License No. DPR-61
HADDAM NECK
Independent Spent Fuel Storage Installation

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

January-December 2007

April 2008

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Tables 1 and 2 summarizes the quantity of radioactive gaseous and liquid effluents, respectively, for each quarter of the monitoring period. Table 3 states that waste was shipped off-site for burial or disposal during the year in review. Table 4 contains supplementary information.

Appendices A through D, indicate the status of reportable items per the requirements of the Off-site Dose Calculation Manual (ODCM).

Changes to the ODCM made during the year are summarized in Appendix E. A complete copy of the revised manual is attached as well as the specific pages that changed.

TABLE 1A

HADDAM NECK ISFSI
Effluent and Waste Disposal Annual Report
First and Second Quarters, 2007
Gaseous Effluents-Summation of All Releases

	Unit	1st Quarter	2nd Quarter	Est. Total Error, %
A. Fission and Activation Gases				
1. Total Release	Ci	N/A*	N/A*	N/A
2. Average release rate for period	uCi/sec	N/A*	N/A*	
3. Percent of regulatory limit	%	N/A*	N/A*	
B. Iodines				
1. Total Iodine-131	Ci	N/A*	N/A*	N/A
2. Average release rate for period	uCi/sec	N/A*	N/A*	
3. Percent of regulatory limit	%	N/A*	N/A*	
C. Particulates				
1. Particulates with T-1/2 > 8 days	Ci	N/A*	N/A*	N/A
2. Average release rate for period	uCi/sec	N/A*	N/A*	
3. Percent of regulatory limit	%	N/A*	N/A*	
4. Gross alpha radioactivity	Ci	N/A*	N/A*	
D. Tritium				
1. Total release	Ci	N/A*	N/A*	N/A
2. Average release rate for period	uCi/sec	N/A*	N/A*	
3. Percent of regulatory limit	%	N/A*	N/A*	

N/D*= Not Detected
N/A*= Not Applicable
There are no gaseous effluent releases associated with the Connecticut Yankee ISFSI

TABLE 1A

HADDAM NECK ISFSI
Effluent and Waste Disposal Annual Report
Third and Fourth Quarters, 2007
Gaseous Effluents-Summation of All Releases

	Unit	3rd Quarter	4th Quarter	Est. Total Error, %
A. Fission and Activation Gases				
1. Total Release	Ci	N/A*	N/A*	N/A
2. Average release rate for period	uCi/sec	N/A*	N/A*	
3. Percent of regulatory limit	%	N/A*	N/A*	
B. Iodines				
1. Total Iodine-131	Ci	N/A*	N/A*	N/A
2. Average release rate for period	uCi/sec	N/A*	N/A*	
3. Percent of regulatory limit	%	N/A*	N/A*	
C. Particulates				
1. Particulates with T-1/2 > 8 days	Ci	N/A*	N/A*	N/A
2. Average release rate for period	uCi/sec	N/A*	N/A*	
3. Percent of regulatory limit	%	N/A*	N/A*	
4. Gross alpha radioactivity	Ci	N/A*	N/A*	
D. Tritium				
1. Total release	Ci	N/A*	N/A*	N/A
2. Average release rate for period	uCi/sec	N/A*	N/A*	
3. Percent of regulatory limit	%	N/A*	N/A*	

N/D*= Not Detected
N/A*= Not Applicable
There are no gaseous effluent releases associated with the Connecticut Yankee ISFSI

TABLE 1B

HADDAM NECK ISFSI
Effluent and Waste Disposal Annual Report
First and Second Quarters, 2007
Gaseous Effluents-Elevated Release

		Continuous Mode		Batch Mode	
Nuclides Released	**Unit**	**1st Quarter**	**2nd Quarter**	**1st Quarter**	**2nd Quarter**
1. Fission Gases					
Krypton-85	Ci	N/A*	N/A*	N/A*	N/A*
Krypton-85m	Ci	N/A*	N/A*	N/A*	N/A*
Krypton-87	Ci	N/A*	N/A*	N/A*	N/A*
Krypton-88	Ci	N/A*	N/A*	N/A*	N/A*
Xenon-133	Ci	N/A*	N/A*	N/A*	N/A*
Xenon-135	Ci	N/A*	N/A*	N/A*	N/A*
Xenon-135m	Ci	N/A*	N/A*	N/A*	N/A*
Xenon-138	Ci	N/A*	N/A*	N/A*	N/A*
Unidentified	Ci	N/A*	N/A*	N/A*	N/A*
Total for period	Ci	N/A*	N/A*	N/A*	N/A*
2. Iodines					
Iodine-131	Ci	N/A*	N/A*	N/A*	N/A*
Iodine-133	Ci	N/A*	N/A*	N/A*	N/A*
Iodine-135	Ci	N/A*	N/A*	N/A*	N/A*
Total for period	Ci	N/A*	N/A*	N/A*	N/A*
3. Particulates					
Strontium-89	Ci	N/A*	N/A*	N/A*	N/A*
Strontium-90	Ci	N/A*	N/A*	N/A*	N/A*
Cesium-134	Ci	N/A*	N/A*	N/A*	N/A*
Cesium-137	Ci	N/A*	N/A*	N/A*	N/A*
Cobalt-60	Ci	N/A*	N/A*	N/A*	N/A*
Barium-Lanthanum-140	Ci	N/A*	N/A*	N/A*	N/A*
Others-					
Plutonium-238	Ci	N/A*	N/A*	N/A*	N/A*
Curium-243,244	Ci	N/A*	N/A*	N/A*	N/A*
Uranium-234	Ci	N/A*	N/A*	N/A*	N/A*
Uranium-238	Ci	N/A*	N/A*	N/A*	N/A*
Thorium-232	Ci	N/A*	N/A*	N/A*	N/A*
Radium-226	Ci	N/A*	N/A*	N/A*	N/A*

N/D*= Not Detected
N/A*= Not Applicable
There are no gaseous effluent releases associated with the Connecticut Yankee ISFSI

TABLE 1B

HADDAM NECK ISFSI
Effluent and Waste Disposal Annual Report
Third and Fourth Quarters, 2007
Gaseous Effluents-Elevated Release

		Continuous Mode		Batch Mode	
Nuclides Released	**Unit**	**3rd Quarter**	**4th Quarter**	**3rd Quarter**	**4th Quarter**
1. Fission Gases					
Krypton-85	Ci	N/A*	N/A*	N/A*	N/A*
Krypton-85m	Ci	N/A*	N/A*	N/A*	N/A*
Krypton-87	Ci	N/A*	N/A*	N/A*	N/A*
Krypton-88	Ci	N/A*	N/A*	N/A*	N/A*
Xenon-133	Ci	N/A*	N/A*	N/A*	N/A*
Xenon-135	Ci	N/A*	N/A*	N/A*	N/A*
Xenon-135m	Ci	N/A*	N/A*	N/A*	N/A*
Xenon-138	Ci	N/A*	N/A*	N/A*	N/A*
Unidentified	Ci	N/A*	N/A*	N/A*	N/A*
Total for period	Ci	N/A*	N/A*	N/A*	N/A*
2. Iodines					
Iodine-131	Ci	N/A*	N/A*	N/A*	N/A*
Iodine-133	Ci	N/A*	N/A*	N/A*	N/A*
Iodine-135	Ci	N/A*	N/A*	N/A*	N/A*
Total for period	Ci	N/A*	N/A*	N/A*	N/A*
3. Particulates					
Strontium-89	Ci	N/A*	N/A*	N/A*	N/A*
Strontium-90	Ci	N/A*	N/A*	N/A*	N/A*
Cesium-134	Ci	N/A*	N/A*	N/A*	N/A*
Cesium-137	Ci	N/A*	N/A*	N/A*	N/A*
Cobalt-60	Ci	N/A*	N/A*	N/A*	N/A*
Barium-Lanthanum-140	Ci	N/A*	N/A*	N/A*	N/A*
Others-					
Plutonium-238	Ci	N/A*	N/A*	N/A*	N/A*
Curium-243,244	Ci	N/A*	N/A*	N/A*	N/A*
Uranium-234	Ci	N/A*	N/A*	N/A*	N/A*
Uranium-238	Ci	N/A*	N/A*	N/A*	N/A*
Thorium-232	Ci	N/A*	N/A*	N/A*	N/A*
Radium-226	Ci	N/A*	N/A*	N/A*	N/A*

N/D*= Not Detected
N/A*= Not Applicable
There are no gaseous effluent releases associated with the Connecticut Yankee ISFSI

TABLE 1C

HADDAM NECK ISFSI
Effluent and Waste Disposal Annual Report
January-December 2007
Gaseous Effluents-Ground Level Release

There are no gaseous effluents associated with the Haddam Neck Independent Spent Fuel Storage Installation (ISFSI)

TABLE 2A

HADDAM NECK ISFSI
Effluent and Waste Disposal Annual Report
First and Second Quarters, 2007
Liquid Effluents-Summation of All Releases

	Unit	1st Quarter	2nd Quarter	Est. Total Error, %
A. Fission and Activation Products				
1. Total Release (not including tritium, gases,alpha)	Ci	N/A*	N/A*	N/A
2. Average diluted concentration during period	.uCi/ml	N/A*	N/A*	
3. Percent of applicable limit	%	N/A*	N/A*	
B. Tritium				
1. Total Release	Ci	N/A*	N/A*	N/A
2. Average diluted concentration during period	.uCi/ml	N/A*	N/A*	
3. Percent of applicable limit	%	N/A*	N/A*	
C. Dissolved and Entrained Gases				
1. Total Release	Ci	N/A*	N/A*	N/A
2. Average diluted concentration during period	.uCi/ml	N/A*	N/A*	
3. Percent of applicable limit	%	N/A*	N/A*	
D. Gross Alpha Radioactivity				
1. Total release	Ci	N/A	N/A	N/A
2. Average diluted concentration during period	.uCi/ml	N/A*	N/A	
E. Volume of Waste Released (prior to dilution)	Liters	N/A*	N/A*	
F. Volume of Dilution Water Used During Period	Liters	N/A*	N/A*	

N/D*= Not Detected
N/A*= Not Applicable

There are no liquid releases associated with the Connecticut Yankee ISFSI

TABLE 2A

HADDAM NECK ISFSI
Effluent and Waste Disposal Annual Report
Third and Fourth Quarters, 2007
Liquid Effluents-Summation of All Releases

	Unit	3rd Quarter	4th Quarter	Est. Total Error, %
A. Fission and Activation Products				
1. Total Release (not including tritium, gases,alpha)	Ci	N/A	N/A	N/A
2. Average diluted concentration during period	.uCi/ml	N/A	N/A	
3. Percent of applicable limit	%	N/A	N/A	
B. Tritium				
1. Total Release	Ci	N/A	N/A	N/A
2. Average diluted concentration during period	.uCi/ml	N/A	N/A	
3. Percent of applicable limit	%	N/A	N/A	
C. Dissolved and Entrained Gases				
1. Total Release	Ci	N/A	N/A	N/A
2. Average diluted concentration during period	.uCi/ml	N/A	N/A	
3. Percent of applicable limit	%	N/A	N/A	
D. Gross Alpha Radioactivity				
1. Total release	Ci	N/A	N/A	N/A
2. Average diluted concentration during period	.uCi/ml	N/A	N/A	
E. Volume of Waste Released (prior to dilution)	Liters	N/A	N/A	N/A
F. Volume of Dilution Water Used During Period	Liters	N/A	N/A	N/A

N/D*= Not Detected
N/A*= Not Applicable

There are no liquid releases associated with the Connecticut Yankee ISFSI

TABLE 2B

HADDAM NECK ISFSI
Effluent and Waste Disposal Annual Report
First and Second Quarters, 2007
Liquid Effluents

