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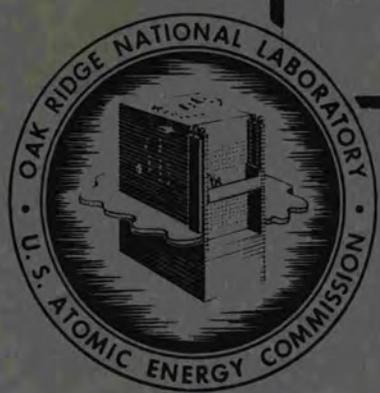
OPERATIONS DIVISION
MONTHLY REPORT

for

Month Ending December 31, 1951

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OPERATED BY
CARBIDE AND CARBON CHEMICALS COMPANY
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**OPERATIONS DIVISION
MONTHLY REPORT**

for

Month Ending December 31, 1951

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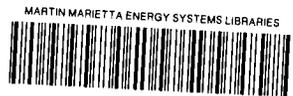
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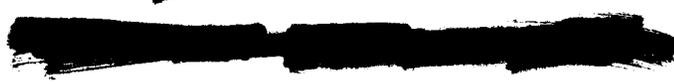
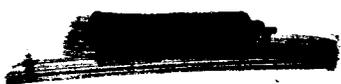
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OPERATIONS DIVISION MONTHLY REPORT

SUMMARY

The following indexed items summarize the activities of the Operations Division for the month ending December 31, 1951. In some instances a comparison with 1950 and other previous yearly operational data is also given.

1. Lost pile-operating time averaged 14.4% compared with 10.0% for the year of 1951 and 11.1% for the year of 1950 (p.3).

2. The average pile power per operating hour was 3806.7 kw for 1951, compared with 3454.7 kw for 1950. The higher average power in 1951 was made possible by the installation of larger and more efficient fans late in 1950 (p.3).

3. Three ruptured slugs were located and discharged without difficulty. A total of 15 jacket failures occurred in 1951 compared with 13 in 1950, 14 in 1949, 14 in 1948, and 13 in 1947 (p.3).

4. The lead-dip process of bonding slugs is producing no better bonded slugs than was produced by the bronze-dip process (p.4).

5. The low-intensity testing reactor (LITR) was down 15.0% of the time during the month. The down time was decreased from 40.0% in September to its present level largely by better instrumentation (p.5).

6. The small oscillations of the LITR power are suspected to be caused by dissolved gases (p.6).

7. Radioactive iodine shipments are currently averaging approximately 40 curies per month. Shipments for 1951 totaled 467.5 curies compared with 310.7 curies during 1950 (p. 9).

8. Radioactive phosphorus shipments increased from 96.0 curies during 1950 to 107.2 curies during 1951 (p. 11).

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9. During 1951, 10,297 mc of C^{14} was produced with an average isotopic ratio of 11.5%; the highest isotopic ratio obtained was 25.3%. The separation process is working very smoothly (p.12).

10. Work on the separation of fission products by ion exchange and by precipitation was the most important development item during 1951 (p.13).

11. It now appears that Fe^{59} in sufficient quantity and of acceptable grade for injection into humans will be available soon, since the specification of not over 2% Fe^{55} in the Fe^{59} is to be changed shortly to permit a higher Fe^{55} content (p.16).

12. The Chemical Separations Department is now operating the 75-kv Cottrell precipitator that is a part of the off-gas system (p.17).

13. The beta-curie discharge to White Oak Creek was 12.4 compared with 22.5 during November. The discharge rate was 172 curies during 1951 compared with 187 curies during 1950 (p.20).

14. The waste evaporator continued to operate satisfactorily. During 1951 the evaporation rate was 282 gal/hr with a decontamination factor of 7912 compared with 283 gal/hr with a decontamination factor of 2994 during 1950 (p.22).

15. The revised RaLa cubicle was replaced and a successful 150-curies test run made. The next full-scale RaLa run is scheduled for January 6, 1952. The RaLa operation for 1951 is discussed briefly (p.23).

16. There were 749 radioisotope shipments compared with 816 last month. During 1951 there were 9491 radioisotope shipments compared with 8075 during the previous year (p.27).

FOR MONTH ENDING DECEMBER 31, 1951

PILE DEPARTMENT

OPERATING DATA

Graphite Pile

	DECEMBER 1951	YEAR 1951	YEAR 1950
Total accumulated kwhr	2,461,386	29,997,102	26,908,563
Average kw/operating hr	3863.6	3806.7	3454.7
Average kw/24-hr day	3308.3	3424.3	3071.7
Per cent lost time	14.4	10.0	11.1
Excess pile reactivity	~ 170 inhr		
Slugs discharged	223	3544	2859
Slugs charged	223	3657	2987
Product made (grams)	89.83	1094.78	982.06
Product discharged (grams)	30.48	416.24	168.93

Low-Intensity Testing Reactor

	DECEMBER 1951	FROM RECORDS 9/5/51 TO 12/31/51	ESTIMATED 3/2/51 TO 9/5/51
Total accumulated kwhr	480,857	1,339,589	310,267
Average kw/operating hr	760.5	647.8	100.0
Average kw/24-hr day	646.3	473.0	42.4
Per cent lost time	15.0	27.0	57.6
Position of No. 2 shim rod (in. out)	27.363		

PILE OPERATIONS

Graphite Pile. The average pile power per operating hour for December was 3863.6 kw compared with 3937.1 kw for November and 3806.7 kw for the year 1951 compared with 3454.7 kw for the year 1950. The higher average power in 1951 was made possible by the installation of larger and more efficient fans late in 1950.

The pile-down time was 14.4% for December compared with 8.0% for November and 10.0% for the year 1951 compared with 11.1% for the year 1950.

Three ruptured slugs were indicated by the probe and located by the scanner during December. The data are as follows:

RUPTURE NO.	CHANNEL NO.	DAYS IN PILE	APPROXIMATE TEMPERATURE
92	1270	2602	200 °C
93	1370	304	240 °C
94	1274	2611	175 °C

There were 15 ruptures during 1951 compared with 13 in 1950, 14 in 1949, 14 in 1948, and 13 in 1947. Apparently, the rate at which ruptures occur has not risen significantly in spite of

OPERATIONS DIVISION MONTHLY REPORT

the fact that some of the slugs have been in the pile for more than seven years.

Production of bonded slugs at Y-12 by the aluminum-silicon triple-dip process began in the summer of 1951, and approximately 16,000 slugs have been produced. These slugs, however, when tested in an oven at 400°C for one week, gave an average rate of failure owing to blistering of about 20%. Because of the continued failure of the Y-12 slugs in the oven test, production at Y-12 was stopped in September 1951, and since then only pilot runs have been made in an attempt to produce slugs that will pass the oven test.

At first it was thought that blistering was caused by the presence of tin that permitted penetration of the aluminum-silicon layer. However, during December 1951 it was learned, as a result of the use of the lead-dip process in which tin is eliminated, that blistering apparently is not caused by the presence of tin, inasmuch as blistering occurred in slugs canned by the new process. It is now believed that the trouble may be caused by lack of wetting by the aluminum-silicon mixture. In an effort to assure wetting, a number of batches will be prepared in which the baths are covered with a molten flux. Other factors being investigated are cleaning of slugs by electropolishing as compared with HNO_3 , quenching in a still bath as compared with a flowing bath, and the effects of machining.

During the month some of the slugs bonded by the aluminum-silicon process were compared with unbonded slugs, and indications were that the unbonded slugs may stand up better at 300°C. Further checks of this are being made.

A program was initiated to replace the four safety rods with three larger

and more efficient rods to release one of the safety-rod holes for research.

Two safety rods were replaced with new rods during December, and a gain of approximately 60 inhr was realized. The explanation for this appears to be that the old rods were hanging down too far inside the graphite. The third safety rod is scheduled to be changed on January 7, 1952. The fourth rod will then be removed as soon as a special shield is ready to be installed. The hole will then be ready for experimental use.

The canal demineralizer was installed in the summer of 1951 and put into operation. Although it operated efficiently, the filter and resin tanks became very radioactive and it was necessary to add 4 in. of lead shielding. After the shielding was added, operation of the demineralizer was resumed.

The canal slug-cutter was equipped with new micro-metallic filters during the year, and the effluent from the slug-cutter was piped directly to the canal weir box to reduce contamination in the canal.

