A Pilot Plant Investigation of

THE RECOVERY OF LEAD AND ZINC

from Grum Deposit Samples

submitted by

KERR ADDISON MINES LIMITED

Progress Report No. 11, (Volume 1)

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Project No. L.R. 2027

NOTE:

This report refers to the samples as received.

LAKEFIELD RESEARCH OF CANADA LIMITED
Lakefield, Ontario
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REPORT COMPOSITION

VOLUME 1 - Summary, Discussion, Description of Equipment
Appendix No. 1 and No. 2
Tests PP-1 to PP-6

VOLUME 2 - Tests PP-7 to PP-23

VOLUME 3 - Tests PP-24 to PP-38

VOLUME 4 - Tests PP-39 to PP-53
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DISCUSSION

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A B S T R A C T

A pilot plant investigation on bulk samples, representing twelve different locations of the Grum deposit, showed that treatment of the Grum ore is possible. Lead concentrates assaying 60 to 62 % Pb at 77 to 78 % lead recovery were obtained using a fine primary grind and a light lead rougher concentrate regrind. Zinc concentrate grades of 55 - 57 % Zn were achieved at recoveries of 79 % to 80 % of the total zinc.

Several different flowsheets were tested. The final reagent scheme included Na_2CO_3 and lime as pH modifiers in the lead and zinc circuits, respectively NaCN as a zinc depressant, Z-11 as Pb collector and Z-11 and Z-200 as zinc collectors.

Optimization of the reagent scheme was carried out to eliminate $ZnSO_4$ from the circuit and to lower the NaCN requirements. It was found that $ZnSO_4$ could be eliminated from the circuit, and that the optimum NaCN addition was 0.6 lb/ton. Optimization of the primary grinding fineness and lead and zinc concentrate regrinding fineness, represented the bulk of the testwork. Fine primary grinding, light Pb concentrate regrinding and fine zinc concentrate regrinding was considered the best approach. The differences in the flotation behaviour under laboratory and pilot plant conditions are discussed.

It was established that 75 % of the total water input to the mill could be recycle water from the tailing pond.

I N T R O D U C T I O N

On August 25, 1977 a meeting was held at Lakefield with Mr. K.V. Konigsmann and Mr. B.P. Wallace of Noranda Mines Limited to discuss the primary objectives of the pilot plant testwork on Grum ore. Flowsheet and reagent schedule to be investigated initially were established.

The compositing instructions were defined in Dr. D. Carson's letter, dated October 1, 1977, which is presented as Appendix No. 3 at the end of the report.

Mr. K.V. Konigsmann and Mr. K. Stowe visited Lakefield frequently during the pilot plant operation. The majority of the tests were carried out under the supervision and direction of Mr. Konigsmann.

LAKEFIELD RESEARCH OF CANADA LIMITED

REGISTERED PROFESSIONAL ENGINEER
D. M. WYSLOUZIL
PROVINCE OF ONTARIO

D. M. Wyslouzil

D.M. Wyslouzil, P. Eng.
Manager

Bulatovic

Investigation by: R.G. Irwin
B.F. Glassford

S. Bulatovic, P. Eng.
Project Metallurgist

S U M M A R Y

1. Sample Description

Twelve samples of minus 10 inch ore were received during August 1977 from Kerr Addison Mines Limited. The pilot plant composite was prepared following the instructions from Dr. D. Carson of Noranda Mines Limited. The amount of the individual samples used, together with their assays, are shown below.

