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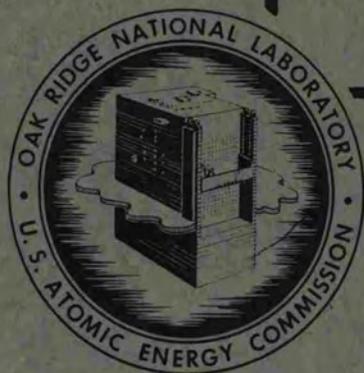
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RADIOISOTOPE PRODUCTION AND

PROCESS DEVELOPMENT

ANNUAL REPORT FOR 1954



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RADIOISOTOPE PRODUCTION AND PROCESS DEVELOPMENT

ANNUAL REPORT FOR 1954

A. F. Rupp

Compiled from data by:

E. E. Beauchamp
J. H. Gillette
E. J. Witkowski

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RADIOISOTOPE PRODUCTION AND PROCESS DEVELOPMENT – ANNUAL REPORT FOR 1954

A. P. Rupp

This report summarizes the main production and process development activities during the calendar year 1954. The number of shipments made (12,585) showed only a slight increase over those of 1953 (12,036), but the quantity of activity shipped increased greatly – from 10,587 curies in 1953 to 28,879 curies in 1954. Much of this increase is accounted for by large Co⁶⁰ and Ir¹⁹² sources. Details are given in Tables 1 through 6.

TABLE 1. IRRADIATIONS MADE AT HANFORD

Batch Number	Target	1954	1953
ORNL-13	Beryllium nitride		113
ORNL-81	Zinc	1	1
ORNL-113	Scandium oxide		4
ORNL-118	Tantalum foil		1
ORNL-129	Calcium carbonate	2	2
ORNL-130	Iron-54	2	2
ORNL-141	Samarium	1	1
ORNL-142	Samarium	1	1
ORNL-144	Chromium metal		2
ORNL-146	Cobalt		22
ORNL-147	Iron oxide	6	6
ORNL-148	Potassium chloride		6
ORNL-149	Mercury	1	2
ORNL-150	Zinc	2	1
ORNL-151	Nickel	3	1
ORNL-152	Silver nitrate	1	1
ORNL-153	Selenium	1	1
ORNL-154	Thallium	2	
ORNL-155	Tin	2	
ORNL-156	Cadmium		3
ORNL-157	Calcium carbonate	3	4
ORNL-158	Antimony		3
ORNL-159	Potassium chloride	16	16
ORNL-160	Cesium carbonate	1	3
ORNL-161	Iron oxide	2	2
ORNL-162	Iridium	1	2
ORNL-164	Hafnium oxide		2
ORNL-165	Calcium carbonate	11	16
ORNL-166	Tool steels		4
ORNL-167	Ceramic materials	3	4
ORNL-168	Antimony	4	
ORNL-169	Cobalt	10	
ORNL-172	Cesium chloride	2	
ORNL-177	Tungsten	2	
ORNL-180	Mercury	2	

TABLE 2. ANALYSIS OF RADIOISOTOPE INCOME – CALENDAR YEARS 1953 AND 1954

	1954	1953
Foreign	\$ 52,770	\$ 51,015
Project	183,072	87,569
Domestic	1,039,768	862,751
Cancer program subsidy	251,190	229,078
Technical cooperation program	4,233	10,208
Local sales to Carbide	63,498	90,681
Civilian defense program	370	1,755
Total income	\$1,594,901	\$1,333,057

TABLE 3. SALES AND INCOME OF MAJOR RADIOISOTOPE PRODUCT CATEGORIES

Product	Number of Shipments	Amount (mc)	Income
I ¹³¹	5,023	557,477	\$ 455,907
P ³²	2,405	152,922	186,173
C ¹⁴	265	4,767	169,315
Co ⁶⁰	118	10,529,656	75,782
Co ⁶⁰ (teletherapy)	16	14,956,940	120,174
Cs ¹³⁷	104	1,491,568	*
All others	4,650	1,185,872	587,550
Total**	12,585	28,879,202	\$1,594,901

*Cesium income included in "All others."

