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OPERATIONS DIVISION

REPORT FOR SEPTEMBER 1955

By

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Date Issued: OCT 18 1955

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TABLE 1

GRAPHITE REACTOR OPERATIONS

Period 9-1-55 to 9-30-55

	This Month	Last Month	Year to Date
Total energy, Mwd	92.1	91.4	859.2
Average power, kw /Operating Hour	3359	3211	3428
Time operating, %	91.4	91.9	91.8
Excess reactivity, inhr	129	205	
Slugs charged	143	174	1031
Slugs discharged	143	150	994
Input air temperature (av), °F	72	77	
Exit air temperature (av), °F	179	184	
Exit air filters, Δp, in. H_2O	4.9	4.8	
Canal water radioactivity, counts/min/ml	2000	4300	
Total facilities assigned, %	82	82	
Facilities in use for research, %	56	59	
Facilities in use for radioisotopes, %	20	20	
Research samples	72	129	1232
Radioisotope samples	204	239	2088

GRAPHITE REACTOR

There were three slug ruptures in September; this brings the total number of ruptured slugs found in 1955 to 16.

Rupture No.	Date	Row No.	Days in Reactor	Approx. Temp.	No. from West End of Row	Remarks
143	9-6-55	0964	1191	159° C	29	Found by visual inspection.
144	9-12-55	0974	1197	159° C	14	Found by visual inspection.
145	9-19-55	2274	1253	215° C	21	Found by visual inspection.

The slugs stored in the canal since 1952 are being shipped to the Metal Recovery Plant at a slightly increased rate. Shipments totaled 10,811 during September, leaving approximately 17,500 still in the canal. Two hundred and ten ruptured slugs were found among those stored in the canal, which is approximately 1.9% of those shipped to the Metal Recovery Plant. This is a large increase over the number of ruptured slugs found in the ones shipped for processing in August (0.3%). The larger number of ruptured slugs is apparently due to the fact that the slugs are being processed in the order of increased

irradiation; i.e., the slugs shipped in August had been irradiated in a much lower flux than those shipped in September. If this holds true, even more ruptured slugs should be found in the following months when slugs discharged from channels near the center of the reactor will be shipped to the Metal Recovery Plant.

The No. 2 fan motor installed in August was found to have an unusual sound and was inspected by a factory representative. No reason for the noise was found and it was decided that it was probably not serious.

The control wiring is being inspected and the wiring diagram checked on each shut-down day; this will probably require several months.

In order to reduce the personnel exposure in the canal, which has been high lately because of the considerable time spent in loading slugs for processing at the Metal Recovery Plant, the water has been purged to the settling basin at a rate of about 500,000 gallons a week. This has reduced the radioactivity in the canal water from about 8000 c/m/ml to 2000 c/m/ml. The radioactivity is largely due to the slugs which have ruptured in the canal during storage there and also to some MTR fuel elements which have corroded slightly. During the period when purging is necessary, the canal demineralizer is not being operated, since it does not have sufficient capacity to purge enough water to compensate for the large amount of radioactivity being added to the canal water from the ruptured slugs. Several alterations are being made on the anion columns to decrease the amount of washing required after regeneration.

Channel 2568 will be discharged early in October so that a thermopile may be installed adjacent to hole 12. This will enable the reactor to be operated from the signal of this thermopile so that the neutron flux in hole 12 will be constant during special experiments. In normal operation the reactor is controlled from a chamber in hole 40, resulting in some variation in the flux of hole 12.

TABLE 2

LITR OPERATIONS

Period 9-1-55 to 9-30-55

	This Month	Last Month	Year to Date
Total energy, Mwd	74.6	85.6	680.8
Average power, kw /Operating Hour	2,992	2,985	2,981
Time operating, %	83.1	92.5	83.7
Excess reactivity, %	3.7	2.5	
Unscheduled shutdowns, hr	6.216	1.301	36.882
Regular shutdowns, hr	89.250	33.801	373.635
Research shutdowns, hr	26.302	20.434	662.414
Inlet water temperature (av), °F	94.5	95.6	
Outlet water temperature (av), °F	111.7	112.2	
Cooling water reactivity, counts/min/ml	45,000	55,000	
Cooling water resistivity, ohms	400,000	413,000	
Fuel pieces charged	2	1	10
Fuel pieces discharged	2	1	9
Total facilities assigned, %	100	100	
Facilities in use for research, %	55	60	
Facilities in use for radioisotopes, %	30	30	
Research samples	37	41	261
Radioisotope samples	43	45	362

LOW-INTENSITY TEST REACTOR

The LITR operated without trouble during September. Downtime was higher than last month because of a shutdown to make tie-ins for the remote control test.

