

**CY HEALTH PHYSICS  
TECHNICAL SUPPORT DOCUMENT**

**Connecticut Yankee Decommissioning**  
**Health Physics Department Technical Support**  
**Document**

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**Subject: Control of Releases to the Discharge Canal after**  
**Completion of the Canal Final Status Survey:**

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## ***Control of Liquid Releases to the Discharge Canal after Completion of the Canal Final Status Survey***

### 1.0 Introduction

Revision 0 of this technical support document defined a process and the limits to be used to control the quantity of radioactivity that could be released in liquid effluents to the discharge canal after the final status survey (FSS) of the canal has been completed without repeating the FSS. This revision (Rev 1) of this document corrects some inconsistencies (H-3 limits incorrectly included in Table 1), reflects changes made to the effected survey units and adds a comparison of the actual post-Canal FSS discharges to the limits calculated in Revision 0.

Two categories of discharges were made prior to and during the CY discharge canal FSS. These were:

1. Discharge Permit Category 001A. These were batch type discharges which can contain measurable levels of radionuclides and generally required processing and sampling of each batch prior to discharge. Examples of these types of discharges are drainage water from process systems that contained radioactive fluids and discharge of the water in the Spent Fuel Pool prior to its decon and dismantlement. The Canal FSS was begun on April 24, 2006. As of that time, essentially all water from the Spent Fuel Pool drain down had been discharged. Although it was expected that little Category 001A water would be generated, after April 24, 2006, CYAPCO needed to be prepared to handle significant quantities of Category 001A water if necessary.
2. Discharge Permit category 001F. These types of releases were continuous or semi-batch type releases. A continuous release was that from the Containment Mat Sump, which was pumped directly from the sump to Yard Drain 6 where a composite sampler drew representative samples. These samples were used to quantify the activity released. As the Mat Sump had been secured and backfilled and Yard Drain 6 had been rendered inoperable, this operation was no longer being conducted after April 24, 2006.

Another type of release under category 001F was groundwater primarily from localized excavation dewatering that was pumped thru the groundwater processing system to the discharge header for sampling and discharge. Permit category 001F-type discharges had been relocated so as to discharge to the canal in the area of the barge slip before April 24, 2006. Samples were taken from the volume of water being discharged at the effluent from the groundwater treatment system. These samples were used to quantify releases as the use of the composite sampler on Yard Drain 6 had been discontinued.

As of the start of the Canal FSS, the following was the status of discharges from the site:

1. Category 001A discharges:
  - Fuel Pool drained and essentially all water discharged
  - All radioactive process systems drained and the water discharged
  - Containment interior decon completed and essentially all water discharged.

## 2. Category 001F Discharges:

- Major subsurface remediation/removals complete and major dewatering secured

Considering the above, the discharge canal FSS was not conducted until discharge of essentially all Category 001A water on site was complete. Also other large volume discharges of groundwater such as the Mat Sump operation and dewatering due to all currently known major remediations had been completed. This meant that the need to release significant quantities of radionuclides after completion of the FSS to the Discharge Canal was not expected. This expectation was confirmed as only approximately 16,000 gallons of Category 001A water and a total of 96,000 gallons of water were released after the start of the Canal FSS on 4/24/06.

The remainder of this document will describe the appropriate controls that were used to allow the release of measurable quantities of radionuclides to the discharge canal after completion of its FSS.

## 2.0 Analysis and Discussion

### 2.1 General Model

The basis of the model that was used was to limit the total activity (except for H-3 which has been shown to not deposit in the canal sediments) that could be released to the canal so as to limit the **increase** in the radionuclide concentration in canal sediments to no more than the quantity that corresponds to 1 mrem/yr post closure dose based on the use of the CY License Termination Plan (LTP) Soil Derived Concentration Guideline Levels (DCGLs). This value of 1 mrem/yr (4% of the 25 mrem/yr Soil DCGLs) has been approved as a de minimus quantity by the NRC in the past for CY (Reference 4.1, Section 5.4.7.5 concerning the Release of Buried Piping).

A calculation, (Shown in Attachment 1) has been performed to determine the allowable quantity of activity that could be released post canal FSS before reconsidering the results of the FSS. The conservative assumptions used were:

1. All of the activity released (except for H-3) is assumed to deposit in the sediments in the three survey units adjacent to the barge slip of the discharge canal (Survey Units 9106-0001, 9106-0002 and 9106-0014) where discharges are currently made. Note that survey unit 9106-0001 (a Class 2 unit) was reclassified and divided into two Class 1 units (9106-0001 and 9106-0014) due to remediation that was conducted in the original survey unit 9106-0001. The total size of the two new survey units (9106-0001 and 9106-0014) together is the same as the original size of survey unit 9106-0001. This assumption is conservative as it considers that tidal flow (which is moving downstream approximately half the time) is not transporting any released radionuclides (Except H-3) away from the barge slip area.