During the year several irradiations of tantalum were made for the Army Chemical Corps; the last one was shipped in October. It was found that the irradiation can being used was too long and caused the cans to stick in the discharge chute. Also, the cans were poorly sealed and several were broken open during discharge. Future irradiations will be made using a shorter can with a more efficient seal that will not break open.

A hydrogen liquefier was installed in a small room built for this purpose in the northwest corner of the store-room and is being operated routinely

to furnish liquid hydrogen for research. As much as 3.6 liters have been produced in one 8-hr day.

A number of special sources have been loaded at the request of radio-isotope customers. One of the largest was a cobalt source of approximately 300 curies loaded into a special tungsten shield for the Medical Division of ORINS. This source was prepared in the canal.

Twenty-three experiments are now accommodated in the 4-in.-square stringer holes. All the available holes are in active use or are blocked by work being done at adjacent holes. During 1951, one vacant hole was put into use and six others converted to new experiments. In addition, 14 fuel channels are being used for experimental work.

Low-Intensity Testing Reactor. Operation of the LITR by the Operations Division was begun on March 5, 1951. From March through May operation of this reactor was mainly for the purpose of training personnel and preparing for steady operation. A training program for personnel of the Phillips Petroleum Company was conducted during June, July, and August; approximately 20 Phillips' technical employees were trained in operation of the LITR and the X-10 graphite pile in preparation for operation of the materials testing reactor at Arco, Idaho. Also during this period, several experiments were carried out at the LITR by Reactor Technology Division personnel assisted by Phillips Petroleum Company personnel.

Routine operation of the LITR for research was begun on September 5, 1951, and since that time the reactor has operated more and more steadily as troubles in the instruments were eliminated. This is readily illustrated by the down-time percentage, which has decreased from approximately 40% in

September and October to 15% in December. Since a number of the instruments had been in use at the LITR during the period it was used as a mockup, many had been in constant service for two years or longer. A program is under way to repair all the old instruments, to provide spare instruments that can be inserted quickly in case of failure, and to initiate a routine maintenance schedule by which all instruments will be replaced and checked at regular intervals. This program has proceeded slowly because of the shortage of personnel, but progress is being made.

The down time at the LITR decreased to 15.0% as compared with 17.8% in November. There were only four unscheduled shutdowns caused by malfunctioning of instruments during December.

On November 22 it was observed that the regulating rod was moving more than had been customary. It was also observed that gas was collecting under the top plug, and the question arose as to whether this gas might be caused by corrosion of the fuel elements or other parts inside the reactor tank. The gas was checked and found to be radioactive with two xenon radioisotopes; however, no fission products were definitely identified, and when the water was checked no fission products were found. This indicated that the radioactivity was due to activation of natural xenon. Several aluminum-covered graphite pieces were removed from the grid when it was observed that they were corroding. A number of experiments that had been put into the reactor lattice were removed on the assumption that there was local boiling owing to gamma-ray heating in some of them. The oscillations continued, however, and it was decided that boiling in these experiments did not explain the oscillations.

OPERATIONS DIVISION MONTHLY REPORT

Analysis of the gas collected under the top plug showed 7.5% hydrogen, 18% oxygen, and the balance as inert gases. On the basis of this, it was decided that the gas was mostly from air dissolved in the reactor cooling water, which is exposed to the atmosphere in the seal tank. The gas is liberated when it is heated in the reactor lattice and collects in pockets under some of the surfaces beneath the reactor lattice. Small bubbles from these pockets apparently come up through the lattice occasionally and cause oscillations in the power level. A small amount of gas is also contributed by water dissociation during irradiation in the lattice.

It does not appear that these oscillations will have any serious consequences as far as the LITR is concerned, since the regulating rod is able to control power without difficulty. Manual operation is somewhat difficult, but this will not cause any ill effects. It appears that it will be possible to reduce the amount of air dissolved in the reactor water by degassing the seal tank.

Experiments have already been installed in three of the six beam holes, and experiments will be installed in the other three very shortly. It was found possible to install tubes, approximately 1.5 in. I.D., through the top plug and to extend them into the beryllium core pieces, even though such facilities were not planned in the original design. Two such tubes are now in use for experiments and a third one is planned. Because of the lack of space on the top plug, the third tube will probably be brought out through the flange at the southwest side of the reactor tank.

At the request of the Reactor Safeguard Committee, several tests were

conducted during the year at the LITR in which the water in the reactor tank was drained rapidly while the reactor was operating. This caused the reactor to shut down at the time the water left the lattice because of lack of a moderator. The gamma heating in the fuel elements was recorded from thermocouples that had previously been installed between fuel-element plates. The last of these tests was made after operating at a power of 770 kw for six days, and it was found that the central fuel element rose in temperature to a maximum of 135°C. On this basis it was determined that the power level could safely be raised by a considerable degree. The installation of new pumps and heat exchangers, which are on hand, will permit the power level to be raised to between 2000 and 3000 kw.

During the period since the Operations Division assumed responsibility for operating the LITR, a number of changes necessary for routine operation have been made. These include:

1. Installation of an extra foot of concrete block shielding.
2. Installation of two earthen pits, located approximately 200 yd east of the LITR, in which radioactive water purged from the LITR cooling system can be held until it can be safely discharged.
3. Reworking the LITR instruments into a permanent installation.
4. Provision of a number of safety circuits that can be connected to experiments at any one of the beam or vertical holes or to monitoring instruments located near the holes.
5. Provision of special handling equipment that permits working at beam holes without overexposure of personnel. (This is especially important since some of the beam holes read approximately 100 r/hr when opened with the reactor shut down.)

FOR MONTH ENDING DECEMBER 31, 1951

Table 1

Pressure-Drop Data

DATE	PRESSURE DROP (inches water gage)		
	GLASS WOOL	CWS NO. 6	TOTAL ACROSS HOUSE
12/31/51	3.2	1.6	6.1
11/30/51	3.2	1.5	6.0
12/31/50	2.4	3.8	7.6
Clean filters	1.1	1.0	3.3

FILTER HOUSE

Table 1 gives the pressure drop across the exit air filters for December and a comparison of this data for 1951 with that of 1950.

The No. 2 filter replacement was completed in May after two and one-half years of service. The pressure drop across the No. 2 filters was accordingly reduced from 4.0 to 1.2 in. of water.

Approximately 200 new filters are being purchased from Flanders Mills, Riverhead, New York, according to new specifications issued by the AEC. Whereas the old CWS filters cost about \$70.00 each, the new filters will cost only \$50.00 each.

The No. 1 filters were not changed in 1951; the last change of these occurred in October 1950.

FAN HOUSE

The new Sturtevant fans installed in 1950 have performed very satisfactorily all year, and it has been possible to operate the X-10 graphite pile at an appreciably higher power because of the increased air flow.

A new Allis-Chalmers motor was installed on the No. 3 fan in April to replace the No. 3 motor that had been operating with one burned-out coil. The old motor was returned to Allis-Chalmers for repair, and the repaired motor was reinstalled in place of the No. 2 motor in November 1951.

RADIOISOTOPES

Table 2 is a comparison of the research and radioisotope samples inserted into the X-10 graphite pile during 1951 with those inserted during 1950.

At the end of 1951 there were 376 cans of target material in the stringers, compared with 341 cans at the end of 1950.

WATER-DEMINERALIZATION PLANT

The operation of the water-demineralization plant was normal in December, with 463,920 gal of water being demineralized, of which 13,066 gal was also deaerated. Table 3 shows data for December and a comparison of data for 1951 with that of 1950.

OPERATIONS DIVISION MONTHLY REPORT

Table 2

Radioisotope and Research Samples Charged into Pile During 1950 and 1951

	1951		1950	
	RESEARCH	RADIOISOTOPES	RESEARCH	RADIOISOTOPES
Stringers	169	1765	331	1988
Hole 22	763	50	751	88
Other holes	75	297	105	291
Total by groups	1007	2112	1187	2367
Total for year	3119		3554	

Table 3

Water Demineralized and Deaerated

	GALLONS PRODUCED		
	DECEMBER 1951	YEAR 1951	YEAR 1950
Demineralized	463,920	6,750,085	7,207,200
Deaerated	13,066	492,121	461,700

Even though the water demineralizer in Building 3004 has operated quite satisfactorily during the year, a need has been indicated for a more efficient resin that will eliminate the deaeration step now necessary to remove carbon dioxide. Water for the LITR, for example, must be deaerated in order

to bring the pH up to the minimum of 5.5. As a result of the large amount of labor and steam required, deaeration is rather expensive; however, it is believed that several resins are now available that will give water of satisfactory quality without the deaeration step.

