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OPERATIONS DIVISION

REPORT FOR FEBRUARY 1955

By

A. F. Rupp

Prepared from reports by:
J. A. Cox
E. E. Beauchamp
J. H. Gillette
E. J. Witkowski

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TABLE 1

GRAPHITE REACTOR OPERATIONS

Period 2-1-55 to 2-28-55

	This Month	Last Month	Year to Date
Total energy, Mwd	88.8	100.5	189.3
Average power, kw/operating hour	3483	3498	3491
Time operating, %	91.0	92.7	91.9
Excess reactivity, inhr	55.5	72	
Slugs charged	56	50	106
Slugs discharged	64	74	138
Input air temperature (av), °F	40.8	34	
Exit air temperature (av), °F	151.3	138	
Exit air filters, Δp, in. H_2O	4.5	4.3	
Canal water radioactivity, counts/min/ml	~3400	~2600	
Total facilities assigned, %	82.6	91	
Facilities in use for research, %	50.0	53	
Facilities in use for radioisotopes, %	21.7	27	
Research samples	133	98	231
Radioisotope samples	226	247	473

GRAPHITE REACTOR

There was a slug rupture on February 22; this slug had been in the reactor 1016 days at 175° C. Experiments done for the Reactor School which required fast start-ups are believed to have caused the rupture.

A new shield was installed at hole No. 10, which will now be used for operations formerly done in hole No. 12, which has been turned over to the Solid States Division for use as a low temperature facility. The new equipment at hole No. 10 will permit sample removal with less exposure to radiation.

An electromagnet was built from discarded LITR magnets for use in picking up pieces of radioactive cobalt from the canal floor. The radioactivity of the canal water has been reduced from 10,000 c/min/ml to 4000 c/min/ml in the section west of the canal dam.

[redacted]

[redacted]

TABLE 2

LITR OPERATIONS

Period 2-1-55 to 2-28-55

	This Month	Last Month	Year to Date
Total energy, Mwd	64.1	64.0	128.1
Average power, kw /operating hour	2982	2968	2975
Time operating, %	76.8	69.6	73.0
Excess reactivity, %	2.9	2.8	
Unscheduled shutdowns, hr	6.633	0.933	7.566
Regular shutdowns, hr	32.483	54.250	86.733
Research shutdowns, hr	117.015	171.184	288.199
Inlet water temperature (av), °F	92.8	92	
Outlet water temperature (av), °F	109.6	109	
Cooling water reactivity, counts/min/ml	60,697	65,000	
Cooling water resistivity, ohms	400,000	450,000	
Fuel pieces charged	1	0	1
Fuel pieces discharged	0	0	0
Total facilities assigned, %	100.0	100	
Facilities in use for research, %	55.5	61	
Facilities in use for radioisotopes, %	27.7	28	
Research samples	29	19	48
Radioisotope samples	39	37	76

LOW-INTENSITY TEST REACTOR

Research activities around holes HB-4, HB-5, and HB-6 were responsible for two-thirds of the high downtime this month (23.2%).

The three shim rods were calibrated, using the growth of xenon after shutdown as a reference standard. Rods Nos. 2 and 3 were found to be of about equal value, while rod No. 1 was about one-half as effective as the other two rods. Rod No. 2, which has about 50 grams of fuel used up, was 20% less effective than when originally installed.

Using the newly calibrated shim rods, an experiment containing 130 g U^{235} in a stainless steel can was checked in position C-48; the maximum effect (4" above the center line) was 0.14 $\frac{\Delta K}{K}$.

RADIOISOTOPE PRODUCTION AND SALES

Radioisotope Shipments are shown below.

	February 1955	January 1955	February 1954	Since August 1946
Processed Material	929	889	850	52,762
Irradiation Units	215	219	198	13,805
Total	1144	1108	1048	66,567
Domestic	1029	1015	937	
Foreign	38	11	26	
AEC Projects	77	82	85	
Total	1144	1108	1048	

Detailed radioisotope production and sales data are given in Tables 3 and 4.