**Totals include sales of tritium and polonium.

TABLE 4. SALES OF MISCELLANEOUS MATERIALS AND SERVICES – CALENDAR YEAR 1954

Product	Amount	Income
He ³ (stable isotope)	2862 cc	\$70,441
Boron (stable isotope)	4029 g	
Activation analyses	31	\$10,151
Irradiation units (reactor)	1734	*
Service irradiations (reactor)	746	*
Service irradiations (86-in. cyclotron)	94	*

*Included under "All others" in Table 2.

TABLE 5 (continued)

Product	Type	Source	1954		1953	
			Produced (mc)	Sold (mc)	Produced (mc)	Sold (mc)
Iodine-125	P-CF	C	14	1		
Iodine-131	P-CF	X	817,879	557,482		514,000
Iridium-192	P-HSA	L	1,104,000	12	10,300	192
Iron-55,59	P-HSA	W		67	267	61
Iron-55	P-E	W	3,213	115	162	89
Iron-59	P-E	L	806	565	410	248
Krypton-85	P-CF	M	7,200	2,831		
Manganese-54	P-CF	C	15	15	425	21
Mercury-203	P-HSA	W	5,415	393	15,273	367
Neodymium-147	P-CF	X	70	9	13	1
Nickel-63	P-HSA	W		58	297	35
Niobium-95	P-CF	X	121	68	682	141
Phosphorus-32	P-HSA	X	188,209	152,922		137,000
Potassium-42	P-HSA	L	190	40		
Praseodymium-143	P-CF	X	155	1	60	8
Promethium-147	P-CF	S	6,237	218	0	417
Ruthenium-103	P-CF	X	107	9	843	333
Ruthenium-106	P-CF	S	710	1,026	42,852	9,496
Scandium-46	P-HSA	L	7,500	62	13,482	180
Selenium-75	P-HSA	W	10,395	359	12,018	451
Silver-110	P-HSA	W	1,200	714	720	349
Sodium-22	P-CF	C	150	90	137	103
Sodium-24	P-HSA	L	25,651	1,275	41,681	360
Strontium-85	P-CF	C	172	5	0	1
Strontium-89	P-CF	X	1,588	1,287	1,938	1,513
Strontium-90	P-CF	S	284,000	116,536	91,858	61,375
Sulfur-35	All types			11,766	59,278	7,527
Sulfur-35	P-CF (sulfate)	W	172,000			
Sulfur-35	P-HSA (sulfide)	W	52,033			
Sulfur-35	P-HSA (element)	W	4,000			
Tantalum-182	P-HSA	W		13	384	402
Technetium-99	P			2		0.05

TABLE 5 (continued)

Product	Type	Source	1954		1953	
			Produced (mc)	Sold (mc)	Produced (mc)	Sold (mc)
Thallium-204	P-HSA	W		2,258	0	1,247
Tin-113	P-HSA	W	61	15	61	31
Tungsten-185	P-HSA	W	424	162	935	115
Yttrium-88	P-CF	C	13	2		
Yttrium-91	P-CF	X	764	390	1,337	571
Zinc-65	P-HSA	W	12,981	762		
Zinc-65	P-CF	C		74	14	
Zirconium-95	P-CF	X	3,058	1,108	11,302	2,193
Total			4,670,647	1,373,002	439,112	805,663.35

TABLE 6. RADIOISOTOPE PRODUCTION AND SALES - SOURCES AND MISCELLANEOUS PRODUCTS

Kind	Number	Amount (curies)
Co ⁶⁰ sources	1128	22,965
Ir ¹⁹² sources	90	1,104
Cs ¹³⁷ sources	48	1,735
Zr ⁹⁵ -Nb ⁹⁵ sources	19	1,300
Sr ⁹⁰ sources	22	5
Ce ¹⁴⁴ source	1	200 mc
Fe ⁵⁵ sources	4	21 mc
A ³⁷ (ampoules)	15	13.7
Kr ⁸⁵ (ampoules)	16	7.2
H ³ -Zr targets	27	36.6
H ³ (ampoules)	187	127.8
H ² -Zr targets	19	17 cc
He ³ (ampoules)	13	1,590 cc