Remote control test equipment is almost completely installed, lacking only a few final adjustments. It is planned to begin performing most of the operating procedures from the Graphite Reactor except start-ups. An operator will, however, be kept in the LITR control room until the tests have demonstrated feasibility of remote control operation and all requirements are satisfied.

The scrams caused by the period safety circuit continued in September except for a period of approximately two weeks after a new Sola transformer was installed. A similar trouble-free period occurred last summer after another new Sola transformer was installed. Both times, however, the trouble-free period lasted only two weeks before scrams began occurring again. A total of five scrams occurred from this cause during September.

The 30-cubic-foot monobed column was regenerated on September 24 and the small anion pre-column was regenerated on September 20, at which time it was found that the support plate at the bottom of the resin had come loose. During the regeneration of the large monobed column, the plastic distributor at the interface between the anion and cation resins broke. It was replaced with a stainless steel distributor.

The 40-horsepower fan motor on the west air cooler had to be removed for bearing repairs. The small cooling fan inside the motor was found to be cracked, apparently due to vibration from the bad bearings, and more than one week was required for repairs. The manufacturer is being checked to determine whether the motors are well-suited for this application, since this is the second bearing failure that has occurred. The east motor failed approximately a year ago, at which time thrust bearings were installed.

RESEARCH REACTOR (ORR)

Personnel training for the Research Reactor has begun. Two supervisors have spent some time at the MTR studying the problems encountered in operating a reactor with a flux seven to ten times higher than that of the LTTR. Several additional operators will be hired within the next few months so that they will be adequately trained when operation of the ORR begins.

Plans are being made to supply the demineralized water necessary for the ORR from the present water system with a minimum of additional expense. It was originally thought that it might be necessary to buy new equipment at a cost of ~ $15,000, but it appears that sufficient water can be supplied by revising the schedules to produce the additional amount required over a longer period of time.

Excavation for the reactor was about completed by the contractor, and the work of installing footings was started. The status of the work is shown in the photograph below.

RADIOISOTOPE PRODUCTION AND SALES

Radioisotope Shipments are shown below.

	September 1955	August 1955	September 1954	Since August 1946
Processed Material	852	825	751	58,832
Irradiation Units	186	219	199	15,347
Total	1038	1044	950	74,179
Domestic	918	954	863	
Foreign	27	15	66	
AEC Projects	93	75	21	
Total	1038	1044	950	

Detailed data on radioisotope production and sales are given in Tables 3, 4, and 4-A.

Radioiodine production equipment was shut down for two weeks to decontaminate and repair a leak in a stainless steel evaporator. Enough I^{131} was held in storage to fill all orders promptly during this period.

Operations in the fission product semi-works are directed toward the recovery of only Sr^{90} and Tc^{99}. The Sr^{90} is required to satisfy a fairly brisk current demand, and the Tc^{99} is needed for development of F3P processes.

Work has progressed on the new radioisotope catalog to a point where it probably will be available for distribution during December.

The largest irradiation device yet made at the Laboratory, containing 10,000 curies of Co^{60}, was fabricated in the new remote control cell. The irradiator consisted of 24 individual parts, each of which was sealed with solder and tested for leaks.

Our request for the irradiation of additional cobalt in the MTR has been verbally approved with the reservation that it will take two years to produce 50,000 curies. Design work is being done on a new container in which this cobalt will be placed for irradiation.

Additional cobalt metal wafers have been received from Kulite Tungsten Company. We now have sufficient cobalt to meet any requests SRO may have.

The report requested by the AEC on a breakdown of all costs incurred in the radioisotope distribution program was completed and forwarded to the AEC.

In order to conserve steam and water, automatic control equipment was installed on the Radioisotope Area water stills at a cost of $1700. It was estimated that the savings will pay for the installation in one year.

RADIOISOTOPE DEVELOPMENT

Several improvements were made in the helium-3 packaging system. This is reported more fully in the Appendix.

Design work was completed on the cobalt storage garden. No schedule for construction has yet been established by the contractor.

