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ENGINEERING CHANGE NOTICE

1. ECN 629415

Proj. ECN

2. ECN Category (mark one) Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	3. Originator's Name, Organization, MSIN, and Telephone No. S. A. Jones, 15F00, T5-12, 373-3347	4. USQ Required? [] Yes [X] No	5. Date July 30, 1998
	6. Project Title/No./Work Order No. Tank 241-Z-361/K6215	7. Bldg./Sys./Fac. No. 234-5Z/200W	8. Approval Designator N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-1989, Rev. 0	10. Related ECN No(s). NA	11. Related PO No. NA

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	NA	NA Design Authority/Cog. Engineer Signature & Date	NA Design Authority/Cog. Engineer Signature & Date

13a. Description of Change — 13b. Design Baseline Document? [] Yes [X] No

Replace HNF-1989, Rev. 0 with attached copy of HNF-1989, Rev. 1.

14a. Justification (mark one)

Criteria Change	[X]	Design Improvement	[]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

Document was revised to include additional information.

15. Distribution (include name, MSIN, and no. of copies)

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16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

19. *Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1)* that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
None		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. S. A. Jones	[signature]	8/3/98	PE		
Cog. Mgr. C. S. Sutter	[signature]	8/3/98	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other			Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

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Tank 241-Z-361 Process and Characterization History

S. A. Jones
B&W Hanford Company, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

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Abstract: The history of the Plutonium Finishing Plant processes that sent waste to Tank 241-Z-361 is summarized. Documents reviewed include engineering files, laboratory notebooks from characterization efforts, and interviews of people. Records of transfers to the tank, past characterization efforts, and speculation were used to estimate the current condition of Tank 241-Z-361 and its contents.

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RECORD OF REVISION

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Page 1

(2) Title
Tank 241-Z-361 Process and Characterization History

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
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TANK 241-Z-361 PROCESS AND CHARACTERIZATION HISTORY

S. A. Jones

INTRODUCTION

An Unreviewed Safety Question (Wagoner, 1997) was declared based on lack of adequate authorization basis for Tank 241-Z-361 in the 200W Area at Hanford. This document is a summary of the history of Tank 241-Z-361 through December 1997. Documents reviewed include engineering files, laboratory notebooks from characterization efforts, waste facility process procedures, supporting documents and interviews of people's recollections of over twenty years ago. Records of transfers into the tank, past characterization efforts, and speculation were used to estimate the current condition of Tank 241-Z-361 and its contents. Information about the overall waste system as related to the settling tank was included to for help in understanding the numbering system and process relationships.

The Plutonium Finishing Plant was built in 1948 and began processing plutonium in mid-1949. The Incinerator (232-Z) operated from December 1961 until May 1973. The Plutonium Reclamation Facility (PRF, 236-Z) began operation in May 1964. The Waste Treatment Facility (242-Z) (Kasper, 1980) operated from August 1964 until August 1976. Waste from some processes went through transfer lines to 241-Z sump tanks. High salt and organic waste under normal operation were sent to Z-9 or Z-18 crib. Water from the retention basin may have also passed through this tank.

The transfer lines to 241-Z were numbered D-4 to D-6. The 241-Z sump tanks were numbered D-4 through D-8. The D-4, 5, and 6 drains went to the D-6 sump tank. When D-6 tank was full it was transferred to D-7 tank. Prior to transfer to cribs, the D-7 tank contents was sampled. If the plutonium content was analyzed to be more than 10 g per batch, the material was (generally) reprocessed. Below the discard limit, caustic was added and the material was sent to the cribs via the 241-Z-361 settling tank where solids settled out and the liquid overflowed by gravity to the cribs.

Waste liquids that passed through the 241-Z-361 settling tank flowed from PFP to ground in the following sequence:

Processes → D-4, D-5, D-6 Drains → D-6 Sump Tank → D-7 or D-8 Sump Tank → 241-Z-361 Settling Tank → Cribs

Each is discussed below. In addition, samples taken of the settling tank sludge and analyzed in the mid-1970s are evaluated.

PROCESSES

"Low-salt" waste passing through 241-Z-361 consisted of large volumes of water containing relatively low concentrations of chemicals compared to the "high-salt" waste transferred to Z-9 or Z-18. Process streams contributing to the low-salt waste are listed in Table 1.

Table 1. Low-salt Aqueous Process Streams in the Plutonium Finishing Plant

Stream	Source	Thousands of Gallons/Year	Plutonium Grams/Year	Chemical Contaminant
Uncontaminated lab wastes	Cooling equipment in labs	127	0	None
Contaminated lab wastes	Lab sink drains	174	100	Miscellaneous lab chemicals
Waste treatment aqueous waste	Ion exchange	86	60	Principally Al, Ca, Mg, nitrate
Incinerator scrubber solution	Spent caustic from scrubber	6	600	Considerable Na
Reclamation condensate	Process concentrators	54	12	Slight
Fluorinator off-gas jet	Water for vacuum jet	1906	100	hydrogen fluoride
total		2353	872	

Cooling water was simply sanitary water in closed lines that did not come in contact with chemicals or radioactive material.

Laboratory wastes constituted a very small portion of the total volume of wastes. While there may have been almost anything in that waste stream and there is virtually no information about it, the small volume coupled with large dilutions with the process streams make it unlikely to contain enough material to be of concern.

Aluminum nitrate was added during waste treatment for plutonium recovry in PRF to complex fluoride in the waste. The amount varied depending upon the feed that was sand, slag, and crucible (SS&C) from RMC processing, assorted feeds, and CAW rework. Calcium, magnesium, and iodine also originated in the SS&C.

The incinerator burned a variety of materials including organic chemicals, paper and plastic. A caustic off-gas scrub solution was used to trap acid fumes, combustion products and fine particles. The incinerator operated intermittently from December 1961 to May 1973. In 1969, it was estimated that 600 grams of the 870 grams of plutonium sent to Z-12 were from the incinerator.

There is little known about reclamation condensate except that the chemical contaminants were considered "slight".

Fluorinator off-gas from hood HC-9B on the "Button Lines" contributed the largest volume of waste to D-6. It was also responsible for failure of D-6 due to corrosion. The HF concentration was approximately 0.06 M.

An estimate of the chemicals in the low salt waste from all sources in 1969 is given in Table 2. The process waste streams from 236-Z and 234-5Z to 241-Z were documented in 1990 (Barrington). As can be seen in

Table 3, the concentrations of some constituents are quite high. The low-salt designation is a relative term. Compared to the 5 M HNO_3 in PRF CAW, 2 M HNO_3 in PRF LSW is low salt. It should be noted also that these were concentrations from streams prior to blending and treatment at the 241-Z Waste Treatment Facility. Although this 1990 memo was written long after Tank 241-Z-361 was inactivated, the chemistry of the processes had not changed, only the final disposition of the waste.

Table 2. Process chemicals discharged to low-salt waste in 1969.

Chemical	Weight/year	Chemical	Weight/year
Plutonium	870 g	Aluminum	96 kg
Calcium	320 kg	Sodium	7,394 kg
Magnesium	128 kg	Fluoride	6,100 kg
Manganese	13 kg	Nitrate	19,904 kg

Table 3. PFP Radioactive Effluent Stream Compositions

PFP Radioactive Effluent stream Compositions				
	Units	PRF LSW	RMC LSW	D&AL LSW
Normal Flow	l/hr	43	66	20
Peak Flow	l/hr	110	90	200
SpG	g/cc	1.06	1.03	1.01
Species		Nominal Composition		
Al	M	0	0	0
Ba	M	4.40E-06	1.80E-06	2.00E-07
Ca	M	0.0001	0.00006	7.90E-06
Cr	M	2.00E-07	2.00E-07	2.00E-07
Fe	M	0.0002	0.00007	8.50E-06
H+	M	2	0.8	0.1
K+	M	0.005	0.0003	0
Mg++	M	0.000002	0.00001	1.30E-06
Mn++	M	0.003	0.005	4.00E-07
Na+	M	0.006	0.005	0.004
Ni++	M	2.00E-07	2.00E-07	2.00E-07
Pb++	M	0	0	0
Sr++	M	1.70E-06	7.00E-07	9.00E-08

Table 4. PFP Radioactive Effluent Stream Compositions (cont.)

Species		Nominal Composition		
	Units	PRF LSW	RMC LSW	D&AL LSW
OH-	M	0	0	0
CO3-	M	0	0	0
Cl-	M	0.006	0.001	0.0003
F-	M	0	0	0
I-	M	0	0	0
NO3-	M	2	0.8	0.02
NO2-	M	0.01	0.01	0.0003
PO4---	M	0.00009	0.00004	5.00E-06
SO4--	M	0	0	0
CCL4	M	0.002	0	0
Ammonia	M	0	0	0
TBP	M	0	0	0
Butanol	M	0.008	0	0
DBP	M	0	0	0
MBP	M	0	0	0
TOC	g/l	0.4	0	0
Silica	g/l		0	0
Pu	g/l	0.003	0	0.00001
Am	g/l	0.001	0	0.00001
U	g/l	0	0	0

DRAINS

Drains that fed into the 241-Z Waste Treatment facility are listed in Table 5. The sump tanks have the same numbering system, but do not necessarily feed to the same location. When reading some of the old documentation, it was some times difficult to determine if the author was referring to a drain or sump tank. This may be one reason for some of the confusion that exists regarding the waste systems.

Table 5. Drains that fed into the D-6 tank in 241-Z (Rodgers 1991).

Drain	Area serviced
D-4	Plutonium Chemistry Laboratory
D-5	Analytical Laboratory - including film washing
D-6	232-Z Incinerator
	234-5 Process - hood 9-B fluorinator off-gas
	236-Z PRF
	242-Z Waste treatment

241-Z SUMP TANKS

Neutralization of acid wastes was initially accomplished by addition of soda ash. Later sodium hydroxide was used to bring the pH up to 10. Still later it was found that a pH of 8 was better for immobilizing Pu in soil (Rhodes) and the waste process was changed accordingly. Kasper stated in RHO-ST-44 "Occasionally, the wastes were only partially neutralized and were discharged slightly acidic."

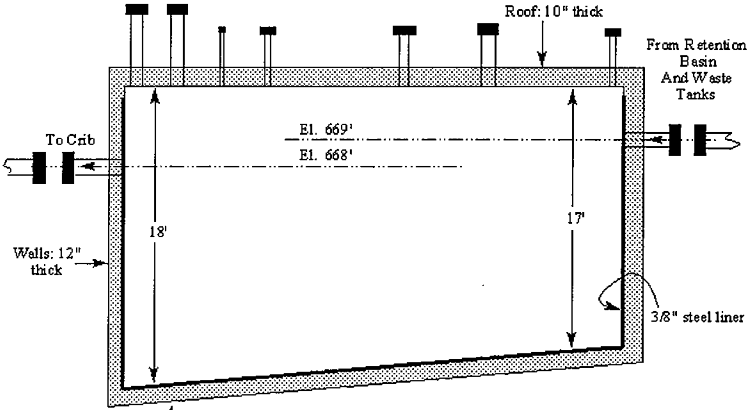
Procedures in the waste treatment facility manual called for addition of caustic to the D-7 tank, checking with alkoacid paper. If the paper was still red, more caustic was added. If the paper turned blue, tank contents were jetted to the settling tank and crib. In 1962, the sump tanks were assayed for plutonium hold up. The D-7 tank contained approximately 300 g of plutonium, which was removed by flushing the tank with nitric acid coupled with some mechanical scraping. Apparently, the acid flushes were sent directly to the settling tank. This may account for one observation that the sludge was acidic (Lundgren).