Sample No.	Weight %	Assays, %				Ag oz/ton
		Pb	Zn	Fe	S	
K76-1	5.0	6.95	10.30	26.8	38.5	3.11
K80-1	10.0	5.18	9.38	19.3	26.1	2.34
K68-1	10.0	5.42	11.3	31.3	36.9	2.59
J76-1	15.0	6.38	8.81	28.5	35.9	2.55
B-5	10.0	8.96	15.5	22.6	34.9	4.40
C-4	10.0	4.20	8.26	15.5	21.2	1.93
FV-4	5.0	6.88	16.8	18.1	27.9	3.34
D-4	5.0	4.10	8.44	6.98	11.6	2.04
H-4	10.0	3.78	8.20	14.4	17.0	1.89
G-4	10.0	1.49	3.40	5.56	6.87	0.68
FQ-4	5.0	7.81	14.1	17.8	26.9	3.60
A-2	5.0	9.23	6.15	23.7	29.2	3.01
Total (Calc.)	100.0	5.70	9.81	20.3	26.4	2.52
Assays*	-	6.06	10.1	20.5	27.0	2.85

* direct assays

Over sixty percent of the pilot plant composite sample consisted of massive sulphides with high lead and zinc concentrations.

A head sample removed from the crushed pilot plant feed composite was analysed for the following elements:

Summary - Continued

1. Sample Description

	Assays, %
Copper (Cu)	0.13
Zinc (Zn)	10.0
Iron (Fe)	20.5
Nickel (Ni)	0.036
Lead (Pb)	6.06
Cadmium (Cd)	0.0029
Cobalt (Co)	0.0076
Arsenic (As)	0.23
Sulphur (S)	27.0
Silica (SiO_2)	25.30
Lime (CaO)	0.85
Magnesia (MgO)	0.27
Mercury (Hg)	0.0082
Gold* (Au)	0.04
Silver* (Ag)	2.85
Insoluble Matter	28.2

* oz/ton

2. Pilot Plant Operation

A total of 53 tests were performed, most of which were run on a single-shift basis, averaging 7.75 hours duration per test. Eight tests were conducted in which the tailing effluent was recycled in the grinding and flotation circuits. One continuous test, over a period of 32 hours was run. This test was split into two 12-hour test periods and one 8-hour test period.

Summary - Continued

3. Grinding

One primary grinding and three regrinding mills were utilized in the flowsheet, and most of the flowsheet variation involved these mills in some way, either through a change in the steel load or a complete change of the mill.

3.1. Primary Grind

In the preliminary tests the primary grind was 87.6 % minus 200 mesh. In several tests, PP26 to PP31, the fineness of grind was decreased to between 69 % and 82 % minus 200 mesh and from test PP31 on was increased to 90 % minus 200 mesh, and was maintained at this fineness throughout the testwork. The grinding circuit in all tests consisted of a Hendy ball mill in closed circuit with a 2 inch P50 Dorr Cyclone. The circuit operated well and no changes were made. A feed rate of 700 pounds per hour was maintained throughout the testwork. Pertinent data for tests at different fineness of grind are shown in table No. 1 below.

Table No. 1

Primary Grinding Tests

Test No.	Cyclone O'flow Product			Power input kWh/ton*	Work Index
	% Passing -200 mesh	% Passing -400 mesh	D50 Microns		
PP14-24	87.6	64.1	37.5	14.6	11.59
PP26-30 and 35	79.9	54.6	46.3	11.2	10.30
PP31-34 and 38-44	90.7	69.1	33.4	17.8	13.50

The fineness of grind was controlled by varying the steel load, cyclone apex diameter and the pulp density of the cyclone feed.

Summary - Continued

3. Grinding

3.2. Lead Concentrate Regrind

The combined lead rougher concentrate and 2nd cleaner tailing were classified in a 1 inch Krebs cyclone. The cyclone underflow was reground and discharged to the cyclone feed pump. The cyclone overflow was pumped directly to the Pb cleaner circuit.

In tests PP1 to PP37 a Sala mill was used in the regrinding circuit. The steel load in the Sala mill was varied from 350 pounds to 1200 pounds. In some tests, PP38 to PP53, the Sala mill was replaced by a small Denver mill. The operation of the regrinding circuit was stable during the testwork, and consistent size distribution in the regrind and classification were produced. The lead regrinding results are shown in table No. 2 below.

