WHC-SD-WM-EMP-032

Tritium Emissions From 200 East Area Double-Shell Tanks

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse
Hanford Company Richland, Washington

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7. Abstract

This document evaluates the need for tritium sampling of the emissions from the 200 East Area Double Shell Tanks based on the requirements of "National Emission Standards for Hazardous Air Pollutants" (NESHAP). The NESHAP requirements are specified in 40 Code of Federal Regulation (CFR), Part 61, Subpart H; "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities".

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LIST OF TERMS

AMU	Atomic mass units
C	Celsius
cc	cubic centimeter
cfm	cubic feet per minute
CFR	Code of Federal Regulations
Ci	Curies
CY	Calendar Year
DAC	Derived Air Concentration
DCG	Derived Concentration Guide
deg	degrees
DOE	U.S. Department of Energy
DST	Double-Shell Tank
EEM	Effluent and Emission Monitoring Group
F	Fahrenheit
FY	Fiscal Year
HEPA	High Efficiency Particulate Air (Filters)
m^3	Cubic Meters
Mev	Mega-electron volts
min	minutes
ml	milliliter
mrem	millirem
NESHAP	National Emission Standards for Hazardous Air Pollutants
PDD	PUREX Process Distillate Discharge
PUREX	Plutonium Uranium Extraction Plant
QUEST	Quality, Environmental, and Safety Tracking
rem	Roentgen Equivalent Man
μCi	micro-curies
WHC	Westinghouse Hanford Company

1.0 OBJECTIVE

1.1 BACKGROUND

Waste in the 200 Area double-shell tanks contains tritium. Tritium is an unstable isotope of hydrogen that contains three neutrons (denoted H^3 or T). The chemical and physical properties of tritium are similar to hydrogen, but differ slightly due to the significantly larger atomic weight (3 atomic mass units [AMU] compared to 1 AMU for hydrogen). Tritium is a relatively low energy beta particle emitter (0.018 Mev) with a half-life of 12.3 years (GE 1977).

Tritium may exist in several different molecular forms (H-T, T-T, H-T-O, T-T-O, and T-C-H). The two most common forms are a liquid or vapor (H-T-O), and a gas (H-T) (NUREG/CR-3332).

Tritium is produced in the primary cooling water loop of nuclear reactors through reactions with cooling water additives, and in the reactor fuel by ternary fission (NUREG/CR-3332). The tritium in the tanks is most likely a waste from the spent nuclear fuel. Greater than 95 percent of the tritium from spent nuclear fuel is in the form of H-T-O (NUREG/CR-3332). Tritium sampling on the main PUREX stack (296-A-1) during spent nuclear fuel processing (which has since discontinued) indicated that all of the tritium being released from the stack was in the form H-T-O (Catlow 1994). Therefore, all of the tritium released from the 200 Area double-shell tanks is assumed to be H-T-O.

The tritium is removed from the tank vapor space by the tank ventilation systems. All of the double-shell tanks have ventilation systems to maintain a slightly negative pressure in the tanks to pull all of the emissions from the waste through HEPA filters. The HEPA filters remove particulate emissions, but not vapors or gasses. In the double-shell tank farms, the emissions from every tank are released through one stack after passing through the HEPA filters. The stacks have sampling and monitoring systems that are used to quantify emissions from the stack and alert personnel to possible problems.

The vapor (or gaseous) forms of tritium cannot be collected in the existing effluent sampling or monitoring systems. The existing sampling systems consist of Record Sample filter paper (used for collecting particulate samples). Some of the sampling systems also include Silver Zeolite cartridges (used for collecting radioactive iodine samples). The monitoring systems consist of beta/gamma continuous air monitors (CAM) and alpha CAMs. Consequently, the offsite dose from tritium can only be estimated, and is not currently reported for the 200 East Area double-shell tank farms in the annual emission reports for Hanford.

This project involved sampling tritium from the 200 East Area double-shell tank farm stacks in FY94. The sampling took place over a period of one to seven days on each stack. The sampling method involved continuously removing a sample of air from the stack effluent (downstream of the HEPA filters). The sample was transported from the stack to the

sampling unit through stainless steel tubing. Inside the sampling unit, the sample was passed through a catalytic converter to convert the H-T (if present) to H-T-O, then absorbed in a sampling cartridge. The sample cartridge was transported to the 222-S Laboratory for analysis.

1.2 SCOPE

The scope of this study includes all the double-shell tank farms in the 200 East Area (AY/AZ, AN, AP, and AW Tank Farms). These facilities received spent nuclear fuel reprocessing waste from the Plutonium Uranium Extraction Facility (PUREX) that contained tritium.

Since the 242-A Evaporator processes waste from the 200 East Area double-shell tanks, a request was made to have tritium emissions from the evaporator evaluated by this project. Because the evaporator was not included in the original scope, and the request was made after the sampling was completed, tritium emissions from the evaporator are not included in this report. However, potential tritium emissions from the evaporator are evaluated in Appendix H, and addressed in the recommendations.

1.3 PURPOSE AND NEED

The purpose of this tritium sampling project is to determine if the potential offsite dose from tritium is a large enough percentage of the potential offsite dose from all radionuclides in the double-shell tanks to necessitate additional sampling (either periodic or continuous).

National Emission Standards for Hazardous Air Pollutants (NESHAP) Subpart H applies to emissions of radionuclides other than radon from Department of Energy Facilities, and can be found in 40 Code of Federal Regulations (CFR). Section 61.93(b)(4)(i) of Subpart H requires measurement of all radionuclides which could contribute greater than 10% of the potential effective dose equivalent for a release point.

This project also addresses the following related issue resolutions:

1. DOE-RL Milestone number TW1-94-445; Conduct confirmatory tritium sampling on tanks AP, AN, AW, AY/AZ primary ventilation stacks.

2. Quality, Environmental, and Safety Tracking (QUEST) system items:

QUEST ITEM Number	DESCRIPTION
ECP-88-0000-RHOMA-139CP06-01E	Correct problem with tritium sampler and take samples (on A-17 stack).
ECP-88-0000-RHOMA-139CP06-02E	Collect tritium emission data for Engineering Study.

ECP-89-0011-CP89017-03E	Submit to Effluent and Emission Monitoring for temporary increase in administrative control value (for 296-A-40 stack).
ECP-89-0011-CP89017-04E	Issue engineering service request for tritium sampler design (for 296-A-40 stack).
ECP-89-0011-CP89017-05E	Complete tritium sampler design (for 296-A-40 stack).
ECP-89-0011-CP89017-06E	Procure parts and install permanent tritium sampler (for 296-A-40 stack).

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2.0 SUMMARY

2.1 PURPOSE

The purpose of this project is to determine if the emissions from the 200 East double-shell tanks need to be sampled for tritium either periodically or continuously, as required by National Emission Standards for Hazardous Air Pollutants (NESHAP), Subpart H. Section 40 CFR 61.93(b)(4)(i) of NESHAP requires measurement of all radionuclides which could contribute to greater than ten percent of the potential offsite dose from a release point.

2.2 RESULTS

Effluent from the 200 East Area double-shell tanks (AY/AZ, AN, AW, and AP Tank Farms) was sampled for tritium in FY94. The results are presented in this document.

Table 2-1 gives the potential offsite dose from tritium as a fraction of the potential offsite dose from all radionuclides (by stack). Potential offsite dose is an estimate of the annual dose that a person offsite could receive if all engineering controls (HEPA filters, etc.) were removed. For all of the 200 East Area double-shell tanks, the potential offsite dose from tritium could not contribute to greater than 10 percent of the total potential offsite dose from a release point. Therefore, continuous tritium sampling is not required by NESHAPs.

Table 2-1. Tritium Fraction of Potential Offsite Dose.

Tank Farm	Tritium Potential Offsite Dose (mrem/yr)	Total Stack Potential Offsite Dose[1] (mrem/yr)	Fraction of Total Stack Potential Offsite Dose (percent)
AN	1.69E-6[4]	846.00	< 1%
AP	7.38E-3[3]	47.43[2]	< 1%
AW	2.37E-3[3]	148.00	< 1%
AY/AZ	1.16E-4[4]	226.00	< 1%

[1]Calculated in WHC-SD-WM-EMP-031 unless otherwise noted.
[2]See Appendix G for this calculation.
[3]Based on source term (total quantity of tritium in tanks).
[4]Based on back calculation using 1994 measured tritium concentrations and HEPA filter decontamination factor of 1.

Table 2-2 shows the tritium concentration as a fraction of the derived (air) concentration guide (DCG) and derived air concentration (DAC); and the actual offsite dose from tritium as a fraction of the actual (total) offsite dose from each tank farm stack. Derived Concentration Guides are standards used by the U.S. Department of Energy (DOE) and it's contractors to minimize public exposure to radionuclides. Derived Air Concentrations are standards used by the DOE and it's contractors to minimize employee exposure to radionuclides.

Table 2-2. Tritium Fraction of DCG, DAC, and Total Stack Offsite Dose.

Tank Farm	CY94 Tritium Concentration[1] (μCi/cc)	Fraction of DCG[5] (percent)	Fraction of DAC[7] (percent)	Tritium Offsite Dose[2] (mrem/yr)	Fraction of CY93 Total Stack Offsite Dose[6] (percent)
AN	6.85E-9	7%	< 1%	1.75E-6	99.70%
AP	5.45E-8[3]	55%	< 1%	1.74E-5	99.98%
AW	2.63E-8	26%	< 1%	9.05E-6	97.88%
AY/AZ	1.11E-7[4]	111%	1%	6.55E-5	88.75%

[1]Upper 95 percent confidence interval of five 3 gram aliquots.
[2]Based on CY94 tritium concentration decay corrected to CY93, and CAP-88 (WHC-EP-0498).
[3]Average of three AP samples.
[4]Concentration from A-17 stack.
[5]DCG (H^3) = 1.0 E-7 μCi/ml (WHC-CM-7-5).
[6]Based on curies released (DOE/RL-94-51) and CAP-88 (WHC-EP-0498).
[7]DAC (H^3) = 2.0 E-5 μCi/ml (DOE/EH-0256T, Rev. 1)

Tritium concentrations could potentially exceed 10 percent of the DCG for all four tank farms. Therefore, continuous tritium sampling (or monitoring) is required by WHC-CM-7-5, Paragraph 2.5.4.3. At the time this report was being prepared, it was understood that the DCGs were soon to be replaced with standards that more closely reflect the requirements of NESHAPs (Bates 1994).

Because the concentration is less than 2 percent of the DAC, air sampling is not required for monitoring employee exposure. Since there are no other requirements to sample for tritium (other than in WHC-CM-7-5), a waiver from the requirements of WHC-CM-7-5, Paragraph 2.5.4.3 is recommended.

Tritium accounts for more than 80 percent of the offsite dose (from radionuclides) received from the four tank farms. In order to ensure that Westinghouse and the Department of Energy are not significantly underestimating emissions, it is recommended that the offsite dose from tritium be reported in the annual emission reports. Periodic sampling should be used to verify that the tritium concentrations are not significantly changing, and to provide a basis for annual emission estimates.

