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SECTION II

OFFSITE DOSE CALCULATION MANUAL

For The

HADDAM NECK PLANT

Docket No. 50-213

HADDAM NECK PLANT

OFFSITE DOSE CALCULATION MANUAL

TABLE OF CONTENTS

HADDAM NECK PLANT

OFFSITE DOSE CALCULATION MANUAL

LIST OF FIGURES

HADDAM NECK PLANT

OFFSITE DOSE CALCULATION MANUAL

APPENDICES

A. INTRODUCTION

Connecticut Yankee Quality Assurance Program (CY QAP), requires that Section II of the REMODCM 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 designated manager prior to implementation.

It is the responsibility of the designated 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. As required for dose consideration, plant supplied 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, if the flow will be included dose calculations, 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 REMM requires that the instantaneous off-site dose rate from tritium and particulates (half-lives > 8 days) released to the atmosphere not exceed 1500 mrem/year at any time for the inhalation pathway critical organ.

a. Critical Organ Dose Rate from Particulates and Tritium

The critical organ rate limit (1500 mrem/yr) applies to the combination of 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 are determined independently, and then summed to obtain the overall critical organ dose rate.

(1) Method 1

For **ground-level** releases 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 (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 (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 all concurrent ground level sources. (Iodine-131 and 133 have been removed from the potential sources term due to radioactive decay, tritium no longer considered after SFP bulk drain). 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 **ground-level** releases 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)

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. If an evaluation finds a significant direct dose impact, information about the dose impact will be included in the 40CFR190 limit evaluation.

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

E. LIQUID EFFLUENT RELEASE CALCULATIONS

Control C.3.3 of Part I of this manual requires that the radioactive liquid effluent instrumentation in Table C.3.3 are available 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 Discharge Line Flow Rates

Prior to releasing radioactive liquid to the environment, calculations are performed to ensure that Control C.3.1 of Part 1 of this manual is not exceeded. The known or estimated nuclides present are compared to each individual MPC. If the sum of the ratios is above the Administrative Factor then the maximum discharge flow rate is estimated and the minimum dilution flow required for the release is calculated.

Step 1

Determine the ratio between each individual activity concentration known or estimated to be present in the waste stream to the MPC value associated with the nuclide of interest. The sum of the ratios is compared to an administrative limit.

$$SR = \Sigma_i \frac{C_i}{MPC_i}$$

where: SR = Summation of the MPC ratios

C_i = Activity concentration of each radionuclide "i" (uCi/ml) determine to be in the test tank. This includes Gross Alpha, Tritum, 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

If the summation of the ratios is less than or equal to the AF (SR ≤ AF) then the rate of release to the environment is not restricted.

If the summation of the ratios is greater than the AF (SR >AF) then a conservative dilution flow is required. The minimum required dilution flow calculation is based upon an estimated discharge flow rate.

$$DF_{min} = Fmax \times \left(\frac{SR}{AF} - 1 \right)$$

where: DF_{min} = Minimum required dilution flow for the radioactive liquid release based upon F_{max} (gpm).

F_{max} = Estimated maximum radioactive liquid discharge flow rate to the environment (gpm).

AF = Administrative Factor for SR (between 0.1 and 0.7) used to set the threshold for performing additional release rate and dilution flow calculations. This factor is conservative and will account for ongoing releases from other sources.

If the plant supplied dilution flow is less than DF_{min} then reduce the discharge flow rate, reprocess liquid to lower activity levels or increase the available dilution flow. The radioactive release shall not be performed until the minimum dilution flow is available.

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

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

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

10. Vendor/CY Calculation No. CY-ESG-02-001, "Estimating the Site-Specific Usage Factor for Fish Consumption (CY)".

11. Vendor/CY Calculation No. CY-ESG-01-001, "Tidal Dilution Flows for Liquid Release Dose Calculations".

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]

ADULT							
NUCLIDE	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
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							
NUCLIDE	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
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							
NUCLIDE	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
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
6. Regulatory Guide 1.109 usage factors for maximum individual for fish, shoreline, swimming and boating. Site specific fish consumption usage may be used as documented in reference 12.
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].