		Continuous Mode		Batch Mode	
Nuclides Released	**Unit**	**1st Quarter**	**2nd Quarter**	**1st Quarter**	**2nd Quarter**
Strontium-89	Ci	N/A*	N/A*	N/A*	N/A*
Strontium-90	Ci	N/A*	N/A*	N/A*	N/A*
Cesium-134	Ci	N/A*	N/A*	N/A*	N/A*
Cesium-137	Ci	N/A*	N/A*	N/A*	N/A*
Iodine-131	Ci	N/A*	N/A*	N/A*	N/A*
Cobalt-58	Ci	N/A*	N/A*	N/A*	N/A*
Cobalt-60	Ci	N/A*	N/A*	N/A*	N/A*
Iron-59	Ci	N/A*	N/A*	N/A*	N/A*
Zinc-65	Ci	N/A*	N/A*	N/A*	N/A*
Manganese-54	Ci	N/A*	N/A*	N/A*	N/A*
Chromium-51	Ci	N/A*	N/A*	N/A*	N/A*
Zirconium-Niobium-95	Ci	N/A*	N/A*	N/A*	N/A*
Molybdenum-99	Ci	N/A*	N/A*	N/A*	N/A*
Technetium-99m	Ci	N/A*	N/A*	N/A*	N/A*
Barium-Lathanium-140	Ci	N/A*	N/A*	N/A*	N/A*
Cerium-141	Ci	N/A*	N/A*	N/A*	N/A*
Others- Iron-55	Ci	N/A*	N/A*	N/A*	N/A*
Antimony-125	Ci	N/A*	N/A*	N/A*	N/A*
Unidentified	Ci	N/A*	N/A*	N/A*	N/A*
Total for period (above)	Ci	N/A*	N/A*	N/A*	N/A*
Xenon-133	Ci	N/A*	N/A*	N/A*	N/A*
Xenon-135	Ci	N/A*	N/A*	N/A*	N/A*

N/D*= Not Detected
N/A*= Not Applicable
There are no liquid releases associated with the Connecticut Yankee ISFSI

TABLE 2B

HADDAM NECK ISFSI
Effluent and Waste Disposal Annual Report
Third and Fourth Quarters, 2007
Liquid Effluents

		Continuous Mode		Batch Mode	
Nuclides Released	**Unit**	**3rd Quarter**	**4th Quarter**	**3rd Quarter**	**4th Quarter**
Strontium-89	Ci	N/A*	N/A*	N/A*	N/A*
Strontium-90	Ci	N/A*	N/A*	N/A*	N/A*
Cesium-134	Ci	N/A*	N/A*	N/A*	N/A*
Cesium-137	Ci	N/A*	N/A*	N/A*	N/A*
Iodine-131	Ci	N/A*	N/A*	N/A*	N/A*
Cobalt-58	Ci	N/A*	N/A*	N/A*	N/A*
Cobalt-60	Ci	N/A*	N/A*	N/A*	N/A*
Iron-59	Ci	N/A*	N/A*	N/A*	N/A*
Zinc-65	Ci	N/A*	N/A*	N/A*	N/A*
Manganese-54	Ci	N/A*	N/A*	N/A*	N/A*
Chromium-51	Ci	N/A*	N/A*	N/A*	N/A*
Zirconium-Niobium-95	Ci	N/A*	N/A*	N/A*	N/A*
Molybdenum-99	Ci	N/A*	N/A*	N/A*	N/A*
Technetium-99m	Ci	N/A*	N/A*	N/A*	N/A*
Barium-Lathanium-140	Ci	N/A*	N/A*	N/A*	N/A*
Cerium-141	Ci	N/A*	N/A*	N/A*	N/A*
Others- Iron-55	Ci	N/A*	N/A*	N/A*	N/A*
Antimony-125	Ci	N/A*	N/A*	N/A*	N/A*
Unidentified	Ci	N/A*	N/A*	N/A*	N/A*
Total for period (above)	Ci	N/A*	N/A*	N/A*	N/A*
Xenon-133	Ci	N/A*	N/A*	N/A*	N/A*
Xenon-135	Ci	N/A*	N/A*	N/A*	N/A*

N/D*= Not Detected
N/A*= Not Applicable
There are no liquid releases associated with the Connecticut Yankee ISFSI

TABLE 3
HADDAM NECK ISFSI
Effluent and Waste Disposal Semiannual Report
First Half, 2007
Solid Waste and Irradiated Fuel Shipments

A. Solid Waste Shipped Off-Site for Burial or Disposal (Not Irradiated Fuel).

1. Type of Waste.	Unit	6-Month Period	Est. Total Error, %
a. Spent resins, filter sludges, etc.	Cu. M.	0.0	
	Ci.	0.0	+/- 25
b. Dry compressible waste, contaminated equipment, DAW, cement.	Cu. M.	0.0	
	Ci.	0.00	+/- 25
c. Irradiated Hardware.	Cu. M.	0.0	
	Ci.	0.0	+/- 25

2. Estimate of major nuclide composition (by type of waste).

a.	Co-60	0	0
	Ni-63	0	0
	Cs-137	0	0
	Fe-55	0	0
b.	Co-60	0	0
	Fe-55	0	0
	Ni-63	0	0
	Cs-137	0	0
	Ce-144	0	0
	Pu-241	0	0
c.	Co-60	0	0
	Fe-55	0	0
	Ni-63	0	0

3. Solid Waste Disposition

Number of Shipments	Mode of Transportation	Destination
0	Trucking over highway	N/A
0	Trucking over highway	N/A
0	Rail	N/A

Table 3 (Cont.)

B. Irradiated Fuel Shipments (Disposition): None Shipped.

Additional ODCM Requirements.

Solid Waste Class	Volume (Cu. M.)	Est. Activity (Ci)	Est. Total Error
A	0.00E+00	0.00E+00	+/- 25%
B	0.00E+00	0.00E+00	+/- 25%
C	0.00E+00	0.00E+00	+/- 25%

Container	Type	Package Volume (Cu. M.)
Gondola Car	Strong Tight Container	N/A
B-25 Steel Box	Strong Tight Container	N/A

TABLE 3
HADDAM NECK ISFSI
Effluent and Waste Disposal Semiannual Report
Second Half, 2007
Solid Waste and Irradiated Fuel Shipments

A. Solid Waste Shipped Off-Site for Burial or Disposal (Not Irradiated Fuel).

1. Type of Waste.	Unit	6-Month Period	Est. Total Error, %
b Dry compressible waste, contaminated equipment, DAW, cement.	Cu. M.	12.461	
	Ci	1.12 E-3	+/- 25

2. Estimate of major nuclide composition (by type of waste).

b.	H-3	0.191%	2.15E-6
	Fe-55	28.12	3.15E-4
	Co-60	33.12	3.71E-4
	Ni-63	8.13%	9.11E-5
	Sr-90D	0.136%	1.53E-6
	Cs-134	2.43%	2.72E-5
	Cs-137D	19.64%	2.20E-4
	Ce-144D	4.62%	5.18E-5
	Pu-238	0.157%	1.76E-6
	Pu-239	0.054%	6.06E-7
	Pu-241	3.01%	3.37E-5
	Am-241	0.213%	2.39E-6
	Cm-242	0.0015%	1.70E-8
	Cm-243	0.085%	9.59E-7
	C-14		4.0E-9/cc
	Tc-99		1.0E-9/cc
	I-129		6.47E-10/cc

3. Solid Waste Disposition

Number of Shipments	Mode of Transportation	Destination
1	Truck Over Highway	Duratek, Inc Oak Ridge, TN

TABLE 3
(Continued)

B. Irradiated Fuel Shipments (Disposition):

None Shipped.

Additional ODCM Requirements.

Solid Waste Class	Volume (Cu. M.)	Est. Activity (Ci)	Est. Total Error
A	1.246E+04	1.12E-03	+/- 25%
B	0.00E+00	0.00E+00	+/- 25%
C	0.00E+00	0.00E+00	+/- 25%

Container	Type	Package Volume (Cu. M.)
B-25	Strong Tight Container	2.719
Intermodel	Strong Tight Container	29.340

TABLE 4

Supplemental Information

1. Regulatory Limits

Effluent Concentrations

a. Fission and activation gases	10 CFR 20; Appendix B, Table 2, Column 1
b. Iodines	10 CFR 20; Appendix B, Table 2, Column 1
c. Particulates, (with half lives greater than 8 days)	10 CFR 20; Appendix B, Table 2, Column 1
d. Liquid effluents:	10 CFR 20; Appendix B, Table 2, Column 2
e. Total noble gas concentration:	2.0 E-4 uCi/ml

2. Average Energy- Not Applicable

3. Measurements and Approximations of Radioactivity

   a. Fission and Activation Gases
   There are no gaseous effluent release paths associated with ISFSI Operations.

   b. Iodines
   There are no gaseous effluent release paths associated with ISFSI Operations

   c. Particulates
   There are no particulate release paths associated with ISFSI Operations

   d. Liquid Effluents

   Continuous Discharges
   There are no liquid effluent release paths associated with ISFSI Operations.

4. Batch Releases
   a. Liquids
      1. Number of Batch release: N/A
         Number of Continuous Release: N/A
      2. Total time period for batch releases: N/A
         Total time period for continuous release: N/A
      3. Maximum time period for a batch release: N/A
      4. Average time period for batch releases: N/A
      5. Minimum time period for a batch release: N/A
      6. Average stream flow during periods of release of effluents into a flowing stream: N/A
      7. Maximum gross release concentration (uCi/ml): N/A

   b. Gaseous
      1. Number of batch release: N/A
      2. Total time period for batch releases: Not Applicable
      3. Maximum time period for a batch release: Not Applicable
      4. Average time period for batch releases: Not Applicable
      5. Minimum time period for a batch release: Not Applicable
      6. Maximum gross release rate (uCi/sec): Not Applicable

5. Unplanned Releases -N/A

6.

APPENDIX A

Radioactive Effluent Monitoring Instrumentation

There are no gaseous or liquid effluent release pathways associated with ISFSI Operations. Therefore, effluent monitoring instrumentation is not required.

APPENDIX B

Liquid Radwaste Treatment System

There are no liquid release pathways associated with ISFSI Operations. Therefore, radwaste treatment systems are not required.

APPENDIX C

Gaseous Radwaste Treatment System

There are no gaseous effluent release pathways associated with ISFSI Operations. Therefore, a gaseous waste treatment system was not required.

APPENDIX D

Lower Limit of Detection for Radiological Analysis

There are no liquid or gaseous sampling requirements associated with ISFSI Operations since effluent release pathways do not exist.

APPENDIX E

Summary of Off-site Dose Calculation Manual Revisions

There were several changes to the Offsite Dose Calculation in the year 2007. A description of changes are provided below

Change # 20- Dated 6-5-2006
NOTE: Revision 20 was issued in 2006, but was not captured in the 2006 Annual Effluent Release Report. Therefore, it is being provided in the 2007 report.

Description Of Changes Are As Follows;

Section; Radiological Environmental Monitoring Program
Section #; Table E1 #'s 4 and 5

Changed the type and frequency of the analysis from semi-annual to annual.

Sections; -Radioactive Effluents Dose- Liquid Surveillance Requirements
-Radioactive Effluents Dose- Radioactive Material in Particulate Form and Radionuclides Other Than Noble Gas
-Liquid Dose Calculations
-10 CFR Appendix I Limits (Particulates & Tritium)

Section #'s; C.4.2.1 & D.4.2.1 & C & D-2 respectively

Changed the frequency from 31 days to 92 days per Appendix E of the CY Quality Assurance Program.

Change # 21- Dated 1-2-2007

Description Of Change;
Added a note that only ISFSI TLD's will be collected as part of the REMP/ODCM, and provided clarification of the offsite "control" location TLD.

TLD's pertaining to the site of the former nuclear plant were removed/reassigned to the ISFSI due to the completion of facility decommissioning.

Change # 22- Dated 9-1-2007

Description Of Change;
ODCM change 22 was made to remove the sampling and monitoring requirements associated with the plant decommissioning. This change was made to provide a stand alone ODCM for the Connecticut Yankee ISFSI since the decommissioning was complete.

Change # 23- Dated 12-6-2007

Description Of Change;

-Removed the statements and references that the ODCM includes Radioactive Effluent Controls. These controls were removed in the previous revision to the ODCM.

-Replaced "the designated manager" with "the ISFSI manager of designee" in terms of approval to changes of the ODCM.

-Removed the statement from section F.2 that "a table totaling and comparing doses from liquid and airborne sources to the 40 CFR 190 limit will be provided in the Annual Radioactive Effluent Report and based on ERC-161-3-ER-99-012, direct dose will not be included in the dose assessment."

