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RADIONUCLIDE CONTENT OF AN EXHUMED CANYON VESSEL AND NEIGHBORING SOIL

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by

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ABSTRACT

The long-term hazard potential associated with burial of process equipment from radiochemical separations plants is being evaluated. As part of this evaluation, a feed adjustment tank was exhumed eighteen years after burial. The tank had been in service in the fuel reprocessing plant for twenty-nine months before it was retired. Assay of the exhumed tank indicated that 7 mg (0.4 mCi) of ^{239}Pu and 1 mCi of ^{137}Cs remained on its surfaces; 1.1 mg (0.07 mCi) ^{239}Pu, 0.4 mCi ^{137}Cs, and 3.5 mCi ^{90}Sr were found in neighboring soil. The vessel and surrounding soil have met the present guidelines ($\leq$10 nCi/g) of the U.S. Energy Research and Development Administration (ERDA) for non-retrievable waste.

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RADIONUCLIDE CONTENT OF AN EXHUMED CANYON VESSEL AND NEIGHBORING SOIL

INTRODUCTION

To assess the long-term hazard potential associated with the burial of retired, intensely contaminated process equipment, an emplacement of canyon equipment was exhumed and examined. During the previous twenty years, failed or obsolete process equipment, amounting to 10^5 cubic feet, from radiochemical separations processes have been placed in earthen trenches at the solid waste storage area of the Savannah River Plant (SRP). Radionuclides associated with this waste are principally the fission products ^{95}Zr-^{95}Nb, $^{141-144}Ce$, and $^{103-106}Ru$. These species have short to moderate half-lives and present no significant requirements for control and surveillance of the waste storage site beyond a time span of a few decades. However, this type of waste also includes longer-lived contaminants, such as ^{90}Sr, ^{137}Cs, and $^{238-239}Pu$. These species greatly influence planning for future control and surveillance of the waste storage site. The transuranium (TRU) nuclide content of this equipment was not measured prior to burial because of the intense beta-gamma radiation associated with the equipment, generally several tens of R/hr at distances of a few feet.

One vessel, a Purex feed adjustment tank from the hot canyon of an SRP separations plant, has been exhumed and studied. This piece of equipment was retired from service and buried in 1957. This report describes soil sampling, exhumation, assay results, and conclusions. The assays showed that 7 mg (0.4 mCi) of ^{239}Pu and 1 mCi of ^{137}Cs remain on the surfaces of the vessel; the amount of these radionuclides in nearby soil is substantially less. The vessel and neighboring soil contained less than 10 nCi $^{239}Pu/g$, the maximum TRU level for non-retrievable waste according to ERDA standards. Radionuclidic migration in soil was detected. ^{90}Sr exhibited the greatest movement, which confirmed previous work.[1]

PRE-EXCAVATION WORK

Before the contaminated vessel was unearthed, the following steps were taken:

- Criteria for the selection of buried equipment were established.
- Records of buried available equipment were examined.
- A candidate vessel was selected.
- The buried vessel was located by drill probing.
- Adjacent soil was sampled.
- Laboratory leaching experiments were designed.
- A job plan was written.

The first choice of a candidate for the exhumation was a first-cycle Purex feed tank. This tank was an 8-ft-diameter by 8-ft-high vessel that had been buried after it was retired from service in 1957. Figure 1 is a drawing of the tank showing the agitator in place. However, the agitator was removed prior to burial.

The first task was to find the buried process vessel by drill probing in a high-level waste trench. The location of the feed tank was shown on an old map of the solid waste storage site. A feed adjustment tank was shown to be nearby in the same trench. However, probing the chosen area of the burial trench indicated the presence of only one vessel, an 8-ft-diameter vessel that was buried about 3 ft beneath the surface.

Soil samples were taken by vertically coring as close to the vessel as possible. Another series of cores was taken at a distance of one foot from the vessel wall. After the vessel was exhumed, soil that had been beneath the vessel was also sampled. Locations of sampling points relative to the buried vessel are shown in Figure 2.

TRENCH EXCAVATION AND VESSEL EXHUMATION

The remaining steps in the procedure, beginning with the exhumation of the vessel, are listed below:

- Soil around vessel was excavated.
- Vessel was removed and transported to examination site.