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(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/m^3)	Depleted (X/Q) (sec/m^3)	Deposition Factor (D/Q) (m^{-2})
Ground-Level Releases	Temporary Tent Exhaust (worst-case release point) Alternate Stack	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 (Terry Turbine Access)	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

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

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,IF	On-site-Mouth of Discharge Canal	1.1 Mi, ESE (0.5 Mi, SSE IF)	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
6-I, IF	On-site-Substation (w/in 10 miles)	0.5 Mi, NE (0.6 Mi, NW IF)	TLD
7-I	Haddam	1.8 Mi, SE	TLD
8-I	East Haddam	3.1 Mi, ESE	TLD
9-I	Higganum	4.3 Mi, WNW	TLD
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
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
48-IF	Onsite Met Tower Shack	0.4 Mi, WSW	TLD
52-IF	Schmidt Cemetery(onsite0	0.5 Mi, NNE	TLD
53-IF	ISFSI Haul Route (onsite)	0.2 Mi, SSW	TLD
54-IF	Route 149 (near Salmon River mouth)	1.0 Mi, ESE	TLD
55-IF	High Voltage Tower (onsite, NW of Pad)	0.4 Mi, NW	TLD
56-IF	Burrow Pit (onsite)	0.2 Mi, E	TLD
57-IF	Dibble Creek Sediment Sample	0.1 Mi, SE	Bottom Sediment
58-IF	ISFSI Pad Enclosure Soil Sample Coll.	0.0 Mi	Soil

[1]This table does not require updating based on the elimination of sampling as described in the REMM.

I= Indicator C = Control IF= ISFSI Indicator

The release points are the center of the site for terrestrial locations and the end of the discharge canal for aquatic locations. The ISFSI pad is the release point for the ISFSI indicators.