-Removed reference document ERC-16103-ER-99-012 from section G.

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 plant and ISFSI 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 designated manager prior to implementation.

All changes and their rationale shall be documented in the Annual Radioactive Effluent Report in accordance with the Connecticut Yankee Quality Assurance Program (CY QAP).

It shall be the responsibility of the designated 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 designated manager shall ensure that the REMODCM is maintained and controlled in accordance with the CY QAP.

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 ISFSI – INDEPENDENT SPENT FUEL STORAGE INSTALLATION

Dry storage facility for spent fuel.

B.7 MEMBER(S) OF THE PUBLIC

MEMBER(S) OF THE PUBLIC shall include all persons who are not receiving an occupational dose associated with the plant. 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.8 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.9 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.10 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 the CY QAP.

B.11 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.12 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.13 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: filters, ion exchangers and various tanks (as required). The liquid radioactive waste treatment system is depicted in Figure H-2 Liquid Radwaste System.

B.14 ALL APPLICABLE GASEOUS RADIOACTIVE WASTE TREATMENTS SYSTEMS

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[f] *From these sources:*	Prior to Each Batch Release	Prior to Each Batch Release	Principal Gamma Emitters[d]	5.00E-07
Temporary Tanks[g]		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 Groundwater Treatment System Discharge	Daily Grab Sample[e]	Weekly Composite[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):

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

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 (when applicable)

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

SAF self absorption factor (when applicable)

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, when discharges are in progress.

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

g. 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 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 (pre 1994 version).

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 (pre 1994 version). 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 92 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 settings to ensure that the limits of Control C.3.1 are not exceeded. The settings 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 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 settings 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 and CHANNEL CALIBRATION, at the frequencies shown in Table C.4.3.

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. The setpoints for this instrument shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure compliance with 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. FLOW RATE MEASUREMENT		
a. Temporary Tank Discharge Line	1	46

TABLE C.3.3
(Continued)

ACTION STATEMENTS

ACTION 46 - 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.

TABLE C.4.3

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. FLOW RATE MEASUREMENT				
a. Temporary Test Tank Discharge Line	D(1)	N.A.	R	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.

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 Waste Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[a] (µCi/cc)
A. Miscellaneous Points[d] For example: • Alternate Containment Access • Tented Enclosures	Continuous[b]	Weekly Particulate[d]	Principal Gamma Emitters[c]	1.00E-11
		Monthly Particulate Composite	Gross Alpha	1.00E-11
		Quarterly Particulate Composite	Sr-90[e]	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 actual or estimated 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. 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.

e. 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 0.3 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 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 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).

* Tritium is only required until the bulk SFP liquid is drained.

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 (pre 1994 version). 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 (pre 1994 version) 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, RADIOACTIVE MATERIAL IN PARTICULATE FORM AND RADIONUCLIDES OTHER THAN NOBLE GASES

CONTROLS

D.3.2 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.4.2.1 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 92 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 the REMODCM.

RADIOACTIVE EFFLUENTS

BASES

D.3/4.2 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.

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 from plant or ISFSI activities. 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 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.

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	20	Quarterly	Gamma Dose - Quarterly
2. Bottom Sediment (1)	4	Annual	Gamma Isotopic
3. River Water (1)	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.
4. Fish (edible portion) - bullheads and, when available, Perch or other edible fish (1)	2	Annual	Gamma Isotopic - Annual
5. Shellfish (1)	2	Annual	Gamma Isotopic - Annual

(1) Not required after bulk SFP liquid has been released, except for ISFSI related samples.

One final set of canal related discharge samples will be obtained after bulk SFP liquid has been released.

TABLE E-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

Analysis	Water (pCi/l)	Fish (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+03	5.00E+03
Cs-137	5.00E+01	2.00E+03	8.00E+03

TABLE E-3

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

Analysis	Water (pCi/l)	Fish (pCi/kg, wet)	Sediment (pCi/kg, dry)
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	1.30E+02	1.50E+02
Cs-137	1.80E+01	1.50E+02	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):

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

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.

Due to the current status of the Decommissioning Project the Land Use Census is not expected to change in a manner that would affect the Environmental Monitoring Program. The most recent census shall be in effect until superseded. During the course of the Decommissioning Project an updated Land Use Census can be obtained at any time as directed by the Site Management. The following information is relative to the performance of the census:

- The Land Use Census 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 can be verified 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.

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 and ISFSI 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. A table totaling and comparing doses from liquid and airborne sources to the 40 CFR 190 limit will be provided in the Annual Radioactive Effluent Report and based on ERC-161-3-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. Dose 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 or D.3.2, 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 and D.4.2.1 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

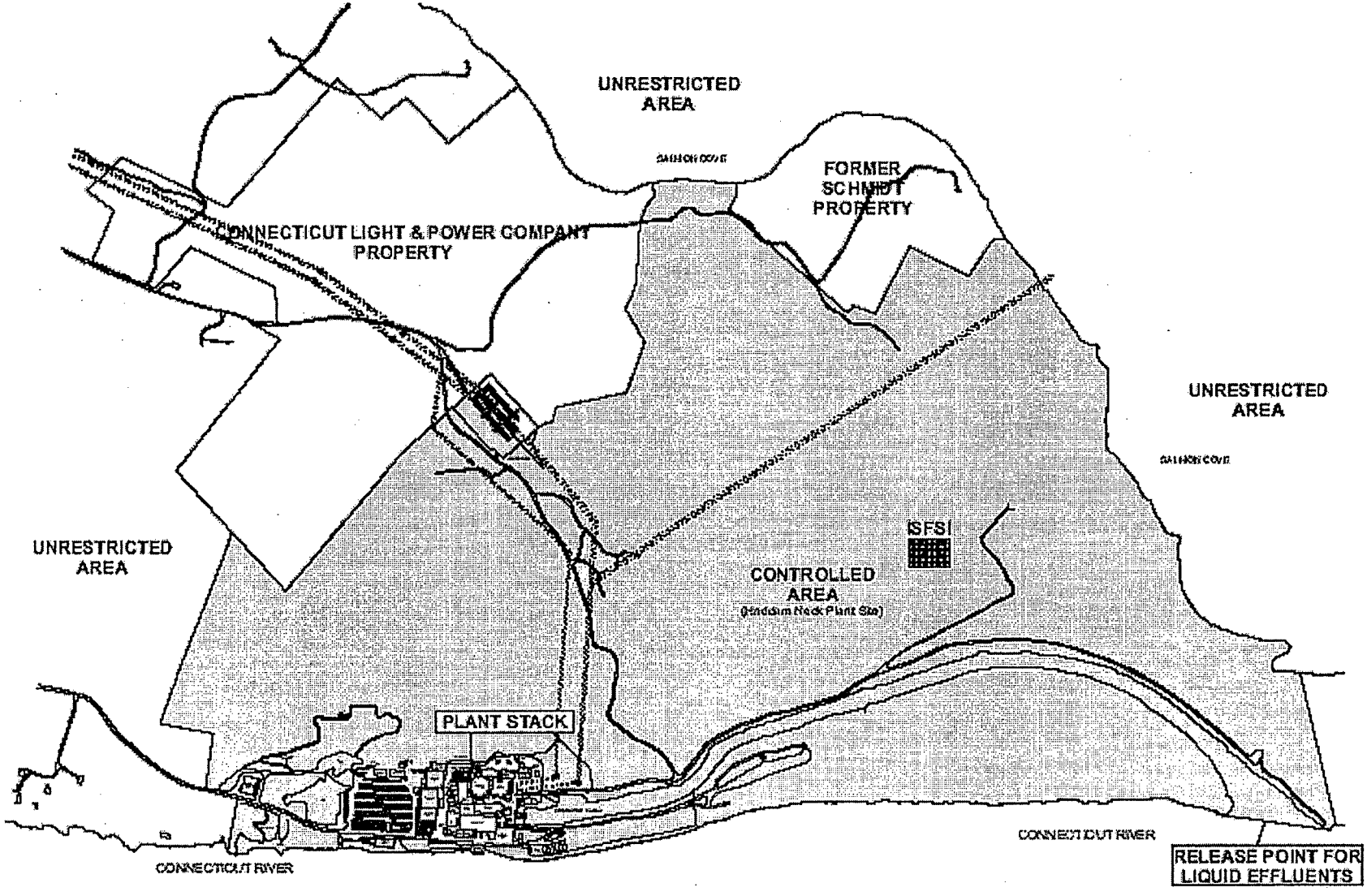
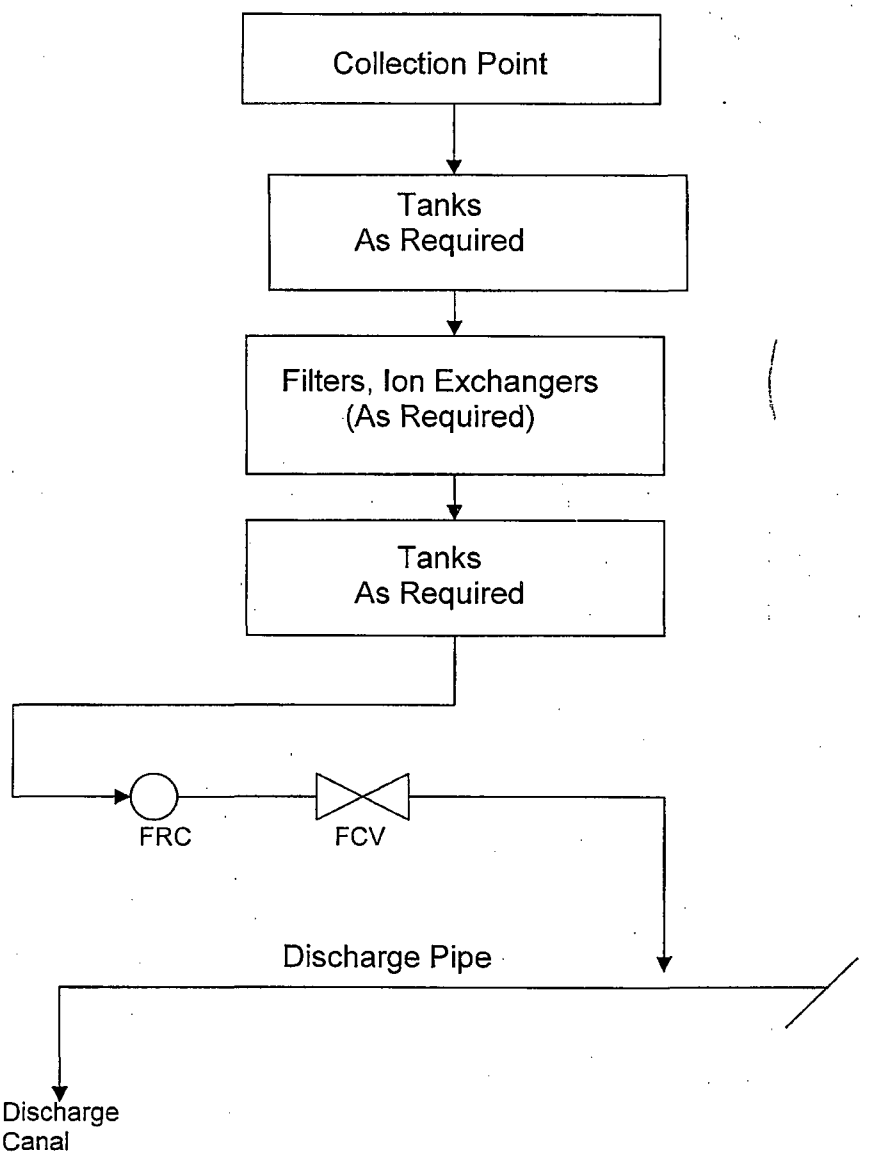


Figure H-2 Liquid Radwaste System



FRC – Flow Controller
FCV – Flow Control Valve

JUN 6 2006

SECTION II

OFFSITE DOSE CALCULATION MANUAL

For The

HADDAM NECK PLANT

Docket No. 50-213

ODCM

Revision 20

HADDAM NECK PLANT

OFFSITE DOSE CALCULATION MANUAL

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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 92 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 92 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	3.16E+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].