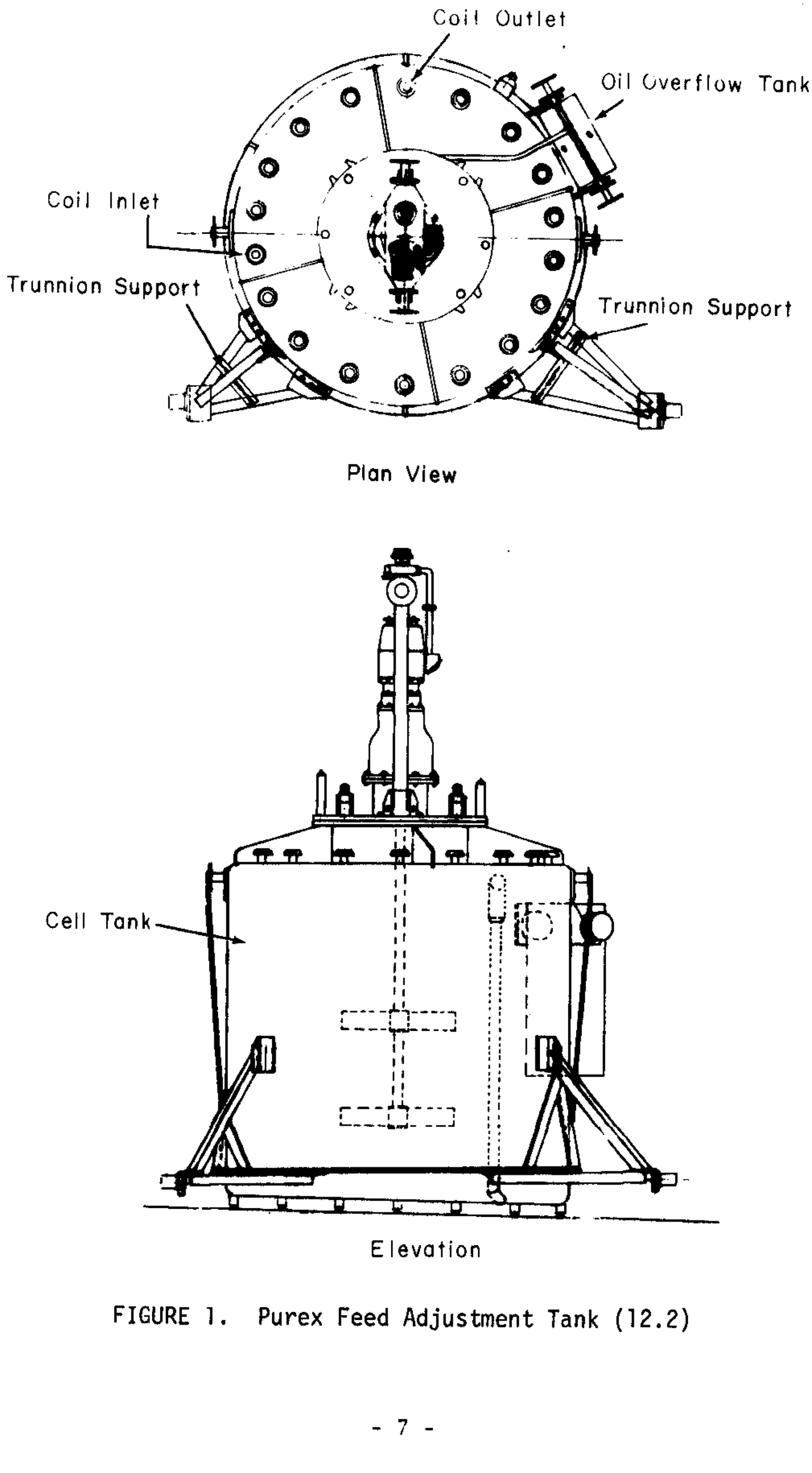


FIGURE 1. Purex Feed Adjustment Tank (12.2)

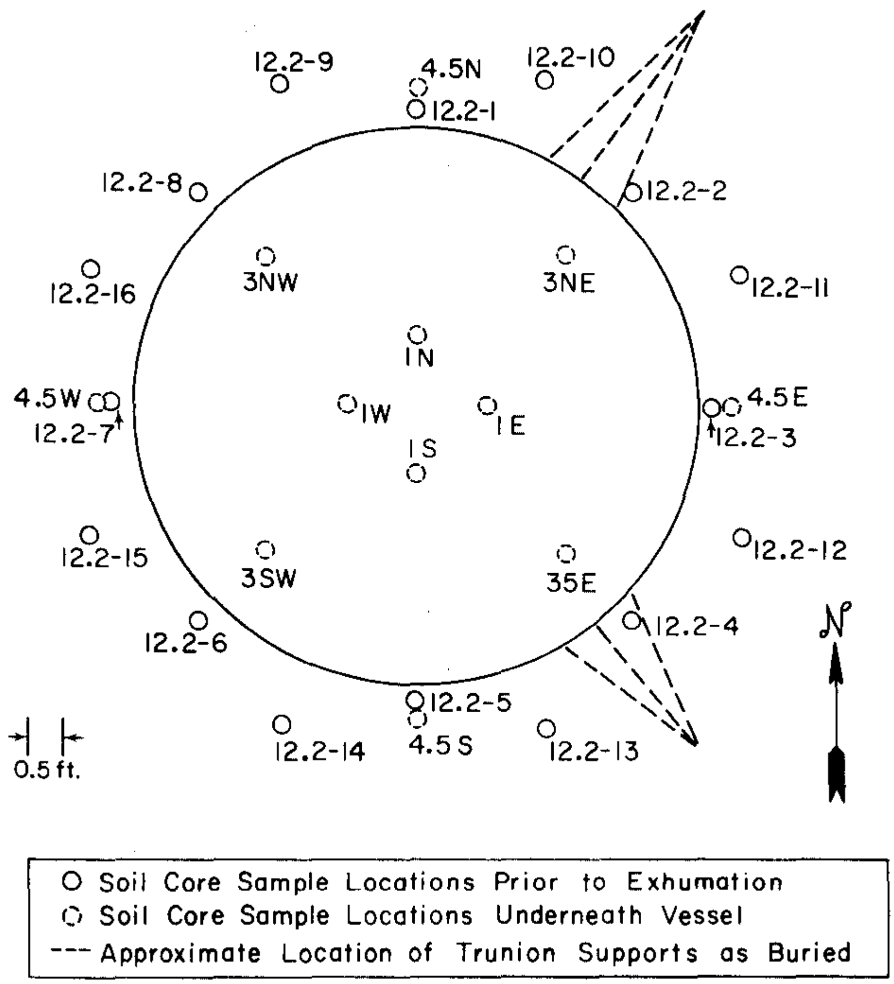


FIGURE 2. Soil Sampling Locations

- Cores of soil beneath vessel were taken after the excavation was backfilled.
- Vessel contents were sampled.
- Adhering and contained soil were removed from vessel.
- A temporary hut was constructed around vessel.
- Radiation surveys and measurements of vessel and surrounding soil were conducted.
- Sample coupons were cut from vessel.
- Leach tests and soil analyses were performed in the laboratory.

This was not the first piece of equipment to be exhumed from the SRP solid waste storage site. Previously, five batch evaporators and a process centrifuge were reclaimed, reworked, and returned to service; but this was the first attempt at SRP to recover buried equipment for the purpose of measuring contamination levels.

A clam-shell digger was used to uncover the vessel. As excavation and soil removal from around the vessel continued, the serial number, painted on the side, was exposed. On reviewing the records, the vessel being exhumed was found to be the Purex feed adjustment tank instead of the feed tank originally sought. For this examination, however, either vessel would suffice because their process histories were very similar. The feed adjustment tank had been in hot canyon service for 29 months, from October 1954 to March 1957. Although the vessel underwent decontamination prior to shipment to the storage site, Health Physics records at the time of burial showed a radiation level of 22.5 R/hr at 1 ft. The radiation level at the time of exhumation was calculated to be about 2 mR/hr at 3 in., sufficiently low for extended periods of close work.

When the overburden was removed, the tank was found to have been buried with the agitator opening uncovered, and the tank was filled with soil and water. Figure 3 shows the mud-filled tank, with clods bridging the opening. The tank and its contents weighed about 18 tons. A 75-ton crane (Figure 4) lifted the tank from the emplacement and placed it in a transport box on a trailer for moving to the examination site.