Notable increases were made in Cs¹³⁷ production, up 2300% from 83 curies to 1903 curies, and in Sr⁹⁰, up 310% from 92 curies to 284 curies. However, sales of I¹³¹ increased only 8%, P³² increased 11%, and C¹⁴ sales actually decreased 19%. It appears that a leveling off of the "traditional-type" radioisotope business is occurring, but it is accompanied by a spectacular increase in demand for radioactivity in large quantities for irradiation purposes.

The physical facilities for radioisotope production were improved by the completion of a new

I¹³¹ plant and the near completion of a manipulator cell for handling up to 10,000 curies of Co⁶⁰.

Major process development items were: production of a 1540-curie Cs¹³⁷ teletherapy source; Cs¹³⁷ radiographic sources; fission-product separations processes for Ru¹⁰⁶, Sr⁹⁰, Tc⁹⁹, and Ce¹⁴⁴ to be incorporated into a new fission-products plant; empirical data on Eu^{152,154} neutron-activation rates; improved H³-Zr thin targets; new Be₃N₂ target-material preparation techniques; purification and packaging of Kr⁸⁵; purification of I¹³¹ by fractional distillation.

The main engineering design effort during the year was on the preliminary design of the Multicurie Fission-Product Pilot Plant; this will continue to occupy the main attention of radioisotope development personnel until 1957.

IODINE-131

Iodine continued to be one of the radioisotopes in greatest demand; the total amount produced during the year was 817,879 mc. The old processing plant in Building 3026 was abandoned, and operations were started in the new plant on a tentative schedule in August. In general, the equipment has worked well, but one dissolver finally was replaced because of persistent leaks in welded seams which could not be corrected because of poor metallurgical characteristics of the stainless steel used in fabrication (type 309). A new dissolver, of a slightly different design, was fabricated from type 347 stainless steel.

The yield obtained in the new equipment thus far shows an improvement of about 27% over that obtained in the old plant. It has been noted, however, that the yield per slug decreases when the number of slugs dissolved per batch is reduced below 12; this is probably because the new dissolver is considerably larger than the one previously used. However, this condition does not interfere with normal production, since more than 12 slugs are usually dissolved for each run.

The principal process improvements were the abandonment of the caustic scrubber processing step, the oxidation of nitrous compounds carried into the final processing equipment with oxygen gas, the lowering of the concentration of sodium hydroxide in the caustic scrubber and the primary iodine distillate receiver, the addition of a glass bubble-cap fractionating column on the finishing still, and the use of dilute sulfurous acid as the product scrubbing solution to ensure complete reduction of iodine to iodide. The over-all iodine recovery averaged about 80%, based on the calculated amount of iodine in the slugs.

Experiments were made on a possible method of concentrating and purifying iodine by plating the element on silver surfaces, followed by removal in water containing dissolved hydrogen sulfide. The tests were discontinued after a number of hot runs were made which disclosed that the silver surfaces became progressively less effective in taking up iodine after a few cycles of operation.

RADIOPHOSPHORUS

Total P^{32} production for the year was 188,209 mc. Only one major change was made this year. The Transite hood housing the two extractors was replaced with one of stainless steel, and the type 347 stainless steel extractors were replaced with ones made of Carpenter 20 stainless steel. The old hood was replaced because it could not be decontaminated sufficiently to prevent excessive radiation exposure of operating personnel. The old extractors were seriously corroded by sulfuric acid generated in the process and had to be replaced to eliminate excessive maintenance.

The only difficulty frequently experienced in the purification operations was in the primary evaporation and lanthanum precipitation steps; high product losses were encountered with the formation of a precipitate of foreign material. It is believed that these difficulties were caused by

one or more of the following: (1) corrosion of the aluminum irradiation cans resulting from the treatment of sulfur with HNO_3 , which was used for purification of the sulfur prior to its exposure in the reactor; (2) overheating of the sulfur for can-testing before irradiation; (3) excessive corrosion of the glass extractors during long periods of use, which resulted in the formation of silica. The situation was alleviated after the HNO_3 cleanup of the sulfur was discontinued, the testing temperature of the irradiation cans was lowered, and the new extractor tubes were installed.