241-Z-361 SETTLING TANK

The 241-Z-361 settling tank is 13' by 26' rectangular structure that is 17' deep at the influent end and 18' deep at the effluent end. A cross-section view of the tank is shown in Figure 1. Liquid entered 241-Z-361 through a baffled opening on the north end of the tank. The overflow to the cribs is at the south end at the 15' depth. The tank was constructed with 12" thick concrete walls, a layer of waterproofing, and a 3/8" thick carbon steel liner. Removal of all but about 800 liters of the supernate was completed May 1975. Photographs of the tank taken in 1975 showed that in the lower half of the tank the steel liner appears to have been corroded away with the waterproofing and concrete visible. This will contribute to the chemistry of the tank by adding iron from the dissolved liner. In addition, any concrete that reacts with the tank contents will raise the pH of acidic sludge. There has been much speculation as to the effect of the sludge on the structural integrity of the concrete and rebar in the tank. Scenarios have been proposed that range from the tank walls crumbling to the contents having a hardening effect on the concrete. The only certainty is that the tank condition will not be known until it is examined.

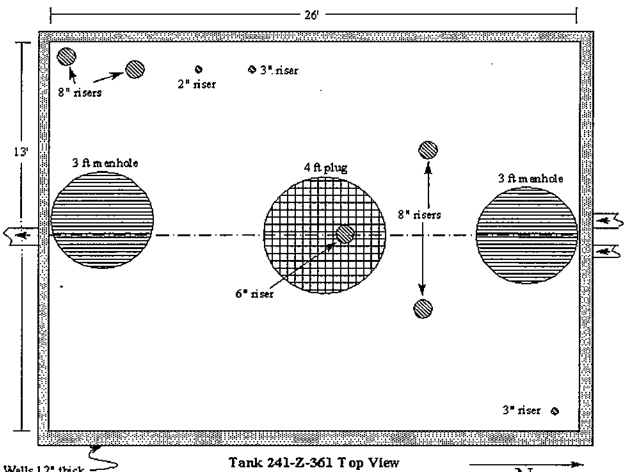
There are eight penetrations into the tank visible from above ground. In addition, underground there is a 4' cement in the center of the tank cover, a 3' manhole at the north end, and a 3' manhole at the south end of the tank. These are illustrated in Figure 2.

Figure 1. Side View Tank 241-Z-361



Centerline Cross-Section Tank 241-Z-361 (Not To Scale)

Figure 2. Top View 241-Z-361 Settling Tank.



Tank 241-Z-361 Top View (Not To Scale)

In March 1975, samples were taken through the north manhole. The liquid was analyzed as 0.0002 g/L Pu and pH 4 at the 14'3" level, 0.0006 g/L Pu and pH 4 at the 16'3" level, and sludge contained 0.91 g/L Pu and pH was very acid at the 18'3" level (Lundgren). All measurements were from the top of the riser. The sampler rod stopped at the 18'3" level, possibly from hitting what remained of the corroded dry well. A sample request for differential thermal analysis of the samples was made, but no record of analysis results could be found.

There was an estimated 4000 gallons of supernate solution in the tank. Sodium hydroxide was added to the tank to bring the pH up to 12 for transfer to Tank Farms. After the caustic addition, the supernate was sampled and the pH was 6. Buffering by hydrolyzable metal ions in solution must have been responsible for this lower than expected pH. In May 1975, all but about 800 liters of liquid was pumped from the tank.

The sludge in the tank was sampled five times from 1975 to 1977. The nonradioactive components that were analyzed are summarized in

Table 6.

Table 6. Average Nonradioactive Elements in 241-Z-361 Sludge.

Chemical	Wt%	Conc., g/L
Al	11.99	0.222
Ca	18.11	0.335
Cd	0.05	0.001
Fe	12.50	0.232
Na	3.59	0.066
Si	0.45	0.008
O	5.94	0.110
H	1.64	0.030
C	3.60	0.067
Cl	1.85	0.034
F	0.21	0.004

The absolute concentrations of the nonradioactive species are suspect for the same reasons discussed later for plutonium concentration due to problems with the use of volume percent solids to calculate sludge concentrations. In addition, this matrix introduces significant interferences in the analytical method. Large deviations in sample concentrations were observed and these values should be used as a general indication of sludge composition only.

Carbon analysis results have not been found except for a few samples. The carbon concentration was as high as 6% by weight of the sample. This could be as carbon from fly ash in the incinerator scrubber solution, carbonate from neutralization and absorption in to caustic solution, or from organic compounds. Most likely it is from a combination of all of these sources.

The bulk of the plutonium processed was weapons grade with an isotopic composition of approximately 93% ^{239}Pu, 6% ^{240}Pu, and 0.6% ^{241}Pu. In the late 1960's, limited processing of fuel elements from power reactors occurred. The plutonium recovered from this fuel had a different isotopic composition estimated at 55% ^{239}Pu, 25% ^{240}Pu, and 15% ^{241}Pu. The amount of ^{241}Pu is directly related to the amount of ^{241}Am that will be found in the tank. In cores drilled in the Z-12 crib, the nCi/g of ^{239}Pu was approximated 4 times the nCi/g of ^{241}Am in the mid-1970's. Stated another way, on average the plutonium contains approximately O.45% ^{241}Am by weight.

A sample of sludge taken from the settling tank in 1977 had the following isotopic distribution (Bouse 1977a): Isotope, Wt%, ^{238}Pu 0.00874%, ^{239}Pu 93.7%, ^{240}Pu 6.023%, ^{241}Pu 0.2333%, ^{241}Am, 0.4758%. The sample was identified as NW-5 and was selected because it was the core segment with the highest plutonium concentration. Section 5 was at the 60 inch from bottom of tank level in a 90-inch segment. These values are consistent with the types of material that was processed in PFP. These data indicate that the plutonium in Tank 241-Z-361 has an isotopic distribution consistent with weapons grade plutonium. The americium concentration in 241-Z-361 is the same as found in the Z-12 crib. Current isotopic composition (calculated from Bouse 1977 data) is: Isotope Wt%, ^{238}Pu 0.0074%, ^{239}Pu 93.82%, ^{240}Pu 6.047%, ^{241}Pu 0.087%, ^{241}Am, 0.61%.

Dressen (1976) and Dodd (1976) reported plutonium concentrations from samples taken in 1975. The numbers reported by Dodd were corrected and reported again to be consistent with the calculation method used by Dressen. The results are shown in Table 7 and Table 8. Examination of raw data in Dodd's notebook (Dodd 1975b) when compared to data later collected by Bouse indicates an error. Dodd filtered the sludge and measured the volume of liquid collected. This volume of liquid collected from filtration, combined with a volume for solids calculated assuming a solid density of 2 g/cc, was used to report a percent solids in the sludge. When Bouse measured the filtered liquid volume and the additional weight lost by the filtered solids upon drying, it was found that approximately an equal volume of liquid was trapped as was separated by filtration. Another corrected plutonium concentration was calculated and is presented in Table 8 with the results reported by Dodd (1976). See Appendix A for detailed comparison of sampling campaign results. Transcriptions of the notebooks of Dressen and Bouse are presented in Appendices C and D.

Table 7. Solids and Plutonium measured in 241-Z-361 Sludge (Dressen).

		Pu Concentration g/L	
Section #	Vol % solids	in Solids	in Sludge
2	19.2	2.18	0.42
4	12.8	3.37	0.43
6	19.5	1.89	0.37
8	28.4	0.89	0.25
10	15.8	1.97	0.31
12	18.7	1.11	0.21
	avg.	1.90	0.33
	std dev	0.88	0.09

Table 8. Solids and Plutonium measured in 241-Z-361 Sludge (Dodd).

Sample ID 361-Z-	Vol ml Filtrate	wt solids	Corrected vol% solids	Pu g/L dry solids	Corrected Pu in situ g/L	PPSL corrected vol % solids	PPSL corrected Pu in sludge g/L
3"-1-4	62	28.7	27.2	3.1	0.84	10.4	0.32
6"-1-2	32	22.8	27.0	1.9	0.52	15.1	0.29
6"-1-3	46	30.5	24.8			14.2	
6"-1-5	57	27.7	19.4	1.9	0.37	10.8	0.21
6"-1-6	45	25.1	21.9			12.2	0.00
6"-1-8	55	26.5	19.4	2.6	0.50	10.8	0.28
6"-1-9	48	31.8	24.9	3.0	0.75	14.2	0.43
6"-1-9 rerun	48	31.8	16.4	4.1	0.67	14.2	0.58
6"-1-11	50	19.6	16.4	2.6	0.43	8.9	0.23
6"-1-13	66	15.3	10.3			5.5	0.00
6"-1-16	37	14.8	16.7	2.4	0.41	9.1	0.22
1-3(10")	55	24.4	18.2	2.9	0.53	10.0	0.29
2-2(6")	128	86.0	25.1	1.5	0.38	14.4	0.22
2-4 (10")	110	62.8	22.2	2.8	0.62	12.5	0.35
3-3(10")	90	57.5	24.2	1.0	0.24	13.8	0.14
1-2	61	20.0	14.1			7.6	
1-5 (valve)	76	38.4	20.2	1.6	0.32	11.2	0.18
3-2	71	47.2	24.9			14.2	
3-5 (valve)	84	84.3	22.4	1.4	0.31	20.1	0.28
2-6 (valve)	73	48.7	25.0	2.6	0.65	14.3	0.37
4-2	85	63.9	27.4	1.6	0.43	15.8	0.25
4-3	64	37.1	22.5			12.7	
4-5 (valve)	86	85.3	33.4	0.5	0.15	19.9	0.09
3-5 (valve)	36	34.3	32.3	1.8	0.58	19.2	0.35
4-3	43	40.6	32.1	0.8	0.24	19.1	0.14
4-5 (valve)	45	75.3	45.5	1.2	0.56	29.5	0.37
4-4	42	39.4	31.9			19.0	
3-1	52	16.6	13.8			7.4	
3-3	43	41.0	32.3	1.1	0.37	19.2	0.22
3-4	42	15.7	15.7			8.6	0.00
4-1	43	16.2	15.9			8.6	0.00
3 B	48	28.5	22.8	2.7	0.62	12.9	0.35
3 B rerun	48	28.5	22.8	2.4	0.54	12.9	0.31
5 B	48	29.0	23.2	2.9	0.67	13.1	0.38
7 B	56	28.0	20.0	3.0	0.61	11.1	0.34
7 B rerun	56	28.0	20.0	8.6	1.71	11.1	0.95
7 B rerun	56	28.0	20.0	10.5	2.10	11.1	1.17
13B	72	29.8	17.1	2.8	0.47	9.4	0.26
15 B	64	18.4	11.1	1.9	0.21	6.7	0.12
avg.			22.58		0.58	13.10	0.29

An improved method using only the amount of dry solids was used to calculate sludge plutonium concentrations. The method is explained in Appendix A and presented in Table 9. Average values from Bouse data were used when actual data was not available.