DEC 2 1 2005

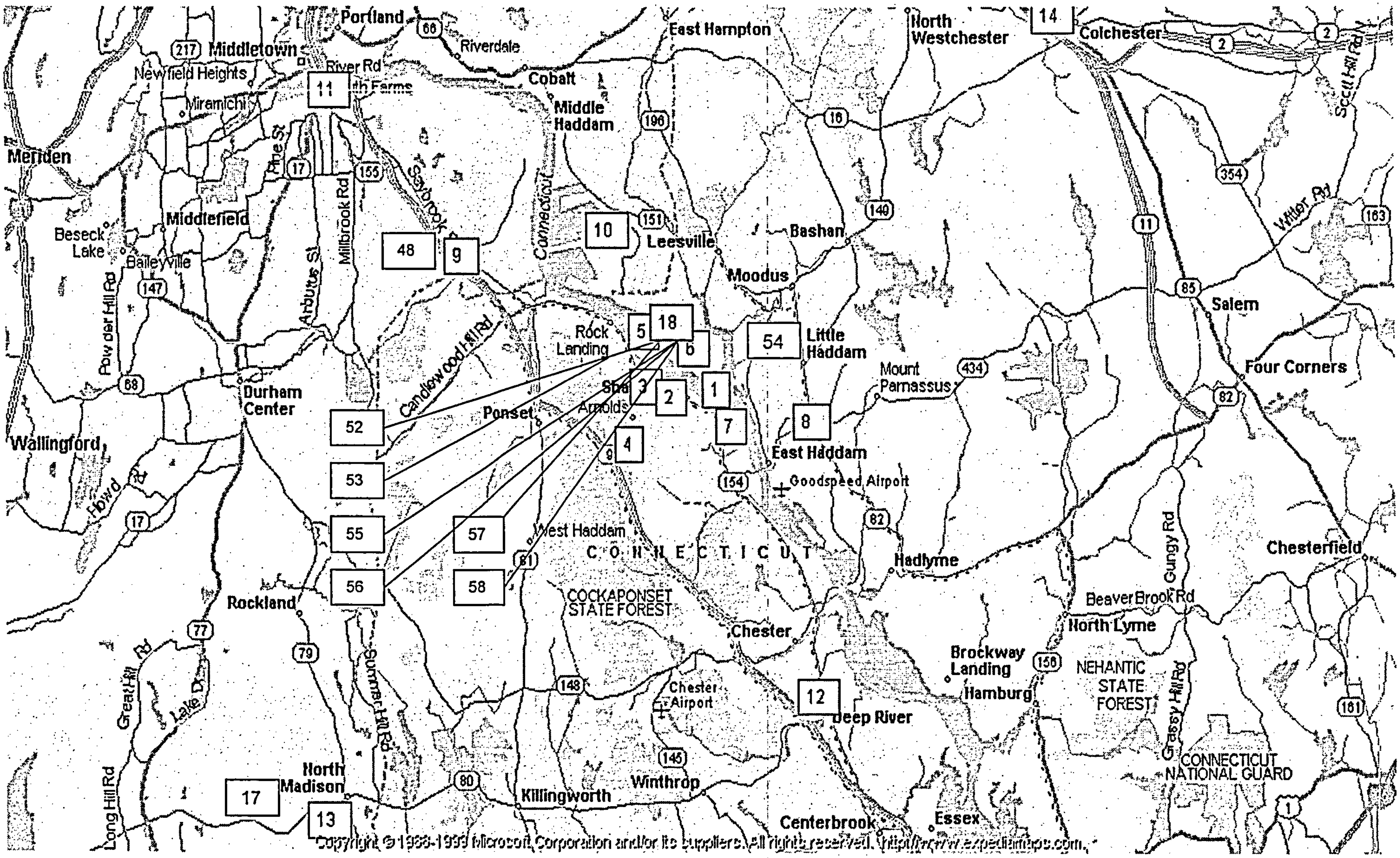

Figure G- 1: Haddam Neck Plant Inner Terrestrial Monitoring Stations

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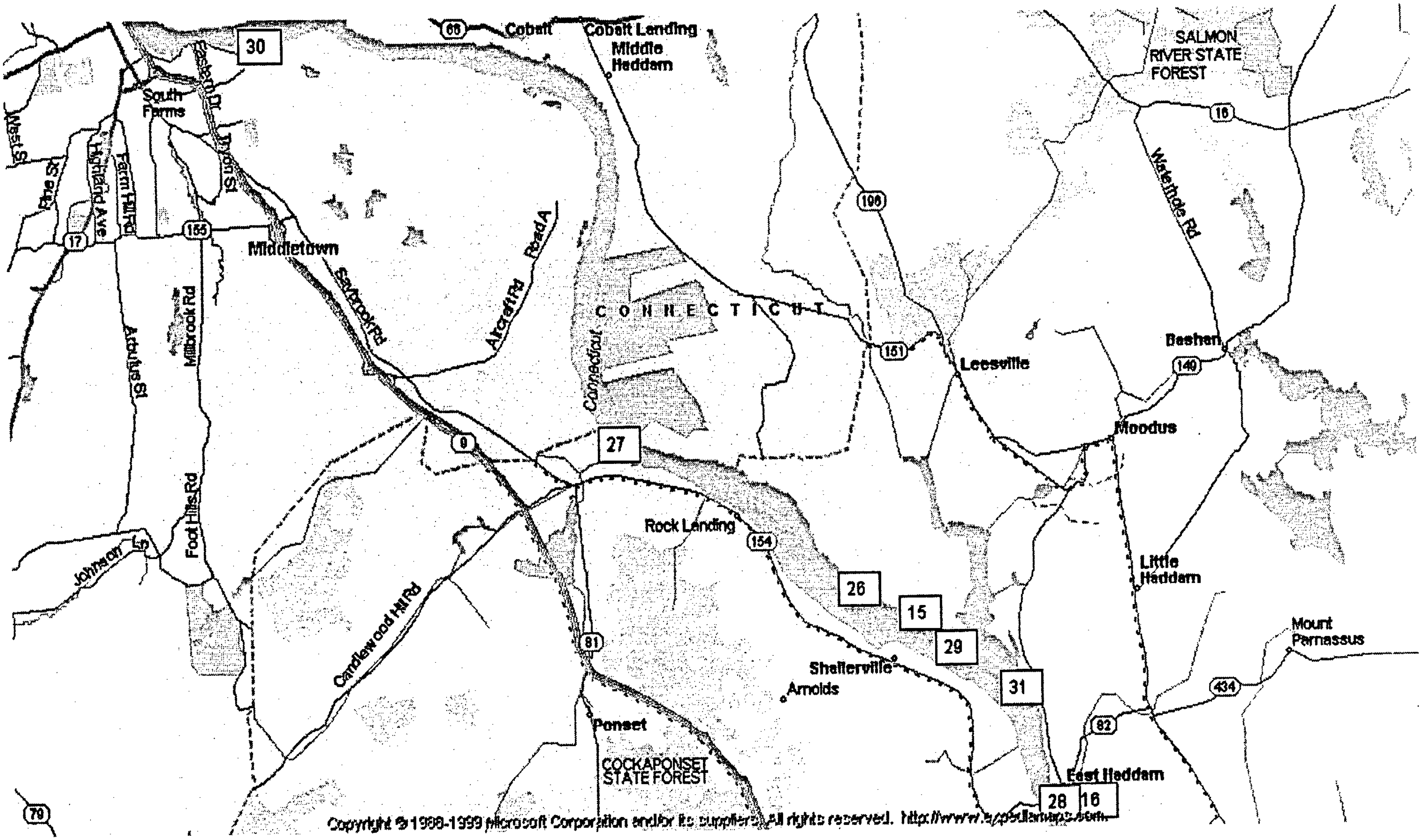