Our part of the first cesium-137 teletherapy project was completed with installation of the 1540-curie source in the head of the ORINS machine. The loading was uneventful. This source was completed approximately one year ago and has been in storage since then; periodic tests have shown no leakage of activity; no distortion or obvious radiation damage to the container was observed.

All back orders for short-lived fission products (Sr^{89}, Ba^{140}, Y^{91}, Nd^{147}, Zr^{95}-Nb^{95}, etc.) were filled.

One batch of Fe^{59} (from enriched Fe^{58}) was processed which enabled us to complete all but one back order for extremely high specific activity Fe^{59}.

A proposal on the method of handling the C^{14}-labelled compound sale was sent to the Isotopes Division for approval.

Although high specific activity cobalt for teletherapy units is still in short supply, enough emphasis has been placed on this in Washington to enable us to feel a little more optimistic about future production. It is anticipated that two more cans containing approximately 7500 curies of cobalt will be received from the MTR about the first week of March.

It was proposed to the AEC Isotopes Division that the system for selling cobalt be changed somewhat; i.e., authorizations be granted to fabricators of teletherapy equipment so that it would not be necessary for ORNL to do business with both the fabricator and the ultimate user. The Isotopes Division has accepted this proposal in regard to the hectocurie unit but not the kilocurie units.

New revised shipping documents will be ordered to fit with the IBM card system. Approval has been given to open cost sub-accounts on all items listed in the catalog.

The following work remains to be done on the multikilocurie handling cell: install viewing window; polish liner; pour concrete roadway; install manipulators. The contractor is about five weeks behind schedule.

RADIOISOTOPE DEVELOPMENT

Fabrication of the 250-gal shielded transfer vessel is scheduled for completion by March 26.

Approximately 2500 curies of Cs^{137} has been accumulated in the main crystallizer of the F. P. semi-works; this will be removed for final purification.

It was determined that technetium is carried down in good yield on expecially-formed iron hydroxide precipitates, at pH 2.5. This step is being incorporated in the FPPP flow sheet and is expected to greatly decrease Tc separation costs. About one-half gram of Tc was separated from waste and is now being purified.

An experimental cell containing a "Boltaron" liner (unplasticized vinyl polymers) is nearing completion. Craftsmen had some difficulty in welding the seams (with a hot-air gun) in the beginning, but after gaining skill and speed they produced a good-looking cell surface. This plastic has been found satisfactory after doses up to 10^9 roentgens and should provide a surface of extraordinarily good decontaminability.

Fairly detailed reports of experiments conducted on Cs^{137} purification and TBP extraction of cerium are given as appendices to this report.

Fission Product Pilot Plant (F3P)

This project is now in the second design stage, which includes the making of construction drawings for the cell block, process vessels, process piping, special mechanical equipment, cell ventilation, and hot off-gas connections to the isotope area stack.

The McPherson Company was selected as the architect-engineer; this is the same firm that is doing the architectural design of the ORR.

A capacity of 200,000 curies of Cs^{137} per year was found to be possible only with acid-base waste as feed material (within the limits of the funds available for construction). Use of other (highly-salted) feed materials will lower the plant capacity.

Conferences held with manufacturers of centrifugals indicated that a 26" diameter bowl, center-slung centrifugal is the best type for the F3P process. A somewhat slower speed will be used, reducing the settling force from 1900 to 550 X gravity; additional one-quarter plant scale tests are being made under these conditions.

Airborne ammonia gas will be used for all homogeneous hydroxide precipitations instead of urea hydrolysis. Close pH control can be more easily obtained with ammonia gas. It will be necessary to circulate samples semi-continuously to check the pH during precipitation; this is being done on a quarter-plant scale, at low radioactivity levels. It will be necessary to water-jacket the sampling lines to provide good temperature control.

Duriron is being considered for constructing the evaporator pot, which will be subjected to the most extremely corrosive conditions. Duriron pots can be obtained in sizes up to 400 gals as standard equipment. Non-lubricated Duriron-and-stainless steel plug cocks are of interest also; one cock was ordered for testing purposes.