Many radionuclides historically detected at CY are soluble and therefore would remain in solution and subsequently be flushed from the discharge canal. Samples of the canal

sediments support this as only small quantities of soluble radionuclides such as Sr-90 and Cs-137 have been detected in canal sediments (The primary detected radionuclide is Co-60, See Attachment 1) while significant quantities of these radionuclides have been historically released. The degree of deposition assumed is therefore conservative.

2. Survey Units 9106-0001, -0002 and -0014 are significantly smaller than most of the downstream survey units. Use of these areas in the calculation will result in conservative limits on the quantity allowed to be discharged.

3. The analysis uses an assumed sample depth of 3 feet. This corresponds to the minimum sample depth for sediments described in the CY LTP. As sediment sample depths to as much as 6 feet may be encountered during the canal FSS, the use of the 3 foot depth is therefore conservative.

Table 1  
Allowable Release Activity after Canal FSS

Radionuclide	Maximum Release Quantity (Note 1) (pCi)
H-3	Not Limited by FSS
C-14	3.11E+09
Mn-54	9.58E+09
Fe-55	1.51E+13
Co-60	2.10E+09
Ni-63	3.98E+11
Sr-90	8.53E+08
Nb-94	3.92E+09
Tc-99	6.93E+09
Ag-108m	3.93E+09
Cs-134	2.57E+09
Cs-137	4.35E+09
Eu-152	5.56E+09
Eu-154	5.11E+09
Eu-155	2.16E+11
Pu-238	1.63E+10
Pu-239	1.47E+10
Pu-241	4.79E+11
Am-241	1.42E+10
Cm-243	1.60E+10

Note 1: Sum of the Fractions calculation to be performed if more than one radionuclide is detected in the water to be discharged

The Attachment 1 spreadsheet uses the above model to calculate the maximum quantity of activity that could be released (subject to a sum of the fractions calculation if more

then one radionuclide is detected) to the discharge canal and not result in more than a 1 m/yr increase in the post closure dose due to canal sediments. These limits are shown above in Table 1.

Attachment 1 also shows an example calculation of the allowable release duration using recent release concentrations for excavations and the allowable activity limits from Table 1. This example shows an expected allowable continuous release duration of 6.9 months without exceeding the activity limits in Table 1.

## 2.2 Implementation of the General Model

The approach discussed above required that the total inventory of released activity be tracked to insure the allowable release quantity was not exceeded. This requirement was met as follows:

### 1. The water to be discharged such as that:

- Collected for treatment and discharge under Permit Category 001A
- Generated by excavation dewatering and collected in a batch tank prior to discharge

Was sampled using the same protocols that were previously used as follows:

For Category 001A discharges, the same radionuclide suite as for recent discharges of this type was used. The contents of tanks to be discharged were sampled and analyzed for H-3 and gamma radionuclides. Although, the results of the previous quarterly composite sample was used as the concentration of Sr-90 in the release permit, the actual sample results were used in the Table 2 comparison. The protocol used meets the requirements of the CY REMODCM.

Excavation related water after 4/24/07 was pumped to a batch tank and sampled prior to discharge. Grab samples were also taken from the effluent of the Groundwater Treatment System and composited for subsequent analysis in conformance with the CY REMODCM. This protocol along with that described in the last paragraph ensured that releases were in compliance with the permitted discharge limits for radioactivity.

- ### 2. All discharged quantities of radioactivity (as determined by the REMODCM process) made after the Canal FSS had been conducted were included in the cumulative total (See Section 3). If the total post-FSS releases had exceeded the allowable quantity given in Table 1, the canal FSS for the first four canal survey units (9106-0001, -0002, -0003 and -0014) would have been repeated. If the results of the repeated FSS were a failure for any of these three survey units, the FSS would have been repeated for additional downstream canal survey units until three survey units in a row passed the FSS.

3. This revision to this TSD demonstrates (See Section 3) that the total allowable release activity given in Table 1 (considering the sum of the fractions if applicable) was not exceeded when all releases had been made. This TSD will be provided to the NRC as additional documentation of the adequacy of the Discharge Canal Final Status Survey.