FIGURE 3. Buried Purex Feed Adjustment Tank
Filled with Soil and Water

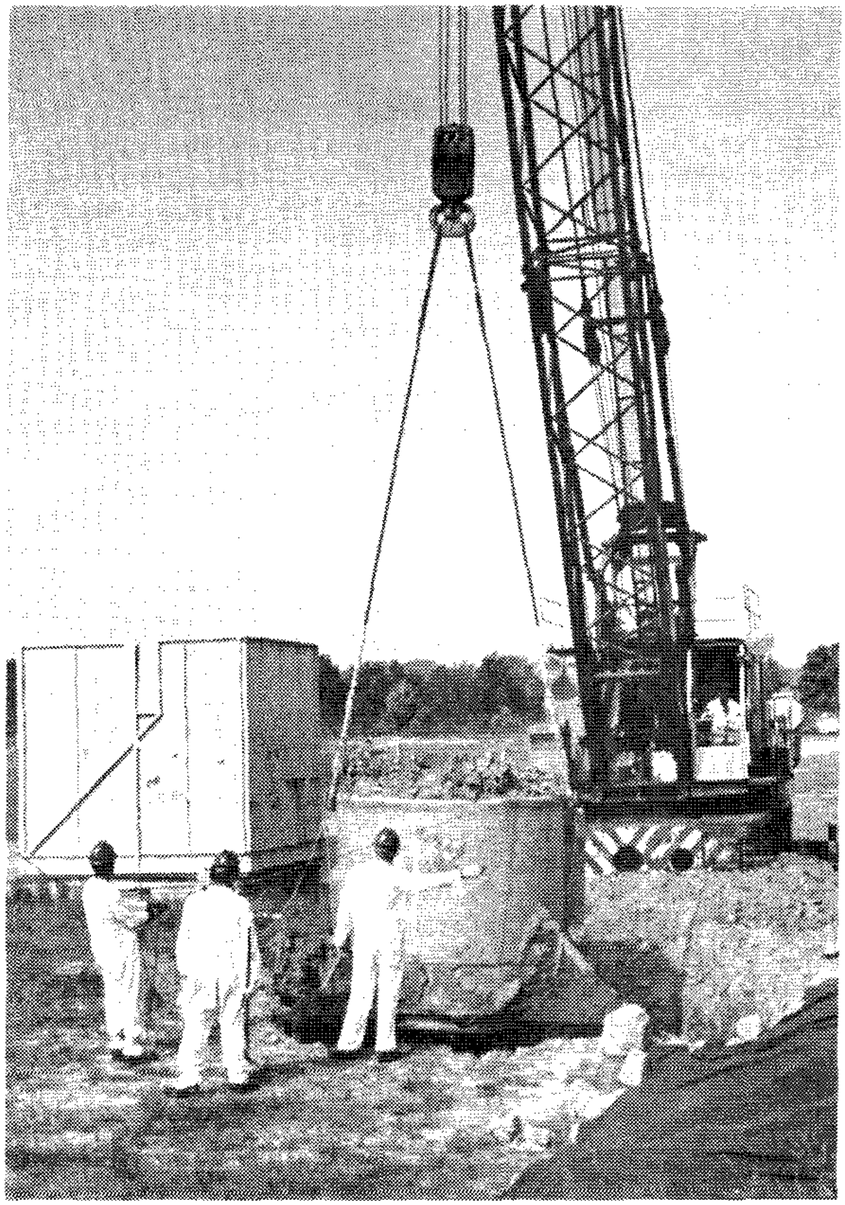


FIGURE 4. Purex Feed Adjustment Tank Being Lifted from Excavation for Placement in Transport Box

CLEANING AND ASSAYING EXHUMED TANK

At the examination site, a platform was constructed to permit working over the tank while it was still in the transport box. About 350 gal of water was removed and sampled, leaving a mud cake that was sampled by coring. The tank was lifted from the box and suspended over an adjacent open trench. The exterior soil was removed by washing (Figure 5), and the interior mud cake was then washed out (Figure 6). When contained soil was removed from the tank, cursory visual inspection revealed that the cooling coils were still intact. A closer view revealed the coils and interior of the vessel were bright and shiny, indicating that the vessel was in excellent metallurgical condition, as a more thorough visual inspection later confirmed.

Some surface radioactivity on the outside wall of the vessel was probably washed off along with the adhering soil. To ascertain how much, activities were measured on a section of the outside vessel surface prior to soil washoff. The same external wall section was then dry-wiped to remove loose or lightly bound activity or material. The activity on the smear sample thus obtained was measured, and 4% of the alpha activity and 50% of the beta-gamma activity originally on the vessel surface was found on the smear sample. The smear sample contained small soil particulates that previously adhered to the wall. It was not possible to determine whether the activity was associated strictly with the soil particles, or whether it had come from the vessel surface. It was not determined if the abrasive action of the particulates had removed some of the surface activity during the wipe. Therefore, the 4% alpha and 50% beta-gamma were considered to be the maximum quantities removable. No corrections were made in the total assay data for any activity that might have been lost on washing the exterior.

Most of the radioactivity associated with the vessel interior was probably accounted for. The vessel was initially filled with soil and water, which were sampled and assayed for radionuclides prior to emptying and washing out the interior of the vessel.

After the tank was cleaned and visually inspected, the radiation levels were measured in detail. These included twelve measurements around the exterior with an open-window Cutie Pie instrument to determine residual gross beta-gamma activity. This activity averaged 3 mRad/hr at one foot from the tank. Comprehensive alpha surveys of both exterior and interior were made with an Eberline Instrument Corporation Pulse Rate Meter, Model PRB-4B, with a detector area of 75 cm^2 (Figure 7). The alpha surveys of the individual surfaces were made systematically with several readings being taken over each surface. The number of