COBALT

The total amount of Co^{60} shipped in 1954 exceeded that of the previous year by 300%, the increase being due, mainly, to the distribution of teletherapy sources. Exclusive of teletherapy sources, there was an increase of 70% in the amount of low-specific-activity material shipped.

At the insistence of teletherapy source users, a decision was made to load large teletherapy sources in the existing remote manipulator cell, and the first such source was shipped in August. These sources are being enclosed in a capsule, provided by ORNL, that is designed to fit into all teletherapy machines now on the market. Sixteen teletherapy sources were shipped; nine of these exceeded 1000 curies. In addition, several other large sources for use in irradiators were prepared and shipped.

Plans were approved and construction was started in November on a new high-level loading facility which is designed for safe handling of 10,000 curies of Co^{60} . It is scheduled to be placed in operation about April 1, 1955. In addition to the loading facility, it has become necessary to expand facilities for storing cobalt metal pieces in a dry atmosphere. New monitoring equipment was also installed which greatly increases the accuracy of measurement of the amount of Co^{60} in individual pieces of cobalt.

The production rate of high-specific-activity Co^{60} at the MTR has been disappointing; to date, approximately 18,000 curies has been received. At the current rate, orders now on hand for teletherapy sources will not all be filled until 1956. An effort is being made to relocate the cobalt in the reactor to increase production.

Negotiations are under way to pay for all the costs connected with irradiations at the MTR,

including reactor time. It has been proposed that in the case of Co^{60} , the MTR be paid 80% of the total sales price of MTR-produced cobalt, with the balance going for other expenses connected with the fabrication into sources, packing, shipping, and other details.

CESIUM-137 FISSION-PRODUCT SOURCES

The preparation of large gamma sources from fission-product Cs^{137}Cl was successfully demonstrated by the completion of a 1540-curie unit in March of this year.

A preliminary concentration and purification of the Cs^{137} was made in the fission-product semi-works, and an additional purification of this material was made in glass equipment installed in the isotope area. The chemical steps involved were: three or more fractional crystallizations of cesium ammonium alum, precipitation of aluminum hydroxide by air-ammonia gas mixture, removal of sulfate ions by an anion exchange resin column, evaporation and conversion of the product to cesium chloride.

A total of 2042 ± 50 curies of Cs^{137} was processed in 400-curie batches. The product totaled 1903 ± 50 curies, which is an over-all yield of approximately 93%. The only alkali-metal impurity detected was 0.5% rubidium.

The gamma source was made in the form of two right cylinders, each containing an equal quantity of Cs^{137}Cl (Fig. 1). The pelletizing and source assembly operations were done in a manipulator cell. Average values for the physical data on the two pellets are given below:

Weight, g	60.93
Amount of Cs^{137} , curies	1540
Concentration by weight, curies of Cs^{137} per gram of material	25.27
Concentration by volume, curies/cc	73.61
Dimensions, cm	
Diameter	3.183
Height	2.630
Volume, cc	2.922
Density, g/cc	2.912

The two pellets were sealed within two concentric stainless steel cylinders. The window of the finished source, through which the gamma beam emerges, is 1 mm thick. The radiation intensity through this window was measured to be 450 rhm (roentgens per hour at 1 meter).



Fig. 1. Cs^{137}Cl Source (1540 curies) Photographed by Its Own Light. Two-hour exposure through 2 ft of high-density glass.

Approximately 25 Cs^{137} gamma sources were made from Cs^{137}Cl pellets which ranged in size from 5 curies to 120 curies. A new encapsulation method was perfected, using press-fit plugs for the stainless steel capsules, which are overlaid with solder to complete a double seal.

The all-glass Cs^{137} purification equipment was completely revised and installed during the latter half of the year. An additional 990 curies of Cs^{137} was processed through this equipment, which was enlarged to handle 500-curie batches.