Figure G- 2: Haddam Neck Plant Aquatic and Well Water Sample Stations

ATTACHMENT 8
Connecticut Yankee REM/ODCM Change Request

I.
Originator Name (Print): Joe Bourassa
(Attach markup pages)

Section No.	Section Title	Page No.	Description of Change & Reason
Table E-1	Haddam Neck REMP	E-3	Changed items 2, 4, 5 to Annual and added additional information to Note (1). These changes are being made to require one additional sampling event to occur after the bulk SFP water has been discharged. One would not have been required based on the schedule for performing a discharge by December 2005. No sample is needed in the fall of 2005 because the discharges were very limited and of low activity since June of 2005. Indication over the history of the plant have not indicated any discernable impact on these sample media. No environmental impacts have been identified during periods of significantly higher activity releases from these sampling activities. This change to an annual sample will ensure that one final is obtained after the major radioactive discharges have been made. Obtaining an annual sample of sediment for ISFSI related samples is sufficient to identify any long term trends since radioactive leakage is not from the VCCs and not expected.
F-2	Annual Rad Effluent Release Report	F-2	Deleted "CY direct radiation from the site" because it should have been deleted in a previous change and was missed.
Various	Various	Various	Changed "Unit Manager" to "Designated Manager" to reflect the change to the CYQAP.
Table C-1	Radioactive Waste Sampling and Analysis Program	C-2 & 4	Changed Table to reflect the Groundwater Treatment is the only discharge remaining from this pathway.

Originator signature: Joseph Bourassa Date: 11/9/05

ATTACHMENT 8
Connecticut Yankee REM/ODCM Change Request

II. List the procedures and/or setpoints that require revision in order to implement the proposed change.

	Estimated date for implementation	Name of Manager responsible to implement
ACP 1.2-2.90	11-30-05	Harvey Farr/Kerry Comisky

III. Technical Reviewers:

Approve or disapprove
If disapproving, attach bases.
List procedures/setpoints that require revision in Section II.