2.3 RECOMMENDATIONS

The following recommendations are described in detail in Section 5.0 of this report.

2.3.1 Reporting

Include annual estimates of tritium emissions in the DOE and WHC annual air emission reports.

2.3.2 Sampling

Conduct periodic confirmatory sampling for tritium in the effluent from the 200 East Tank Farm double-shell tanks to support annual emission estimates and to determine tritium concentration variability.

2.3.3 W-030 Project

Design the sampling system for this project to include tritium sampling capability.

2.3.4 W-314 Project

Design the sampling systems for the AN and AW Tank Farm ventilation systems to include tritium sampling capability.

2.3.5 A-40 Stack Upgrade (AP Tank Farm)

Design the sampling system to include tritium sampling capability.

2.3.6 Request a Waiver from WHC-CM-7-5, Paragraph 2.5.4.3

Request a waiver from the requirements of WHC-CM-7-5, Paragraph 2.5.4.3, for all of the 200 East Area double-shell tank farms (A-17/P-26, A-27, A-29, and A-40 stacks).

2.3.7 Determine the Need to Evaluate Worker Exposure to Tritium During Unique Operating Conditions

Unique operating conditions (such as a dump of the 242-A Evaporator pot, waste transfer, etc.) may result in increased tritium emissions. Radiological control should determine if an evaluation of tritium emissions is needed to assess worker exposure during unique operating conditions.

2.3.8 Evaluate Actual Offsite Dose from Tritium Emissions from the 242-A Evaporator

The potential offsite dose from tritium emissions from the evaporator vessel vent is less than 10 percent of the potential offsite dose from all radionuclides, therefore continuous sampling is not required. However, actual tritium emissions may be a significant portion of the offsite dose from the evaporator vessel vent stack.

2.3.9 Replace O-Ring Seals in Existing Sampling Cartridges

If Effluent and Emissions Monitoring group intends to use the RADeCO Model ACT-100 Tritium/Carbon-14 Sampler again, recommend replacing the O-ring seals of the cartridge holder with gaskets that are available from the manufacturer.

3.0 SAMPLE RESULTS

3.1 EFFLUENT CONCENTRATIONS

Tritium concentrations were sampled in the effluent of the 200 East Area double-shell tank exhauster stacks (AY/AZ, AN, AP, and AW Tank Farms) from May 31, 1994 to July 27, 1994. The results are shown in Table 3-1.

Table 3-1. Tritium Sampling Results.

Sample[2]	Sample Period (1994)	Sample Tritium Activity (μCi)	Average Sample Flow Rate (cc/min)	Sample Time (min)	Average Tritium Concentration (μCi/cc)	Tritium Concentration[1] (μCi/cc)
AN-1	6/7 - 6/14	4.38E-3	93.5	9793	4.78E-9	**6.85E-9**
AP-1	6/15 - 6/20	2.36E-2	101.5	7124	3.26E-8	**4.14E-8**
AP-2	6/22 - 6/24	8.64E-3	88.7	2872	3.39E-8	**4.86E-8**
AP-3	7/6 - 7/7	5.17E-3	87.5	1208	4.89E-8	**7.35E-8**
AW-1	6/24 - 6/27	4.74E-3	99.0	4240	1.13E-8	**2.63E-8**
AY/AZ-1	5/31 - 6/7	4.72E-2	105.0	4716	9.53E-8	**1.11E-7**
AY/AZ-2	7/25 - 7/27	3.61E-3	90.0	2900	1.38E-8	**2.08E-8**

[1]Upper 95 percent confidence interval of five 3 gram aliquots.
[2]Alpha numeric sample # indicates Tank Farm followed by Sample #.

UNLESS OTHERWISE NOTED:

1. The Upper 95 percent confidence interval tritium concentration will be used for compliance assessment calculations.
2. The average of the 95 percent confidence interval tritium concentrations measured from the A-40 stack (AP Tank Farm) will be used for compliance assessment calculations.
3. The upper 95 percent confidence interval tritium concentration from the A-17 stack will be used for compliance calculations for the AY/AZ tanks because this is the primary exhauster.

3.2 INTERPRETATION OF RESULTS

3.2.1 DIFFERENCES IN TRITIUM CONCENTRATIONS MEASURED IN EMISSIONS FROM AY/AZ TANK FARM

Sample AY/AZ-1 was taken from the A-17 (primary) exhaust stack, and sample AY/AZ-2 was from the P-26 (backup) exhaust stack. The reason that the results differ by almost an order of magnitude is partially attributed to the significantly higher stack flowrate through the P-26 stack. As the flowrate through a tank increases, the concentration is expected to decrease because the amount of tritium being released is limited by the rate at which tritium diffuses from the liquid waste into the vapor space above the waste. However, the rate of diffusion should not decrease as the flowrate increases, as is shown in Table 3-2.

Table 3-2. Rate of Tritium Diffusion from AY/AZ Tanks.

Stack	Tritium Concentration (μCi/ml)	CY91-CY93 Average Stack Flowrate [m^3/min (cfm)]	Rate of Tritium Diffusion[1] (μCi/min)
A-17	1.11E-7	90.6 (3,198)	355.0
P-26	2.08E-8	151.6 (5,318)	111.0

[1]The rate of diffusion was calculated by multiplying the tritium concentration in the effluent by the average stack flowrate.

A sampling error (such as the sample flowrate), or a tank environment variable (such as the deentrainer operation) is believed to also account for the difference in measured concentration of tritium and hence, the difference in calculated diffusion rate from these two stacks.

3.2.2 SAMPLE BREAKTHROUGH

The sampling cartridges contain a colorimetric indicator to qualitatively estimate the amount of water that has been absorbed into the sampling cartridge media, so that breakthrough can be avoided. The manufacturer recommends removing the sample cartridge when the indicator has turns pink, and checking for breakthrough at the laboratory when the sample cartridge is disassembled for analysis. The lab personnel noted a color change (pink) in the indicator for samples AP-1 and AP-2. Observations for other samples were "no pink" or not noted (Catlow 1994).

The indicator on a new cartridge is blue, and gradually turns pink as the sampling media becomes loaded with water vapor. To evaluate the possibility that breakthrough occurred, three samples were taken from the A-40 stack (AP Farm). The sample period for each successive sample was reduced until the colorimetric indicator was blue at the end of the last sample period. A summary of the tritium activity in the sampling media, tritium concentration, and colorimetric indication is listed in Table 3-3.

Table 3-3. Colorimetric Indication at End of Sample Period.

Sample	Sample Period (minutes)	Tritium Activity of Sample (μCi)	Tritium Concentration[1] (μCi/ml)	Colorimetric Indication[2]
AP-1	7124	2.36E-2	4.14E-8	PINK
AP-2	2872	8.64E-3	4.86E-8	PINK-BLUE
AP-3	1208	5.17E-3	7.35E-8	BLUE

[1]Upper 95 percent confidence interval
[2]Pink - indicates saturation or near saturation
Blue - indicates relatively moisture free

If breakthrough had not occurred, the concentrations expected would be nearly equal (with some variability due to sample flowrate or tank environment conditions). However, the concentration increases slightly as the sampling period decreases which suggests that some breakthrough may have occurred.

The possibility of breakthrough is believed to have a negligible affect on the concentrations measured and offsite dose calculations for the following reasons:

- Trend in AP sample concentrations may have been caused by other tank environment or sampling variables
- Difference between the AP-1 concentration and AP-3 concentration is less than an order of magnitude
- Samples from the other tank farms appear to have contained less moisture, and would have been less likely to have had breakthrough.

For information, the colorimetric indication at the end of the sample period is shown in Table 3-4 for the other samples.

Table 3-4. Colorimetric Indication at End of Sample Period.

Sample	Colorimetric Indication[1]
AN-1	Blue-Pink
AW-1	Blue
AY/AZ-1	Pink-Blue
AY/AZ-2	Blue

[1]Pink - indicates saturation or near saturation
Blue - indicates relatively moisture free

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4.0 COMPLIANCE ASSESSMENT

4.1 FRACTION OF POTENTIAL OFFSITE DOSE

Tritium concentrations in the waste have been measured in five of the eight tanks in AP Tank Farm, and three of the six tanks in AW Tank Farm. Table 4-1 shows the potential offsite dose from tritium as a fraction of the offsite dose from all radionuclides.

Note: The potential offsite dose for the AP Tank Farm was recalculated because more recent and detailed tank characterization data has become available since WHC-SD-WM-EMP-031, "Determination of the NESHAP Status of Tank Farm Stacks Based on Calculations Using 40 CFR, Part 61, Appendix D Factors" was published. If the potential offsite dose for AP Tank Farm reported in WHC-SD-WM-EMP-031 was used (0.21 mrem/yr, not including tritium), the potential offsite dose from tritium would have been 1.04 percent of the potential offsite dose from this stack, rather than 0.02 percent.

Table 4-1. Potential Offsite Dose from Tritium Based on Tritium Concentration in Waste (Liquid). (2 sheets)

Tank	Date Sampled[1]	Waste Liquid Tritium Concentration (μCi/ml)	Tritium Inventory (Ci)	Release Factor	Potential Tritium Release Quantity (Ci)	Tritium Potential Offsite Dose[2] (mrem/yr)	Total Stack Potential Offsite Dose (mrem/yr)	Fraction of Total Stack Potential Offsite Dose (percent)
AP-101[9]	July 1993	2.10E-03	8.42E+00	1.00E+00	8.42E+00			
AP-102[8]	April 1993	n/a	n/a	1.00E+00	-			
AP-103[10]	Sept.-Nov. 1991	5.24E-03	2.24E+01	1.00E+00	2.24E+01			
AP-104[7]	-	-	-	1.00E+00	-			
AP-105[11]	March 1993	3.87E-03	1.20E+01	1.00E+00	1.20E+01			
AP-106[12]	March 1993	4.90E-03	2.09E+01	1.00E+00	2.09E+01			
AP-107[13]	Aug. 1993	3.52E-02	1.47E+02	1.00E+00	1.47E+02			
AP-108[7]	-	-	-	1.00E+00	-			
					2.11E+02	7.38E-03[3]	4.74E+01[4]	< 1%
AW-101[7]	-	-	-	1.00E+00	-			
AW-102[14]	October 1991	5.72E-03	1.78E+00	1.00E+00	1.78E+00			
AW-103[7]	-	-	-	1.00E+00	-			
AW-104[7]	-	-	-	1.00E+00	-			
AW-105[15]	May 1990	6.24E-03	1.55E+01	1.00E+00	1.55E+01			
AW-106[16]	December 1993	1.20E-02	3.68E+01	1.00E+00	3.68E+01			
					5.41E+01	2.37E-03[5]	1.48E+02[6]	< 1%

Table 4-1. Potential Offsite Dose from Tritium Based on Tritium Concentration in Waste (Liquid). (2 sheets)

[1]Date analyzed not available.