FISSION-PRODUCT SEPARATIONS PROCESS DEVELOPMENT

By use of the process proposed for the Fission-Products Pilot Plant, the separation and concentration of the main classes of long-lived radioisotopes found in process wastes were demonstrated on a semiworks scale. A total of 3000 curies has now been isolated from ORNL tank-farm wastes by the ammonium alum process, with an over-all recovery of more than 90%. Fifty curies of Ru^{106} and 238 curies of Sr^{90} were also recovered from concentrates prepared in the semi-works. A mixture of rare earths containing more than 100 curies was also separated and used for experiments in separating Ce^{144} by iodate precipitation and for ion exchange separation of the other main components, Eu^{155} and Pm^{147} . The same rare-earth mixture was used to study oxalate precipitation for purification from iron and to study fractionation of the rare earths by TBP solvent extraction from 8 to 16 M nitric acid solutions. The oxalate precipitation was found to be a most

effective way of purifying the rare earths; experiments are continuing on the TBP extraction of rare earths, since the preliminary results obtained here and data obtained by other experimenters make this method appear quite promising.

An increasing interest in the production of large amounts of technetium prompted development work on methods of also removing this fission product from waste streams. By use of existing data on the properties of highly selective tetraphenyl arsonium (TPA) precipitation of technetium, laboratory studies were made on coprecipitation of pertechnetate ion with TPA-MnO₄. While this method appeared practicable, the large amount of expensive TPA reagent required was undesirable. It was then found that TPA-NO₃ is fairly soluble in water but is salted out in 2 to 3 M NaNO₃ solution; it was further noted that the precipitated TPA-NO₃ carried down the technetium in greater than 90% yield in the presence of very small amounts of perchlorate ion. Since this method offers the possibility of easy recovery of the TPA reagent, it is being studied further and may be used in the plant; semiworks trials were under way at the end of the year.

Nickel ferrocyanide slurries carrying Cs¹³⁷ are a possible source of raw material, so several methods of recovery of the cesium from this material were undertaken on a laboratory scale. The most feasible methods were: (1) absorption of Cs¹³⁷ on Attapulgus clay, after complexing the nickel with Versene or ammonia; (2) oxidation of the ferrocyanide to ferricyanide, with the consequent release of the cesium ion; (3) destruction of the ferrocyanide anion by complexing with cuprous oxide. All the methods depend upon the subsequent isolation of the cesium by the alum process.

MULTICURIE FISSION-PRODUCTS PILOT PLANT

Approval was received for the construction of a pilot plant to produce kilocurie sources of certain long-lived fission products from process wastes. Data were submitted to the AEC in *Preliminary Proposal No. 212* (ORNL CF-54-8-3); the directive giving approval for construction, issued November 15, 1954, designates the project as 5-24X-5029.

The plant will have a designed capacity of 200,000 curies of Cs¹³⁷ per year. Although Cs¹³⁷ is considered to be the primary product, it is planned to turn out relatively large quantities of

Tc⁹⁹, Sr⁹⁰, Ce¹⁴⁴, Pm¹⁴⁷, and Eu¹⁵⁵. Most of the preliminary design was completed by the end of the year; the working design is scheduled for completion by May 30, 1955, and construction is to be finished by September 1956. Large quantities of Scrup waste will be available for feed material; this will be supplemented by some high-level wastes, or waste concentrates, to be shipped in from other sites. Facilities are included for fabricating both teletherapy and industrial-type radiation sources.

CARBON-14

Because of a large holdover of C¹⁴ produced in 1953, it was necessary to separate only 703 mc of C¹⁴ this year.

The main effort during the year was on implementing the purchase of 400 lb of highly purified (low-carbon) Be₃N₂ (C¹⁴ target material), fabricated in the form of pellets, ready for canning. Cans to be used for irradiation of Be₃N₂ were approved by W-personnel; an order for the fabrication of 1200 of these cans has been placed. The procedure for canning the Be₃N₂ and welding on the caps was worked out and approved from the health-safety standpoint.

