[redacted] COVER SHEET

UCN-2031
(3 9-60)

OAK RIDGE NATIONAL LABORATORY
Operated By
UNION CARBIDE NUCLEAR COMPANY

UCC

POST OFFICE BOX X
OAK RIDGE, TENNESSEE

ORNL
CENTRAL FILES NUMBE
60-2-119

DATE: 2-10-60

This document consists of 15 page
Copy 1 of 1 copies. Series A

SUBJECT: Evaporator Incident of November 20, 1959: Isotopic Composition of Plutonium Removed from the Evaporator

TO: F.L.Culler

FROM: W.T.McDuffie

INV 83 INV 65 INV 64 INV 91 INV 77 INV 78 INV 63 INV 79 INV 86 INV 89 INV 81 INV 88

1-31-90 BF

SEP 8 1971

DEC 1 1977

Classification changed to: Unclassified
(level and category)
By authority of: PR-2; DAR-1; SRIC-50 Rev. 8
(classification guide)
[signature] 5/23/94
ADC or ADD signature (first reviewer) Date
[signature] 5/24/94
ADD signature (final reviewer) Date

This document has been approved for release to the public by:

[signature] 7/13/95
Technical Information Officer Date
ORNL Site

[redacted]NOTICE

This document contains in[redacted]ation of a prelimina[redacted] at the Oak Ridge National Laborator[redacted] subject [redacted] represent a final report. T[redacted] information is not be ab[redacted] reprinted or otherwise [redacted] public d[redacted] without the approval [redacted] ORNL Pa[redacted], Legal and Information Control Dep[redacted]ment.

[redacted] of 1954. Its transmittal or the [redacted] contents in any manner to an unauthorized person [redacted]hibited.

[redacted]OVER SHEET

ChemRisk Document No. 1972

[redacted]

TABLE OF CONTENTS

[redacted]

[redacted]

60-2-119

X-847

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

February 10, 1960

To: F. L. Culler
Building 4500

Subject: EVAPORATOR INCIDENT OF NOVEMBER 20, 1959: ISOTOPIC COMPOSITION OF PLUTONIUM REMOVED FROM THE EVAPORATOR

A sample of the plutonium recovered from the Turco 4501 mixture drained from the evaporator to tank P-3 prior to the explosion was examined for isotopic composition; results are shown compared with the average composition observed in the S- and H-240 programs:

[redacted]

ATC-
10/5/62

	Wt., per cent			
Isotope	P-3 Solution	S-240	H-240	Avg., both programs
239	78.76	78.41	84.89	81.65
240	17.36	17.19	13.31	15.21
241	3.31	3.74	1.62	2.68
242	0.57	0.66	0.18	0.42

On the basis of the isotopic composition it appears that the plutonium remaining in the evaporator at the time of the explosion originated in the S-240 program.

W. T. McDuffee

WTMcD:lj

cc: J. C. Bresee
W. H. Lewis
J. R. Parrott
R. E. Brooksbank
J. L. Matherne
D. E. Arthur
W. T. McDuffee - File

[redacted]

[redacted]

X-847

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

476
10/5/62

January 23, 1960

To: E. D. Arnold
Building 4500

Subject: PRFR PILOT PLANT: Pu-240 FEED MATERIAL DATA

The feed material data requested by you in our telephone conversation yesterday is summarized in Tables 1 and 2, attached. The g/t data as found by analyses were based on the most recent results as determined in George Sadowski's studies relating to accountability measurements.

ORIGINAL SIGNED BY
W. T. McDUFFEE
W. T. McDuffee

WTMcD:lj

cc: F. L. Culler
J. C. Bresee
W. H. Lewis
W. T. McDuffee - File

[redacted]