A construction request was prepared for submission to complete the installation of the short-lived fission products unit adjacent to the iodine plant. Demand has risen sharply for several of the short-lived fission products, notably Sr^{89}.

Four Cs^{137} final purification runs have been completed in the equipment in Building 3029. The Cs^{137} activity processed totaled 2590 curies, of which 1988 curies was recovered as a product. A similar quantity of Cs^{137} remains to be processed, so the total material of teletherapy-source grade might be expected to total about 4000 curies.

All high-loss waste solutions were recovered. The largest single loss occurred in a poorly formed $Al(OH)_3$ precipitate and was about 60 curies, as compared with the approximately 10 curies lost in a well-formed granular precipitate. These figures are based on 600-curie runs.

An analysis of the analytical procedure for Cs^{137} showed the gamma chamber (GIC) results to be the most accurate. In the future, the Cs^{134} content will be determined by the scintillation counter, and its contribution to the gamma chamber reading will be subtracted.

The recovery of rubidium from cesium alum decant solutions is being investigated. The precipitation of rubidium fluosilicate (Rb_2SiF_6) shows promise. The solubility of the rubidium compound is 0.16 g/100 ml, and that of cesium fluosilicate is 60 g/100 ml. The results of the first "hot" experiment were obscured by the presence of aluminum in the solution, which also forms an insoluble fluosilicate.

Cesium pyrosulfate was prepared by heating a mixture of $CsNO_3$ and $(NH_4)_2SO_4$. The $Cs_2S_2O_7$ compound appeared to melt at $\sim 550^\circ$ C, with slow decomposition to yield Cs_2SO_4 and SO_3. The melt was very corrosive when in contact with SST-316, Carpenter 20, and type "R" Monel metals.

Fission Product Pilot Plant (F3P)

Construction

Excavation for the building and tank farm foundation was completed by ORNL forces. The excavation for the cell ventilation duct is in progress.

The Malan Construction Company is scheduled to begin work on this project on October 10.

The status of the work is indicated in the following photograph.

Engineering

All drawings for Phase II of F3P have been completed. The specifications for this part of the project are 90% complete.

Process Chemistry

Laboratory experiments indicate that Sr^{90} will be a serious waste problem, since the Sr^{90} will precipitate in the ammonium alum when the accompanying Ba builds up to a concentration sufficient to precipitate as $BaSO_4$. The $BaSO_4$ carries some of the Sr^{90}. The laboratory results indicated a 6% average loss of Sr^{90} per cycle for a simulated plant run through ten cycles. These results indicate that the proposed procedure for Redox waste is inadequate as a decontamination process, unless some cheap and simple method can be found to remove Sr^{90} from the aluminum that will go to the waste stream.

TABLE 3.
RADIOISOTOPE PRODUCTION AND SALES

Period 9-1-55 to 9-30-55

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

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

Product	Type	Source	Specific Activity	This Month		Year to Date	
				Produced	Sold	Produced	Sold
Antimony-122	I						
Antimony-124	I				1		2
Antimony-124	P-HSA	W	557	891	5	891	138
Antimony-125	I						1
Antimony-125	P-CF						5.2
Argon-37	P-CF					5,000	11
Arsenic-73,74	P-CF						
Arsenic-76	I						15
Arsenic-77	I				1		7
Barium-131	I				1		10
Barium-133	P-HSA					25	8
Barium-140	P-CF	W	CF	530	49	2,103	920
Beryllium-7	P-CF						7
Bismuth-210	I						3
Bromine-82	I				2		31
Cadmium-115	I						1
Cadmium-115m	I						
Cadmium-115	P-HSA					20.2	21
Calcium-45	I						
Calcium-45	P-LSA				20		284
Calcium-45	P-HSA				244		1,103
Calcium-45	P-E				1		44
Calcium-45	P-CF						0.013
Carbon-14	P				685	4,262	3,774
Cerium-141	I				1		2
Cerium-141	P-CF					1,300	178
Cerium-144	P-CF				130	67,964	938
Cesium-134	I						
Cesium-134	P-HSA				580	3,094	1,905
Cesium-137	P-CF				3,288	3,675	20,577
Chlorine-36	I				2		13
Chlorine-36	P	M	0.580	23.3	1	90.9	2.8
Chromium-51	I						5
Chromium-51	P-HSA	L	2,770	4,536	816	18,276	6,184
Cobalt-57	P-CF				10		22
Cobalt-58	P-CF					1.4	2
Cobalt-60	I						1
Cobalt-60	P-HSA				93	588	701
Copper-64	I				1		11
Europium-152,154	I						2
F. P. (gross)	P				157	4,230	1,034
Gallium-72	I				5		32