CHEMICAL SEPARATIONS AND RADIOISOTOPE DEVELOPMENT DEPARTMENTS

RADIOISOTOPES

Iodine (I^{131} - 8d). Sixty-three ORNL uranium slugs were processed and 40,348 mc of I^{131} was shipped.

Very little difficulty was encountered this month. The crude product from the caustic-scrubber stills was acid in one run and was not processed; this caused a loss of approximately 2 curies of product.

Iodine -- Summary of Operation during 1951. Table 4 is a comparison of the materials processed and product shipped during the past two years.

The decrease in the amount of product shipped per pound of uranium processed can be attributed entirely to the difference in the number of Hanford slugs used. Normally, a batch of three Hanford slugs yields a quantity

Table 4

Iodine Processed and Shipped

YEAR	ORNL SLUGS	HANFORD SLUGS	URANIUM (lb)	MILLICURIES SHIPPED	MILLICURIES SHIPPED/LB OF URANIUM USED
1951	651	5	1693	467,544	276
1950	396	12	1066	310,698	291

of product adequate to make all shipments for a three-week period, whereas a batch of at least nine X slugs is required to produce enough for one week's shipments.

The greatest difficulty encountered in operation this year was in the processing of the scrubber solutions. When the solution was made acid, put through the first distillation step, and trapped in the normal amount of NaOH, the distillate would be acid, and thus the bulk of the I^{131} content was lost. After several of these experiences a procedure was worked out whereby an additional amount of NaOH is added to the distillate receiver when the scrubber is processed, and the crude product from the scrubber stills is kept separate from the remainder of the run until it can be

determined whether the crude product is acid or basic. If it is basic, it is then combined with the remainder of the run; if not, it is thrown out and the major portion of the run is saved. This procedure is satisfactory, and since operating in this manner only one batch of crude product has been lost.

The extraction cell was decontaminated for repairs once this year when, for an unknown reason, the yields dropped to very low levels. It was discovered that leaking gaskets on top of the dissolver and on the bottom of the condenser permitted air to sweep the product through the equipment into the off-gas system. While the equipment was down, many other minor repairs were made and a leaking condenser was replaced.

OPERATIONS DIVISION MONTHLY REPORT

The purification glassware was decontaminated and one general overhaul made. Also, an additional $\frac{1}{2}$ in. of lead shielding was added to the hood to lower the radiation background in the operating area.

Because of high radiation exposure to personnel as a result of increased production, it became necessary this year to stop the practice of assigning one operator to work on this process exclusively. Although it is less desirable from the standpoint of efficiency and risk of error in operation, several operators are now rotated on this job.

Iodine -- Summary of Development During 1951. Development and design work on the new iodine plant to be located in the radioisotope area was completed during the first part of year. Nearly all the working drawings and specifications were completed by the Engineering Department. Construction plans are set up so that the plant can be installed in two parts as follows: (a) the building, cell blocks, and services; (b) the equipment and instrumentation. However, at the end of the year approval had not been granted by the AEC for starting construction.

The most significant process developments were cold-water scrubbing of iodine in a bubble-cap scrubber and evaluation of the influence of sparging of the dissolver solution during iodine removal by various gases other than air, such as nitrogen, oxygen, sulfur dioxide, and carbon dioxide. Indications are that by proper sparging techniques and introduction of small amounts of sulfur dioxide gas (reducing agent) at appropriate points in the cycle, the over-all yield can be raised by about 15%. Approximately 95% of the iodine carried in a gas stream can be removed by scrubbing with

chilled water in a bubble-cap tower. It was determined that iodine does not exist, except momentarily, as iodide in the dissolver solution, but iodate is formed in varying amounts under the influence of high temperature and in the presence of nitric acid. Proper utilization of these data in the operating procedure in the new iodine plant should result in improved yields.

A report* has been issued on the iodine process and equipment that have been in use during the last five years.

Paper chromatography was successfully applied to the determination of iodate and iodide ions in carrier-free I^{131} solutions. Use of an 80% ethyl alcohol -- 20% water solution resulted in excellent separation of the two ions on Whatman No. 1 filter-paper strips.

Phosphorus (P^{32} - 14.3d). Sixteen 2500-g cans of irradiated sulfur were processed and 9274 mc was shipped. It was necessary to reprocess three runs because of precipitate formation when a sample of the product was adjusted to a pH of 7.

A run was put through the new carrier-free production equipment this month. An over-all yield of 65% across the glassware was experienced in spite of high adsorption on the glassware. The product, however, had a precipitate when a sample was adjusted to a pH of 7 and had to be reprocessed.

The glass-lined extractor was removed and the floor refinished this month. All necessary data has been gathered from this equipment, which is no longer needed.

*A. F. Rupp, E. E. Beauchamp, and J. R. Farmakes, *Production of Fission Product Iodine¹³¹*, ORNL-1047 (July 17, 1951).

Table 5

Sulfur Processed vs. Phosphorus Shipped

YEAR	SULFUR PROCESSED (kg)	MILLICURIES SHIPPED	MILLICURIES SHIPPED PER kg OF SULFUR
1951	406	107,187	264
1950	452	95,954	212

Phosphorus — Summary of Operation During 1951. Table 5 shows the amount of material processed and product shipped compared with that of the previous year.

The operation of the equipment this year was relatively trouble-free as compared with last year. The purification glassware also operated very satisfactorily throughout 1951. Thus, satisfactory operation of the equipment plus improvements in operating techniques account for the increase in yields for 1951.

Phosphorus — Summary of Development During 1951. Experiments on the rocker-agitated P^{32} extraction apparatus were discontinued early in the year when it became evident that although the method worked well, mechanical difficulties with valves and gaskets in particular were too serious to warrant further work at the time. In addition, the demand for P^{32} has levelled off and production can be adequately met by the stationary autoclave extractors, which require several 24-hr extraction periods. Improvements in sulfur discharge were introduced by the Chemical Separations Department. Simplicity and reliability of operation were deemed more important than speed of operation, and the stationary autoclaves therefore continue to be used for routine production work. No

further development work is planned on extraction methods unless large increases in demand necessitate a higher production rate than is possible with present equipment.

Very little difficulty was experienced with the chemical purification process during the year; however, during the last two months there were several instances when products did not pass the pH 7.5 precipitation test and were reprocessed. An additional evaporator was added to precede the bulk-precipitation step in the production equipment, since there is evidence that the organic matter that causes the precipitate is altered by treatment with strong nitric acid during evaporation. Little additional work was done on the purification (removal of tars, etc.) of the sulfur target material. Work was started on the removal of tars by prolonged digestion of molten sulfur with magnesium oxide and this will be continued in 1952.

Round, sulfur-irradiation cans were put into routine use during the year with very good results.

A method was developed for fabricating red phosphorus-bakelite plaques that are able to withstand irradiation in the pile, and approximately 200 plaques were fabricated during the

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year. These were irradiated and calibrated before shipment. Most of the plaques were used by the ORNL Biology Division.

Carbon (C^{14} - 5740y) — Summary of Development During 1951. Practically all C^{14} production this year was from Be_3N_2 , which was irradiated at Hanford. A total of 10,297 mc was produced with an average isotopic ratio of 11.5%; the highest isotopic ratio obtained was 25.3%. This represents a great increase over the average isotopic ratio of 2.65% obtained during 1950; the average value in 1949 was 5.39%.

The process worked smoothly throughout the year with very little downtime for repairs. The most significant improvement was elimination of the step in which Be_3N_2 pellets were crushed. Improvements were made in the furnace used to melt off the aluminum jackets so that slugs could be pushed continuously through the furnace instead of melting them batchwise; the molten metal waste is discharged from the furnace intermittently.

The beryllium waste-recovery process was revised so that most of the beryllium passed through the process was recovered in the form of pure, dry, basic beryllium carbonate. This process was incorporated into the routine procedures. The carbonate has been stored pending the development of a process to reconvert the beryllium to Be_3N_2 target material. The recovered beryllium salt contains a small amount of very long-lived Be^{10} .