Table 1. Savannah River Pu-240 Feed Material Data

Weight, metric tons	Category	Predicted g Pu/ton	Predicted % 240	Found g Pu/ton	Found % 240	Isotopic Analyses, wt %[a] Uranium 235	Uranium 238	Plutonium 239	Plutonium 240	Plutonium 241	Plutonium 242
1.10	B	1450	8.9	1180	10.6	0.11 ± 0.02	99.89 ± 0.02	87.4[b]	10.64[b]	1.74[b]	0.22[b]
1.06	B	2210	12.6	1700	12.6	0.10 ± 0.02	99.90 ± 0.02	84.88 ± 0.09	12.64 ± 0.09	2.27 ± 0.09	0.21 ± 0.0[illegible]
1.91	B	3050	18.3	2900	18.5	0.10 ± 0.03	99.90 ± 0.03	76.5 ± 0.2	18.5 ± 0.2	4.20 ± 0.1	0.8 ± 0.0[illegible]
1.79	A	3550	21.7	2240	20.4	0.08 ± 0.03	99.92 ± 0.03	74.12[b]	20.43[b]	4.62[b]	0.83[b]
-	A	3550	21.7	5550	20.4	0.10 ± 0.03	99.90 ± 0.03	73.93[b]	20.37[b]	4.83[b]	0.87[b]
	Average				16.5[c]	-	-	78.41[d]	17.19[d]	3.74[d]	0.66[d]

Average Exposure - ≅ 2195 Mwd/ton

[a] As found by ORNL analysis of recovered material.

[b] Analyses of Pu product sample chosen for minimum intermixing with other batches.

[c] Weighted average.

[d] Weighted average determined from Pu product analyses.

[redacted]

[redacted]

Table 2. Hanford Pu-240 Feed Material Data

Weight, metric tons U	Category	Predicted g Pu/ton	Predicted % 240	Found g Pu/ton	Found % 240	Isotopic Analysis, wt %[a] Uranium 235	Uranium 238	Plutonium 239	Plutonium 240	Plutonium 241	Plutonium 242
1.69	B	1840	16.8	1900	15.99	0.09 ± 0.01	99.91 ± 0.01	81.55 ± 0.09	15.99 ± 0.08	2.17 ± 0.05	0.29 ± 0.05
1.89	C	1560	13.8	1580	14.15	0.10 ± 0.01	99.90 ± 0.01	83.95 ± 0.08	14.15 ± 0.08	1.74 ± 0.05	0.16 ± 0.05
2.48	D	1180	10.5	1170	10.85	0.11 ± 0.01	99.89 ± 0.01	87.88 ± 0.08	10.85 ± 0.08	1.16 ± 0.05	0.12 ± 0.05
Average[b]		1480	13.3	1500		0.10	99.90	84.89	13.31	1.62	0.18

Average Exposure - 780 Mwd/ton

[a] As found by ORNL analyses of feed solutions.

[b] Weighted for amount of material in each category.

[redacted]

[redacted]

[redacted]

X-847

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

To: F. C. Maienschein Date: May 4, 1960

Subject: Measurement of Plutonium Accumulation in Pilot Plant Process Equipment.

This memo is to confirm our telephone conversation of May 3rd. We have a piece of process equipment located in cell 6, Building 3019, which contains an unknown quantity of plutonium. The plutonium is probably in the form of hydrated oxide which accumulated on the packing of a steam stripper during the processing of more than a hundred pounds of plutonium in the fall of 1959. The plutonium had been highly irradiated and contained 16.4% Pu-240 and approximately 0.5% Pu-242.

It may be possible to determine the quantity of plutonium in the equipment by a measurement of the fast neutron flux on the surface of the equipment. Since the quantity might vary from a few hundred grams to as much as four kilograms, a measurement with an accuracy of ± 50% would provide data of real significance from the standpoint of criticality.

Based upon a spontaneous fission rate of 425 fissions/g. sec. for Pu-240 and 760 fissions/g. sec. for Pu-242 and assume an eta of approximately three for both isotopes, a total accumulation of 4 kgs of plutonium would result in a neutron production rate of approximately 9×10^5 neutrons per second. It is my understanding that a thermal fission chamber with an appropriate moderating cover can be used to detect the resulting flux and could be designed to be operated at the end of an extension handle.

We propose to borrow a fission chamber, cable, and counter equipment to be used inside cell 6, Building 3019. The interior of the cell is grossly contaminated with Pu, so it will be necessary to use several layers of protective plastic over all equipment which will be taken into the cell. Our experience in using and removing counting and photographic equipment in the cell since the November 20th incident makes me confident that the operation can be performed without danger of contamination of the borrowed equipment. Two engineers will be asked the responsibility of working with you to assemble and calibrate necessary equipment. They are W. J. Greter of the Instrumentation and Controls Division and W. T. McCarley of the Chemical Technology Division. Before any hot operations, a complete detailed procedure will be written and reviewed by the appropriate committees responsible for radiation safety and control.