Table 9. Best estimate corrections to Dodd plutonium concentrations 241-Z-361 sludge.

	Sample ID 361-Z-	wt solids	Pu g/L dry solids	PPSL corr'd Pu in sludge – Best Estimate
	3"-1-2		3.0	0.39
	3"-1-4	28.7	3.1	0.40
	8"-1-2	lost	2.5	0.33
Center Manhole	6"-1-2	22.8	1.9	0.25
	6"-1-3	30.5		
	6"-1-4			
	6"-1-5	27.7	1.9	0.25
	6"-1-6	25.1		
	6"-1-7			
	6"-1-8	26.5	2.6	0.34
	6"-1-9	31.8	3.0	0.39
			4.1	0.54
	6"-1-11	19.6	2.6	0.34
	6"-1-13	15.3		
	6"-1-16	14.8	2.4	0.32
Core Sample 3ftS-	1-3(10")	24.4	2.9	0.38
	2-2(6")	86.0	1.5	0.20
	2-4 (10")	62.8	2.8	0.37
	3-3(10")	57.5	1.0	0.13
	1-2	20.0		
	1-5 (valve)	38.4	1.6	0.21
	3-2	47.2		
	3-5 (valve)	84.3	1.4	0.18
	2-6 (valve)	48.7	2.6	0.34
	4-2	63.9	1.6	0.21
	4-3	37.1		
	4-5 (valve)	85.3	0.5	0.06
3ft N-	3-5 (valve)	34.3	1.8	0.23
	4-3	40.6	0.8	0.10
	4-5 (valve)	75.3	1.2	0.16
	4-4	39.4		
		16.6		
	3-3	41.0	1.1	0.15
	3-4	15.7		
	4-1	16.2		

Table 9. Best estimate corrections to Dodd plutonium concentrations 241-Z-361 sludge. (cont)

	Sample ID 361-Z-	wt solids	Pu g/L dry solids	PPSL corr'd Pu in sludge – Best Estimate
3ft N-15 bottle sample	1 B		0.9	0.12
	2 B			
	3 B	28.5	2.7	0.35
			2.4	0.31
	4 B	30.2		
	5 B	29.0	2.9	0.38
	6 B			
	7 B	28.0	3.0	0.40
	8 B	25.7	10.5	1.37
			8.6	1.12
			3.0	0.39
	9 B			
	10 B		2.1	0.28
	11 B			
	12 B			
	13 B	29.8	2.8	0.36
	14 B			
	15 B	18.4	1.9	0.24

The last core sample taken was the one that was analyzed and documented most thoroughly. The results are presented in Table 10.

Table 10. Sludge analysis results from 1977 North West sampling (Bouse).

	Dried Solids Density (g/L)	Pu Solids (g/L)	Volume % Solids in Sample	Pu in Sludge (g/L) based on dried	Pu g/L sludge (NDA)	Wet analysis/ NDA
NW-1	2.08	1.02	9%	0.09	0.27	0.32
NW-2	1.86	0.84	11%	0.10	0.29	0.33
NW-3	2.17	0.86	13%	0.12	0.35	0.33
NW-4	2.50	1.00	13%	0.13	0.25	0.54
NW-5	1.69	0.87	36%	0.32	0.60	0.52
NW-6	1.63	1.20	27%	0.32	0.23	1.44
NW-7	1.79	1.15	15%	0.18	0.59	0.30
NW-8	2.17	1.27	11%	0.14	0.18	0.77
NW-9	1.56	0.62	35%	0.22	0.37	0.59
NW-10	1.50	0.74	32%	0.24	0.28	0.84
NW-11	1.56	0.41	31%	0.13	0.20	0.63
NW-12	1.71	0.54	31%	0.17	0.17	0.99

The sludge contained layers of different material. These are described for the 1977 sludge samples in Table 11. This layering indicates that solids settled from waste and did not mix with existing sludge.

Table 11. Sample descriptions for 1977 Sludge sample.

	Sample Description
NW-1	Dark Brown -almost Black - loose –wet
NW-2	Color of Sample 1 – thicker
NW-3	Small amount of free liquid on top Color of sample 1 – thicker than 2
NW-4	Dark brown -lighter than 2- thinner
NW-5	Lighter color than 4 - very watery - thin soup
NW-6	Thicker than 5 - lighter color than 5 - gritty – sandy
NW-7	Thicker than 6 - dark tank color - pasty, creamy consistency
NW-8	same a 7 except lighter color
NW-9	Free liquid on top - only slightly darker color than 8 – same consistency
NW-10	same as 9
NW-11	tan-brown Same at 10 - slightly a darker
NW-12	Lot of liquid on top. Lt. brown darker than 5 above samples

CRIBS

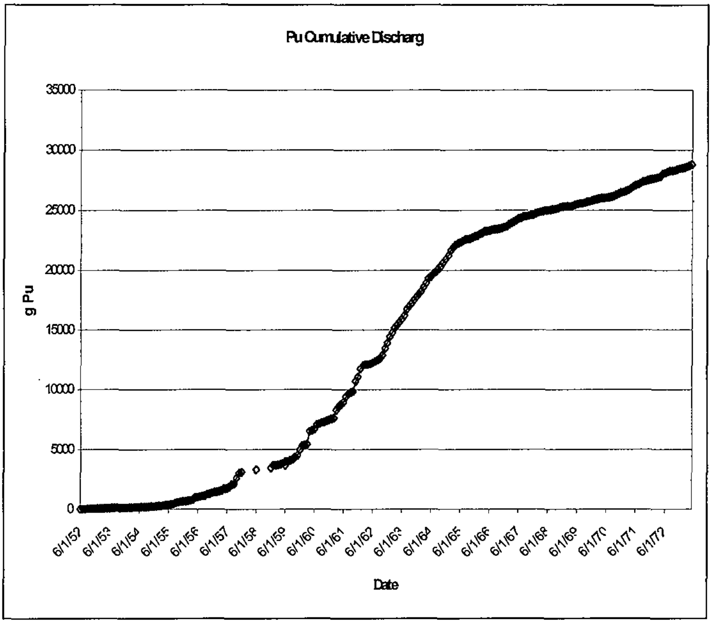
When the settling tank was filled to the overflow level, the liquid flowed by gravity to one of the cribs. Composition of the material in the settling tank can be inferred from descriptions of material being sent to the cribs. Routing to Z-1A appears to have changed between 1959 and 1964. Up until 1959, the overflow from Z-1, 2, and 3 went to Z-1A. When those cribs were taken out of service, Z-1A was not used for 5 years. When Z-1A was extended and put back in service in 1964, it is believed there was a waste route that did not include the 241-Z-361 settling tank.

Plutonium discharged to cribs that used 241-Z-361 for settling solids is plotted in Figure 3. From June 1949 to July 1952 the cribs used were Z-1 and Z-2 and there was 199 g plutonium discharged. July 1952 through March 1959 Crib Z-3 received waste from 241-Z-361. In March 1959, Crib Z-12 replaced Z-3. Waste was discharge to Z-12 until the same time as 241-Z-361 was taken out of service in May 1973. The analyses of sludge plutonium concentrations compared to the amount of plutonium discharged to the cribs indicate that most of the plutonium remained in the settling tank. Considering that plutonium is insoluble at the pH of solution discharged to the cribs, this is what would be expected. Data used to produce Figure 3 are listed in Appendix D. As can be seen in the figure, the discharge of plutonium is spread fairly consistently over the life of the tank.

Table 12. Cribs receiving waste from 241-Z (Knight).

Number	Description	Use From	Use To	Status
216-Z-1	231-Z, 234-5 Cooling Water Ditch	12/44	3/59	Terminated - Backfilled
216-Z-1	D-6 Waste	6/49	4/69	Terminated
	U	3/68	5/68	
216-Z-1A	Overflow from Z-1, 2 and 3	6/49	3/59	Replaced by Z-12
	Reclamation Waste	6/64	3/69	Replaced by Z-18
216-Z-2	D-6 Waste	4/49	6/52	Replaced by Z-3
	Reclamation Waste	6/52	5/66	Terminated
	CAW	5/66	6/66	Temporary routing
216-Z-12	D-6 Waste	6/52	5/73	Inactive

Figure 3. Cumulative Plutonium Discharged to Cribs Serviced by 241-Z-361.



CONCLUSIONS

Despite the large number of unanswered questions about the chemicals in the sludge several observations can be made.

Core samples of sludge taken in 1975 through 1977 all indicated layering in the sludge. For there to be distinct layers indicates there was no mixing of the sludge after solids settle. From this it can be inferred that migration of plutonium to form pockets of higher concentration would not occur.

Much of the plutonium in the sludge came from the incinerator scrubber. The plutonium would likely be present as plutonium oxide. When the fluorinator was operating, the plutonium may have been plutonium fluoride. Neutralization of PRF low-salt waste would have resulted in hydrous oxides of plutonium coprecipitating with large volumes of hydrous oxides of other metals.

Dodd indicated the sludge samples were difficult to dissolve even in B-acid (12 M HNO3, 0.5 M HF). Large volumes of water were discharged through this tank. Soluble components would have been washed away at that time. Addition of water to the tank would not dissolve the plutonium or other solids. .

One question being asked is "What's the current pH?" The information is not available as to what the pH of the sludge or streams into the tank were. It seems that the statements that the waste was neutralized to pH 10 or 12 are erroneous. Some of it may have been, but it appears that not all of it was. Unfortunately, the pH was not measured and recorded in the sampling campaigns.

The pH is sufficiently high (greater than 2) that plutonium is not mostly insoluble.

PRF low salt waste contained CCl4, TBP, DBP, MBP, and butanol. Transfer of this waste to the settling tank was accomplished using steam jetting. The CCl4 was likely steam distilled from the waste stream. The butyl phosphates and alcohol likely stayed in solution and were transferred to the cribs. Some may remain in the waste. Conditions that are required to form reactive degradation products do not exist in this tank. Reactive mixtures of tributyl phosphate require concentrated nitric acid and elevated temperatures to form.