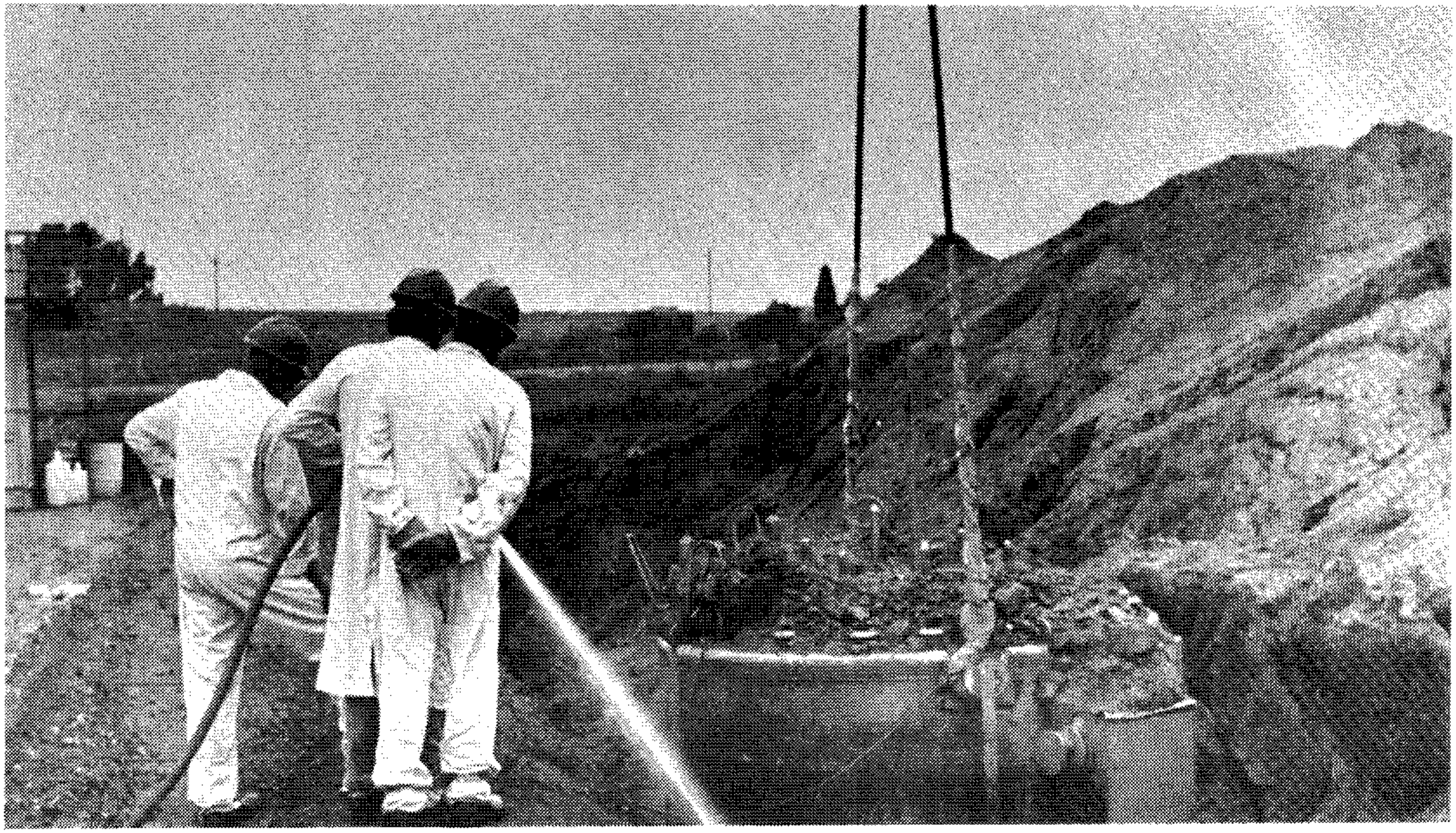


FIGURE 5. Washing Exterior of Exhumed Purex Feed Adjustment Tank

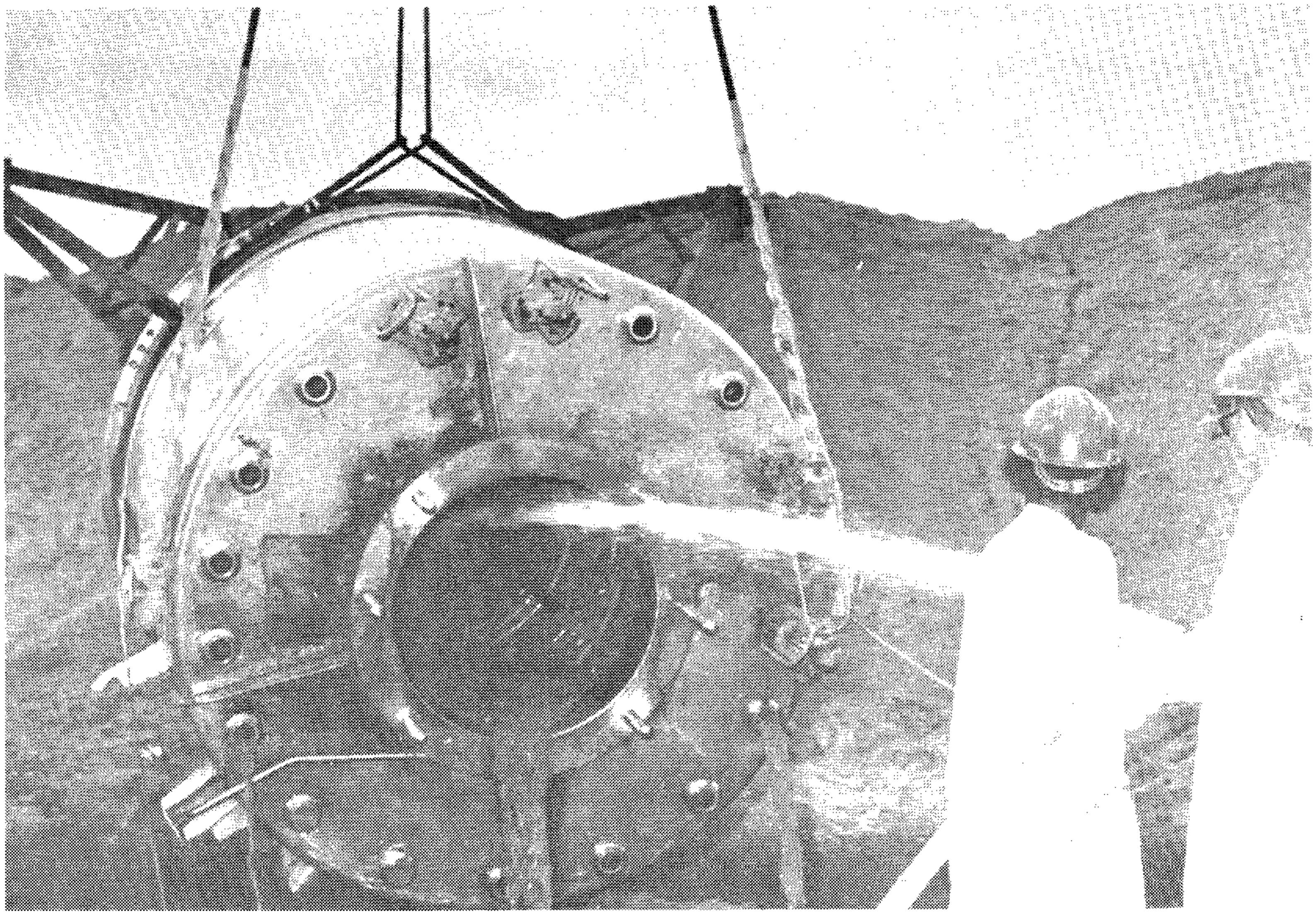


FIGURE 6. Washing the Interior of the Exhumed Purex Feed Adjustment Tank

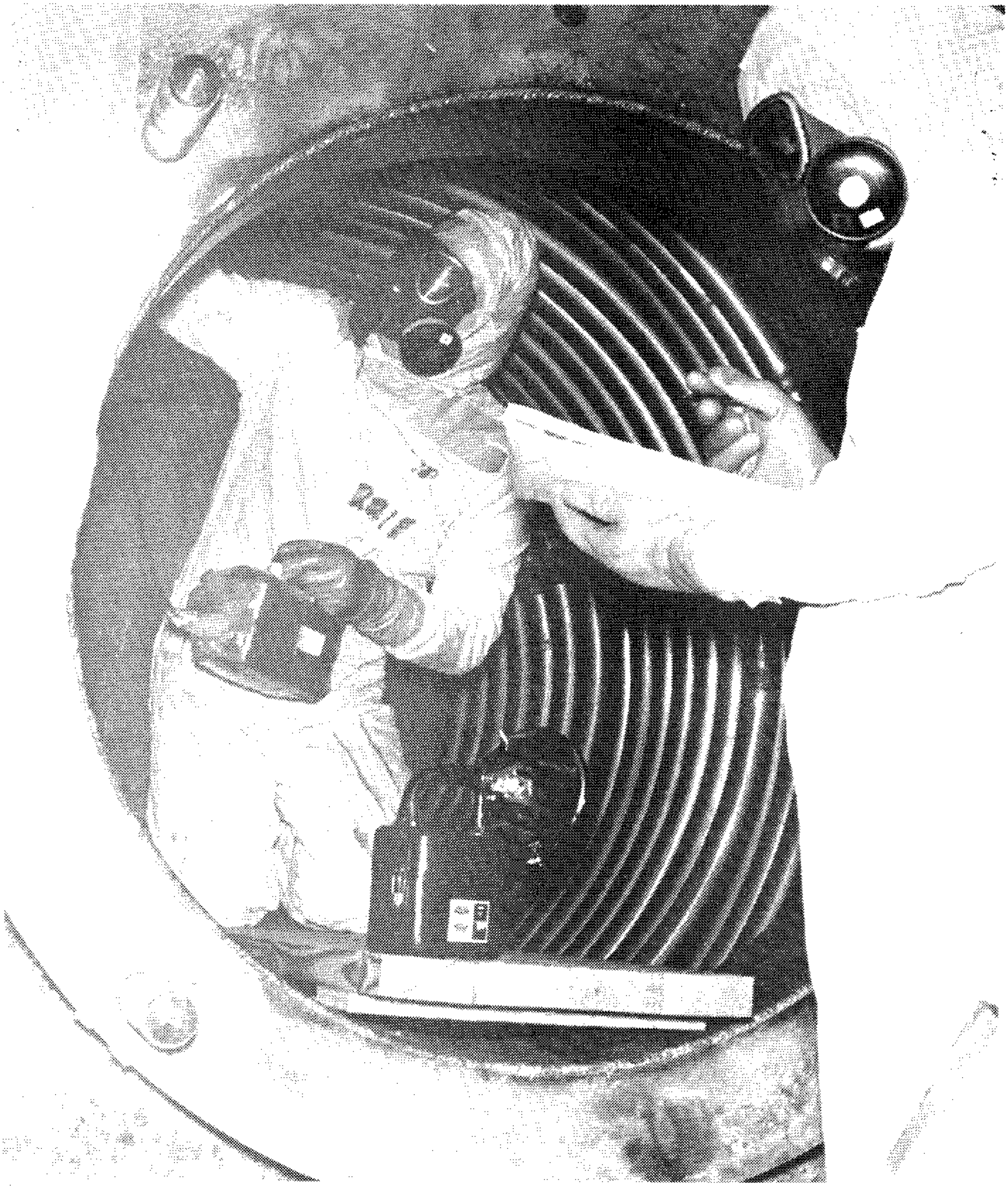


FIGURE 7. Survey of the Washed Interior of the Exhumed Purex Feed Adjustment Tank for Alpha Activity

readings and the averages are given in Table 1. A gamma pulse height analysis was made with portable equipment that included a Ge(Li) detector and a Canberra (Model 8100) 4096-channel analyzer with magnetic tape storage. The Ge(Li) detector was located 40 ft away from, and directly in front of, the agitator opening with the vessel resting on its side. The location of the detector was marked to permit background measurement at the same location after the vessel was removed.