Table No. 2

Pb Regrinding Tests

Test No. PP	Pb Rougher Concentrate % Passing -20 μm	Regrind Cyclone O'flow			Power Consumption kWh/ton*
		% Passing - 20 μm	% Passing - 10 μm	D50 μm	
9,25,26,27 37	54.2	98.6	75.6	7.6	15.77
31 - 34	53.0	90.5	47.1	11.5	6.32
28 - 44	68.0	84.0	47.6	11.4	N.D.

* kWh per short ton of flotation feed

Summary - Continued

3. Grinding

3.3. Zinc Regrinding

The combined zinc rougher concentrate, zinc 2nd cleaner tailing and zinc 1st cleaner scavenger concentrate were classified with a 1½ inch Krebs Cyclone. The Cyclone underflow was reground in a Hardinge Conical ball mill which discharged to the cyclone feed pump, and the cyclone overflow was pumped directly to the zinc cleaning circuit. The steel load as well as the regrinding feed, i.e. composition was varied during the testwork.

The operation of the regrind circuit was not stable during the testwork. The main problem was the variation in the weight recoveries of the zinc rougher concentrate and the zinc 1st cleaner scavenger concentrate. This resulted in unstable circulation loads in the classification and regrinding circuit thus decreasing grinding efficiency. The zinc regrind results from the representative tests are shown in table No. 3.

Table No. 3

Zn Regrinding Tests

Test No. PP	Regrind Cyclone O'flow			Power Consumption kWh/ton*
	% Passing -20 µm	% Passing -10 µm	d 50 µm	
31,32 and 33	60.7	31.8	18.5	3.37
30,36 and 37	64.0	37.3	16.0	4.04
41,47 and 49	83.5	48.7	12.4	6.86

* kWh per short ton of flotation feed

Summary - Continued

4. Flotation

4.1. General Evaluation

The pilot plant test program was designed a) to confirm the flowsheet and reagent balance established in the laboratory with the batch samples, b) to determine the optimum grinding and regrinding requirement, c) to select the lead and zinc flotation conditions that would stress the importance of high concentrate grades consistent with high metal recoveries.

During the course of the testwork an attempt was made to improve the selectivity between lead, zinc and pyrite in the lead and zinc rougher circuits and to lower the zinc losses in the zinc scavenger tailing. Different collectors and zinc and pyrite depressants that were evaluated during the testwork did not improve selectivity in the lead and zinc rougher circuit. Only the quantity of reagent additions affected flotation. In both circuits bulk concentrates were produced that were successfully separated after regrinding in the cleaning circuits.

In general, the metallurgical processing characteristics of the Grum composite sample could be summarized as follows:

1) The selectivity between lead, zinc and pyrite was a function of fineness of grind.
2) Extremely fine dissemination of the zinc in pyrite and gangue minerals resulted in high losses of zinc in the zinc scavenger tailing.
3) In the zinc cleaning circuit the fineness of the regrind and pH were found to be critical. Variations of only 0.1 to 0.3 pH units affected zinc concentrate grade.
4) In the lead cleaning low pulp density (5 - 10 % solids) had to be maintained in order to achieve effective cleaning and produce a high-grade lead concentrate.

Summary - Continued

4. Flotation

4.1. General Evaluation

5) Since in the lead rougher and cleaning circuits middling particles predominated over free lead particles, high recirulating loads were observed in most of the tests in which only a light Pb concentrate regrind was applied (Test PP31 to PP53).

4.2. Final Flowsheet

The final flowsheet employed in the testwork in tests PP38 to PP53 is illustrated in figure No. 1 (a,b). This flowsheet involved the following steps:

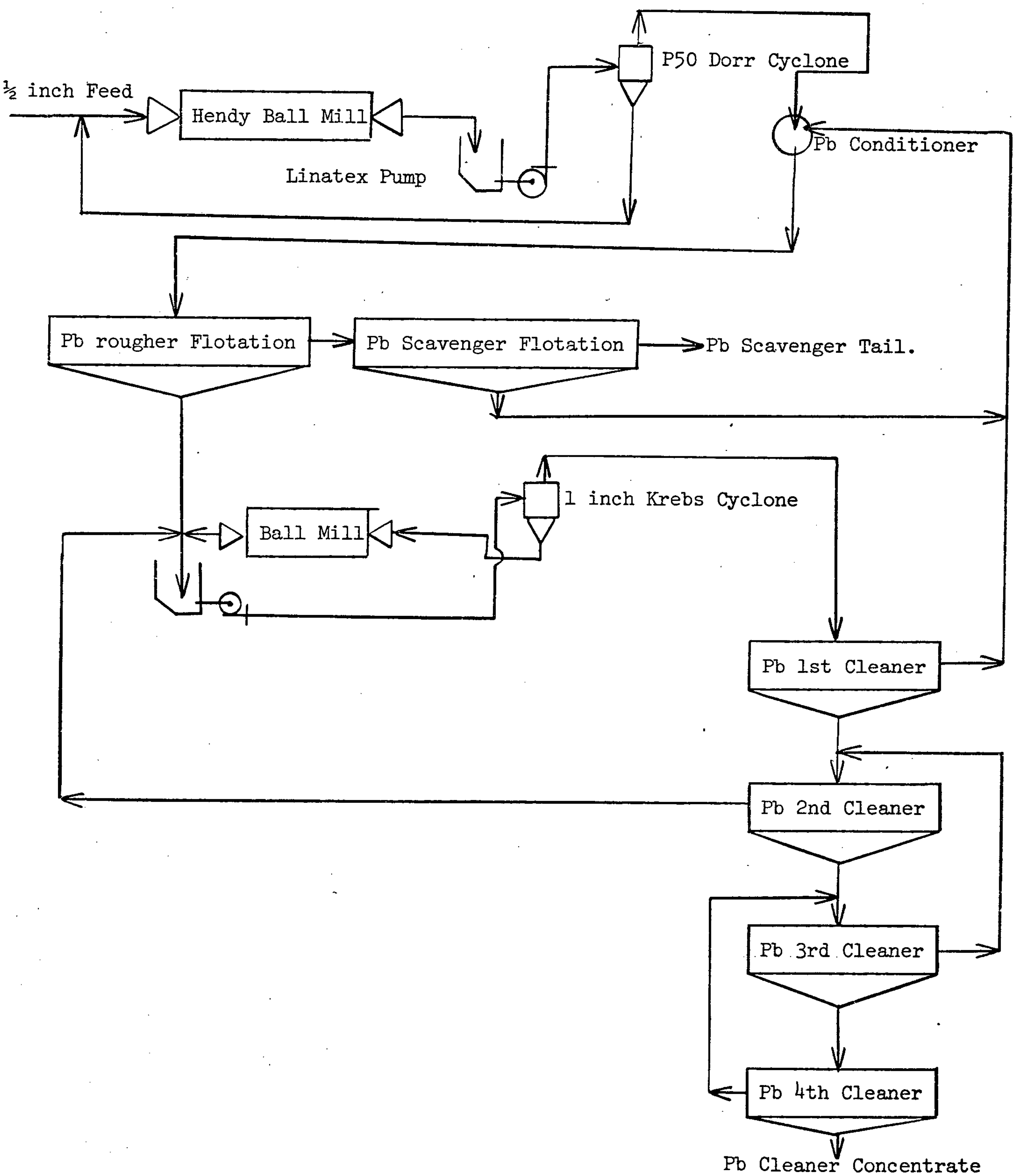
1) Grinding the ore in the presence of NaCN and collector Z-11 at pH 9.0, controlled with soda ash
2) Conditioning the flotation feed with collector R-242 and Z-11
3) Flotation of lead rougher and scavenger concentrate with extra Z-11 additions
4) Regrinding the combined lead rougher concentrate and lead 2nd cleaner tailing with additions of NaCN and soda ash, and cleaning the rougher concentrate in four stages.
5) Stage-conditioning the lead scavenger tailing with $CuSO_4$ and $Ca(OH)_2$
6) Flotation of the zinc rougher and scavenger concentrates with collector Z-11 and Z-200
7) Regrinding the combined zinc rougher concentrate, zinc 2nd cleaner tailing and zinc 1st cleaner scavenger concentrate. Cleaning the zinc reground products in four stages in open-circuit cleaning.
8) Re-flotation of the zinc 1st cleaner tailing with collector Z-11 and Z-200