[2]Using CAP-88 = 2.19E-5 mrem/Ci (WHC-EP-0498).

[3]Assumes potential quantity released from each of AP-102, AP-104, and AP-108 is 211. Ci/5 tanks.

[4]See Appendix G for potential emissions calculations for AP Tank Farm.

[5]Assumes potential quantity released from each of AW-101, AW-103, and AW-104 is 54.1 Ci/3 tanks.

[6]WHC-SD-WM-EMP-031, Rev. 0.

[7]Tritium concentration has not been measured in tank waste.

[8]Tritium concentration was not reported with sample results (WHC-SD-WM-ER-358, Rev. 0).

[9]WHC-SD-WM-ER-357, Rev. 0.

[10]WHC-SD-WM-ER-359, Rev. 0.

[11]WHC-SD-WM-ER-360, Rev. 0.

[12]WHC-SD-WM-ER-361, Rev. 0.

[13]WHC-SD-WM-ER-362, Rev. 0.

[14]WHC-SD-WM-ER-363, Rev. 0.

[15]WHC-SD-WM-ER-364, Rev. 0.

[16]WHC-SD-WM-ER-365, Rev. 0.

This conservative estimate assumes that all of the tritium in the tanks is released over a period of one year. Note that tritium could not contribute greater than ten percent of the potential offsite dose from either AP or AW Tank Farm.

Tritium concentrations in the liquid waste have not been measured for the AN or AY/AZ tanks. In this case, the appropriate method for estimating the potential emissions is to multiply the tritium emissions from the stack by the appropriate HEPA filter decontamination factor. Since the tritium is in the form of a vapor, and is not removed from the effluent by the HEPA filters, the HEPA filter decontamination factor is 1. The tritium emissions from each stack were estimated by multiplying the concentration of tritium measured in the stack effluent by the total volume of air released from the stack. Table 4-2 shows the potential offsite dose from tritium as a percentage of the offsite dose from all radionuclides.

Note that tritium could not contribute more than ten percent of the potential offsite dose from either AN or AY/AZ tank farm.

4.2 FRACTION OF ACTUAL OFFSITE DOSE

Using an average stack flow rate (from measurements taken during 1991, 1992, and 1993 (WHC-SD-WM-ES-291)), the offsite dose from tritium was calculated and is shown in Tables 4-3 and 4-4 along with the reported offsite dose from all radionuclides.

Note that the actual offsite dose received from the double-shell tanks sampled is primarily from tritium.

Table 4-2. Potential Offsite Dose From Tritium Based on Current Emissions.

Stack No.	Tank Farm	CY94 Tritium Concentration[1] (airborne effluent) (μCi/ml)	CY91-CY93 Average Stack Flowrate[2]		CY93 Total Flow (m^3/yr)	Tritium Potential Offsite Dose[3] (mrem/yr)	Total Stack Potential Offsite Dose[4] (mrem/yr)	Fraction of Total Stack Potential Offsite Dose (percent)
			(m^3/min)	(cfm)				
A-29	AN	6.85E-09	2.15E+01	(759.00)	1.13E+07	1.69E-06	846.00	< 1%
A-17	AY/AZ	1.11E-07	9.06E+01	(3198.00)	4.76E+07	1.16E-04	226.00	< 1%

[1]Upper 95 percent confidence interval.

[2]WHC-SD-WM-ES-291, Rev. 1.

[3]Using CAP-88 = 2.19E-5 mrem/curie (WHC-EP-0498).

[4]WHC-SD-WM-EMP-031, Rev. 0.

Table 4-3. CY92 Offsite Dose from Tritium as a Fraction of CY92 Total Stack Offsite Dose.

Stack No.	Tank Farm	CY94 Tritium Concentration[1] (Effluent) (μCi/ml)	Tritium Concentration Decay Corrected to CY92 (μCi/ml)	CY91-CY93 Average Stack Flowrate[2]		CY93 Total Flow (m^3)	CY92 Estimated Tritium Offsite Dose[3] (mrem/yr)	CY92 Reported Stack Offsite Dose[4] (mrem/yr)	Fraction of CY92 Total Stack Offsite Dose[5] (percent)
				(m^3/min)	(cfm)				
A-17	AY/AZ	1.11E-07	1.21E-07	90.6	(3198)	4.76E+07	1.26E-04[6]	4.38E-05	**74.22%**
A-27	AW	2.63E-08	2.87E-08	29.9	(1055)	1.57E+07	9.86E-06	1.84E-09	**99.98%**
A-29	AN	6.85E-09	7.47E-09	21.5	(759)	1.13E+07	1.85E-06	1.80E-07	**91.12%**
A-40	AP	5.45E-08	5.94E-08	27.0	(955)	1.42E+07	1.85E-05	1.40E-09	**99.99%**

[1]Upper 95 Percent Confidence Interval.

[2]WHC-SD-WM-ES-291, Rev. 1.

[3]Using CAP-88 = 2.19E-5 mrem/curie (WHC-EP-0498).

[4] Using Ci reported in DOE/RL-93-36 and CAP-88 from WHC-EP-0498 (does not include tritium).

[5]Tritium Offsite Dose/(Tritium Offsite Dose + Reported Stack Offsite Dose).

Note that tritium accounted for more than 70 percent of the offsite dose received from each of the 200 East Area double-shell tank farms in CY92.

Table 4-4. CY93 Offsite Dose from Tritium as a Fraction of CY93 Total Stack Offsite Dose.

Stack No.	Tank Farm	CY94 Tritium Concentration[1] (Effluent) (μCi/ml)	Tritium Concentration Decay Corrected to CY93 (μCi/ml)	CY91-CY93 Average Stack Flowrate[2]		CY93 Total Flow (m^3)	CY93 Estimated Tritium Offsite Dose[3] (mrem/yr)	CY93 Reported Stack Offsite Dose[4] (mrem/yr)	Fraction of CY93 Total Stack Offsite Dose[5] (percent)
				(m^3/min)	(cfm)				
A-17	AY/AZ	1.11E-07	1.14E-07	90.6	(3198)	4.76E+07	1.19E-04	1.51E-05	**88.75%**
A-27	AW	2.63E-08	2.71E-08	29.9	(1055)	1.57E+07	9.31E-06	2.02E-07	**97.88%**
A-29	AN	6.85E-09	7.06E-09	21.5	(759)	1.13E+07	1.75E-06	5.26E-09	**99.70%**
A-40	AP	5.45E-08	5.61E-08	27.0	(955)	1.42E+07	1.75E-05	2.89E-09	**99.98%**

[1]Upper 95 Percent Confidence Interval.

[2]WHC-SD-WM-ES-291, Rev. 1.

[3]Using CAP-88 = 2.19E-5 mrem/curie (WHC-EP-0498).

[4]Using Ci reported in DOE/RL-94-51 and CAP-88 from WHC-EP-0498.

[5]Tritium Offsite Dose/(Tritium Offsite Dose + Reported Stack Offsite Dose).

Note that tritium accounted for more than 85 percent of the offsite dose received from each of the 200 East Area double-shell tank farms in CY93.

4.3 DOE/EH-0173T, "ENVIRONMENTAL REGULATORY GUIDE FOR RADIONUCLIDE EFFLUENT MONITORING AND ENVIRONMENTAL SURVEILLANCE"

The sampling/monitoring requirements of DOE/EH-0173T are summarized in Table 3-1 of the guide. The applicable requirements for stacks which have a projected effective dose equivalent (EDE) to members of the public (i.e., offsite dose) of 0.1 mrem/year or greater are as follows:

- Continuously monitor emission points that could contribute greater than or equal to 0.1 mrem/year
- Identify radionuclides that contribute greater than or equal to 10 percent of the dose.

The only action that needs to be taken to be in compliance with DOE/EH-0173T is to identify that tritium accounts for greater than 10 percent of the dose.

4.4 FRACTION OF DERIVED CONCENTRATION GUIDE

Table 4-5 is a comparison of the measured tritium concentrations to established DCG values (WHC-CM-7-5).

Table 4-5. Comparison of Tritium Concentrations to Derived Concentration Guide.

Tank Farm	Tritium Concentration (μCi/ml)	Fraction of DCG[1] (percent)
AY/AZ	1.11 E-07	**111%**
AW	2.63 E-08	**26%**
AN	6.85 E-09	**7%**
AP	5.45 E-08	**55%**

[1]DCG = 1.0 E-7 μCi/ml

Paragraph 2.5.4.3 of the WHC Environmental Compliance Manual (WHC-CM-7-5) requires record sampling for airborne emissions that have the potential to exceed 10 percent of the DCG. Based on the sampling results, tritium concentrations from all of the stacks sampled have the potential to exceed 10 percent of the DCG.

At the time this report was being prepared, it was understood that the DCGs and associated requirements would be replaced by standards that are similar to those of NESHAPs (Bates 1994). Given that new DOE/WHC standards are being developed, the preferred response to the existing WHC-CM-7-5 manual requirement for record sampling is to request a waiver for the four East Area double-shell tanks farms until application of the new requirements to tritium emissions can be evaluated.

4.5 FRACTION OF DERIVED AIR CONCENTRATION

Table 4-6 is a comparison of the measured tritium concentrations to the DAC value.

Table 4-6. Comparison of Tritium Concentrations to the Derived Air Concentration.

Tank Farm	Tritium Concentration (μCi/ml)	Fraction of DAC[1] (percent)
AY/AZ	1.11E-7	1%
AW	2.63E-8	< 1%
AN	6.85E-9	< 1%
AP	5.45E-8	< 1%

[1]DAC = 2.0E-05 μCi/mL

Section 555, Paragraph 2 of the DOE Radiological Control Manual (DOE/EH-0256T) requires sampling in normally occupied areas where airborne concentrations exceed 2 percent of the DAC. Since the effluent concentrations of tritium are less than 2 percent of the DAC, the need for workplace air sampling adjacent to the stacks should not require further evaluation for normal operating conditions.

Radiological Controls should determine if an evaluation of tritium emissions is needed to assess worker exposure during unique operating conditions (i.e., a dump of the 242-A Evaporator pot, waste transfer, etc.) when tritium concentrations may be elevated.

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5.0 RECOMMENDATIONS

5.1 REPORTING

Include annual estimates of tritium emissions in the following annual air emission reports:

a. "Environmental Releases for Calendar Year 199x;" WHC-EP-0527-x

b. "Radionuclide Air Emission Report for the Hanford Site, Calendar Year 199x;" DOE/RL-9x-xx.

5.2 SAMPLING

Conduct periodic confirmatory sampling for tritium in the effluent from the 200 East Tank Farm double-shell tanks to support annual emission estimates and to determine tritium concentration variability.

5.3 W-030 PROJECT

Design the sampling system for this project to include tritium sampling capability. [The W-030 project will replace the existing A-17 and P-26 exhausters (AY/AZ Tank Farm) with a single new exhauster].

