guide 1.109 usage factors for maximum individual for fish, shoreline, swimming and boating

7. Zero usage for shellfish, algae, drinking water and irrigated food pathways. Shellfish, algae and water are not consumed from the river. Bottled water is provided onsite. The river is not used for irrigation.

APPENDIX D

GASEOUS DOSE CONVERSION FACTORS (TRITIUM AND PARTICULATE)

This appendix contains a listing of the dose and dose rate conversion factors (DFG and DFG') for use in the application of the CY ODCM during the decommissioning phase of the plant. The DFGs are for gaseous releases to the atmosphere of tritium and particulate radionuclides, and reflect the following conditions:

(a) On-ground receptors at the closest distance to the site boundary (SB) for ground-level releases, and at the worst-case offsite receptor for elevated releases,
(b) Long-lived radionuclides (in view of the extended decay time since permanent plant shutdown on July 22, 1996),
(c) The inhalation pathway for dose-rate calculations, and all pathways combined for dose calculations (ground-shine, inhalation, meat ingestion, goat milk ingestion, and vegetable ingestion), and
(d) The associated worst-case hypothetical individual (adult, teenager, child or infant) and critical organ (Total Body, GI Tract, Bone, Liver, Kidney, Thyroid, Lung, or Skin).

The DFGs were computed using the GASPAR-2 computer code [(1)], along with site-specific atmospheric dispersion and deposition factors. Details on the basic data and assumptions employed in the derivations of these conversion factors are presented in Section D.1 and the final tabulations are presented in Section D.2.

D.1 Basic Data and Assumptions

(a) A total of 32 long-lived radionuclides were selected for computation of the DFGs. The list includes tritium, I129, and 30 other particulate radionuclides.

(b) Use was made of the GASPAR-2 default built-in data libraries for physical parameters, transfer data and usage factors, with the following exceptions (which were implemented for consistency with Reg. Guide 1.109[(1)]):

1. The accumulation time for ground contamination (t_b) was changed from 20 years to 15 years
2. The transfer rate to meat products (F_f) for Ni was changed from 5.3E-03 (d/kg) to 5.3E-02 (d/kg)
3. The transfer rate to goat-milk (F_m) for Fe was changed from 1.3E-03 (D/L) to 1.3E-04 (D/L)

(c) The pathway parameters were assigned the values shown in Table D.1 [from GASPAR-2, with the exceptions identified under item (b) above].

(1) "GASPAR-2 - A Code System for Evaluation of Radiological Impacts Due to the Release of Radioactive Material to the Atmosphere During Normal Operation of Light Water Reactors," Oak Ridge National Laboratory, RSIC Computer Code Collection CCC-463 (also released as NUREG/CR-4653, "GASPAR-II - Technical Reference and User Guide," March 1987)

(2) 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", (Rev. 1, 10/77)

Table D.1

PATHWAY PARAMETER	VEGETATION INGESTION PATHWAY	
	Stored	Leafy
Agricultural Productivity (kg/m^2)	2	2
Soil Surface Density (kg/m^2)	240	240
Transport Time to User(hrs)	NA	NA
Soil Exposure Time (yrs)	15	15
Crop Exposure Time to Plume (hrs)	1440	1440
Holdup after Harvest (hrs)	336	24
Animal Daily Feed(kg/day)	NA	NA
PATHWAY PARAMETER	**GOAT-MILK INGESTION PATHWAY**	
	Pasture	**Stored Feed**
Agricultural Productivity (kg/m^2)	0.7	2
Soil Surface Density (kg/m^2)	240	240
Transport Time to User (hrs)	48	48
Soil Exposure Time (yrs)	15	15
Crop Exposure Time to Plume (hrs)	720	1440
Holdup after Harvest (hrs)	0	2160
Animal Daily Feed (kg/day)	6	6
PATHWAY PARAMETER	**MEAT INGESTION PATHWAY**	
	Pasture	**Stored Feed**
Agricultural Productivity (kg/m^2)	0.7	2
Soil Surface Density (kg/m^2)	240	240
Transport Time to User (hrs)	480	480
Soil Exposure Time (yrs)	15	15
Crop Exposure Time to Plume (hrs)	720	1440
Holdup after Harvest (hrs)	0	2160
Animal Daily Feed (kg/day)	50	50

(d) Site-specific pathway variables were assigned the following values:

Absolute humidity:	8.0 (g/m^3)
Fraction of time leafy vegetables are grown:	0.50
Fraction of individual vegetable consumption from home garden:	0.76
Fraction of time milk goats are on pasture:	0.75
Fraction of goat feed from pasture:	1.0
Fraction of time beef cattle are on pasture:	0.75
Fraction of beef-cattle feed from pasture:	1.0

[Note: The cow-milk pathway is less restrictive than the goat-milk pathway and was not used in the definition of the final DFGs.]

(e) The usage factors and breathing rates are as listed in Table D.2.

Table D.2

Individual	Ingestion Pathway Usage Factors				Inhalation (m^3/yr)
	Crop (kg/yr)	Leafy Vegetables (kg/yr)	Milk (liters/yr)	Meat (kg/yr)	
Adult	520	64	310	110	8000
Teenager	630	42	400	65	8000
Child	520	26	330	41	3700
Infant	0	0	330	0	1400

(f) The applicable site-specific long-term atmospheric dispersion and deposition factors are presented in Table D.3. It is noted that there are four distinct release points at CY which are classifiable as ground-level releases. The values in Table D.3 are for the worst-case release point.