Summary - Continued

Figure No. 1

Flowsheet

a) Primary Grind and Leach Circuit

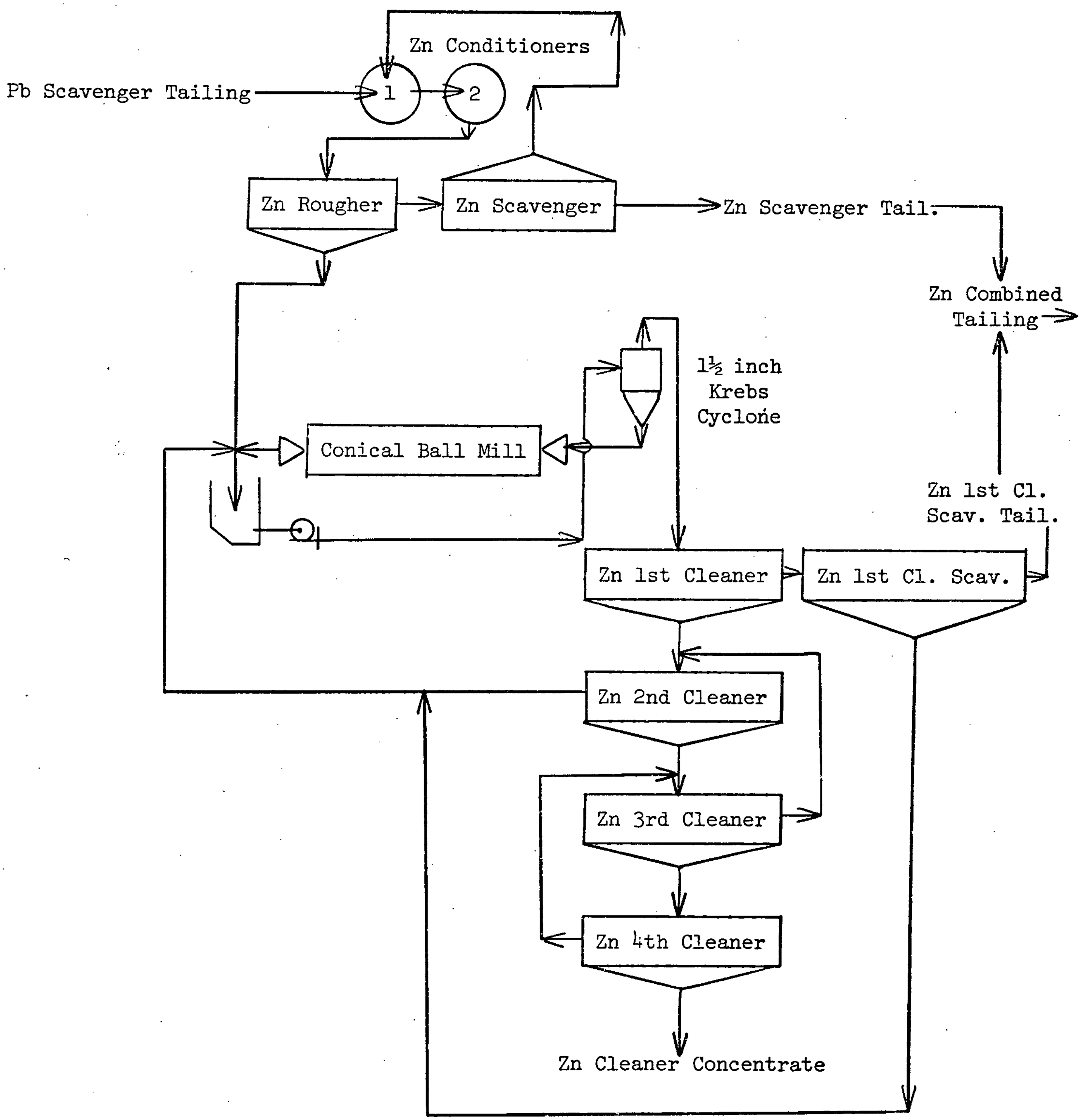


Summary - Continued

Figure No. 1

Flowsheet

b) Zinc Circuit



Summary - Continued

4. Flotation

4.3. Reagent Balance

Table No. 4 shows the reagent balance for the lead and zinc flotation circuits, respectively.

