TECHNICAL DIVISION
SAVANNAH RIVER LABORATORY

DPST-81-441

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MEMORANDUM

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TO: R. B. FERGUSON

FROM: J. R. FOWLER

RADIOCHEMICAL ANALYSES OF SAMPLES
FROM TANK 16 CLEANOUT

To establish the efficiency of radionuclide removal during tank cleaning prior to retirement, Waste Management Technology requested assistance to analyze samples from the Tank 16H cleaning demonstration. Insoluble radionuclides (e.g., Pu, Sr) were removed with sludge solids; concentration of radionuclides was not evident during slurrying operations. More than 99.9% of the estimated 77,000 gallons of sludge originally present in Tank 16H was removed during various cleaning operations. The tank floor is now covered by a thin layer of dried residue.[1] Based on a sample of this residue obtained from a known area ($\sim$7 in^2), 1.67g of dried solids per square foot remain on the floor of Tank 16H corresponding to an estimated total of 9.5 kg solids.

Radionuclide analyses of various samples showed:

- No evidence of increasing Pu concentration in the tank as cleaning proceeded.
- Strontium-90 is the major radionuclide in the solid residue remaining in Tank 16.
- The various cleaning operations effectively removed bulk sludge and radionuclides from Tank 16.

DETAILS

The physical and chemical properties of various samples from the Tank 16 cleanout are shown in Table I. Radionuclides found in these samples are shown in Table II. The estimated total volumes that the samples represent are shown in Table III. Using the data in Tables II and III, the total quantities of various radionuclides removed from and remaining in Tank 16 have been calculated (Table IV). A detailed description of the Tank 16 cleaning demonstration has been previously published by Waste Management Technology.[1,2,3]

JRF:lmn

REFERENCES

1. W. L. West to O. M. Morris, "Tank 16 Demonstration - Water Wash and Chemical Cleaning Results," DPSP-80-17-23 (December 16, 1980).

2. C. Comly to O. M. Morris, "Tank 16 Demonstration - Multipump Test Results," DPSP-79-17-17 (June 29, 1979).

3. W. L. West to R. Maher, "Tank 16 Demonstration - Single Pump Test Results," DPSP-79-17-12 (April 12, 1979).

Table I

PHYSICAL AND CHEMICAL ANALYSES FROM TANK 16 CLEANING

Operation	Sample ID	Physical Properties: Density, kg/ℓ	Physical Properties: Vol % Solids	Chemical Analyses, Moles/Liter of Sample Taken: NO_3^-	NO_2^-	Free OH^-	$C_2O_4^=$	Fe^c	Mn^c	Al^c	H^+
I. Bulk Sludge Removal											
A. 1 Pump Slurry											
Water	PT-16A[d]	1.35	37	n.m.[b]	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.	basic
Supernate	PT-16B[d]	1.35	19	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.	basic
B. 3 Pump Slurry											
First supernate	PT-16C[d]	1.32	30	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.	basic
Second supernate	PT-16D[d]	1.30	12	3.6	0.58	0.85	n.m.	n.m.	n.m.	n.m.	basic
Third supernate	TK16-3I	1.24	4.0	2.3	0.12	1.2	n.m.	n.m.	n.m.	n.m.	basic
II. Cleaning of Upper Surfaces											
First Water Spray/Slurry	TK16-5A	1.01	1.2	0.34	0.006	0.007	n.m.	n.m.	n.m.	n.m.	basic
Second Water Spray/Slurry	TK16-5C	1.01	3.1	0.06	0.002	$<10^{-4}$	n.m.	n.m.	n.m.	n.m.	basic
III. Oxalic Acid Treatments (3 pump)											
1 wt % Slurry	TK16-7B	1.02	<0.5	0.03	n.m.	acidic	0.051	0.017 (n.m.)	0.010 (n.m.)	0.004 (n.m.)	0.03
4 wt % Slurry	TK16-9B	1.03	0.6	0.006	n.m.	acidic	0.048	(0.011 (0.0057)	0.00065 (0.00044)	0.0072 (0.0033)	0.05
4 wt % Spray/4 wt % Slurry	TK16-11B	1.02	<0.5	0.003	n.m.	acidic	0.31	0.076 (0.040)	0.0007 (0.00007)	0.0059 (0.0046)	0.49
IV. Final Rinse											
Water Spray/Slurry	TK16-12A	1.01	<0.5	n.m.	n.m.	n.m.	0.0065	n.m.	n.m.	n.m.	0.01
Water Heel Left in Tank	TK16-12B	1.01	<0.5	n.m.	n.m.	n.m.	0.0057	n.m.	n.m.	n.m.	n.m.