Table D.3

RELEASE POINT		Undepleted (X/Q) (sec/m³)	Depleted (X/Q) (sec/m³)	Deposition Factor (D/Q) (m⁻²)
Ground-Level Releases	Temporary Tent Exhaust (worst-case release point)	3.09E-04	2.93E-04	2.22E-07
Elevated Releases	Primary Vent Stack	2.85E-05	2.85E-05	3.45E-08

D.2 DFG Tabulations

The DFGs for tritium and particulate radionuclides were computed through use of GASPAR-2, along with the data and assumptions listed in Section D.1. Summaries of the results are presented in Table D.5 for the inhalation pathway (dose rate calculations), and Table D.6 for all pathways combined (dose calculations).

It is noted that the DFGs for ground-level releases were based on the worst-case atmospheric dispersion and deposition factors, and as such are conservatively applicable to all ground-level releases from the site. Should some reduction be required to ensure that specified dose limits are not exceeded, then the ground-level DFGs in Tables D.5 and D.6 can be multiplied by the conservative adjustment factors in Table D.4.

Table D.4

Ground-Level Release Point	Conservative Adjustment Factor Applicable to the Ground-Level DFG in ...	
	Inhalation Pathway	All Pathways Combined
Spent Fuel Bldg Ventilation Exhaust and Spray Cooler	0.39	0.51
Containment Bldg Personnel Access Hatch	0.30	0.56
'B' Switchgear Bldg (potential Chemistry Fume Hood)	0.54	0.65
Temporary Tent Exhaust (*)	1.0	1.0

* Worst-case release point

For instance, the Cs-137 limiting DFG for Containment Building releases and all exposure pathways combined is 9.64E-04 (Table D.6) x 0.56 (Table D.4) = 5.40E-04 (mrem-sec/μCi-yr).

Table D.5
CY ODCM - Dose Rate Conversion Factors (DFG')
for Critical Receptor and Organ (Inhalation Pathway)

Radionuclide[b]	Dose Rate Conversion Factor (mrem-sec/μCi-yr)	
	Ground-Level Releases[a] $DFG'_{ico(g)}$	Elevated Releases $DFG'_{ico(e)}$
H 3	2.24E-01	2.07E-02
MN 54	5.80E+02	5.65E+01
FE 55	3.63E+01	3.53E+00
FE 59	4.48E+02	4.35E+01
CO 57	1.72E+02	1.67E+01
CO 58	3.94E+02	3.82E+01
CO 60	2.55E+03	2.49E+02
ZN 65	3.63E+02	3.53E+01
SR 90	1.13E+04	1.10E+03
ZR 95	7.89E+02	7.66E+01
NB 95	2.20E+02	2.14E+01
TC 99	4.07E+02	3.97E+01
RU103	2.29E+02	2.23E+01
RU106	4.70E+03	4.57E+02
AG110M	1.98E+03	1.92E+02
SB125	8.01E+02	7.79E+01
CS134	3.31E+02	3.22E+01
CS137	2.66E+02	2.58E+01
CE144	3.91E+03	3.82E+02
EU152	1.17E+03	1.14E+02
EU154	2.97E+03	2.89E+02
PU238	3.50E+06	3.41E+05
PU239	4.07E+06	3.94E+05
PU240	4.04E+06	3.91E+05
PU241	8.77E+04	8.52E+03
AM241	4.16E+06	4.04E+05
CM242	1.58E+05	1.54E+04
CM243	2.79E+06	2.71E+05
CM244	2.15E+06	2.09E+05

(a) Worst-case release point. Refer to Table D.4 for optional adjustments.

(b) C14, Ni63, and I129 are not included in this table as they do not pose a significant source for dose and are not included in the sampling tables of the REMM.

Table D.6
CY ODCM - Dose Conversion Factors (DFG)
for Critical Receptor and Organ (All Pathways Combined)

Radionuclide[b]	Dose Conversion Factor (mrem/μCi)	
	Ground-Level Releases[a] $DFG_{ico(g)}$	Elevated Releases $DFG_{ico(e)}$
H 3	4.76E-08	4.39E-09
MN 54	2.81E-05	3.30E-06
FE 55	7.94E-06	1.21E-06
FE 59	2.43E-05	3.67E-06
CO 57	6.78E-06	7.36E-07
CO 58	1.52E-05	1.67E-06
CO 60	2.32E-04	3.14E-05
ZN 65	3.97E-05	6.12E-06
SR 90	1.64E-02	2.54E-03
ZR 95	2.67E-05	3.52E-06
NB 95	4.48E-05	6.90E-06
TC 99	9.17E-05	1.42E-05
RU103	6.63E-05	1.02E-05
RU106	9.65E-04	1.49E-04
AG110M	8.70E-05	1.28E-05
SB125	4.33E-05	5.24E-06
CS134	1.01E-03	1.57E-04
CS137	9.64E-04	1.50E-04
CE144	1.24E-04	1.58E-05
EU152	1.42E-04	1.99E-05
EU154	1.88E-04	2.37E-05
PU238	1.11E-01	1.09E-02
PU239	1.29E-01	1.26E-02
PU240	1.28E-01	1.25E-02
PU241	2.79E-03	2.72E-04
AM241	1.32E-01	1.29E-02
CM242	5.02E-03	4.89E-04
CM243	8.88E-02	8.67E-03
CM244	6.86E-02	6.69E-03

(a) Worst-case release point. Refer to Table D.4 for optional adjustments.

(b) C14, Ni63, and I129 are not included in this table as they do not pose a significant source for dose and are not included in the sampling tables of the REMM.

