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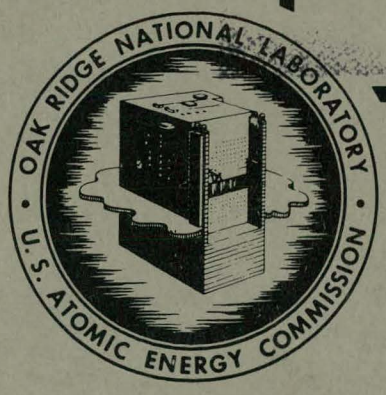
CAPITAL AND DIRECT AND INDIRECT OPERATING COST ESTIMATES FOR MILL FOR RECOVERING URANIUM FROM LOW-GRADE ORE WITH THE HIGGINS CONTINUOUS ION EXCHANGE CONTACTOR



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CAPITAL AND DIRECT AND INDIRECT OPERATING COST ESTIMATES FOR MILL FOR RECOVERING URANIUM FROM LOW-GRADE ORE WITH THE HIGGINS CONTINUOUS ION EXCHANGE CONTACTOR

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October 27, 1955

CONTENTS

Tables

Tables, Continued

Figures

0.0 ABSTRACT

The capital and direct and indirect operating costs were estimated for erecting and operating mills of 220 and 440 tons of ore per day capacity. The ores considered contained 0.15 or 0.30% uranium. The processes considered included crushing, grinding, acid or carbonate leaching, and final recovery of the U_3O_8 in a Higgins ion exchange contactor with a 5 M NaCl, 1 M NaCl, 1 M NH_4NO_3, or 1 M $NaHCO_3$ strip.

It is felt that all phases of this preliminary cost estimate have been given due and careful consideration with reference to requirements for a mill of this type. Further detailed information with reference to the construction and operation characteristics of the Higgins ion exchange contactor are given in ORNL reports 1907 and 1918.

1.0 INTRODUCTION

This preliminary estimate includes necessary capital and direct and indirect operating expense for the erection and operation of a mill to process uranium ore and to package the U_3O_8.

1.1 Base Case

The processing of 220 tons of ore per day, assaying 0.30% U_3O_8, by crushing and grinding, acid leaching, and final recovery of 1,252 lb of U_3O_8 with the Higgins ion exchange contactor using 5 M NaCl strip (see Fig. 2).

1.2 Alternate No. 1

Same as base case except that 1 M NaCl is used as the strip (see Fig. 3).

1.3 Alternate No. 2

Same as base case except that 1 M NH_4NO_3 is used as the strip (see Fig. 4).

1.4 Alternate No. 3A

Same as base case except that the ore assays 0.15% U_3O_8, and the final recovery of U_3O_8 is 626 lb (see Fig. 2).

1.5 Alternate No. 3B

Same as Alternate No. 1 except that the ore assay is 0.15% U_3O_8, and the final recovery of U_3O_8 is 626 lb (see Fig. 3).

1.6 Alternate No. 3C

Same as Alternate No. 2 except that the ore assay is 0.15% U_3O_8, and the final recovery of U_3O_8 is 626 lb (see Fig. 4).

1.7 Alternate No. 4

Same as base case except that the mill capacity is 440 tons of ore per day and the final recovery of U_3O_8 is 2,504 lb.

1.8 Alternate No. 5

Same as base case except that a carbonate leach is used instead of an acid leach and a carbonate strip is used in the Higgins ion exchange contactor for the final recovery of 1,228 lb of U_3O_8 (see Fig. 5).

Capital cost estimates for the mill are included in Table 1-A.

Direct operating cost estimates for the mill are included in Table 1-B.

Indirect operating cost estimates for the mill are included in Table 1-C.

2.0 SITE IMPROVEMENT

The site for this mill is assumed to be in the vicinity of Grand Junction, Colorado. It is further assumed that facilities such as railroad siding and ore access road will be acquired by extensions from present and existing facilities to the site.

2.1 Clearing, Grading, and Drainage

Included in this estimate are provisions for minimum clearing, grading, and drainage for the mill area and parking lot.

2.2 Roads and Parking Lot

Included in this estimate are provisions for minimum grading, rolling, and gravel fill for a 40-car parking lot and for roads within the mill area.

2.3 Railroad Spur Track

Included in this estimate are provisions for 800 lineal feet of spur track.

2.4 Tailings Pond

Included in this estimate are provisions for a tailings pond with an earth dam, and overflow weir, outside and adjacent to the mill area.

Estimated construction costs for items under Site Improvement are shown in Tables 1 and 2. The proposed mill layout showing buildings, roads, and other items is included in Fig. 1.

3.0 GENERAL FACILITY ITEMS

Included in this estimate are the necessary buildings with equipment, fire protection system, and security and safety equipment for the mill.

3.1 Buildings and Equipment

Buildings for utilities and services, crushing and grinding operation, process, shop facilities, laboratory, and warehouse include concrete foundations and flooring, structural steel, galvanized corrugated siding and roofing, inner linings, doors, windows, stairways, platforms, ventilators, lighting and sanitary facilities, and heating where necessary.

The administration building is of frame construction and includes brick front, concrete floors, sanitary facilities, lighting, and heating.

An allowance for building equipment thought to be adequate is included in this estimate for shop, laboratory, administration, and warehouse buildings.

3.2 Fire Protection

The fire protection system includes a 50,000-gal tank elevated to 40 ft above the tallest building roof, necessary piping, hydrants, hoses, etc.

3.3 Security Equipment

The security equipment includes a suitable frame guard house and a 6-ft-high cyclone wire fence with three strands of barbed wire at the top, around the entire mill area.

3.4 Safety Equipment

This item includes the necessary first aid boxes, stretchers, respirators, etc. Estimated construction costs for items under General Facility Items are shown in Tables 3 and 4.

4.0 MOBILE EQUIPMENT

Included in this estimate are a 1-1/2-ton pickup truck, a bulldozer, and a three-wheeled ore loader. Estimated cost for items under Mobile Equipment are shown in Tables 5 and 6.

5.0 UTILITIES AND SERVICES

Included in this estimate are a boiler-burner unit for generation of steam; an insulated tank, heater, and pumps for fuel oil storage and handling; a demineralized water system for boiler feed water; a compressed air system for the mill; a 500-kva substation and switch gear enclosed with necessary fencing; a sewage disposal system, including septic tanks, diversion boxes, disposal fields, manholes, and necessary piping; and water main, steam, air, and condensate lines and waste line to the tailings pond. Estimated construction costs for items under Utilities and Services are shown in Tables 7 and 8.

6.0 PROCESS DESCRIPTION

The processing steps for crushing and grinding, leaching (acid or carbonate), final recovery of U_3O_8 by ion exchange with the Higgins ion exchange contactor, using either 5 M NaCl, 1 M NaCl, 1 M NH_4NO_3 or 1 M $NaHCO_3$ strip, and packaging of the product is described in detail in this section. This process has been found to yield good uranium extraction, with a variety of ores, with only minor adjustment of processing conditions. For these reasons this process is believed to be completely feasible and to represent an adequate system for the purpose of this cost estimate. For this mill design, it was assumed that ore would be sampled at a buying and sampling station before delivery to the mill.

6.1 Crushing and Grinding

Sampled ore is delivered to the mill by rail or truck and dumped on a pad adjacent to the mill building. Ore is fed from this pad with an ore loader through a grizzley to the primary jaw crusher by a vibrating feeder. Any oversize or frozen ore is reduced to a 2-in. maximum size by the jaw crusher and conveyed to the intermediate storage bin by a belt conveyor. Crushed ore from the intermediate storage bin is fed to an impactor to reduce the ore to 0.5-in. rod mill feed. Ore discharged from the impactor is screened on a vibrating screen operating in closed circuit with the impactor. Oversize ore from the screen is returned to the impactor. Undersize ore from the screen

is conveyed to the rod mill storage bins. Operations to this point are designed on a one-shift-per-day basis. The rest of the processing steps are based on continuous 24-hr-per-day operation.

Rod mill feed ore is metered from the storage bin by vibrating feeders to a conveyor belt which discharges into an Aikens classifier operated in closed circuit with the rod mill. The ore feed rate is controlled with the vibrating feeders and recorded by a weightometer mounted on the feed conveyor belt. The rod mill and classifier are operated to produce an overflow pulp containing 50% by weight of -28 mesh solids. Automatic sampling equipment is included for continuously sampling the classifier overflow.

The crushing section of the mill designed for carbonate leach of uranium ore is similar to the crushing section for acid leach process. The only modification necessary is to increase the size and capacity of the rod mill to produce a pulp containing -100 mesh solids. The finer grind is necessary because the carbonate leach liquor does not release and dissolve the uranium values as readily as does sulfuric acid.

Estimated construction cost of equipment for crushing and grinding is shown in Tables 9 and 10.

6.2 Acid Leaching and Sand-Slime Separation

Pulp from the grinding circuit is pumped to the first of three agitated digestion tanks in which sulfuric acid is added to dissolve the uranium values. The digestion tanks are arranged for series pulp flow to provide the required retention and reaction time. Equipment is provided for feeding iron or manganese oxide to the first digestion tank if it is necessary to adjust the solution electromotive force for good ion exchange operation.

Overflow pulp from the digestion system is pumped to the first of four countercurrent sand-slime separation and sand washing drag classifiers operating in series. Water-washed sand from the classifiers is pumped to the tailings neutralization and disposal system. Overflow pulp from the first classifier, containing the soluble uranium values, is pumped through a DorrClone, to remove all solids greater than 300 mesh in size, and to the pregnant feed storage tanks. Oversize solids discharged from the Dorrclone flow to the second of the spiral classifiers.

Estimated construction cost of equipment for acid leaching and sand-slime separation is shown in Tables 11 and 12.

6.3 Carbonate Leaching and Sand-Slime Separation

The flow system for carbonate leach and sand-slime separation is described below. As this process has not been investigated thoroughly in pilot plant operation, some modifications could be expected before commercial use would be possible.

Leaching. Ore is ground in a carbonate solution to produce a pulp containing 25% weight of -100 mesh solids. The carbonate feed liquor used contains approximately 50 g of Na_2CO_3 and 20 g of $NaHCO_3$ per liter. The ground pulp is thickened to 50% solids and pumped to the first of four pachuca tanks. Overflow liquor from the thickener is recycled to the rod mill. The temperature in the tanks is 170°F and the pressure is atmospheric during leaching. Air is pumped to each tank to agitate the pulp and supply the oxygen necessary for the reaction. Residence time in the tanks will depend on the ore treated; in this case 100 hrs residence time has been assumed.

Reagent Recovery and Sand-Slime Separation. Leached pulp flows from the pachuca tanks to the first of two countercurrent decantation thickeners. These thickeners are used to partially recover the reagents in the pulp liquor. A dilution ratio of 1/1 is used. Washed pulp from the second thickener, which contains approximately 33% of the reagent present in the feed to the CCD system, is pumped to the sand-slime separation drags. Overflow liquor from the thickener is pumped to a solution makeup tank where it is brought to strength with sodium carbonate and sodium bicarbonate and recycled.

Four countercurrent sand-slime separation drags are used to separate the -200 mesh solids from the remaining sands. The diluted -200 mesh pulp from the drags is pumped through a DorrClone to separate out the +300, -200 mesh solids. The final feed pulp contains weight 10% -300 mesh solids, approximately 7.2 g of Na_2CO_3 per liter and 2.9 g of $NaHCO_3$ per liter. This pulp is pumped to the pregnant liquor storage and feed tank.

Estimated construction cost of equipment for carbonate leaching and sand-slime separation is shown in Table 13.

6.4 The Higgins Ion Exchange Contactor

The leached and desanded pulp enters the loading section of the contactor, the uranium is sorbed, and the barren pulp is discarded. The uranium-loaded

resin feeds into the strip section and countercurrently meets a flow of strip solution.

With 5 M NaCl Strip. With 5 M NaCl strip, the sulfate is eluted and the uranium is left on the resin and subsequently eluted with water as UO_2Cl_2. The UO_2Cl_2 product is precipitated by adding MgO, and the resulting diuranate cake is filtered and water-washed. The wet cake is removed from the filter press in pans, and is dried to cake for packaging.

To the 5 M NaCl, containing sulfate, is added $CaCl_2$. $CaSO_4$ is precipitated and the 5 M NaCl is recycled. The $CaSO_4$ is filtered or centrifuged and added as a pulp to the incoming pregnant pulp.

Estimated construction costs of the Higgins ion exchange contactor and other equipment for use with 5 M NaCl strip are shown in Tables 14 and 15.

With 1 M NaCl Strip. When the strip is 1 M NaCl-0.1 M H_2SO_4, both sulfate and uranium are eluted and transferred to a precipitate tank. MgO is added to neutralize the acid, and the resulting diuranate cake is filtered. The wet cake is transferred to drying trays and afterwards packaged. The diuranate cake supernatant, NaCl solution containing sulfate, is discarded.

Estimated construction costs of the Higgins ion exchange contactor and other equipment for use with 1 M NaCl strip are shown in Table 16.

With 1 M NH_4NO_3 Strip. When the strip is of 1 M NH_4NO_3--0.1 NH_2SO_4, both sulfate and uranium are eluted and transferred to a precipitate tank. MgO is added to neutralize the acid and the resulting diuranate cake is filtered. The wet cake is transferred to drying trays, and afterwards packaged. The diuranate cake supernatant containing NH_4NO_3 is discarded or recycled.

Estimated construction costs of the Higgins ion exchange contactor and other equipment for use with 1 M NH_4NO_3 strip are shown in Table 17.

With 1 M $NaHCO_3$ Strip. When the strip is of 1 M $NaHCO_3$, the uranium is eluted, and then precipitated by adding NaOH. The diuranate cake is filtered, washed, dried, and packaged. It is possible for the $NaOH \cdot Na_2CO_3$ supernatant to be reconverted to $Na_2CO_3 \cdot NaHCO_3$ by adding CO_2 from boiler stack gases, which may be used for further leaching. but this is not done

Estimated construction costs of the Higgins ion exchange contactor and other equipment for use with the 1 M $NaHCO_3$ strip are shown in Table 18.

7.0 DRYING AND PACKAGING OF PRODUCT

Wet filter cake is removed from the filter press and placed in shallow pans or other suitable containers for drying on a steam table. After being sufficiently dried, the cake is placed in steel drums, weighed, and made ready for shipment.

Estimated construction costs of drying and packaging equipment are shown in Tables 21 and 22. A schematic outline of this phase of the process is shown in Fig. 6.