The tank carbon steel liner has been dissolved through corrosion. This was evident from photographs in 1975.

Some degradation of the concrete tank has occurred, but is most of the concrete remains intact.

There is no separate organic phase in the tank. Organic compounds in the waste possibly include carbon tetrachloride (CCl4), tributyl phosphate (TBP), lard oil (triolein), and various complexants and solvents from the laboratories. The volatile compounds such as CCl4 may have been steam-distilled from the waste during the steam jetting transfer from the 241-Z sump tanks to the cribs. Folklore has it that steam rose from the settling tank during the transfers. Nonvolatile organic compounds constituted a very small portion of a large volume of waste.

These would likely be distributed through the waste. A separate organic phase is not expected.

The plutonium in the tank has not migrated or segregated

Layers that were observed in samples of the sludge will still be stratified. There is no mechanism for mixing in the tank. The solids settled over many years and are expected to remain in the layered configuration.

Some drying of the sludge has occurred, but the volume of the sludge has not decreased significantly. The tank was blanked off in 1973. Supernate liquid was pumped from the tank and the tank was sealed. There is no active ventilation. The tank is expected to breathe through loose-fitting covers. The contents are not generating much heat, so the sludge is not expected to be dry.

The tanks sludge may contain some or all of the components listed in Table 13. This list is based on the processes that were known or suspected to send waste to 241-Z-361 and analyses of the nonradioactive components in the tank.

Table 13. Known and Probable Components of 241-Z-361 Tank Sludge.

Type of Component	Component	Probable Source
Known Metals	Al	Waste Treatment
	Na	Incinerator Off-gas Treatment
	Ca	Waste Treatment
	Si	Incinerator Off-gas Treatment
	Cd	Most likely Analytical Artifact
Known Non-Metals	F^-	Hydrogen Fluorinator
	Cl^-	Waste Treatment
	C (organic or total?)	Incinerator Off-gas Treatment
	H_2O	All
	H^+	All
Probable Metals	Pb	Incinerator Off-gas Treatment
	Mg	Waste Treatment
	Mn	Waste Treatment
	Cr	Corrosion of SS Equipment
	Ni	Corrosion of SS Equipment
	Ag	Lab Film Processing
Probable Non-Metals	NO_3^-	Waste Treatment
	NO_2^-	Radiolysis of NO_3^-
	SO_4^{2-}	Waste Treatment
	PO_4^{3-}	Degradation of TBP
	CO_3^{2-}	Incinerator Off-gas Treatment
Probable Organics	CCl_4	Waste Treatment
	DBBP	Waste Treatment
	TBP	Waste Treatment
	DBP	Degradation of TBP
	MBP	Degradation of TBP
	Butanol	Degradation of TBP
	Urea	Incinerator Off-gas Treatment
	Lard Oil (Triolein)	Waste Treatment
	Oxalic Acid	Waste Treatment
	Acetic Acid	Incinerator Off-gas Treatment
	Benzene	Incinerator Off-gas Treatment
	Phthalic Acid	Incinerator Off-gas Treatment
Known Radionuclides	Pu	All
	Am	Decay of Pu^{241}
	U	Waste Treatment

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APPENDIX: A

DETAILED EXPLANATION OF CALCULATIONS APPLIED TO PLUTONIUM CONCENTRATION MEASUREMENT IN TANK 241-Z-361 SLUDGE

November 1976, D. A. Dodd (Dodd 1976) wrote a letter correcting data that was reported December 1975 (Dodd 1975). This section provides an explanation of the corrections made and an evaluation of the measurement methods used for samples of 241-Z-361 sludge analyzed by Dodd, Bouse and Dressen.

EXAMINATION OF DODD DATA

1	2	3	4	5	6	7	8	9	10	11
	Sample ID 361-Z-	Vol ml Filtrate	wt filtrate	wt solids	Vol (calc) solids	vol % solids	Corrected vol% solids	Pu g/L dry solids	Pu in sludge	Corrected Pu in situ
	3"-1-2							3.0		
	3"-1-4	62		28.7	23.2	37.4	27.2	3.1	1.16	0.84
	8"-1-2	lost		lost				2.5		
Center	6"-1-2	32		22.8	11.8	35.6	27.0	1.9	0.69	0.52
Manhole	6"-1-3	46	46.1	30.5	15.2		24.8			
	6"-1-4									
	6"-1-5	57	56.9	27.7	13.8	24.7	19.4	1.9	0.47	0.37
	6"-1-6	45	44.8	25.1	12.6	27.9	21.9			
	6"-1-7									
	6"-1-8	55	55.2	26.5	13.2	24.0	19.4	2.6	0.62	0.50
	6"-1-9	48	47.9	31.8	15.9	33.1	24.9	3.0	0.99	0.75
							16.4	4.1	0.00	0.67
	6"-1-11	50	50.4	19.6	9.8	19.6	16.4	2.6	0.51	0.43
	6"-1-13	66	66.3	15.3	7.6		10.3		0.00	
	6"-1-16	37		14.8	7.4	20.0	16.7	2.4	0.49	0.41
									0.00	
Core	1-3(10")	55		24.4	12.2	22.2	18.2	2.9	0.64	0.53
Sample	2-2(6")	128		86.0	43.0	39.5	25.1	1.5	0.59	0.38
3ftS-	2-4 (10")	110		62.8	31.4	33.5	22.2	2.8	0.94	0.62
	3-3(10")	90		57.5	28.8	37.6	24.2	1.0	0.38	0.24
	1-2	61		20.0	10.0		14.1		0.00	
	1-5 (valve)	76		38.4	19.2	25.3	20.2	1.6	0.40	0.32
	3-2	71		47.2	23.6		24.9		0.00	
	3-5 (valve)	84		84.3	42.2	50.1	33.4	1.4	0.70	0.47
	2-6 (valve)	73		48.7	24.3	33.3	25.0	2.6	0.87	0.65
	4-2	85		63.9	32.0	37.5	27.3	1.6	0.59	0.43
	4-3	64		37.1	18.6		22.5		0.00	
	4-5 (valve)	86		85.3	42.6	49.5	33.2	0.5	0.22	0.15
3ft N-	3-5 (valve)	36		34.3	17.2	47.8	32.3	1.8	0.86	0.58
	4-3	43		40.6	20.3	47.2	32.1	0.8	0.35	0.24
	4-5 (valve)	45		75.3	37.6	83.6	45.5	1.2	1.04	0.56
	4-4	42		39.4	19.7	46.9	31.9			
		52		16.6	8.3	16.0	13.8			
	3-3	43		41.0	20.5	47.7	32.3	1.1	0.54	0.37
	3-4	42		15.7	7.8	18.7	15.7			
	4-1	43		16.2	8.1	18.8	15.9			
3ft N-15	1 B					60.5		0.9	0.55	
Bottle	3 B	48		28.5	14.2	29.7	22.8	2.7	0.80	0.62
sample								2.4		
	4 B	53		30.2	15.1	28.5	22.2			

	5 B	48		29.0	14.5	30.2	23.2	2.9	0.88	0.67
	6 B									
	7 B	56		28.0	14.0	25.0	20.0	3.0	0.76	0.61
	8 B	62		25.7	12.8	20.7	17.1	10.5	2.17	
								8.6		
							17.1	3.0		0.51
	10 B					18.0		2.1	0.38	
	13 B	72		29.8	14.9	20.7	17.1	2.8	0.57	0.47
	15 B	64		18.4	9.2	14.4	11.1	1.9	0.26	0.21

Column 1:
Sampling location.

Column 2:
Sample ID

Column 3:
Volume in mL of filtrate collected from vacuum filtration of the sludge.

Column 4:
Weight of the filtrate collected.

The density of the sludge was calculated using the values in columns 3 and 4 as follows

$$\rho_{filtrate} = \frac{Weight_{filtrate}}{Volume_{filtrate}}$$

Column 5:
Weight of solids. This is the weight of solids that remained after filtering and air-drying.

Column 6:
Volume (calculated) solids. With the exception of samples 3-1-4 and 6-1-2, this value is the weight of solids (column 5) divided by 2. This value of 2 appears to be an assumed density of the solids in g/mL or g/cm^3.

$$Vol_{calc} = \frac{Weight_{solids}}{\rho_{solids}}$$

Column 7:
Volume percent solids was then calculated as the volume of solids (column 6) divided by the volume of filtrate (column 3) divided by 2 and times 100 (to convert to percentage). It is not clear what reason was used for the division by 2. Restated, the equation used to calculate volume percent solids was

$$Vol\%solids = \frac{vol_{calc,solids}}{vol_{filtrate}/2} * 100 = \frac{Weight_{solids}}{vol_{filtrate}} * 100$$

Column 8:
These are the values of the "corrected" volume percent solids. In the 1976 letter reporting these results, Dodd states that since the time when the results were first reported, "additional samples had been analyzed by A. L. Dressen. The percent solids were not calculated on the same basis." The "corrected" values were calculated using the equation

$$Vol\%solids = \frac{Weight_{solids}/2}{(2 * vol_{filtrate}) + Weight_{solids}/2} * 100$$

Restating this equation in terms of the columns of data

$$Vol\%solids = \frac{Column6}{(2 * Column3) + Column6} * 100$$

Column 9:
These numbers are assumed to be values calculated from laboratory plutonium concentration measurements from dissolution of a weighed amount of dry solids.

Column 10:
Plutonium in sludge was calculated from the corrected volume percent solids (column 8) multiplied by the concentration of plutonium in dry solids (column 9) divided by 100.

$$Pu_{sludge}(g/L) = Pu_{solids}(g/L) * vol\%solids_{corr} * 100$$

EXAMINATION OF DRESSEN DATA

Data collected by Dressen is summarized below.

SAMPLE NUMBER	WT. SLUDGE	DENSITY SLUDGE	WT. SOLIDS	DENSITY SOLIDS	VOL % SOLIDS
NE-2	225.8	1.4	77.5	2.5	19.2%
NE-4	251.6	1.6	60.6	3	12.8%
NE-6	258.4	1.6	70.8	2.25	19.5%
NE-8	249	1.4	101.2	2	28.4%
NE-10	400.9	1.6	99.3	2.5	15.9%
NE-12	100	1.5	31.1	2.5	18.7%
NE-3	263.9	1.5	134	1.67	45.6%
NE-5	444.2	1.05	184.5	2	21.8%

The weight of sludge was the weight of the sludge as received. Density of the sludge was measured either by placing sludge in a graduated cylinder and measuring the weight and volume (for the flowable sludge) or by adding about a gram of sample to a graduated cylinder containing about 5 mL of NPH and recording the volume change (for sludge that was "largely solids"). The sludge was filtered and air-dried over night. Dried solids were weighed. Density of dried solids was determine by placing a weighed amount of solids into a know volume of NPH and determining the solid volume. Volume percent solids was calculated using the equation

$$vol\%solids = \frac{Weight_{solids} * \rho_{sludge}}{Weight_{sludge} * \rho_{solids}} * 100$$

The concentration of plutonium in sludge was calculated by multiplying the concentration of plutonium in dried solids by the volume percent solids in sludge.