Several special preparations were made in the form of $Na_2C^{14}O_3$ and in the form of $CaC^{14}O_3$ rather than the usual $BaC^{14}O_3$. Carbon¹⁴ was not offered as $Na_2C^{14}O_3$ solution this

year, but consideration is being given to offering it in the 1952 catalog.

Some progress was made on the low-temperature fractionation of C^{14} process gases. However, it was not possible to devote much time to this project, which will continue on a limited basis as the manpower available permits. Most of the work during the year was devoted to testing equipment, such as low-temperature fractionating columns, gas-handling devices, and C^{14} gas-counting equipment.

Attention will be given during 1952 to the economics of recovering beryllium and reconvert it to Be_3N_2 as compared with purchasing or locally producing Be_3N_2 from new beryllium metal.

Fission Products

Separations from Process Waste. Work continued on the processing of Purex waste, chiefly for the purpose of obtaining Sr^{90} . This separation is being done with the ion-exchange equipment previously used for experimental work on Redox waste. Products of crude Sr^{90} have been accumulated for final purification, but no assay has been made to determine the total amount on hand. This material is high in Sr^{89} content, but it can be used to fill some large orders for Sr^{90} for certain uses.

Approximately 140 curies of Ce^{144} was precipitated as the iodate, without added carrier. The product was converted to the nitrate and removed as a solution, which was stored in the underground "garden." Processing of this material was of particular interest since the glowing radioactive material could be followed visually through the various stages

by observation through the cell periscopes. The balance of the crude rare-earth material was removed and stored for future processing.

Precipitation-Process Design. Work on the precipitation-process flow sheet continued, and it was decided that a construction request would not be required for this work. Costs will be accumulated on two work orders and later transferred to the proper capital accounts. Several purchase orders were issued for valves and other important equipment.

Building 3026 Processing. Five processing runs were completed in Building 3026 during the month, and approximately two curies of crude Sr^{90} was separated. This material is from old "W" slugs and contains from 10 to 15% Sr^{89} .

Purified Products. A purification run on the steam-heated ion-exchange column was started late in the month for purification of short-lived rare earths; 732 mc of Y^{91} was produced. Processing continued for Nd^{147} , Pr^{143} , and Ce^{141} needed for current orders. A purification run was also started for Sr^{89} .

Fission-Product Purification Equipment, Building 3028. Work on the installation of the fission-product purification equipment is 75% complete. Further work depends upon delivery of heavy hinges for lead doors.

Fission-Products — Summary of Development During 1951. Development work on fission-product processes was the largest and most important project of this department during 1951. Work was done on two processes for separating fission products from Redox and Purex wastes: ion exchange, which was used chiefly for Redox waste; and the precipitation process, which

is still in the chemical-development stage and will be used for Purex wastes. The first nine months of the year were spent on the process development and the installation and operation of ion-exchange equipment at full-scale on Redox wastes. The last three months were spent on chemical development for the precipitation method and preliminary process-equipment design. Some laboratory work was also done on adapting the precipitation process to "W"-type wastes as well as Purex wastes. Approximately 1000 gal of Redox waste from Pilot Plant processing of Chalk River metal was passed through the equipment in 14 runs. The material was not as rich in fission products as expected, since the waste available was from only the ends of the Chalk River rods. However, approximately 10 curies of Sr^{90} and 150 curies of rare earths were removed as crude products. The Sr^{90} was used to fill some of the requirements of this department during the year.

The principal objective in using the column process on Redox waste was to separate the relatively large amount of aluminum and chromium without resorting to alkaline precipitation of these elements, which results in a hard-to-handle gelatinous precipitate. However, the ion-exchange process was found to have limitations for the following reasons: low yields of fission products; high waste-effluent volume; low throughput; high chemical cost; precision control required at certain points; radiation damage to ion-exchange resins, requiring frequent changing; organic matter (decomposed resin) in product solutions.

Not all of the information obtained in developing the ion-exchange process was negative. The conditions for removing aluminum selectively from Dowex-50 resin were precisely determined, and this step is an essential

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one in the established Cs¹³⁷ production process. It was observed that uranium is very well complexed by oxalic acid, and this step was added to the old 3026-C ion-exchange process for separating the last traces of uranium from the fission products. It was also shown that oxalic acid removes most of the plutonium from a column so that an additional decontamination of plutonium from fission products can be achieved.

The precipitation process developed uses Ba⁺⁺ as a carrier in a fission-product solution from which all the plutonium and uranium have been removed by solvent extraction; the barium is precipitated as BaCO₃ by a mixture of NaOH and Na₂CO₃. All the important fission products except cesium and technetium are precipitated in good yield. The carbonates are dissolved in HNO₃, and the Ru¹⁰⁶ is distilled off as the tetroxide with HIO₄ as the oxidizing agent. Strontium and barium are precipitated as the mixed nitrates from fuming nitric acid, cerium is precipitated as the iodate, and the rare earths as oxalates; neptunium will probably be found in the rare-earth oxalate filtrate with other miscellaneous activities. Cesium is recovered from the first filtrate by alum crystallization.

It is planned to install the precipitation process in Building 3515, after removal of the ion-exchange equipment. Purex wastes from the metal-recovery building and pilot plant will be processed to produce kilocurie quantities of Sr⁹⁰, Cs¹³⁷, and possibly other fission products to satisfy anticipated large demands for these materials. The main ob-

jective, however, is the developmental work on the process itself.

After the separation of kilocurie quantities of Cs¹³⁷, it is planned to fabricate a large source in revised facilities of the old Ra-Be Building 3013.

Fission-product production (excluding I¹³¹) during 1951 is given in the following list:

FISSION PRODUCT	MILLICURIES
Sr ⁹⁰	8,158
Sr ⁸⁹	929
Y ⁹¹	818
Ba ¹⁴⁰	370
Nb ⁹⁵	105
Ce ¹⁴⁴	1,984
Ce ¹⁴¹	220
Zr ⁹⁵ -Nb ⁹⁵	3,509
Pr ¹⁴³	309
La ¹⁴⁰ (separated from Ba ¹⁴⁰)	222
Mixed rare earths	1,368
Pr ¹⁴⁷	38
Mixed fission products	16,166
Ru ¹⁰⁶	1,685

Cs¹³⁷ was not separated since a large supply was made in 1950, and much of the Sr⁹⁰ sold in 1951 was produced in 1950.

Miscellaneous Processed Radioisotopes. Table 6 is a list of radioisotope products made during the month.

Table 6

Radioisotopes Processed During December

PRODUCT	AMOUNT (mc)	SPECIFIC ACTIVITY	
		mc/g	ELEMENT
Antimony (Sb ¹²⁴ - 60d)	229	2587	Sb
Tantalum (Ta ¹⁸² - 117d)	29	784	Ta
Iron (Fe ⁵⁹ - 46.3d; Fe ⁵⁵ - 2.9y)			
From enriched "W" material	26.3 (Fe ⁵⁹)	1207	Fe
	0.26 (Fe ⁵⁵)	12	Fe*
Chromium (Cr ⁵¹ - 26d)	168	240	Cr
Selenium (Se ⁷⁵ - 127d)	860	119	Se
Mercury (Hg ²⁰³ - 43.5d)			
Sample 1	1650	173.6	Hg
Sample 2	1660	214.9	Hg
Calcium (Ca ⁴⁵ - 180d)	247	0.65	Ca

*This sample had the lowest Fe⁵⁵ contamination of any made to date.

Miscellaneous Process Radioisotopes
 — Summary for 1951. The miscellaneous, purified-radioisotope production during the year is summarized in the following list:

RADIOISOTOPE	MILLICURIES
S ^{35*}	156,716
Ca ⁴⁵	1,482
Co ⁶⁰ (solution)	786
Hg ²⁰³	3,350
Cd ¹¹⁵	26
Fe ⁵⁹	68
Fe ⁵⁵	139
Tl ²⁰⁴	2,649
Cr ⁵¹	866
Cl ³⁶	1.667

Sc ⁴⁶	522
W ¹⁸⁵	864
In ¹¹⁴	227
Zn ⁶⁵	100
Sb ¹²⁵ (carrier-free)	2.84
A ³⁷	0.1

*Separated as by-product; therefore production is out of proportion to sales.