8.0 ACKNOWLEDGMENT

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Table 1-A

Capital Cost Estimates

Item	Description	Base	Alt. No. 1	Alt. No. 2	Alt. No. 3A	Alt. No. 3B	Alt. No. 3C	Table	Alt. No. 4	Table	Alt. No. 5	Table
A.	Process											
	1. Type	acid	acid	acid	acid	acid	acid	—	acid	—	carbonate	—
	2. Tons ore/operating day	220	220	220	220	220	220	—	440	—	220	—
	3. % U_3O_8 in ore	0.30	0.30	0.30	0.15	0.15	0.15	—	0.30	—	0.30	—
	4. Lbs U_3O_8/operating day	1,252	1,252	1,252	626	626	626	—	2,504	—	1,228	—
B.	Type elution											
	1. 5 M NaCl	Yes	—	—	Yes	—	—	—	Yes	—	—	—
	2. 1 M NaCl	—	Yes	—	—	Yes	—	—	—	—	—	—
	3. NH_4NO_3	—	—	Yes	—	—	Yes	—	—	—	—	—
	4. Carbonate system	—	—	—	—	—	—	—	—	—	Yes	—
C.	Capital Costs											
	1. Site improvement	40,110	40,110	40,110	40,110	40,110	40,110	1	56,955	2	40,110[1]	1
	2. General facility items	638,340	638,340	638,340	638,340	638,340	638,340	3	966,570	4	638,340	3
	3. Mobile equipment	10,000	10,000	10,000	10,000	10,000	10,000	5	12,000	6	10,000	5
	4. Utilities and services	69,675	69,675	69,675	69,675	69,675	69,675	7	105,500	8	89,675	7
	5. Crushing and grinding	259,670	259,670	259,670	259,670	259,670	259,670	9	332,500	10	259,670	9
	6. Acid leaching	183,320	183,320	183,320	183,320	183,320	183,320	11	260,000	12	371,085	13
	7. Carbonate leaching	—	—	—	—	—	—	—	—	—	—	—
	8. Higgins - 5M NaCl strip	96,400	—	—	96,400	—	—	14	196,090	15	—	—
	9. Higgins - 1M NaCl strip	—	81,360	—	—	81,360	—	16	—	—	—	—
	10. Higgins - NH_4NO_3 strip	—	—	99,365	—	—	99,365	17	—	—	68,730	18
	11. Higgins - carbonate strip	—	—	—	—	—	—	—	—	—	—	—
	12. Resin for Higgins contactor	20,025	20,025	20,025	20,025	20,025	20,025	19	40,050	20	20,025	19
	13. Drying and packaging	9,370	9,370	9,370	9,370	9,370	9,370	21	9,500	22	9,370	21
D.	Total Mill Cost	$1,326,910	$1,311,870	$1,329,875	$1,326,910	$1,311,870	$1,329,875	—	$1,979,165	—	$1,507,005	—

1 Does not include cost of land.

Table 1-B

Direct Operating Cost Estimates

		Base	Alt. No. 1	Alt. No. 2	Alt. No. 3A	Alt. No. 3B	Alt. No. 3C	Table	Alt. No. 4	Table	Alt. No. 5	Table
A.	Crushing and grinding	$ 408.42	$ 408.42	$ 408.42	$ 408.42	$ 408.42	$ 408.42	23	$ 565.84	24	$ 408.42	23
B.	Acid leaching	883.13	883.13	883.13	883.13	883.13	883.13	25	1,424.78	26	———	—
C.	Carbonate leaching	———	———	———	———	———	———	—	———	—	1,068.89	27
D.	Higgins - 5 M NaCl strip	318.97	———	———	———	———	———	28	591.49	30	———	—
		———	———	———	292.09	———	———	29	———	—	———	—
E.	Higgins - 1 M NaCl strip	———	330.47	———	———	———	———	31	———	—	———	—
		———	———	———	———	291.24	———	32	———	—	———	—
F.	Higgins - NH_4NO_3 strip	———	———	419.26	———	———	———	33	———	—	———	—
		———	———	———	———	———	343.54	34	———	—	———	—
G.	Higgins - carbonate strip	———	———	———	———	———	———	—	———	—	474.88	35
H.	Drying and packaging	28.24	28.24	28.24	———	———	———	36	48.34	38	28.24	36
		———	———	———	18.24	18.24	18.24	37	———	—	———	--
	Summary:											
	1 Cost per Operating Day	$ 1,638.76	$ 1,650.26	$1,709.05	$1,581.88	$1,601.03	$1,653.33		$2,630.45		$1,980.43	
	2 Cost per ton of ore	7.45	7.50	7.77	7.19	7.28	7.52		5.98		9.00	
	3 Cost per lb U_3O_8 recovered	1.3089	1.3180	1.3650	2.5269	2.5575	2.6411		1.0504		1.6127	

Table 1-C

Indirect Operating Cost Estimates

		Base	Alt. No. 1	Alt. No. 2	Alt. No. 3A	Alt. No. 3B	Alt. No. 3C	Table	Alt. No. 4	Table	Alt. No. 5	Table
A.	Labor											
	1. Supervision, clerical, security, etc.	348.00	348.00	348.00	348.00	348.00	348.00	39	348.00	39	348.00	39
	2. Maintenance overhead	66.00	66.00	66.00	66.00	66.00	66.00	40	88.00	40	66.00	40
B.	Supplies											
	1. Water treatment	.32	.32	.32	.32	.32	.32	43	.64	43	.32	43
	2. Clerical, supervisory, security, safety and health, etc.	7.58	7.58	7.58	7.58	7.58	7.58	43	7.58	43	7.58	43
	3. Maintenance supplies for general facilities	66.00	66.00	66.00	66.00	66.00	66.00	41	88.00	41	66.00	41
C.	Utilities											
	1. Electricity	9.55	9.55	9.55	9.55	9.55	9.55	43	15.00	43	9.55	43
	2. Water	10.00	10.00	10.00	10.00	10.00	10.00	43	20.00	43	10.00	43
	3. Fuel oil	26.40	26.40	26.40	26.40	26.40	26.40	43	39.60	43	26.40	43
D.	Payroll overhead	131.76	131.54	131.81	131.76	131.54	131.81	42	161.87	42	140.09	42
E.	Taxes and insurance	60.32	59.63	60.45	60.32	59.63	60.45	43	89.96	43	68.50	43
F.	Amortization of general facilities	471.61	471.61	471.61	471.61	471.61	471.61	43	715.80	43	483.73	43
	Summary:											
	1. Cost per operating day	$1,197.54	$1,196.63	$1,197.72	$1,197.54	$1,196.63	$1,197.72	—	$1,574.45	—	$1,226.17	—
	2. Cost per ton of ore	5.443	5.439	5.444	5.443	5.439	5.444	—	3.578	—	5.573	—
	3. Cost per lb U_3O_8 recovered	0.9565	0.9557	0.9566	1.9130	1.9115	1.9132	—	0.6288	—	0.9985	—
	4. Total Direct and Indirect Cost per Operating Day	$2,836.30	$2,846.89	$2,906.77	$2,779.42	$2,797.66	$2,851.05	—	$4,204.90	—	$3,206.60	—
	5. Cost per Ton of Ore	12.89	12.94	13.21	12.63	12.72	12.96	—	9.56	—	14.58	—
	6. Cost per lb U_3O_8 Recovered	$ 2.2654	$ 2.2738	$ 2.3217	$ 4.4399	$ 4.4691	$ 4.5543	—	$ 1.6793	—	$ 2.6112	—

Table 1

Site Improvement for 220 Tons Ore/Day Mill

Item	Description	Unit	Estimated Total Units	Estimated Unit Cost	Estimated Total Cost
1.	Land[1]	acre	--	--	--
2.	Clearing	acre	4±	$ 75.00	300
3.	Grading	yd^3	2550	0.1666	425
4.	Drainage				
	a. 6" terra cotta pipe	ft	1000	1.175	1175
	b. Manhole	manhole	3	200.00	600
5.	Roads and parking lot				
	a. Grade, roll and fill	yd^2	4766	0.1007	480
	b. Gravel fill	yd^2	4766	1.6785	8000
6.	Railroad spur	ft	800	16.75	13400
7.	Tailings pond and waste disposal				
	a. Earth dam	dam	--	--	5000
	b. Overflow weir	weir	--	--	750
A.	Total Direct Cost for Site Improvement Items				$ 30,130
B.	Engineering and Field Expense (10% of A)				3,015
C.	Contingencies (10% of (A+B))				3,315
D.	Contractors Fee and Overhead (10% of (A+B+C))				3,650
E.	Total Construction Cost				$ 40,110

1 - Cost of land not included

Table 2

Site Improvement for 440 Tons Ore/Day Mill

A.	Total direct cost of site improvement for 220 tons ore/day mill	$ 30,130	
B.	Factor from cost comparison to raise site improvement		
	Items from 220 tons ore/day to 440 tons ore/day by 1.42		$ 42,785
C.	Engineering and field expense (10% of B)		4,280
D.	Contingencies (10% of (B+C))		4,710
E.	Contractors fee and overhead (10% of (B+C+D))		5,180
F.	Total construction cost		$ 56,955

Table 3

General Facility Items for 220 Tons Ore/Day Mill

Item	Description	Estimated Size Required	Floor Area Ft^2	Building Cube Ft^3	Estimated Building Weight	COST				Estimated Allowance for Equipment	Total Cost Building and Equipment	Cost Ft^2 Less Equipment	Cost Ft^3 Less Equipment
						Bare Building	Estimated Freight	Estimated Sanitary Facilities	Complete Building Total				
1.	Utilities and service bldg.[1]	30'x30'x20'	900	18,000	12,600	$ 16,000	$ 505	___	$ 16,505	___	$ 16,505	$ 18.34	$ 0.92
2.	Crushing and grinding bldg.[1]	55'x130'x40'	7,150	286,000	200,200	100,500	8,000	3,000	111,500	___	111,500	15.59	0.39
3.	Process bldg.[1]	60'x100'x30'	6,000	180,000	127,400	76,000	5,040	3,000	84,040	___	84,040	14.01	0.47
4.	Shop facilities bldg.[1-2]	40'x60'x20'	2,400	48,000	33,600	31,000	1,345	3,000	35,345	55,355	90,700	14.73	0.74
5.	Laboratory bldg.[1-3]	40'x50'x10'	2,000	20,000	14,000	17,000	560	3,000	20,560	56,440	77,000	10.28	1.03
6.	Administration bldg.[4]	36'x72'x10'	2,592	25,920	___	___	___	___	13,700	13,700	27,400	5.29	0.53
7.	Warehouse bldg.[1-5]	40'x40'x20'	1,600	32,000	22,400	23,000	895	3,000	26,895	16,105	43,000	16.81	0.84
8.	Fire protection system[6]										20,000		
9.	Security equipment[7]										7,450		
10.	Safety equipment[8]										2,000		
A.	Total Direct Cost of General Facility Items										$479,595		
B.	Engineering and Field Expense (10% of A)										47,960		
C.	Contingencies (10% of (A+B))										52,755		
D.	Contractor's fee and overhead (10% of (A+B+C))										58,030		
E.	Total Construction Cost										$638,340		

1 These items are industrial type steel buildings, including structural steel, excavation, concrete foundations and floorings, galvanized corrugated siding, roofing and innerlinings and platforms, doors, stairways, and ventilators. Weight of the buildings for freight is based on 0.70 pounds per ft^3.

2 This item includes 7-1/2 ton crane, 1 - 8 in. by 16 ft lathe, 1 - 30 in. by 20 ft lathe, 1 - 36 in. radial drill press, 1 - 150 ton hydraulic press, 1 - blacksmith's forge, 1 - bolt threading machine, 2 - 300 amp welding machines, 2 - acetylene welding outfits, 1 - power hacksaw, 1 - 20 in. shaper, 1 - milling machine, 1 - 1/2 in. punch and shear, and 1 - set of electric drills, wrenches, 1 - 1/8 in. to 2 in. pipe threading machine, 1 - 2-1/2 in. to 8 in. pipe threading machine, etc.

3 This item includes equipment necessary for assaying and metallurgical testing, and is similar to laboratory building and equipment recently erected and equipped at Monticello, Utah, for the AEC at a comparable cost to that as shown.

4 This item includes materials and labor for an administration and office building similar to such a building recently erected by the S & M Supply Company, of Grand Junction, Colorado, for the Ordmeyer Mining Company, which included a brick front, two rest rooms, 4-in. reinforced concrete floor, sanitary facilities, heating and lighting at a cost comparable to that as shown. It is felt a like amount as shown is reasonable for office furniture and equipment.

5 This item includes crane, shelving, bins, heating for offices, and office furniture and equipment.

6 This item includes a 50,000 gallon tank elevated to 40 ft above the highest building roof, piping, hydrants, hoses, etc.

7 This item includes 1,490 ft of 6 ft high fencing and gates, with three strands of barbed wire, and suitable guard house.

8 This item includes first air boxes, stretchers, respirators, etc.

Table 4

General Facility Items for 440 Tons Ore/Day Mill

A.	Total direct cost of erected general facility items for 220 tons ore/day mill	$479,595	
B.	Factor from major equipment cost comparison to raise 220 tons ore/day to 440 tons ore/day by 1.5142		$726,200
C.	Engineering and field expense (10% of B)		72,620
D.	Contingencies (10% of (B+C))		79,880
E.	Contractors fee and overhead (10% of (B+C+D))		87,870
F.	Total construction cost		$966,570

Table 5

Mobile Equipment for 220 Tons Ore/Day Mill

Item	Description	Estimated Total Cost
1.	1/2-ton pickup truck	$ 1,700
2.	Bulldozer	5,000
3.	3-wheel ore loader	3,300
	Total Cost at Mill Site	$10,000

Table 6

Mobile Equipment for 440 Tons Ore/Day Mill

Item	Description	Estimated Total Cost
1.	1/2-ton pickup truck	$ 1,700
2.	Bulldozer	6,000
3.	3-wheel ore loader	4,300
	Total Cost at Mill Site	$ 12,000

Table 7

Equipment, Etc., for Utilities and Services for 220 Tons Ore/Day

Item	Description	Total Number Required	Estimated Shipping Weight	Estimated Cost FOB Factory	Estimated Freight Charges	Estimated Special Foundation Cost	Estimated Installation Cost	Estimated Excavation Cost	Estimated Backfill Cost	Estimated Total Installed Cost
B-601	100-horsepower fire tube boiler-burner unit for 100 psi, with stack, fans, and controls (15-horsepower electric motors)	1	20,000	6,600	800	330	4,500	____	____	12,230
F-601	Insulated fuel storage tank, 10,000 gallon capacity	1	10,000	2,700	400	250	370	____	____	3,725
E-601	Fuel oil heater	1	500	300	20	___	30	____	____	350
G-603	Fuel oil unloading pump, with 5-horsepower electric motor, capacity 100 gallons per minute	1	350	550	15	100	30	____	____	695
G-601 G-601A	Fuel oil burner pumps, capacity 2 gallons per minute, with 2-horsepower electric motor each	2	360	560	20	30	____	____	____	610
D-601	Demineralizer for boiler feed water	1	5,000	2,500	200	250	250	____	____	3,200
G-602 F-602	Plant air compressor, after-cooler, air receiver and 10-horsepower electric motor	1	3,000	2,000	120	100	300	____	____	2,520
M-601	Transformer substation, and switch gear capacity 500 KVA	1	10,000	10,400	400	300	900	____	____	12,000
	Sewage Disposal:									
	(a) 8-in. terra cotta line	400 ft	10,000	260	200	___	400	250	150	1,260
	(b) manhole	2	2,000	350	100	___	250	60	10	770
	(c) septic tank	2	12,000	350	240	___	420	625	375	2,010
	Utility and Service Lines:									
	(a) 6-in. cast iron water main (underground)	1,000 ft	26,900	1,880	405	___	1,755	625	375	5,040
	(b) 3-in. steam and 2-in. condensate (insulated and elevated)	300 ft	8,000	1,035	120	___	735	____	____	1,890
	(c) 1-in. compressed air (elevated)	150 ft	250	30	5	___	25	____	____	60
	(d) 3-in. galvanized tailings (on ground surface)	300 ft	2,275	280	45	___	115	____	____	440

Table 7 (continued)

Equipment, Etc., for Utilities and Services for 220 Tons Ore/Day

A.	Total direct cost of installed equipment and facilities	$ 46,800
B.	Other direct costs:	
	1. Piping at 12-1/2% installed cost of boiler, fuel system, air compressor and demineralizer	2,950
	2. Electrical wiring, including lighting and instrumentation at $50 per installed KW	1,150
	3. Instrumentation at 2% installed cost of boiler, fuel system, air compressor and demineralizer	700
	4. Painting and scaffolding at 2% installed cost of all items, except sewage disposal, water main and tailings line	745
C.	Total Direct Cost	$ 52,345
D.	Engineering and field expense (10% of C)	5,235
E.	Contingencies (10% of (C+D))	5,760
F.	Contractor's fee and overhead (10% of (C+D+E))	6,335
G.	Total Construction Cost	$ 69,675[1]

1 Cost of utilities and services for acid system (alternate No. 5) increased by $20,000 to cover additional steam generating facilities.