APPENDIX E

GASEOUS DOSE CALCULATIONS – GASPAR-2 (OR EQUIVALENT)

The GASPAR-2 code was written by the NRC to compute doses from gaseous releases using the models given in Regulatory Guide 1.109. The revision date of the code is December 1986. Other codes which implement the guidance provided in Regulatory Guide 1.109, Revision 1, are also acceptable, including Method 1.

For calculating the maximum individual dose from Haddam Neck, the following options and parameters may be used (Method 1):

1. Historical meteorology using a χ/Q, D/Q model which incorporates the methodology of Regulatory Guide 1.111. The five year period of 1976 – 1980 was used to determine dispersion estimates.

2. 100% of vegetation grown locally, 76% of vegetation intake from garden, harvest season from April through September.

3. Animals on pasture April through December – 100% pasture intake.

4. Air water concentration equals 8 g/m^3.

5. Maximum individual dose calculations for Method 1 were performed at the nearest land site boundary with maximum χ/Q. For conservatism in the Method 1 model, this location is assumed to have a resident, vegetable garden, and milk and meat animal with the maximum D/Q value.

APPENDIX F

METEOROLOGICAL DISPERSION FACTORS

The ODCM atmospheric dispersion factors were derived using the AEOLUS-3 computer code. AEOLUS-3 was written to implement regulatory guidance for continuous (Regulatory Guide 1.111) and intermittent releases (NRC computer code XOQDOQ). The code has various options including building wake effects, plume depletion via dry deposition, and an effective plume height that accounts for physical release height, plume downwash, plume rise, and terrain features.

A set of atmospheric dispersion factors which are a function of release duration were generated. NUREG/CR-2919 (the documentation package for the NRC atmospheric dispersion computer code XOQDOQ, Reference 1) presents a methodology for determining atmospheric dispersion factors (CHI/Q values) for intermittent releases at user specified receptor locations (intermittent releases being defined as releases with durations between 1 and 8760 hours). The CHI/Q values for intermittent releases are determined by linearly interpolating (on a log-log basis) between an hourly 15-percentile CHI/Q value and an annual average CHI/Q value as a function of release duration. These time-dependent factors were derived using one-hour 15 percentile and long-term average atmospheric dispersion factors.

The following assumptions were used in executing AEOLUS-3 to determine one-hour 15 percentile and long-term average atmospheric dispersion factors for each of the two release pathway categories (ground-level and Primary Vent Stack):

- Plume centerline CHI/Q and D/Q values were used to generate the one-hour 15 percentile dispersion factors (an AEOLUS-3 default assumption); sector average CHI/Q and D/Q values were used to generate the long-term average dispersion factors.

- AEOLUS-3 default open terrain recirculation correction factors (Regulatory Guide 1.111) were used to generate the long-term average dispersion factors in order to consider the effects of recirculation of effluent.

- The ground level release pathways (e.g., Spent Fuel Building ventilation exhaust vent, Spent Fuel Building component spray cooler, Personnel Access Hatch on the Containment Building, potential Chemistry Fume Hood exhaust out of 'B' Switchgear Building, and for a limiting condition associated with temporary tent exhaust for work on contaminated components) were treated as Reg Guide 1.111 (Rev 1) ground-mode releases with releases emitted below the height of adjacent buildings.

- The Primary Vent Stack was treated as a Reg Guide 1.111 mix-mode release since the vent is above (but less that 2 times above) the height of adjacent buildings. A stack conservative exit flow rate of 117,000 cfm was assumed.

- Lower level wind speed data were provided to the code for both types of release pathways. These data were used without adjustment to disperse the plume for the ground level release pathways. For the mix-mode Primary Vent Stack release pathway, the lower level wind speed data were extrapolated up to the Primary Vent Stack release height for evaluating plume entrainment effects and for determining plume rise and dispersion for the elevated-mode portion of the plume. The lower level wind speed data were used to disperse the ground-mode portion of the Primary Vent Stack plumes.

- Lower level wind direction data were provided to the code to determine plume transport for both types of release pathways.

- The 196'-33' delta-temperature data were provided to the code to determine atmospheric stability for both types of release pathways.

- The Reg Guide 1.111 (Rev. 1) depletion/deposition model was used for determining depleted CHI/Q and D/Q values for both types of release pathways. Wet depletion/deposition and decay-in-transit were not considered.

Meteorological data measured by the onsite monitoring system from January 1976 through December 1980 were used as input to the AEOLUS-3 computer code. Analysis of meteorological data measured at the Haddam Neck Plant during the following five-year periods, 1976-1980, 1988-1992, 1993-1997, indicated that the lower level wind speed data have been influenced by foliage growth over the years and that the older data set (1976-1980) is most appropriate for use in analyses.

Atmospheric dispersion factors were calculated for three time periods:
- Annual
- Growing season (defined as April through December)
- Non-growing season (January through March)

The most conservative values from the three time periods were used to develop the dose factors.

The one-hour 15-percentile undepleted CHI/Q, depleted CHI/Q, and D/Q dispersion factors used in the time dependent equations were derived by averaging the highest one-hour 15-percentile dispersion factors which occurred in each downwind sector, weighted by the fraction of the time the wind blew towards each downwind sector. The long-term average undepleted CHI/Q, depleted CHI/Q, and D/Q dispersion factors used in the time dependent equations were the highest long-term average dispersion factors calculated for receptors at and beyond the Site Boundary.