(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:

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

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

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	Primary Vent Stack 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	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 Ml, 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
48-1F	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.

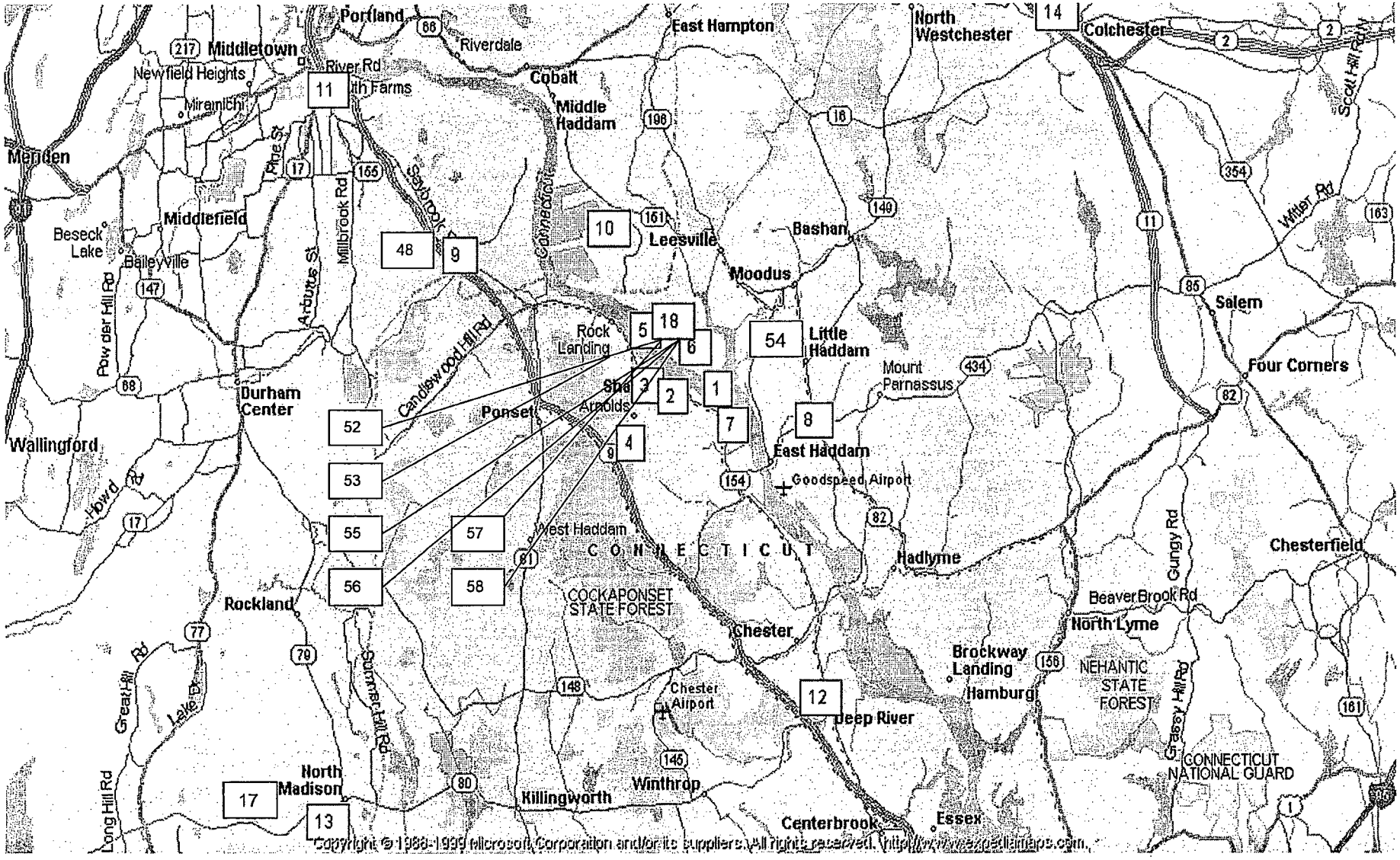


Figure G- 1: Haddam Neck Plant Inner Terrestrial Monitoring Stations

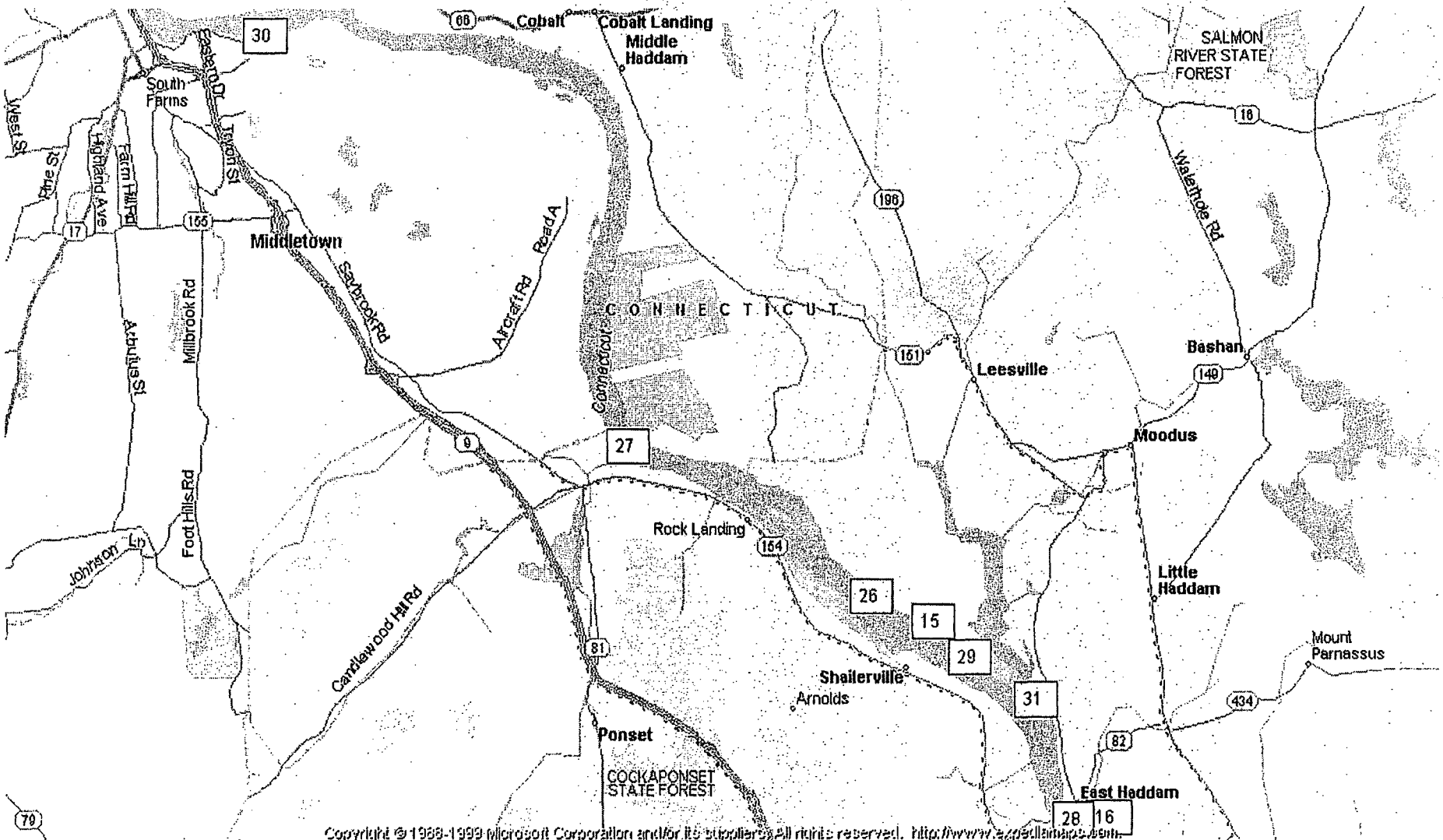


Figure G- 2: Haddam Neck Plant Aquatic and Well Water Sample Stations

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 plant and ISFSI 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 designated manager prior to implementation.

All changes and their rationale shall be documented in the Annual Radioactive Effluent Report in accordance with the Connecticut Yankee Quality Assurance Program (CY QAP).

It shall be the responsibility of the designated 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 designated manager shall ensure that the REMODCM is maintained and controlled in accordance with the CY QAP.

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 ISFSI – INDEPENDENT SPENT FUEL STORAGE INSTALLATION

Dry storage facility for spent fuel.

B.7 MEMBER(S) OF THE PUBLIC

MEMBER(S) OF THE PUBLIC shall include all persons who are not receiving an occupational dose associated with the plant. 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.8 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.9 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.10 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 the CY QAP.

B.11 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.12 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.13 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: filters, ion exchangers and various tanks (as required). The liquid radioactive waste treatment system is depicted in Figure H-2 Liquid Radwaste System.

B.14 ALL APPLICABLE GASEOUS RADIOACTIVE WASTE TREATMENTS SYSTEMS

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[f] *From these sources:*	Prior to Each Batch Release	Prior to Each Batch Release	Principal Gamma Emitters[d]	5.00E-07
Temporary Tanks[g]		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 Groundwater Treatment System Discharge	Daily Grab Sample[e]	Weekly Composite[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):

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

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 (when applicable)

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

SAF self absorption factor (when applicable)

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, when discharges are in progress.

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

g. 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 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 (pre 1994 version).

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 (pre 1994 version). 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 92 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 settings to ensure that the limits of Control C.3.1 are not exceeded. The settings 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 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 settings 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 and CHANNEL CALIBRATION, at the frequencies shown in Table C.4.3.

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. The setpoints for this instrument shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure compliance with 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. FLOW RATE MEASUREMENT		
a. Temporary Tank Discharge Line	1	46

TABLE C.3.3
(Continued)

ACTION STATEMENTS

ACTION 46 - 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.

TABLE C.4.3

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. FLOW RATE MEASUREMENT				
a. Temporary Test Tank Discharge Line	D(1)	N.A.	R	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.

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 Waste Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[a] (µCi/cc)
A. Miscellaneous Points[d] For example: • Alternate Containment Access • Tented Enclosures	Continuous[b]	Weekly Particulate[d]	Principal Gamma Emitters[c]	1.00E-11
		Monthly Particulate Composite	Gross Alpha	1.00E-11
		Quarterly Particulate Composite	Sr-90[e]	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 actual or estimated 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. 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.

e. 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 0.3 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 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 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).

* Tritium is only required until the bulk SFP liquid is drained.

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 (pre 1994 version). 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 (pre 1994 version) 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, RADIOACTIVE MATERIAL IN PARTICULATE FORM AND RADIONUCLIDES OTHER THAN NOBLE GASES

CONTROLS

D.3.2 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.4.2.1 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 92 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 the REMODCM.

RADIOACTIVE EFFLUENTS

BASES

D.3/4.2 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.

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 from plant or ISFSI activities. 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 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.

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 (2)	20 (2)	Quarterly	Gamma Dose - Quarterly
2. Bottom Sediment (1)	4	Annual	Gamma Isotopic
3. River Water (1)	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.
4. Fish (edible portion) - bullheads and, when available, Perch or other edible fish (1)	3	Annual	Gamma Isotopic - Annual
5. Shellfish (1)	2	Annual	Gamma Isotopic - Annual

(1) Not required after bulk SFP liquid has been released, except for ISFSI related samples.

One final set of canal related discharge samples will be obtained after bulk SFP liquid has been released.

(2) After 12/31/06 only ISFSI related TLDs will be placed and collected.

TABLE E-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

Analysis	Water (pCi/l)	Fish (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+03	5.00E+03
Cs-137	5.00E+01	2.00E+03	8.00E+03

TABLE E-3

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

Analysis	Water (pCi/l)	Fish (pCi/kg, wet)	Sediment (pCi/kg, dry)
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	1.30E+02	1.50E+02
Cs-137	1.80E+01	1.50E+02	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):

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

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.

Due to the current status of the Decommissioning Project the Land Use Census is not expected to change in a manner that would affect the Environmental Monitoring Program. The most recent census shall be in effect until superseded. During the course of the Decommissioning Project an updated Land Use Census can be obtained at any time as directed by the Site Management. The following information is relative to the performance of the census:

- The Land Use Census 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 can be verified 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.