[b] n.m. = not measured
[c] Total concentration, including insoluble solids; soluble concentrations are shown in parentheses.
[d] A. J. Hill sample ID, results shown obtained by A. J. Hill.

Table 11

RADIONUCLIDE ANALYSES FROM TANK 16 CLEANING

Operation	Sample ID	Radionuclide concentration, mCi/Liter of Sample Taken									Gross Alpha	Gross Beta-Gamma
		Pu-238	Pu-239	Cm-242,244	Cs-137	Sr-90	Ru-106	Ce-144	Eu-154	Nb-95		
I. Bulk Sludge Removal												
A. 1 Pump Slurry												
Water	PT-16A	20	1.1	n.d.	2400	1900	n.d.	14	12	n.d.	22	10900
Supernate	PT-16B	16	0.8	n.d.	250	1800	n.d.	39	10	n.d.	18	950
B. 3 Pump Slurry												
First Supernate	PT-16C	17	1.3	n.d.	390	2700	n.d.	43	15	n.d.	19	900
Second Supernate	PT-16D	13	1.0	n.d.	360	3200	n.d.	n.d.	n.d.	n.d.	18	12000
Third Supernate	TK16-3I	30	n.d.	n.d.	65	110	2.1	2.2	0.6	0.5	35	810
II. Cleaning of Upper Surfaces												
First Water Spray/Slurry	TK16-5A	0.29	n.d.	n.d.	5.0	50	n.d.	1.6	0.19	0.17	0.25	140
Second Water Spray/Slurry	TK16-5C	0.49	n.d.	n.d.	1.0	26	0.63	4.6	0.24	0.11	0.68	27
III. Oxalic Acid Treatments												
1 wt % Slurry	TK16-7B	0.21	n.d.	0.04	0.6	60	0.2	0.3	0.05	0.03	0.22	120
4 wt % Spray/1 wt % Slurry	TK16-9B	0.15	n.d.	n.d.	0.3	43	n.d.	n.d.	n.d.	n.d.	0.17	59
4 wt % Spray/Slurry	TK16-11B	0.24	n.d.	0.04	0.1	64	n.d.	0.11	0.07	n.d.	0.28	63
IV. Final Rinse												
Water Spray/Slurry	TK16-12A	0.02	n.d.	n.d.	0.08	38	n.d.	n.d.	n.d.	n.d.	0.05	98
Water Heel Left in Tank	TK16-12B	0.007	n.d.	n.d.	0.09	31	n.d.	n.d.	n.d.	n.d.	0.04	99
V. Dried Residue in Tank[a] (mCi/gram of solid)	TK16-Residue	0.0064	n.d.	n.d.	0.004	87	n.d.	n.d.	n.d.	n.d.	0.022	432

[a] Based on 3 inch pan sample, 1.67 g/ft^2 of solid residue remains in Tank 16 (assuming 85 ft diameter, a total of 9.5 kg of solids remains).

Table III

ESTIMATED VOLUMES OF SLURRIES REMOVED FROM TANK 16[a]

Operation	Volume Removed, Liters	Heel Left in Tank, Liters
I. Bulk Sludge Removal		
A. 1-Pump Slurry		
Water	8.36E4	Indeterminate
Supernate	2.14E5	Indeterminate
B. 3-Pump Slurry		
1st Supernate	2.69E5	Indeterminate
2nd Supernate	2.84E5	2.52E4
3rd Supernate	2.69E5	1.99E4
II. Cleaning of Upper Surfaces		
1st Water Spray/Slurry	3.05E5	3.97E4
2nd Water Spray/Slurry	3.31E5	1.32E4[b]
III. Oxalic Acid Treatments		
1 wt % Slurry	2.78E5	1.32E4
4 wt % Spray/1 wt % Slurry	2.78E5	1.32E4
4 wt % Spray/Slurry	2.90E5	1.32E4
IV. Final Rinse		
Water Spray/Slurry	2.65E5[c]	1.32E4

[a] Data from W. L. West, Waste Management Technology.