TABLE 3 (continued)
RADIOISOTOPE PRODUCTION AND SALES

Product	Type	Source	Specific Activity	This Month		Year to Date	
				Produced	Sold	Produced	Sold
Gold-198	I				70		616
Gold-199	I				1		1
Hafnium-181	I						5
H^3 (tritium)	P-CF				3,000		226,898
Indium-114	I						1
Indium-114	P-HSA	L	537	483	19	868	50
Iodine-129	P						0.001 g
Iodine-131	I						33
Iodine-131	P-CF	X, W	CF	140,781*	51,959	823,577	497,092
Iridium-192	P-HSA				34		368
Iridium-194	I						
Iron-55,59	I				6		16
Iron-55,59	P-HSA						45
Iron-55	P-E				26	620	83
Iron-59	P-E	L	3,179	43	49	368.5	323.7
Krypton-85	P-CF	M		3,000	7,800	53,000	10,401
Lanthanum-140	I						7
Manganese-54	P-CF				0.5	49	19.5
Mercury-197	I						2
Mercury-203	I				1		10
Mercury-203	P-CF	W	467	933	154	11,213	667
Molybdenum-99	I				7		26
Neodymium-147	P-CF					19	3
Nickel-63	I				1		5
Nickel-63	P-HSA				7	384	61
Niobium-95	P-CF	W	CF	43	11	214	45
Osmium-191	I						2
Palladium-109	I						2
Phosphorus-32	I				13		136
Phosphorus-32	P-HSA	X	40,000	18,049	13,609	146,845	120,251
Phosphorus-32	P-CF	X	CF	77	56	729	302
Potassium-42	I				21		182
Potassium-42	P-HSA	L	195	109.5	34	591.5	233
Praseodymium-142	I						
Praseodymium-143	P-CF						
Promethium-147	I						1
Promethium-147	P-CF	S	CF	986	52	4,834	5,590
Rhenium-186	I						4
Rubidium-86	I				2		35
Ruthenium-97	I						
Ruthenium-103	P-CF	W	CF	76	8	1,020	202
Ruthenium-106	P-CF				36		350
Samarium-153	I				1		2
Scandium-46	I						
Scandium-46	P-HSA				20	14,385	129
Selenium-75	I						
Selenium-75	P-HSA				1	2,160	358

* 30,750 mc was made for production of Xe^{131} for Physics Division.

TABLE 3 (continued)
RADIOISOTOPE PRODUCTION AND SALES

Product	Type	Source	Specific Activity	This Month		Year to Date	
				Produced	Sold	Produced	Sold
Silver-110	I						1
Silver-110	P-HSA				233	2,301	609
Silver-111	I				2		25
Silver-111	P-CF						
Sodium-22	P-HSA				0.5	27.2	23.5
Sodium-22	P-CF						30.5
Sodium-24	I				17		203
Sodium-24	P-HSA	L	1,333	585	238	7,784.5	1,088
Strontium-85	P-CF				1.9	7.5	11.9
Strontium-89	I						3
Strontium-89	P-CF				157	1,810	1,182
Strontium-90	P-CF				11,057		110,894
Sulfur-35	I						2
Sulfur-35	P-CF (SO_4^{--})				463	50,026	11,396
Sulfur-35	P-HSA (sulfide)				12	3,225	218
Sulfur-35	P-HSA (element)				30	3,500	583
Tantalum-182	I						
Tantalum-182	P-HSA				5	553	73
Technetium-99	I						
Technetium-99	P						1.2
Thallium-204	I						1
Thallium-204	P-HSA				858		1,694
Tin-113	P-HSA					39	116
Tungsten-185	I						
Tungsten-185	P-HSA					540	76
Tungsten-187	I						1
Yttrium-90	I				5		7
Yttrium-91	P-CF				7	1,231	199
Zinc-65	I						1
Zinc-65	P-HSA				163		1,559
Zinc-65	P-CF					49	11
Zirconium-95	I						6
Zirconium-95	P-CF	W	CF	1,521		3,990	913
Chromium-51	P-E					83	65
Service Irradiations					39		580
Carbon-14 Sheets							30
C^{14} Labelled Compounds							187
Gold-198	P-HSA	L	5,261	555	50	555	55
TOTALS	Processed Material, mc			173,221.8	96,179.9	1,248,118.7	1,032,260.3
	Irradiated Material, units				161		1,472
	Service Irradiations				39		580