5.4 W-314 PROJECT

Design the sampling systems for this project to include tritium sampling capability. [The W-314 project is planned to replace the existing A-27 ventilation system (AW Tank Farm) and A-29 ventilation system (AN Tank Farm) in addition to other tank ventilation systems].

5.5 A-40 STACK UPGRADE (AP TANK FARM)

Design the sampling system to include tritium sampling capability.

5.6 REQUEST A WAIVER FROM WHC-CM-7-5, PARAGRAPH 2.5.4.3

Request a waiver from the requirements of WHC-CM-7-5, Paragraph 2.5.4.3, for all of the 200 East Area double-shell tank farms (A-17/P-26, A-27, A-29, and A-40 stacks). Paragraph 2.5.4.3 requires continuous sampling or monitoring of airborne emissions that have the potential to exceed 10 percent of any DCG public value.

5.7 DETERMINE THE NEED TO EVALUATE WORKER EXPOSURE TO TRITIUM DURING UNIQUE OPERATING CONDITIONS

Unique operating conditions (such as a dump of the 242-A Evaporator pot, waste transfer, etc.) may result in increased tritium emissions. Radiological Control should determine if an evaluation of tritium emissions is needed to assess worker exposure during unique operating conditions.

5.8 EVALUATE ACTUAL OFFSITE DOSE FROM TRITIUM EMISSIONS FROM THE 242-A EVAPORATOR

The potential offsite dose from tritium emissions from the evaporator vessel vent is less than 10 percent of the potential offsite dose from all radionuclides (see Appendix H), therefore continuous sampling for tritium is not required by NESHAPs. However, tritium emissions from the evaporator may be a significant portion of the offsite dose from the evaporator vessel vent stack.

5.9 REPLACE O-RING SEALS IN EXISTING SAMPLING CARTRIDGES

If Effluent and Emissions Monitoring intends to use the RADeCO Model ACT-100 Tritium/Carbon-14 Sampler again, recommend replacing the O-ring seals of the cartridge holder with gaskets that are available from the manufacturer. The gaskets are designed to reduce or eliminate air infiltration into the sample cartridge.

6.0 UNCERTAINTIES

6.1 VARIABLES IN TANK ENVIRONMENTS AND EFFLUENT TREATMENT

6.1.1 Transfers

The only transfer that occurred during the sampling period was from 244-BX (originated from 111-BX, 102-BY, and 109-BY) to 101-AN (Rios 1994). Based on the psychrometric data collected on June 2, 1994 (WHC Work Package #2E-94-00558/P), the airflow through tank 101-AN is not significantly greater than the airflow through any of the other tanks in AN Farm (see Table 6-1).

Table 6-1. AN Tank Farm, Tank Exhaust Airflow.

Tank	Exhaust Air Flow [m^3/min (cfm)]
101-AN	2.83 (100)
102-AN	5.49 (194)
103-AN	4.90 (173)
104-AN	3.99 (141)
105-AN	3.20 (113)
106-AN	2.55 (90)
107-AN	4.81 (170)

The transfer likely affected the sampling result by indicating that the tritium concentration in the effluent is slightly higher than it actually is during normal operating conditions. The waste being transferred into the tank would have free-fallen into the tank waste from the inlet, which is approximately 6.1 meters (20 feet) above the tank waste level (Reberger 1994). The free-fall of the waste as well as the disturbance created when the transferred waste came in contact with the tank waste would tend increase emissions.

6.1.2 Airlift Circulators

The airlift circulators are a device used to cool the waste by bubbling air through it. Airlift Circulators are located in the AY and AZ double-shell tanks, and on tanks 107-AN and 102-AW. The status of the airlift circulators during the sampling period is shown in Table 6-2.

Table 6-2. Airlift Circulator Status During Sample Period.

Tank	Sample Period (CY94)	Status
102-AW	6/24 - 6/27	OFF DURING SAMPLE PERIOD
107-AN	6/7 - 6/14	NOT OPERATIONAL
101-AY	5/31 - 6/7 7/25 - 7/27	OFF DURING SAMPLE PERIOD OFF DURING SAMPLE PERIOD
102-AY	5/31 - 6/7 7/25 - 7/27	OFF DURING SAMPLE PERIOD OFF DURING SAMPLE PERIOD
101-AZ	5/31 - 6/7 7/25 - 7/27	OFF DURING SAMPLE PERIOD OFF DURING SAMPLE PERIOD
102-AZ	5/31 - 6/7 7/25 - 7/27	OFF DURING SAMPLE PERIOD OFF DURING SAMPLE PERIOD

6.1.3 Deentrainers

Deentrainers are used for removing excess moisture from the exhaust air to avoid loading the HEPA filters. The moisture removal efficiency of a deentrainer is a function of the velocity of the exhaust air passing through it. Deentrainers are located on all of the 200 East Area double-shell tank ventilation systems, and were believed to be in normal operation during the sample periods.

6.1.4 Variations in Inlet Air Temperature and Humidity

Variations in the inlet temperature and humidity may affect H-T-O emissions by changing the evaporation rate. Ambient air temperatures and relative humidity measured during the sampling periods are listed in Appendix D.

6.1.5 Variations in Tank Pressure

A negative tank pressure (or vacuum) is maintained by the ventilation systems to ensure that emissions from the waste are pulled through HEPA filters. Variations in the tank pressure (vacuum) could have affected the rate at which tritium was released from the waste.

6.2 SAMPLING VARIABLES

6.2.1 Ratio of H-T-O Concentration to H-T Concentration

The instrument used to collect the tritium sample was designed to collect both forms of tritium (gas and vapor). The H-T (if present) was converted to H-T-O by a catalytic converter so that it could be collected on the solid sorbant (sampling media).

If a significant amount of H-T is present in the tank waste and airborne emissions from the tanks, then the offsite dose from tritium emissions reported by this project are overestimated.

EXAMPLE: Assuming that the ratio of H-T-O concentration to H-T concentration is 9 and based on the sampling method that was used (which collected both H-T-O and H-T), the offsite dose will be overestimated by the following amount:

[The dose received from H-T-O is 25,000 greater than the dose received from H-T, (DOE/EH-0173T).]

CONCENTRATION		CATALYTIC CONVERTER EFFICIENCY		SAMPLE COLLECTION EFFICIENCY		AMOUNT OF H-T-O
90. units (H-T-O)	*	n/a	*	0.99	=	89.1
10. units (H-T)	*	0.70	*	0.99	=	6.9
TOTAL INDICATED AMOUNT OF H-T-O						96.0 units

Actual Dose (90. * 25,000.) + (10. * 1.) = 2,250,010.

INDICATED DOSE = 96. * 25,000. = 2,400,000.

DIFFERENCE 149,990.

ERROR (overestimation of dose) = $\frac{149{,}990.}{2{,}250{,}010.}$ = 7%

6.2.2 Sample Flow Variability

At the start of each sampling run, and at the midpoint of the sample period, the sample flowrate was checked, and adjusted to 100 cc/min (if necessary). During some of the sample periods, it was noted that the sample flow had decreased or increased. The operating manual for the sampling unit suggests the following as potential causes of flow variability:

- Excessive dirt or moisture in the rotameter
- Leaks in tube fittings
- Leaks in cartridge holder
- Plugged lines.

Leaks in the cartridge holder are believed to be the cause of the sampling variability. Excessive dirt/moisture was not observed in the rotameter. The sample periods were sufficiently short such that plugging would not be expected and the sample tube did not appear to contain debris or excessive moisture.

The manufacturer of the sample cartridges stated that air leakage through the O-ring seals of the cartridge holder is common. The problem should be corrected by obtaining gaskets from the manufacturer, that are designed to reduce or eliminate air infiltration into the sample cartridge (Kline 1994).

6.2.3 Sampling System Shut Down

During collection of the sample from stack A-17, the sampler was shut down by a thermal fuse in the sampler three days into the seven day sample period. The sampler sat idle for the remaining four days of the sample period. It is possible that some of the H-T-O in the sample was lost. The H-T-O may have desorbed from the sampling media and escaped. The manufacturer of the sampling cartridges stated that the collection efficiency of the sampling media is (99+/-1) percent, and that desorption is unlikely (Kline 1994).

Since the concentrations measured in the A-17 stack were greater than the concentrations measured from the P-26 stack, and air would not be expected to flow through the sampler when the pump is not operating, it is believed that the effect this event had on the A-17 sample was negligible.

7.0 DESCRIPTION OF ALTERNATIVES AND SOLUTION

7.1 CRITERIA

The recommendations of this study are primarily based on the requirements in 40 CFR 61.94(b)(4)(i) that "All radionuclides which could contribute to greater than 10 percent of the potential effective dose equivalent for an emission point shall be measured."

Requirements from the following other sources were also briefly addressed in the compliance section and were considered in the recommendations:

a. "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance" (DOE/EH-0173T)

b. "Environmental Compliance" (WHC-CM-7-5)

c. "Radiological Control Manual" (DOE/EH-0256T, Rev. 1).

7.2 ASSUMPTIONS

7.2.1 All of the Tritium Released from the Tanks is in the Form of H-T-O

Tritium is produced in the primary cooling water loop of nuclear reactors through reactions with cooling water additives, and in the reactor fuel by ternary fission (NUREG/CR-3332). The tritium in the tanks is most likely a waste from the spent fuel. Greater than 95 percent of the tritium from spent nuclear fuel is in the form of H-T-O (NUREG/CR-3332). Tritium sampling on the main PUREX stack, taken when the facility was processing spent nuclear fuel, indicated that all of the tritium released was in a vapor form (Catlow 1994), therefore, all of the tritium in the 200 Area double-shell tanks is assumed to be H-T-O.

If the sampling method used only collected tritium in the form H-T-O, the error in calculated offsite dose from tritium would be negligible even if the concentration of H-T is equal to the concentration of H-T-O.

EVALUATION: If the concentration of H-T is equal to the concentration of H-T-O and only the H-T-O was sampled, the offsite dose would be underestimated by the following amount:

	CONCENTRATION		COLLECTION EFFICIENCY		RELATIVE DOSE	
CALCULATED DOSE	1. μCi/ml (H-T-O)	*	0.99	= 0.99 *	25,000.	= 24,750.
UNDETECTED DOSE	1. μCi/ml (H-T)	*			1.	= 1.

$$\textbf{ERROR (underestimation of dose)} = \frac{1.}{24{,}750. + 1.} << 1\% \quad (0.00004)$$

CONCLUSION: A tritium sampling system that collects only H-T-O will not significantly underestimate tritium emissions.

7.2.2 The Derived Concentration Guides will be replaced

At the time this report was being prepared, the understanding was that the Derived Concentration Guides and associated sampling requirements in WHC-CM-7-5 would be replaced with standards that are similar to those of NESHAPs (Bates 1994).

