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Radioactive Liquid Waste Treatment Facility

Discharges in 2013

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Acronyms and Abbreviations

Ci	curie (3.7×10^{10} disintegrations per second)
DOE	United States Department of Energy
EPA	United States Environmental Protection Agency
L	liter
LANL	Los Alamos National Laboratory
nCi/L	nanocuries per liter (10^{-9} curies per liter)
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
pCi/L	picocuries per liter (10^{-12} curies per liter)
RLW	radioactive liquid waste(s)
RLWTF	Radioactive Liquid Waste Treatment Facility
TA	technical area

Radioactive Liquid Waste Treatment Facility Discharges in 2013

1. Purpose

This report documents radioactive discharges from the TA50 Radioactive Liquid Waste Treatment Facilities (RLWTF) during calendar 2013.

2. Summary

During 2013, all treated water was fed to the effluent evaporator. The evaporator was operated 3654 hours on 201 days during 2013, in both one-burner and two-burner mode. A total of 2.64 million liters of treated water were fed to the evaporator, and 2.55 million liters were discharged to the environment as steam from the evaporator stack.

The quality of treated water was monitored by collecting a weekly grab sample of water being fed to the effluent evaporator. Each sample was analyzed for gross alpha, gross beta, and tritium.

Weekly samples were then composited at the end of each month. These flow-weighted composite samples were analyzed for 37 radioisotopes: nine alpha-emitting isotopes, 27 beta emitters, and tritium. These monthly analyses were used to estimate the radioactive content of treated water fed to the effluent evaporator.

Samples were also collected of water drained from the evaporator. These samples, analyzed for alpha, beta, and tritium concentrations, were then used to estimate radioactive quantities present in evaporator drain water. The difference, rad fed less rad drained, yielded quantities of radioactivity discharged through the stack into the environment . Table 1 summarizes this information.

Table 1
RLWTF Discharges of Treated Water During 2013

	Feed (2.64E+06 Liters)		**Drain** (9.06E+04 Liters)		**Stack** (2.55E+06 Liters)	
	Avg.Conc. Ci/L	Curies	Avg.Conc. Ci/L	Curies	Avg.Conc. Ci/L	Curies
Alpha	1.86E-10	4.91E-04	3.17E-09	2.87E-04	8.00E-11	2.04E-04
Beta	1.27E-10	3.35E-04	1.17E-09	1.06E-04	8.97E-11	2.29E-04
Tritium	6.58E-09	1.74E-02	9.97E-09	9.03E-04	6.47E-09	1.65E-02

3. Production Data

3.1 Unit Overview

The evaporator is equipped with two natural-gas burners with low-NOx controls, a 6000-CFM blower, a heat exchanger, and a stack mist eliminator. It has a capacity of 4.5 million BTU per hour. Either or both burners can be used to heat the water, yielding typical throughputs of 180 gallons per hour (one burner) or 360 gph (two burners).

From the treated water storage tanks in Room 34B, water is pumped into a reservoir within the evaporator. Water in the reservoir is heated to boiling, and leaves via the stack as a vapor. Evaporation lowers the water level in the reservoir, and triggers a call for more water to be automatically fed to the reservoir.

As water is evaporated, however, the concentration of dissolved solids in the reservoir increases. If left unchecked, the dissolved solids would eventually plate out on evaporator heat transfer surfaces, leading to performance problems. The evaporator reservoir is therefore periodically drained in order to prevent plating; drain water is returned to the MTP for re-treatment.

3.2 Data for 2013

The effluent evaporator was operated for 3654 hours on 201 days during calendar 2013, primarily in one-burner mode. The unit was drained on twenty occasions. Intervals between drains varied from one week during the winter months (concerns about freezing over the weekends) to once per month during the summer months (to prevent plating). A total of 2.64 million liters of treated water were fed to the evaporator, and 2.55 million liters were discharged to the environment as steam from the evaporator stack. Table 2 provides a monthly summary.

Table 2
Effluent Evaporator Production During 2013

	Production		Liters	Liters	Liters
Date	Days	Hours	Fed	Drained	Evaporated
Jan-13	19	312	252,426	4,724	243,153
Feb-13	19	344	234,116	4,883	234,116
Mar-13	19	361	277,568	9,614	264,093
Apr-13	20	366	258,411	9,349	249,187
May-13	23	470	335,113	4,012	330,586
Jun-13	16	273	190,728	4,996	185,755
Jul-13	22	409	288,341	9,614	278,538
Aug-13	11	176	129,481	13,986	120,056
Sep-13	23	417	298,358	9,659	283,873
Oct-13	9	159	112,814	9,512	108,193
Nov-13	5	75	55,498	4,493	50,994
Dec-13	15	293	205,473	5,746	200,666
CY2013	201	3,654	2,638,327	90,588	2,549,210

4. Samples and Results

4.1 Weekly Feed Samples

A grab sample of feed to the effluent evaporator was collected once per week; 36 weekly samples were collected during 2013. The evaporator did not operate every week due to maintenance, lack of feed, or holiday). These weekly samples were analyzed for alpha, beta, and tritium in order to assess the quality of treated water being fed to the evaporator. Analytical results are summarized in Table 3.