DRESSEN CORE SAMPLES			
		Pu Concentration g/L	
Section #	Vol % solids	in Solids	in Sludge
2	19.2	2.18	0.42
4	12.8	3.37	0.43
6	19.5	1.89	0.37
8	28.4	0.89	0.25
10	15.8	1.97	0.31
12	18.7	1.11	0.21

EVALUATION OF BOUSE DATA (ARH-N-375)

Bouse measured the density of sludge by placing a sample in a graduated cylinder and measuring the volume but said that measure produced "unbelievably low" specific gravities. The method used was to place approximated 20 grams of sample in a tared centrifuge cone, centrifuge the sludge for 10 minutes, and then read the meniscus of the clear liquid on top of the sludge for a total sludge volume. The specific gravity was calculated by dividing the weight of sludge by the volume observed following centrifuging.

The container of sludge was weighed, sludge was transferred to a filter, and the weight of the empty container was weighed. This was done because quantitative transfer of the sludge was not possible. After filtering, the sludge was air-dried. The volume of filtrate collected was also measured. Bouse found that the weight of filtrate plus the weight of dried solids left much weight not accounted for. He concluded that weight must be due to the liquid trapped in the filter cake that is lost when the sludge is air-dried.

Density of the solids was measured by adding approximately 1 gram of solids to a graduated cylinder containing 5 mL of NPH and the final volume recorded. Volume percent solids was calculated using the method of Dressen.

	1	2	3	4	5	6	7	8	9
NW-1	38.88	198.17	18.69	197.58	7.11E-03	19.13	1.91E+01	1.02	0.089
NW-2	64.16	266.55	34.49	265.22	1.25E-02	29.06	2.91E+01	0.84	0.095

NW-3	87.57	239.17	40.35	239.17	9.09E-03	34.68	3.47E+01	0.86	0.116
NW-4	84.43	207.72	33.77	207.51	8.09E-03	33.77	3.38E+01	1.00	0.135
NW-5	140.59	146.92	83.19	146.19	7.20E-03	72.40	7.24E+01	0.87	0.315
NW-6	110.24	177.60	67.63	176.37	2.29E-03	80.81	8.08E+01	1.20	0.319
NW-7	52.14	163.30	29.13	162.16	5.19E-03	33.55	3.36E+01	1.15	0.171
NW-8	61.61	214.68	28.39	213.19	9.17E-03	36.04	3.60E+01	1.27	0.138
NW-9	151.69	177.35	97.24	176.12	3.87E-03	60.68	6.07E+01	0.62	0.221
NW-10	130.32	170.65	86.88	168.96	3.89E-03	64.38	6.44E+01	0.74	0.238
NW-11	80.89	106.36	51.85	105.52	2.00E-03	21.35	2.14E+01	0.41	0.128
NW-12	152.64	190.38	89.26	188.87	3.97E-03	48.08	4.81E+01	0.54	0.167

COLUMN #	COMMENT
1 -	Total solids in sample gm. Initial sample wt x w/o dried solids
2 -	Total liquid gm - solids wt minus told sample wt
3 -	Total solids volume - ml Total solids wt/spGr
4 -	total volume liquid - mL . Total liquid wt/spGr.
5 -	Total Pu in liquid - mg
6 -	Total Pu in sludge - mg
7 -	Total Pu in Sludge - gm - Pu in liquid + Pu in solids
8 -	Pu in solids g/L
9 -	Pu in Sludge g/L

CONCLUSIONS

Dodd's calculations use assumed densities for sludge and solids and approximated the amount of liquid in the sludge. These values are used to calculate the concentration of plutonium in sludge. Based on the data collected by both Dressen and Bouse, there is considerable variation in the actual samples. A comparison is listed below.

A recalculation of Dodd's data was performed using the following assumptions:

- Dodd used a solids density of 2 g/cm^3 to calculate concentration of solids in the dry solids.
- Dodd used a sludge density of 1 g/cm^3.
- The average sludge density from Bouse was 1.15 g/cm^3.
- The average dried solids weight fraction of total sample (from Bouse) was 22.7%

The best value that can be calculated from the available data eliminates the volume percent solids value from the calculation. The corrected concentration is then calculated using

$$Pu_{insitu} = \frac{Pu_{solids} * 1.15\, g/cm^3}{.227}$$

	SAMPLE ID 361-Z-	WT SOLIDS	PU G/L DRY SOLIDS	PPSL CORR'D PU IN SLUDGE – BEST ESTIMATE
	3"-1-2		3.0	0.39
	3"-1-4	28.7	3.1	0.40
	8"-1-2	lost	2.5	0.33
Center Manhole	6"-1-2	22.8	1.9	0.25
	6"-1-3	30.5		
	6"-1-4			
	6"-1-5	27.7	1.9	0.25
	6"-1-6	25.1		
	6"-1-7			
	6"-1-8	26.5	2.6	0.34
	6"-1-9	31.8	3.0	0.39
			4.1	0.54
	6"-1-11	19.6	2.6	0.34
	6"-1-13	15.3		
	6"-1-16	14.8	2.4	0.32
Core Sample 3ftS-	1-3(10")	24.4	2.9	0.38
	2-2(6")	86.0	1.5	0.20
	2-4 (10")	62.8	2.8	0.37
	3-3(10")	57.5	1.0	0.13
	1-2	20.0		
	1-5 (valve)	38.4	1.6	0.21
	3-2	47.2		
	3-5 (valve)	84.3	1.4	0.18
	2-6 (valve)	48.7	2.6	0.34
	4-2	63.9	1.6	0.21
	4-3	37.1		
	4-5 (valve)	85.3	0.5	0.06
3ft N-	3-5 (valve)	34.3	1.8	0.23
	4-3	40.6	0.8	0.10
	4-5 (valve)	75.3	1.2	0.16
	4-4	39.4		
		16.6		
	3-3	41.0	1.1	0.15
	3-4	15.7		
	4-1	16.2		
3ft N-15 bottle sample	1 B		0.9	0.12
	2 B			

	3 B	28.5	2.7	0.35
			2.4	0.31
	4 B	30.2		
	5 B	29.0	2.9	0.38
	6 B			
	7 B	28.0	3.0	0.40
	8 B	25.7	10.5	1.37
			8.6	1.12
			3.0	0.39
	9 B			
	10 B		2.1	0.28
	11 B			
	12 B			
	13 B	29.8	2.8	0.36
	14 B			
	15 B	18.4	1.9	0.24

APPENDIX: B

TRANSCRIPTION OF LABORATORY NOTEBOOK DATA RELATED TO TANK 241-Z361 IN ARH-N-400

ARH-N-342
Z Plant Process Assistance
D. G. Bouse

4-13-77 241Z361 Tank Core Sampling & Processing

A full core sample of 361 Tan k was taken on 4-12-77. The sample was NDA checked in the field and reported to contain <20 gm Pu. The sample was place in leach hood-2 of the 232-Z Building (incinerator) and disassembled. The plastic liner of the sampler was full top to bottom. Some free liquid ran out the top of the plastic tubing and was lost to the hood floor. Near the bottom of the sample, the tubing was ruptured with some loss of sample. The bottom of the sample contained some almost white clay like material and was sampled separately as NW-12. Sample 11 was material tat had oozed out of the ruptured plastic and recovered from the hood floor. Samples were sectioned into 5: each of the plastic tubing (the ID was greater than the sample tube after removal) and represented ~6: of tank solids/sample. 12 samples were obtained.

Samples were numbered 1 thru 12 from the top surface to the bottom. Samples were placed in tared 1 pint plastic Jars: The samples were individually counted on the 3rd floor 880 sludge counter. 2-30 second counts – the average background for the series. C. Kindel says the net average count/260 yields an approximate Pu value. Results were:

Sample No.	Total Pu g/sample	Sample Container Tare weight g	Container + sludge g	Sludge wt (g)
NW-1	0.065	80.750	317.800	237.050
NW-2	0.096	80.390	411.100	330.710
NW-3	0.115	81.260	408.000	326.740
NW-4	0.073	80.750	372.900	292.150
NW-5	0.173	81.290	368.800	287.510
NW-6	0.065	80.660	368.500	287.840
NW-7	0.127	80.560	296.000	215.440
NW-8	0.050	78.810	355.100	276.290
NW-9	0.123	78.860	407.900	329.040
NW-10	0.085	81.930	382.900	300.970
NW-11	0.038	78.750	266.000	187.250
NW-12	0.058	80.480	423.500	343.020

4-15-77 241-Z-361 Tank (continued)
Efforts to obtain density measurements by placing the sample in a graduated cylinder resulted in unbelievably low spGrs. The method finally used was to tare graduated centrifuge cones, centrifuging a sample of sludge for 10 minutes leaving clear solution on top so the meniscus

could be read. A description of samples plus the densities were as follows:

	Cent. Cone, Tare	Cent. Con Net Wt.	Sample Wt (g)	Total Vol (mL)	Solids Volume	Sp Gr g/cc	
NW-1	36.3	57.2	20.9	19.0		1.10	Dark Brown -almost Black - loose -wet
NW-2	36.6	57.2	20.6	19.0		1.08	Color of Sample 1 - thicker
NW-3	36.3	56.7	20.4	18.7	16.8	1.09	small amount of free liquid on top Color of sample 1 - thicker than 2
NW-4	36.2	56.6	20.4	17.5	15.0	1.17	Dark brown -lighter than 2- thinner
NW-5	36.5	56.5	20.0	16.0	13.0	1.25	lighter color than 4 - very watery - thin soup
NW-6	36.1	56.3	20.2	17.5	14.3	1.15	thicker than 5 - lighter color than 5 - gritty - sandy
NW-7	36.0	56.6	20.6	18.2	17.5	1.13	thicker than 6 - dark tank color - pasty, creamy consistency
NW-8	36.0	57.0	21.0	19.8	18.5	1.06	same a 7 except lighter color
NW-9	35.9	56.9	21.0	17.5	14.2	1.20	Free liquid on top - only slightly darker color than 8 - same consistency
NW-10	36.2	56.7	20.5	18.5	16.5	1.11	same as 9
NW-11	36.1	57.4	21.3	19.0	17.0	1.12	tan-brown Same at 10 - slightly a darker
NW-12	35.8	56.0	20.2	17.0	15.0	1.19	lot of liquid on top. Lt brown darker than 5 above samples

Samples 1-4 Very dark brown - almost black
Sample 5 Lighter dark brown than above
Sample 6 look just like ordinary soil mixed with water
Samples 7-8-9-10 & 11 light brown to tan color - sample 8 lightest of all - creamy consistency
Sample 12 was darker brown than 7 thru 11 - looks more like sample 6

4-19-77 241-Z-361 Tank Core Sample Characterization (continued)

All samples will be filtered, the solids air-dried and the density of the air-dried solids determined. Since there is some sample loss through handling for density measurements, sludge sticking to containers, etc., the sample will be weighed before removing sludge to filter and the sample container reweighed after placing sludge on filter.