7.2.3 All of the Tritium is in the Liquid Waste

Assume that all of the tritium that is being released is from the liquid waste, rather than from the sludge or saltcake.

7.3 ALTERNATIVES

Four alternatives have been developed to address the options for tritium sampling/ monitoring. The alternatives do not address options for any of the other actions recommended in Section 5.

- **No Action**

For the No Action Alternative, it is assumed that a waiver from the requirement for Continuous Sampling (WHC-CM-7-5, Paragraph 2.5.4.3) could be successfully pursued for the 200 East DSTs.

The only action that is not currently being performed but is required by the regulations listed in Section 7.1 is continuously sampling for tritium.

The disadvantage of the No Action Alternative is:

- Annual radionuclide emissions from the 200 East double shell tank farms will be significantly underestimated in the DOE/RL and WHC annual emission reports.

- **Continuous Monitoring**

Continuous monitoring involves the installation of a direct reading instrument and new sampling line on each of the 200 East DST stacks. The instrument would directly measure the tritium concentration.

Based on the tritium concentrations measured by this project, continuous monitoring is only required by WHC-CM-7-5 as an alternative to continuous sampling.

This alternative may be appropriate in a situation where tritium concentrations could significantly change within a short period of time, and a means is needed to alert personnel of a potential inhalation hazard. Tritium concentrations are not expected to significantly change within a short period of time during normal operating conditions, compared to particulate emissions, which could significantly increase in the unlikely event of HEPA filter failure.

The advantages of the Continuous Monitoring Alternative are as follows:

- Provides the ability to determine the tritium concentration in the effluent from the stacks at any time.

- Provides alarm capability which is not available with the sampling alternatives.

- Precludes the need for lab analysis of samples.

The disadvantage of the Continuous Monitoring Alternative is as follows:

- High costs for procurement, installation, calibration, operation, and maintenance.

- **Continuous Sampling**

Continuous sampling involves the installation of a sample cartridge holder, new sampling line, sample pump, sample flow totalizer, and sample flow indicator on each of the 200 East DST stacks. The sample cartridges would need to be replaced on a weekly or biweekly schedule, and sent to a laboratory on site for analysis to determine tritium emissions during the sample period.

Continuous sampling for tritium is not required by NESHAP because the potential offsite dose from tritium is less than 10 percent of the potential offsite dose from all radionuclides for each of the 200 East DST stacks.

Continuous sampling for tritium is required by WHC-CM-7-5, Paragraph 2.5.4.3 because the tritium concentrations measured exceed or potentially exceed 10 percent of the DCG for tritium. At the time this report was being prepared, it was understood that the DCGs and associated requirements will be replaced with new standards that are similar to NESHAP requirements (Bates 1994). Since waste containing tritium is not currently being added to the 200 East DSTs, and because the tank environments remain relatively static (ie. waste temperatures, stack flowrates, etc.), the concentration of tritium in the stack emissions is not expected to vary significantly. Furthermore, tritium vapor emissions are not expected to significantly increase in the unlikely event of a HEPA filter failure, as would be the case with particulate emissions. Therefore, continuous sampling does not appear to be much more beneficial than periodic confirmatory measurements.

The advantages of the Continuous Sampling Alternative are as follows:

- Provides the ability to quantify annual tritium emissions.
- Samples would be collected during unique operating conditions.

The disadvantages of the Continuous Sampling Alternative are as follows:

- The cost of installing a new sampling port and sample line, upgrading electrical power (if required), upgrading the sampling/monitoring cabinet heating/ventilation system (if required due to additional cooling load from pump motor), and upgrading the sampling/monitoring cabinets (if required due to insufficient space) for each of the 200 East DST stacks would be significant.

- Costs for calibration, operation, and maintenance of the sampling unit.

- Sample analysis cost is approximately $26,000./year ($100./sample x 52 samples/year x five DST stacks).

- **Periodic Confirmatory Measurements**

Periodic confirmatory sampling involves the temporary, one-week installation of a tritium sampler and sampling line on each of the 200 East DST stacks. The sampling frequency would initially be quarterly, until the variability of the tritium concentrations is determined, then reduced to annual if appropriate. The sample cartridges would need to be sent to a laboratory on site for analysis to determine tritium emissions during the sample period.

Periodic confirmatory sampling is only clearly required by NESHAPs for release points that have the potential to discharge radionuclides into the air in quantities which could cause an effective dose equivalent no greater than 0.1 mrem/year. Since the release points (stacks) are already being continuously sampled for radionuclides which could potentially cause an effective dose equivalent greater than 0.1 mrem/year, and tritium emissions could not potentially cause an effective dose equivalent greater than 0.1 mrem/year, periodic confirmatory measurements for tritium are not clearly required.

The advantages of the Periodic Confirmatory Measurement Alternative are as follows:

- Provides increased confidence in annual tritium emission estimates for reporting purposes (compared to predicting emissions based on CY94 tritium sampling concentrations and decrease in tritium inventory due to radioactive decay, or some other method).

- Does not requires costly permanent modifications to existing equipment.

The disadvantages of the Periodic Confirmatory Measurement Alternative are as follows:

- Procedures would need to be developed to conduct the periodic confirmatory measurements.

- Sample analysis cost is approximately $2,000./year ($100./sample x four samples/year x five stacks).

- Labor cost for setting up and relocating the sampler.

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Reberger, D. W., 1994, *Discussion of Transfer From Tank 244-BX to Tank AN-101*," (memo #11-10-3), D. D. Bachand, September 7) Westinghouse Hanford Company, Richland, Washington.

Rios, R. R., 1994, *Tank Transfers During Sample Period*, (Tank Liquid Level Logbook, September), Westinghouse Hanford Company, Richland, Washington.

Till, J. E., and H. R. Meyer, 1983, *Radiological Assessment: A Textbook on Environmental Dose Analysis*, NUREG/CR-3332, ORNL-5968, U.S. Nuclear Regulatory Commission, Washington, D.C., and Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Walker, F. W., G. J. Kirouac, F. M. Rourke, and Knolls Atomic Power Laboratory, 1977, *Chart of the Nuclides*, Twelfth Edition, General Electric Company, Schenectady, New York.

WHC, 1991, *Unit Dose Calculation Methods and Summary of Facility Effluent Monitoring Plan Determinations*, WHC-EP-0498, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993, *Determination of the NESHAP Status of Tank Farm Stacks Based on Calculations Using 40 CFR, Part 61, Appendix D Factors*, WHC-SD-WM-EMP-031, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994, *Tank Characterization Report for Double-Shell Tank 241-AP-101*, WHC-SD-WM-ER-357, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994, *Tank Farm Stack Sampling System Configuration and Efficiency Study*, WHC-SD-WM-ES-291, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-7-5, *Environmental Compliance*, Westinghouse Hanford Company, Richland, Washington.

10 CFR 40, 1993, "Protection of Environment," Subpart H, *Code of Federal Regulations*, as amended.

APPENDIX A

EQUIPMENT LIST AND SETUP

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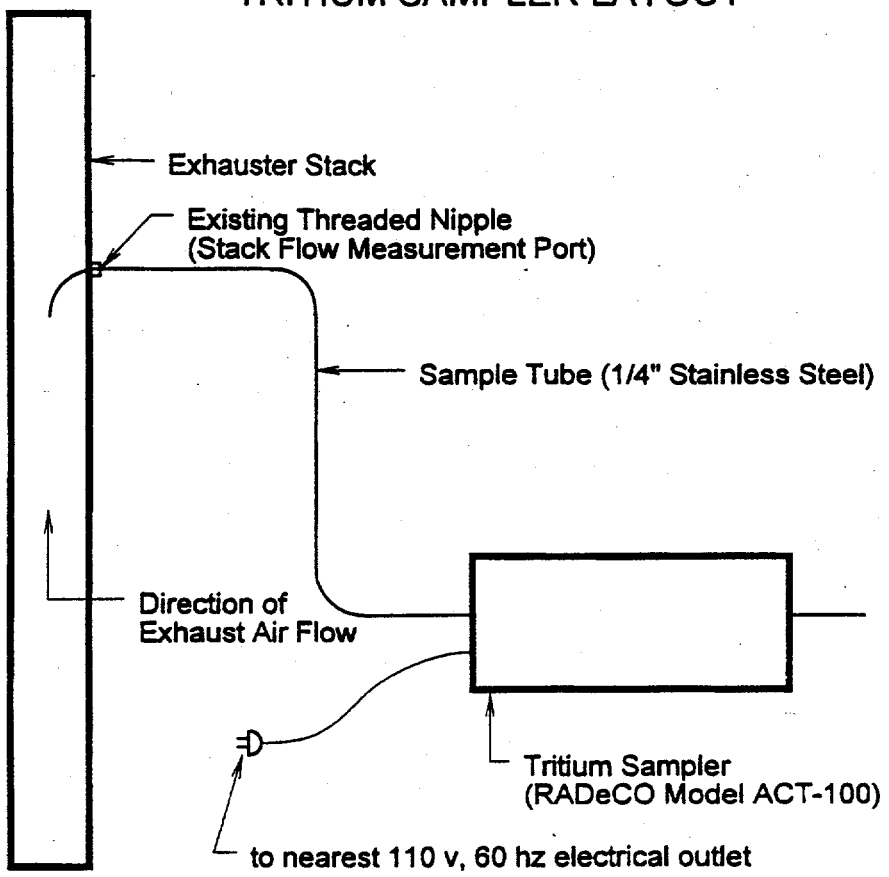
APPENDIX A
EQUIPMENT LIST AND SETUP

The primary piece of equipment was an SAIC RADeCO Model ACT-100 Tritium and Carbon 14 Gaseous Effluent Sampler. The sampling cartridge used was strictly for collecting tritium in the vapor form (H-T-O). Tritium in the gaseous form (H-T) was converted to the vapor form by a catalytic converter in the sampling unit. The catalytic converter efficiency is (70+/-10) percent for the oxidation of hydrogen. The sampling media ($CaSO_4$) collection efficiency is (99+/-1) percent for absorption of tritium in the vapor form.

The tritium sampler was placed adjacent to the stack (usually on scaffolding adjacent to the stack), and plugged into the nearest 120 V electrical outlet. A 1/4" stainless steel tube was bent into the shape of a probe, inserted into a flow measurement port in the stack, and connected to the tritium sampler using threaded fittings. The remaining opening between the sampling tube and flow measurement port was sealed with duct tape.

TRITIUM SAMPLER LAYOUT



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APPENDIX B

HISTORICAL TRITIUM SAMPLE RESULTS

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Tritium concentrations have been measured in the effluent from AP Tank Farm stack and the 242-A Evaporator Vessel Vent. The results are shown in table B-1.

Table B-1. Historical Sample Results From 242-A Evaporator and AP Tank Farm.