Table No. 4

Reagent Balance

Lead and Zinc Circuit

Stage	Reagents Added, pounds per short ton									
	Na_2CO_3	NaCN	$ZnSO_4$*	$Ca(OH)_2$	$CuSO_4$	Z-11	MIBC	Z-200	DF-250	R-242
Primary Grind	3.5	0.22	0.9	-	-	0.09	-	-	-	-
Pb Rougher	-	-	-	-	-	-	0.160	-	-	0.02
Pb Scavenger	-	-	-	-	-	0.04	0.02	-	-	-
Pb Regrind	0.5	0.30	0.5	-	-	-	-	-	-	-
Pb Cleaning	-	0.16	-	-	-	-	-	-	-	0.01
Zn Conditioning	-	-	-	2.2	2.0	-	-	-	-	-
Zn Ro. and Scav.	-	-	-	-	-	0.24	-	-	0.13	-
Zn Regrind	-	-	-	1.2	0.3	-	-	0.05	-	-
Zn Cleaning	-	-	-	0.8- 1.2	-	0.03 0.02	-	0.01 0.02	0.03	-

*Omitted from the circuit in tests PP50 - 52

None of the collectors or pyrite and zinc depressants tested in the lead and zinc rougher circuits enhanced the selectivity between lead, zinc and pyrite. The low collector additions were helpful in the lead and zinc rougher circuits but resulted in decreased recoveries. However, the additions of collector in the lead cleaning should be kept at the low level in order to produce a high-grade lead concentrate.

Summary - Continued

4. Flotation

4.3. Reagent Balance

At higher NaCN additions, over 0.6 lb/ton, no noticeable improvement in selectivity was achieved. $ZnSO_4$ could be entirely removed from the lead circuit (Test PP50 and 51). Replacing collector Z-200 with collector Z-11 in tests PP49-53 lowered the grade of the zinc concentrate. The level of $CuSO_4$ additions were maintained at 2.0 lb/ton in most of the tests. Lower additions (1.5 lb/ton) were tried in tests 18, 19 and 20. No deterioration in the zinc flotation was observed in these tests. The additions of collector R-242 in the lead rougher circuit improved froth conditions.

4.4. Metallurgical Results

4.4.1. Single-Shift Results

The best flotation results obtained in a single shift test period using the above reagent balance and flowsheet are summarized in table No. 5 below.

Table No. 5

Metallurgical Results - Single Shift

Test No.	Product	Weight %	Assays, %		% Distribution	
			Pb	Zn	Pb	Zn
PP32	Pb Cleaner Concentrate	6.97	65.40	9.45	78.1	6.6
	Zn Cleaner Concentrate	14.65	2.16	54.50	5.4	79.8
	Zn Combined Tailing	78.38	1.23	1.73	16.5	13.6
	Flotation Feed (Calc.)	100.00	5.80	10.00	100.0	100.0
PP41	Pb Cleaner Concentrate	7.07	62.70	10.40	77.2	7.3
	Zn Cleaner Concentrate	13.78	2.37	57.40	5.7	79.6
	Zn Combined Tailing	79.15	1.24	1.65	16.8	12.4
	Flotation Feed (Calc.)	100.00	5.74	9.95	100.0	100.0

Summary - Continued

4. Flotation

4.4. Metallurgical Results

4.4.1. Single-Shift Results

The above results were obtained at a fine primary grind, light regrind of the lead rougher concentrate and fine regrind of the zinc rougher concentrate. The lead concentrate grade averaged 63.5 % Pb at 77.6 % Pb recovery. The zinc concentrate grade averaged 56 % Zn at 79.8 % Zn recovery.