Table 8

Equipment, Etc. for Utilities and Services for 440 Tons Ore/Day

A.	Total direct cost of installed equipment and services for 220 tons ore/day facility	$52,345	
B.	Factor from major equipment cost comparison to raise 220 tons ore/day to 440 tons ore/day by 1.5142 ($52,345 x 1.5142)		$ 79,260
C.	Engineering and field expense (10% of B)		7,930
D.	Contingencies (10% of (B + C))		8,720
E.	Contractor's fee and overhead (10% of (B + C + D))		9,590
F	Total Construction Cost		$105,500

Table 9

Equipment for Ore Crushing and Grinding for 220 Tons Ore/Day

Item	Description	Total Number Required	Estimated Shipping Weight	Estimated Cost FOB Factory	Estimated Freight Charges	Estimated Special Foundation Cost	Estimated Installation Cost	Estimated Total Installed Cost
C-101	"Syntron" driven ore feeder and Grizzley 50 ton/hr capacity (12 in. maximum size normal) (12 in. maximum size frozen lumps) Feeder size - 24 in. by 60 in. Grizzley size - 36 in.	1 1	3,500	2,030	140	___	$ 400	$ 2,570
M-101	Jaw crusher with 50-horsepower electric motor - 50 tons/hr capacity (12 in. maximum lump size) size 18 in. by 24 in.	1	14,300	8,600	570	430	1,290	10,890
C-102	Belt conveyor from crusher to coarse ore bin, 50 ton/hr capacity (2 in. maximum size) for 18° slope with 5-horsepower electric motor - size 120 ft by 18 in.	1	10,400	6,650	420	___	665	7,735
F-101	Coarse ore bin, capacity 8770 ft^3 size 21 ft- 6 in. by 24 ft - 1-1/2 in.	1	22,000	4,155	880	480	400	5,915
C-103	Ore feeder, capacity 50 tons/hr (2 in. maximum size) with 1-horsepower electric motor, size 10 ft by 30 in.	1	3,250	2,000	140	___	400	2,540
C-104	Belt conveyor from ore bin to compactor, capacity 50 tons/hr (2 in. maximum size) with 5-horsepower electric motor size 120 ft by 18 in.	1	10,400	6,650	420	___	665	7,735
M-102	Impactor, capacity 50 tons/hr, 2 in. maximum size, fresh feed, 50 tons/hr recycle - 2 in. plus 1/2 in. with 150 horsepower electric motor	1	20,025	13,565	800	680	680	15,725
C-105	Belt conveyor to vibrating screen - capacity 100 tons/hr (2 in. maximum size) with 5-horsepower electric motor, size 65 ft by 18 in.	1	7,100	4,850	285	___	485	5,620
M-103	"Syntron" driven vibrating screen - capacity 50 tons/hr - 1/2 in. size, 50 tons/hr plus 1/2 - 2 in. recycle. Size 5 ft by 10 ft enclosed screen, 1 deck	1	1,050	3,200	40	___	160	3,400
C-106	Oversize return conveyor, capacity 50 tons/hr plus 1/2 in. - 2 in. recycle, for 18° slope, with 3-horsepower electric motor, size 65 ft by 16 in.	1	6,900	4,700	275	___	470	5,445

Table 9 (continued)

Equipment for Ore Crushing and Grinding for 220 Tons Ore/Day

Item	Description	Total Number Required	Estimated Shipping Weight	Estimated Cost FOB Factory	Estimated Freight Charges	Estimated Special Foundation Cost	Estimated Installation Cost	Estimated Total Installed Cost
C-107	Crushed ore conveyor - capacity 50 tons/hr 1/2 in., with 3-horsepower electric motor, size 80 ft by 18 in.	1	7,700	5,100	310	___	510	5,920
C-108	Crushed ore transfer conveyor - capacity 50 tons/hr - 1/2 in. with 2-horsepower electric motor, size 40 ft by 18 in.	1	5,200	3,700	210	___	370	4,280
C-109	Bin feed conveyor and tripper, capacity 50 tons/hr - 1/2 in., with 2-horsepower electric motor, size 30 ft by 16 in. (conveyor)	1	5,200	3,700	210	___	370	4,280
	Tripper	1	2,800	3,650	110	___	180	3,940
F-102 F-103	Crushed ore storage bins, (for 72-hrs operation) capacity 8770 ft3 each size 21 ft-6 in. by 24 ft-1-1/2 in. each	2	44,000	8,310	1,760	960	800	11,830
C-110 C-111	"Syntron" driven vibrating feeders, capacity 10 tons/hr - 1/2 in.	2	1,000	800	40	___	160	1,000
C-112	Conveyor to rod mill, capacity 10 tons/hr 1/2 in., with 2-horsepower electric motor, size 40 ft by 18 in.	1	5,200	3,700	210	___	370	4,280
M-104	Weightometer, capacity 10 tons/hr	1	1,500	3,500	60	175	175	3,910
M-105	Automatic ore sampler	1	400	575	15	___	25	615
M-106	Rod mill, capacity 10 tons/hr fresh feed, 1/2 in., 5 tons/hr recycle and 10 tons/hr water, size 4 ft by 10 in., with 60-horsepower electric motor	1	*65,950	15,900	2,625	1,590	2,385	22,500
M-107	Aikens classifier, sand raking capacity 5 tons/hr, overflow capacity 10 tons/hr, 50% pulp, overflow solids 28 mesh, with 5-horsepower electric motor, size 48 in. Simplex	1	14,420	6,400	580	320	960	8,260
M-108	Automatic classifier, overflow sampler and timer, with 1/4-horsepower electric motor	1	400	575	15	___	25	615

*Includes 32,100 pounds of rod.

Table 9 (continued)

Equipment for Ore Crushing and Grinding for 220 Tons Ore/Day

Item	Description	Total Number Required	Estimated Shipping Weight	Estimated Cost FOB Factory	Estimated Freight Charges	Estimated Special Foundation Cost	Estimated Installation Cost	Estimated Total Installed Cost
F-104 F-105	Wilfley 4 ft by 4 ft steel pump sump, and agitator combination, with 1-1/2 horsepower electric motor	1	1,100	560	45	___	100	705
G-101 G-101S	Wilfley sand pump, capacity 51 gpm, 50% solids pulp, with 1-1/2-horsepower electric motor	2	900	1,600	40	___	80	1,720
G-102	Dust collection system, including ducts, fan, cyclone, 15-horsepower electric motor and controls for items C-101, M-101, C-102, F-101, C-103, C-104, M-102, C-105, C-106, M-103, C-107, C-108, C-109, C-110, and C-111	1	19,000	9,000	760	___	1,700	11,460
	Floor Spill Recovery System Consisting of:							
F-105 A-102	Steel floor sump tank, size 7 ft by 7 ft by 6 ft and agitator with 5-horsepower electric motor	1	3,000	4,500	120	___	450	5,070
G-103	Wilfley sump pump with 10-horsepower electric motor	1	520	910	20	___	45	975
M-109	Crusher maintenance hoist, capacity 2 tons, electrically operated	1	1,000	2,000	40	___	100	2,140
___	Steel plate for ore chutes, Grizzlies, etc.		10,000	5,000	400	___	500	5,900
___	Spare parts for crusher			2,000				2,000
A.	Total direct cost of installed process equipment							$168,975
B.	Other direct costs:							
	1. Process piping (5% of A)							8,450
	2. Electrical wiring, including lighting and instrumentation at $50 per installed KW							12,600
	3. Instrumentation (1% of A)							1,690
	4. Painting and scaffolding (2% of A)							3,380
C.	Total Direct Cost							$195,095
D.	Engineering and field expense (10% of C)							19,510
E.	Contingencies (10% of (C+D))							21,460
F.	Contractor's fee and overhead (10% of (C+D+E))							23,605
G.	Total Construction Cost							$259,670

Table 10

Equipment for Ore Crushing and Grinding for 440 Tons Ore/Day

A.	Total direct cost of installed process equipment, process piping, electrical wiring, instrumentation, painting and scaffolding for 220 tons ore/day facility	$195,095	
B.	Factor from major equipment cost comparison to raise 220 tons ore/day to 440 tons ore/day by 1.28		$250,000
C.	Engineering and field expense (10% of B)		25,000
D.	Contingencies (10% of (B+C))		27,500
E.	Contractor's fee and overhead (10% of (B+C+D))		30,000
F.	Total Construction Cost		$332,500

Table 11

Equipment For Leaching (Acid Process) 220 Tons Ore/Day

Item	Description	Total Number Required	Estimated Shipping Weight	Estimated Cost FOB Factory	Estimated Freight Charges	Estimated Special Foundation Cost	Estimated Installation Cost	Estimated Total Installed Cost
D-201 D-202 D-203 A-201 A-202 A-203	20,000 gallon open top wood digestion tank and agitator combination, tank size 16 ft diameter by 16 ft high, agitator equipped with 15-horsepower electric motor	3	42,360	12,825	1,695	645	1,920	$ 17,085
G-201 G-201S	Pulp pump (Wilfley AF), capacity 51 gallons per minute, 30 ft head, electric motor 1-1/2 horsepower	2	1,040	1,820	40	___	90	1,950
M-201 M-202 M-203 M-204	Stainless steel classifier size 6 ft by 24 ft with 2-horsepower electric motor	4	18,000	27,000	720	___	4,040	31,760
G-202 G-203 G-204 G-202S G-203S G-204S	Classifier wash pump, with 3-horsepower electric motor, capacity 50 gallons per minute, 30 ft head (100 gallons per minute maximum)	6	3,120	5,460	120	___	270	5,850
C-201 C-202	Reagent feeder, with 1/2-horsepower electric motor (Fe and MnO_2)	2	1,370	850	50	___	80	980
G-205 G-205S	Acid feed pump, 5 gallons per minute, 1-horsepower electric motor	2	300	650	20	___	30	700
F-201	H_2SO_4 storage tank, capacity 15,000 gallons	1	7,500	3,500	300	350	525	4,675
G-206	H_2SO_4 tank filling pump, capacity 100 gallons per minute, 100 ft head, with 7-1/2-horsepower electric motor	1	350	550	15	___	30	595
___	PH Indicator and controller (Beckman Model 7400, with indicator, electrodes, and control valve)	1	200	945	10	___	50	1,005
M-205	6-in. Dorrclone separator of 316 stainless steel, with rubber-liner, Vortex finder, and Apex valve	1	475	650	20	___	65	735

Table 11 (continued)

Equipment For Leaching (Acid Process) 220 Tons Ore/Day

Item	Description	Total Number Required	Estimated Shipping Weight	Estimated Cost FOB Factory	Estimated Freight Charges	Estimated Special Foundation Cost	Estimated Installation Cost	Estimated Total Installed Cost
___	Indicating rotameter for water line to No. 4 classifier	1	25	325	5	___	15	345
G-208 G-208S	Sand pump, capacity 100 gallons per minute, 30 ft head, with 3-horsepower electric motor	2	1,040	1,820	40	___	90	1,950
D-104 A-107	Rubber-lined neutralization, tank and agitator combination, capacity 3800 gallons, with 5-horsepower electric motor	1	5,840	3,285	250	165	490	4,190
C-203 F-205	Lime feeder and hopper combination, hopper capacity 60 ft^3, feeder size 12 in. by 6 ft, with 1/2-horsepower electric motor	1	780	970	30	___	100	1,100
G-209 G-209S	Tailings pump, 100 gallons per minute, maximum, 100 ft head, with 10-horsepower electric motor	2	1,790	2,390	70	___	120	2,580
M-206	Tailings sampler and timer, with 1/4-horsepower electric motor	1	400	575	15	___	25	615
F-202 F-203 F-204 A-204 A-205 A-206	Wooden pregnant slurry storage tank agitator combination, capacity 11,000 gallons, with 7-1/2-horsepower electric motor	3	30,525	12,195	1,200	600	1,830	15,825
G-207 G-207S	Pregnant pulp feed pump, capacity 100 gallons per minute maximum, 100 ft head, with 10-horsepower electric motor	2	1,790	2,390	70	___	120	2,580
F-209 A-209	Rubber-lined sand sump tank and rubber-covered agitator combination, with 3-horsepower electric motor	1	2,000	800	80	40	120	1,040
	Floor Spill Recovery System:							
(A) G-213	Floor wash pump with 2-horsepower electric motor, capacity 20 gallons per minute, 60 ft head	1	190		10	___	20	395

Table 11 (continued)

Equipment For Leaching (Acid Process) 220 Tons Ore/Day

	Item	Description	Total Number Required	Estimated Shipping Weight	Estimated Cost FOB Factory	Estimated Freight Charges	Estimated Special Foundation Cost	Estimated Installation Cost	Estimated Total Installed Cost
(B)	F-206 A-208	Floor sump and agitator combination, tank size 7 ft by 7 ft by 6 ft, agitator motor 5-horsepower	1	3,000	4,500	120	___	450	5,070
(C)	G-210	Floor sump pump with 3-horsepower electric motor, capacity 50 gallons per minute, 30 ft head	1	520	910	20	___	45	975
(D)	F-207	Rubber-lined settling cone	1	1,950	1,000	80	50	150	1,280
(E)	G-211	Sand pump for cone underflow	1	100	400	5	___	20	425
(F)	F-208	Rubber-lined sump liquor storage tank, capacity 2700 gallons	1	3,100	1,260	125	65	190	1,640
(G)	G-212	Liquor pump to digestion tank, with 2-horsepower electric motor, capacity 20 gallons per minute, 60 ft head	1	190	365	10	___	20	395
	A.	Total direct cost of installed process equipment							$105,740
	B.	Other direct costs:							
		1. Process piping (20% of A)							21,200
		2. Electrical wiring, including lighting and instrumentation at $50 per installed KW							6,550
		3. Instrumentation (2% of A)							2,120
		4. Painting and scaffolding (2% of A)							2,120
	C.	Total Direct Cost							$137,730
	D.	Engineering and field expense (10% of C)							13,775
	E.	Contingencies (10% of (C+D))							15,150
	F.	Contractor's fee and overhead (10% of (C+D+E))							16,665
	G.	Total Construction Cost							$183,320

Table 12

Equipment for Leaching (Acid Process) 440 Tons Ore/Day

A.	Total direct cost of installed process equipment, process piping, electrical wiring, instrumentation, painting and scaffolding for 220 tons ore/day mill	$137,730	
B.	Factor from major equipment cost comparison to raise 220 tons ore/day to 440 tons ore/day by 1.42		$195,500
C.	Engineering and field expense (10% of B)		19,500
D.	Contingencies (10% of (B+C))		21,500
E.	Contractor's fee and overhead (10% of (B+C+D))		23,500
F.	Total Construction Cost		$260,000