SAMPLE LOCATION	SAMPLE DATE	TRITIUM CONCENTRATION (μCi/ml)	COMMENTS
AP TANK FARM[1]	10/27/89	4.9E-8	Base Line Sample
	11/21/89	3.5E-8	Base Line Sample
	1/15/90	1.3E-8	Sampled After 8 inches[4] PDD[5] were Transferred
	1/22/90	1.2E-7	Sampled During Transfer of 68 inches PDD
	1/29/90	1.1E-7	Sampled After 109 inches PDD were Transferred
242-A EVAPORATOR VESSEL VENT[2]	2/7/89	8.9E-9[3]	
	2/8/89		
	3/1/89		

[1]WHC Internal Memo #13331-90-078; "Tritium Levels in 241-AP Farm", Dated February 21, 1990, from L. M. Bergmann to J. P. Bramson, et al.
[2]WHC Internal Memo #12715-ASL-136; "Tritium Content of 242-A Evaporator Stack Gases", Dated April 6, 1989, from V. B. Subrahmanyam to C. M. Winkler, et al.
[3]Upper 95 percent confidence interval tritium concentration.
[4]Inches of PDD Received in Tank 107-AP.
[5]PUREX Process Distillate Discharge.

The data in Table B-1 is not directly comparable to the 1994 tritium concentrations discussed in this report, other than to note that the historical tritium concentrations are not significantly different from the 1994 tritium concentrations. Other than that similarity, the tritium samples were collected by a different sampling method (possible difference in collection efficiencies); the tritium inventory in AP Tank Farm would have decreased (due to radioactive decay) by approximately 20 percent since the historical samples were taken; and waste containing tritium (from PUREX) is believed to have been transferred to AP Tank Farm since the historical samples were taken.

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APPENDIX C

TANK WASTE LIQUID TEMPERATURES

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Tables C-1 through C-4. Tank Waste Liquid Temperatures.

Tank	Date/period Measured	Average Liquid Temperature deg C (deg F)
AY-101	10/10/94	24 (75)
AY-102	9/28/94	22 (72)
AZ-101	8/4/94	66 (151)
AZ-102	8/4/94	51 (124)

Tank	Date/period Measured	Average Liquid Temperature deg C (deg F)
AW-101	CY 94	41 (105)
AW-102	CY 94	21 (70)
AW-103	CY 94	21 (70)
AW-104	CY 94	29 (85)
AW-105	CY 94	22 (72)
AW-106	CY 94	37 (98)

Tank	Date/period Measured	Average Liquid Temperature deg C (deg F)
AN-101	CY 94	21 (70)
AN-102	CY 94	38 (100)
AN-103	CY 94	47 (116)
AN-104	CY 94	51 (124)
AN-105	CY 94	46 (114)
AN-106	CY 94	20 (68)
AN-107	CY 94	39 (102)

Tank	Date/period Measured	Average Liquid Temperature deg C (deg F)
AP-101	CY 94	17 (62)
AP-102	CY 94	28 (82)
AP-103	9/26/94	19 (67)
AP-104	CY 94	16 (60)
AP-105	CY 94	22 (72)
AP-106	CY 94	20 (68)
AP-107	CY 94	16 (60)
AP-108	CY 94	18 (64)

Gooding, B. C., 1994, *Double-Shell Tank Temperature Reports and Graphs*, Westinghouse Hanford Company, Richland, Washington.

APPENDIX D

AMBIENT TEMPERATURE/HUMIDITY DURING SAMPLE PERIOD

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Table D-1. Ambient Temperature/Humidity During Sample Period

Sample	Date	Relative Humidity (percent) High / Low	Ambient Temperature deg C (deg F) High / Low
AY-1	5/31/94	60 / 21	27 (80) / 13 (55)
	6/1	69 / 11	26 (78) / 12 (53)
	6/2	66 / 13	29 (84) / 7 (44)
	6/3	63 / 25	30 (86) / 12 (54)
	6/4	57 / 21	27 (80) / 14 (58)
	6/5	88 / 35	25 (77) / 13 (55)
	6/6	90 / 28	22 (72) / 10 (50)
	6/7	64 / 26	22 (71) / 10 (50)
AN-1	6/7	64 / 26	22 (71) / 10 (50)
	6/8	71 / 15	26 (78) / 8 (46)
	6/9	48 / 19	29 (85) / 15 (59)
	6/10	60 / 20	32 (89) / 13 (55)
	6/11	51 / 21	32 (89) / 18 (64)
	6/12	70 / 13	29 (85) / 16 (60)
	6/13	55 / 23	23 (73) / 10 (50)
	6/14	53 / 19	24 (75) / 12 (53)
AP-1	6/15	56 / 20	24 (76) / 8 (46)
	6/16	53 / 18	27 (80) / 11 (52)
	6/17	64 / 14	28 (83) / 10 (50)
	6/18	87 / 25	24 (76) / 12 (53)
	6/19	61 / 19	29 (84) / 9 (49)
	6/20	38 / 14	34 (94) / 17 (62)

Sample	Date	Relative Humidity (percent) High / Low	Ambient Temperature deg C (deg F) High / Low
AP-2	6/22	46 / 14	38 (101) / 20 (68)
	6/23	52 / 24	33 (91) / 15 (59)
	6/24	65 / 18	29 (84) / 10 (50)
AW-1	6/24	65 / 18	29 (84) / 10 (50)
	6/25	52 / 15	33 (91) / 16 (60)
	6/26	61 / 25	27 (80) / 14 (57)
	6/27	67 / 17	31 (88) / 11 (52)
AP-3	7/6	85 / 25	31 (88) / 11 (52)
	7/7	76 / 18	34 (94) / 14 (58)
AY-2	7/25	64 / 15	39 (102) / 19 (66)
	7/26	55 / 16	37 (99) / 18 (64)
	7/27	39 / 13	39 (103) / 17 (63)

Gifford, O. P., 1994, *Ambient Temperature/Humidity During Sample Period*, (cc:Mail to D. D. Bachand, September 6), Westinghouse Hanford Company, Richland, Washington.

APPENDIX E

LABORATORY ANALYTICAL RESULTS

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Sample ID	Lab ID	Result uCi/Sample	2 Sigma Uncertainty %	Average Efficiency %	Counting Time Minutes	Background c/m	Background 2 Sigma Uncertainty
AY-1	E7858	4.72E-02	16.2	21.95	50	20.48	6.3
AN-1	E7881	4.38E-03	43.4	24.19	5	19.20	20.4
AP-1	E7918	2.36E-02	27.1	23.88	50	20.60	6.3
AP-2	E7957	8.64E-03	43.5	23.54	50	20.48	6.3
AW-1	E7960	4.74E-03	132.9	23.18	5	19.20	20.4
AP-3	E8008	5.17E-03	50.3	16.92	50	19.96	6.3

Results and 2 sigma uncertainty for each sample are based on five 3 gram aliquots.

SAMPLE STATUS REPORT FOR E 7858. E-BLANK AY-1 TIME: 7/11/94 14:45
DISPATCHED: 6/ 7/94 13:27 SAMPLE HAS NOT BEEN SLURPED
RECEIVED: 6/ 7/94 13:35

EXT.	DETER.	RESULTS OR STATUS	OUT OF RANGE?	GOOD ANS?	CHARGE CODE
****	********	**********	***	***	******
2311	H3-SLGL	4.72E-2 UCI/SAMPLE 16.2%ERROR			VOGEL

END OF REPORT

SAMPLE STATUS REPORT FOR E 7881. E-BLANK AY-1 TIME: 7/11/94 14:45
DISPATCHED: 6/14/94 7:51 SAMPLE HAS NOT BEEN SLURPED
RECEIVED: 7/11/94 14:37

EXT.	DETER.	RESULTS OR STATUS	OUT OF RANGE?	GOOD ANS?	CHARGE CODE
****	********	**********	***	***	******
2311	H3-SLGL	4.38E-3 UCI/SAMPLE 43.4%ERROR			VOGEL

END OF REPORT

SAMPLE STATUS REPORT FOR E 7918. E-BLANK AP-1 TIME: 7/11/94 14:45
DISPATCHED: 6/21/94 13:28 SAMPLE HAS NOT BEEN SLURPED
RECEIVED: 6/23/94 8:31

EXT.	DETER.	RESULTS OR STATUS	OUT OF RANGE?	GOOD ANS?	CHARGE CODE
****	********	**********	***	***	******
2311	H3-SLGL	2.37E-2 UCI/SAMPLE 27.1%ERROR			VOGEL

END OF REPORT

SAMPLE STATUS REPORT FOR E 7957. E-BLANK AT-2 TIME: 7/11/94 14:45
DISPATCHED: 6/23/94 15:14 SAMPLE HAS NOT BEEN SLURPED
RECEIVED: 6/27/94 7:55

EXT.	DETER.	RESULTS OR STATUS	OUT OF RANGE?	GOOD ANS?	CHARGE CODE
****	********	**********	***	***	******
2311	H3-SLGL	8.64E-3 UCI/SAMPLE 43.5%ERROR			VOGEL

END OF REPORT

SAMPLE STATUS REPORT FOR E 7960. E-BLANK AW-1 TIME: 7/11/94 14:45
DISPATCHED: 6/27/94 8:16 SAMPLE HAS NOT BEEN SLURPED
RECEIVED: 6/28/94 7:48

EXT.	DETER.	RESULTS OR STATUS	OUT OF RANGE?	GOOD ANS?	CHARGE CODE
****	********	**********	***	***	******
2311	H3-SLGL	4.74E-3 UCI/SAMPLE 132.9%ERROR			VOGEL

END OF REPORT

SAMPLE STATUS REPORT FOR E 8008. E-BLANK AP3 TIME: 7/15/94 8:45
DISPATCHED: 7/ 6/94 15:37 SAMPLE HAS NOT BEEN SLURPED
RECEIVED: 7/14/94 15:14

EXT.	DETER.	RESULTS OR STATUS	OUT OF RANGE?	GOOD ANS?	CHARGE CODE
****	********	**********	***	***	******
2311	H3-SLGL	5.17E-3 UCI/SAMPLE 50.3%ERROR			J12UP

END OF REPORT

[3] From: Stanley A Catlow at ~WHC168 8/8/94 8:17AM (684 bytes: 15 ln)
To: Judson L Kenoyer at ~WHC266, Donald D Bachand at ~WHC266
cc: John R Prilucik at ~WHC167
Subject: Tritium in Dririte
---------- Message Contents ----------

Judson,

Here are the results of the latest Dririte sample:

Activity	3.61E-03
2 sigma Uncert	1.83E-03
Background	0.00
Average Eff	21.5 %
Counting time	50 min.

If you have any questions, give me a call 373-5638.