TABLE 3.
RADIOISOTOPE PRODUCTION AND SALES

Period 2-1-55 to 2-28-55

Symbols: I = irradiated unit; P = processed material; HSA = high specific activity; LSA = low specific activity; CF = carrier-free; E = enriched target; X = ORNL Graphite Reactor; FP = fission product

C-86 = 86" Cyclotron; W = Hanford; L = LITR; M = Arco; S = Scrup

Product	Type	Source	* Specific Activity	This Month		Year to Date	
				Produced	Sold	Produced	Sold
Antimony-122	I						
Antimony-124	I						1
Antimony-124	P-HSA				10		30
Antimony-125	I				1		1
Antimony-125	P-CF						0.5
Argon-37	P-CF	L	CF	2,500		2,500	7
Arsenic-73,74	P-CF						
Arsenic-76	I				3		6
Arsenic-77	I						
Barium-131	I				2		2
Barium-133	P-HSA	X	0.269	7.65	5	7.65	8
Barium-140	P-CF	X	CF	189	220	189	220
Beryllium-7	P-CF						6
Bismuth-210	I						
Bromine-82	I				4		6
Cadmium-115	I						
Cadmium-115*m*	I						
Cadmium-115	P-HSA	L	6.47	6.6	1	6.6	1
Calcium-45	I						
Calcium-45	P-LSA				105		138
Calcium-45	P-HSA				196		253
Calcium-45	P-E				10		14
Calcium-45	P-CF						0.008
Carbon-14	P				212.2		636.9
Cerium-141	I						
Cerium-141	P-CF	X	CF	891	142.5	891	142.5
Cerium-144	P-CF				80		96
Cesium-134	I						
Cesium-134	P-HSA				170	3,094	220
Cesium-137	P-CF				342		2,409
Chlorine-36	I						3
Chlorine-36	P				0.05		0.80
Chromium-51	I						
Chromium-51	P-HSA				375	2,301	1,139
Cobalt-57	P-CF				3		4
Cobalt-58	P-CF				2		2
Cobalt-60	I						1
Cobalt-60	P-HSA	M	21,800	588	150	588	190
Copper-64	I				2		5
Europium-152,154	I						
F. P. (gross)	P	X	CF	780	253	780	253
Gallium-72	I				2		2

* Specific activity is in mc/gram.

Amounts produced and sold are in mc for processed material and in units for irradiated material.

TABLE 3 (continued)
RADIOISOTOPE PRODUCTION AND SALES

Product	Type	Source	Specific Activity	This Month		Year to Date	
				Produced	Sold	Produced	Sold
Gold-198	I				57		131
Gold-199	I						
Hafnium-181	I				2		2
H^3 (tritium)	P-CF				41,600		85,208
Indium-114	I						
Indium-114	P-HSA	L	511	385	7	385	7
Iodine-129	P						
Iodine-131	I				6		11
Iodine-131	P-CF	X	CF	63,162	48,081	125,046	94,768
Iridium-192	P-HSA	L	8,600	1,102	82	1,102	85
Iridium-194	I						
Iron-55,59	I						
Iron-55,59	P-HSA				5		16
Iron-55	P-E	L	5,103	620	27.55	620	38.55
Iron-59	P-E	L	1,533	78.7	59.05	135.7	80
Krypton-85	P-CF						
Lanthanum-140	I				2		2
Manganese-54	P-CF	C-86	CF	46.8	6.7	48.8	8.4
Mercury-197	I						
Mercury-203	I				1		3
Mercury-203	P-HSA				21.1	8,680	137.1
Molybdenum-99	I				2		4
Neodymium-147	P-CF	X	CF	19	3	19	3
Nickel-63	I				3		3
Nickel-63	P-HSA				3		15
Niobium-95	P-CF				2		18
Osmium-191	I						
Palladium-109	I						
Phosphorus-32	I				3		4
Phosphorus-32	P-HSA	X	40,000	16,156	12,492	30,815	28,261
Phosphorus-32	P-CF	X	CF	76	36	117	73
Potassium-42	I				18		41
Potassium-42	P-HSA						
Praseodymium-142	I						
Praseodymium-143	P-CF						
Promethium-147	I						
Promethium-147	P-CF	S	CF	1,058		1,058	60
Rhenium-186	I						
Rubidium-86	I				3		7
Ruthenium-97	I						
Ruthenium-103	P-CF	X	CF	600	69	600	69
Ruthenium-106	P-CF				10		52
Samarium-153	I						
Scandium-46	I						
Scandium-46	P-HSA				2		17
Selenium-75	I						
Selenium-75	P-HSA				11		81