The time-dependent equation is:

$$X/Q = X/Q_{hr}\, t^{-0.11 \ln\left(\frac{X/Q_{hr}}{X/Q_{lt}}\right)}$$

where X/Q_{hr} is the weighted one-hour 15-percentile value and X/Q_{lt} is the long-term average value. For the derivation of the time-dependent equation, see Reference 1.

The time-adjusted Method 1 dose equation for Particulate and Tritium releases can be written as:

$$D_{co} = \frac{\left(\frac{X}{Q}\right)_{depl,1\,hr}}{\left(\frac{X}{Q}\right)_{depl,Apr-Dec}} * t^{-a} * \sum_i \left(Q_i * DFG_{ico}\right)$$

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

where

D_{co} = The critical organ dose from particulates and tritium;

$\left(\frac{X}{Q}\right)_{depl,1\,hr}$ = The 1-hour depleted atmospheric dispersion factor;

$\left(\frac{X}{Q}\right)_{depl,Apr-Dec}$ = The depleted atmospheric dispersion factor for the growing season (see Section Table F.1);

t^{-a} = A unitless adjustment factor to account for a release with a total duration of t hours;

Q_i = The total activity in µCi of radionuclide "i" released to the atmosphere during the period of interest;

DFG_{ico} = The site-specific critical organ dose factor for radionuclide "i", based on the age group and organ with the largest dose factor (see Table 3).

Incorporating location-specific (i.e., temporary tent release point) atmospheric dispersion factors and the time-adjustment factor (t^{-a}) yields an equation for the determination of critical organ dose. The substituted values are as follows:

$\left(\frac{X}{Q}\right)_{depl,1\,hr}$ = 2.89E-03 (sec/m^3)

$\left(\frac{X}{Q}\right)_{depl,Apr-Dec}$ = 2.93E-04 (sec/m^3)

$$\frac{\left(\frac{X}{Q}\right)_{depl,1hr}}{\left(\frac{X}{Q}\right)_{depl,Apr-Dec}} = 9.86$$

$$t^{-a} = t^{-0.252}$$

For the maximum off-site receptor location and a **ground level** release condition, the above values were used to simplify the above time-dependent equation as follows:

$$D_{co(g)} = 9.86 * t^{-.252} * \sum_i \left(Q_{i(g)} * DFG_{ico(g)}\right)$$

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

The long term and 1 hour site specific atmospheric dispersion factors are listed on Tables F.1 and F.2.

TABLE F.1
ATMOSPHERIC DISPERSION FACTORS
GROUND LEVEL RELEASES

		Spent Fuel Bldg		**Cont. Bldg Access Hatch**		**'B" Switch gear/new Chem Fume Hood**		**Temporary Tent**		**Max Ground Level Pt.**	
Dispersion Factor	**Met Data Period**	1-Hour	Long-Term	1-Hour	Long-Term	1-Hour	Long-Term	1-Hour	Long-Term	1-Hour	Long-Term
Undepl. X/Q	Jan-Dec	1.41E-03	1.14E-04	8.80E-04	8.98E-05	1.73E-03	1.60E-04	2.82E-03	2.75E-04	2.82E-03	2.75E-04
(sec/m^3)			(537 m WNW)		(503 m WNW)		(457 m WNW)		(360 m WNW)		
	Apr-Dec	1.53E-03	1.19E-04	9.56E-04	9.35E-05	1.88E-03	1.67E-04	3.07E-03	3.09E-04	3.07E-03	3.09E-04
			(537 m WNW)		(503 m WNW)		(457 m WNW)		(383 m W)		
	Jan-Mar	1.08E-03	9.75E-05	6.75E-04	7.89E-05	1.34E-03	1.38E-04	2.18E-03	2.42E-04	2.18E-03	2.42E-04
			(537 m WNW)		(503 m WNW)		(457 m WNW)		(360 m WNW)		
									Max-All Seasons	3.07E-03	3.09E-04
Depl.X/Q	Jan-Dec	1.30E-03	1.06E-04	8.14E-04	8.42E-05	1.61E-03	1.51E-04	2.66E-03	2.61E-04	2.66E-03	2.61E-04
(sec/m^3)			(537 m WNW)		(503 m WNW)		(457 m WNW)		(360 m WNW)		
	Apr-Dec	1.41E-03	1.11E-04	8.85E-04	8.76E-05	1.75E-03	1.58E-04	2.89E-03	2.93E-04	2.89E-03	2.93E-04
			(537 m WNW)		(503 m WNW)		(457 m WNW)		(383 m W)		
	Jan-Mar	9.95E-04	9.11E-05	6.24E-04	7.39E-05	1.25E-03	1.30E-04	2.05E-03	2.31E-04	2.05E-03	2.31E-04
			(537 m WNW)		(503 m WNW)		(457 m WNW)		(360 m WNW)		
									Max-All Seasons	2.89E-03	2.93E-04
D/Q	Jan-Dec	8.95E-07	1.11E-07	7.56E-07	1.22E-07	1.05E-06	1.42E-07	1.48E-06	2.12E-07	1.48E-06	2.12E-07
(1/m^2)			(537 m WNW)		(503 m WNW)		(457 m WNW)		(383 m W)		
	Apr-Dec	9.25E-07	1.13E-07	7.77E-07	1.25E-07	1.09E-06	1.45E-07	1.54E-06	2.22E-07	1.54E-06	2.22E-07
			(537 m WNW)		(503 m WNW)		(457 m WNW)		(383 m W)		
	Jan-Mar	7.05E-07	1.03E-07	6.21E-07	1.14E-07	8.34E-07	1.33E-07	1.17E-06	1.90E-07	1.17E-06	1.90E-07
			(537 m WNW)		(503 m WNW)		(457 m WNW)		(360 m WNW)		
									Max-All Seasons	1.54E-06	2.22E-07