[signature] Chemistry Supervisor — Approve ☒ Disapprove ☐ 11-16-05 Date

IV. Radiological Environmental Review:
See change description.

Unreviewed Environmental Impact? Yes ☐ No ☑

(Bases Attached)
[signature] Technical Reviewer — Approve ☑ Disapprove ☐ 12/8/05 Date

V. Radiation Protection Manager Review:
[signature] Radiation Protection Manager — Approve ☑ Disapprove ☐ 12/14/05 Date

VI. Compliance Review:
G. van Noordennen Regulatory Affairs Manager — Approve ☑ Disapprove ☐ 12/19/05 Date

ATTACHMENT 8
Connecticut Yankee REM/ODCM Change Request

VII. ISR Review: Joel Goencl Approve ☒ Disapprove ☐ 12-19-05 ISR Reviewer Date
VIII. Unit/~~ISFSI~~ Manager Approval: R. M. Mitchell Approve ☑ Disapprove ☐ 12-21-05 Unit/ISFSI Manager Date
IX. CY IRAC Approval: (As required) N/A Approve ☐ Disapprove ☐ IRAC Chairman Date
X. Verify that the Section II procedure and/or setpoint changes have been approved and are consistent with this Change Request. Effective Date of REM/ODCM Revision: ~~58~~ 19 12/21/05 Joseph Bourassa 12/21/05 Radiation Protection Department Representative Date
XI. Change sent to Administration for implementation: Joseph Bourassa 12/21/05 Radiation Protection Department Representative Date
XII. Change documented in Annual Radioactive Effluent Report: Radiation Protection Department Representative Date

CONNECTICUT YANKEE ATOMIC POWER COMPANY

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

December 14, 2005
RP-05-077

To: File

From: R. Gault

Subject: Radiological Environmental Review

The change to the REMODCM is being made to correct several minor errors from previous changes, to provide clarifications to several sections and to change the frequency for sampling and analyzing several Radiological Environmental Monitoring Program (REMP) sampling frequencies.

The changes are minor in nature and have no impact on the program. The administrative and editorial changes are clarification only and do not change the Radiological Effluent Controls Program (RECP) or the REMP. The changes to the sampling and analysis frequencies for the REMP do not have an impact on the program. The data being obtained for the REMP is to validate the effectiveness of the RECP as described in the REMODCM. The liquid radiological effluents released during the second half of 2005 was minimal and had very low radiological constituents. There would be not impact on the environment even at the immediate discharge point based on the amount of water released and the activity concentrations. There is significant dilution water in the canal and it would not have been even detectable in the canal or the Connecticut River. There have been no major indications of environmental impacts identified as part of the REMP sampling activities in the past with much high concentrations of radioactivity released and much greater volumes. The change being made ensures that one additional REMP sampling event will be performed to ensure the effectiveness of the RECP after the Spent Fuel Pool water will be discharged. This will be performed in the May or June timeframe.

This evaluation documents the fact that this change will maintain the level of radioactive effluent control required by 10CFR20.1302, 40CFR190, 10CFR50.36a and 10CFR50 Appendix I and will not adversely impact the accuracy or reliability of effluent dose or setpoint calculations. No Unreviewed Environmental Impact has been identified with this change.

CC: H. Farr
File

Attachment 3
Radiological Environmental Review
Page 1 of 1

> **NOTE**
>
> The following questions relate to the normal use of the proposed change. Any radioactive release resulting from the failure of the proposed change are addressed in a separate 50.59 Evaluation.

	Initial "Yes" or "No"	
	Yes	No
1. Will the change cause an increase or potential increase in the amounts of radioactive airborne effluents or liquid effluents, or significantly alter the nuclide mix of such effluents?		GN
2. Will the change result in a new radioactive liquid or gaseous discharge point, or decrease the ability to sample or monitor existing release paths?		GN
3. Will the change significantly increase the eventual number of solid waste shipments?		GN
4. Will the change cause movement and subsequent storage of radioactive material in an unshielded area without evaluating RCA boundary dose rate and site boundary dose limitations (10 CFR 20.1301, 40 CFR 190)?		GN
5. Will the change, in the judgment of the individual performing this review, constitute an increased Radiological Environmental Impact for reasons not already considered above?		GN

If the answer is "Yes" to ANY of the above questions, develop a plan to address the issue with Radiological Engineering. This determination was made by:

R. GAULT [signature] — Reviewer

12/8/05 — Date