TABLE 3 (continued)
RADIOISOTOPE PRODUCTION AND SALES

Product	Type	Source	Specific Activity	This Month		Year to Date	
				Produced	Sold	Produced	Sold
Silver-110	I						
Silver-110	P-HSA	W,M	1,800	2,301	106	2,301	189
Silver-111	I				4		5
Silver-111	P-CF						
Sodium-22	P-HSA				4		5.7
Sodium-22	P-CF				0.5		9.1
Sodium-24	I				23		50
Sodium-24	P-HSA	L	2,060	731	56	1,697	149
Strontium-85	P-CF						
Strontium-89	I						1
Strontium-89	P-CF	X	CF	395	366	395	366
Strontium-90	P-CF				10,949		21,165
Sulfur-35	I				1		1
Sulfur-35	P-CF (SO_4^{--})				811		1,614
Sulfur-35	P-HSA (sulfide)				22		43
Sulfur-35	P-HSA (element)						1
Tantalum-182	I						
Tantalum-182	P-HSA				8	75	30
Technetium-99	I						
Technetium-99	P				0.06		0.06
Thallium-204	I						
Thallium-204	P-HSA				61		81
Tin-113	P-HSA	W	4.1	39.2	3.05	39.2	4.05
Tungsten-185	I						
Tungsten-185	P-HSA				30	540	30
Tungsten-187	I				1		1
Yttrium-90	I				1		2
Yttrium-91	P-CF	X	CF	273	78	273	78
Zinc-65	I						
Zinc-65	P-HSA				182		403
Zinc-65	P-CF	C-86	CF	49.15	3	49.15	3
Zirconium-95	I				5		5
Zirconium-95	P-CF	X	CF	780	138	780	138
Service Irradiations					59		122
TOTALS	Processed Material, mc			92,834	117,612	185,133	239,076
	Irradiated Material, units				146		300
	Service Irradiations				59		122

TABLE 4
RADIOISOTOPE PRODUCTION AND SALES – SOURCES AND MISCELLANEOUS PRODUCTS

Period 2-1-55 to 2-28-55

Symbols: VHSA = very high specific activity; HSA = high specific activity; MSA = medium specific activity; LSA = low specific activity; CF = carrier-free; T = teletherapy; R = radiography; IR = irradiator

Product	Type	Number of Sources	Use	Size of Sources		Sales	
				Minimum	Maximum	Month	Year
Antimony-beryllium	Neutron						
Cesium-137	CF	1	T	1500 c	1500 c	1500 c	1500 c
Cesium-137	CF		R				25 c
Cesium-137	CF		IR				
Cobalt-60	VHSA	1	T	1434 c	1434 c	1434 c	1434 c
Cobalt-60	HSA		T				1546 c
Cobalt-60	MSA		T				
Cobalt-60	HSA		R				
Cobalt-60	MSA	4	R	610 mc	2.9 c	7 c	7 c
Cobalt-60	LSA	2	R	50 mc	990 mc	1 c	51.5 c
Cobalt-60	HSA		IR				413 c
Cobalt-60	MSA		IR				
Cobalt-60	LSA	345	IR	0.1 mc	30 c	1026 c	3598 c
Iridium-192	HSA		R				
Iridium-192	MSA	17	R	4 c	17 c	213 c	298 c
Iron-55	HSA	1		5 mc	5 mc	5 mc	17 mc
Phosphorus-32	Plaques, 1 in.		IR				
Phosphorus-32	Plaques, 3 in.		IR				
Strontium-90	CF		IR				9 c
Tritium-zirconium	Evaporated target	2		332 mc	333 mc	665 mc	1265 mc
Tritium-zirconium	Fused target	2		1164 mc	1456 mc	2610 mc	24.1 c
Cobalt-60	LSA	1	T	305 c	305 c	305 c	305 c
Helium	Ampoules	1		1 cc	1 cc	1 cc	201 cc
Tritium	Ampoules	14		100 mc	10 c	41.6 c	**
Deuterium	Fused target	1		1.36 cc	1.36 cc	1.36 cc	4.8 cc
Argon-37	Ampoules						**