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 and ISFSI 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. A table totaling and comparing doses from liquid and airborne sources to the 40 CFR 190 limit will be provided in the Annual Radioactive Effluent Report and based on ERC-161-3-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. Dose 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 or D.3.2, 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 and D.4.2.1 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

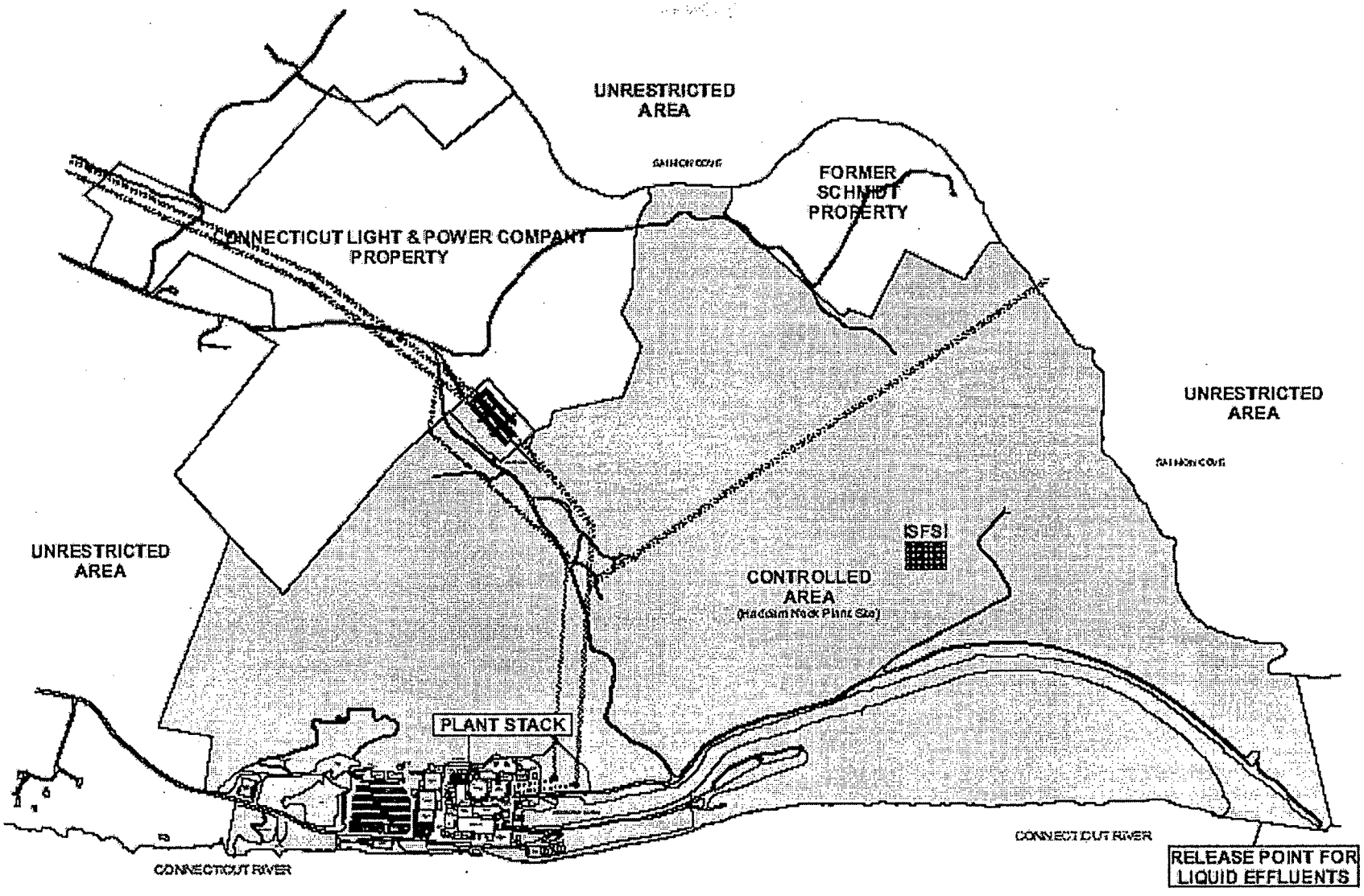
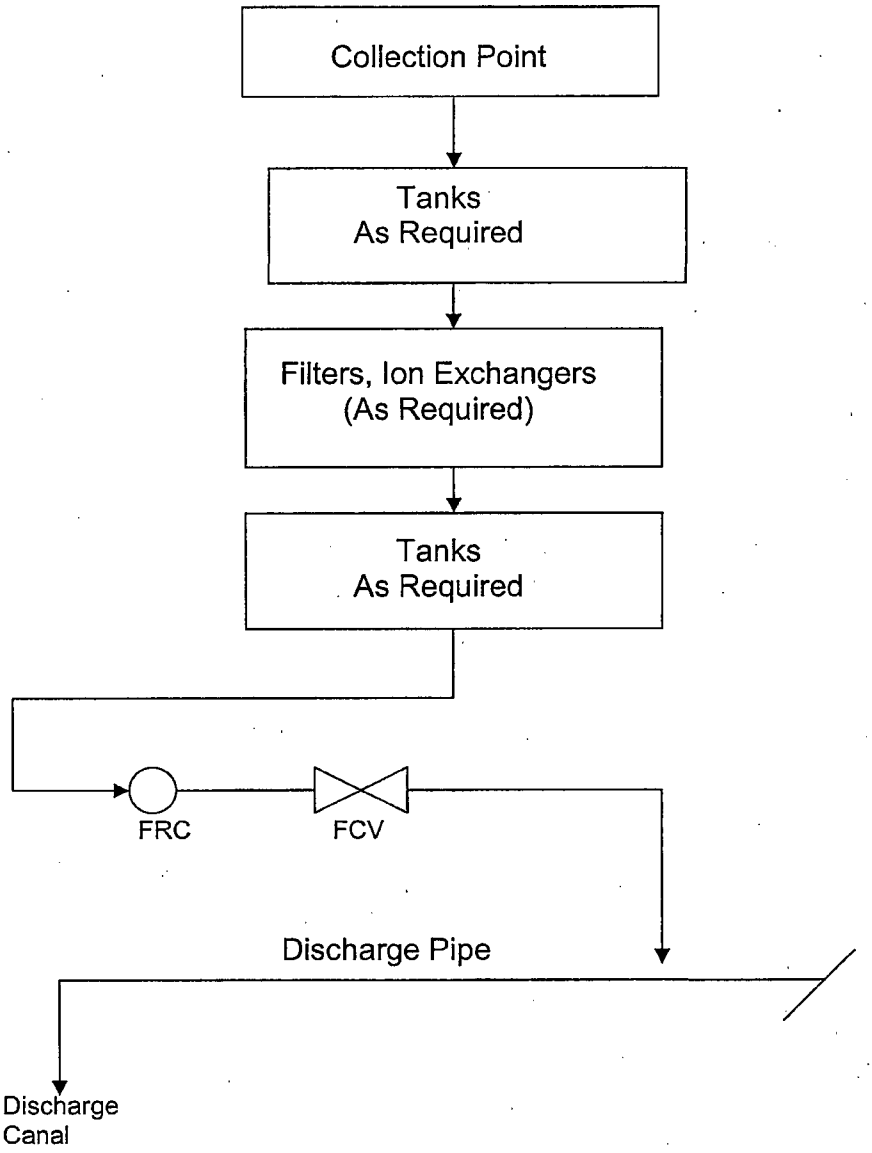


Figure H-2 Liquid Radwaste System



FRC – Flow Controller
FCV – Flow Control Valve

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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

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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 92 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 92 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	7.69E-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	5.05E+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].

(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:

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

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

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	Primary Vent Stack 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	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-IFC [3]	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
48-1F	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[2]	Dibble Creek Sediment Sample	0.1 Mi, SE	Bottom Sediment
58-IF[2]	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.
[2]These samples are not a part of the REMP Program.
[3]This TLD location changes from an Indicator Location to an ISFSI Related Control Location after 12/31/06.

I= Indicator C = Control IF= ISFSI Related Indicator IFC = ISFSI Related Control
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.