Table 13

Equipment for Leaching (Carbonate Process) 220 Tons Ore/Day

Item	Description	Total Number Required	Estimated Shipping Weight	Estimated Cost FOB Factory	Estimated Freight Charges	Estimated Special Foundation Cost	Estimated Installation Cost	Estimated Total Installed Cost
D-201	Thickener (steel construction) with 5-horsepower electric motor, size 75 ft diameter by 12 ft	1	120,000	27,200	4,800	2,000	7,000	$ 41,000
G-201 G-201S	Thickener overflow pump, with $1\frac{1}{2}$ -horsepower electric motor, capacity 50 gpm - 50 ft head	2	340	1,600	20		80	1,700
G-202 G-202S	Thickener underflow pump, with 7-1/2 horsepower electric motor, capacity 100 gpm - 75 ft head	2	1,000	2,100	40		100	2,240
D-202 D-203 D-204 D-205	Pachuca tank with 250 ft^2 heating coil, and for air sparging size 16 ft diameter by 49 ft	4	84,000	22,000	3,360	1,600	4,000	30,960
F-201	Leach solution storage tank, steel construction, capacity - 12,000 gallons	1	3,500	780	140	40	200	1,160
G-203 G-203S	Leach solution feed pump, with 2-horsepower electric motor, capacity 100 gpm - 30 ft head	2	380	1,720	20		80	1,820
D-206 D-207	Thickeners (steel construction), with 5-horsepower electric motor size 75 ft diameter by 12 ft	2	240,000	54,400	9,600	4,000	14,000	82,000
G-204 G-204S G-205 G-205S	Thickener overflow pump, with 1-1/2 horsepower electric motor capacity 50 gpm 50 ft head	4	680	3,200	40		160	3,400
F-206 A-203	Leach solution makeup tank (bolted steel construction) and agitator combination, tank size 12 ft by 12 ft, capacity - 10,000 gallons, agitator motor - 7-1/2 horsepower	1	8,700	3,000	350	150	600	4,100
G-218 G-218S	Fresh leach solution pump, with 2 horsepower electric motor capacity 100 gpm - 30 ft head	2	380	1,720	20		80	1,820

Table 13 (continued)

Equipment for Leaching (Carbonate Process) 220 Tons Ore/Day

Item	Description	Total Number Required	Estimated Shipping Weight	Estimated Cost FOB Factory	Estimated Freight Charges	Estimated Special Foundation Cost	Estimated Installation Cost	Estimated Total Installed Cost
G-206 G-206S G-207 G-207S	Thickener underflow pump, with 3-horsepower electric motor, capacity 100 gpm 30 ft head	4	1,800	3,560	80		160	3,800
M-201 M-202 M-203 M-204	Sand-slime classifiers, (in series) with 2-horsepower electric motor	4	18,000	14,000	720		2,100	16,820
G-208 G-208S G-209 G-209S G-210 G-210S	Classifier wash pump, with 2-horsepower electric motor capacity 100 gpm head 30 ft	6	1,140	5,160	60		240	5,460
G-211 G-211S	Pulp pump with 2-horsepower electric motor, capacity 100 gpm - 30 ft head	2	380	1,720	20		80	1,820
M-205	Dorrclone separator (6-in. Dorrclone) with rubber liner, Vortex finder, and Apex valve	1	475	650	20		65	735
	Indicating rotameter for water line to No. 4 classifier	1	25	325	5		15	345
F-202	Open top pregnant slurry storage tank (bolted steel), capacity- 40,000 gallons	1	13,600	3,810	545	190	950	5,495
G-212 G-212S	Pulp feed pump, with 3-horsepower electric motor, capacity 100 gpm - 50 ft head	2	900	1,780	40		80	1,900
G-213	Wilfley sand pump, with 3-horsepower electric motor, capacity 100 gpm, 30 ft head	2	900	1,780	40		80	1,900
F-203 A-201	Sand sump tank (steel) and agitator combination, tank size - 4 ft by 4 ft, agitator motor - 1-1/2 horsepower	1	1,100	560	45		100	705
M-206	Tailings sampler and timer, with 1/4-horsepower electric motor	1	400	575	15		25	615

Table 13 (continued)

Equipment for Leaching (Carbonate Process) 220 Tons Ore/Day

Item	Description	Total Number Required	Estimated Shipping Weight	Estimated Cost FOB Factory	Estimated Freight Charges	Estimated Special Foundation Cost	Estimated Installation Cost	Estimated Total Installed Cost
	Floor Spill Recovery System:							
(A) G-217	Floor wash pump with 3/4-horsepower electric motor, capacity 20 gpm, 60 ft head	1	190	365	10		20	$ 395
(B) F-204 A-202	Floor sump (steel lined) and agitator combination, tank size 7 ft by 7 ft, agitator motor 3-horsepower	1	3,825	1,160	155		200	1,515
(C) G-214	Floor sump pump, with 1-horsepower electric motor, capacity 50 gpm, 30 ft head	1	150	760	10		35	805
(D) F-209	Settling cone for sump product (steel) size - 5 ft-8 in. diameter	1	825	400	30		40	470
(E) G-215	Sand pump for cone underflow, with 1/4-horsepower electric motor, capacity 5 gpm, 50 ft head	1	150	570	10		30	610
(F) F-205	Sump liquor storage tank (bolted steel) capacity 5,000 gallons	1	1,500	370	60	20	90	540
(G) G-216	Liquor pump to thickener No. 1, with 1-horsepower electric motor, capacity 50 gpm, 30 ft head	1	150	760	10		35	805
F-207 F-208	Reagent feeder with 60 ft^3 hopper and 12 in. by 6 ft belt conveyor, conveyor motor - 1/2-horsepower, electric	2	1,560	1,940	60		200	2,200
C-203	Electric hoist for reagents; hoist motor 3-horsepower, electric; trolley motor 1/2-horsepower, electric	1	1,250	2,260	50		230	2,540

Table 13 (continued)

Equipment for Leaching (Carbonate Process) 220 Tons Ore/Day

A.	Total Direct Cost of Installed Process Equipment	$ 219,675
B.	Other Direct Costs:	
	1. Process piping (22% of A)	48,330
	2. Electrical wiring, including lighting and instrumentation at $50 per installed KW	4,200
	3. Instrumentation (1% of A)	2,200
	4. Painting and scaffolding (2% of A)	4,395
C.	Total Direct Cost	$ 278,800
D.	Engineering and Field Expense (10% of C)	27,880
E.	Contingencies (10% of (C+D))	30,670
F.	Contractor's fee and overhead (10% of (C+D+E))	33,735
G.	Total Construction Cost	$ 371,085

Table 14

Ore Pulp Processing in the Higgins Ion Exchange Contactor (Concentrated Chloride Process) 220 Tons Ore/Day Mill

Item	Description	Total Number Required	Estimated Cost FOB Mill	Estimated Installation Cost	Total Installed Cost
1.	300 gallon wood tank	1	$ 225	$ 90	$ 315
2.	200 gallon wood tank	2	400	160	560
3.	750 gallon rubber-lined steel tank	1	2,250	750	3,000
4.	36-in. - 46 plate filter	1	3,280	950	4,230
5.	Rubber-lined centrifuge with 2-horsepower electric motor	1	4,100	600	4,700
6.	Agitator-mixer, with 1/2-horsepower electric motor	1	250	60	310
7.	Agitator-mixer, with 1-horsepower electric motor	1	340	85	425
8.	Rubber-lined pump with 1/2-horsepower electric motor	4	2,760	415	3,175
9.	Hasteloy pump with 3/4-horsepower electric motor	1	780	120	900
10.	Gear pump - 10,000 gallons per hour, with 10-horsepower electric motor	1	3,600	540	4,140
11.	4 ft by 12 ft rubber-lined loading section	1	6,600	1,200	7,800
12.	2 ft-6 in. by 12 ft rubber-lined strip section	1	5,000	1,150	6,150
13.	2 ft-6 in. by 12 ft rubber-lined reservoir classifier section	1	3,500	750	4,250
14.	1 ft-6 in. by 3 ft rubber-lined head tank	1	600	100	700
15.	Power cylinder for air operation	3	450	120	570
16.	12-in. steel plug cock	2	600	150	750
17.	8-in. 3-way steel plug cock	1	380	90	470
18.	2-in. rotameter	1	260	55	315

Table 14 (continued)

Ore Pulp Processing in the Higgins Ion Exchange Contactor (Concentrated Chloride Process) 220 Tons Ore/Day Mill

A.	Total direct cost of installed process equipment	$42,760
B.	Other direct costs	
	1. Process piping (50% of A)	21,380
	2. Instrumentation (10% of A)	4,280
	3. Electrical wiring (includes power, lighting, and instrumentation at $50 per installed KWH)	1,000
	4. Footings and foundations (5% of A)	2,140
	5. Painting and scaffolding (2% of A)	855
C.	Total direct cost	$72,415
D.	Engineering and field expense (10% of C)	7,250
E.	Contingencies (10% of (C+D))	7,970
F.	Contractor's fee and overhead (10% of (C+D+E))	8,765
G.	Total Construction Cost	$96,400

Table 15

Ore Pulp Processing in the Higgins Ion Exchange Contactor (Concentrated Chloride Process) 440 Tons Ore/Day Mill

A.	Total direct cost of installed process equipment for 220 tons ore/day mill	$42,760	
B.	Factor by Cost Comparison to raise process equipment items from 220 tons ore/day mill to 440 tons ore/day mill by 2 ($42,760 x 2) for total direct cost of installed process equipment*		$85,520
C.	Other direct costs:		
	1. Process piping (50% of B)		42,760
	2. Instrumentation (10% of B)		8,550
	3. Electrical wiring (includes power, lighting and instrumentation at $50 per installed KWH		2,000
	4. Footings and foundations (5% of B)		4,275
	5. Painting and scaffolding (2% of B)		1,710
D.	Total Direct Cost		$144,815
E.	Engineering and field expense (10% of D)		14,480
F.	Contingencies (10% of (D+E))		17,520
G.	Contractor's fee and overhead (10% of (D+E+F))		19,275
H.	Total Construction Cost		$196,090

*Column sizes for 220 tons ore/day mill are thought to be maximum, and if 440 tons ore/day mill is considered, then it is necessary to use two sets of the same columns and equipment, rather than to enlarge.

Table 16

Ore Pulp Processing in the Higgins Ion Exchange Contactor (the Dilute Chloride Process) 220 Tons Ore/Day Mill

Item	Description	Total Number Required	Estimated Cost FOB Mill	Estimated Installation Cost	Total Installed Cost
1.	2000 gallon wood tank	2	$1,200	$ 500	$ 1,700
2.	36-in. 46 plate filter	1	3,280	950	4,230
3.	Agitator-mixer for side mounting, with 3-horsepower electric motor	2	1,700	340	2,040
4.	Gear pump, 10,000 gallons per hour, with 10-horsepower electric motor	1	3,600	540	4,140
5.	Rubber-lined transfer pump, with 1-horsepower electric motor	3	2,400	360	2,760
6.	4 ft by 12 ft rubber-lined loading section	1	6,600	1,200	7,800
7.	2 ft - 6 in. by 12 ft. rubber-lined strip section	1	5,000	1,150	6,150
8.	2 ft- 6 in. by 12 ft rubber-lined reservoir classifier section	1	3,500	750	4,250
9.	1 ft - 6 in. by 3 ft rubber-lined head tank	1	700	125	825
10.	Cylinder for air operating	3	450	120	570
11.	12-in. steel plug cock	2	600	150	750
12.	8-in. 3-way steel plug cock	1	380	90	470
13.	2-in. rotameter	1	260	55	315
A.	Total Direct Cost of Process Equipment				$36,000
B.	Other Direct Costs:				
	1. Process piping (50% of A) — we use 30%				18,000
	2. Instrumentation (10% of A) we use 3%				3,600
	3. Electrical wiring (includes power, lighting, and instrumentation at $50 per installed KWH)				1,000
	4. Footings and foundations (5% of A)				1,800
	5. Painting and scaffolding (2% of A)				720
C.	Total Direct Cost				$61,120
D.	Engineering and field expense (10% of C)				6,115
E.	Contingencies (10% of (C+D))				6,725
F.	Contractor's fee and overhead (10% of (C+D+E))				7,400
G.	Total Construction Cost				$81,360

Table 17

Ore Pulp Processing in the Higgins Ion Exchange Contactor (the Nitrate Process) 220 Tons Ore/Day Mill

Item	Description	Total Number Required	Estimated Cost FOB Mill	Estimated Installation Cost	Total Installed Cost
1.	2000 gallon wood tank	2	$1,200	$ 500	$ 1,700
2.	36 in.- 46 plate filter	1	3,280	950	4,230
3.	Agitator-mixer with 3-horsepower motor, for side mounting	2	1,700	340	2,040
4.	Gear pump, 10,000 gallons per hour, with 10-horsepower electric motor	1	3,600	540	4,140
5.	Stainless steel transfer pump with 1-horsepower electric motor	3	3,450	520	3,970
6.	4 ft. by 12 ft stainless steel loading section	1	8,400	1,680	10,080
7.	2 ft -6 in. by 12 ft stainless steel strip section	1	7,000	1,750	8,750
8.	2 ft -6 in. by 12 ft stainless steel reservoir, classifier section	1	4,800	1,200	6,000
9.	1 ft -6 in. by 3 ft stainless steel head tank	1	900	180	1,080
10.	Power cylinder for air operation	3	450	120	570
11.	12 in. steel plug cock	2	600	150	750
12.	8 in. 3-way steel plug cock	1	380	90	470
13.	2 in. rotameter	1	260	55	315
A.	Total Direct Cost of Installed Process Equipment				$44,095
B.	Other Direct Costs:				
	1. Process piping (50% of A)				22,050
	2. Instrumentation (10% of A)				4,410
	3. Electrical wiring (includes power, lighting, and instrumentation at $50 per installed KWH)				1,000
	4. Footings and foundations (5% of A)				2,205
	5. Painting and scaffolding (2% of A)				885
C.	Total Direct Cost				$74,645
D.	Engineering and Field Expense (10% of C)				7,470
E.	Contingencies (10% of (C+D))				8,215
F.	Contractor's fee and overhead (10% of (C+D+E))				9,035
G.	Total Construction Cost				$99,365

Table 18

Ore Pulp Processing in the Higgins Ion Exchange Contactor (the Carbonate Process) 220 Tons Ore/Day Mill

(C.30% U_3O_8 in Ore)

Item	Description	Total Number Required	Estimated Cost FOB Mill	Estimated Installation Cost	Total Installed Cost
1.	2000 gallon wood tank	2	$1,200	$ 500	$ 1,700
2.	36 in. - 46 plate filter	1	3,280	950	4,230
3.	Agitator-mixer for side mounting, with 3-horsepower electric motor	2	1,700	340	2,040
4.	Gear pump, 10,000 gallons per hour, with 10-horsepower electric motor	1	3,600	540	4,140
5.	Steel transfer pump with 1-horsepower electric motor	3	1,000	180	1,180
6.	4 ft x 12 ft steel loading section	1	4,800	960	5,760
7.	2 ft-6 in. by 12 ft steel strip section	1	4,000	1,000	5,000
8.	2 ft-6 in. by 12 ft steel reservoir, classifier section	1	2,500	650	3,150
9.	1 ft-6 in. by 3 ft steel head tank	1	300	60	360
10.	Cylinder for air operation	3	450	120	570
11.	12 in. semi-steel plug cock	2	600	150	750
12.	8 in. semi-steel 3-way plug cock	1	380	90	470
13.	2 in. rotameter	1	260	55	315
A.	Total Direct Cost of Installed Process Equipment				$29,655
B.	Other Direct Costs:				
	1. Process piping (50% of A)				14,850
	2. Instrumentation (same as for the Dilute Chloride Process)				3,600
	3. Electrical wiring (including power, lighting, and instrumentation at $50 per installed KWH)				1,000
	4. Footings and foundations (same as for the Dilute Chloride Process)				1,800
	5. Painting and scaffolding (same as for the Dilute Chloride Process)				720
C.	Total Direct Cost				$51,635
D.	Engineering and field expense (10% of C)				5,165
E.	Contingencies (10% of (C+D))				5,680
F.	Contractor's fee and overhead (10% of (C+D+E)				6,250
G.	Total Construction Cost				$68,730

Table 19

Resin Cost for 220 Tons Ore/Day Mill

		Estimated Total Cost	
1.	Resin for Higgins Contactor (267 ft^3 at $75)	$20,025	
	Total Direct Cost at Mill Site		$20,025