[b] Represents 1-inch heel left in tank.

[c] Volume at time sample TK16-12A taken; simultaneous water addition and pumping begun to enhance radionuclide removal via dilution. An additional sample was taken (TK16-12B) at the end of pumpthrough to establish the composition of the heel left in the tank.

Table IV

ESTIMATED TOTAL RADIONUCLIDES REMOVED FROM TANK 16[a]

Operation	Sample ID	Radionuclides Removed, Ci									Gross α	Gross β,α
		Pu-238	Pu-239	CM-242,244	Cs-137	Sr-90	Ru-106	Ce-144	Eu-154	Nb-95		
I. Bulk Sludge Removal												
A. 1-Pump Slurry												
Water	PT16-A	1.7E3	9.2E1	n.d.[b]	2.0E5	1.6E5	n.d.	1.2E3	1.0E3	n.d.	1.8E3	9.1E5
Supernate	PT16-B	3.4E3	1.7E2	n.d.	5.4E4	3.8E5	n.d.	8.4E3	2.1E3	n.d.	3.8E2	2.0E5
B. 3-Pump Slurry												
1st supernate	PT16-C	4.6E3	3.5E2	n.d.	1.1E5	7.3E5	n.d.	1.2E4	4.0E3	n.d.	5.1E3	2.4E5
2nd supernate	PT16-D	3.7E3	2.8E2	n.d.	1.0E5	9.1E5	n.d.	n.d.	n.d.	n.d.	5.1E3	3.4E6
3rd supernate	PT16-3I	8.1E3	n.d.	n.d.	1.7E4	3.0E4	5.6E2	5.9E2	1.6E2	1.3E2	9.4E3	2.2E5
II. Cleaning of Upper Surfaces												
1st Water Spray	TK16-5A	8.8E1	n.d.	n.d.	1.5E3	1.5E4	n.d.	4.9E2	5.6E1	5.2E1	7.6E1	4.3E4
2nd Water Spray	TK16-5C	1.6E2	n.d.	n.d.	3.3E2	8.6E3	2.1E2	1.5E3	7.9E1	3.6E1	2.3E2	8.9E3
III. Oxalic Acid Treatment (3 pump)												
1 wt %	TK16-7B	5.8E1	n.d.	1.1E1	1.7E2	1.7E4	5.6E1	8.3E1	1.4E1	8.3	6.1E1	3.3E4
4 wt % Spray/1% Slurry	TK16-9B	4.2E1	n.d.	n.d.	8.3E1	1.2E4	n.d.	n.d.	n.d.	n.d.	4.7E1	1.6E4
4 wt % Spray/Slurry	TK16-11B	7.0E1	n.d.	1.2E1	2.9E1	1.9E4	n.d.	3.2E1	2.0E1	n.d.	8.1E1	1.8E4
IV. Final Water Rinse												
Spray/Slurry	TK16-12A	5.3	n.d.	n.d.	2.1E1	1.0E4	n.d.	n.d.	n.d.	n.d.	1.3E1	2.6E4
Total Ci Removed		2.0E4	8.9E2	2.3E1	4.8E5	2.3E6	8.3E2	2.4E4	7.4E3	2.3E2	2.2E4	5.1E6
V. Solid Residue[c]		0.061	n.d.	n.d.	0.038	8.3E2	n.d.	n.d.	n.d.	n.d.	0.21	4.1E3

[a] Calculated from sample analysis and estimated volumes removed (Table II and Table III).

[b] n.d. = not detected.

[c] 9.5 kg of solid residue assumed based on wt of solid in 3-inch diameter pan sample left in Tank 16.