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OPERATIONS DIVISION
RADIOACTIVE WASTE DISPOSAL AND MISCELLANEOUS WORK
ANNUAL REPORT FOR 1955

By
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RADIOACTIVE WASTE DISPOSAL AND MISCELLANEOUS WORK

ANNUAL REPORT FOR 1955

A. F. Rupp and E. J. Witkowski

INTRODUCTION

The waste-disposal section of this report covers the operation of the main waste-disposal facilities, under the jurisdiction of the Operations Division, servicing the laboratories and operating buildings located in the Bethel Valley Area. These facilities include the hot-chemical- and the metal-waste systems, the process-waste system (frequently called the "semihot-waste system"), and the radioactive-gas-disposal system, which utilizes the 250-ft stack located in the Radioisotope Area. The report does not cover the disposal of cooling water from the LITR, of gases from the Hot Pilot Plant and the ORNL Graphite Reactor buildings, of wastes discharged to White Oak Creek from the Homogeneous Reactor, and of solid wastes at the burial ground.

Certain miscellaneous operations for which the Operations Division is responsible are also covered in this report: SS (source and special nuclear) material control, SS material recovery, off-shift services for research divisions, Water Demineralizer Plant operation, and hydrogen liquefaction. Other Operation Division activities, reactor operations, radioisotope production and development, and classified chemical processing are given in separate annual reports.

WASTE-DISPOSAL OPERATING COSTS

The operating cost for calendar year 1955 was \$175,500, an increase of \$7,907 over the previous year. The excavation of waste pits was an unusual expense item and accounts for more than the amount of the increase. Only \$10,623, representing a portion of one pit excavation, was charged to the operation in the year 1954, while \$20,365 was charged in 1955 to complete the excavation begun in 1954 and to almost complete the work on a new one. It is interesting to note that the pit dug by the Laboratory forces and completed early in 1955 cost a total of \$14,320, while the new one, which is, for the most part, under contract to a construction company, has already cost \$16,658, and several thousand dollars more will have to be spent before the job will be completed.

Unless there should be a considerable increase in the Laboratory's rate of waste production, which is not anticipated at present, an expenditure of about \$4000 during 1956 will be sufficient for the completion of all pit excavation work. It should be several years before additional pits are necessary, since the capacity of the existing three waste pits is now more than adequate for the current rate of waste production.

A breakdown of the \$175,500 expended for waste-disposal operation is given in Fig. 1. The Operations Division's total contribution of 15.5% (\$27,217) in direct labor, supervision, and clerical work represents a cost of \$3.11 per operating hour, or 1.33 times one operator's normal rate of pay. The manpower used was less in 1955 than during the early years of Laboratory operation, when the waste-disposal system was quite small. A comparison of costs, including overhead, for the last five calendar years follows:

Year	Cost
1955	\$175,500
1954	167,593
1953	199,704
1952	208,331
1951	288,465

HOT-CHEMICAL-WASTE SYSTEM

Waste Volume and Activity

The disposal of waste into open pits, without evaporation, was continued throughout 1955. A total of 1,674,000 gal of radioactive waste, containing 21,391 "beta curies" of activity, was pumped into the pits. This represents an increase of 84% in volume and 196% in activity over the previous year. Significant waste-disposal data for 1955 are compared with those of the five previous years in Table 1.

The waste evaporator was not operated during 1955. This was the first full year that the evaporator had been shut down since pit disposal was begun in 1951, which accounts for the increase in