TABLE 4
RADIOISOTOPE PRODUCTION AND SALES – SOURCES AND MISCELLANEOUS PRODUCTS

Period 9-1-55 to 9-30-55

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

Product	Type	Number of Sources	Use	Size of Sources		Sales	
				Minimum	Maximum	Month	Year
Antimony-beryllium	Neutron	1		3.5 c	3.5 c	3.5 c	18.5 c
Cesium-137	CF		T				1,501 c
Cesium-137	CF	53	R	1 μc	63 c	143.8 c	463.8 c
Cesium-137	CF		IR				
Cobalt-60	VHSA	1	T	1,477 c	1,477 c	1,477 c	8,161 c
Cobalt-60	HSA		T				2,027 c
Cobalt-60	MSA	1	T	612.9 c	612.9 c	652 c	2,903 c
Cobalt-60	HSA		R				
Cobalt-60	MSA	1	R	22.31 c	22.31 c	22.31 c	64.31 c
Cobalt-60	LSA	6	R	5 mc	2,330 c	2,330.7 c	4,888.7 c
Cobalt-60	HSA		IR				413 c
Cobalt-60	MSA		IR				
Cobalt-60	LSA		IR				5,634 c
Iridium-192	HSA		R				
Iridium-192	MSA	20	R	5 c	120 c	340.95 c	2,310.95 c
Iron-55	HSA						481 mc
Phosphorus-32	Plaques, 1 in.		IR				
Phosphorus-32	Plaques, 3 in.		IR				
Strontium-90	CF		IR				9 c
Tritium-zirconium	Evaporated target	1		2.47 c	2.47 c	2.47 c	18.17 c
Tritium-zirconium	Fused target						24 c
Cobalt-60	LSA		T				847 c
Helium	Ampoules	3	Low	100 cc	1,000 cc	1,200 cc	2,445 cc
Tritium	Ampoules	1		3 c	3 c	3 c	**
Deuterium	Fused Targets						5.8 cc
Argon-37	Ampoules						**

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

**See Table 3.

TABLE 4-A

COBALT-60 SOURCE PRODUCTION AND SALES

SIZE	GRADE	INVENTORY CURIES	INVENTORY PIECES	PRODUCTION RATE C/g/Month	PRODUCTION CURIES This Month	ORDERS FILLED	ORDERS ON FILE	CURIES FILLED	CURIES ON FILE
1/16" X 1/16"	10-25	505	978	2.5	37.5	0	0	0	0
1/8" X 1/8"	1-10	9,728	9,911	2.5	445	0	3	0	8,833
	10-25	132	319	0	0	3	0	23	0
1/8" X 1/4"	1-10	6,125	3,656	0	0	1	2	2,330	4,448
1/8" X 1/2"	1-10	10	3	0	0	0	0	0	0
1 cm X 1 cm	1-10	6,576	123	0	0	0	4	0	4,500
	10-25	0	0	2.5	9,450	0	0	0	0
1 cm X 2 mm	1-10	6,784	589	0	0	0	6	0	8,330
	10-25	7,070	336	1.5	450	1	12	613	9,995
1 cm X 1 mm	10-25	0	0	1.5	600	0	0	0	0
	25-40	0	0	1.5	530	0	22	0	13,400
2 cm X 1 mm	10-25	0	0	1.5	1,494	0	0	0	0
	25-40	2,548	42	0	0	0	2	0	2,100
	> 40	13,832	87	2.2	2,880	1	34	1,477	51,800
Sub-Totals:	1-10	29,223	14,282						
	10-25	7,707	1,633						
	25-40	2,548	42						
	> 40	13,832	87						
Total		53,310	16,044						

NOTE: Holding 10,003 curies in container for General Electric Company.
Holding in container 1000 curies which was refused by Fort McClellan.