Table 20

Resin Cost for 440 Tons Ore/Day Mill

		Estimated Total Cost	
1.	Resin for Higgins Contactor (534 ft^3 at $75)	$40,050	
	Total Direct Cost at Mill Site		$40,050

Table 21

Steam Table Drying and Packaging Facility for 220 Tons Ore/Day Mill

Item	Description	Total Number Required	Estimated Shipping Weight	Estimated Cost FOB Factory	Estimated Freight Charges	Estimated Special Foundation Cost	Estimated Installation Cost	Estimated Total Installed Cost
19	1. Steam drying table	1	2,000	3,520	80		900	4,500
20	2. Scales (0 - 1000 lb)	1	800	1,235	35		220	1,490

A.	Total Direct Cost of Installed Drying and Packaging Facility	$ 5,990
B.	Other Direct Costs:	
	1. Process piping (7% of A)	420
	2. Instrumentation (3% of A)	180
	3. Electrical wiring ($50 per installed KWH)	30
	4. Painting and scaffolding (2% of A)	120
	5. Footings and foundations (5% of A)	300
C.	Total Direct Cost	$ 7,040
D.	Engineering and Field Expense (10% of C)	705
E.	Contingencies (10% of (C+D))	775
F.	Contractor's fee and overhead (10% of (C+D+E))	850
G.	Total Construction Cost	$ 9,370

Table 22

Steam Table Drying and Packaging Facility for 440 Tons Ore/Day Mill

A.	Total Direct Cost of Installed Drying and Packaging Facility Items for 220 Tons Ore/Day Mill	$ 7,040	
B.	Factor from Major Equipment Cost Comparison to Raise 220 Tons Ore/Day to 440 Tons Ore/Day by 1.0125		$ 7,130
C.	Engineering and Field Expense (10% of B)		715
D.	Contingencies (10% of (B+C))		790
E.	Contractor's fee and overhead (10% of (B+C+D))		865
F.	Total Construction Cost		$ 9,500

Table 23

Operating Expense for Crushing and Grinding for 220 Tons Ore/Day

Item	Description	Cost Per Operating Day	Cost Tons of Ore / Operating Day
A.	Operating labor[1]	$ 130.60	$ 0.5936
B.	Operating supplies[2]	27.00	0.1227
C.	Maintenance labor[3]	31.50	0.1432
D.	Maintenance supplies[4]	39.50	0.1796
E.	Utilities[5]	22.44	0.1020
F.	Total Direct Cost	$ 251.04	1.1411
G.	Amortization[6]	157.38	0.7154
H.	Total Direct Operating Cost	$ 408.42	$1.8565

	Classification	Men/Shift	Shift/Day	MH/Day	$/Hr	Days/Week	$/Week	$/Operating Day
1.	Leadman	1	1	8	1.95	5	78.00	12.38
	Operator	1	1	8	1.80	5	72.00	11.43
	Helper	1	1	8	1.70	5	68.00	10.79
	Operator (rod mill)	1	3	24	1.85	7	310.80	49.33
	Laborers	1	3	24	1.75	7	294.00	46.67
	Total Cost per Operating Day							130.60

	Description	1 lb Rod / 1 ton ore	Per lb	Sub-Total	Total
2	Grinding rods	220	$0.10	$ 22.00	
	Miscellaneous			5.00	$ 27.00
3	$\frac{\$259,670 \text{ at } 4\%}{330}$				$ 31.50
4	$\frac{\$259,670 \text{ at } 5\%}{330}$				$ 39.50
5	2040 KWH/8hr operating day at $0.011 per KWH				$ 22.44
6	$\frac{\$259,670}{5 \times 330}$				$157.38

Table 24

Operating Expense for Crushing and Grinding for 440 Tons Ore/Day

Item	Description	Cost Per Operating Day	Cost Ton of Ore Operating Day
A.	Operating labor[1]	$ 177.26	$ 0.4029
B.	Operating supplies[2]	51.50	0.1170
C.	Maintenance labor[3]	40.30	0.0916
D.	Maintenance supplies[4]	50.38	0.1145
E.	Utilities[5]	44.88	0.1020
F.	Total Direct Cost	$ 364.32	0.8280
G.	Amortization[6]	201.52	0.4580
H.	Total Direct Operating Cost	$ 565.84	1.2860

	Classification	Men/Shift	Shift/Day	MH/Day	$/Hr	Days/Week	$/Week	$/Operating Day
1	Leadman	1	1	8	1.95	5	78.00	12.38
	Operator	1	1	8	1.80	5	72.00	11.43
	Helper	1	1	8	1.70	5	68.00	10.79
	Operator (rod mill)	1	3	24	1.85	7	310.80	49.33
	Laborers	2	3	48	1.75	7	588.00	93.33
	Total Cost Per Operating Day							177.26

	Description	1 Lb Rod / 1 Ton Ore	Per/Lb	Sub-Total	Total
2	Grinding rods	440	$0.10	$44.00	$51.50
	Miscellaneous			7.50	
3	$332,500 at 4% / 330				40.30
4	$332,500 at 5% / 330				50.38
5	4080 KWH/8 hr operating day at $0.011 per KWH				$ 44.88
6	$332,500 / 5 x 330				$201.52

Table 25

Operating Expense for Leaching (Acid Process) 220 Tons Ore/Day

Item	Description	Cost Per Operating Day	Cost Ton of Ore Operating Day
A.	Operating labor[1]	$ 338.66	$ 1.5394
B.	Operating supplies[2]	362.94	1.6497
C.	Maintenance labor[3]	22.20	0.1009
D.	Maintenance supplies[4]	27.77	0.1262
E.	Utilities[5]	20.46	0.0930
F.	Total Direct Operating Cost	772.03	3.5092
G.	Amortization[6]	111.10	0.5050
H.	Total	883.13	4.0142

	Classification	Men/Shift	Shift/Day	MH/Day	$/Hr	Total
1	Leadman	1	3	24	2.00	$48.00
	Operators	2	3	48	1.85	88.80
	Helpers	2	3	48	1.75	84.00
	Laborers	2	3	48	1.75	84.00
	Total Cost per Calendar Day					$304.80
	Total Cost per Operating Day $\frac{\$304.80}{.9}$					$338.66

	Description	Lbs/Ton Ore	Total Lbs	Unit Cost	Total
2	H_2SO_4	75	16,500	$30/Ton	$247.50
	$Ca(OH)_2$	40	8,800	$25.10/Ton	110.44
	Miscellaneous				5.00
	Total Cost per Operating Day				$362.94
3	$\frac{\$183,320 \text{ at } 4\%}{330}$				22.20
4	$\frac{\$183,320 \text{ at } 5\%}{330}$				27.77
5	Electricity for lighting & power, 1860 KWH/24 hr Operating day at $0.011 per KWH				20.46
6	$\frac{\$183,320}{5 \times 330}$				$111.10

Table 26

Operating Expense for Leaching (Acid Process) 440 Tons Ore/Day

Item	Description	Cost Per Operating Day	Cost Tons of Ore / Operating Day
A.	Operating labor[1]	$ 432.00	$ 0.9818
B.	Operating supplies[2]	723.38	1.6440
C.	Maintenance labor[3]	31.51	0.0716
D.	Maintenance supplies[4]	39.39	0.0895
E.	Utilities[5]	40.92	0.0930
F.	Total Direct Operating Cost	$1,267.20	2.8800
G.	Amortization[6]	157.58	0.3581
H.	Total	$1,424.78	3.2381

	Classification	Men/Shift	Shift/Day	MH/Day	$/Hr	Total
1	Leadman	1	3	24	2.00	$48.00
	Operators	2	3	48	1.85	88.80
	Helpers	3	3	72	1.75	126.00
	Laborers	3	3	72	1.75	126.00
	Total Cost per Calendar Day					$388.80
	Total Cost per Operating Day $\frac{\$388.80}{.9}$					$432.00

	Description	Lbs/Ton Ore	Total	Unit Cost	Total
2	H_2SO_4	75 lbs	33,000 lbs	$30/Ton	$495.00
	$Ca(OH)_2$	40 lbs	17,600 lbs	$25.10/Ton	220.88
	Miscellaneous				7.50
	Total Cost per Operating Day				$723.38
3	$\frac{\$260,000 \text{ at } 4\%}{330}$				31.51
4	$\frac{\$260,000 \text{ at } 5\%}{330}$				39.39
5	3720 KWH/per 24 hr Operating Day at $0.011 per KWH				40.92
6	$\frac{\$260,000}{5 \times 330}$				$157.58

Table 27

Operating Expense for Leaching - Carbonate Process - 220 Tons Ore/Day

		Cost Per Operating Day	Cost - Tons of Ore Operating Day
A.	Operating labor[1]	385.33	1.7515
B.	Operating supplies[2]	309.00	1.4045
C.	Maintance labor[3]	44.98	.2045
D.	Maintance supplies[4]	56.23	.2556
E.	Utilities[5]	48.45	.2202
F.	Total direct operating cost	843.99	3.8363
G.	Amortization[6]	224.90	1.0222
H.	Total	$ 1,068.89	4.8585

	Classification	Men/Shift	Shift/Day	MH/Day	$/Hour	Total
1.	Leadman (mill house)	1	3	24	$ 2.00	$ 48.00
	Operators (thickener no.1)	1/2	3	12	1.85	22.20
	Operators (pachuca tanks)	1/2	3	12	1.85	22.20
	Operators (CCD thickeners)	1/2	3	12	1.85	22.20
	Operators (sands-slime separator)	1/2	3	12	1.85	22.20
	Helpers (sands-slime separator)	1	3	24	1.75	42.00
	Helpers (CCD thickeners)	1	3	24	1.75	42.00
	Helpers (reagent make up)	1	3	24	1.75	42.00
	Laborers (general)	2	3	48	1.75	84.00
	Total cost per calendar day					$ 346.80

Total cost per operating day $\frac{\$346.80}{.9} = \$385.33$

	Description	Lbs/Ton Ore	Total	Unit Cost	Total
2.	Na_2CO_3	28.14	6190.	$45/Ton	$ 139.00
	$NaHCO_3$	17.09	3760.	$85/Ton	160.00
	Miscellaneous				10.00
	Total cost per operating day				$ 309.00

Table 27 (continued)

Operating Expense for Leaching (Carbonate Process) 220 Tons Ore/Day

	Description		Total
3	$\frac{\$371,085 \text{ at } 4\%}{330}$		$44.98
4	$\frac{\$371,085 \text{ at } 5\%}{330}$		$56.23
5	950 KWH/24 hr operating day at $0.011 per KWH	$10.45	$48.45
	Process steam ($\frac{85,000,000 \text{ Btu}}{0.75 \times 6.25 \times 10^6}$ = 18.1 Bbls at $2.10)	$38.00	
6	$\frac{\$371,085}{5 \times 330}$		$224.90

Table 28

Operating Expense for the Higgins Ion Exchange Contactor (Concentrated Chloride Process) 220 Tons Ore/Day Mill

(0.30% U_3O_8 in Ore)

		Cost Per Operating Day	Cost Ton of Ore Operating Day
A.	Operating labor[1]	$ 96.00	$ 0.4364
B.	Operating supplies[2]	118.67	0.5394
C.	Maintenance labor[3]	11.68	0.0531
D.	Maintenance supplies[4]	14.61	0.0664
E.	Utilities[5]	7.45	0.0339
F.	Total Direct Cost	$ 248.41	$ 1.1292
G.	Amortization[6]	70.56	0.3207
H.	Total Direct Operating Cost	$ 318.97	$ 1.4499

	Classification	Men/Shift	Shift/Day	MH/Day	$/Hr	Total
1	Operator	1	3	24	1.85	$ 44.40
	Laborer	1	3	24	1.75	42.00
	Total Cost per Calendar Day					$ 86.40
	Total Cost per Operating Day	$86.40 / .9				$ 96.00

	Description	Lbs/Day	Ft^3/Day	Cost/Lb	Cost/Ft^3	Total
2	NaCl	660		$0.0075		$ 4.95
	$CaCl_2$	2,600		0.0175		45.50
	MgO	47		0.0525		2.47
	Resin		0.81		$75.00	60.75
	Miscellaneous					5.00
	Total Cost per Operating Day					$118.67

3	$96,400 at 4% / 330		$ 11.68
4	$96,400 at 5% / 330		$ 14.61
5	600 KWH/24 hr operating day at $0.011 per KWH	$6.60	$ 7.45
	Process steam	0.85	
6	$96,400 (construction cost of facility) / 5 x 330	$58.42	$ 70.56
	$20,025 (resin) / 5 x 330	12.14	

Table 29

Operating Expense for the Higgins Ion Exchange Contactor (Concentrated Chloride Process) 220 Tons Ore/Day Mill
(0.15% U_3O_8 in Ore)

		Cost Per Operating Day	Cost Ton of Ore / Operating Day
A.	Operating labor[1]	$ 96.00	$ 0.4364
B.	Operating supplies[2]	92.21	0.4191
C.	Maintenance labor[3]	11.68	0.0531
D.	Maintenance supplies[4]	14.61	0.0664
E.	Utilities[5]	7.03	0.0320
F.	Total Direct Cost	$ 221.53	$ 1.0070
G.	Amortization[6]	70.56	0.3207
H.	Total Direct Operating Cost	$ 292.09	$ 1.3277

	Classification	Men/Shift	Shift/Day	MH/Day	$/Hr	Total
1	Operator	1	3	24	1.85	$ 44.40
	Laborer	1	3	24	1.75	42.00
	Total Cost per Calendar Day					$ 86.40
	Total Cost per Operating Day	$\frac{\$86.40}{.9}$				$ 96.00

	Description	Lbs/Day	Ft^3/Day	Cost/Lb	Cost/Ft^3	Total
2	NaCl	330		$ 0.0075		$ 2.48
	$CaCl_2$	1,300		0.0175		22.75
	MgO	23.5		0.0525		1.23
	Resin		0.81		$75.00	60.75
	Miscellaneous					5.00
	Total Cost per Operating Day					92.21
3	$\frac{\$96,400 \text{ at } 4\%}{330}$					$ 11.68
4	$\frac{\$96,400 \text{ at } 5\%}{330}$					$ 14.61
5	600 KWH/24 hr operating day at $0.011 per KWH		$6.60			7.03
	Process steam		0.43			
6	$\frac{\$96,400}{5 \times 330}$ (construction cost of facility)		$58.42			$ 70.56
	$\frac{\$20,025}{5 \times 330}$ (resin)		$12.14			

Table 30

Operating Expense for the Higgins Ion Exchange Contactor (Concentrated Chloride Process) 440 Tons Ore/Day Mill

(0.30% U_3O_8 in Ore)

		Cost Per Operating Day	Cost Ton of Ore Operating Day
A.	Operating labor[1]	$ 142.66	$ 0.3242
B.	Operating supplies[2]	237.34	0.5394
C.	Maintenance labor[3]	23.77	0.0540
D.	Maintenance supplies[4]	29.71	0.0675
E.	Utilities[5]	14.90	0.0339
F.	Total Direct Cost	$ 448.38	$ 1.0190
G.	Amortization[6]	143.11	0.3253
H.	Total Direct Operating Cost	$ 591.49	$ 1.3443

	Classification	Men/Shift	Shift/Day	MH/Day	$/Hr	Total
1	Operator	1	3	24	1.85	$ 44.40
	Laborer	1	3	24	1.75	42.00
	Helper	1	3	24	1.75	42.00
	Total Cost per Calendar Day					$128.40
	Total Cost per Operating Day	$\frac{\$128.40}{.9}$				$142.66