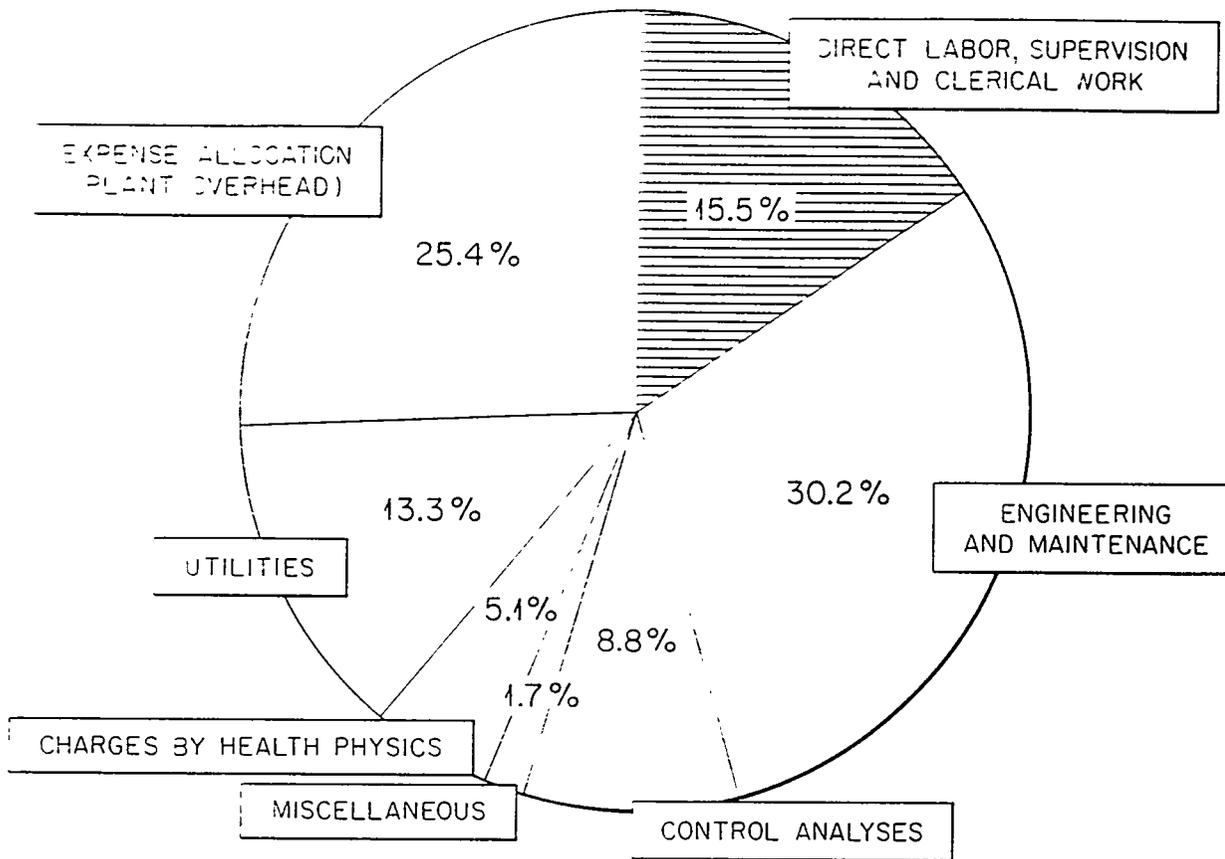


Fig. 1. Cost Breakdown of Waste-Disposal Operation in 1955. Total cost, \$175,500.

volume and a large portion of the increase in activity pumped into the pits. Without a reduction in volume, the waste could not be stored in the tank farm for a long period of time to permit decay of short-lived materials prior to transfer to the pits.

The total volume of radioactive waste received was 1,691,000 gal, which is lower by 20% than the average for the five previous years but higher by 7% than the volume in 1954, the lowest on record. The low volume in 1954 was due mainly to a long shutdown of operations at the Hot Pilot Plant.

Excavation of Waste Pits

The second 1,000,000-gal waste pit (No. 3) was completed and put in service in January 1955. The excavation of the third pit (No. 4) was completed by the contractor in October but will not be ready for use until the Laboratory forces install a sam-

pling platform and a screen cover. It is estimated that at the current rate of production the capacity of the two pits used at present will be adequate for several more months. The pits currently used are shown in Fig. 2.

Replacement of Tank-Farm Transfer System

The old, above-ground, black iron, jet-transfer system which had been the cause of a high radiation background at the tank farm was replaced this year with a stainless steel, underground system (see Figs. 3 and 4). The new system consists of a single pump connected by a single line to each tank through a valve manifold. By valve adjustments, it is possible to use each line for either suction or discharge and to pump solutions in either direction between any two tanks.

TABLE 1. LIQUID WASTE-DISPOSAL DATA FOR 1950 THROUGH 1955

	1950		1951		1952		1953		1954		1955	
	Volume (gal)	Activity ("beta curies")										
Hot Chemical Waste System												
Radioactive waste received	2,229,000		2,294,000*		2,192,000		2,287,000		1,582,000		1,691,000	
Nonradioactive waste received**	0		0		0		0		87,000		11,000	
Radioactive waste evaporated	2,224,000		2,212,000		2,102,000		2,042,000		711,000		0	
Disposal in test pit Ho. 1												
Radioactive waste	0	0	123,000	390	0	0	0	0	0	0	0	0
Nonradioactive waste	0		0		0		0		0		3,000	
Disposal in test pit Hos. 2 and 3												
Radioactive waste	0	0	0	0	43,000	953	227,000	7,716	910,000	7,224	1,674,000	21,391
Nonradioactive waste	0		0		0		0		87,000		8,000	
Process Waste System												
Total waste discharged to White Oak Creek	226,350,000		297,590,000		268,180,000		239,356,000		164,290,000		210,600,000	
Discharged from retention pond		15		3		87		140		17		54
Discharged from settling basin		172		169		411		289		237		213
Total activity of waste discharged to White Oak Creek		187		172		498		429		254		267

*Includes 94,000 gal of metal waste supernatant transferred directly by truck from metal waste tanks to tank pit.