Six 2-in.-diameter coupons were cut from the 3/8-in.-thick stainless steel tank wall and bottom. These coupons have been assayed for alpha and gamma emitters and are undergoing long-term leach testing in the laboratory. During assay and coupon cutting operations, a plastic hut prevented the spread of contamination from the tank.

TABLE 1

Contribution of Individual Surfaces to Residual ^{239}Pu Activity on Exhumed Purex Feed Adjustment Tank

Vessel Surface	*Area, ft^2*	*Number of Measurements*	*Total ^{239}Pu on Surface, dis/min*[a]	*% of Total ^{239}Pu on Vessel*
Wall, inside	201	36	7.0×10^7	7.4
Wall, outside	201	24	4.0×10^7	4.2
Bottom, inside	50	14	1.1×10^7	1.2
Bottom, outside	50	14	3.8×10^7	4.0
Top, inside	43	14	5.4×10^6	0.6
Top, outside	56	14	5.2×10^8	54.7
Top flange	5.5	12	9.6×10^6	1.0
Annular opening	7.1	12	3.3×10^6	0.3
Coils	307	24	6.1×10^7	6.4
Trunnion guides and supports	11	12	1.9×10^8	20.0

a. Total ^{239}Pu surface activity equals 9.5×10^8 dis/min = 7.0 mg = 4.3×10^5 nCi.