	Description	Lbs/Day	Ft^3/Day	Cost/Lb	Cost/Ft^3	Total
2	NaCl	1,320		$0.0075		$ 9.90
	$CaCl_2$	5,200		0.0175		91.00
	MgO	94		0.0525		4.94
	Resin		1.62		$ 75.00	121.50
	Miscellaneous					10.00
	Total Cost per Operating Day					$237.34
3	$\frac{\$196,090 \text{ at } 4\%}{330}$					$ 23.77
4	$\frac{\$196,090 \text{ at } 5\%}{330}$					$ 29.71
5	1200 KWH/24 hr operating day at $0.011 per KWH		$13.20			$ 14.90
	Process steam		1.70			
6	$\frac{\$196,090}{5 \times 330}$ (construction cost of facility)		$118.84			$143.11
	$\frac{\$40,050}{5 \times 330}$ (resin)		$ 24.27			

Table 31

Operating Expense for the Higgins Ion Exchange Contactor (the Dilute Chloride Process) 220 Tons Ore/Day Mill

(0.30% U_3O_8 in Ore)

		Cost Per Operating Day	Cost Ton of Ore Operating Day
A.	Operating labor[1]	$ 96.00	$ 0.4364
B.	Operating supplies[2]	143.38	0.6517
C.	Maintenance labor[3]	9.86	0.0448
D.	Maintenance supplies[4]	12.33	0.0560
E.	Utilities[5]	7.45	0.0339
F.	Total Direct Cost	$ 269.02	$ 1.2228
G.	Amortization[6]	61.45	0.2793
H.	Total Direct Operating Cost	$ 330.47	$ 1.5021

	Classification	Men/Shift	Shift/Day	MH/Day	$/Hr	Total
1	Operator	1	3	24	1.85	$44.40
	Laborer	1	3	24	1.75	42.00
	Total Cost per Calendar Day					86.40
	Total Cost per Operating Day	$\frac{\$86.40}{.9}$				96.00

	Description	Lbs/Day	Ft^3/Day	Cost/Lb	Cost/Ft^3	Total
2	NaCl	5,150		$ 0.0075		$38.63
	H_2SO_4	955		0.015		14.32
	MgO	470		0.0525		24.68
	Resin		0.81		$60.75	60.75
	Miscellaneous					5.00
	Total Cost per Operating Day					$143.38
3	$\frac{\$81,360 \text{ at } 4\%}{330}$					$ 9.86
4	$\frac{\$81,360 \text{ at } 5\%}{330}$					$ 12.33
5	600 KWH/24 hr operating day at $0.011 per KWH		$ 6.60			$ 7.45
	Process steam		0.85			
6	$\frac{\$81,360}{5 \times 330}$ (construction cost of facility)		$49.31			$ 61.45
	$\frac{\$20,025}{5 \times 330}$ (resin cost)		$12.14			

Table 32

Operating Expense for the Higgins Ion Exchange Contactor (the Dilute Chloride Process) 220 Tons Ore/Day Mill

(0.15% U_3O_8 in Ore)

		Cost Per Operating Day	Cost Tons of Ore / Operating Day
A.	Operating Labor[1]	$ 96.00	$ 0.4364
B.	Operating supplies[2]	104.57	0.4753
C.	Maintenance labor[3]	9.86	0.0448
D.	Maintenance supplies[4]	12.33	0.0560
E.	Utilities[5]	7.03	0.0320
F.	Total Direct Cost	$ 229.79	$ 1.0445
G.	Amortization[6]	61.45	0.2793
H.	Total Direct Operating Cost	$ 291.24	$ 1.3238

	Classification	Men/Shift	Shift/Day	MH/Day	$/Hr	Total
1	Operator	1	3	24	1.85	$44.40
	Laborer	1	3	24	1.75	42.00
	Total Cost per Calendar Day					$84.40
	Total Cost per Operating Day	$\frac{\$86.40}{.9}$				$96.00

	Description	Lbs/Day	Ft^3/Day	Cost/Lb	Cost/Ft^3	Total
2	NaCl	2,575		$0.0075		$19.32
	H_2SO_4	477.5		0.015		7.16
	MgO	235		0.0525		12.34
	Resin		0.81		$75.00	60.75
	Miscellaneous					5.00
	Total Cost per Operating Day					$104.57
3	$\frac{\$81,360 \text{ at } 4\%}{330}$					$ 9.86
4	$\frac{\$81,360 \text{ at } 5\%}{330}$					$ 12.33
5	600 KWH/24 hr operating day at $0.011 per KWH		$ 6.60			$ 7.03
	Process steam		0.43			
6	$\frac{\$81,360}{5 \times 330}$ (construction cost of facility)		$49.31			$ 61.45
	$\frac{\$20,025}{5 \times 330}$ (resin)		$12.14			

Table 33

Operating Expense for the Higgins Ion Exchange Contactor (the Nitrate Process) 220 Tons Ore/Day Mill

(0.30% U_3O_8 in Ore)

		Cost Per Operating Day	Cost Ton of Ore / Operating Day
A.	Operating labor[1]	$ 96.00	$ 0.4364
B.	Operating supplies[2]	216.35	0.9834
C.	Maintenance labor[3]	12.04	0.0547
D.	Maintenance supplies[4]	15.06	0.0684
E.	Utilities[5]	7.45	0.0339
F.	Total Direct Cost	$ 346.90	$ 1.5768
G.	Amortization[6]	72.36	0.3289
H.	Total Direct Operating Cost	$ 419.26	$ 1.9057

	Classification	Men/Shift	Shift/Day	MH/Day	$/Hr	Total
1	Operator	1	3	24	1.85	$44.40
	Laborer	1	3	24	1.75	42.00
	Total Cost per Calendar Day					$86.40
	Total Cost per Operating Day	$\frac{\$86.40}{.9}$				$96.00

	Description	Lbs/Day	Ft^3/Day	Cost/Lb	Cost/Ft^3	Total
2	NH_4NO_3	2,480		$ 0.045		$111.60
	H_2SO_4	955		0.015		14.32
	MgO	470		0.0525		24.68
	Resin		0.81		$ 75.00	60.75
	Miscellaneous					5.00
	Total Cost per Operating Day					$216.35
3	$\frac{\$99,365 \text{ at } 4\%}{330}$					$ 12.04
4	$\frac{\$99,365 \text{ at } 5\%}{330}$					$ 15.06
5	600 KWH/24 hr operating day at $0.011 per KWH		$6.60			
	Process steam		0.85			$ 7.45
6	$\frac{\$99,365}{5 \times 330}$ (construction cost of facility)		$60.22			
	$\frac{\$20,025}{5 \times 330}$ (resin)		$12.14			$ 72.36

Table 34

Operating Expense for the Higgins Ion Exchange Contactor (the Nitrate Process) 220 Tons Ore/Day Mill

(0.15% U_3O_8 in Ore)

		Cost Per Operating Day	Cost Tons of Ore / Operating Day
A.	Operating labor[1]	$ 96.00	$ 0.4364
B.	Operating supplies[2]	141.05	0.6411
C.	Maintenance labor[3]	12.04	0.0547
D.	Maintenance supplies[4]	15.06	0.0684
E.	Utilities[5]	7.03	0.0320
F.	Total Direct Cost	$ 271.18	$ 1.2326
G.	Amortization[6]	72.36	0.3289
H.	Total Direct Cost	$ 343.54	$ 1.5615

	Classification	Men/Shift	Shifts/Day	MH/Day	$/Hr	Total
1	Operator	1	3	24	1.85	$ 44.40
	Laborer	1	3	24	1.75	42.00
	Total Cost per Calendar Day					$ 86.40
	Total Cost per Operating Day	$\frac{\$86.40}{.9}$				$ 96.00

	Description	Lbs/Day	Ft^3/Day	Cost/Lb	Cost/Ft^3	Total
2	NH_4NO_3	1,240		$ 0.045		$ 55.80
	H_2SO_4	477.5		0.015		7.16
	MgO	235		0.0525		12.34
	Resin		0.81		$ 75.00	60.75
	Miscellaneous					5.00
	Total Cost per Operating Day					$141.05
3	$\frac{\$99,365 \text{ at } 4\%}{330}$					$ 12.04
4	$\frac{\$99,365 \text{ at } 5\%}{330}$					$ 15.06
5	600 KWH/24 hr operating day at $0.011 per KWH		$ 6.60			$ 7.03
	Process steam		0.43			
6	$\frac{\$99,365}{5 \times 330}$ (construction cost of facility)		$60.22			$ 72.36
	$\frac{\$20,025}{5 \times 330}$ (resin)		$12.14			

Table 35

Operating Expense for the Higgins Ion Excharge Contactor (the Carbonate Process) 220 Tons Ore/Day Mill

(0.30% U_3O_8 in Ore)

		Cost Per Operating Day	Cost Tons of Ore Operating Day
A.	Operating labor[1]	$ 96.00	$ 0.4364
B.	Operating supplies[2]	298.90	1.3586
C.	Maintenance labor[3]	8.33	0.0378
D.	Maintenance supplies[4]	10.41	0.0473
E.	Utilities[5]	7.45	0.0339
F.	Total Direct Cost	$ 421.09	$ 1.9140
G.	Amortization[6]	53.79 does not include building	0.2445
H.	Total Direct Operating Cost	$ 474.88	$ 2.1585

	Classification	Men/Shift	Shift/Day	MH/Day	$/Hr	Total
1	Operator	1	3	24	1.85	$ 44.80
	Laborer	1	3	24	1.75	42.00
	Total Cost per Calendar Day					$ 86.40
	Total Cost per Operating Day	$\frac{\$86.40}{.9}$				$ 96.00

	Description	Lbs/Day	Ft^3/Day	Cost/Lb	Cost/Ft^3	Total
2	$NaHCO_3$	4,840 low		$ 0.0425 ok		$205.70
	NaOH (2.2 lb / lb eq = 2,700	Wilson reported 3.4 lb/ton		hi 0.061 — .0465 = AEC		164.70
	Na_2CO_3 (credit)	6,100		0.0225 OK		(-) 137.25
	Resin		0.81		$ 75.00	60.75
	Miscellaneous					5.00
	Total Cost per Operating Day					$298.90

How can we take a credit when recarbonation facility is not provided. See page 12

3	$\frac{\$68,730 \text{ at } 4\%}{330}$		$ 8.33
4	$\frac{\$68,730 \text{ at } 5\%}{330}$		$ 10.41
5	600 KWH/24 hr operating day at $0.011 per KWH	$6.60	$ 7.45
	Process steam	0.85	
6	$\frac{\$68,730}{5 \times 330}$ (construction cost of facility)	$41.65	$ 53.79
	$\frac{\$20,025}{5 \times 330}$ (resin)	$12.14	

290 849

Table 36

Operating Expense for Steam Table Drying and Packaging for 220 Tons Ore/Day Mill

1.30% ore

		Cost Per Operating Day	Cost Lb U_3O_8 Operating Day
A.	Operating labor[1]		
B.	Operating supplies[2]	$ 20.00	$ 0.01597
C.	Maintenance labor[3]	1.14	0.00091
D.	Maintenance supplies[4]	1.42	0.00113
E.	Utilities[5]		
F.	Total Direct Cost	$ 22.56	0.01802
G.	Amortization[6]	5.68	0.00453
H.	Total Direct Operating Cost	$ 28.24	0.02255

1 cent low probably due to no bldg

1	Included with cost of leaching	
2	4 drums at $5.00 each OK	$20.00
3	$\frac{\$9370 \text{ at } 4\%}{330}$	$ 1.14
4	$\frac{\$9370 \text{ at } 5\%}{330}$	$ 1.42
5	Included with cost of leaching	
6	$\frac{\$9370}{5 \times 330}$	5.68

Table 37

Operating Expense for Steam Table Drying and Packaging for 220 Tons Ore/Day Mill

(0.115% ore)

		Cost Per Operating Day	Cost Lb U3O8 Operating Day
A.	Operating labor[1]		
B.	Operating supplies[2]	$ 10.00	$ 0.01597
C.	Maintenance labor[3]	1.14	0.00182
D.	Maintenance supplies[4]	1.42	0.00227
E.	Utilities[5]		
F.	Total Direct Cost	$ 12.56	$ 0.02006
G.	Amortization[6]	5.68	0.00907
H.	Total Direct Operating Cost	$ 18.24	$ 0.02913

1 Included with cost of leaching

2 2 drums at $5.00 each — $10.00

3 $\frac{\$9370 \text{ at } 4\%}{330}$ — 1.14

4 $\frac{\$9370 \text{ at } 5\%}{330}$ — 1.42

5 Included with cost of leaching

6 $\frac{\$9370}{5 \times 330}$ — 5.68

Table 38

Operating Expense for Steam Table Drying and Packaging for 440 Tons Ore/Day Mill

		Cost Per Operating Day	Cost Lb U_3O_8 Operating Day
A.	Operating labor[1]		
B.	Operating supplies[2]	$ 40.00	$ 0.01598
C.	Maintenance labor[3]	1.15	0.00046
D.	Maintenance supplies[4]	1.44	0.00057
E.	Utilities[5]		
F.	Total Direct Cost	$ 42.59	$ 0.01701
G.	Amortization[6]	5.75	0.00229
H.	Total Direct Operating Cost	$ 48.34	$ 0.01930

1 Included with cost of leaching

2 8 drums at $5.00 each — $ 40.00

3 $\frac{\$9500 \text{ at } 4\%}{330}$ — 1.15

4 $\frac{\$9500 \text{ at } 5\%}{330}$ — 1.44

5 Included with cost of leaching

6 $\frac{\$9500}{5 \times 330}$ — 5.75

Table 39

Staffing and Salaries of Supervisory, Clerical, Security, Laboratory, Health, and Safety Personnel

Item	Classification	Required	Salary	Total
1.	Plant manager	1	800	$ 800
2.	Plant superintendent	1	700	700
3.	Metallurgist	1	600	600
4.	Chemist	1	500	500
5.	Shift bosses	4	450	1,800
6.	Office manager	1	450	450
7.	Accountant	1	400	400
8.	Clerks and stenographers	2	250	500
9.	Laboratory technicians	2	350	700
10.	Purchasing agent	1	450	450
11.	Master mechanic	1	600	600
12.	Warehouseman	1	400	400
13.	Security, health, safety	1	350	350
14.	Security guards	4	330	1,320
15.	Total Cost per Month			$ 9,570
16.	Total Cost per Operating Day ($\frac{\$9570 \times 12}{330}$)			$ 348

Table 40

Maintenance Overhead Labor for 220 and 440 Tons Ore/Day Mill

Item	Description	Estimated Labor Per Ton Ore	Total Labor for Mill Per Day
1.	220 tons ore/day mill	$ 0.30	$ 66.00
2.	440 tons ore/day mill	0.20	88.00

Table 41

Maintenance Supplies for General Facilities for 220 and 440 Tons Ore/Day Mill

Item	Description	Estimated Supplies For Ton Ore	Total Supplies For Mill Per Day
1.	220 tons ore/day mill	$ 0.30	$ 66.00
2.	440 tons ore/day mill	0.20	88.00

Note - Indirect operating maintenance supplies cost is assumed to be equal to the cost of indirect operating maintenance labor.