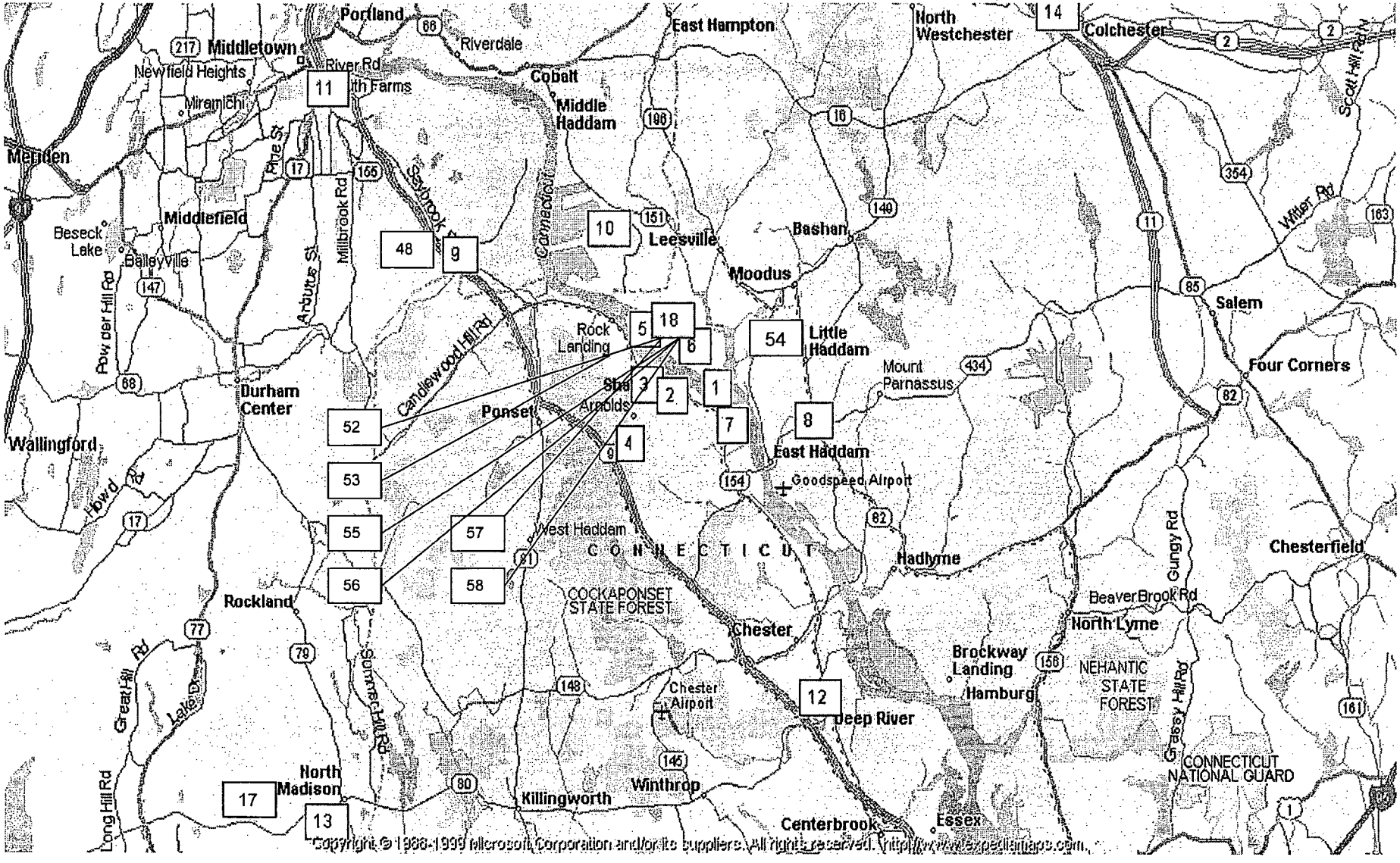

Figure G- 1: Haddam Neck Plant Inner Terrestrial Monitoring Stations

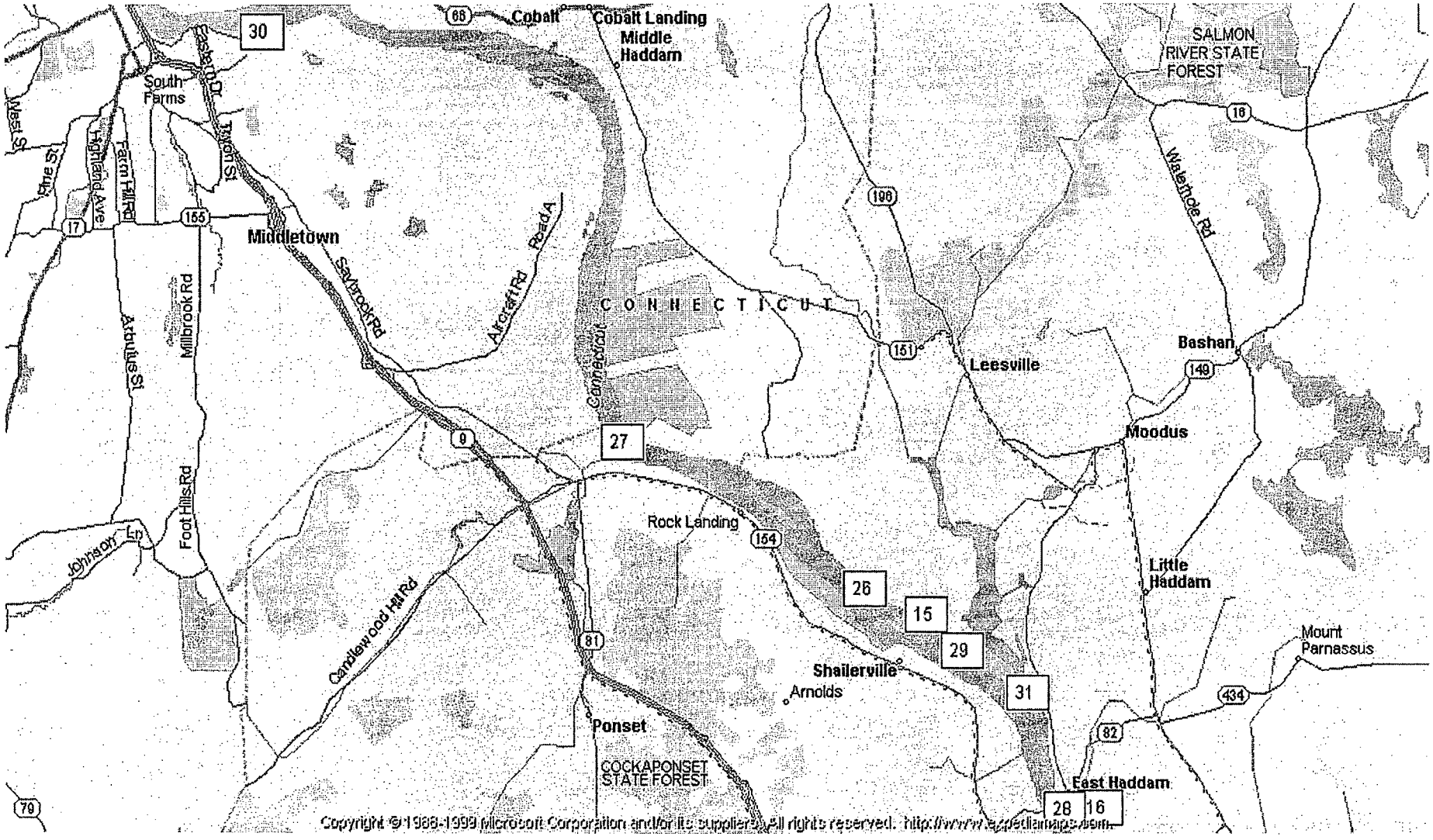

Figure G- 2: Haddam Neck Plant Aquatic and Well Water Sample Stations

HADDAM NECK PLANT

ISFSI OFFSITE DOSE CALCULATION MANUAL

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LIST OF FIGURES

A. INTRODUCTION

The purpose of this document is to provide a method for demonstrating compliance with the dose limits for MEMBERS OF THE PUBLIC and contains the guidance for submittal of the annual reports required by 10 CFR Part 50. In addition, the document provides the locations and type of monitoring required for the Radiological Environmental Monitoring Program (REMP).

In accordance with the requirements of 40CFR Part 190, the dose to a MEMBER OF THE PUBLIC for radioactive material in effluents and direct radiation from an Independent Spent Fuel Storage Installation (ISFSI) is limited to 25 mrem/yr to the whole body, 75 mrem/yr to the thyroid and 25 mrem/yr to any other critical organ as a result of exposure to planned discharges of radioactive materials to the environment, direct radiation from the ISFSI and any other radiation from uranium fuel cycle operations within the region.

Under normal operations, experience has shown that the ISFSI will be operated at a small fraction of the above dose limits. This is primarily due to the design of the Independent Spent Fuel Storage Installation, which prevents the release of radioactive materials in liquid and particulate form and there are no other uranium fuel cycle operations within 5 miles of the Haddam Neck Plant (HNP) site. Therefore, the dose equations from regulatory guide 1.109, Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I are not necessary for inclusion in the ODCM. The remaining dose component to be considered is from direct radiation. 40 CFR 190 establishes this dose limit as 25 mrem/yr for MEMBERS OF THE PUBLIC. Figure 1 shows the site boundary lines for the site and the location of the ISFSI.

B. DEFINITIONS

B.1 Member(s) of the Public

MEMBER(S) OF THE PUBLIC (for the purposes of 10CFR50, Appendix I) shall include all persons who are not occupationally associated with the site. This category does not include employees of the utility, 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 site operations or decommissioning of the plant.

B.2 Offsite Dose Calculation Manual (ODCM)

The ODCM contains the methodology and parameters used in the calculation of off-site doses in the conduct of the Radiological Environmental Monitoring Program. The ODCM also contains (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs required by the Connecticut Yankee Quality Assurance Program (CY QAP) and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operation and Annual Radioactive Effluent Release Reports.

B.3 Site Boundary

The SITE BOUNDARY shall be that line beyond which the land is not owned, leased, or otherwise controlled by the licensee. Realistic occupancy factors shall be applied at these locations for the purposes of dose calculations.

C. 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 ISFSI Manager / or Designee to ensure compliance with all the requirements of this manual.

D. RADIOLOGICAL ENVIRONMENTAL MONITORING

The Radiological Environmental Monitoring Program (REMP) for the ISFSI monitors for direct radiation exposure only.

The type and number of radiological environmental monitoring stations including collection and analysis frequencies are shown in Appendix A.

D.1 Dose/Dose Rate Controls and Calculations

By design, there are no liquid or gaseous effluents associated with the operation of the ISFSI. With the completion of site remediation activities that required periodic dewatering of construction excavations, along with the removal of all systems or operations that generated, contained or processed waste gas or airborne particulates, there are no longer any gaseous or liquid effluent releases from site operations. Therefore, requirements for control, sampling, analyzing, monitoring or dose impact assessment for radioactive liquids or gases are not needed.

D.1.1 Total Dose

Control D.1.1

In accordance with Connecticut Yankee Quality Assurance Program (CYQAP), the dose or dose commitment to any real MEMBER OF THE PUBLIC from all site sources 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 calendar year.

Applicability

At all times.

ACTION

With the calculated or projected dose from direct radiation contributions from the Independent Spent Fuel Storage Installation (ISFSI) determined to be, or projected to be, above the annual (calendar) limits of Control D.1.1, prepare and submit to the commission within 30 days, pursuant to 10CFR50.4, a Special Report that defines the corrective action to be taken to reduce subsequent

exceedences to prevent recurrence of exceeding the above limits and include the schedule for achieving conformance with the above limits. The Special Report shall include an analysis that estimates the radiation exposure (dose) to a member of the public from site sources for the calendar year covered by the report. It also shall describe levels of radiation and concentrations of radioactive material, if any, involved and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits, and if the exposure condition resulting in violation of 40CFR Part 190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40CFR190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

D.2 SURVEILLANCE REQUIREMENTS

SR D.2.1

Dose calculations - Cumulative dose contributions from direct radiation shall be determined semi-annually in accordance with Section D.1.1 of the ODCM.

Bases

Control D.1.1 is provided to meet the dose limitations of 40CFR Part 190 that have been incorporated into 10CFR Part 20 by 46FR18525. The control requires the preparation and submittal of a Special Report whenever the calculated or projected doses from the site exceed the dose limits of 40CFR Part 190. The Special Report will describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40CFR Part 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to a MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40CFRPart 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190 and does not apply in any way to the other requirements for dose limitation of 10CFR Part 20.

D.3 Method to Calculate Direct Dose from ISFSI Operations

Control D.1.1 restricts the dose to the whole body and any organ of any real MEMBERS OF THE PUBLIC at and beyond the Site Boundary from all site sources (including direct radiation) to the limit of 25 mrem in a year, except for the thyroid which is limited to 75 mrem in a year.

Estimates of direct exposure above background in areas at and beyond the site boundary can be determined from measurements made by environmental TLDs that are part of the Environmental Monitoring Program. A net response is determined by subtracting the average TLD value of the control stations from the semi-annual off-site TLD measurements. A positive net exposure is assumed if the net value is greater than the propagated uncertainty of the TLD indicator and control measurements. Alternatively, direct dose calculations from identified fixed sources on-site can be used to estimate the off-site direct dose contribution where TLD information may not be applicable.

E. 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.

Due to the current status of the Haddam Neck Plant Site, the Land Use Census is not expected to change in a manner that would affect the Environmental Monitoring Program. The most recent census shall be in effect until superseded. During the course of the ISFSI Operation, an updated Land Use Census can be obtained at any time as directed by the Site Management.

F. REPORTS

F.1 Annual Radiological Environmental Operating Report

The Annual Radiological 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 ISFSI on the environment. The report shall also include the results of the land use census required by Section E of this manual if necessary. 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. Mean and range of all indicator locations together;

d. Mean and average of all control locations together;

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

f. 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 ISFSI.

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. A table totaling and comparing doses from liquid and airborne sources to the 40 CFR 190 limit will be provided in the Annual Radioactive Effluent Report and based on ERC-161-3-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. Dose 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, as required per Section D.1.1, 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. REFERENCES

G.1 Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR Part 50, Appendix I," U.S. Nuclear Regulatory Commission, Revision 1, October 1977.

G.2 ERC-16103-ER-99-012, Basis for 40CFR190 Doses Used to Implement CY REMM/ODCM.

G.3 Connecticut Yankee Atomic Power Company Quality Assurance Program for the Haddam Neck Plant.

APPENDIX A

ENVIRONMENTAL MONITORING PROGRAM[1]

Environmental Monitoring Locations

The following lists the frequency and locations of environmental TLD sampling.

Exposure Pathway and/or Sample	Number of Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
1. Gamma Dose – Environmental TLD	9	Quarterly	Gamma Dose - Quarterly

Location Number	Name	Direction & Distance From Release Point*	Sample Types
CY-1-IF	On-site-Mouth of Discharge Canal	1.1 Mi, ESE (0.5 Mi, SSE IF)	TLD
CY-6-IF	On-site-Substation (w/in 10 miles)	0.5 Mi, NE (0.6 Mi, NW IF)	TLD
CY-48-IF	Onsite Met Tower Shack	0.4 Mi, WSW	TLD
CY-52-IF	Schmidt Cemetery(off-site)	0.5 Mi, NNE	TLD
CY-53-IF	ISFSI Haul Route (onsite)	0.2 Mi, SSW	TLD
CY-54-IF	Route 149 (near Salmon River mouth)	1.0 Mi, ESE	TLD
CY-55-IF	High Voltage Tower (onsite, NW of Pad)	0.4 Mi, NW	TLD
CY-56-IF	Burrow Pit (onsite)	0.2 Mi, E	TLD
CY-10-IFC	Hurd Park Rd.	2.8 Mi, NNW	TLD, 2 TLDs each Quarter

IFC = ISFSI Control IF= ISFSI Indicator
* The ISFSI pad is the release point for the ISFSI indicators.
[1]This table does not require updating based on the elimination of sampling as described in the REMP.