Stan

LAB ID E8183

SAMPLE ID AY-2

APPENDIX F

TRITIUM SAMPLE CHAIN-OF-CUSTODY FORMS

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COPY

Westinghouse Hanford Company

CHAIN OF CUSTODY/SAMPLE ANALYSIS REQUEST

Page 1 of 1

Data Turnaround: ☐ Priority ☐ Normal

Collector: Steve Mercuin	Company Contact: SAIC - Judson Kenoyer	Telephone No.: 943-3133
Project Designation	Sampling Location: AP Stack	SAF No.
Ice Chest No.	Field Logbook No.	Method of Shipment
Shipped To: 222-S	Offsite Property No.	Bill of Lading/Air Bill No.
Possible Sample Hazards/Remarks	Preservative	
	Type of Container	
	No. of Container(s)	
Special Handling and/or Storage	Volume	

SAMPLE ANALYSIS

Sample No.	Matrix*	Date Sampled	Time Sampled
E-7957		6/24/94	

CHAIN OF POSSESSION

Signature/Print Names

Relinquished By	Date/Time	Received By	Date/Time
[signature]	6/24/94 0935	[signature]	6-24-94 0935
[signature]	6-24-94 0935	[signature]	06-24-94 0830
Relinquished By	Date/Time	Received By	Date/Time
Relinquished By	Date/Time	Received By	Date/Time

SPECIAL INSTRUCTIONS

Matrix*

S	=	Soil
SE	=	Sediment
SO	=	Solid
SL	=	Sludge
W	=	Water
O	=	Oil
A	=	Air
DS	=	Drum Solids
DL	=	Drum Liquids
T	=	Tissue
WI	=	Wipe
L	=	Liquid
V	=	Vegetation
X	=	Other

LABORATORY SECTION: Received By | Title | Date/Time

FINAL SAMPLE DISPOSITION: Disposal Method | Disposed By | Date/Time

BC-0000-828 (12/92)

Westinghouse Hanford Company

CHAIN OF CUSTODY/SAMPLE ANALYSIS REQUEST

COPY

Page 1 of 1

Data Turnaround: Priority / Normal

Collector: S.E. Merwin | Company Contact: SAIC - Judson Kenoyer | Telephone No.: 943-3133

Project Designation | Sampling Location: AY Emergency Exhauster | SAF No.

Ice Chest No. | Field Logbook No. | Method of Shipment

Shipped To: 222-S | Offsite Property No. | Bill of Lading/Air Bill No.

Possible Sample Hazards/Remarks

Special Handling and/or Storage

Preservative																		
Type of Container																		
No. of Containers																		
Volume																		

SAMPLE ANALYSIS

E-9183

Sample No.	Matrix*	Date Sampled	Time Sampled															
AY-2																		

CHAIN OF POSSESSION — Sign/Print Names

Relinquished By	Date/Time	Received By	Date/Time
[signature]	7/27/94	MARK L. WILSON [signature]	7-26-94 0910
MARK L. WILSON [signature]	7-27-94 0950	[signature]	07/27/94 0930

SPECIAL INSTRUCTIONS

Matrix*: S = Soil; SE = Sediment; SO = Solid; SL = Sludge; W = Water; O = Oil; A = Air; DS = Drum Solids; DL = Drum Liquids; T = Tissue; WI = Wipe; L = Liquid; V = Vegetation; X = Other

LABORATORY SECTION: Received By | Title | Date/Time

FINAL SAMPLE DISPOSITION: Disposal Method | Disposed By | Date/Time

DISTRIBUTION: Original - Sample Yellow - Sampler

Westinghouse Hanford Company

CHAIN OF CUSTODY/SAMPLE ANALYSIS REQUEST

Page ... COPY

Data Turnaround: ☐ Priority ☒ Normal

Collector: S E Merwin
Company Contact: SAIC - Judson Kenoyer
Telephone No.: 943-3133
Project Designation:
Sampling Location: AP Stack
SAF No.:
Ice Chest No.:
Field Logbook No.:
Method of Shipment:
Shipped to: 222-S
Offsite Property No.:
Bill of Lading/Air Bill No.:
Possible Sample Hazards/Remarks:
Special Handling and/or Storage:

Preservative																		
Type of Container																		
No. of Container(s)																		
Volume																		

SAMPLE ANALYSIS

Sample No.	Matrix*	Date Sampled	Time Sampled
F-8008		7/7/94	

CHAIN OF POSSESSION

Sign/Print Names

Relinquished By	Date/Time	Received By	Date/Time
[signature]	7/7/94 9:30	DJ Rettat	7/7/94 9:30
[signature]	7/7/94 10:36	Douglas Cobb	07-07-94 1036

SPECIAL INSTRUCTIONS:

Matrix*
- S = Soil
- SE = Sediment
- SO = Solid
- SL = Sludge
- W = Water
- O = Oil
- A = Air
- DS = Drum Solids
- DL = Drum Liquids
- T = Tissue
- WI = Wipe
- L = Liquid
- V = Vegetation
- X = Other

LABORATORY SECTION: Received By ____ Title ____ Date/Time ____

FINAL SAMPLE DISPOSITION: Shipment Method ____ Disposed By ____ Date/Time ____

DISTRIBUTION: Original - Sample Yellow - Sampler

DC-6000-030 (12/93)

Westinghouse Hanford Company

CHAIN OF CUSTODY/SAMPLE ANALYSIS REQUEST

Page 1 of 1 COPY

Data Turnaround: ☐ Priority ☐ Normal

Collector: Steve Mercuri	Company Contact: SAIC - Judson Kenoyer	Telephone No.: 943-3133
Project Designation:	Sampling Location: AP Stack	SAF No.:
Ice Chest No.:	Field Logbook No.:	Method of Shipment:
Shipped To: 222-S	Offsite Property No.:	Bill of Lading/Air Bill No.:
Possible Sample Hazards/Remarks:		
Special Handling and/or Storage:		

SAMPLE ANALYSIS

Sample No.	Matrix*	Date Sampled	Time Sampled	Preservative	Type of Container	No. of Container(s)	Volume
[illegible]-7918		6/22/94					

CHAIN OF POSSESSION

Relinquished By	Date/Time	Received By	Date/Time
Steve Mercuri	6/22/94 0925	Sandra DeMott	6-22-94
Sandra DeMott	6-22-94	Sandra Cobb	06-22-94

SPECIAL INSTRUCTIONS: 1000

*Matrix: S = Soil; SE = Sediment; SO = Solid; SL = Sludge; W = Water; O = Oil; A = Air; DS = Drum Solids; DL = Drum Liquids; T = Tissue; WI = Wipe; L = Liquid; V = Vegetation; X = Other

LABORATORY SECTION: Received By ____ Title ____ Date/Time ____

FINAL SAMPLE DISPOSITION: Disposal Method ____ Disposed By ____ Date/Time ____

DISTRIBUTION: Original - Sample Yellow - Sampler

BC-6000-820 (12/91)

Westinghouse Hanford Company

CHAIN OF CUSTODY/SAMPLE ANALYSIS REQUEST

Page COPY

Data Turnaround: ☐ Priority ☐ Normal

Collector: Judson Kenoyer	Company Contact: SAIC - Judson Kenoyer	Telephone No.: 943-8153
Project Designation	Sampling Location: AW Stack	SAF No.
Ice Chest No.	Field Logbook No.	Method of Shipment
Shipped To: 222-S	Offsite Property No.	Bill of Lading/Air Bill No.
Possible Sample Hazards/Remarks	Preservative	
	Type of Container	
	No. of Container(s)	
Special Handling and/or Storage	Volume	

SAMPLE ANALYSIS

Sample No.	Matrix*	Date Sampled	Time Sampled
E-7960		6/27/94	

CHAIN OF POSSESSION

Sign/Print Names			
Relinquished By: Judson Kenoyer	Date/Time: 6/27/94 9:30	Received By: Don Redekopp	Date/Time: 6/27/94
Relinquished By: Don Redekopp	Date/Time: 6/27/94 9:55	Received By: Sandra Cobb	Date/Time: 06-27-94 1000
Relinquished By	Date/Time	Received By	Date/Time
Relinquished By	Date/Time	Received By	Date/Time

SPECIAL INSTRUCTIONS

Matrix*

S	= Soil
SE	= Sediment
SO	= Solid
SL	= Sludge
W	= Water
O	= Oil
A	= Air
DS	= Drum Solids
DL	= Drum Liquids
T	= Tissue
WI	= Wipe
L	= Liquid
V	= Vegetation
X	= Other

LABORATORY SECTION	Received By	Title	Date/Time
FINAL SAMPLE DISPOSITION	Disposal Method	Disposed By	Date/Time

DISTRIBUTION: Original - Sample Yellow - Sampler

BC-8000-820 (12/92)

Westinghouse Hanford Company

CHAIN OF CUSTODY/SAMPLE ANALYSIS REQUEST

Page COPY

Data Turnaround: ☐ Priority ☐ Normal

Collector: Steve Merwin	Company Contact: SAIC - Judson Kenoyer	Telephone No.: 943-3133
Project Designation	Sampling Location: AN Stack	SAF No.
Ice Chest No.	Field Logbook No.	Method of Shipment
Shipped To: 222-S	Offsite Property No.	Bill of Lading/Air Bill No.
Possible Sample Hazards/Remarks	Preservative	
	Type of Container	
	No. of Container(s)	
Special Handling and/or Storage	Volume	

SAMPLE ANALYSIS

Sample No.	Matrix*	Date Sampled	Time Sampled
E-7891		6/14/94	

CHAIN OF POSSESSION

Sign/Print Names

Relinquished By	Date/Time	Received By	Date/Time
[signature]	6/14/94 9:55	J Muscarella	6-14-94 0950
J Muscarella	6-14-94 1300	[signature]	6-14-94/1300
[signature]	6-14-94/1555	[signature]	06-14-94/1580
Relinquished By	Date/Time	Received By	Date/Time

SPECIAL INSTRUCTIONS

Matrix*
- S = Soil
- SE = Sediment
- SO = Solid
- SL = Sludge
- W = Water
- O = Oil
- A = Air
- DS = Drum Solids
- DL = Drum Liquids
- T = Tissue
- WI = Wipe
- L = Liquid
- V = Vegetation
- X = Other

LABORATORY SECTION: Received By | Title | Date/Time

FINAL SAMPLE DISPOSITION: Disposal Method | Disposed By | Date/Time

DISTRIBUTION: Original - Sample Yellow - Sampler

BC-0000-028 (12/92)

Westinghouse Hanford Company

CHAIN OF CUSTODY/SAMPLE ANALYSIS REQUEST

Pg COPY of 1

Date Turnaround: ☐ Priority ☐ Normal

Collector S. E. Merwin	Company Contact SAIC - Judson Kenoyer	Telephone No. 943-3133
Project Designation	Sampling Location AY/AZ Stack	SAF No.
Ice Chest No.	Field Logbook No.	Method of Shipment
Shipped To 222-S	Offsite Property No.	Bill of Lading/Air Bill No.
Possible Sample Hazards/Remarks	Preservative	
	Type of Container	
	No. of Container(s)	
Special Handling and/or Storage	Volume	