No further work was done on the separation, identification, and purification of organic-C¹⁴ gases generated in the Be₃N₂-C¹⁴ separation process. This work will be resumed after the present emphasis on the fission-products process is lessened.

MULTIKILOCURIE LOADING CELL

Because of the huge increase in the level at which Co⁶⁰ is handled, particularly for teletherapy sources (up to 2000 curies of Co⁶⁰), it became imperative to build another manipulator cell to handle these very large sources. A request for such a facility was submitted in November 1953, and approval was received in April 1954 to proceed with the design of the cell. Some difficulty was experienced in finding a contractor to do the job within the estimated cost. After many delays, a contract was let in November 1954, and construction was under way at the end of the year (see Fig. 2). This cell will handle up to 10,000 curies of Co⁶⁰. Argonne-type model 8 manipulators are used, and observations are made through a 3-ft-thick window of high-density Corning

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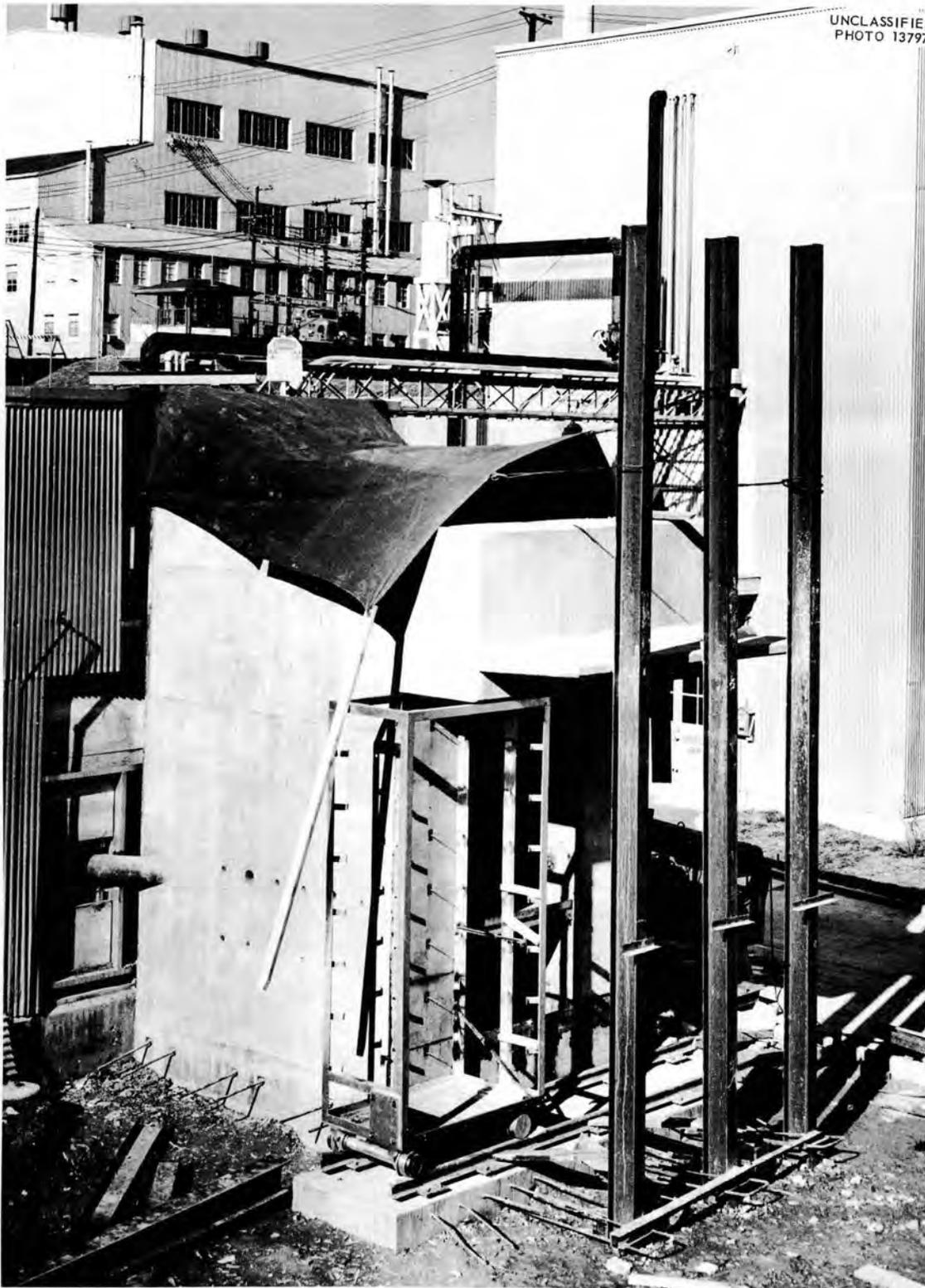