Table 42

Payroll Overhead

Item	Description	Base	Alt. No. 1	Alt. No. 2	Table	Alt. No. 3A	Alt. No. 3B	Alt. No. 3C	Table	Alt. No. 4	Table	Alt. No. 5	Table
A.	Crushing and grinding												
	1. Operating labor	$ 130.60	$ 130.60	$ 130.60	--	$ 130.60	$ 130.60	$ 130.60	23	$ 177.26	24	$ 130.60	23
	2. Maintenance labor	31.50	31.50	31.50	--	31.50	31.50	31.50	23	40.30	24	31.50	23
B.	Acid leaching												
	1. Operating labor	338.66	338.66	338.66	--	338.66	338.36	338.66	25	432.00	26	--	--
	2. Maintenance labor	22.20	22.20	22.20	--	22.20	22.20	22.20	25	31.51	26	--	---
C.	Carbonite leaching												
	1. Operating labor	--	--	--	--	--	--	--	--	--	--	385.33	27
	2. Maintenance labor	--	--	--	--	--	--	--	--	--	--	44.98	27
D.	Higgins - 5 M NaCl strip												
	1. Operating labor	96.00	--	--	28	96.00	--	--	29	142.66	30	--	--
	2. Maintenance labor	11.68	--	--	28	11.68	--	--	29	23.77	30	--	--
E.	Higgins - 1 M NaCl strip												
	1. Operating labor	--	96.00	--	31	--	96.00	--	32	--	--	--	--
	2. Maintenance labor	--	9.86	--	31	--	9.86	--	32	--	--	---	--
F.	Higgins - NH_4NO_3 strip												
	1. Operating labor	--	--	96.00	33	--	--	96.00	34	--	--	--	--
	2. Maintenance labor	--	--	12.04	33	--	--	12.04	34	--	--	---	--
G.	Higgins - carbonate strip												
	1. Operating labor	--	--	--	--	--	--	--	--	--	--	96.00	35
	2. Maintenance labor	--	--	--	--	--	--	--	--	--	--	8.33	35
H.	Drying and packaging												
	1. Operating labor	--	--	--	--	--	--	--	--	--	--	--	--
	2. Maintenance labor	1.14	1.14	1.14	36	1.14	1.14	1.14	37	1.15	38	1.14	36
I.	Supervision labor	348.00	348.00	348.00	39	348.00	348.00	348.00	39	348.00	39	348.00	39
J.	Maintenance overhead labor	66.00	66.00	66.00	40	66.00	66.00	66.00	40	88.00	40	66.00	40
K.	Total payroll	$1,045.78	$1,043.96	$1,046.14	--	$1,045.78	$1,043.96	$1,046.14	--	$1,284.65	--	$1,111.88	---
L.	Payroll overhead at 12.6%	$ 131.76	$ 131.54	$ 131.81	--	$ 131.76	$ 131.54	$ 131.81	--	$ 161.87	--	$ 140.09	--

Table 43

Indirect Operating Cost Items - (Cost per Operating Day)

Item	Description	Estimated Gallons Required	Estimated Cost Per 1000 Gal	Estimated Cost Per KWH	Estimated KWH For 220 Ton Mill	Estimated KWH For 440 Ton Mill	Total Cost 220 Ton/Day Mill	Total Cost 440 Ton/Day Mill
A.	Water treatment for steam	6.44 M	$ 0.05				$ 0.32	$ 0.64
B.	Clerical supplies ($\frac{\$2500}{330}$)						7.58	7.58
C.	Electricity for general facilities			$0.011	868	1,363	9.55	15.00
D.	Water for mill	500 M	0.02				10.00	20.00
E.	Fuel oil	(Cost based on 100-horsepower boiler, 8 months/year, 6.25 MM Btu/bbl fuel oil at $2.10 and 75% boiler efficiency $\frac{33475 \times 100 \times 240 \times 24}{0.75 \times 6.25 \times 10^6} = \frac{4120 \times \$2.1}{365 \times .9}$)					26.40	39.60

F. Taxes and insurance cost based on 1-1/2% construction cost of mill per annum.

G. Amortization cost based on construction cost of general facilities over 5-year period.

LEGEND

1. 10'×10' Guard House
2. 36'×72' Administration Bldg.
3. 40'×50' Laboratory Bldg.
4. 40'×60' Shop & Equipment Bldg.
5. 40'×40' Warehouse Bldg.
6. 55'×130' Crusher Bldg.
7. 55'× 30' Ore Receiving Pad
8. 60'×100' Process Bldg.
9. 30'×30' Utilities & Service Bldg.
10. 6' Manholes
11. Septic Tanks
12. Diversion Boxes
13. Disposal Fields
14. Entrance Gate
15. 10,000 Gal. Oil Storage Tank (F-601)
16. Fuel Oil Unloading Pump (G-603)
17. 15000 Gal. H_2SO_4 Tank & Concrete Saddles (F-201)
18. H_2SO_4 Unloading Pump (G-206)
19. 50,000 Gal. Elevated Tank
20. 500 KVA Sub Station (M-601)
21. Security Fence With Lighting
22. 3" Line To Tailings Pond
23. Tailings Pond & Dam (Not Shown)
24. 75' Dia×12' Thickener (D-201)
25. 16' Dia×49' Pachuca Tanks (D-202, 203, 204, & 205)
26. 75' Dia. ×12' Thickeners (D 206, 207)
27. 40 Car Parking Area (Not Shown)
28. Railroad Spur (Not Shown)

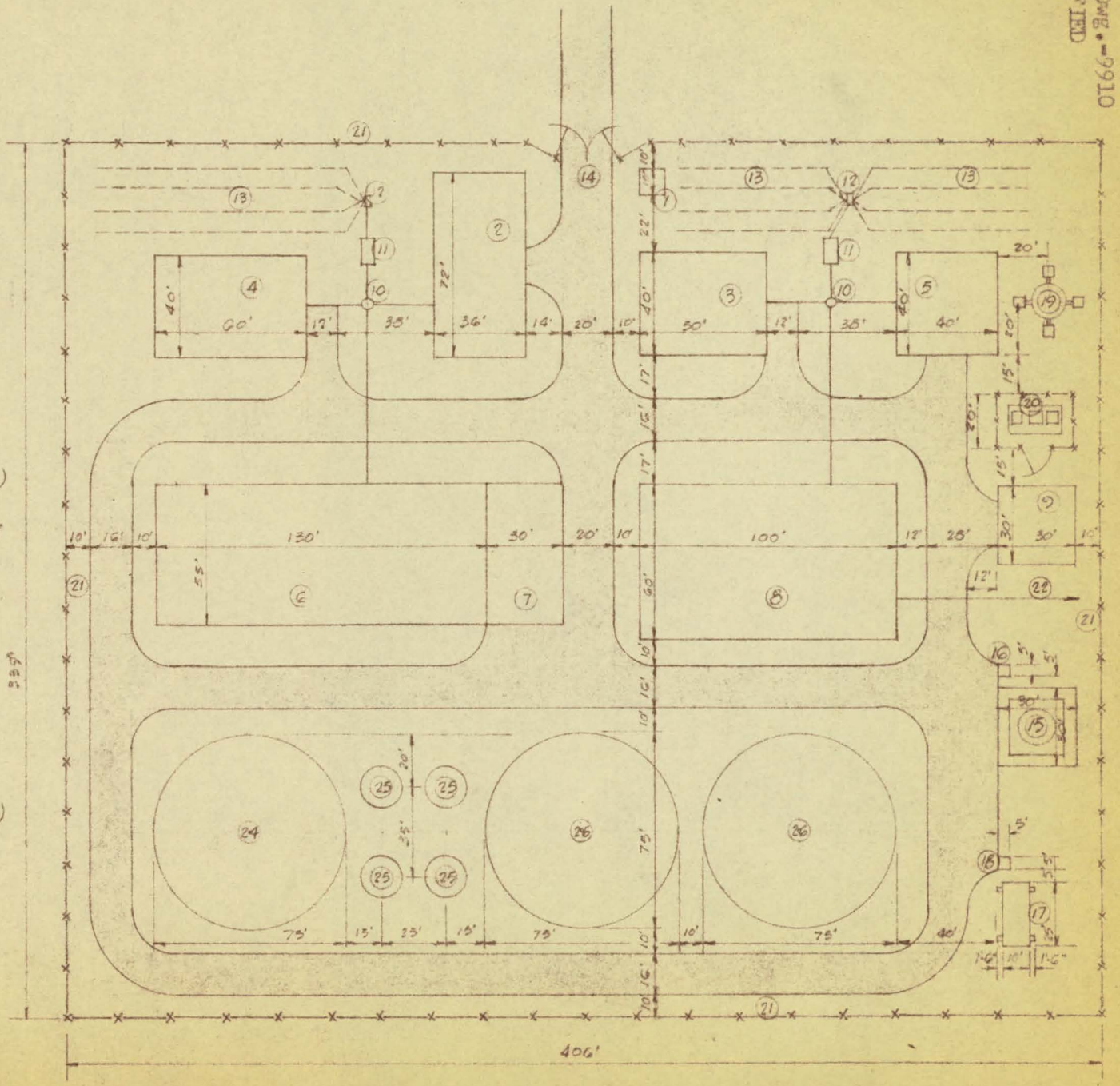

FIG. 1 PROPOSED MILL LAYOUT PLAN

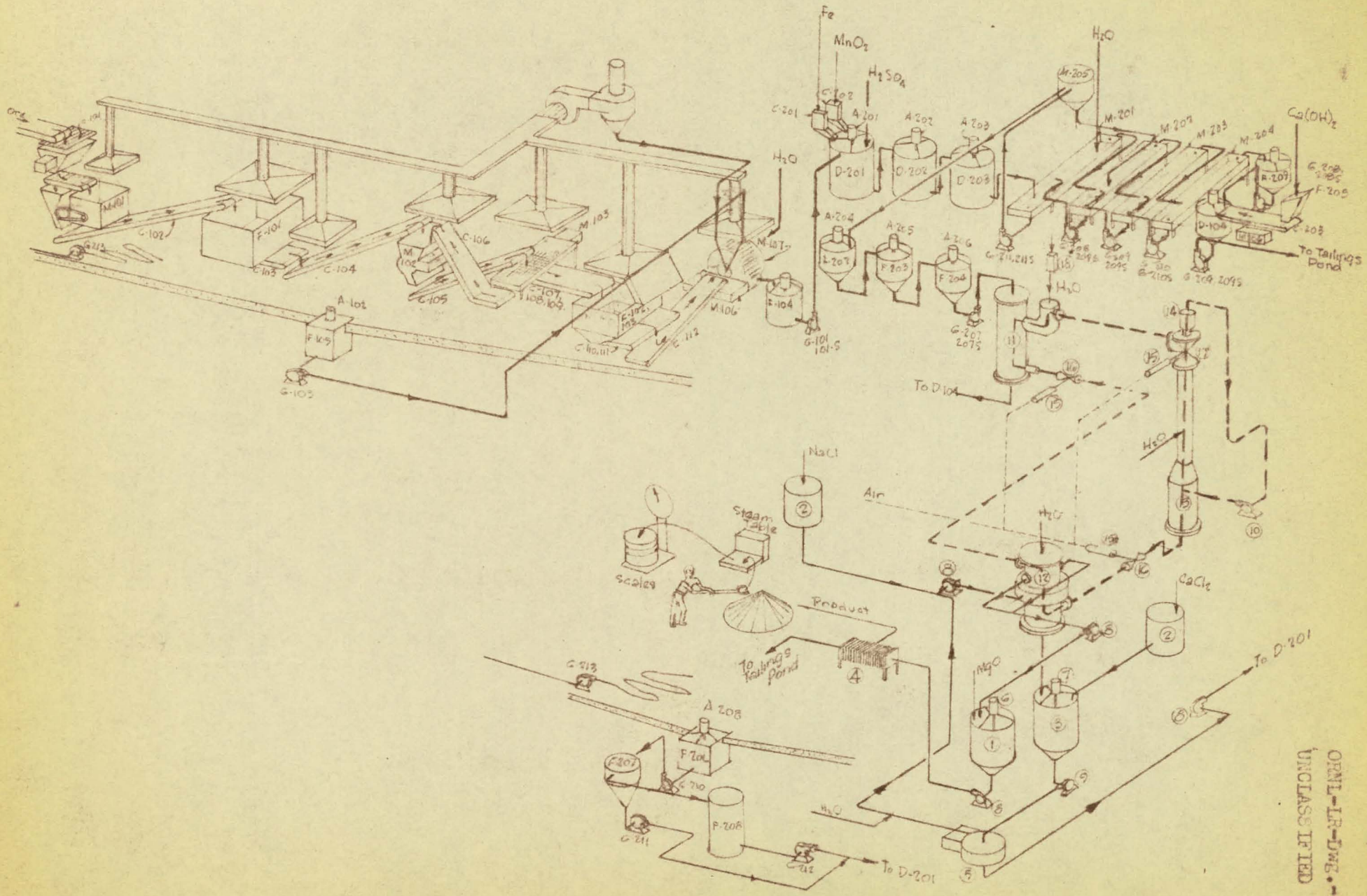

FIG. 2 ISOMETRIC FLOW DIAGRAM (BASE CASE & ALT. 3A.)

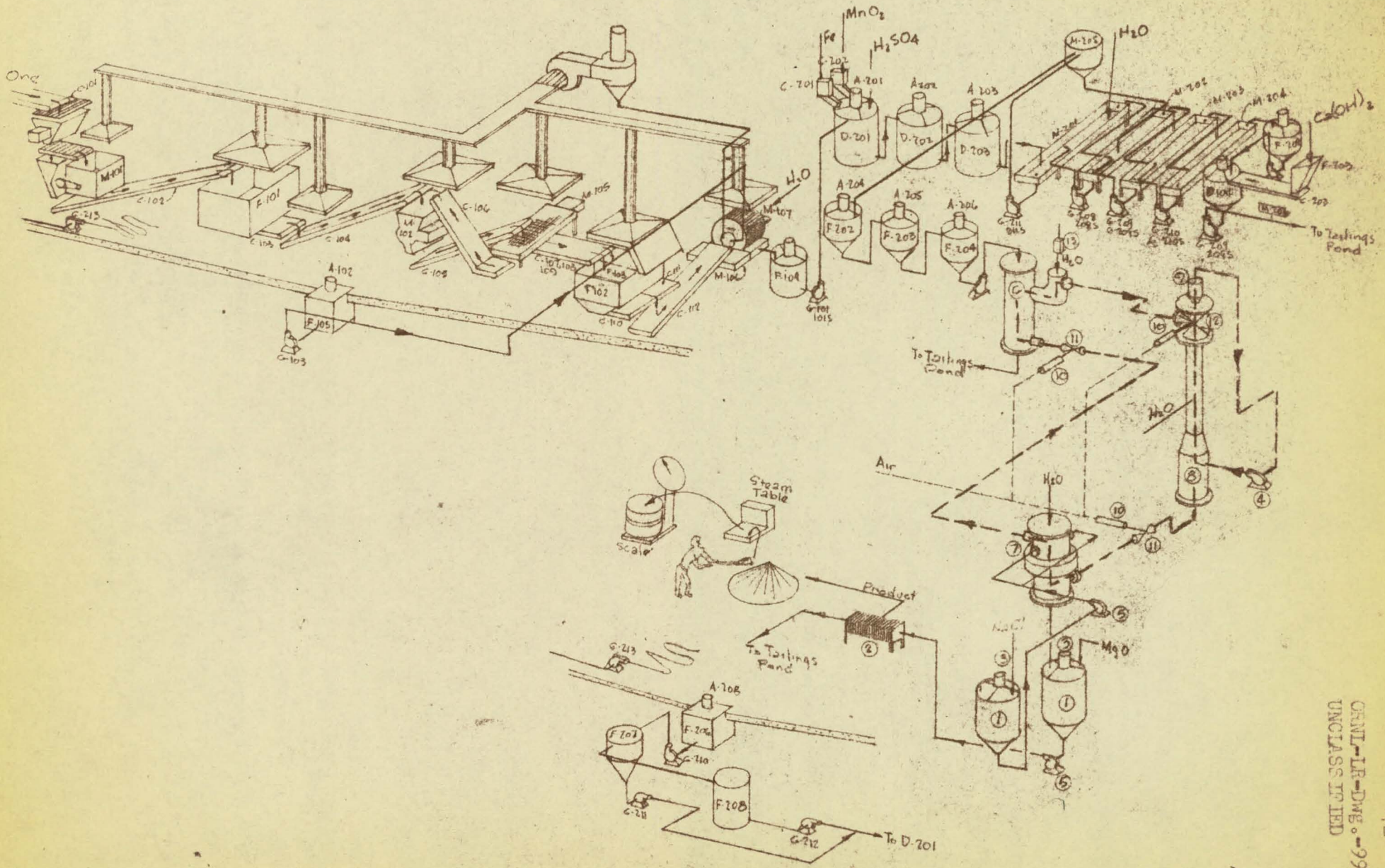

FIG. 3 ISOMETRIC FLOW DIAGRAM (ALT. 1 & ALT. 3B)