** All nonradioactive waste was transferred directly from the operating buildings to the pits by tank trailer.

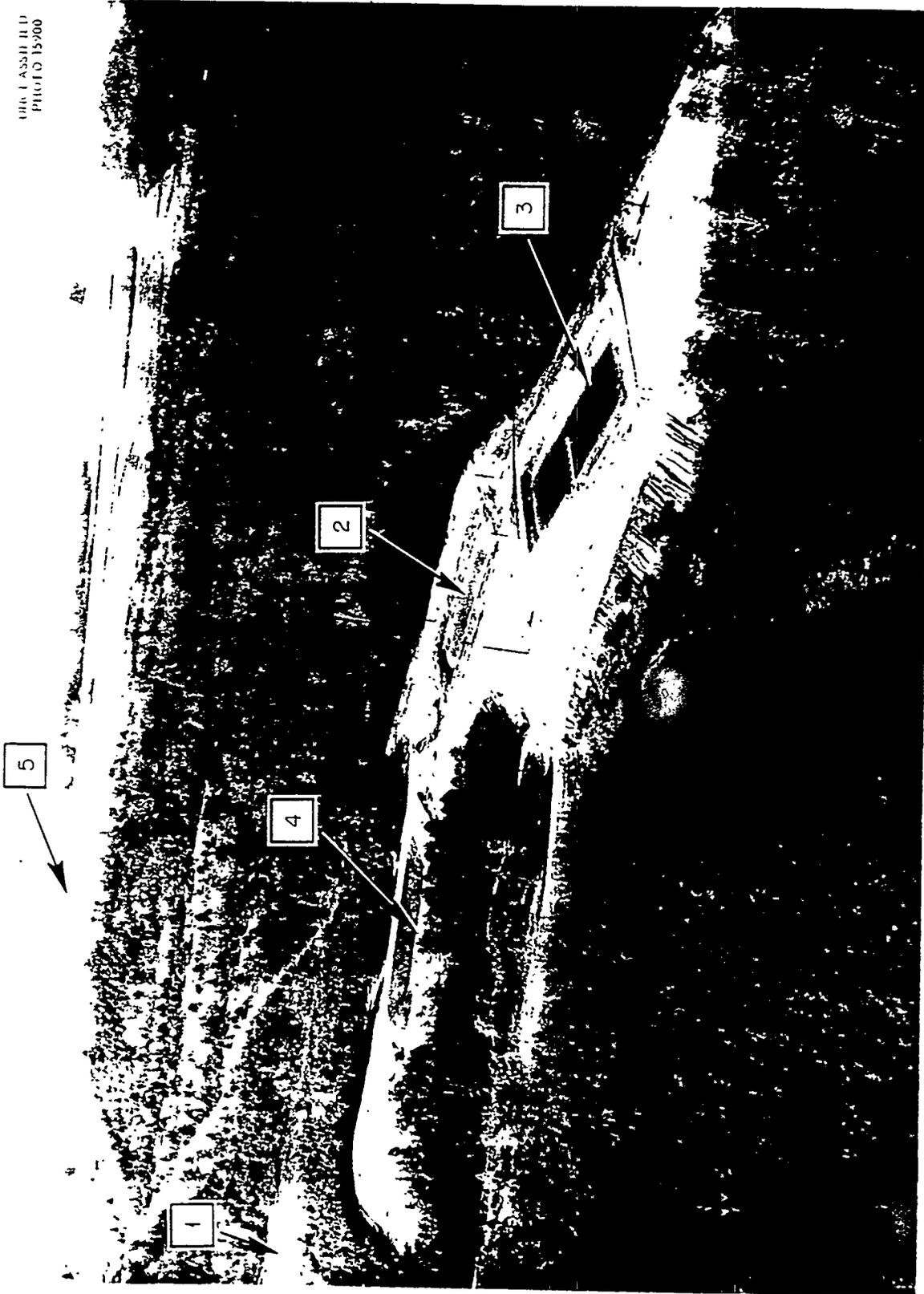


Fig. 2. Aerial View, Looking Southwest, of Waste Pits Nos. 2, 3, and 4. Also shown is a section of White Oak Lake (1) and of the Clinch River (5).