Fig. 2. Multikilocurie Loading Cell Construction, February 1955.

glass. The entire rear wall is movable (on railroad track) so that a mobile hoist can place containers weighing up to 7000 lb and 4½ ft in diameter inside the cell.

EUROPIUM ACTIVATION EXPERIMENT

The neutron activation of Eu_2O_3 for the production of Eu^{152} and Eu^{154} radioisotopes progressed far enough to show that the saturation value will be reached in about two years at a neutron flux averaging 1.3×10^{13} neutrons/sec/cm². This is more than twice the value for the time required to reach saturation, as obtained by calculations in which available neutron-cross-section values are used.

Two Eu_2O_3 pellets, each containing 345 ± 1 mg of oxide, are being used in this experiment. The activity growth is being followed by measuring the gamma radiation intensity of the pellets. A graph of the experimental values obtained to date is shown in Fig. 3.

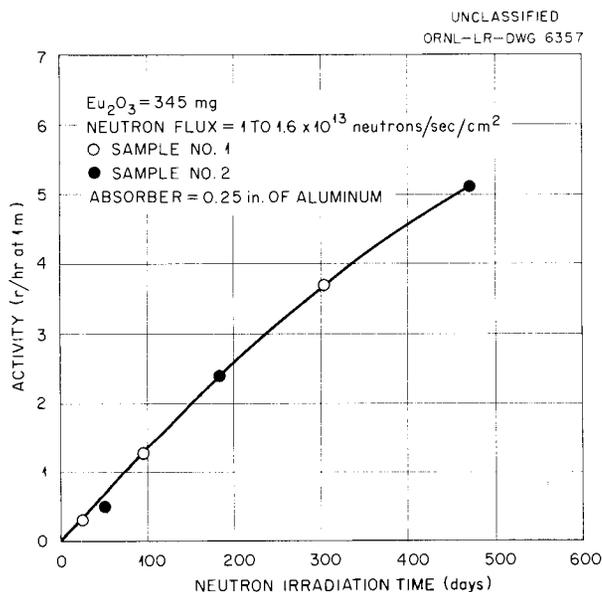


Fig. 3. Experimental Values from Europium Activation.

TRITIUM-ZIRCONIUM TARGETS

There was a marked increase in demand for $\text{H}^3\text{-Zr}$ targets during the year; targets were made at a rate of about one per week. Although it was not possible to produce perfect targets each time,

the techniques were refined, and it now appears that the ORNL Radioisotope Department is one of the few places in the country where acceptable targets can be made. Targets were mishandled and improperly used by many customers during the year, resulting in claims by the customer that the targets should be replaced. Consideration was given to dropping the manufacture of these targets because of recriminations involved in distributing them, but because of the great importance of these targets in physical research, it was decided to continue their manufacture for one more year.

Incomplete degassing of backing material was found to have an extremely bad effect on the production of targets. Degassing times were greatly increased, and it was further noted that some batches of tungsten were particularly hard to degas. Apparently, if oil has been used at any time in preparing the tungsten pieces for backing, it is virtually impossible to degas the metal.

The use of tungsten as a backing material is undesirable because it is brittle and because breakage rates are high. It was decided to standardize on platinum as a backing material. Effort is also being made to standardize the size, shape, and other target characteristics in an effort to produce better targets.