TABLE F2
ATMOSPHERIC DISPERSION FACTORS
ELEVATED (MIXED MODE) RELEASES

Dispersion Factor	**Met Data Period**	**Primary Vent Stack** 1-Hour	Long-Term
Undepl. X/Q (sec/m^3)	Jan-Dec	2.64E-04	2.64E-05 (617 m NE)
	Apr-Dec	2.86E-04	2.85E-05 (617 m NE)
	Jan-Mar	2.19E-04	2.02E-05 (617 m NE)
	Max - All Seasons	2.86E-04	2.85E-05
Depl.X/Q (sec/m^3)	Jan-Dec	2.65E-04	2.64E-05 (617 m NE)
	Apr-Dec	2.86E-04	2.85E-05 (617 m NE)
	Jan-Mar	2.19E-04	2.01E-05 (617 m NE)
	Max - All Seasons	2.86E-04	2.85E-05
D/Q (1/m^2)	Jan-Dec	1.54E-07	2.33E-08 (932 m E)
	Apr-Dec	1.56E-07	2.24E-08 (583 m NNE)
	Jan-Mar	1.56E-07	3.45E-08 (1572 m ESE)
	Max - All Seasons	1.56E-07	3.45E-08

References:

1. NUREG/CR-2919, "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations", September 1982.

APPENDIX G

ENVIRONMENTAL MONITORING PROGRAM

Sampling Locations

The following lists the environmental sampling locations and the types of samples obtained at each location. Sampling locations are also shown on Figures G-1, and G-2.

Location Number	Location Name	Direction & Distance From Release Point***	Sample Types
1-I*	On-site-Mouth of Discharge Canal	1.1 Mi, ESE	TLD
2-I	Haddam-Park Rd.	0.8 Mi, S	TLD
3-I	Haddam-Jail Hill Rd.	0.8 Mi, WSW	TLD
4-I	Haddam-Ranger Rd.	1.8 Mi, SW	TLD
5-I	On-site-Injun Hollow Rd. (Site Boundary)	0.4 Mi, NW	TLD, Air Particulate,
6-I	On-site-Substation (w/in 10 miles)	0.5 Mi, NE	TLD, Air Particulate, Broadleaf Vegetation
7-I	Haddam	1.8 Mi, SE	TLD, Air Particulate
8-I	East Haddam	3.1 Mi, ESE	TLD
9-I	Higganum	4.3 Mi, WNW	TLD, Air Particulate
10-I	Hurd Park Rd.	2.8 Mi, NNW	TLD
11-C**	Middletown	9.0 Mi, NW	TLD
12-C	Deep River	7.1 Mi, SSE	TLD
13-C	North Madison	12.5 Mi, SW	TLD, Air Particulate
14-C	Colchester	10.5 Mi, NE	TLD
15-I	On-site Wells	0.5 MI, ESE	Well Water
16-C	East Haddam Town Office Building	2.8 Mi, SE	Well Water
17-C	Fruits & Vegetables Stand/Supply, normally in North Madison (beyond 10 miles; normally within ~2 miles of location 13-C	Approx. 13 Mi, SW (beyond 10 miles)	Fruits & Vegetables Broad Leaf Vegetation
18-I	Site Boundary (Within one mile of Location 5-I)	0.4 Mi, NW (within 10 miles)	Broad Leaf Vegetation
25-I	Fruits & Vegetable Stand normally w/in one mile of Location 5-I	Approx. 1.0 Mile, NW (w/in 10 miles)	Fruit & Vegetables
26-I	Conn. River-Near Intake	1.0 Mi, WNW	Fish
27-C	Conn. River-Higganum Light	4.0 Mi, WNW	Shellfish
28-I	Conn. River-E. Haddam Bridge	1.8 Mi, SE	Bottom Sediment, River Water
29-I	Vicinity of Discharge	0.0 Mi	Bottom Sediment, Fish
30-C	Conn. River-Middletown	9.0 Mi, NW 7.6 Mi, NW	River Water, Bottom Sediment Fish
31-I	Mouth of Salmon River	0.8 Mi, ESE	Shellfish