ASSAY OF VESSEL

The residual ^{239}Pu contamination found on individual surfaces of the exhumed tank is summarized in Table 1. More than half of the contamination was determined to be on the outside top surface (Figure 1). Of the total of 7 mg ^{239}Pu found on the inner and outer surfaces, contamination on the mild-steel trunnion guides and supports contributed about 20%, although those surfaces comprised only 1% of the total surface area of the vessel. However, these mild-steel components were heavily pitted from attack by the nitric acid Purex feed solution. The pitted surfaces were difficult to decontaminate prior to transporting the tank to the waste storage site. A gamma pulse-height analysis showed that ^{137}Cs was the only detectable gamma-emitting fission product on the tank surfaces. A total of 1 mCi ^{137}Cs was determined to be present on the surfaces of the empty tank. Tank surfaces were not assayed for ^{90}Sr after preliminary surveys revealed little difference between gamma and beta-gamma readings.

Under ERDA guidelines,[2] waste with a TRU content of greater than 10 nCi/g must be stored retrievably. However, discarded bulky process equipment with a TRU content above 10 nCi/g is presently exempted from retrievable storage. Therefore, although the exhumed tank would be classified as bulky equipment, its low TRU content would also place it below the category for required retrievable waste. The total surface contamination is only about 1% of the guideline limit of 10 nCi/g (Table 2). The quantities of ^{239}Pu and ^{137}Cs found in the mud-cake and water contained in the vessel upon exhumation are summarized in Table 3. The mud, i.e., the soil and interstitial water, contained only 0.08 mg ^{239}Pu (5 μCi), about 1% of the quantity found on the vessel surfaces; the 356 gallons of water contained less than 0.01 mg (<1 μCi) of plutonium. The mud contained 175 μCi ^{137}Cs (18% of the surface quantity); the water contained 0.2 μCi ^{137}Cs.

TABLE 2

^{239}Pu Contamination on Exhumed Purex Feed Adjustment Tank, on Weight Basis

Total Empty Weight	7300 lb
Weight of Coils	1820
Total Weight	9120
or	4.14×10^6 g

$$^{239}Pu = \frac{4.30 \times 10^5 \text{ nCi}}{4.14 \times 10^6 \text{ g}} = 0.1 \text{ nCi/g}$$

TABLE 3

^{239}Pu and ^{137}Cs in Soil and Water Contained in Exhumed Purex Feed Adjustment Tank

SOIL (and interstitial water)

Layer Depth	*^{239}Pu, pCi/g*	*^{239}Pu in Layer, pCi*	*^{137}Cs, pCi/g*	*^{137}Cs in Layer, pCi*
0 - 1'	0.529	7.09×10^5	3.49	4.68×10^6
1' - 2'	0.072	9.65×10^4	0.54	7.24×10^5
2' - 3'	0.110	1.47×10^5	0.28	3.75×10^5
3' - 4'	0.094	1.26×10^5	0.63	8.44×10^5
4' - 4'10"	0.229	2.56×10^5	2.07	2.32×10^6
4'10" - 5'9"	0.667	8.20×10^5	3.94	4.85×10^6
5'9" - 5'10"	4.963	2.53×10^6	316	1.61×10^8
	TOTAL =	4.68×10^6 pCi	TOTAL =	1.75×10^8
		= 1.04×10^7 dis/min		
		= 0.076 mg		

WATER

Emptied from vessel = 356 gal or 1.35×10^6 ml

Analysis of composite sample = <1 dis/min/ml ^{239}Pu, 121 pCi/l ^{137}Cs

Total ^{239}Pu in water = $<1.35 \times 10^6$ dis/min

= <0.01 mg

Total ^{137}Cs in water = 1.63×10^5 pCi

Each of six 2-in.-diameter coupons cut from the vessel wall is undergoing long-term static leach testing in 2 liters of ground water taken from the burial ground. Two control blanks are included in the tests. Table 4 shows results of the leach test after 30 and 124 days. After 124 days, only 3 of the 6 coupons showed positive leaching results, and those were 0.01 pCi/ml or less ^{239}Pu. Maximum total quantity leached was 20 pCi or about 1.5% of the ^{239}Pu initial surface activity.

TABLE 4

Plutonium Activity Leached from Coupons of Process Vessel

Coupon No.	*Initial ^{239}Pu on Surface, pCi*	*^{239}Pu in Water After Leaching 30 days, pCi/ml*	*^{239}Pu in Water After Leaching 124 days, pCi/ml*	*Total ^{239}Pu Leached, pCi*
1	1300	$\leq$ blank	0.010	20
2	2100	$\leq$ blank	$\leq$ blank	-
3	1500	$\leq$ blank	0.0086	17
4	700	$\leq$ blank	$\leq$ blank	-
5	1500	$\leq$ blank	0.003	6
6	1300	$\leq$ blank	$\leq$ blank	-

ANALYSES OF SOIL SURROUNDING VESSEL

Tables 5, 6, and 7 give the respective ^{239}Pu, ^{137}Cs, and ^{90}Sr contents of samples of soil taken by coring as close to the vessel as possible prior to its exhumation. Samples were taken in 2-ft-depth increments beginning two feet below the soil surface (one foot above the buried vessel top). Coring began at Position 12.2-1 (called North) and proceeded circumferentially as shown by the sampling pattern in Figure 2. Missing data points are due to lack of samples as a result of soil voids, lost samples on coring, or the inability to core within 3 in. of the vessel side because of appendages being in the way. Thirty-two samples were obtained and analyzed.

The ^{239}Pu, ^{137}Cs, and ^{90}Sr contents of the 3-in.-increment of soil contiguous to the vessel wall, extending from one foot above the vessel to the bottom of the vessel are summarized in Table 8. The basis for the calculations is the average of the radionuclidic content of the 32 samples. Background values are also listed. The average ^{239}Pu content in the contiguous soil is about 500 times less than the ERDA limit for non-retrievable waste. The 3-in. contiguous soil layer contained about 1 mg ^{239}Pu, or 15% of the quantity of ^{239}Pu found on the tank's surfaces. Approximately 340 μCi of ^{137}Cs was found in the soil layer, or some 35% of the quantity of ^{137}Cs measured on the surfaces. The greatest contributor of activity to the soil layer was ^{90}Sr, totaling about 2.3 mCi.