Among the miscellaneous radioisotopes, the production of Fe⁵⁹ was of most interest from a development standpoint. Experimental work was done to recheck the possibility of producing iron by the Szilard-Chalmers reaction of irradiating magnesium or potassium ferrocyanide. Results

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confirmed the previously-held opinion that this method is not practical for producing commercial quantities of Fe^{59} . Yields from cyclotron-irradiated cobalt metal were disappointing and were of low specific activity because of the iron impurity in the cobalt targets. One experimental target from the Y-12 cyclotron also gave a very low yield. A program was started by this department to prepare pure iron-free cobalt for cyclotron targets by extracting the iron with dichloroethyl ether. Irradiation of enriched Fe^{58} (from Y-12) remained the best method for Fe^{59} production. The specification of $< 2\% Fe^{55}$ in Fe^{59} for human usage will be raised in the near future, so that satisfactory Fe^{59} can be produced by irradiating enriched Fe^{58} in the LITR or at Hanford. A program to reassess the practicability of producing Fe^{59} by (n,p) reaction on cobalt in the X-10 graphite pile was started late in the year and will be continued in 1952 if results are promising.

Argon³⁷ was recovered from $CaCO_3$ and assayed in a gas counter and a scintillation counter for the first time. The yield of 0.1 mc of A^{37} per 50 g of $CaCO_3$ in the X-10 graphite pile is very low, and irradiations will have to be made in a high-flux pile if high yields are needed.

Processing methods were improved, and a general conclusion was reached that target materials should be in metallic form wherever possible to facilitate handling and chemical processing.

Cyclotron Radioisotopes. The following cyclotron radioisotope preparations were made during the month:

Na^{22} - 2.6y	13.3 mc, carrier-free
Be^7 - 57.9d	104 mc, carrier-free

Cyclotron Radioisotopes - Summary for 1951. The following list is a summary showing production of cyclotron radioisotopes in 1951.

RADIOISOTOPE	MILLICURIES
Sr^{85}	8.19
$As^{73,74}$	2.74
Be^7	643.3
Mn^{54}	1.5
Na^{22}	24.7
Zn^{65}	14.6
Fe^{59}	0.84
$Co^{56,57,58}$	43.5

Development work on methods was chiefly devoted to improving the ion-exchange process for separating carrier-free Na^{22} from magnesium. An ion-exchange method for separating carrier-free $Mn^{52,54}$ from chromium was also developed.

Tritium (H^3 - 12y) - Summary for 1951. Approximately 160 curies of H^3 was packaged in 42 ampoules of various sizes during the year. In addition 100 ml of He^3 gas was purified and packaged in 23 ampoules.

The preparation of Zr- H^3 targets occupied a large portion of the time spent on tritium work. Twenty-one Zr- H^3 targets containing a total of 60 curies of H^3 were made. A demand developed for very thin Zr- H^3 targets, and the basic work on these methods was done with the cooperation of W. M. Good and his group in the Physics Division. During the course of this work it was found that it would be desirable to build an all-metal tritium system. This system, which is being fabricated, utilizes uranium metal traps for storage and purification of H^3 . It will also be possible to purify and package pure or diluted He^3 in relatively large quantities.

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A metal-evaporation apparatus was designed and is in process of fabrication. This will be used for making thin deposits of zirconium or other metals.

The above-mentioned improvements will permit the production of high-quality thin Zr-H³ targets with high Zr-H ratios (1:1 atomic ratio). The production of such targets for nuclear research is expected to be a significant scientific contribution.

Special Preparations

Co⁶⁰ sources

Civil Defense, Duluth, Minnesota	2 sources, 50 mc each
Civil Defense, New York City	5 sources, 1 curie each; 5 sources, 100 mc each
Sixth Army Head- quarters	8 sources, 100-400 mc
Tracerlab, Inc.	10 sources, 1 curie each
University of Wisconsin	1 source, 40 curies
Wright-Patterson USAF Base	205 sources, 40 mc each

Cs¹³⁷ sources

U. S. Naval Air Station	1 source, 1 curie
U. S. Naval Research Laboratory	1 source, 950 mc

Ru¹⁰⁶ source

K-25 Laboratory	1 electro- plated 1 mc source
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Services

Brookhaven National Laboratory	30 mc C ¹⁴ as CaC ¹⁴ O ₃
University of North Carolina	Isotonic Be ⁷ SO ₄ solu- tion

Special Preparations -- Summary for 1951. The following list shows a summary of special sources made during the year, exclusive of Zr-H³ targets.

Co ⁶⁰	764 sources, ranging from 10 mc to 40 curies
Cs ¹³⁷	7 sources, maximum 2 curies
S ³⁵	4 sources
Sr ⁹⁰	14 sources, ranging from 10 to 1000 mc
Nb ⁹⁵	2 sources
Ca ⁴⁵	2 sources
Ru ¹⁰⁶	3 sources
Fe ⁵⁵	2 sources
Ag ¹¹⁰	2 sources

Notable development work in source preparation was done in making an Fe⁵⁵ x-ray source to be used for x-ray diffraction work. This was accomplished by reduction of Fe₂⁵⁵O₃ to Fe⁵⁵ metal with hydrogen on the surface of a platinum foil; self-absorption was thus kept at a minimum.

Cottrell Precipitator. The Chemical Separations Department is now operating the 75-kv Cottrell precipitator, which is a part of the process off-gas system. The precipitator is at present being operated at about 45 kv, which is slightly below the suggested level of 50 to 55 kv.

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The continuous wash-water line and the recirculating pump to the Cottrell precipitator froze during the cold weather. The pump was thawed out, but the water line burst and emergency repairs were necessary. None of the underground shut-off valves could be closed to prevent the water-line freeze-ups; the valves are being checked and repaired.

The semiannual inspection of the high-voltage bus insulators was performed this month. The equipment was cleaned and otherwise found to be in good condition.

During the inspection shutdown, two 12-in. gate valves were installed in the hot off-gas system. One was placed at the inlet to the Cottrell precipitator and the other in the bypass line from the off-gas manifold to the exit-air heater. The addition of these valves will permit maintenance and inspection of the Cottrell precipitator by by-passing it without shutting down the entire off-gas system.

A cyclone fence is being installed around the precipitator as a safety measure.

Miscellaneous Work

Zinc Bromide Purification. Equipment was set up and operated by the Chemical Separations Department to purify an 80% ZnBr₂ solution, which the department had on hand for use in high-density windows. Five gallons was clarified and made available to ORINS.

Microfurnace. A small furnace consisting of a carbon resistor in a vacuum chamber was designed and built for the preparation of Sr⁹⁰ sources.

Pellet-Pressing Tests. Tests were started on methods of compressing

powders into pellets; these methods will be used in fabricating kilocurie fission-product sources. Sodium sulfate was used as a substitute for Cs₂SO₄; it was found that a pressure of 1000 psi is required for proper pelleting.

Pressure-Relief Cap. Alterations were made on a standard bottle-cap by drilling 0.028-in.-diameter holes in the cap and in a polyethylene insert so that gas generated by radiation decomposition of water may be released. Liquid does not leak out through the cap even though the bottle is inverted.

Miscellaneous Work - Summary for 1951. In addition to the larger design jobs on iodine, fission products, and other work listed under specific subjects, the following work was done by the engineering group:

1. Minor changes were made in P³² equipment.
2. The pile-building canal-water-purification equipment was put into operation and test runs were made to establish operating conditions.
3. A uranium dissolver for waste SF material was designed and put into operation.
4. The 3026-C fission-product equipment was changed to include small-batch TBP solvent-extraction equipment to produce mixed fission products.
5. Cobalt handling equipment for the storage and packing barricade was installed.
6. Design work was done on new equipment for processing carrier-free P³².

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7. Additional antiscatter shielding was installed in the storage barricade.

8. Equipment consisting principally of a hydraulic press and a ball mill was installed for fabricating red phosphorus plaques.

9. An underground garden, special bottle holders, and a shield carrier for storing very hot solutions were designed and built.

10. New Ru¹⁰⁶ purification equipment was installed in Building 3030.

11. The following remote-control equipment was developed: air-operated pinch clamps; a motorized, pipet-elevator unit; a motorized pinch clamp; a remotely lubricated, glass stopcock; low-cost bottle snares; an improved electrical unit for heating glass vessels.

12. Displays were prepared for the New York office of Union Carbide and Carbon Corporation, the Atomic Energy Museum, and Delta Airlines.