*I = Indicator **C = Control

*** The release points are the stack for terrestrial locations and the end of the discharge canal for aquatic locations.

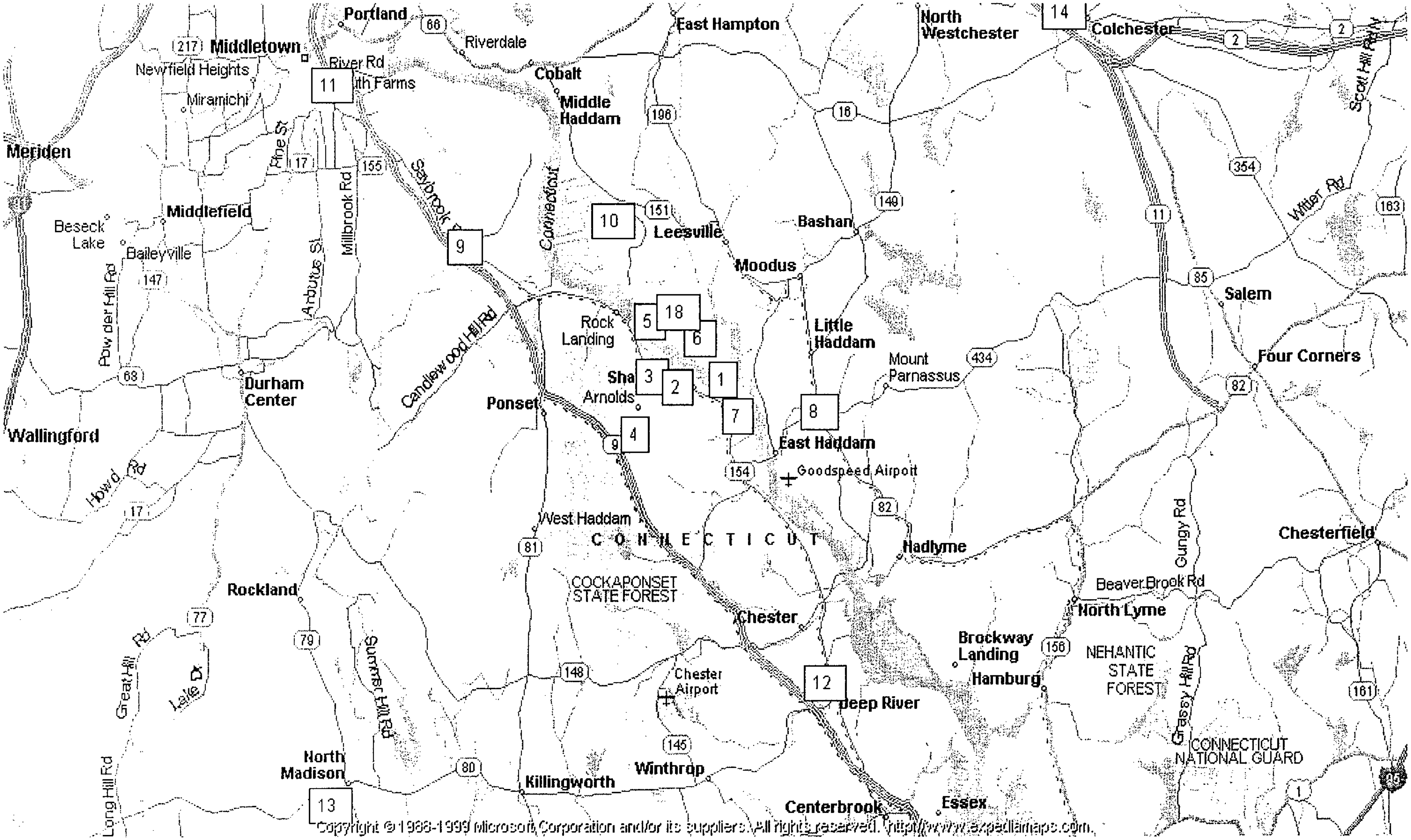

Figure G- 1: Haddam Neck Plant Inner Terrestrial Monitoring Stations

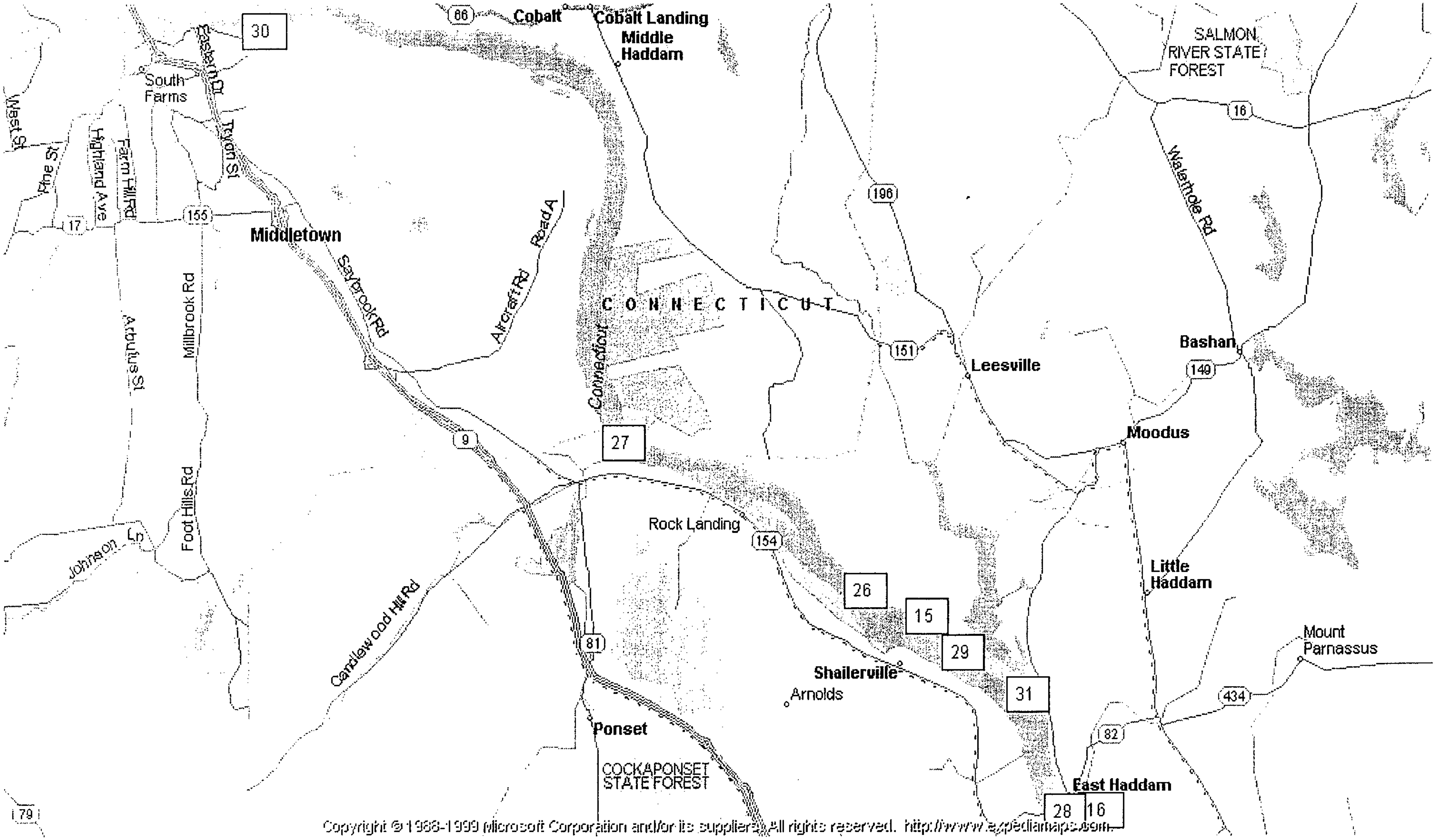

Figure G- 2: Haddam Neck Plant Aquatic and Well Water Sample Stations

APPENDIX H

DOSE FACTORS FOR Kr-85

H.1 Approach

The REMM requires the calculation of gamma and beta air doses, and total body and skin dose rates resulting from the release of noble gases (i.e., Kr-85) to the atmosphere.

The gamma air and beta air doses, as well as the total body dose rates, will be determined using the dose factors taken from Table B-1 of Reg. Guide 1.109 for individual radionuclides. The skin dose factor, DF', is calculated for individual radionuclides (i.e., Kr-85 here) by combining the gamma air dose and beta skin dose factors to give a combined skin dose factor. The following subsections detail the development of these dose factors and the equation for calculating site specific doses with them.

Meteorological dispersion factors are calculated for the CY site as described in Appendix F, and are summarized in Tables F.1 and F.2. These represent a long-term (5 years) site average meteorological history that was used to determine the location of minimum dispersion (maximum dose) for off-site receptors.

The Kr-85 dose factors to be used in the ODCM Method 1 calculations are listed in Table H-1.

H.2 Total Body Dose Rate

Method 1 was derived from general equation B-8 in Regulatory Guide 1.109 as follows:

$$\dot{D}_{tb} = (1E+06) * \left[\frac{X}{Q}\right] * \dot{Q} * DFB \qquad \text{(H-1)}$$

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

where:

$\frac{X}{Q}$ = Maximum undepleted X/Q for release point of interest (see Tables F.1 & F.2),

$\dot{Q}$ = Release rate to the environment of Kr-85 (μCi/sec);

DFB = Total body dose factor (see Table H.1 and Reg. Guide 1.109, Table B-1).

Equation H-1 reduces to the following for **elevated** (mixed mode) releases:

$$\dot{D}_{ib(e)} = 28.5 * \dot{Q}_e * DFB \tag{H-2}$$

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