	Sample + Container Wt. (g)	Empty Container	Sludge on Filter	Dried Solids (g)	Sludge on Filter - Dried Solids	Assumed to be wt of "trapped" liquid	Vol liq filter/ vol liq trapped	Liquid Vol (mL)	Liquid SpG	Pu in Liquid (g/L)	Using Corrected Vol	Total Pu in Liquid (g)
NW-1	290.6	106.9	183.7	30.2	153.5	73.3	1.1	80	1.003	3.60E-05	7.11	2.9E-06
NW-2	363.9	122.9	241	46.8	194.2	96.7	1.0	97	1.005	4.70E-05	1.25	4.6E-06
NW-3	392	114.3	277.7	74.3	203.4	108.4	0.9	95	1.000	3.80E-05	9.09	3.6E-06
NW-4	331.7	116.5	215.2	62.1	153.1	78.0	1.0	75	1.001	3.90E-05	8.09	2.9E-06
NW-5	333.9	105.5	228.4	111.8	116.6	42.2	1.8	74	1.005	4.90E-05	7.2	3.6E-06
NW-6	357.6	101.7	255.9	98	157.9	85.4	0.8	72	1.007	1.30E-05	2.29	9.4E-07
NW-7	270.6	107.4	163.2	39.5	123.7	82.4	0.5	41	1.007	3.20E-05	5.19	1.3E-06
NW-8	346.1	97.4	248.7	55.5	193.2	128.8	0.5	64	1.007	4.30E-05	9.17	2.8E-06
NW-9	388	105.5	282.5	130.2	152.3	60.7	1.5	91	1.007	2.20E-05	3.87	2.0E-06
NW-10	368.9	105.1	263.8	114.3	149.5	76.8	0.9	72	1.010	2.30E-05	3.89	1.7E-06
NW-11	250.2	108.5	141.7	61.2	80.5	42.2	0.9	38	1.008	1.90E-05	2	7.2E-07
NW-12	380.9	118.8	262.1	116.7	145.4	85.9	0.7	59	1.008	2.10E-05	3.97	1.2E-06
											Ave	2.4E-06
											Total =	2.8E-05

Sample #5 contained the highest Pu value according to NDA tests. The sample isotopic concentration was determined by gamma counting. Results were as follows:

Isotope	wt%
238Pu	0.00874
239Pu	93.7
240Pu	6.023
241Pu	0.2333
241Am	0.4758

The sample weight loss between the sludge and the dry solids has got to be loss of liquid from evaporation. Most liquid comes off rapidly from and was removed frequently from flask, but most of the liquid trapped by solids evaporates as the sample dries and is not accounted for.

	Weight loss between Sludge and dry solids + liquid	Total Liquid if all wt. Loss is Liquid (g)
1 -	73.3	153.5
2 -	96.7	194.2
3 -	108.4	203.4
4 -	78.0	153.1
5 -	42.2	116.6
6 -	85.4	157.9
7 -	82.4	123.7
8 -	128.8	193.2
9 -	60.7	152.3
10 -	76.8	149.5
11 -	42.2	80.5
12 -	85.9	145.4

4-27-77 241-Z-361 Tank Core Sample Characterization (continued)

After drying (air dried – some require ~ 48 hrs or over the weekend) the density of the solids was determined by adding ~ 1 gm of solids to a graduate containing 5 mL of NPH and the final volume measured. The volume % solids in the samples were calculated the way Dressen calculated them, i.e.,

$$\frac{[\text{wt solids (gm)}]\,[\rho\ \text{sludge}]\ \text{x}100}{[\text{wt sludge (gm)}]\,[\rho\ \text{solids}]} = \text{vol.\% solids}$$

1 gm sample of the dried solids were fused with KOH-Na_2O_2 for 1 Hour. Samples were dissolved in 6-12 M HNO_3. Sample 5 12 M HNO_3 – all others 6 M HNO_3. A sample of NQ-5 will be submitted for E spec analysis. Portions of the dissolved solids will be sent to 222-S for further analyses. AT will be run by 234-5 lab.

	Dried Solids Density (g/L)	Solution Vol (mL)	Pu (g/L)	Pu total (mg)	Pu Solids (g/L)	Volume % Solids in Sample	Dried Solids wt % of total Sample wt
NW-1*	2.08	169	0.0032	0.54	1.02	8.69%	16.4%
NW-2	1.86	146	0.0031	0.45	0.84	11.32%	19.4%
NW-3	2.17	180	0.0022	0.40	0.86	13.5%	26.8%
NW-4	2.50	182	0.0022	0.40	1.00	13.5%	28.9%
NW-5	1.69	112	0.0046	0.52	0.87	36.2%	48.9%
NW-6	1.63	188	0.0039	0.73	1.20	27.1%	38.3%
NW-7	1.79	195	0.0033	0.64	1.15	15.3%	24.2%
NW-8	2.17	195	0.003	0.59	1.27	10.9%	22.3%
NW-9	1.56	138	0.0029	0.40	0.62	35.5%	46.1%
NW-10	1.50	183	0.0027	0.49	0.74	32.0%	43.3%
NW-11	1.56	155	0.0017	0.26	0.41	31.0%	43.2%
NW-12	1.71	210	0.0015	0.32	0.54	30.9%	44.5%

Sample NW-1 = 1.1 gm of solids – all other 1 gm.

One gm each of the following samples were fused in KOH only – dissolved in 12 M HCl and submitted for Na & N analysis.

NW-3A – Vol = 206mL
NW-4A – Vol = 181mL
NW-5A – Vol = 193mL
NW-6A – Vol = 192mL
NW-7A – Vol = 210mL
NW-9A – Vol = 206mL

5-5-77 241-Z-361 Tank Core Sample Characterization (continued)

The following details were extracted from previous pages

	1	2	3	4	5	6	7	8	9
NW-1	38.97066	198.079	18.74	197.4869	7.11E-03	19.15939	1.92E+01	1.02	0.089
NW-2	64.22086	266.489	34.53	265.1633	1.25E-02	29.06636	2.91E+01	0.84	0.095
NW-3	87.42089	239.319	40.29	239.3191	9.09E-03	34.61867	3.46E+01	0.86	0.116
NW-4	84.30537	207.845	33.72	207.637	8.10E-03	33.75587	3.38E+01	1.00	0.135
NW-5	140.7339	146.776	83.27	146.0459	7.16E-03	72.50609	7.25E+01	0.87	0.315
NW-6	110.2318	177.608	67.63	176.3736	2.29E-03	80.82196	8.08E+01	1.20	0.324
NW-7	52.14387	163.296	29.13	162.161	5.19E-03	33.55458	3.36E+01	1.15	0.176
NW-8	61.657	214.633	28.41	213.141	9.17E-03	36.06934	3.61E+01	1.27	0.138
NW-9	151.6496	177.390	97.21	176.1573	3.88E-03	60.69016	6.07E+01	0.62	0.221
NW-10	130.4051	170.565	86.94	168.8761	3.88E-03	64.43317	6.44E+01	0.74	0.237
NW-11	80.87297	106.377	51.84	105.5328	2.01E-03	21.31003	2.13E+01	0.41	0.128
NW-12	152.7296	190.290	89.32	188.7801	3.96E-03	48.10983	4.81E+01	0.54	0.167

1 - Total solids in sample gm. Initial sample wt x w/o dried solids
2 - Total liquid gm - solids wt minus told sample wt
3 - Total solids volume - ml Total solids wt/spGr
4 - total volume liquid - mL . Total liquid wt/spGr.
5 - Total Pu in liquid - mg
6 - Total Pu in sludge - mg
7 - Total Pu in Sludge - gm - Pu in liquid + Pu in solids
8 - Pu in solids g/L
9 - Pu in Sludge g/L

APPENDIX: C

TRANSCRIPTION OF LABORATORY NOTEBOOK DATA RELATED TO TANK 241-Z361 IN ARH-N-400

ARH-N-400
Plutonium Processing Assistance
A. L. Dressen

361-Z Tank Sludge

7-12-76
A request has been received to determine the presence of free liquid in core samples of 361-Z sludge. We will examine samples of both the black and brown solids. First we will pour off any supernates and measure the volume. We will then determine if the solids will flow. If they do, we will then filter them and measure the volume of filtrate; the solids may then be dried on a hot plate to measure weight loss. If the solids do not flow, they will be placed in a porcelain filter without paper or vacuum and enough supernate added to make them flow.

7-20-76
Labeling system for 361-Z samples:

3 = 3"riser
S = south end of tank
1 = #1 core barrel (from top)
1 = 1st 6" fraction from top

3S-1-3
No supernate appeared on the sample and the solids would not flow. The solids were black and had the consistency of frosting. The sample was filtered overnight with a vacuum but any liquid drawn off had evaporated by morning.

3S-4-3
Some brown soupy supernate appeared on the sample and 28 mL flowed through a filter without paper or vacuum. Most of the rest of the solids would slowly flow and were filtered overnight with the sample result as the sample above.

7-21-76
3-S-1-2
Appeared like black tar with no supernate and solids would not flow. However, 81 mL of liquids was pulled thru the filter when vacuum was used. The resulting solids were still quite gummy and 10 mL of filtrate was required to make 5 g of the solids flow.

3S-4-2
Brown soup appeared over the solids; 40 mL of the sample would flow. The material which flowed separated on standing for a24 hours into 25 mL of still flowable solids and 15 mL of liquid. The nonflowing solids yielded 52 mL of liquid when filtered with a vacuum. 10 mL of the filtrate was required to make 5 g of the dried solids flow.

<u>9-15-76</u>
A core sample of 361-Z sludge will be delivered to CTL within a few days. Process has requested the following analyses:
For every other section
Volume percent solids
Density of sample
If sample s readily flowable, measure the weight and volume in a graduated cylinder
If sample is largely solids, with the total sample, add ~1 gram to cylinder containing 5 mL NPH and record the final volume;
Filter the sample and air-dry overnight
Weigh the solids
Density of solids – same as 1.b. above
Pu content of solids
If the solids are black, fuse ~1 g sample.
If the solids are brown, dissolve 1 g in12 M HNO_3
Submit the solution for Pu (AT-AEA)
For the section containing the highest Pu concentration from I. Above
Determine the volume percent solids and Pu content for the sections on each side as in I. Above
Send 3-4 grams of the solid to Merrill Bert, HEDL, for analysis of nitrogen, chlorine, carbon, and oxygen.
Send sample of solids for emission spec. analysis.
Dissolve ~1 gram in H_2O in a polypropylene vial and send for atomic absorption for Na, Fe Si, Al, Cd.
For the sections containing the next 2 highest Pu concentration from I. above, run the analyses in II. B., C., D.