Soil immediately beneath the vessel was sampled following exhumation and backfilling. Again, 2-ft-long vertical core samples were taken starting at the former location of the vessel bottom. Four samples were taken at each of 3 radii (1-, 3-, and 4.5-ft) from the original center of the vessel. Results of individual sample analyses are given in Table 9, while integrated section values, based on perimeter averages, are shown in Table 10. In the 2-ft-deep cylinder of soil, extending 6 in. past the original vessel perimeter and immediately beneath the vessel, a total of 5 μCi ^{239}Pu (about 0.1 mg), 60 μCi ^{137}Cs, and 1200 μCi ^{90}Sr were found. These values were, respectively, 9%, 18%, and 52% of the activities found in the 3-in.-thick contiguous layer. This difference is indicative of downward movement of activity from around the buried vessel's wall with ^{90}Sr migrating to a greater extent than ^{239}Pu and ^{137}Cs.

TABLE 5

^{239}Pu in Soil Contiguous to Process Vessel

Sample Designation:[a]	*12.2-1*	*12.2-2*	*12.2-3*	*12.2-4*	*12.2-5*	*12.2-6*	*12.2-7*	*12.2-8*
Sample Location:[a]	*N*	*NE*	*E*	*SE*	*S*	*SW*	*W*	*NW*
Sample Depth, ft	*^{239}Pu Activity, pCi/g dried soil*							
Ground Surface 0–2								
2–4 (Top of Buried Vessel → 3)	0.025	0.044	3.24	281	2.19 (2–6)	0.35	0.034	7.31
4–6	0.023	0.085	0.497			0.098	0.050	8.47
6–8	0.076	0.277	1.13		6.31 (6–12)	0.471		8.30
8–10	0.246	410	0.323			0.164		
10–12 (Bottom of Buried Vessel → 11)			0.067			0.070		13.1
12–14			0.617		0.62	0.090	0.923	7.14

Average = 23.54 pCi/g

---

a. See Figure 2.

TABLE 6

^{137}Cs in Soil Contiguous to Process Vessel

Sample Designation:[a]	^{137}Cs *Activity, pCi/g dried soil* 12.2-1	12.2-2	12.2-3	12.2-4	12.2-5	12.2-6	12.2-7	12.2-8
Sample Location:[a]	*N*	*NE*	*E*	*SE*	*S*	*SW*	*W*	*NW*
Sample Depth, ft								
Ground Surface 0–2								
2–4 (Top of Buried Vessel → 3)	0.26	3.14	2.07	3140	253 (2–6 ft)	1.05	<1.5	3.19
4–6	<0.7	0.58	7.17			0.52	0.47	3.22
6–8	1.56	0.54	19.1		105 (6–12 ft)	0.95		1.86
8–10	1.57	726	0.23			<0.68		
10–12 (Bottom of Buried Vessel → 11)			0.28			0.91		12.5
12–14			4.89		50.9	0.67	77.1	3.68

Average = 138 pCi/g

a. See Figure 2.

TABLE 7

^{90}Sr in Soil Contiguous to Process Vessel

Sample Designation:[a]	*12.2-1*	*12.2-2*	*12.2-3*	*12.2-4*	*12.2-5*	*12.2-6*	*12.2-7*	*12.2-8*
Sample Location:[a]	*N*	*NE*	*E*	*SE*	*S*	*SW*	*W*	*NW*
Sample Depth, ft	*^{90}Sr Activity, pCi/g dried soil*							
Ground Surface								
1								
2–4 (Top of Buried Vessel →)	13	13	17,000	380	100 (2–6)	240	66	300
4–6	16	4	9,900			8	18	230
6–8	35	9	77		41 (6–12)	48		410
8–10	40	270	120			34		
10–12 (Bottom of Buried Vessel →)			5			26		480
12–14			250		11	16	58	15

Average = 944 pCi/g

a. See Figure 2.

TABLE 8

Summary of Nuclide Contents of Soil Layer[a] Contiguous to Process Tank Wall

	Nuclide		
Content:	^{239}Pu	^{137}Cs	^{90}Sr
Avg. soil activity, pCi/g	23.5	138	944
Total μCi	58	340	2300
Total milligrams	0.95	3.9×10^{-3}	1.7×10^{-2}
Soil background, pCi/g[b]	0.014	0.89	0.31

a. Depth of layer extending from one foot above tank to tank bottom; total soil volume = 1.65×10^6 cc; total soil weight = 2.48×10^6 g.

b. Soil layer, 0-5 cm deep; average of 4 SRP perimeter sampling locations.[3]

TABLE 9

Nuclide Contents of Soil Layer Beneath Process Vessel[a]

		Nuclide Activity, pCi/g dried soil								
Sample Location:[b]		*N*	*NE*	*E*	*SE*	*S*	*SW*	*W*	*NW*	*Average*[c]
Sample Distance from Center of Process Tank	*Nuclide*									
One Foot	^{239}Pu	0.11		0.65		0.30		0.91		0.49
	^{137}Cs	0.94		8.66		3.69		12.6		6.47
	^{90}Sr	100		65		66		43		68
Three Feet	^{239}Pu		0.08		0.01		0.66		0.06	0.20
	^{137}Cs		1.27		0.23		12.4		1.14	3.76
	^{90}Sr		7		100		120		82	77
Four and one-half feet	^{239}Pu	1.76		0.10		2.95		1.55		1.59
	^{137}Cs	9.08		0.28		48.1		11.9		17.3
	^{90}Sr	23		1300		18		27		342