ANTIMONY-125 AND TIN-113 SEPARATION

A simple, rapid, and complete separation method for removing Sb^{125} activity from a neutron-activated tin target was developed. The tin target was dissolved in concentrated hydrochloric acid, and the resulting solution was then diluted with water until it was 3 N in HCl. This solution was passed through a column of 30- to 40-mesh tin granules, which removed, on the top of the tin column, all the Sb^{125} activity by reduction of the antimony chloride to the metal. The Sn^{113} solution was radiochemically pure and contained very little added tin from the column. The Sb^{125} may be recovered by conventional methods, such as distillation or by carrying on a CuS precipitate.

BORON EVAPORATOR

An evaporator was designed and constructed which can be used for the evaporation (*in vacuo*) of most materials, including those which are difficult to evaporate, such as boron.

A carbon crucible in the evaporator is heated by electron bombardment. Temperatures in the region

of 3500°C can be obtained and readily controlled. The complete unit is compact and may be taken apart for cleaning and reassembled in about 1 hr.

SUMMARY OF OTHER ITEMS OF INTEREST

Inorganic Ion Exchange Material. This material, made by the Minnesota Mill and Mining Company, was tested, since there is a great desire to find an ion exchange medium resistant to intense radiation. Cesium and other alkali metals were effectively removed from solution by the exchanger, and resistance to radiation was good. However, poor resistance to internal osmotic forces caused serious physical breakdown of the material, and alkaline solutions attacked it chemically. Despite these limitations, it may be useful for special applications.

Purification of Rubidium. The purifying of rubidium target material by removing traces of cesium is necessary in order to produce irradiated units of Rb^{86} free of Cs^{134} . The purification was done on Ir^{105} resin by using 5 M $(\text{NH}_4)_2\text{CO}_3$ as an elutriant. Approximately 230 g of Rb_2CO_3 containing only 0.001% cesium was obtained; the best cp grade ordinarily contains 0.03%.

Assay of Kr^{85} , A^{37} , and H^3 . A chamber for the assay of Kr^{85} , A^{37} , and H^3 was calibrated by using samples standardized by mass spectrographic analysis.

Short-lived Fission Products. Design was completed on a new unit to be operated in conjunction with the new 131 plant for the separation of short-lived fission products. The uranium will be extracted in batch solvent extractors; the alkaline-earth and rare-earth groups will also be separated by solvent extraction. Final purification and separation of the individual rare earths will be done on ion exchange columns.

Shielded Transfer Tank. This tank was designed to transport, from other sites, hot wastes that are to be used in development work on fission-product separations processes. The carrier is a spherical 5-ft-dia 250-gal stainless steel tank enclosed in lead 5 in. thick and has a heavy-steel spherical outer shell. The tank is heavily constructed throughout and will survive a disaster such as a train wreck or building fire. The total weight is 15 tons; it is designed to be handled by hoist and transported by rail freight.

Sealing Hot LITR Cans. A tool for sealing hot LITR cans was developed and put into operation in a remote manipulator. This device makes it possible to can hot samples, such as iridium radiographic sources, for reirradiation.

Rotary and Reciprocating Saws. These saws, for remote opening of irradiation containers, were developed and are now in routine use.

X-Ray-Type Unit. A compact unit of this type was designed for testing sources of Tm^{170} , Eu^{155} , Am^{241} , and Ce^{144} for weak gamma radiography of thin metallic sections and plastics and for some medical applications. The unit will be made of lead and a tungsten alloy; it is scheduled for completion in May 1955.

Remote Rotary Soldering Apparatus. This apparatus was made for sealing Cs^{137} and similar stainless steel, double-jacketed sources.

Aluminum-26. Fractions containing Al^{26} were isolated from wastes from Na^{22} cyclotron target processing and were sent to interested research workers at Princeton and at Carnegie Institute of Technology.

Improved Chemical Procedures. These procedures were developed for the following separations: Zn^{65} from copper, Ag^{111} from palladium, Cd^{109} from silver, and Sb^{125} from tin.