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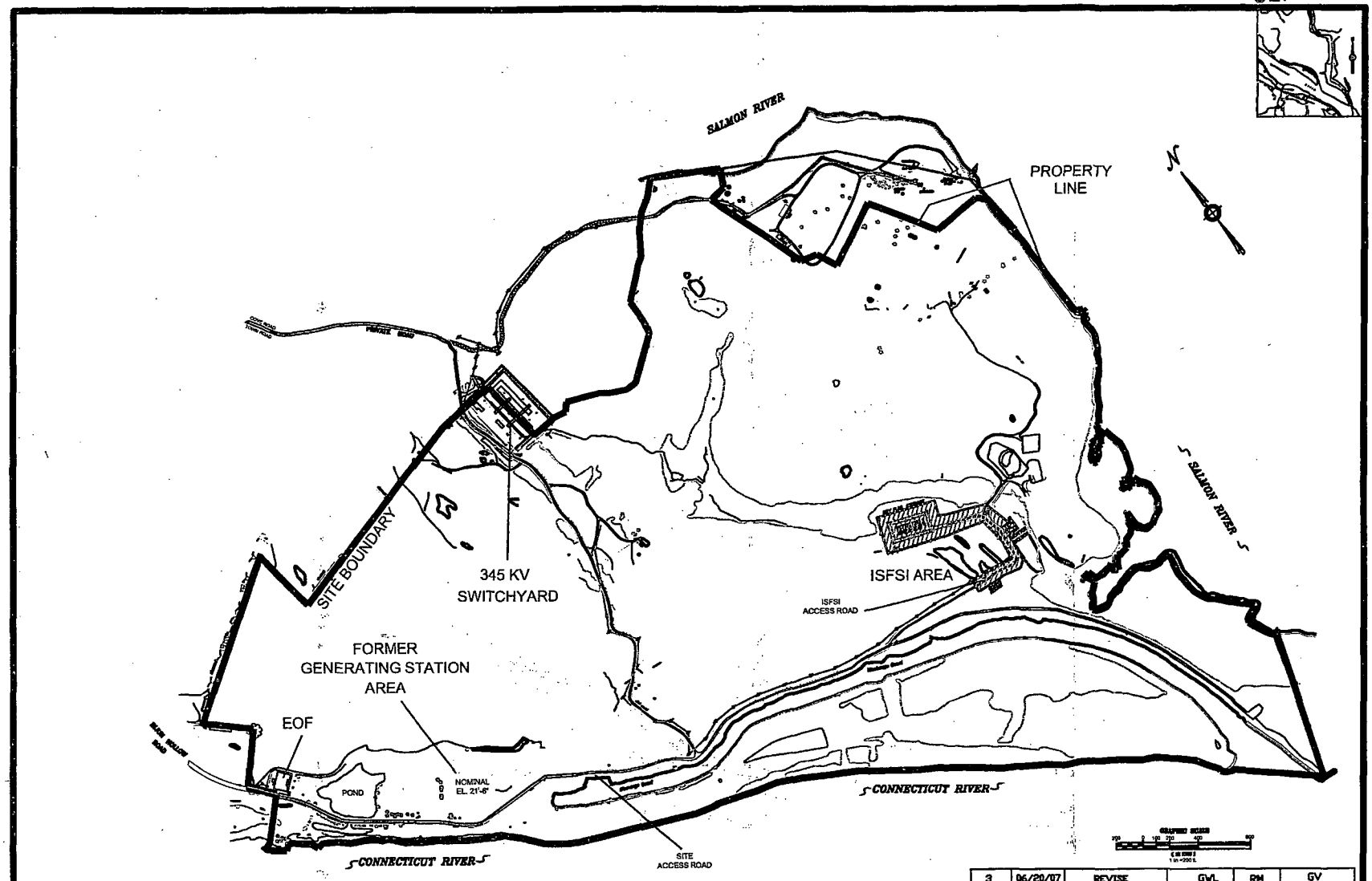


REV	DATE	DESCRIPTION	DRAWN	CKD	PFE
3	06/20/07	REVISE	GWL	RM	GV
2	05/10/07	REVISE	GWL	RM	GV
1	11/30/06	ISSUE	GWL	JF	GV

CONNECTICUT YANKEE DECOMMISSIONING PROJECT

HADDAM NECK PLANT
SITE BOUNDARY

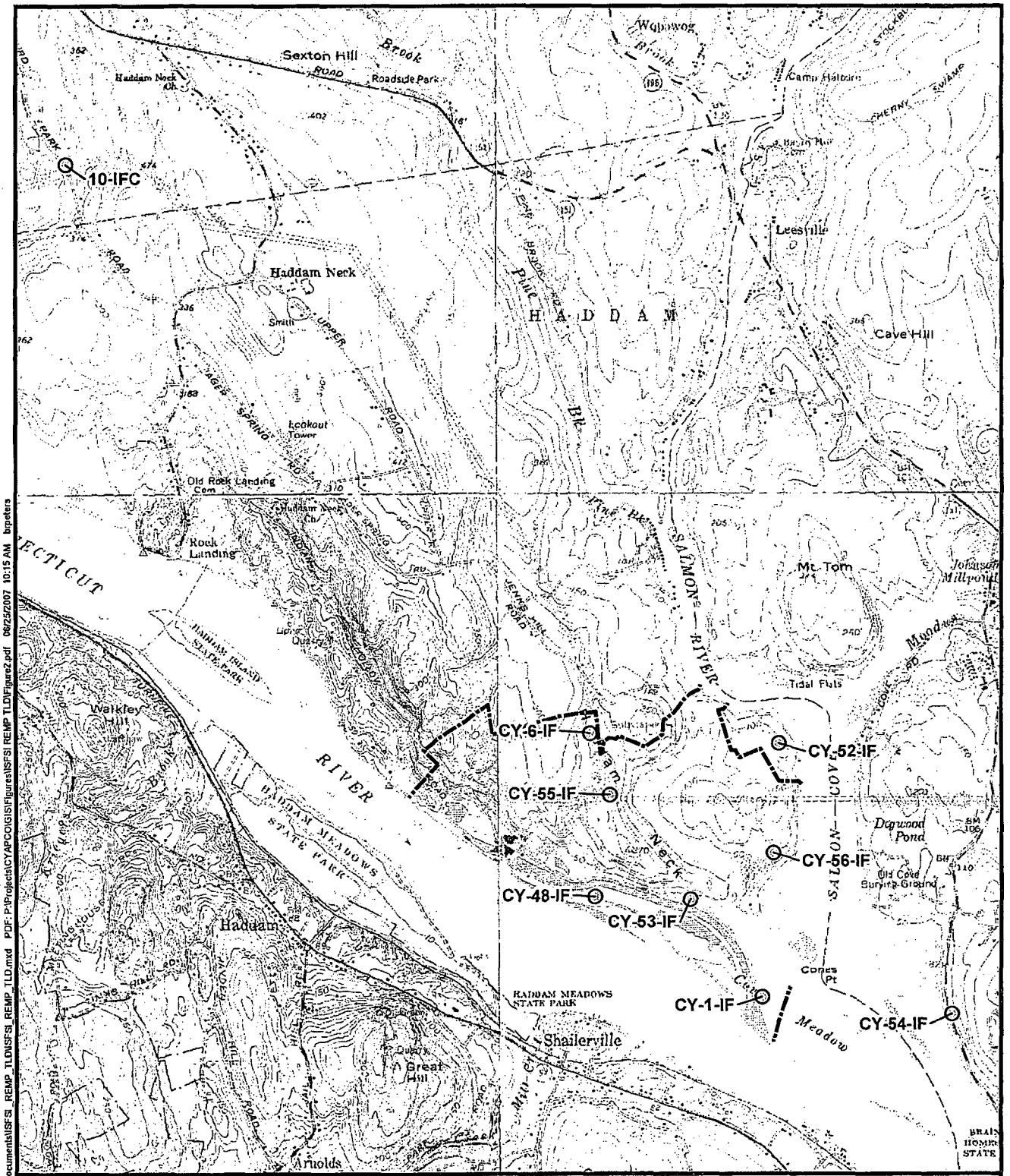
JOB NO. SCALE

FIGURE 1 SHEET 1 OF 1

NOTES:
1. SITE BOUNDARY LINES ARE THE SAME AS THE PROPERTY LINES.
2. ISFSI SITE AREA IS APPROX. 4.6 ACRES.

AREA TO BE RETAINED IN NRC LICENSE

SEP 1 2007



Legend

- ISFSI REMP TLD Locations
- Approximate Property Outline

N

0 1,250 2,500 Feet

Prepared by BRP | Checked by NSG

Figure 2
ISFSI REMP TLD Locations

CYAPCO, Haddam Neck Plant
Haddam, Connecticut
MACTEC, Inc.

OFF-SITE DOSE CALCULATION MANUAL (ODCM)

For The

HADDAM NECK ISFSI

Docket No. 50-213

HADDAM NECK ISFSI

OFFSITE DOSE CALCULATION MANUAL (ODCM)

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Under normal operations, experience has shown that the ISFSI will be operated at a small fraction of the above dose limits. This is primarily due to the design of the Independent Spent Fuel Storage Installation, which prevents the release of radioactive materials in liquid and particulate form and there are no other uranium fuel cycle operations within 5 miles of the Haddam Neck Plant (HNP) site. Therefore, the dose equations from regulatory guide 1.109, Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I are not necessary for inclusion in the ODCM. The remaining dose component to be considered is from direct radiation. 40 CFR 190 establishes this dose limit as 25 mrem/yr for MEMBERS OF THE PUBLIC. Figure 1 shows the site boundary lines for the site and the location of the ISFSI.

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The SITE BOUNDARY shall be that line beyond which the land is not owned, leased, or otherwise controlled by the licensee. Realistic occupancy factors shall be applied at these locations for the purposes of dose calculations.

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

It is the responsibility of the ISFSI Manager or Designee to ensure compliance with all the requirements of this manual.

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The Radiological Environmental Monitoring Program (REMP) for the ISFSI monitors for direct radiation exposure only.

The type and number of radiological environmental monitoring stations including collection and analysis frequencies are shown in Appendix A.

D.1 Dose/Dose Rate Controls and Calculations

By design, there are no liquid or gaseous effluents associated with the operation of the ISFSI. With the completion of site remediation activities that required periodic dewatering of construction excavations, along with the removal of all systems or operations that generated, contained or processed waste gas or airborne particulates, there are no longer any gaseous or liquid effluent releases from site operations. Therefore, requirements for control, sampling, analyzing, monitoring or dose impact assessment for radioactive liquids or gases are not needed.

D.1.1 Total Dose

Control D.1.1

The dose or dose commitment to any real MEMBER OF THE PUBLIC from all site sources 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 calendar year.

Applicability

At all times.

ACTION

With the calculated or projected dose from direct radiation contributions from the Independent Spent Fuel Storage Installation (ISFSI) determined to be, or projected to be, above the annual (calendar) limits of Control D.1.1, prepare and submit to the commission within 30 days, pursuant to 10CFR50.4, a Special Report that defines the corrective action to be taken to reduce subsequent

exceedences to prevent recurrence of exceeding the above limits and include the schedule for achieving conformance with the above limits. The Special Report shall include an analysis that estimates the radiation exposure (dose) to a member of the public from site sources for the calendar year covered by the report. It also shall describe levels of radiation and concentrations of radioactive material, if any, involved and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits, and if the exposure condition resulting in violation of 40CFR Part 190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40CFR190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

D.2 SURVEILLANCE REQUIREMENTS

SR D.2.1

Dose calculations - Cumulative dose contributions from direct radiation shall be determined semi-annually in accordance with Section D.1.1.

Bases

Control D.1.1 is provided to meet the dose limitations of 40CFR Part 190 that have been incorporated into 10CFR Part 20 by 46FR18525. The control requires the preparation and submittal of a Special Report whenever the calculated or projected doses from the site exceed the dose limits of 40CFR Part 190. The Special Report will describe a course of action that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40CFR Part 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to a MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40CFRPart 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190 and does not apply in any way to the other requirements for dose limitation of 10CFR Part 20.