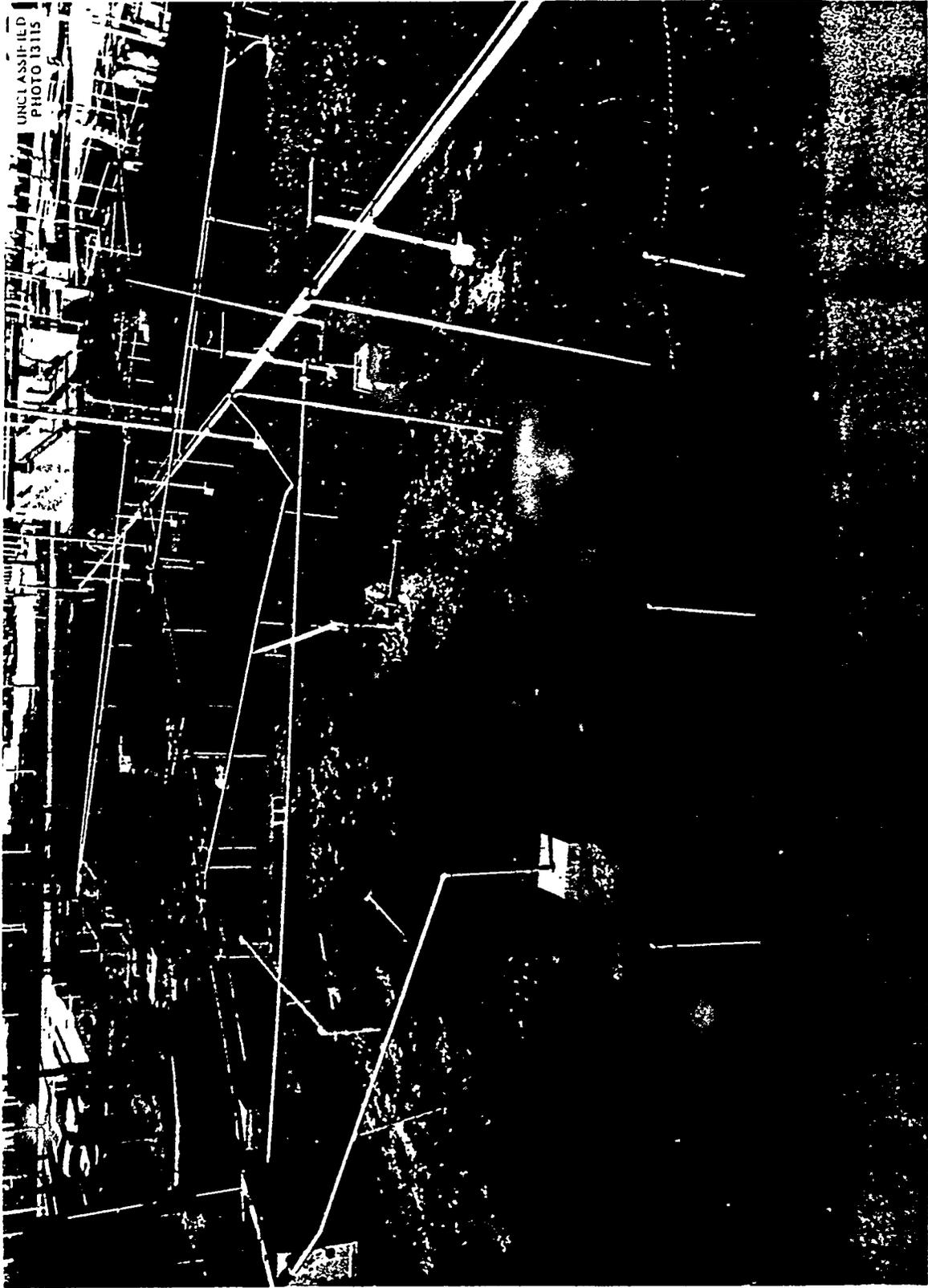


Fig 3. View of South Tank Farm Before Replacement of Above-Ground Jet-Transfer System.