*Ranges of specific activity used for Co^{60}: VHSA - > 40 c/g; HSA - 25-40 c/g; MSA - 10-25 c/g; LSA - Up to 10 c/g.

**See Table 3.

TABLE 5

WASTE DISPOSAL – WATER DEMINERALIZATION – HYDROGEN LIQUEFACTION SHIFT OPERATIONAL SERVICES – EQUIPMENT DECONTAMINATION ACTIVATION ANALYSIS – SF ACCOUNTING

Period 2-1-55 to 2-28-55

	This Month	Last Month	Year to Date	Total Last Year
Water through settling basin, gal	15,400,000	17,100,000	32,500,000	158,200,000
Activity through settling basin, curies	12.7	10.1	22.8	237.3
Water through retention pond, gal	750,000	590,000	1,340,000	6,090,000
Activity through retention pond, curies	1.4	1.0	2.4	17.2
Waste to lagoons, gal	108,000	195,300	303,300	997,000
Activity to lagoons, curies	4,026	1,053	5,079	7,224
Total activity in lagoons 2 and 3, curies	20,973	16,947	20,973	15,893
Demineralized water produced, gal	331,000	487,000	818,000	4,416,250
Liquid hydrogen produced, liters	None	None	None	135
Shift services for research division, man-hours	331	347	678	
Equipment decontamination services, man-hours	226	180	406	
Activation analyses completed	5	4	9	31
SF and special material receipts, number of lots	23	24	47	338
SF and special material shipped, number of lots	31	40	71	480
Number of research issuances	4	1	5	62
Materials requests issued	15	9	24	196
SF and special materials reports issued	8	7	15	95
Internal audits and surveys	11	8	19	97

WASTE DISPOSAL

The carbon steam seals were replaced on the steam turbine powering the standby hood and cell ventilation fan servicing the 4500 Area. This completes the inspection, lubrication and repair of all equipment at the stack area.

A 2" black iron steam-heated line was installed between the caustic storage tank located at the Metal Recovery Building and tank W-5. This installation permits direct neutralization of all chemical wastes entering the tank farm system and eliminates the need for running the caustic through the Metal Recovery Building, as had been the procedure in the past.

WATER DEMINERALIZATION

The cation columns are giving much better service since they are being regenerated with HNO_3 rather than H_2SO_4. The anion columns still appear to have lower than normal capacity; no explanation for this has been found.

HYDROGEN LIQUEFACTION

The new hydrogen liquefier is being installed and will be tested during the next month.

APPENDIX I

EXPERIMENTS WITH CERTAIN VARIABLES IN THE CESIUM-137 PURIFICATION PROCESS (T. A. Butler)

Further experiments were undertaken to develop a method of following the course of cesium-137 purification by alum crystallizations using the exothermic property of alum crystal formation. In addition, the removal of rubidium was followed by adding Rb^{86} tracer to a mixture of cesium and rubidium alums.

In each experiment, the total volume of solution was held at one liter. The solution was heated to dissolve all salts and then cooled while stirring vigorously. The cooling curves were recorded on a Brown potentiometer and the temperature at which crystallization began was noted visually and by the rate of change of cooling.

I. In the first experiment, varying amounts of ammonium alum were dissolved in one liter of solution and cooling curves were recorded. The temperature at which crystallization began was noted.

NH_4 Alum g/liter	Crystallization Temperature, °C
75	None
100	15
125	17.5
150	22
175	27
200	29
225	31.5
250	34.5
275	38
300	41
325	43.5
350	46.5
400	50

Some of these experiments in which 20 grams of Al_2O_3 were added to the solution were repeated.