13. Seventy-two purchase requisitions and 113 work orders were issued; 185 working drawings and flow sheets were made.

14. The bearings on the main off-gas blowers failed and had to be replaced twice.

15. The bearings on the steam turbine driving the emergency off-gas blower failed once.

16. The coupling between the motor and the main off-gas blower failed and was repaired.

17. The CWS filter paper in the Building 3026 ventilation system was replaced only once.

18. The glass-wool filters in the off-gas system were replaced once and packed double to increase efficiency during RaLa runs.

19. One of the two vacuum pumps in Building 3034 had to be overhauled once and the bearings replaced once.

20. A concrete decontamination pad, which approximately doubled the decontamination working space at Building 3036, and a pad for storage of contaminated equipment north of Building 3036 were constructed.

21. A metal-waste tank to service the radioisotope area was installed.

22. Changes now in process are the installation of valves in the by-pass line in the off-gas system to permit uninterrupted operation while maintenance work on the Cottrell precipitator and filters is being done.

TANK FARM

General. The installation of the off-gas line from its junction and manifold at tanks W-16, W-17, and W-18 to Building 3505 was completed.

A longer dip leg was installed on the decant jet in tank W-3 and the excessive liquor was decanted to tank W-5 of the chemical-waste system.

A walkway was constructed from the evaporator, Building 3506, to tank W-6.

The transfer of metal-waste precipitate from tank W-7 to W-10 was carried on regularly throughout the month. Although the total amount transferred is not known, it was evidently a large amount because the sludge depth in W-10 tank has increased about 10 inches. Also, it has been

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noted that the appearance of the slurry in the sight glass of the recirculating line indicated less uranium than was indicated at the beginning of the transfer. This transferring operation is being discontinued temporarily until the material in W-10 tank can be settled out. The supernatant will be decanted to chemical-waste tank W-5, and some metal-waste solution jetted from W-9 to W-10 to make space for current plant wastes entering tank W-9.

Wastes Discharged to White Oak Creek. A total of 11.87 curies of beta activity was discharged from the

settling basin this month (see Table 7); the discharge is about 50% lower than that of last month. It is known that some of this activity was from the canal at Building 3001, which was purged following the pushing of three ruptured slugs, and the canal at Building 3505, which was purged and discharged several times to permit easier operation.

The retention pond activity discharge increased about 100% because of a leaking flange in a jet pit and unintentional jetting of a hot jet pit to the retention pond system.

Table 7

Activity Discharged to White Oak Creek

DISCHARGED FROM	DECEMBER 1951		NOVEMBER 1951	
	GALLONS	BETA CURIES	GALLONS	BETA CURIES
Settling Basin	25,147,000	11.87*	24,580,000	22.25
Retention Pond	623,000	0.49	492,500	0.21
Total	25,770,000	12.36	25,072,500	22.46

*Less than 0.07 curie contributed by the evaporator.

Chemical-Waste Evaporator (see Table 8). The evaporator was shut down for 8 hr this month to repair a faulty valve.

Table 8

Waste-Evaporator Operation for November and December

SOLUTION FED TO EVAPORATOR (gal)	CONCENTRATE TO W-6 (gal)	VOLUME REDUCTION	BETA CURIES TO EVAPORATOR	BETA CURIES TO SETTLING BASIN
December - 219,500	16,000	13.7:1	1,614.0	0.07
November - 199,000	30,200	6.6:1	6,160	0.35

Waste-Tank Inventory

Table 9

Waste Storage

HOT PILOT PLANT STORAGE			
TANKS	CAPACITY (gal)	FREE SPACE (December)	FREE SPACE (November)
W-3, 13, 14, 15	48,500	34,800	22,800
CHEMICAL-WASTE STORAGE			
W-5	170,000	108,500	95,000
EVAPORATOR-CONCENTRATE STORAGE			
W-6, 8	340,000	101,000	100,000
METAL-WASTE STORAGE			
W-4, 7, 9, 10	543,000	239,000	217,000

Summary of Tank-Farm Operation During 1951. The total volume of waste received for processing through the waste evaporator this year was essentially the same as that received during the previous year. The capacities of the waste-storage tanks and the evaporator were adequate to dispose of all wastes with little difficulty, except during periods of hot pilot plant operation when highly radioactive wastes entering tanks W-1 and W-2 were being diluted with very large volumes of water. Repeated investigations of this difficulty indicated that the source of trouble was located in the hot pilot plant building, but the exact point of entry of the excess water into the waste line could never be located.

The quantity of activity discharged into White Oak Creek by the settling

basin this year was practically the same as that discharged in 1950. Of the total 169 curies sent to the Creek, less than 7.2 curies was contributed by the waste evaporator; almost the entire balance of the activity came from the process-waste system as a result of difficulties encountered in operation and the lack of control of wastes entering the process-waste system. The known difficulties that were traced to operation were the fission-product separations process in Building 3515, an underground leak west of Building 3026, and the pile canal in Building 3001. These difficulties contributed roughly 65 curies, or 38% of the total discharged to the Creek. The total contribution from unknown sources as a result of lack of adequate monitoring was 104 curies, or 61%.

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Table 10

Beta Curies Discharged During 1950 and 1951

YEAR	BETA CURIES FROM SETTLING BASIN	BETA CURIES FROM RETENTION POND	TOTAL
1951	169	3	172
1950	172	15	187

Only 3 curies was discharged to the Creek through the retention pond. The reason for the decrease over last year was that the leaks into the tank farm drywell system were easily located and repaired this year, whereas considerable difficulty was experienced in locating some of them during the previous year.

Table 10 shows a comparison of the discharges for the Years 1950 and 1951.

The installation of the process-waste monitoring system, which was begun in 1950 and was expected to substantially decrease the activity sent to the Creek this year, was not completed. It is now planned to have it in operation in March 1952.

The evaporator operated normally throughout most of the year and only normal maintenance was necessary. The operation was substantially simplified and made more efficient by the addition of an electric liquid-level probe. The operator is now able to keep a constant check on the foam level and to prevent a foam-over by decreasing the evaporation rate when the foam level begins to rise rapidly. The better operation is reflected in higher decontamination factors for 1951. Table 11 is a summary of significant operating data for 1951, compared with that of 1950.

Estimates made in the summer of this year indicated that the free space in the evaporator-concentrate storage tanks was adequate to permit operation

Table 11

Waste-Evaporator Operation for 1950 and 1951

YEAR	SOLUTION PROCESSED (gal)	BETA CURIES IN FEED	BETA CURIES DISCHARGED TO SETTLING BASIN	DECONTAMINATION FACTOR	AVERAGE RATE OF PROCESSING (gal/hr)
1951	2,474,254	57,285	7.24	7912	282
1950	2,481,207	22,631	7.56	2994	283

only through January 1, 1952. The metal-recovery program that was to permit the conversion of the metal-waste tanks to concentrate-storage tanks was not begun last spring as originally scheduled.

At the suggestion of the Health Physics Division, additional storage space was provided last fall by transferring approximately 123,000 gal of a mixture of evaporator concentrate and metal-waste supernatant to a 170,000-gal pit dug for this purpose southwest of the new burial ground. This method was to be considered an experiment which, if it proved to be practical, would pave the way for a simple and very economical method of permanent disposal of concentrated evaporator wastes. The pit and the surrounding area are still under Health Physics surveillance; no decision concerning the practicality of this method of disposal has yet been made.

Several monitoring tanks were added to the chemical-waste system as part of the program of separating the various wastes for control purposes. Three tanks were installed to collect wastes from Building 3026; the old W-12 tank, which was formerly used for Buildings 3026 and 3550, is now used to monitor wastes from Building 3550 exclusively. Monitoring tanks are also being provided with the construction of all new laboratories.

The telemetering system, which is to be used in conjunction with the monitoring tanks to provide control from one central location, is approximately 75% completed and is expected to be in operation in the summer of 1952.

Much was accomplished toward permanentizing the equipment and improving the general appearance of the tank farm. The unsightly, rotted, wooden poles used to support service lines

were replaced with metal poles; the rotted wooden stairs and the manhole covers were replaced with metal ones; new manhole covers with multiple inlets were installed on tanks W-10 and W-5 to facilitate connections from new buildings and to provide for expansion in the future; and a standard float was installed on the metal-waste tank at Building 3026. New flood lights to eliminate the poor lighting conditions were also installed. In general, an attempt was made to make all necessary replacements of outside wooden equipment with steel and concrete to reduce the constant repairs and replacements required in the past. As a result, the appearance of the tank farm has also been markedly improved.