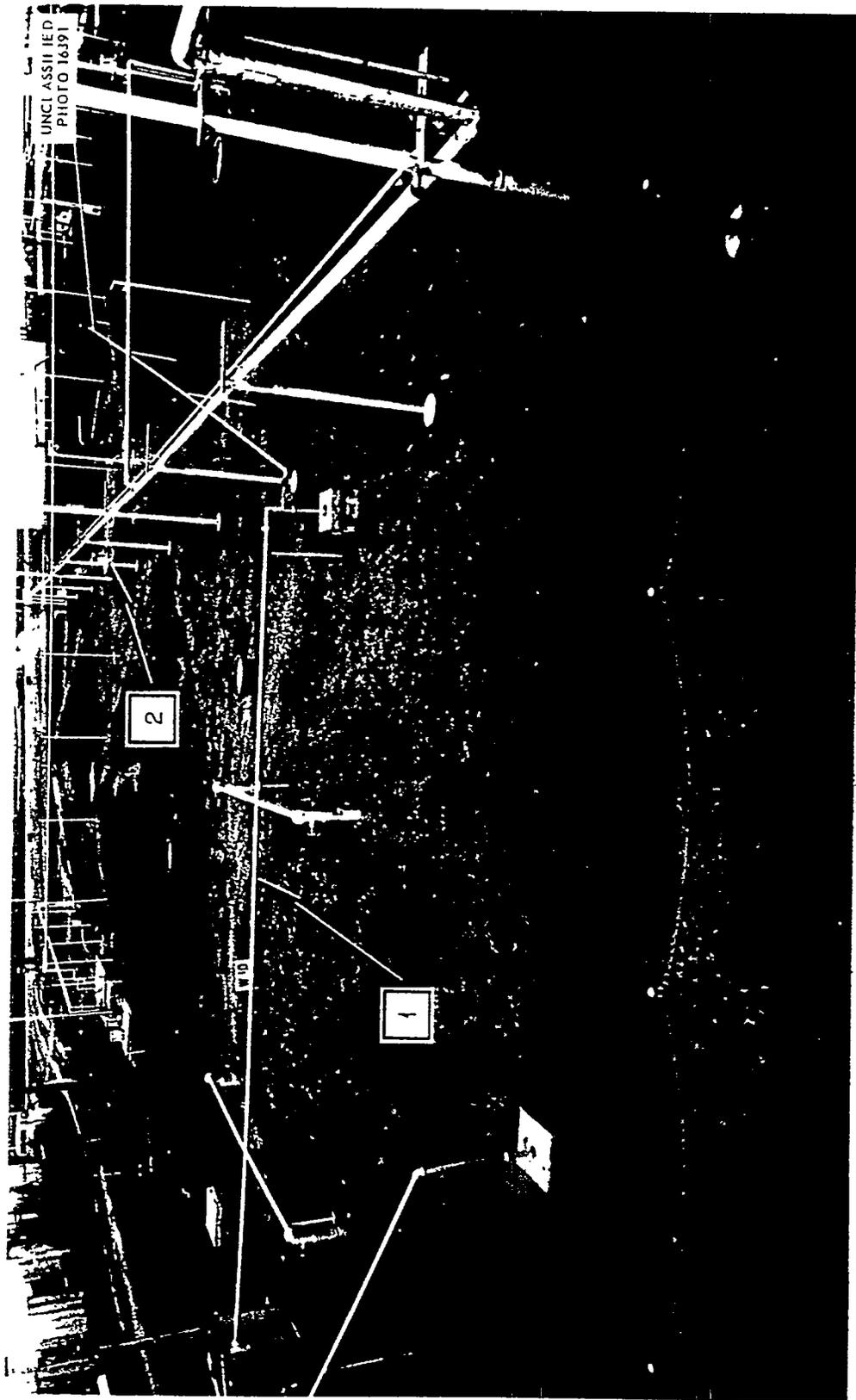


Fig. 4. View of South Tank Farm After Installation of New Transfer System. The only waste line remaining above ground, used for transfer of uranium to the Metal Recovery Building, is indicated by the figure 1. The top of the new pump pit is indicated by the figure 2.

The only radioactive spill of any significance in 1955 occurred while the new system was being installed. The old system, which had always required a great deal of maintenance because of corrosion, sprang a leak while the trenches were open for the new installation, and high-level waste ran into the excavation. The project was stalled for several weeks because of the extensive removal of contaminated earth from the trenches and the surrounding area to lower the radiation background. The old transfer system was completely removed immediately after the spill, and transfers between tanks were made through temporary hoses until the new system was completed.

PROCESS-WASTE SYSTEM

Waste Volume and Activity to White Oak Creek

A total of 267 "beta curies" of activity was discharged to White Oak Creek. This discharge is 105% of that of 1954 and 87% of the average over the previous five years. Seventy curies (26%) of the total was discharged during December, mainly as a result of two underground valve leaks in the tank-farm waste valves into the retention pond system, of a leak through the cell floor into the process-waste lines in the Radioisotope Wastes Processing Laboratory, Building 3515, and of the cleanup of a shielded container which was brought into the Equipment Decontamination Building as empty but which was found to contain radioactive solution after it had been flushed into a process-waste drain.

The volume of contaminated water discharged was 210,600,000 gal, an increase of 28% over that of 1954, but only 88% of the average of the previous five years. As in the case of the hot-chemical-waste system, the low discharge in 1954 was due mainly to a prolonged shutdown period at the Hot Pilot Plant. A complete comparison of process-waste system data for the last six years is shown in Table 1.

Process-Waste Treatment Plant

The lime-soda ash water-treatment plant for removal of activity from process waste, under consideration since 1952, was approved this year by the AEC. The design of the plant, contracted to Burns & McDonnell Engineering Company, of Kansas City, Missouri, was started in July and

was completed in November. Bids for the construction of the plant were received in December, but the project is being temporarily held up pending the appropriation of funds sufficient to cover the anticipated construction costs.

RADIOACTIVE-GAS-DISPOSAL SYSTEM

Maintenance

The frequent failure of bearings on the off-gas blowers and cell ventilation fans, which required an excessive amount of repairs in previous years, was reduced to normal levels in 1955. A large portion of the good performance can be attributed to improvements in equipment made in 1954; the most important was the installation of larger bearings and an Alemite oil-mist lubrication system on the electrically driven, 2400-cfm off-gas blower. A bearing failure in January was the only one experienced on the off-gas blower since the new equipment was put into operation in June 1954. The failure was unusual in that it was caused by plugging of the lubrication line, which was the result of faulty factory assembly of the lubrication system. A new shaft and impeller were installed in the same off-gas blower after the impeller broke away at the shaft at the welds. The shaft was known to be out of line prior to this incident, and a spare shaft had been kept on hand for such an emergency.

New, larger bearings were also installed this year on the emergency steam-driven off-gas blower after it had developed an unusually bad vibration. Both off-gas blowers are now believed to be in better mechanical condition than they have been at any time since their installation.