G NH_4 Alum per Liter Plus 20 G of Al_2O_3	Crystallization Temperature, °C	Crystallization Temperature, °C Without Al_2O_3
150	21.5	21.5
200	29.5	29.5
250	36	35
300	41.5	40.5
350	47.5	45

It was concluded that the addition of an inert material to promote crystal growth has very little effect at lower concentrations of ammonium alum, but increases the temperature of crystallization by about $1\frac{1}{2}$ degrees at the higher concentrations. These data are shown in the accompanying graph.

II. In a second series of experiments, mixtures of ammonium and cesium alums were tested and the temperature of cesium alum and ammonium alum crystallization noted.

G NH_4 Alum per Liter	G Cs Alum per Liter	NH_4 Alum Crystallization Temperature, °C	Cs Alum Crystallization Temperature, °C
None	10	-	-
150	10	23	46
150	20	23	55
150	30	22	62
200	30	30	65
250	30	37.5	66.5
250	50	37	74
300	50	45	75
300	None	43	-

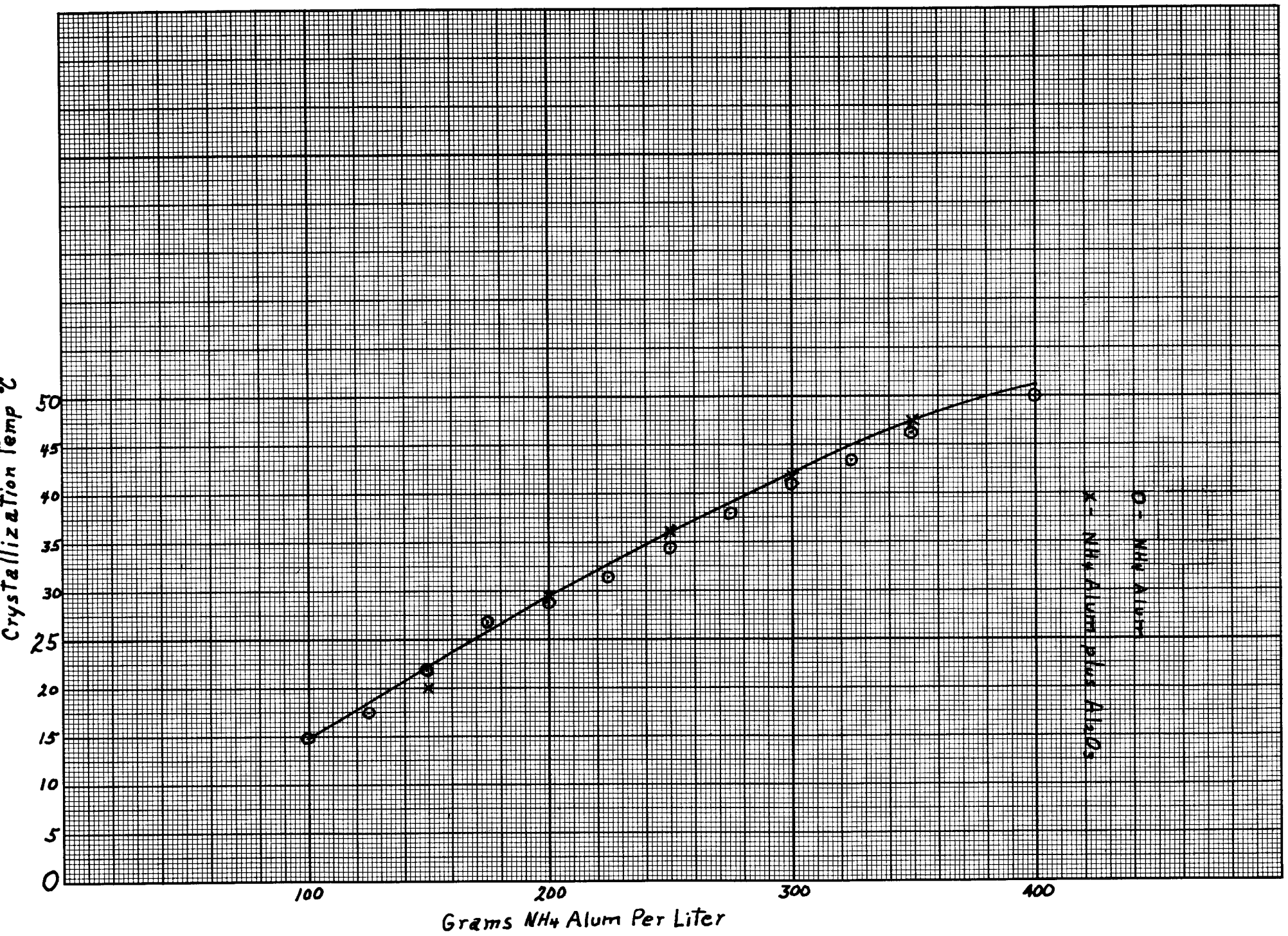
These experiments show that the presence of cesium alum in the ammonium alum solution increases the temperature of ammonium alum crystal formation to approximately the same extent as an inert substance, such as Al_2O_3. It therefore seems entirely possible to follow the course of the alum crystallizations by simply recording the cooling curves for each crystallization. The rate of change of cooling at the cesium alum crystallization temperature is small and may not be a reliable indicator in plant scale operations.