I appreciate very much your offer to loan us the necessary equipment for this experiment and I assure you that all efforts will be made to limit the time that we will use the equipment and the possibility of damage to it.

Original Signed by
J. C. Bresee
J. C. Bresee

APPROVED - F. L. CULLER

JCB:bjh
cc: F. L. Culler, Jr.
F. R. Bruce
W. H. Lewis, L. J. King
W. J. Greter, W. T. McCarley

[redacted]

X-647

[redacted]

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

October 19, 1960

To: F. L. Culler

Subject: Summary of Pilot Plant Activities for the Period 1950-1960

Summaries have been prepared for the pilot plant operation and cost for the period 1950-1960. The accounting data prior to 1950 includes all the Technical Division cost without providing a separate pilot plant account. For this reason costs prior to 1950 were omitted. Start-up dates through completion of the program are quite accurate beginning with the "25" Program through the early stages of the PRFR Program.

From the following tables of operation for Buildings 3019 and 3505 it is quite apparent that the 3019 operation lends itself to large development programs extending from one to 2-1/2 years, excluding the Thorium Processing Program. The Thorex Process facilities are unique in that they are the only thorium facilities in the Commission. Without this thorium capacity, the reprocessing of the U-233 for Dixon Callahan's Eta Program could not have been performed.

In the case of Metal Recovery more than 20 separate campaigns have been completed over an eight-year period, with many of the programs lasting no more than a month. It has been said, and it can been seen from reviewing the materials processed, that the Metal Recovery is a garbage disposal unit of the Commission. During the eight-year period of operation of the Metal Recovery 274,460 kg uranium, 1,252 kg plutonium, 70 g americium, and 545 g neptunium have been recovered.

If you ignore the cost associated with americium and neptunium recovery and divide the cost of operation during this period equally between uranium and plutonium recovery, the cost of uranium is $6.84/kg and $1,500/kg plutonium. These costs are far below average. If it had not been for Metal Recovery facilities, the plutonium and uranium would probably still be in storage and not back in production channels. The Metal Recovery facility is very flexible, which has made possible recovery of such items as plutonium from sand; neptunium from K-25 and Paducah ash; americium, plutonium and uranium from metallurgical waste. Because of the relatively small amounts of metal processed during one campaign and the great variety of materials, production site facilities are unable to process this material easily. The size of their equipment and the large amount of feed required to operate a production plant makes the plant inflexible to change for each new program.

[redacted]

[redacted]

Tables I, II, and III give the summary of 3019 and 3505 plant cost beginning with the "25" Processing Program through the PRFR combined operations. Figures 1 and 2 show the schedule of operation during the same period of time.

H. B. Graham

HBG:rt

[redacted]

TABLE I

SUMMARY OF PILOT PLANTS COST

Program Building 3019	Date	Plant Mod.	Costs, $$10^3$ Operating Preop.	Operating	Post Op.	Total	Processed Material kg U	Pu	U-233	Unit Cost $/Unit kg U	g Pu
25	11/47-11/49	-	-	-	-						
Redox	7/48-7/49	-	-	-	-						
Purex	10/50-4/53		781	1,444	363	2,588	8,500	3.3	-		
Thorex	10/53-11/58		168	4,015	62	4,245	50,000	-	84		
PRFR	11 [illegible] -11/59										
3019		60		769	-	829	73,000	54			
3505		188		711	-	899					
Total		248		1,480		1,728					
Total		248	949	6,939	425	8,561	131,500	57.3	84		
Metal Recovery 3505											
Scrup	3-9/52		35	129	-	164	-	3.8	-		42.8
Metal Recovery	9/52-1/54	30	81	442	-	552	100,000	.2	-	2.70	(30)
Met. Waste	1/54-9/54	65	127	362	-	554		67.0*	-	-	6.8
Clementine	9/54-11/54	-	14	43	-	57		15	-		3.88
BNL - Slugs	12/54-5/55	39	61	150	-	250	13,500	2.7	-	4.62	46.25
X-10 - Slugs	6/55-11/55	27	55	275	-	357	60,000	7.0	-	1.49	25.50
ANL - CP2	12/55-6/56	-	-	26		26	2,700	0.2	-	4.80	
ANL - CP3				127		127	26,500	-		2.38	
Pu-Al	6/56		38	45		83	-	171	-	-	
TF-W-10	8/56-3/57		38	360	6	404	28,000		-		
CRTC	3-4/57		6	27	6	40	7,500		-		
K-25 Ash	4/57		6	16	8	30	960	(18 g Am)*			

* Also 10 g Am (credit taken for $96,600).