Table 3
Results of Weekly Samples of Feed to the Evaporator During 2013

	#Samples	* Avg(ci/L)	Min(ci/L)	Max(ci/L)	#<MDL
Alpha	36	1.97E-10	0	9.5E-10	1
Beta	36	1.70E-10	0	8.2E-10	11
Tritium	36	6.65E-09	1.3E-09	1.6E-08	0

*Arithmetic average, not flow-weighted average.

4.2 Monthly Composite Feed Samples

Samples of evaporator feed from a given month were held, then composited at the end of each month[1]. Monthly composite samples were analyzed for 37 individual radionuclides: nine alpha-emitting isotopes, 27 beta-emitters, and tritium. Sample results are discussed below, and summarized in Tables 4 and 5 on the next page.

Alpha results: Seven of the nine alpha-emitters were detected in at least one monthly composite sample; Np-237 and Ra-226 were not detected in any of the twelve monthly composite samples. When added together, a flow-weighted average of 186 pCi/L resulted for these nine isotopes. Three isotopes, Pu-238, Pu-239, and U-234 accounted for approximately 90% of this total.

Beta results: Eleven of the 27 beta-emitters were detected in at least one monthly composite sample, or conversely, sixteen beta emitters were not detected in any of the monthly composite samples. When added together, a flow-weighted average of 53 pCi/L resulted for the eleven beta-emitting isotope. However, a flow-weighted average of 127 pCi/L resulted for *gross* beta analysis of evaporator feed. For conservatism, this higher concentration was used to calculate rad quantities in feed to the evaporator.

Tritium results:

Avg = 6.6 nCi/L Min = 2.5 nCi/L Max = 14 nCi/L

[1] Composites were flow-weighted so that results accurately represent water fed to the evaporator.

Table 4
Alpha-Emitting Isotopes
in Feed to the Effluent Evaporator During 2013

	Avg (pCi/L)	Max (pCi/L)	Min (pCi/L)
Alpha Gross	1.81E+02	7.4E+02	9.0E+00
Alpha Sum	1.86E+02	7.6E+02	1.8E+00
Am-241	1.60E+01	5.5E+01	*
Np-237	*	*	*
Pu-238	7.19E+01	3.3E+02	*
Pu-239	2.97E+01	2.0E+02	*
Ra-226	*	*	*
Th-232	6.32E-04	3.0E-03	*
U-234	6.12E+01	1.9E+02	1.6E+00
U-235	2.62E-01	1.2E+00	6.0E-03
U-238	7.22E+00	3.5E+01	1.7E-01

* Less than Detection Limit

Table 5
Beta-Emitting Isotopes
in Feed to the Effluent Evaporator During 2013

	Avg (pCi/L)	Max (pCi/L)	Min (pCi/L)
BETA Gross	1.27E+02	4.0E+02	*
BETA Sum	5.31E+01	--	--
As-74	5.86E+00	2.1E+01	*
Be-7	5.11E+00	6.2E+01	*
Co-58	5.94E-01	1.4E+01	*
Cs-134	3.39E+00	2.0E+01	*
Cs-137	1.10E+00	2.6E+01	*
Mn-52	7.64E-01	1.8E+01	*
Ra-228	2.07E+00	1.6E+01	*
Rb-83	1.19E+01	2.6E+01	*
Se-75	1.32E+01	5.0E+01	*
Sr-85	7.43E+00	4.2E+01	*
Y-88	1.64E+00	1.3E+01	*
H-3	6.58E+03	1.40E+04	2.50E+03

* Less than Detection Limit

4.3 Drain Samples

The evaporator was drained on 20 occasions during 2013; a sample of the drain water was collected on 18 of these occasions. Samples were analyzed for radioactive content, results of which are summarized in Table 6. Table 6 reports arithmetic averages of the 18 drain samples. Since drain volumes were typically of similar volumes, the arithmetic average approximates a flow-weighted average.