III. In a third series of experiments, the loss of cesium in the alum process was followed with the aid of Cs^{137} tracer. The initial solution contained 200 grams of ammonium alum, plus 50 grams of cesium alum, in a volume of one liter. To this solution, 1.065 mc of Cs^{137} was added and a series of crystallizations were made. Activity measurements were made in a gamma chamber. The final temperature of the solution was held at 13-15° C, which resulted in an ammonium alum loss at the rate of 74 grams per liter of decanted solution.

Estimated Grams of NH_4 Alum per Liter	Per Cent Cesium Loss
200	0.16
130	0.16
59	0.47
None	7.37
None	10.2

These results indicate that the "salting" effect of ammonium alum on cesium alum is large, even at concentrations below the saturation value.

IV. A fourth series of experiments was carried out to demonstrate the removal of rubidium from a three-component mixture of ammonium, cesium and rubidium alums. The cesium losses were estimated from the data given in section III. Rubidium-86 tracer was


Crystallization Temp °C
0
5
10
15
20
25
30
35
40
45
50
100
200
300
400
Grams NH4 Alum Per Liter
X - NH4 Alum plus Al2O3
O - NH4 Alum

prepared by neutron activation of a rubidium carbonate sample containing 0.155% Na, 9.90% K, and 0.002% Cs. The initial solution was made up to contain 250 grams of NH_4 alum, 25 grams of Cs alum, and 12.2 grams of Rb alum, plus Rb^{86} tracer, in a volume of one liter. The crystallizations were performed in the usual manner.

Crystallization No.	Estimated NH_4 Alum Grams/Liter	Estimated Per Cent Cs Loss	Per Cent Rb Loss
1	250	0.16	3.3
2	190	0.16	1.3
3	129	0.16	2.3
4	60	0.5	14.0
5	Added 50	0.5	19.4
6	Added 50	0.5	41.7
7	Added 50	0.5	15.9
		2.5	97.9

The data show that cesium product free of rubidium may be obtained with a 3% or less loss of cesium (which would be recycled in plant operations).

V. Discussion. The concentration of an ammonium alum solution may be determined within ±10 g/liter by observing the temperature break in the cooling curve of the solution. The formation of cesium alum crystals is apparently independent of the ammonium alum concentration, except for a "salting" action, which is large, even at ammonium alum concentrations as low as 50 g/liter.

The removal of rubidium from cesium is not rapid (at 15° C) unless the ammonium alum concentration of the solution is below 74 g/liter.

APPENDIX II

SEPARATION OF CERIUM FROM EUROPIUM BY TBP EXTRACTION

(T. A. Butler and W. E. Darst)

Several series of tests were run to determine the possibility of separating cerium from the other rare earths by extraction with TBP. Europium was used to represent the "other rare earths." In all cases, the Ce or Eu to be extracted was mixed with 250 ml of HNO_3 of the desired normality. After addition of some activity, 250 ml of TBP (previously equilibrated with HNO_3 of the normality being used for the test) was added and the mixture equilibrated by stirring for 15 minutes. Samples of 10 ml were then taken from both the aqueous and organic phases and read in the gamma chamber. The per cent extraction was then calculated.