SAMPLE ANALYSIS: E7858

Sample No.	Matrix*	Date Sampled	Time Sampled
AY-1			

CHAIN OF POSSESSION

Relinquished By	Date/Time	Received By	Date/Time
Steve E Merwin	6/7/94 10 AM	[signature]	6-7-94 1045 AM
[signature]	6-7-94 11:15 AM	[signature]	6-7-94 1115

Sign/Print Names

SPECIAL INSTRUCTIONS

Matrix*: S = Soil; SE = Sediment; SO = Solid; SL = Sludge; W = Water; O = Oil; A = Air; DB = Drum Solids; DL = Drum Liquids; T = Tissue; WI = Wipe; L = Liquid; V = Vegetation; X = Other

LABORATORY RECEIPT: Received By ____ Title ____ Date/Time ____

FINAL SAMPLE DISPOSITION: Disposal Method ____ Disposed By ____ Date/Time ____

DISTRIBUTION: Original - Sample Yellow - Sampler

BC-6000-828 (12/92)

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APPENDIX G

AP TANK FARM POTENTIAL EMISSION CALCULATION

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Table G-1. AP Tank Farm Potential Offsite Dose. (2 sheets)

Radionuclide	Quantity[2] (Ci)	Form	Release Factor	Potential Quantity Released (Ci)	CAP-88[5] (mrem/Ci)	Potential Offsite Dose (mrem/yr)
^{3}H	2.11E+02	gas	1.00E+00	2.11E+02	2.19E-05	4.61E-03
^{14}C	2.65E+01	particulate	1.00E-03	2.65E-02	2.62E-03	6.95E-05
^{60}Co	3.20E+02	particulate	1.00E-03	3.20E-01	2.90E-02	9.27E-03
^{79}Se	4.79E-02	particulate	1.00E-03	4.79E-05	6.60E-05[1]	3.16E-09
$^{89,90}Sr$	6.70E+03	particulate	1.00E-03	6.70E+00	4.38E-02	2.93E-01
^{90}Y		particulate	1.00E-03		3.77E-04	
^{99}Tc	5.85E+02	particulate	1.00E-03	5.85E-01	1.09E-03	6.38E-04
$^{106}Ru/Rh$		gas	1.00E+00		2.09E-02	
^{125}Sb		particulate	1.00E-03		4.15E-03	
^{129}I	4.73E-01	gas	1.00E+00	4.73E-01	2.91E-01	1.38E-01[2]
^{134}Cs	1.67E+03	particulate	1.00E-03	1.67E+00	3.13E-02	5.24E-02
^{137}Cs	1.71E+06	particulate	1.00E-03	1.71E+03	2.39E-02	4.08E+01
^{144}Ce	4.31E+03	particulate	1.00E-03	4.31E+00	1.37E-02	5.90E-02
^{147}Pm	1.74E+00	particulate	1.00E-03	1.74E-03	1.14E-03	1.98E-06
^{154}Eu		particulate	1.00E-03			
^{234}U	2.81E-02	particulate	1.00E-03	2.81E-05	3.19E+00	8.96E-05
^{235}U	1.45E-03	particulate	1.00E-03	1.45E-06	2.96E+00	4.29E-06
^{238}U	5.39E-03	particulate	1.00E-03	5.39E-06	2.84E+00	1.53E-05

Table G-1. AP Tank Farm Potential Offsite Dose. (2 sheets)

Radionuclide	Quantity[2] (Ci)	Form	Release Factor	Potential Quantity Released (Ci)	CAP-88[5] (mrem/Ci)	Potential Offsite Dose (mrem/yr)
^{237}Np	2.83E+00	particulate	1.00E-03	2.83E-03	1.19E+01	3.37E-02
^{238}Pu	3.81E-02	particulate	1.00E-03	3.81E-05	8.02E+00	3.06E-04
$^{239,240}Pu$	5.62E-01	particulate	1.00E-03	5.62E-04	8.67E+00	4.87E-03
^{241}Pu		particulate	1.00E-03		1.38E-01	
^{241}Am	9.13E+00	particulate	1.00E-03	9.13E-03	1.31E+01	1.20E-01
^{242}Cm						0.00E+00[3]
^{244}Cm	1.49E-01	particulate	1.00E-03	1.49E-04	6.94	1.03E-03
Potential offsite dose for AP-101 through AP-107 =						41.50
Potential offsite dose for AP101 through AP-108 =						**47.43[4]**

[1]This is the GENII dose conversion factor (WHC-EP-0498). CAP-88 dose conversion factor was not available.

[2]Not decay corrected.

[3]Assume all has decayed to ^{238}Pu.

[4]Assuming potential offsite dose from tank AP-108 is 41.50 Ci./7 tanks.

[5]WHC-EP-0498.

Table G-2. Total Activity in Each AP Tank by Radionuclide (curies). (2 sheets)

Radionuclide	AP-101[1]	AP-102[2]	AP-103[3]	AP-104	AP-105[4]	AP-106[5]	AP-107[6]	Total
^{3}H	8.42E+00		2.24E+01		1.20E+01	2.09E+01	1.47E+02	2.11E+02
^{14}C		2.58E+01[7]	1.91E-02	9.48E-05[7]	6.75E-01	3.30E-02	1.33E-02	2.65E+01
^{60}Co		3.19E+02		5.54E-01[7]				3.20E+02
^{79}Se			4.79E-02					4.79E-02
$^{89,90}Sr$	2.26E+00	6.02E+03	2.68E+01[7]	2.70E-03[7]	6.47E+02	2.98E+00	4.94E-01	6.70E+03
^{90}Y								
^{99}Tc		3.58E+02	4.62E+00	4.02E-03[7]	2.17E+02	5.72E+00		5.85E+02
$^{106}Ru/Rh$								
^{125}Sb								
^{129}I					4.73E-01			4.73E-01
^{134}Cs			1.87E-02[7]		1.62E+03	5.38E+01		1.67E+03
^{137}Cs	1.30E+01	9.53E+05	2.80E+04	4.83E-02[7]	7.06E+05	1.95E+04	5.15E-01	1.71E+06
^{144}Ce		4.31E+03						4.31E+03
^{147}Pm			1.74E+00[7]					1.74E+00
^{154}Eu								
^{234}U			2.81E-02					2.81E-02
^{235}U			1.45E-03					1.45E-03

Table G-2. Total Activity in Each AP Tank by Radionuclide (curies). (2 sheets)

Radionuclide	AP-101[1]	AP-102[2]	AP-103[3]	AP-104	AP-105[4]	AP-106[5]	AP-107[6]	Total
^{238}U			5.39E-03					5.39E-03
^{237}Np			7.59E-02[7]		9.77E-01	1.78E+00		2.83E+00
^{238}Pu								
$^{239,240}Pu$			7.05E-02[7]	2.66E-04[7]	4.91E-01			5.62E-01
^{241}Pu								
^{241}Am		1.75E+00	5.70E+00[7]	6.53E-05[7]	1.27E+00	4.07E-01		9.13E+00
^{242}Cm		3.81E-02[7]						3.81E-02
^{244}Cm		1.49E-01[7]		1.11E-04[7]				1.49E-01

[1]WHC-SD-WM-ER-357, Rev. 0 (unless otherwise noted)
[2]WHC-SD-WM-ER-358, Rev. 0 (unless otherwise noted)
[3]WHC-SD-WM-ER-359, Rev. 0 (unless otherwise noted)
[4]WHC-SD-WM-ER-360, Rev. 0 (unless otherwise noted)
[5]WHC-SD-WM-ER-361, Rev. 0 (unless otherwise noted)
[6]WHC-SD-WM-ER-362, Rev. 0 (unless otherwise noted)
[7]WHC-SD-WM-TI-543

Note: Blank squares indicate radionuclide was not sampled, not analyzed, or not detected.

REFERENCES

WHC, 1993, *Radionuclide and Chemical Inventories for the Double-Shell Tanks*, WHC-SD-WM-TI-543, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994a, *Tank Characterization Report for Double-Shell Tank 241-AP-101*, WHC-SD-WM-ER-357, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994b, *Tank Characterization Report for Double-Shell Tank 241-AP-102*, WHC-SD-WM-ER-358, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994c, *Tank Characterization Report for Double-Shell Tank 241-AP-103*, WHC-SD-WM-ER-359, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994d, *Tank Characterization Report for Double-Shell Tank 241-AP-105*, WHC-SD-WM-ER-360, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994e, *Tank Characterization Report for Double-Shell Tank 241-AP-106*, WHC-SD-WM-ER-361, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994f, *Tank Characterization Report for Double-Shell Tank 241-AP-107*, WHC-SD-WM-ER-362, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994g, *Tank Characterization Report for Double-Shell Tank 241-AW-102*, WHC-SD-WM-ER-363, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994h, *Tank Characterization Report for Double-Shell Tank 241-AW-105*, WHC-SD-WM-ER-364, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994i, *Tank Characterization Report for Double-Shell Tank 241-AW-106*, WHC-SD-WM-ER-365, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX H

EVAPORATOR POTENTIAL TRITIUM EMISSIONS

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This section was added as an appendix because it was not included in the original scope of this project.

PURPOSE: Determine if the 242-A Evaporator Vessel Vent emissions should be sampled for tritium, either periodically or continuously.

POTENTIAL EMISSION CALCULATION:

ASSUMPTIONS:

1. The evaporator processes 230,000. gallons of waste per day (DOE/RL-90-42, "Evaporator Dangerous Waste Permit Application").
2. The evaporator processes waste 365 days per year.
3. All of the tritium in the waste processed is released through the vessel vent stack.
4. The waste is from Tank AP-107 (worst case, tritium concentration in the liquid waste is 3.52E-2 uCi/ml, WHC-SD-WM-ER-362, Rev. 0).

POTENTIAL CURIES OF TRITIUM RELEASED PER YEAR:

$$3.52E\text{-}2 \frac{uCi}{ml} * 3{,}785. \frac{ml}{gal} * 230{,}000. \frac{gal}{day} * 365 \frac{day}{yr} = 11{,}186.\ Ci$$

POTENTIAL OFFSITE DOSE FROM TRITIUM:

$$11{,}186. \frac{Ci}{yr} * 2.19E\text{-}5^{2} \frac{mrem}{Ci} = 0.24 \frac{mrem}{yr}$$

FRACTION OF POTENTIAL OFFSITE DOSE FROM VESSEL VENT STACK:

$$\frac{0.24}{0.24 + 50.2^{1}} = << 1\%$$

CONCLUSION: Tritium could not contribute greater than 10 percent of the potential offsite dose from the 242-A Evaporator Vessel Vent Stack, therefore, tritium sampling is not required by NESHAPs [40 CFR 61.93(b)(4)(i)].

RECOMMENDATION: Actual tritium emissions should be evaluated to determine:

- the actual dose from tritium as a fraction of the total dose from the Vessel Vent stack.

- if tritium emissions from the 242-A Evaporator Vessel Vent should be reported in the annual air emissions reports.

[1]WHC-SD-WM-EMP-031, Rev. 0
[2]WHC-EP-0498, Rev. 0