RaLa (Ba¹⁴⁰ - 12.5d)

The RaLa equipment was reinstalled in its shield and connected to the panel board. Three additional dummy runs were made utilizing a revised procedure to incorporate the use of newly-added flush lines connected to the feed and eluate lines. The analytical results of the three runs were so inconclusive that it became necessary to make a test run of approximately 150 curies.

Sixty-five irradiated X slugs were loaded, dissolved, and extracted in one batch. Three grams of barium as Ba(NO₃)₂ was added in the extraction step in addition to the barium present in the loaded slugs to test the column under the full-design capacity of barium. The run was then completed.

The mechanical performance of the equipment and the analytical results of the run were satisfactory and there were no indications of need for any further changes in the process or equipment. The next full-scale run is to be started on January 6, 1952. Tables 12 and 13 show the analytical summary of the run.

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Table 12

Analytical Summary of Cell A and Resin-Cubicle Operations

	CURIES	PER CENT
Dissolver solution	167.00	100.00
Cell A losses		
Extraction and wash loss	0.51	0.31
Metathesis and wash loss	1.09	0.65
Extraction-tank rinse	1.72	1.03
Total Cell A losses	3.32	1.99
Resin-cubicle losses		
Feed-tank rinse	0.35	0.21
Acetate feed effluent	0.00	0.00
NaOH elution	0.05	0.03
Versene feed effluent	0.30	0.18
Sodium versenate elution	0.72	0.43
HCl elution	0.31	0.18
Fuming HNO ₃ precipitation	1.71	1.03
Total cubicle losses	3.44	2.06
Total process losses	6.76	4.05
Product yield	135.00	80.84
Material balance		84.89

Summary of Operation During 1951.

The major alterations to the RaLa equipment, which were begun in June 1950, were completed in April of this year. The first phase, which included the addition of process and "crud" filters to the Cell A equipment to improve the extraction, metathesis yields, and reliability of the process, was completed in September 1950. The second phase, the construction of duplicate resin cubicles to permit the production of larger-sized batches and to improve product purity, was completed in April of this year. The first of the two resin cubicles was completed in March 1951 - early enough to produce a small batch requested by

Los Alamos for shipment during the first week in April.

The entire project was completed approximately five months after the originally scheduled completion date; however, since the schedule for use of the product at Los Alamos had also been delayed sufficiently, Los Alamos experienced no delay as a result.

Although many dummy runs were made during the year in the course of checking the new equipment and process, only three productions were made for shipment to Los Alamos and all three of these were made through the new equipment. No appraisal of the products

Table 13

Analytical Summary of the Resin-Cubicle Operation

	CURIES	PER CENT
Acetate feed	120.00	87.78
Versene feed	16.70	12.22
Total feed to column	136.70	100.00
Losses		
Feed-tank rinse	0.35	0.25
Acetate feed effluent	0.00	0.00
NaOH elution	0.05	0.04
Versene feed effluent	0.30	0.22
Sodium versenate elution	0.72	0.53
HCl elution	0.31	0.23
Fuming HNO ₃ precipitation	1.71	1.25
Total resin-cubicle losses	3.44	2.52
Product yield	135.00	98.76
Material balance		101.28

has been received, and it is believed that all were used for tracer studies only.

The first shipment contained a total of only 157 curies. It was considered a successful run in spite of high losses that were caused by the small quantity of barium present. The quantity of product shipped was satisfactory to Los Alamos, and results of the run showed a need for only minor alterations to the new equipment.

The second run, made in May, yielded 3157 curies and progressed very satisfactorily until the last step in the resin-column operation where the product was to be eluted from the column into the evaporator. At this point, the plastic plug valve at the bottom of the resin column failed and the product was directed into two waste tanks that contained waste at the time.

A run made to recover this material yielded only 24% of the original product. Following this run, the resin cubicle containing the broken plug valve was decontaminated and repaired in time for the third run in August. Only minor revisions to the equipment were made.

The third and last shipment contained 8700 curies. It was during the preparation of this batch that the need for major alterations to the resin-column cubicle equipment and process became obvious. The accurate adjustment of the pH of the Versene feed, which was so essential to efficient operation of the column process, was found impossible because of a constant rise in pH caused by the high activity of the product. Owing to this lack of pH control, a total of 6900 curies of product was lost as a precipitate in the feed tank. Also,

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another failure of a plastic plug valve immediately following the run rendered the cubicle useless and confirmed a suspected need for drastic alterations to the cubicle valving system.

From the experience gained during the three hot runs, a decision was made to do more development work on the process in order to eliminate the undesirable pH adjustment, to completely redesign and rebuild the damaged resin cubicle to eliminate the plastic plug valves, and to make several other alterations that would make the equipment easier to operate. This program was begun immediately after the August run and was completed in December. Besides several dummy runs made to test the equipment, one hot test run was successfully completed.

(A complete summary of this run is included in the preceding portion of this report.)

The rebuilding of the second cubicle will be held up until at least one large-scale run is successfully processed through the first cubicle.

The next run is scheduled for January 6, 1952. An attempt will be made to produce 30,000 curies. There is some doubt as to whether it is possible to produce a batch of this size in equipment designed for only 10,000 curies. The first request for 30,000-curie batches was received last February after construction of the equipment was well under way, and it was then impossible to redesign the apparatus to be certain that 30,000-curie batches could be handled.

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RADIOISOTOPE CONTROL DEPARTMENT

GENERAL

During December 1951 there were 749 radioisotope shipments compared with 816 during November 1951, and 616 during December 1950. Table 14 shows a breakdown according to separated, unseparated, project, nonproject, and foreign shipments. Table 15 shows a summary of project, nonproject, and foreign shipments for the years 1950 and 1951.

Table 14

Radioisotope Shipments

	DECEMBER 1951	NOVEMBER 1951	DECEMBER 1950	AUGUST 1946 TO DECEMBER 1951, INCLUSIVE
Separated Material	622	674	498	22,450
Unseparated Material	127	142	118	6,468
Total Shipments	749	816	616	28,918
Nonproject	627	698	510	
Project	104	111	93	
Foreign	18	7	13	
Total Shipments	749	816	616	

Table 15

Radioisotope Shipments for 1950 and 1951

TOTAL SHIPMENTS 1951	TOTAL SHIPMENTS 1950	PER CENT INCREASE
7661	6284	+ 22
1652	1572	+ 5
178	219	- 19
9491	8075	+ 17

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HANFORD IRRADIATIONS

The radioisotope samples listed in Table 16 were received from Hanford during December 1951.

Table 16

Radioisotope Samples Received from Hanford

SAMPLE NO.	MATERIAL	NO. OF PIECES	DATE DISCHARGED	DATE RECEIVED
ORNL-145	Enriched Fe ⁵⁸	1	November 1951	12/18/51
ORNL-88	Tin	1	December 1951	12/19/51
ORNL-86	Thallium	1	December 1951	12/19/51
ORNL-28	Iron	2	December 1951	12/19/51
ORNL-84	Silver	1	December 1951	12/19/51
ORNL-80	Mercury	1	December 1951	12/19/51

CYCLOTRON RADIOISOTOPES

Table 17 is a list of the outstanding orders for cyclotron radioisotopes now on hand (see also Tables 18 and 19).