D.3 Method to Calculate Direct Dose from ISFSI Operations

Control D.1.1 restricts the dose to the whole body and any organ of any real MEMBERS OF THE PUBLIC at and beyond the Site Boundary from all site sources (including direct radiation) to the limit of 25 mrem in a year, except for the thyroid which is limited to 75 mrem in a year.

Estimates of direct exposure above background in areas at and beyond the site boundary can be determined from measurements made by environmental TLDs

that are part of the Environmental Monitoring Program. A net response is determined by subtracting the average TLD value of the control stations from the quarterly off-site TLD measurements. A positive net exposure is assumed if the net value is greater than the propagated uncertainty of the TLD indicator and control measurements. Alternatively, direct dose calculations from identified fixed sources on-site can be used to estimate the off-site direct dose contribution where TLD information may not be applicable.

E. 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.

Due to the current status of the Haddam Neck Site, the Land Use Census is not expected to change in a manner that would affect the Environmental Monitoring Program. The most recent census shall be in effect until superseded. During the course of the ISFSI Operation, an updated Land Use Census can be obtained at any time as directed by the ISFSI Management.

F. REPORTS

F.1 Annual Radiological Environmental Operating Report

The Annual Radiological 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 ISFSI on the environment. The report shall also include the results of the land use census required by Section E of this manual if necessary. 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. Mean and range of all indicator locations together;

d. Mean and average of all control locations together;

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

f. 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 ISFSI.

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 ODCM. 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. 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. 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 material 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 OFFSITE DOSE CALCULATION MANUAL (ODCM) 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, as required per Section D.1.1, 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. REFERENCES

G.1 Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR Part 50, Appendix I," U.S. Nuclear Regulatory Commission, Revision 1, October 1977

G.2 Connecticut Yankee Atomic Power Company Quality Assurance Program

APPENDIX A

ENVIRONMENTAL MONITORING PROGRAM[1]

Environmental Monitoring Locations

The following lists the frequency and locations of environmental TLD sampling.

Exposure Pathway and/or Sample	Number of Locations	Frequency	Type and Frequency of Analysis
1. Gamma Dose – Environmental TLD	9	Quarterly	Gamma Dose - Quarterly

Number	Location Name	Direction & Distance From Source*	Sample Types
1-IF	At Mouth of Historical Discharge Canal	1.1 Mi, ESE (0.5 Mi, SSE IF)	TLD
6-IF	Substation	0.5 Mi, NE (0.6 Mi, NW IF)	TLD
48-IF	Near Historical Met Tower Shack	0.4 Mi, WSW	TLD
52-IF	Schmidt Cemetery	0.5 Mi, NNE	TLD
53-IF	ISFSI Haul Route	0.2 Mi, SSW	TLD
54-IF	Route 149 Near Mouth of Salmon River	1.0 Mi, ESE	TLD
55-IF	High Voltage Tower - NW of ISFSI Pad	0.4 Mi, NW	TLD
56-IF	Near Historical Burrow Pit	0.2 Mi, E	TLD
10-IFC	Hurd Park Road	2.8 Mi, NNW	TLD, 2 TLDs each Quarter
IFC = ISFSI Control IF= ISFSI Indicator			
* The ISFSI Pad is the Source.			

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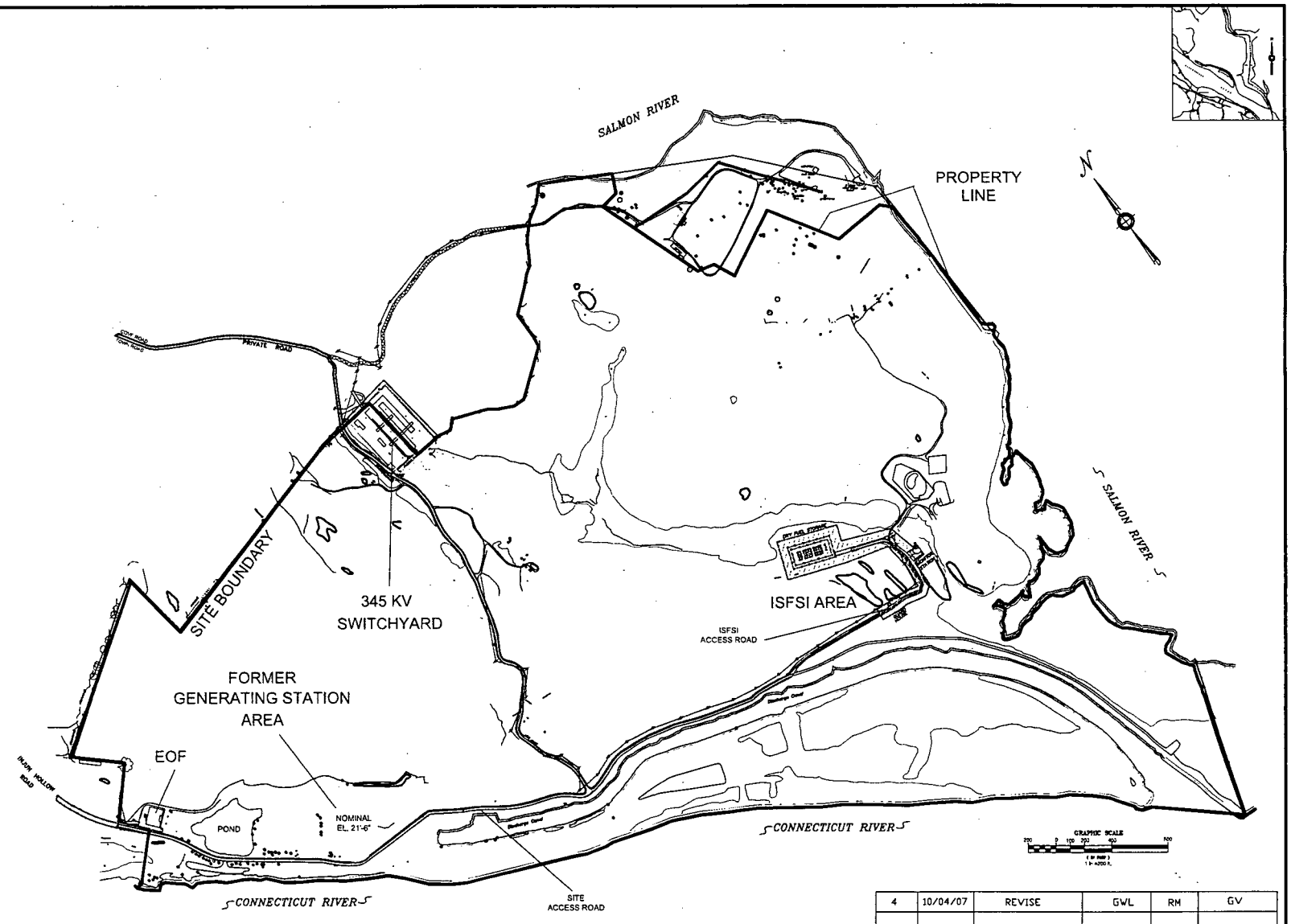


REV	DATE	DESCRIPTION	DRAWN	CKD	PFE
4	10/04/07	REVISE	GWL	RM	GV
2	05/10/07	REVISE	GWL	RM	GV
1	11/30/06	ISSUE	GWL	JF	GV

CONNECTICUT YANKEE DECOMMISSIONING PROJECT

HADDAM NECK PLANT
SITE BOUNDARY

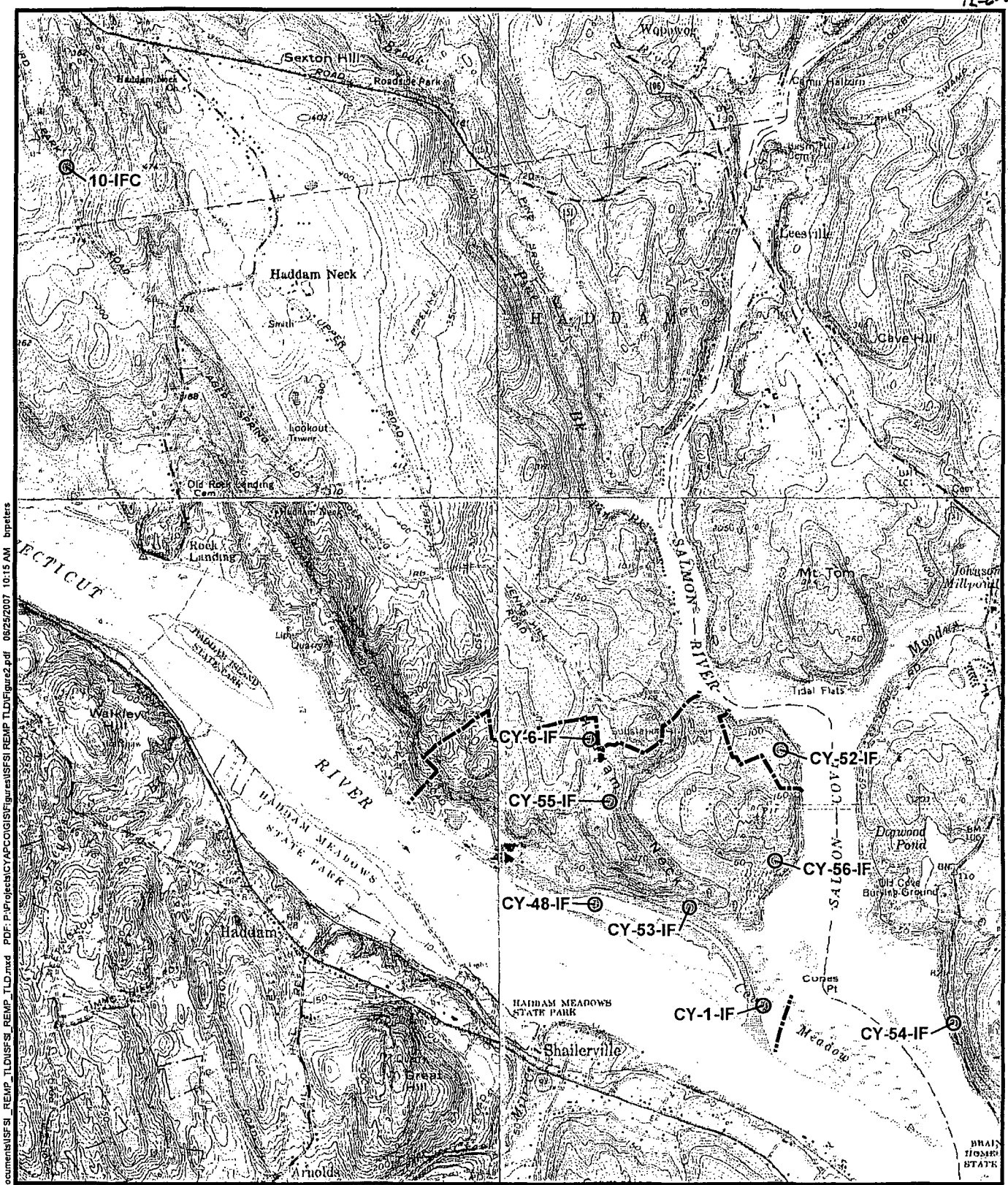
JOB NO. SCALE

FIGURE 1 SHEET 1 OF 1

NOTES:
1. SITE BOUNDARY LINES ARE THE SAME AS THE PROPERTY LINES.
2. ISFSI SITE AREA IS APPROX. 4.6 ACRES.

AREA TO BE RETAINED IN NRC LICENSE

DEC 6 2007
~~SEP 1 2007~~ RJ
12-6-07



Legend

- ISFSI REMP TLD Locations
- Approximate Property Outline

N

0 1,250 2,500 Feet

Prepared by BRP | Checked by NSG

Figure 2
ISFSI REMP TLD Locations

CYAPCO, Haddam Neck Plant
Haddam, Connecticut
MACTEC, Inc.

Document: P:\Projects\CYAPCO\GIS\MapDocuments\ISFSI_REMP_TLD\ISFSI_REMP_TLD.mxd PDF: P:\Projects\CYAPCO\GIS\Figures\ISFSI REMP TLD\Figure2.pdf 08/25/2007 10:15 AM bpeters