TABLE 5

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

Period 9-1-55 to 9-30-55

	This Month	Last Month	Year to Date	Total Last Year
Water through settling basin, gal	16,430,000	17,800,000	147,030,000	158,200,000
Activity through settling basin, curies	15.9	12.7	145.8	237.3
Water through retention pond, gal	690,000	620,000	6,180,000	6,090,000
Activity through retention pond, curies	2.9	4.0	18.0	17.2
Waste to lagoons, gal	158,000*	150,000	1,352,000	997,000
Activity to lagoons, curies	1,135	841	18,082	7,224
Total activity in lagoons 2 and 3, curies	33,975	32,840	33,975	15,893
Demineralized water produced, gal	377,600	395,000	3,396,560	4,416,250
Liquid hydrogen produced, liters	1	17	81.1	135
Shift services for research division, man-hours	360	396	3,400	
Equipment decontamination services, man-hours	228	270	2,384	
Activation analyses completed	3	1	33	31
SF and special material receipts, number of lots	33	43	319	338
SF and special material shipped, number of lots	38	50	395	480
Number of research issuances	0**	0**	19	62
Materials requests issued	6	12	104	196
SF and special materials reports issued	10	9	78	95
Internal audits and surveys	7	8	113	97

*Not included in this figure is 1500 gallons of non-radioactive waste which was transferred from the Unit Operations Section of the Chemical Technology Division to waste pit No. 1.

**Discontinued.

The replacement of corroded water pipes under the Radioisotope Area stack pad has been completed.

The annual inspection of the five cell-ventilation fans at the stack area was performed this month. The housing and impellers of the 60,000 and 40,000 cfm electrically-driven fans and the 60,000 cfm steam-driven fan will have to be painted as soon as decontamination can be performed.

WATER DEMINERALIZATION

The No. 2 anion column was opened and the resin bed found to be approximately 7 inches low. New resin was added to bring the level back to approximately 22 cubic feet and the unit is now operating extremely well.

A study has been made of the most economical way of supplying the Research Reactor with approximately 200,000 gallons of demineralized water during initial operation. The possibility was considered of adding new anion columns which would have a capacity of 100,000 to 150,000 gallons instead of 40,000 to 50,000 gallons in the present columns. The larger columns would permit flow rates of 50 gpm per unit and enable the Research Reactor water system to be filled in approximately one and one-half days. However, new columns cost approximately $12,000 plus installation costs, so it now appears that it would be more economical to buy about $2,000 of new resin for the present columns and take a slightly longer time to fill the water system.

HYDROGEN LIQUEFACTION

Only one run of the hydrogen liquefier was required during September, and one liter was produced without incident.

Since the present liquefier has failed several times, due to leaks requiring repairs of several weeks' duration, it has been proposed that a spare liquefier be obtained. Several concerns that manufacture such equipment have been asked for the specifications of a small liquefier, but none has been found which has a capacity of less than 5 liters per hour. The prices quoted range from $17,000 to $30,000, whereas the present liquefier, with a capacity of about one liter per hour, costs approximately $3,000 to build at ORNL. No decision has been reached regarding the necessity of obtaining a spare.