Table 17

Cyclotron Radioisotope Orders

MATERIAL	AMOUNT (mc)	STATUS
Na ²²	10.5	Material in process
Mn ⁵⁴	11.0	Material in process
Co ⁵⁷	6.0	Material has been requested
Fe ⁵⁹	7.0	Substitution of pile irradiated iron to be requested
As ⁷³	2.0	Material has been requested

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Table 18

Bombardments Received and Requested

MATERIAL	MASS. INSTITUTE OF TECHNOLOGY		UNIVERSITY OF CALIFORNIA		UNIVERSITY OF PITTSBURGH		WASHINGTON UNIVERSITY	
	BOMBARDMENTS	BEAM HOURS	BOMBARDMENTS	BEAM HOURS	BOMBARDMENTS	BEAM HOURS	BOMBARDMENTS	BEAM HOURS
BOMBARDMENTS RECEIVED								
Be ⁷			1	47.2	12	309.0		
Na ²²	2	190.00			8	300.25	4	300.0
Mn ⁵²					2	20.00		
Mn ⁵⁴	1	50.00					5	250.0
Fe ⁵⁴			1	18.7				
Co ⁵⁷	1	10.00					3	100.0
Fe ⁵⁹			7	332.8	2	80.60	1	34.0
Zn ⁶⁵	1	100.00	1	47.8				
Ga ⁶⁷					10	71.75		
Sr ⁸⁵	2	59.75			1	10.00		
As ⁷³			1	10.5	2	20.50		
I ¹²⁵							2	60.0
Molybdenum Metal					2	15.70	3	30.0
Sulfur					1	2.00		
Total received	7	409.75	11	457.0	40	829.80	18	774.0
REQUESTED BUT NOT RECEIVED								
Ti ⁴⁶			1	3.00				
Ti ⁴⁸			1	3.00				
Fe ⁵⁷			1	3.00				
Y ⁸⁸	1	10.00						
Co ⁵⁷							1	40.00
Total hours outstanding (not received or requested)		1,080.25		1,034.00		670.20		686.00

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Table 19

Shipments of Cyclotron-Processed Radioisotopes

MATERIAL	TOTAL SHIPMENTS 1951	NO. SHIPMENTS DEC. 1951	TOTAL MILLICURIES AND SERVICE IRRADIATIONS					
			YEAR 1951		DEC. 1951		TO DATE	
			mc	S.I.	mc	S.I.	mc	S.I.
Be ⁷	15	4	111.170	3	22	1	270.243	3
Na ²²	35	11	26.997		6.181		55.944	
Mn ⁵²							9.991	
Mn ⁵⁴	3		2.72				2.72	
Fe ^{55,59}	7		1.54	2			63.64	4
Co ⁵⁷	2		1.1				3.1	
Zn ⁶⁵	6	1	12.50	1	4		39	4
Ga ⁶⁷	10	3		10		3		10
As ⁷³	4	1	1.560		0.91		1.560	
Sr ⁸⁵	2		6				6	
Mo ⁹⁵	4			4				4

ACTIVATION ANALYSES

During the past year activation analyses have been made for eight different organizations. In each case, an average of four analyses have been made on approximately two to four different elements. Progress has been made toward standardization of prices for analysis of several elements.

SF MATERIAL CONTROL

During the month, 232 pieces of irradiated Chalk River fuel rods were received. These slugs, which contained an estimated 530.6 g of plutonium, were for the SCRUP Program. To date, 7.1 tons of uranium containing approximately 2715 g of plutonium and representing five carload-lot shipments have been received. The next carload-lot shipment is tentatively scheduled

for March 1952. Meanwhile, the express car and containers will be used to transport irradiated thorium slugs from Hanford to ORNL for the forthcoming U²³³ separations program.

The first batches of enriched uranyl sulfate solution for use in the HRE were received on December 17, 1951. The shipment contained 2874.70 g of 93.14% enriched uranium.

On December 19, 1951, twenty "J" slugs were received from Y-12 for encasement into two aluminum sheaths 11 ft in length. Following completion of the encasement work, the assemblies will be forwarded to Chalk River, Canada, for insertion in the pile.

Three batches of aluminum-silicon bonded slugs, amounting to 883 pieces, were received from the Y-12 area for testing and subsequent loading into the 3001 pile.

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A carload-lot shipment was received from Hanford on December 19, 1951. the contents of the shipment consisted of 140 irradiated slugs for the Purex process and two slugs for use by the K-25 area.

SF material in the possession of seven persons was surveyed during the month. The material was inspected and weighed, where feasible, and no apparent discrepancies were encountered. In addition, the records of three analytical laboratories were audited. Results of the audit disclosed that all records were in good order and proper accounting had been made for all samples.

During the month there were 31 receipts and 13 outgoing shipments compared with 25 receipts and 20 shipments last month.

Two reports dealing with special materials were prepared and submitted by the SF office during December, namely, the Laboratory's polonium source requirements for calendar year 1952 and the quarterly radium and radium compound inventory report as of December 31, 1951.

Tables 20 and 21 are summaries of receipts and shipments of SF material for the month of December 1951.

Table 20

SF Materials Received

FROM	MATERIAL	AMOUNT (g)
Argonne National Laboratory	Normal uranium	260.00
Battelle Memorial Institute	Thorium crystal bar	330.00
C&CCC, K-25 Area	Depleted uranium	3,360.42
C&CCC, K-25 Area	Plutonium	1.89
C&CCC, K-25 Area	Depleted uranium	97.14
C&CCC, K-25 Area	Plutonium	0.05
C&CCC, Y-12 Area	Enriched uranium (U-sulphate crystals)	2,677.49
C&CCC, Y-12 Area	Enriched uranium (U ₃ O ₈)	25.02
C&CCC, Y-12 Area	Enriched uranium (UF ₄)	0.70
C&CCC, Y-12 Area	Enriched uranium (U-Al slugs)	770.13
C&CCC, Y-12 Area	Normal uranium (metal)	46.20
C&CCC, Y-12 Area	Normal uranium (slug pieces)	5,875.00
C&CCC, Y-12 Area	Normal uranium (slugs) net	362,600.00
C&CCC, Y-12 Area	Normal uranium (slug)	1,173.00
C&CCC, Y-12 Area	Normal uranium (UF ₄)	5.90
C&CCC, Y-12 Area	Normal uranium (slugs) net	417,400.00
C&CCC, Y-12 Area	Normal uranium (UF ₄)	29.00
C&CCC, Y-12 Area	Normal uranium (UF ₄)	1.08
C&CCC, Y-12 Area	Depleted uranium (metal)	14.80
C&CCC, Y-12 Area	Normal uranium (plate)	61.00
C&CCC, Y-12 Area	Normal uranium (plate)	250.10
C&CCC, Y-12 Area	Normal uranium (plates and tubes)	3,720.50
C&CCC, Y-12 Area	Thorium metal (tubes)	2,040.90
C&CCC, Y-12 Area	Normal uranium (U-sulphate)	1,651.50

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Table 20 (continued)

FROM	MATERIAL	AMOUNT (g)
C&CCC, Y-12 Area	Normal uranium (slugs) net	282,850.00
C&CCC, Y-12 Area	Normal uranium (UF ₄)	27.90
E. I. DuPont de Nemours & Co., Inc.	Normal uranium (disks)	20,540.00
General Electric Co.-AGT	Normal uranium (UO ₂)	108.80
General Electric Co.-AGT	Normal uranium (UO ₂)	108.80
General Electric Co.-AGT	Normal uranium (UO ₂)	108.80
General Electric Co.-HGE	Depleted uranium (slugs)	248,930.00
General Electric Co.-HGE	Plutonium (slugs)	150.00
General Electric Co.-HGE	Depleted uranium (slugs)	3,556.00
General Electric Co.-HGE	Plutonium (slugs)	2.00
Mallinckrodt Chemical Works	Normal uranium (purex)	1,030.00
National Research Council-EVG	Depleted uranium (slugs)	1,248,650.00
National Research Council-EVG	Plutonium (slugs)	530.60
Westinghouse Electric Corp.	Enriched uranium (U ₃ O ₈)	1.62
Westinghouse Electric Corp.	Enriched uranium (U ₃ O ₈)	3.05

Table 21

SF Materials Shipped

TO	MATERIAL	AMOUNT (g)
C&CCC, K-25 Area	Depleted uranium (sliced slug)	111.00
C&CCC, K-25 Area	Plutonium (sliced slug)	0.06
C&CCC, K-25 Area	Depleted uranium (sliced slug)	2,779.00
C&CCC, K-25 Area	Plutonium (sliced slug)	1.56
C&CCC, Y-12 Area	Depleted uranium (purex)	39.30
C&CCC, Y-12 Area	Thorium metal	1.02
C&CCC, Y-12 Area	Thorium metal	1.04
C&CCC, Y-12 Area	Normal uranium (bars)	4,550.00
C&CCC, Y-12 Area	Normal uranium (UO ₂)	308.52
General Electric Co.-AGT	Enriched uranium (plates)	1.158
General Electric Co.-HGE	Depleted uranium (receptacle slug)	1,655.6035
General Electric Co.-SGE	Plutonium (Pu-nitrate solution)	0.015
Mallinckrodt Chemical Works	Normal uranium (solution)	118.90
USAEC, New Brunswick Lab.	Normal uranium (solution)	45.00
Westinghouse Electric Corp.	Enriched uranium (U ₃ O ₈)	4.67