The largest and most expensive maintenance job was the replacement of most of the underground water lines under the concrete stack pad. After some leaks were discovered, the lines were found to be extensively corroded. The new pipes were covered with a protective coating and were electrically insulated from the old pipe to improve galvanic protection for the section of old pipe that was not replaced.

The housing and impellers of the three large cell ventilation blowers were sandblasted and repainted this year for the first time since their installation seven years ago. Even though the old paint had flaked off, the base metal was still in good condition.

Continuity of Operation

A complete failure of the off-gas system occurred on November 16 as a result of an electric power outage at the same time that the emergency off-gas blower was shut down for the installation of the large bearings. The shutdown lasted for 7 min. The main users were notified by telephone in time to prevent any spread of contamination.

Expansion of Facilities

An engineering survey was started in 1954 to determine the alterations and additional equipment required to improve off-gas and cell ventilation service to areas receiving inadequate service and to provide service and connections to certain new areas. The survey was completed in 1955 and showed that extensive alterations to the stack area off-gas piping and cell ventilation duct work will be needed and that the capacities will have to be increased by the installation of another 60,000-cfm cell ventilation fan and another 2,000-cfm off-gas blower. It was estimated that the cost of the entire project will be \$157,000.

On the basis of the survey results, a decision was made to request the AEC to provide funds for advanced planning so that the design could be completed in FY-1956, thus permitting construction to be started promptly at the beginning of FY-1957, when capital funds for the project become available.

OFF-SHIFT SERVICES FOR RESEARCH DIVISIONS

More than 1.6 man-years of labor was furnished to the research divisions in miscellaneous services daily on the 4-12 and 12-8 shifts and on all shifts on week ends. Although there is no record for comparing the demand in 1955 for these services with that in previous years, a steady increase has been noted since the Operations Division took over the responsibility for this work in 1954.

The services performed (for any division requesting them) include routine tasks and jobs that do not require a great deal of training. It would be impossible to take on complicated work because of the great number of jobs already performed by each man. An effort is made, however, to select for even the routine jobs those operators who are above average in reliability and in ability to learn. Some examples of regularly recurring jobs are:

filling liquid nitrogen and dry-ice traps on the Van de Graaff machines, maintaining the oxygen supply in Building 4500, taking readings and maintaining the hydrogen supply on Metallurgy Division's furnaces, and making a routine check of the Metallurgy Division's sodium loops.

As an additional service to the research divisions, patrol work was taken on, without the addition of manpower. This was made possible when the installation of the pipe line to the liquid-waste pits eliminated the need for waste evaporation. Even though a large portion of the work normally assigned to the waste-disposal operations was eliminated, the number of operators working alone was already at an irreducible minimum, and the addition of the patrol work filled out their schedule.

It is difficult to place a monetary value on these services to the Laboratory, but, if they were not available, many scientific experiments requiring continuous operations either would be slowed down or would be made much more costly by personnel having to work overtime.

EQUIPMENT DECONTAMINATION

There was practically no change this year in the demand for equipment decontamination, a service available to all divisions of the Laboratory. The cost of the operation was \$37,943, an increase of 6.5% over the previous year. Two-thirds of the increase was due to increased use of Health Physics services, the balance to higher wages and cost of materials. A breakdown of the total operating cost is shown in Fig. 5.

SS MATERIAL CONTROL

During the latter part of 1955, plans were made for changing from the individual accounting system to the "balance area" accounting system for SS materials. This is to be done during the first half of 1956. The new system is expected to reduce the number of transfers and reports handled by the SS Material Control Office.

The number of lots of SS material shipped in 1955 increased approximately 8% over 1954, and the number received increased 29%. The number of reports increased 9%, and the number of internal