Table 2  
Comparison Actual Releases to Maximum Allowed w/o Repeating the Canal FSS

Release Type	Release Date	Total Release Gallons	Sr-90 Concentration (uCi/ml)	Sr-90 Released (pCi)	Co-60 Concentration (uCi/ml)	Co-60 Released (pCi)	Cs-134 Concentration (uCi/ml)	Cs-134 Released (pCi)	Cs-137 Concentration (uCi/ml)	Cs-137 Released (pCi)
Test Tank	6/5/2006	3825	4.54E-08	6.57E+05	9.73E-07	1.41E+07	0.00E+00	0.00E+00	2.51E-07	3.63E+06
Test Tank	9/8/2006	12325	1.64E-07	7.65E+06	7.57E-07	3.53E+07	8.37E-08	3.90E+06	8.77E-06	4.09E+08
Ground-water Treatment	5/8/06	9042	2.51E-09	8.59E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.85E-09	2.69E+05
Ground-water Treatment	7/10/06	15095	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ground-water Treatment	7/13/06	18722	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ground-water Treatment	9/2/2006	3294	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ground-water Treatment	10/26/06	33287	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-08	1.42E+06
	Total gal Released	9.6E+04	Total pCi Released	8.39E+06		4.94E+07		3.90E+06		4.14E+08
			Total Allowable Release	8.53E+08		2.10E+09		2.57E+09		4.35E+09
			Actual Release as a Fraction of Allowable	9.84E-03		2.35E-02		1.52E-03		9.53E-02
									Total of all Nuclide Fractions	1.30E-01

### 3.0 Evaluation Using Actual Release Data

The above tracking process was followed as discharges were made after April 24, 2006. Table 2 above shows the comparison of the actual releases to the limits presented in Table 1. As can be seen from Table 2, the actual releases were 13 % of the limit and therefore well within the allowable amount.

### 4.0 Conclusions:

This document provides a methodology and general procedure for insuring that any releases to the CY discharge canal after completion of the discharge canal final status survey were maintained below a quantity that would change the post license termination dose to a future occupant of the site by an insignificant amount (i.e. change < 1 mrem/yr). The allowable release quantities that correspond to this insignificant amount are given above in Table 1.

The procedure and the limits defined in this document were used to control post FSS discharges to the canal. As the quantity of radioactivity released was determined to be 13 % of the limits defined herein, the conclusion of final status survey of the canal remain valid.

### 4.0 References

4.1 Connecticut Yankee, License Termination Plan, Revision 3, August 2005.

### 5.0 Attachments

5.1 Attachment 1: Allowable Discharges after Discharge Canal FSS

Attachment 1 to TSD: CY-HP-0209 Revision # 1

**Allowable Discharges after Discharge Canal FSS**

Radio-nuclide	25 mr/yr Soil DCGL (pCi/g)	Concentration @ 1 mr/yr (pCi/g)	Weight of Canal Sediment in Survey Units 9106-0001 and 9106-0002 (g)	Allowable Activity Increase for 1 mr/yr (pCi)
H-3	412	16.48	1.38E+10	Not Limited by FSS
C-14	5.66	0.23	1.38E+10	3.11E+09
Mn-54	17.4	0.70	1.38E+10	9.58E+09
Fe-55	27400	1096.00	1.38E+10	1.51E+13
Co-60	3.81	0.15	1.38E+10	2.10E+09
Ni-63	723	28.92	1.38E+10	3.98E+11
Sr-90	1.55	0.06	1.38E+10	8.53E+08
Nb-94	7.12	0.28	1.38E+10	3.92E+09
Tc-99	12.6	0.50	1.38E+10	6.93E+09
Ag-108m	7.14	0.29	1.38E+10	3.93E+09
Cs-134	4.67	0.19	1.38E+10	2.57E+09
Cs-137	7.91	0.32	1.38E+10	4.35E+09
Eu-152	10.1	0.40	1.38E+10	5.56E+09
Eu-154	9.29	0.37	1.38E+10	5.11E+09
Eu-155	392	15.68	1.38E+10	2.16E+11
Pu-238	29.6	1.18	1.38E+10	1.63E+10
Pu-239	26.7	1.07	1.38E+10	1.47E+10
Pu-241	870	34.80	1.38E+10	4.79E+11
Am-241	25.8	1.03	1.38E+10	1.42E+10
Cm-243	29	1.16	1.38E+10	1.60E+10

Note 1: Unity Rule Must be Used - i.e. Sum of the Fractions of the Allowable must be <1

**Example of Maximum Discharge Duration Calculation (Key Radionuclides)**

Radio-nuclide	Allowable Activity Increase for 1 mr/yr (pCi)	Daily Discharge Volume (Assumes 30 gpm Rate) (L)	Assumed Discharge Concentration (pCi/L)	Maximum Release Duration at Assumed Concentration (See Note 1) (days)	Present In Discharge Canal Sediment (Yes/No)	Max Sediment Activity - Sample 9106-0004 1605D-01 (pCi/g)
Co-60	2.10E+09	1.64E+05	50	256	Yes	3.04
Sr-90	8.53E+08	1.64E+05	25	209	Yes	0.0702
Cs-137	4.35E+09	1.64E+05	100	266	Yes	0.592

Note 1: Assumes only 1 radionuclide detected in water to be released  
 Assumptions: Continuous Discharge Flowrate of 30 gpm