[redacted]

[redacted]

UNCLASS

TABLE I - Page 2

Program	Date	Plant Mod.	Costs, $10^3 Operating: Preop.	Operating	Post Op.	Total	Processed Material kg: U	Pu	U-233	Unit Cost $/Unit: kg U	g Pu
Metal Recovery (con't)											
CR-Pu Sol.	5/57	-	9	13	-	22		1.8			
CR-Pu	6/57	-	-	105	-	105		1.8			
Paducah Ash	7-9/57	-	-	144	-	144	6,000				
CR-Pu-Al	9/57	-	-	53	-	53	-	1.1			
TF-W-10-3	9-12/57	-		113	-	113	3,300				
Amex	12/57-3/58	-	-	168	-	168		(42 g Am)			
Sand	3-4/58	-	-	100	-	100		75			
Paduca Ash	4-9-58	-	-	363	-	363	19,000				
USS	9-10/58	-		57		57	8,000	545 g Np)			
Total		161	470	3,118	20	3,769	275,460	1,252 70 g Am 545 g Np	0		

[redacted]

[redacted]

TABLE II

METAL RECOVERY

Program	Date From	Date To	U Processed Tons	Pu Grams	Np Grams	Am Grams	Cost Per Program	Cost U/Pound	Cost Pu/Gram
CP-3	3/30/56	4/13/56	2.7	200			25,990	4.81	
CP-2	4/13/56	6/14/56	26.5				126,946	2.38	
Pu-Al	6/15/56	6/30/56		171			45,134		263.94
Down Time	6/30/56	8/18/56					76,203		
TF-W-10	8/18/56	3/4/57	28.0				360,378		
Down Time	3/4/57	3/15/57					12,463		
CRTC	3/15/57	4/7/57	7.5				26,619		
Down Time	4/7/57	4/17/57					12,320		
K-25 Ash	4/17/57	4/30/57	0.96		18.0		16,016		
Down Time	4/30/57	5/8/57					17,269		
CR-Pu Sol'n	5/8/57	5/14/57		1,843			12,952	By Ion Exchange	
CR-Pu	5/14/57	6/30/57		1,865			104,784		
PAD-Ash	7/1/57	9/1/57	6.0				143,731		
CR-Pu-Al II	9/1/57	9/30/57		1,128			53,180		
TF-W10-3	9/30/57	12/1/57	3.3				113,479		
AMEX	12/1/57	3/1/58				42	168,351		
SAND	3/1/58	4/15/58		75			99,587		
PAD-Ash	4/15/58	9/1/58	19.0				362,529		
USS	9/1/58	9/25/58	8.0		545		56,825		
Down Time	9/25/58	12/28/58					188,684	For Tie-In to 3019 Bldg.	

[redacted]

TABLE III

PRFR

Program	Dates From	Dates To	U Processed Tons	Pu Processed Grams	3019 Cost	3505 Cost	Total Cost
SCRUP-2	12/28/58	2/12/59	5.3	3,148	78,568	75,899	154,467
SRP-E	1/30/59	2/20/59	1.5	1,495	33,248	47,720	80,968
Down Time	2/20/59	2/22/59			4,750	4,772	9,522
BNL-1	2/22/59	3/25/59	9.7	4,610	73,251	59,904	133,155
Down Time	3/25/59	3/27/59			4,917	3,799	8,716
SNAP	3/27/59	4/18/59	3.0	3,426	44,710	40,313	85,023
Down Time	4/18/59	4/26/59			18,465	17,320	35,785
BNL-2	4/26/59	8/1/60	37.0	18,139	213,518	222,709	436,227
Down Time	8/1/60	8/29/59			78,173	58,932	137,105
S-240	8/29/59	9/20/59	5.8	14,144	63,261	50,364	113,625
Down Time	9/20/59	9/26/59			21,250	16,229	37,479
H-240	9/26/59	10/15/59	6.0	8,281	48,842	37,682	86,524
Down Time	10/15/59	10/21/59			14,680	13,045	27,725
MTR-ANL	10/21/59	11/20/59	4.4	386	71,675	62,401	134,076
Total			72.7 kg	53.6 kg	769,308	711,089	1,480,397

[redacted]