Note: Since the permanent shutdown of the station, the Spent Fuel Building ventilation has been isolated from the plant stack. In addition, the waste gas decay system, which was used for gas holdup before release to the stack during plant operations, has been abandoned. The result is that the potential for noble gas release via the plant stack has been removed.

and for **ground level** releases:

$$\dot{D}_{ib(g)} = 309 * \dot{Q}_g * DFB \tag{H-3}$$

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

H.3 Gamma Dose to Air

For any Kr-85 release, in any period, the increment in dose is taken from Equations B-4 and B-5 of Regulatory Guide 1.109, as follows:

$$D_{air}^{\gamma} = (3.17E-02) * \left(\frac{X}{Q}\right) * (Q) * \left(DF^{\gamma}\right) \tag{H-4}$$

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

where:

3.17E-02	=	Number of pCi per μCi divided by the number of seconds per year;
$\left(\frac{X}{Q}\right)$	=	Maximum undepleted X/Q for the release point of interest,
Q	=	Quantity of Kr-85 released (μCi);
DF^{γ}	=	Gamma air dose factor for a uniform semi-infinite cloud of Kr-85 (from Regulatory Guide 1.109, Table B-1, 1.72 E-5).

For **elevated** (mixed mode) releases, this leads to:

$$D^{\gamma}_{air(e)} = (9.0E-07) * Q_e * DF^{\gamma};$$ (H-5)

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

However, as noted above, the expectation for noble gas (Kr-85) releases from the stack have been removed.

and for **ground level** releases:

$$D^{\gamma}_{air(g)} = (9.8E-06) * Q_g * DF^{\gamma}$$ (H-6)

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

H.4 Beta Dose to Air

For any Kr-85 release, in any period, the increment in dose is taken from Equations B-4 and B-5 of Regulatory Guide 1.109:

$$D^{\beta}_{air} = (3.17E-02) * \left(\frac{X}{Q}\right) * (Q) * (DF^{\beta})$$ (H-7)

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

where:

DF^{β} = Beta air dose factors for a uniform semi-infinite cloud of Kr-85 (from Regulatory Guide 1.109, Table B-1, 1.95 E-3);

Q = Quantity of Kr-85 released (μCi);

$\left(\frac{X}{Q}\right)$ = Maximum undepleted X/Q for the release point of interest.