<u>9-23-76</u>
The 361-Z sample taken from the northeast quadrant of the tank was sectioned into 12 4" portions. SGSAS found the following:

Section Number	Pu Content, g	Cumulative Pu content, g
NE-1	0.68	0.68
NE-2	1.80	2.48
NE-3	0.69	3.17
NE-4	1.20	4.37
NE-5	0.96	5.33
NE-6	1.40	6.73
NE-7	0.30	7.03
NE-8	2.40	9.43
NE-9	1.6	11.03
NE-10	0.93	11.96
NE-11	1.0	12.96
NE-12	1.7	14.66

We will be working with the even-numbered sections initially.

NE-2:
Color = black
Consistency = like frosting
Sample + container = 349.4 g
container = 123.6 g
sample = 225.8 g
density = .7g/.5mL = 1.4 g/cm^3

NE-3:
color = cream-tan
consistency = creamy, buttery
Sample + container = 510.1 g
container = 109.2 g
sample = 400.9 g
density = 1.3g/.8mL = 1.6 g/cm^3

NE-4:
Color = dark brown
Consistency = frosting
Sample + container = 394.4 g
container = 142.8 g
sample = 251.6 g
density = 1.6g/1mL = 1.6 g/cm^3

<u>9-24-76</u>
NE-2:
solids = 77.5 g density = 1g/.4mL = 2.5 g/cm^3

NE-6:
color = light brown
sample + container = 464.4 g
container = 206.0 g
sample = 258.4 g
density = 1.1g/.7mL = 1.6 g/cm^3

NE-6:
sample + container = 432.6 g
container = 183.6 g
sample = 249.0 g
density = 1g/.7mL = 1.4 g/cm^3
color = light brown filtrate = 69 mL

NE-10:
Solids = 99.4 g
Density = 1g/.4mL = 2.5 g/cm^3

NE-12:
sample + container = 231.7 g
container = 131.7 g
sample = 100.0 g
color = medium brown
density = .9g/.6mL = 1.5 g/cm^3

9-28-76
NE-4:
Solids = 60.6 g
Density = .9g/.3mL = 3 g/cm^3 => 12.8 vol % solids

NE-6:
Solids = 70.8 g
Density = .9g/.4mL = 2.25 g/cm^3 => 19.5 vol % solids

9-29-76
NE-8:
Solids = 101.2 g
Density = 1g/.5mL = 2 g/cm^3 => 28.4 vol % solids

NE-12:
Solids = 31.1 g
Density = 1g/.4mL = 2.5 g/cm^3 => 18.7 vol % solids

10-1-76
NE-2 fusion:
Wt sample = 2 g
Soln. Volume = 218 mL
G Pu/L = .008
Wt % Pu in solids = .087

10-4-76
NE-4 fusion:
Wt sample = 2 g
Soln. Volume = 240 mL
G Pu/L = .008
Wt % Pu in solids = .084

10-5-76
NE-6 fusion:
Wt sample = 2 g
Soln. Volume = 240 mL
G Pu/L = .007
Wt % Pu in solids = .084

NE-12 fusion:
Wt sample = 2 g
Soln. Volume = 297 mL
G Pu/L = .003
Wt % Pu in solids = .044

NE-8 fusion:
Wt sample = 2 g
Soln. Volume = 315 mL
G Pu/L = .003
Wt % Pu in solids = .044

NE-10 fusion:
Wt sample = 2 g
Soln. Volume = 304 mL
G Pu/L = .005
Wt % Pu in solids = .079

<u>10-11-76</u>

Section No.	Vol % Solids	G Pu/L solids	G Pu/L sludge	Difference with SGSAS
2	19.2	2.18	.42	-90.1%
4	12.8	3.37	.43	-94.4%
6	19.5	1.89	.37	-95.8%
8	28.4	.89	.25	-89.4%
10	15.8	1.97	.31	-66.4%
12	18.7	1.11	.21	-87.8%
3	45.6	.20	.097	
5	21.8	.72	.157	

<u>10-13-76</u>
NE-3:
Sludge wt = 263.9
Density = 2g/1.3mL = 1.5 g/mL
Filtered overnight => ? mL filtrate

NE-5:
Sludge wt = 444.2
Density = 2g/1.9 ML = 1.05 g/mL
Filtered overnight => ? mL filtrate

<u>10-18-76</u>
NE-3:
Solids = 134 g never did dry completely after 4 days
Density = 1 g/.6mL = 1.67 g/cm3 =>21.8 vol % solids

NE-3 fusion =
Wt sample = 2 g
Soln. Volume = 240 mL
G Pu/L = .001
Wt% Pu in solids = .012

NE-5 fusion:
Wt. Sample = 2 g
Soln. Volume = 220 mL
G Pu/L = .0024
Wt % Pu in solids = .026

<u>10-20-76</u>
Emission spec of NE-4: (ppm)

Al = 60,000	Ga < 80	Si = 5000
B < 10	K = 3000	Sn = 20
Be < 10	Mg = 19,000	Ta <400
Bi = 50	Mn = 400	Ti = 150
Cd = 50	Mo = 300	V < 200
Co = 1000	Na = 50,000	W = 400
Cr = 800	Nb < 160	Zn = 5000
Cu = 2500	Ni = 2000	Zr <160
Fe = 40,000	Pb = 200	

APPENDIX D:

PLUTONIUM DISCHARGES TO CRIBS Z-1, Z-2, Z-3 AND Z-12

		DISCHARGE TO CRIB		12-MONTH TOTAL		RUNNING TOTAL	
Crib	Period	Vol ($x10^6$ L)	Plutonium (g)	Vol ($x10^6$ L)	Plutonium (g)	Vol ($x10^6$ L)	Plutonium (g)
Z-1 & Z-2	up to June-52	34	199			34	199
Z-1, -2, -3	July-52	1.635	8.2			35.635	207.2
	August-52	1.681	6.9			37.316	214.1
	September-52	1.984	5			39.3	219.1
	October-52	1.287	5.8			40.587	224.9
	November-52	1.299	12.9			41.886	237.8
	December-52	1.327	5.9	43.213	243.7	43.213	243.7
	January-53	1.02	6.3			44.233	250
	February-53	0.75	5.8			44.983	255.8
	March-53	0.86	4.2			45.843	260
	April-53	0.91	7.5			46.753	267.5
	May-53	0.87	9.5			47.623	277
	June-53	0.97	10			48.593	287
	July-53	1.04	10.7			49.633	297.7
	August-53	0.65	5.4			50.283	303.1
	September-53	0.82	14.9			51.103	318
	October-53	1.378	8.3			52.481	326.3
	November-53	0.67	4.4			53.151	330.7
	December-53	1.27	8.1	11.208	95.1	54.421	338.8
	January-54	0.89	4.3			55.311	343.1
	February-54	0.92	4.1			56.231	347.2
	March-54	1.57	10			57.801	357.2
	April-54	0.22	6.5			58.021	363.7
	May-54	1.48	17.3			59.501	381
	June-54	0.3	1.4			59.801	382.4
	July-54	0.571	11.8			60.372	394.2
	August-54	0.921	6.72			61.293	400.92
	September-54	0.948	4.86			62.241	405.78
	October-54	1.05	7.47			63.291	413.25
	November-54	1.21	12.6			64.501	425.85
	December-54	1.4	9.2	11.48	96.25	65.901	435.05

		DISCHARGE TO CRIB		12-MONTH TOTAL		RUNNING TOTAL	
Crib	Period	Vol ($x10^6$ L)	Plutonium (g)	Vol ($x10^6$ L)	Plutonium (g)	Vol ($x10^6$ L)	Plutonium (g)
	January-55	0.449	22.3			66.35	457.35
	February-55	0.195	15.4			66.545	472.75
	March-55	0.354	23.2			66.899	495.95
	April-55	1.63	30.2			68.529	526.15
	May-55	2.25	37.1			70.779	563.25
	June-55	6.49	17.9			77.269	581.15
	July-55	2.96	29.8			80.229	610.95
	August-55	4.82	32.6			85.049	643.55
	September-55	4.72	96.1			89.769	739.65
	October-55	3.92	38.4			93.689	778.05
	November-55	1.86	56.6			95.549	834.65
	December-55	3.64	25.5	33.288	425.1	99.189	860.15
	January-56	1.89	16.1			101.079	876.25
	February-56	2.13	19.2			103.209	895.45
	March-56	2.07	47.4			105.279	942.85
	April-56	3.99	38.5			109.269	981.35
	May-56	0.969	199			110.238	1180.35
	June-56	2.07	35.9			112.308	1216.25
	July-56	1.53	41.7			113.838	1257.95
	August-56	3.4	51.6			117.238	1309.55
	September-56	2.51	25.5			119.748	1335.05
	October-56	2.8	119			122.548	1454.05
	November-56	2.9	50.4			125.448	1504.45
	December-56	2.97	69.4	29.229	713.7	128.418	1573.85
	January-57	3.11	57.8			131.528	1631.65
	February-57	2.18	29.6			133.708	1661.25
	March-57	3.33	42.7			137.038	1703.95
	April-57	3.51	64			140.548	1767.95
	May-57	4.06	161			144.608	1928.95
	June-57	2.43	51.3			147.038	1980.25
	July-57	2.76	97.7			149.798	2077.95
	August-57	3.38	182.7			153.178	2260.65
	September-57	3.28	47.2			156.458	2307.85
	October-57	2.1	493			158.558	2800.85
	November-57	2.05	450.7			160.608	3251.55
	December-57	1.98	34.5	34.17	1712.2	162.588	3286.05

		DISCHARGE TO CRIB		12-MONTH TOTAL		RUNNING TOTAL	
Crib	Period	Vol (x10^6 L)	Plutonium (g)	Vol (x10^6 L)	Plutonium (g)	Vol (x10^6 L)	Plutonium (g)
	June-58	17	1330			179.588	4616.05
	December-58	18	858	35	2188	197.588	5474.05
	June-59	9	230			206.588	5704.05
Z-12	January-59					206.588	5704.05
	February-59					206.588	5704.05
	March-59	2.42	25.5			209.008	5729.55
	April-59	3.99	63.7			212.998	5793.25
	May-59	4.55	77.9			217.548	5871.15
	June-59	5.9	118.6			223.448	5989.75
	July-59	5.34	37.05			228.788	6026.8
	August-59	5.1	65.56			233.888	6092.36
	September-59	3.44	94.22			237.328	6186.58
	October-59	2.94	179.68			240.268	6366.26
	November-59	2.88	146.28			243.148	6512.54
	December-59	4.26	467.13	40.82	1275.62	247.408	6979.67
	January-60	3.158	371.42			250.566	7351.09
	February-60	3.402	29.04			253.968	7380.13
	March-60	3.091	60.83			257.059	7440.96
	April-60	3.55	1102.08			260.609	8543.04
	May-60	3.244	71.41			263.853	8614.45
	June-60	3.981	89.13			267.834	8703.58
	July-60	3.174	387.29			271.008	9090.87
	August-60	4.645	59.6			275.653	9150.47
	September-60	4.206	110.9			279.859	9261.37
	October-60	3.113	41.6			282.972	9302.97
	November-60	4.086	95.7			287.058	9398.67
	December-60	4.484	88.7	44.134	2507.7	291.542	9487.37
	January-61	4.112	92.5			295.654	9579.87
	February-61	3.752	87			299.406	9666.87
	March-61	3.047	649.2			302.453	10316.07
	April-61	2.926	272.5			305.379	10588.57
	May-61	2.62	194			307.999	10782.57
	June-61	4.514	192			312.513	10974.57
	July-61	2.566	443			315.079	11417.57
	August-61	3.449	238			318.528	11655.57
	September-61	3.778	121			322.306	11776.57
	October-61	3.578	86			325.884	11862.57
	November-61	2.698	851			328.582	12713.57
	December-61	3.678	366	40.718	3592.2	332.26	13079.57