APPENDIX

OPERATIONS DIVISION
REPORT FOR SEPTEMBER 1955

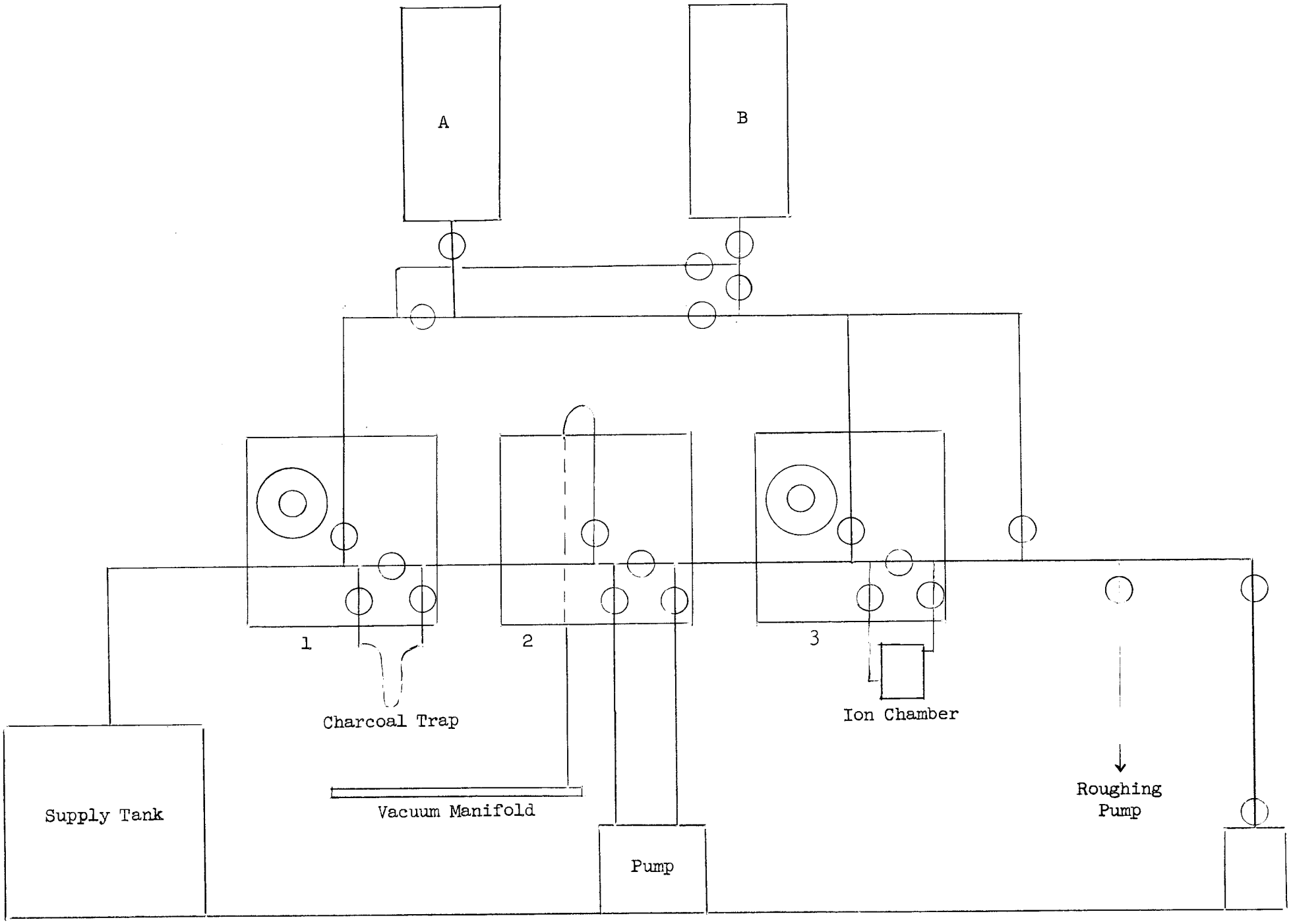
EQUIPMENT FOR HANDLING, MEASURING AND PACKAGING HELIUM-3

B. J. Massey

The helium-3 system shown in the accompanying schematic diagram was built during the month of September at an estimated cost of $500. The design of this system departs from that of previous gas systems in two features: (a) the inclusion of a "Frigidaire" 1/9 H.P. sealed pump to eliminate the mercury-displacement pumps previously used; (b) the use of valves and instruments are mounted on "standard" panels. In using the Frigidaire pump the gas is forced through oil, but for helium this is not objectionable. Some gas is left in the exhaust side of the pump, which will be used as supplementary storage. Three "standard" panels are incorporated in this system, as shown in the schematic diagram.

All valves indicated on the diagram are HGP replaceable bellows-type. The pressure is measured by null-point-diaphragm instruments. For simplicity, instrument service lines are not included in the diagram.

In operation, containers holding the helium-3 supply are attached to the system, using a compression fitting, as shown. The system is "roughed" down by going straight through the panels to the roughing pump, then is "finished" on the vacuum-manifold. The helium in the supply container is pumped through the activated-charcoal trap held at -195° C. The tritium content is analyzed as the gas goes through the ion chamber to storage tank "A" or "B". If a lower tritium content is required, the gas may be moved through the charcoal trap and ion-chamber again, and into the other storage tank. The gas may be packaged from either storage tank by pumping it into a shipping container which is soft-soldered to the system.

During actual operation two faults were discovered, but can be corrected. The Frigidaire pump can lower the pressure in the supply container to only 5 mm; since the volume of this container is 11 liters, this corresponds to 75 cc S.T.P., an appreciable loss. The other defect is that as the pressures approach atmospheric, the null-point diaphragms become inoperable. However, a Bourdon pressure gauge could be used for pressures above 50 cm with an error of only 0.5% even if not calibrated, which can be tolerated in routine packaging.

HELIUM-3 PACKAGING SYSTEM