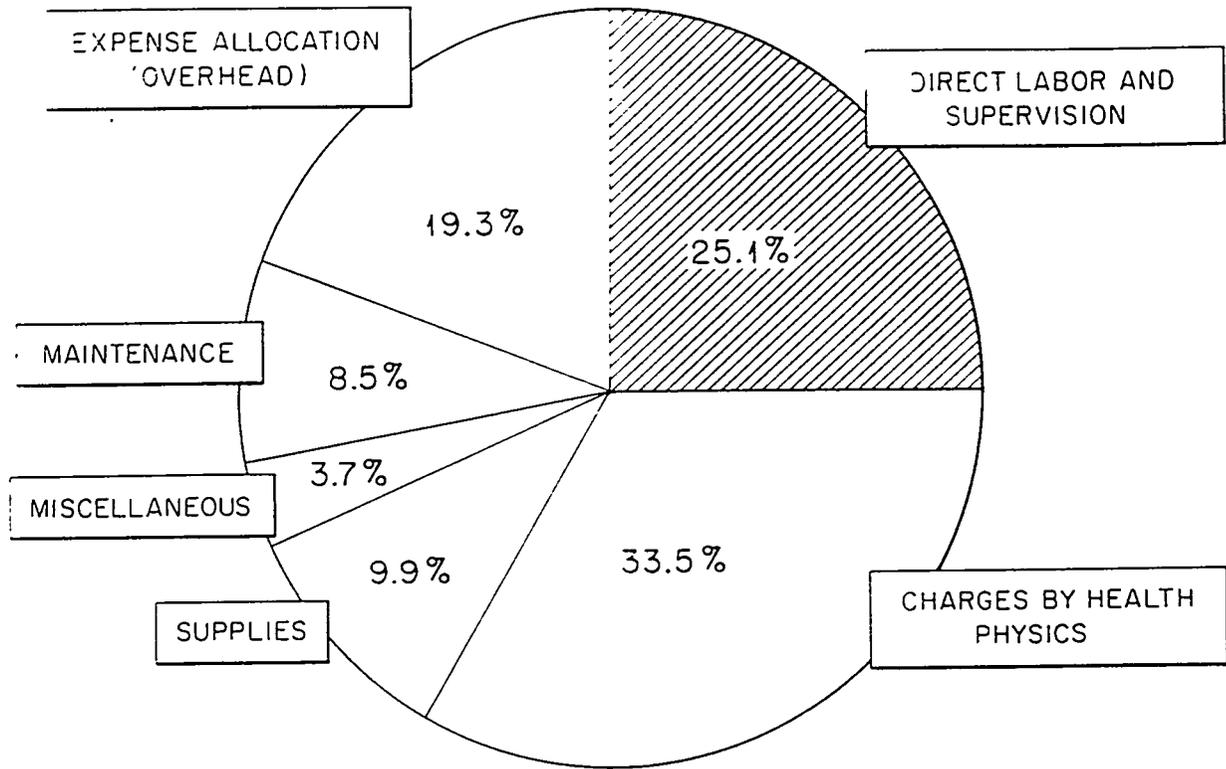


Fig. 5. Cost Breakdown of Equipment-Decontamination Operation in 1955. Total cost, \$37,943.

audits and surveys increased 66%. A comparison of the number of transactions is given below:

	1954	1955
SS material receipts, number of lots	338	437
SS material shipments, number of lots	480	518
Number of research issuances	62	19
Material requests issued	196	148
SS material reports issued	95	104
Internal audits and surveys	97	162

Of the 148 requests for material received during this year, 85 were from personnel within the Laboratory and 63 were from other installations. These materials were either delivered or scheduled for delivery.

Of the 437 shipments received during the year, 15 were carload lots and 18 were trailer-load lots; of the 518 shipments made, 35 were trailer-load lots.

The major facilities engaged in processing SS materials were Thorex, Metal Recovery, and Fabrication Laboratory. During the year the depleted-uranium inventory at the Laboratory was reduced approximately 29% by the recovery of the irradiated X slugs that were being held in storage. Recovery work also reduced the plutonium inventory by 50%. These materials were returned to production channels.

Operations were increased in programs involving the use of thorium and U²³³. This was due primarily to the work being done on the Thorex and

blanket programs. The thorium inventory was increased 43%, and the U^{233} inventory was increased 148%. It is expected that U^{233} separations work will be accelerated in CY-1956. The problem of storing irradiated thorium is being studied. It may prove more economical to discard some of the material than to recover it.

During the year an increase of 20% was experienced in the inventory of enriched uranium containing less than 75% U^{235} . This was due primarily to the Lid Tank Source Plate now being used at the Laboratory. Scrap materials from the various projects, such as the source plate and the Geneva Reactor fuel elements, were returned to production channels. An increase of 12% was experienced in the inventory of enriched uranium containing greater than 75% U^{235} as the result of an increase in the amount of materials held on Laboratory quotas and in materials being fabricated at the Rolling Mill for other installations.

A gain of 35% in the normal-uranium inventory was due to the UO_2 and UO_3 received for recovery from Argonne National Laboratory.

All reported SS material losses and unaccounted-for quantities were investigated, and recommendations were made for remedial procedures. All such losses were satisfactorily explained.

A new vault for storing SS material was completed this year. It is equipped with shelves, skids, and a high lift, and provides 750 ft² of storage space.

RECOVERY OF SS MATERIALS

During the last several years the Chemical Separations Department has been processing for recovery of uranium various scrap materials returned to the SS Material Control Office by the research divisions; the bulk of the materials consisted of machine scraps from the Metallurgy Division. During 1955 about 15 kg of normal uranium and 4.23 kg of greater than 90% enriched uranium were recovered.

Only unirradiated uranium was processed before 1955. During 1955, equipment was set up to process irradiated material as well. The equipment is located in the former U^{131} purification cell in Building 3026 and consists of a small stainless steel dissolver and glassware for solvent extraction. The recovery of uranium from highly radioactive scrap, collected over an eight-year period, was started in December.