Table 6
Analytical Results for Evaporator Drain During 2013

AnalName	#Samples	Avg(Ci/L)	Min(Ci/L)	Max(Ci/L)
Alpha	18	3.17E-09	0	9.90E-09
Beta	15	1.17E-09	0	4.50E-09
Tritium	15	9.97E-09	3.00E-09	2.00E-08

A comparison of Tables 4, 5, and 6 shows that average alpha concentration of drain water was 17 times the average alpha concentration of water fed to the evaporator, and that beta isotopes were concentrated by a factor of 9.2. Tritium results indicate a concentration of 1.5, but since tritium *is* water, this is unlikely. The likely explanation for the higher drain concentration is instrument (i.e., rad counting) interference due to the presence of more impurities in drain water. This interference phenomenon is usually seen in other RLWTF process waters.

Drain waters were also sampled for three non-radioactive parameters during 2013, with similar concentration results. Nitrogen compounds (sum of nitrate plus nitrite) were concentrated by a factor of 58, and dissolved solids by a factor of 19.5

These analytical results confirm that water in the evaporator reservoir concentrates over time, and that a periodic drain is necessary. Moreover, the results can be used to estimate radioactivity that did not exit through the evaporator stack, and hence, was not discharged to the environment.

5. Radioactive Quantities

5.1 Evaporator Feed

Curies of radioactive materials fed to the effluent evaporator during 2013 were calculated by multiplying the evaporator feed volume (2,638,330 liters) times the flow-weighted average concentration of each radionuclide. As summarized in Table 7, feed to the effluent evaporator in 2013 contained approximately 4.9E-04 curie alpha radioactivity, 3.35E-04 curie beta radioactivity, and 1.7E-02 curie of tritium.

Table 7
Isotopes in Feed to the Evaporator During 2013

	Avg (pCi/L)	Evap.Feed (Ci)
Alpha Gross	1.80E+02	4.75E-04
Alpha Sum	1.86E+02	4.91E-04
Am-241	1.60E+01	4.22E-05
Pu-238	7.15E+01	1.89E-04
Pu-239	2.94E+01	7.76E-05
Th-232	6.38E-04	1.68E-09
U-234	6.13E+01	1.62E-04
U-235	2.61E-01	6.89E-07
U-238	7.20E+00	1.90E-05

	Avg (pCi/L)	Evap.Feed (Ci)
BETA Gross	1.27E+02	3.35E-04
BETA Sum	5.29E+01	1.40E-04
As-74	5.87E+00	1.55E-05
Be-7	5.04E+00	1.33E-05
Co-58	5.68E-01	1.50E-06
Cs-134	3.40E+00	8.97E-06
Cs-137	1.05E+00	2.77E-06
Mn-52	7.30E-01	1.93E-06
Ra-228	2.08E+00	5.49E-06
Rb-83	1.19E+01	3.14E-05
Se-75	1.32E+01	3.48E-05
Sr-85	7.49E+00	1.98E-05
Y-88	1.62E+00	4.27E-06
H-3	6.58E+03	1.74E-02

5.2 Evaporator Drain

The evaporator was drained on 20 occasions during 2013, and 18 samples were collected. Curies of radioactive materials drained from the effluent evaporator during 2013 were calculated by multiplying the evaporator drain volume (90,588 liters) times average concentration [2].

[2] Although two of the drain events were not sampled, using the average concentration of the 18 drains that *were* sampled was justifiable because the volume of drain water not sampled was just 5944 liters, or 6.6% of the total drain volume for 2013.

Table 8 summarizes curies contained in evaporator drain water, and also compares curies drained to curies fed. The table shows that 2.9E-04 curie alpha radioactivity were drained, meaning that 58% of alpha radioactivity fed to the effluent evaporator did not exit the evaporator stack. Using the same comparison, 32% of beta alpha radioactivity fed to the evaporator did not exit the evaporator stack, and 5% of the tritium.

The percentage of beta-emitting isotopes drained from the evaporator was lower than for alpha-emitting isotopes, which tend to be heavier. The percentage of tritium drained was very close to the volume percentage of feed that was drained (3.3%). This is as one would expect, since tritium is water, and provides confidence in the alpha and beta analytical results and the curie calculations.

Table 8
Radioactivity in Effluent Evaporator Drain During 2013

	Avg. Drain (Ci/L)	Drained (Ci)		Fed (Ci)	Drained (%)
Alpha	3.17E-09	2.87E-04		4.91E-04	58%
Beta	1.17E-09	1.06E-04		3.35E-04	32%
H3	9.97E-09	9.03E-04		1.74E-02	5%

5.3 Evaporator Stack

Radioactive quantities discharged to the environment by the effluent evaporator were readily calculated as the difference between curies fed and curies drained:

Alpha = 4.91E-04 Ci - 2.87E-04 Ci = 2.0 E-04 Ci
Beta = 3.35E-04 Ci - 1.06E-04 Ci = 2.3 E-04 Ci
Tritium = 1.74E-02 Ci - 9.03E-04 Ci = 1.7 E-02 Ci

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