I. One gram of Ce with Ce^{144} tracer was mixed with HNO_3. Tests were run with plain acid solutions and with acid solutions which were 0.1 M in H_2O_2 to insure the presence of the Ce^{+3} ion.

HNO_3 Normality	Per Cent Ce Extracted	
	No H_2O_2	0.1 M H_2O_2
8	8.9	9.9
10	10.9	10.8
12	10.7	10.0
14	19.5	19.8
16	27.9	--

II. One gram of Ce with Ce^{144} tracer was mixed with HNO_3 (0.1 M in $NaBrO_3$) to determine the extraction of the Ce^{+4} ion.

HNO_3 Normality	Per Cent Ce Extracted
2	30.3
3	57.8
4	84.6
5	95.8
6	98.2
8	99.3

III. Different oxidizing agents were compared with $NaBrO_3$ in 8 N HNO_3.

Oxidizing Agent	Per Cent Ce Extracted	Method of Oxidation
$NaBrO_3$	99.3	Acid was made 0.1 M in $NaBrO_3$.
$NaBiO_3$	80.4	Amount necessary to oxidize Ce was added.
$KMnO_4$	100.0	Amount necessary to oxidize Ce was added and stirred 5 minutes in 0.5 N HNO_3. Normality was then increased to 8 N.
$KMnO_4$	97.5	Amount necessary to oxidize Ce was added and stirred 15 minutes in 8 N HNO_3.

IV. One gram of Ce and 50 mg of Eu_2O_3 (except as noted) with $Eu^{152,154}$ tracer was mixed with HNO_3.

HNO_3 Normality	Per Cent Eu Extracted
4*	35.2
5*	36.1
6*	37.6
8	42.1
12	71.2
14	88.3

*HNO_3 was 0.1 M in $NaBrO_3$. No inactive Eu added.

V. Two methods of double extraction were tried. In the first, the Ce^{+3} and Eu were dissolved in 12 N HNO_3 and the mixture was extracted with TBP (extraction No. 1). The aqueous phase was then discarded and the organic phase was re-extracted with 12 N HNO_3 (extraction No. 2).

	Per Cent Original Ce in TBP	Per Cent Original Eu in TBP
After 1st Extraction	13.6	71.2
After 2nd Extraction	2.0	55.5

In the second method, the Ce and Eu were dissolved in 8 N HNO_3 and the Ce oxidized with $KMnO_4$ (to Ce^{+4}). This mixture was extracted with TBP and the aqueous phase was discarded (1st aqueous phase). Then the organic phase was re-extracted with 8 N HNO_3 containing $KMnO_4$ (2nd aqueous phase).

	Per Cent Original Ce in Aqueous	Per Cent Original Eu in Aqueous
1st Aqueous Phase	1.5	57.7
2nd Aqueous Phase	1.0	24.8
Total	2.5	82.5

VI. Tests were run using twice the mixing time, three times the activity, and twice the concentration of cerium of the above tests, but no significant differences were observed.

One test was run to determine the removal of Ce^{+4} from TBP by reduction to Ce^{+3} with an aqueous solution 0.1 M in H_2O_2. This method removed 98.4% of the cerium.

The extraction of iron from HNO_3 with TBP was determined for several normalities. The method for these tests was the same as for those described above. Ferric nitrate (0.5 g of Fe^{+3} with Fe^{59} tracer) was added to the HNO_3.

HNO_3 Normality	Per Cent Fe Extracted
8	1.7
10	19.3
12	75.8
14	97.1

A few tests on the extraction of ruthenium with TBP were also made. One gram of Ce with Ru^{106} tracer was added to 8 N HNO_3.

	Per Cent Ru Extracted
No Oxidizing Agent	<0.1
With 0.1 M $NaBrO_3$	88.8