ORNL-LR-Dwg.-9912
UNCLASSIFIED

-72-

E4J 879

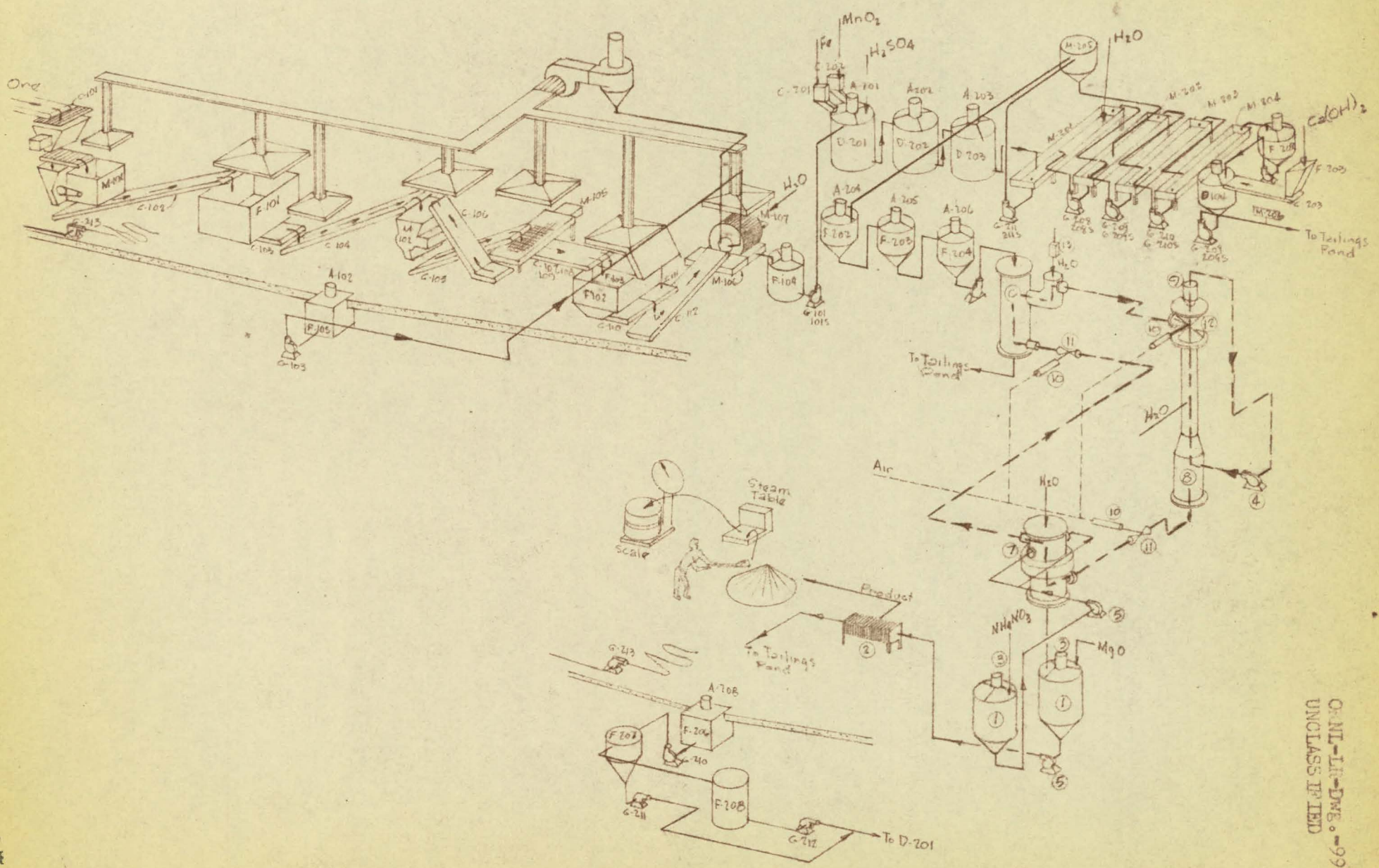

FIG. 4 ISOMETRIC FLOW DIAGRAM (ALT. 2 & ALT. 3C)

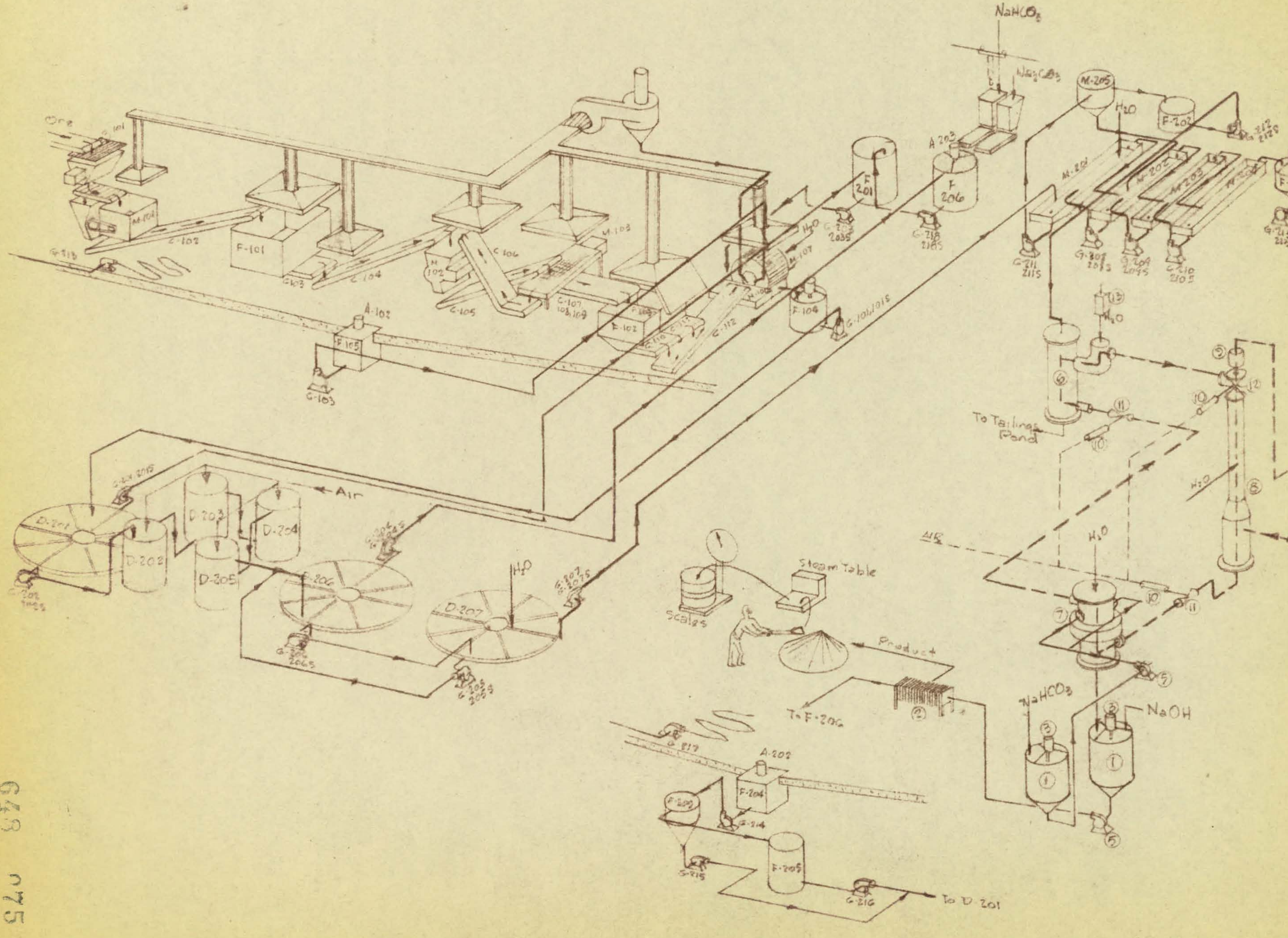

FIG. 5 ISOMETRIC FLOW DIAGRAM (ALT. 5)

ORNL-LR-DWG.-9914
UNCLASSIFIED

ORNL-LR-Dwg.-9915
UNCLASSIFIED

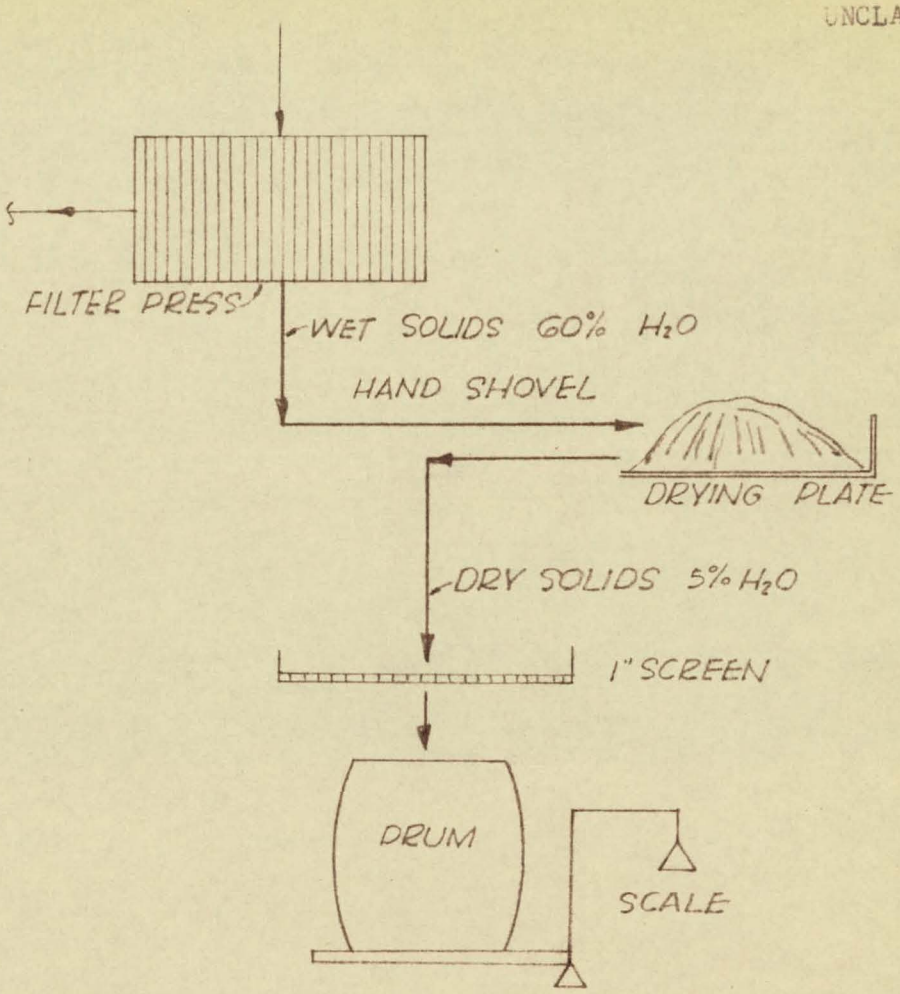

FIG. 6, FLOW DIAGRAM OF OPERATIONS FOR STEAM TABLE DRYING AND PACKAGING OF PRODUCT.

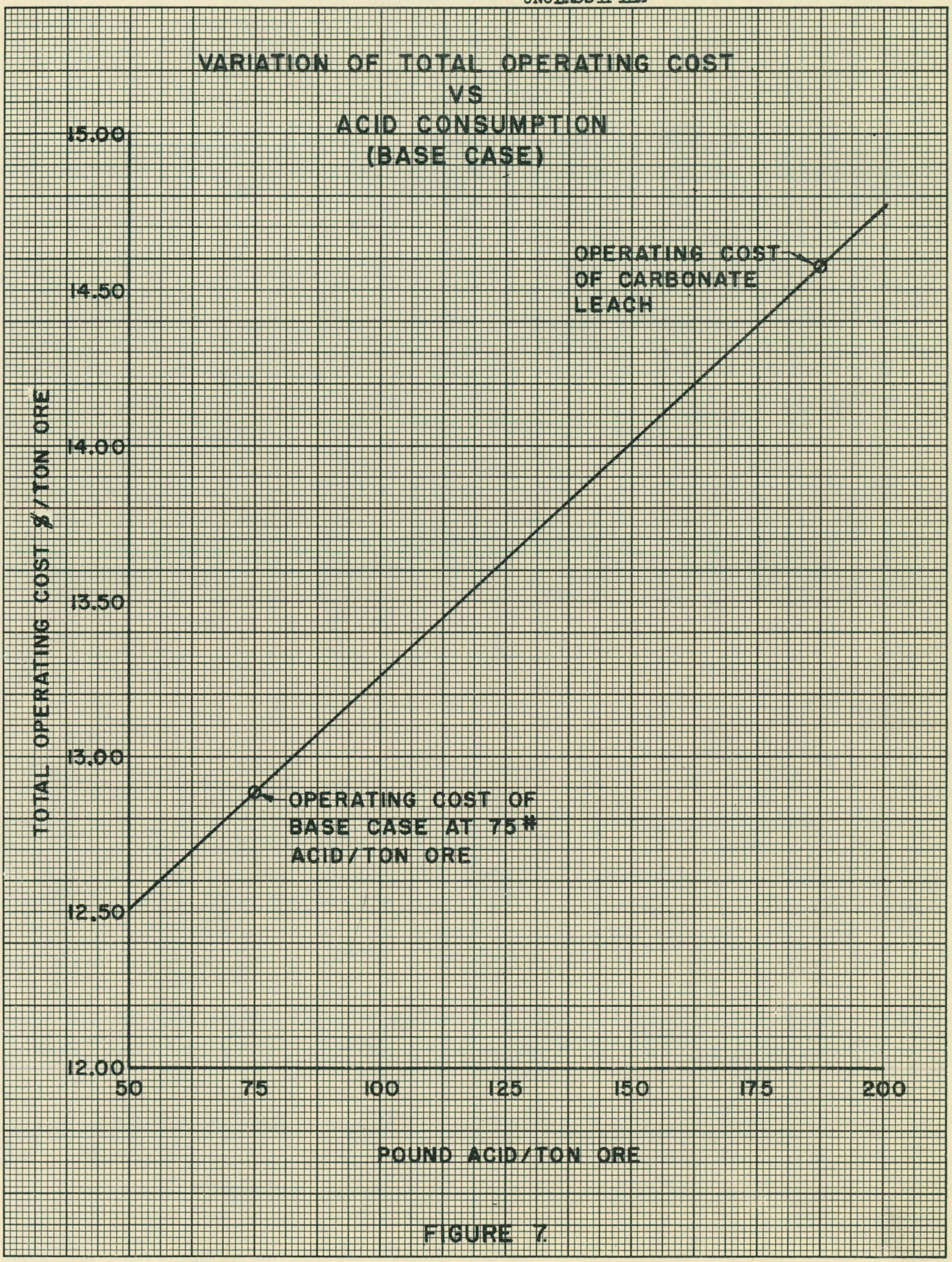

FIGURE 7.