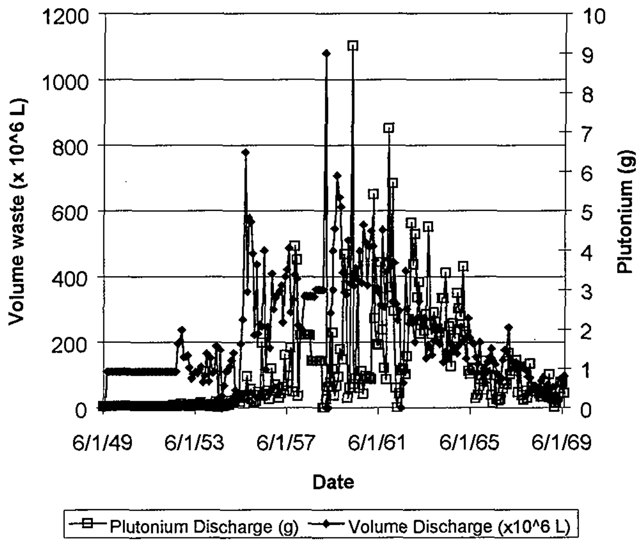
		DISCHARGE TO CRIB		12-MONTH TOTAL		RUNNING TOTAL	
Crib	Period	Vol ($x10^6$ L)	Plutonium (g)	Vol ($x10^6$ L)	Plutonium (g)	Vol ($x10^6$ L)	Plutonium (g)
	January-62	2.64	684			334.9	13763.57
	February-62	2.23	295.3			337.13	14058.87
	March-62	2.47	60			339.6	14118.87
	April-62					339.6	14118.87
	May-62	0.64	43.2			340.24	14162.07
	June-62	3.47	113			343.71	14275.07
	July-62	2.52	118.9			346.23	14393.97
	August-62	2.15	103			348.38	14496.97
	September-62	2.25	157			350.63	14653.97
	October-62	2.15	272			352.78	14925.97
	November-62	1.68	563			354.46	15488.97
	December-62	2.28	436	24.48	2845.4	356.74	15924.97
	January-63	2.71	528.6			359.45	16453.57
	February-63	2.33	336			361.78	16789.57
	March-63	2.11	383			363.89	17172.57
	April-63	2.29	226			366.18	17398.57
	May-63	1.26	266.42			367.44	17664.99
	June-63	1.61	235			369.05	17899.99
	July-63	1.51	286			370.56	18185.99
	August-63	1.35	551			371.91	18736.99
	September-63	1.7	254			373.61	18990.99
	October-63	2.07	224			375.68	19214.99
	November-63	1.68	291			377.36	19505.99
	December-63	1.62	261	22.24	3842.02	378.98	19766.99
	January-64	1.97	242			380.95	20008.99
	February-64	1.16	229			382.11	20237.99
	March-64	1.43	334			383.54	20571.99
	April-64	1.24	334			384.78	20905.99
	May-64	1.36	411			386.14	21316.99
	June-64	1.62	154			387.76	21470.99
	July-64	1.43	248			389.19	21718.99
	August-64	1.53	126			390.72	21844.99
	September-64	1.38	257			392.1	22101.99
	October-64	1.58	212			393.68	22313.99
	November-64	2.07	349			395.75	22662.99
	December-64	1.69	303	18.46	3199	397.44	22965.99

		DISCHARGE TO CRIB		12-MONTH TOTAL		RUNNING TOTAL	
Crib	Period	Vol ($x10^6$ L)	Plutonium (g)	Vol ($x10^6$ L)	Plutonium (g)	Vol ($x10^6$ L)	Plutonium (g)
	January-65	1.727	279			399.167	23244.99
	February-65	1.252	430			400.419	23674.99
	March-65	2.28	232			402.699	23906.99
	April-65	1.773	222			404.472	24128.99
	May-65	1.651	111			406.123	24239.99
	June-65	1.625	103			407.748	24342.99
	July-65	1.289	118			409.037	24460.99
	August-65	1.113	120			410.15	24580.99
	September-65	1.663	28			411.813	24608.99
	October-65	0.871	38			412.684	24646.99
	November-65	1	86			413.684	24732.99
	December-65	0.631	97	16.875	1864	414.315	24829.99
	January-66	1.16	53			415.475	24882.99
	February-66	1.28	143			416.755	25025.99
	March-66	1.5	98			418.255	25123.99
	April-66	1.21	121			419.465	25244.99
	May-66	1.11	38			420.575	25282.99
	June-66	0.86	13			421.435	25295.99
	July-66	0.68	97			422.115	25392.99
	August-66	0.77	24			422.885	25416.99
	September-66	1.22	23			424.105	25439.99
	October-66	1.48	26			425.585	25465.99
	November-66	1.43	58			427.015	25523.99
	December-66	2.05	73	14.75	767	429.065	25596.99
	January-67	1.23	71			430.295	25667.99
	February-67	1.19	167			431.485	25834.99
	March-67	1.04	102			432.525	25936.99
	April-67	1.16	124			433.685	26060.99
	May-67	0.94	111			434.625	26171.99
	June-67	1.09	145			435.715	26316.99
	July-67	1.03	46			436.745	26362.99
	August-67	1.01	124			437.755	26486.99
	September-67	0.959	38			438.714	26524.99
	October-67	0.798	25			439.512	26549.99
	November-67	0.764	52			440.276	26601.99
	December-67	0.478	30	11.689	1035	440.754	26631.99

		DISCHARGE TO CRIB		12-MONTH TOTAL		RUNNING TOTAL	
Crib	Period	Vol ($x10^6$ L)	Plutonium (g)	Vol ($x10^6$ L)	Plutonium (g)	Vol ($x10^6$ L)	Plutonium (g)
	January-68	0.483	133			441.237	26764.99
	February-68	0.504	62			441.741	26826.99
	March-68	0.469	49			442.21	26875.99
	April-68	0.526	48			442.736	26923.99
	May-68	0.689	58			443.425	26981.99
	June-68	0.772	43			444.197	27024.99
	July-68	0.246	34			444.443	27058.99
	August-68	0.57	32			445.013	27090.99
	September-68	0.213	46			445.226	27136.99
	October-68	0.338	43			445.564	27179.99
	November-68	0.53	101			446.094	27280.99
	December-68	0.53	31	5.87	680	446.624	27311.99
	January-69	0.242	27			446.866	27338.99
	February-69	0.151	2			447.017	27340.99
	March-69	0.738	14			447.755	27354.99
	April-69	0.515	31.8			448.27	27386.79
	May-69	0.806	78			449.076	27464.79
	June-69	0.485	77.5			449.561	27542.29
	July-69	0.363	43.8			449.924	27586.09
	August-69	0.522	21.8			450.446	27607.89
	September-69	0.651	37.3			451.097	27645.19
	October-69	0.651	70			451.748	27715.19
	November-69	0.522	51.4			452.27	27766.59
	December-69	0.784	62.5	6.43	517.1	453.054	27829.09
	January-70	0.348	64.6			453.402	27893.69
	February-70	0.344	54.3			453.746	27947.99
	March-70	0.356	48			454.102	27995.99
	April-70	0.428	15.8			454.53	28011.79
	May-70	0.121	24.7			454.651	28036.49
	June-70	0.132	28.2			454.783	28064.69
	July-70	0.204	19.5			454.987	28084.19
	August-70	0.182	38.5			455.169	28122.69
	September-70	0.299	57.5			455.468	28180.19
	October-70	0.371	107.2			455.839	28287.39
	November-70	0.466	88.7			456.305	28376.09
	December-70	0.197	103	3.448	650	456.502	28479.09

		DISCHARGE TO CRIB		12-MONTH TOTAL		RUNNING TOTAL	
Crib	Period	Vol (x10^6 L)	Plutonium (g)	Vol (x10^6 L)	Plutonium (g)	Vol (x10^6 L)	Plutonium (g)
	January-71	0.216	54			456.718	28533.09
	February-71	0.181	66.81			456.899	28599.9
	March-71	0.286	88.36			457.185	28688.26
	April-71	0.659	136.4			457.844	28824.66
	May-71	0.739	152			458.583	28976.66
	June-71	0.95	102			459.533	29078.66
	July-71	0.713	87.93			460.246	29166.59
	August-71	0.872	94.9			461.118	29261.49
	September-71	0.87	139.1			461.988	29400.59
	October-71	0.768	33.08			462.756	29433.67
	November-71	0.863	68.89			463.619	29502.56
	December-71	1.067	43.11	8.184	1066.58	464.686	29545.67
	January-72	1.17	94			465.856	29639.67
	February-72	0.791	40			466.647	29679.67
	March-72	0.898	49			467.545	29728.67
	April-72	1.21	76			468.755	29804.67
	May-72	1.4	230			470.155	30034.67
	June-72	1.16	86.9			471.315	30121.57
	July-72	0.762	94			472.077	30215.57
	August-72	1.24	81			473.317	30296.57
	September-72	0.867	16			474.184	30312.57
	October-72	0.689	33			474.873	30345.57
	November-72	0.784	76			475.657	30421.57
	December-72	0.713	63	11.684	938.9	476.37	30484.57
	January-73	0.571	42			476.941	30526.57
	February-73	0.752	52			477.693	30578.57
	March-73	1.22	62			478.913	30640.57
	April-73	0.82	88			479.733	30728.57
	May-73	0.101	83	3.464	327	479.834	30811.57

Figure 4. Plutonium discharged in waste through 241-Z-361 settling tank from 1949 to 1953.



DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Plutonium Process Support Laboratories	Date 06/24/98
Project Title/Work Order		EDT No. 612477
HNF-1989, Rev. 1, "Tank 241-Z-361 Process and Characterization History"/K6215		ECN No. N/A 629415

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
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