Substituting the X/Q value, we have for **elevated** (mixed mode) releases:

$$D^{\beta}_{air(e)} = (9.0E-07) * (Q_e) * (DF^{\beta});$$ (H-8)

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

As noted above, the expectation for noble gas (Kr-85) releases from the plant stack have been removed due to changes in plant configuration since permanent shutdown.

And for **ground level** releases:

$$D^{\beta}_{air(g)} = (9.8E-06)*(Q_g)*(DF^{\beta}). \qquad \text{(H-9)}$$

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

H.5 Skin Dose Rate

Method 1 was derived from the general equation B-9 in Regulatory Guide 1.109, as follows:

$$D_{skin} = (1.11)*D^{\gamma}_{air} + \left[(3.17E+04)*(Q)*\left(\frac{X}{Q}\right)*(DFS)\right] \qquad \text{(H-10)}$$

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

where:

1.11	=	Average ratio of tissue to air absorption coefficients (will convert mrad in air to mrem in tissue);
3.17E+04	=	Conversion factor for curies to picocuries and seconds to years;
DFS	=	Beta skin dose factor for a semi-infinite cloud of Kr-85 which includes the attenuation by the outer “dead” layer of the skin;

$$D^{\gamma}_{air} = (3.17E+04)*(Q)*\left(\frac{X}{Q}\right)*(DF^{\gamma}) \qquad \text{(H-11)}$$

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

DF^{γ}	=	Gamma air dose factor for a uniform semi-infinite cloud of Kr-85 (see Table H-1).
Q	=	Annual release of Kr-85 in curies per year.

Since $Q = 31.54\dot{Q}$ where 31.54 is the conversion factor for Ci to μCi and from years to seconds, then

$$\dot{D}_{skin} = (1.11)(1E+06)\left(\frac{X}{Q}\right)*\left(\dot{Q}\right)*\left(DF^{\gamma}\right) \quad + \quad (1E+06)\left(\frac{X}{Q}\right)*\left(\dot{Q}\right)*\left(DFS\right) \qquad \text{(H-12)}$$

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

Substituting the X/Q value (2.85E-05 sec/m^3), we have, for an **elevated** (mixed mode) release point:

$$\dot{D}_{skin(e)} = (31.6)*\left(\dot{Q}_e\right)*\left(DF^{\gamma}\right) \quad + \quad (28.5)*\left(\dot{Q}_e\right)*\left(DFS\right) \qquad \text{(H-13)}$$

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

or,

$$\dot{D}_{skin(e)} = \dot{Q}\left(31.6DF^{\gamma} + 28.5DFS\right). \qquad \text{(H-14)}$$

For an elevated (mixed mode) release we substitute the "combined skin dose rate factor" for the expression in parentheses above, as follows:

$$\text{"Combined Skin Dose Rate Factor"} = DF_e' = 31.6DF^{\gamma} + 28.5DFS \ , \qquad \text{(H-15)}$$

where $DF_e' = (31.6)*(1.72E-5)+(28.5)*(1.34E-3) = 3.87E-2 \ \left(\frac{mrem-\sec}{\mu Ci-yr}\right)$

Then:

$$\dot{D}_{skin(e)} = \dot{Q}_e * DF_e'$$

(H-16)

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

Values of DF_e may be found in Table H-1.

As noted above, noble gas (Kr-85) releases from the plant stack have been eliminated due to changes in plant configuration since permanent shutdown. However, the same methodology for the development of a combined skin dose rate equation can be applied to ground level releases.

Substituting the ground level X/Q value (3.09E-04 sec/m^3), we have, for a **ground level** release point:

$$\dot{D}_{skin(g)} = (343)*(\dot{Q}_g)*(DF^{\gamma}) + (309)*(\dot{Q}_g)*(DFS) \quad \text{(H-17)}$$

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

or,

$$\dot{D}_{skin(g)} = \dot{Q}(343DF^{\gamma} + 309DFS). \quad \text{(H-18)}$$

For an ground-level release we substitute the "combined skin dose rate factor" for the expression in parentheses above, as follows:

$$\text{"Combined Skin Dose Rate Factor"} = DF_g' = 343DF^{\gamma} + 309DFS, \quad \text{(H-19)}$$

where $DF_e' = (343)*(1.72E-5) + (309)*(1.34E-3) = 0.42 \left(\frac{mrem-\sec}{\mu Ci-yr}\right)$

then:

$$\dot{D}_{skin(g)} = \dot{Q}_g * DF_g'. \quad \text{(H-20)}$$

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

Values of DF_g' may be found in Table H-1.

TABLE H.1

DOSE AND DOSE RATE FACTORS FOR Kr-85

(Combined Skin dose Rate Factors are derived in Sect. H.5; all other Dose Factors taken from Regulatory Guide 1.109.)

Gamma Total Body Dose Factor $DFB\left(\frac{mrem-m^3}{pCi-yr}\right)$	Beta Skin Dose Factor $DFS\left(\frac{mrem-m^3}{pCi-yr}\right)$	Combined Skin Dose Rate Factor Elevated Releases $DF'_e\left(\frac{mrem-\sec}{\mu Ci-yr}\right)$	Combined Skin Dose Rate Factor Ground Level Releases $DF'_g\left(\frac{mrem-\sec}{\mu Ci-yr}\right)$	Beta Air Dose Factor $DF^{\beta}\left(\frac{mrad-m^3}{pCi-yr}\right)$	Gamma Air Dose Factor $DF^{\gamma}\left(\frac{mrad-m^3}{pCi-yr}\right)$
1.61E-05	1.34E-03	3.87E-02	4.20E-01	1.95E-03	1.72E-05