WATER DEMINERALIZATION PLANT

The Water Demineralization Plant has two sets of demineralizers, which supply demineralized water for the Low-Intensity Test Reactor process system and the Bulk Shielding Facility, cooling for experiments in the Low-Intensity Test Reactor and the ORNL Graphite Reactor, and process water for the Chemical Technology Pilot Plant. The feed for these demineralizers is filtered water from the plant process-water system. The two demineralizer systems are of the separate-bed type. The cation columns normally contain 55 ft³ of strongly acid cation resin (IR-120 and IR-112). The two anion columns contain 20 ft³ each of strongly basic anion resin (IRA-410 and IRA-401).

A 4% solution of HNO_3 is used to regenerate the cation columns, and a water jet is used to dilute the 60% (40° Bé) technical-grade HNO_3 to the proper concentration. Regeneration of the anion columns is done with 4% $NaOH$ at 95°F. This solution is mixed and then heated in a steel tank and then pumped through the anion resin bed.

In anticipation of increased demands for demineralized water when the ORR begins operation, a cost study was made of the most economical means of supplying increased amounts of demineralized water to the ORR. Building a storage facility for 100,000 gal of water was found to be much more expensive than operating the plant in its present state at high capacity and changing the resin occasionally. The second mode of operation has been chosen and is estimated to cost about \$25,000 less than the water-storage method.

The quality limits on the demineralized water are: pH, 5 to 9; specific resistance, greater than 150,000 ohm-cm. For the last three months, the pH has averaged 6.9 and the specific resistance 400,000 ohm-cm. Normal flow through a single demineralizer unit is about 10 gpm.

Experience has shown that after about two years of normal usage in this installation the strongly basic anion resins start to lose their capacity to remove anions. Consequently, the quality of the water produced during 1955 was slightly low. With a new anion resin, it is possible to produce water routinely at 50 gpm per unit, with an average pH of 8 and a specific resistance of 2,000,000 ohm-cm.

The operating data are shown in Table 2, and a chronological outline of resin changes made during 1955 is given below:

January 13. - Twenty-five cubic feet of used IR-112 resin was removed from cation column No. 1 and was replaced with 55 ft³ of IR-120. It was found that IR-112 breaks up into very fine particles which cluster together and cannot be regenerated. The manufacturer replaced the IR-112 with 55 ft³ of IR-120 at no charge. The fines were thoroughly backwashed out of the column before the resin was removed.

February 2. - After a backwash of cation column No. 2, most of the fractured resin particles (fines) were washed out. Then 25 ft³ of used IR-112 resin was added to the 23 ft³ of used IR-112 already in cation column No. 2.

September 27. - On this date, 4 ft³ of anion resin (RA-401) was added to anion column No. 2 to replace the resin lost from the column during backwashing.

December 6. - After a thorough backwash, 8 ft³ of Nalcite HCR cation resin was added to the 36 ft³ of IR-112 already in cation column No. 2.

During 1955 the following troubles were experienced in the operation of the demineralizer plant.

February 28. - While anion column No. 1 was being regenerated the valve to the storage tank was left open. A pH of 11.7 was reached in the demineralized water storage tank. The tank was then drained and flushed. To prevent this accident in the future, a Solu-Bridge controller was

installed in the effluent of each demineralizer. This apparatus closes a solenoid valve in the common demineralized water line when the specific resistance drops below 150,000 ohm-cm.

April 5. - The demineralized water storage tank in the demineralizer building was accidentally drained when a valve between the storage tank and the Bulk Shielding Facility was left open.

HYDROGEN LIQUEFACTION

It was decided to use the hydrogen liquefier built in the research shops even though a small leak had developed (amounting to about 30 cc/year); it was put in operation in March.

In June a large leak developed in the high-pressure hydrogen line to the vacuum chamber of the cryostat, destroying the vacuum and making it impossible to retain hydrogen after it was liquefied. The line was repaired in the ORNL shops.

Occasional demands of 10 to 15 liters of liquid hydrogen tax the capacity of the equipment; therefore a survey was made of the cost of larger liquefiers. The smallest commercial liquefier which could be found had a capacity of about 5 liters/hr, compared with about 1 liter/hr with the present equipment, and the price was approximately \$17,000, compared with a cost of \$3,000 for the present equipment. In view of the uncertainty of the demand for large quantities of liquid hydrogen, no decision has been reached concerning the purchase of a larger unit.

TABLE 2. SUMMARY OF PROCESS-WATER DEMINERALIZER OPERATION IN 1955

	Cation Column		Anion Column	
	No. 1	No. 2	No. 1	No. 2
Number of regenerations	25	22	65	80
Monthly average	1.1	1.8	5.4	6.6
Amount of water produced, gal	2,153,800	1,482,850	1,997,458	1,400,000*
Average production between regenerations, gal	86,152	67,402	30,730	17,500
Resin used	55 ft ³ of IR-120	50 ft ³ of IR-112	20 ft ³ of IR-401 and IR-410	20 ft ³ of IR-410
Regenerant chemical used	23,206 lb of 40% Be HNO ₃		14,500 lb of NaOH as 50% solution	
Man-hours	~ 94		~ 290	

* Estimated.