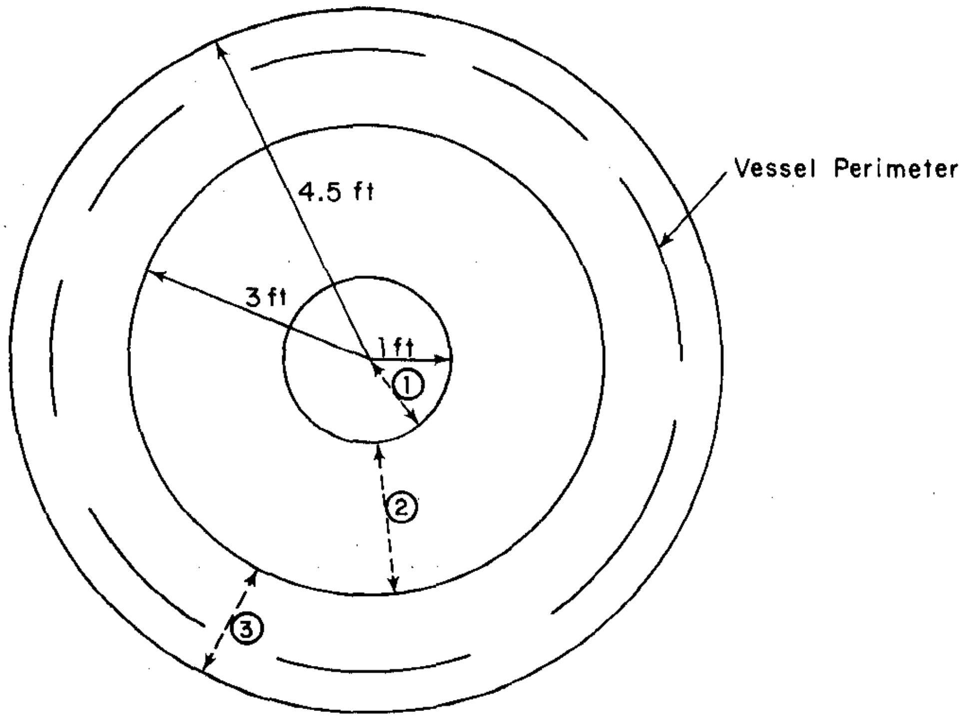
a. Sampled soil layer was 2 ft thick.

b. See Figure 2.

c. Averages for 12 samples.

TABLE 10

Summary of Nuclide Contents of 2-ft Layer of Soil Beneath Process Vessel



Region	*Nuclide Concentrations* ^{239}Pu *Avg. pCi/g*	*µCi Total*	*µg Total*	^{137}Cs *Avg. pCi/g*	*µCi Total*	^{90}Sr *Avg. pCi/g*	*µCi Total*
1	0.49	0.13	2.1	6.47	1.7	68	18
2	0.20	0.43	7.0	3.76	8.0	77	164
3	1.59	4.8	78	17.3	52	340	1030
Total		5.4	87		62		1212

MIGRATION

To examine for further evidence of radionuclidic migration, the activity of two sections of soil around the buried vessel were compared. Soil samples taken one foot from the vessel wall and ranging in depth from 8 ft (3 ft above vessel bottom) to 14 ft (3 ft below vessel bottom) were analyzed. Location of the sampling points (12.2-10, -12, -14, -16) are noted in Figure 2. Results of analyses of these 10 samples for ^{239}Pu, ^{137}Cs and ^{90}Sr are given in Table 11. In Table 12, averages of these data are compared with those of soil from the same depth range (8 ft to 14 ft) located 3 in. away from the vessel. Comparison of the data shows evidence of some movement of ^{239}Pu and ^{137}Cs outward from the soil adjacent to the tank. Activity concentrations 1 ft out from the tank were, respectively, factors of 4 and 8 less than those at 3 in. from the tank wall. However, ^{90}Sr appears to be migrating at a faster rate than ^{239}Pu and ^{137}Cs. Some 15 times more activity, on the average, was found at the greater distance; although this factor may be enlarged due to one sample assaying 12 nCi ^{90}Sr/g, a value 7 times larger than the next largest quantity found. More realistic, perhaps, is the average ^{90}Sr activity at a distance of one foot from the tank wall (790 pCi/g) between 12 ft and 14 ft (1 ft to 3 ft beneath the vessel). The latter average is 7 times that of the 3 in. (contiguous) soil sector. The greater mobility of ^{90}Sr compared with ^{239}Pu and ^{137}Cs in SRP soil has long been recognized.[1]

TABLE 11

Radionuclides in Soil 1 ft from Process Vessel Wall

Sample Designation:[a]		*Activity, pCi/g dried soil* 12.2-10	12.2-12	12.2-14	12.2-16	
Sample Location:[a]		*NNE*	*ESE*	*SSW*	*WNW*	*Average*[b]
Radionuclide	*Depth, ft*					
^{239}Pu	8 - 10	43.4	2.28	0.21	0.43	8.6
	10 - 12	↓	0.01	0.04	↓	
	12 - 14	39.4	0.03	0.03	0.03	
^{137}Cs	8 - 10	35.2	25.8	0.09	0.11	8.6
	10 - 12	↓	0.47	0.30	↓	
	12 - 14	24.3	0.05	0.11	0.04	
^{90}Sr	8 - 10	12,000	150	180	110	1600
	10 - 12	↓	510	180	↓	
	12 - 14	1,705	180	1,100	130	

a. See Figure 2.

b. Averages for 10 samples.

TABLE 12

Comparison of Average Soil Activities at 3-in. and 12-in. from Process Vessel Wall in the 8-ft-to 14-ft-Depth Range

Distance from Vessel Wall, in.	*Activity, pCi/g dried soil* ^{239}Pu	^{137}Cs	^{90}Sr
3	36	73	110
12	9	9	1600

CONCLUSIONS

To summarize, the primary conclusion from this examination is that this process vessel, when buried 18 years ago, contained less plutonium than the 10 nCi/g that ERDA waste management standards currently define as TRU-contaminated, retrievable waste. Also, none of the 54 samples of soil taken from around the vessel prior to exhumation contained enough ^{239}Pu to classify them as solid waste for retrievable storage. Some radionuclidic migration in soil was indicated with ^{90}Sr showing the largest amount of movement among the three radionuclides measured.

Evidence from this single study therefore indicates that bulky process equipment buried at SRP for 10 or more years will probably be in good condition, with some residual surface contamination depending on the efficiency and extent of decontamination efforts prior to burial. For this tank, a low level of TRU contamination was found, and the vessel met the ERDA standards for non-retrievable waste.

Radionuclidic migration from the buried vessel into the surrounding soil appeared to be limited both in quantity and in distance moved. Most of the plutonium and cesium radioactivity buried with the vessel remained on the vessel surfaces after 18 years. More than 50% of migrated plutonium and cesium radioactivity remained within the 3-in. layer of soil contiguous to the vessel as shown by the larger amount of activity found there as compared to that found at a distance of one foot from the tank wall. Strontium migrated more extensively as previous studies have shown.[1] The results of this test indicate that such bulky equipment burials may not have a significant effect upon the environment or the dose-to-man.

Further studies of possibly more highly contaminated, buried unencapsulated equipment, i.e., jumpers, are planned.

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