4.4.2. Continuous Run Test Results

The results obtained during the continuous run after 16 and 24 hours are presented in table No. 6 below.

Table No. 6

Metallurgical Results - Continuous Run

Test No.	Test Period Hours	Product	Weight %	Assays, %		% Distribution	
				Pb	Zn	Pb	Zn
PP42	16	Pb Cleaner Concentrate	7.18	60.90	10.8	75.6	7.7
		Zn Cleaner Concentrate	16.66	2.65	48.4	7.6	79.9
		Zn Combined Tailing	76.16	1.27	1.65	16.8	12.4
		Flotation Feed (Calc.)	100.00	5.74	9.55	100.0	100.0
PP43	24	Pb Cleaner Concentrate	7.30	60.7	10.9	75.9	8.0
		Zn Cleaner Concentrate	14.50	2.64	52.1	6.6	75.5
		Zn Combined Tailing	78.20	1.30	2.11	17.5	16.5
		Flotation Feed (Calc.)	100.00	5.78	10.10	100.0	100.0

Summary - Continued

4. Flotation

4.4. Metallurgical Results

4.4.2. Continuous Run Test Results

Compared with the results obtained in a single shift, the lead concentrate grade was 2 % to 4 % lower and the lead recovery dropped by 1 % to 3 %. The grade and recovery of zinc in tests PP42 and PP43 was affected by an increased circulation load in the regrind circuit which resulted from insufficient regrinding. This indicated that recirculation of middling products, i.e. Zn 2nd cleaner tailing and Zn 1st cleaner scavenger concentrate, must be closely controlled in order to achieve a stable zinc regrinding circuit.

5. Gold and Silver Distribution

The products from several pilot plant tests were assayed for silver and gold to determine the distribution in the various circuits. These results are presented in table No. 7 below.

Table No. 7

Test No.	Product	Weight %	Assays, oz/ton		% Distribution	
			Au	Ag	Au	Ag
PP25	Pb Cleaner Concentrate	8.02	0.100	25.01	48.8	72.5
	Zn Cleaner Concentrate	16.04	0.005	2.13	4.9	12.4
	Zn Combined Tailing	75.94	0.010	0.55	46.3	15.1
	Flotation Feed (Calc.)	100.00	0.020	2.76	100.0	100.0
PP35	Pb Cleaner Concentrate	6.77	0.130	27.82	50.6	74.8
	Zn Cleaner Concentrate	12.30	0.005	20.1	3.4	9.8
	Zn Combined Tailing	80.93	0.010	0.48	46.0	15.4
	Flotation Feed (Calc.)	100.00	0.020	2.52	100.0	100.0
PP37	Pb Cleaner Concentrate	7.32	0.11	27.75	46.6	77.2
	Zn Cleaner Concentrate	16.72	0.01	2.17	9.8	13.8
	Zn Combined Tailing	75.96	0.01	0.31	43.6	9.0
	Flotation Feed (Calc.)	100.00	0.02	2.62	100.0	100.0

Summary - Continued

5. Gold and Silver Distribution

Between 47 % to 50 % of the gold and 72 % to 77 % of the silver could be recovered in the lead concentrate.

6. Effect of Recycle Water

A series of eight tests was conducted in which tailing effluent from the pilot plant tailing was recycled to the grinding and flotation circuits. These results are compared in table No. 8 below.

Table No. 8

Test No.	Water Used	Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
PP41	Fresh 100%	Pb Cleaner Concentrate	7.07	62.70	10.4	77.2	7.3
		Zn Cleaner Concentrate	13.78	2.37	57.4	5.7	79.6
		Zn Combined Tailing	79.15	1.24	1.65	17.1	13.1
		Flotation Feed (Calc.)	100.00	5.75	9.95	100.0	100.0
PP45	Recycle 100%	Pb Cleaner Concentrate	9.38	46.80	15.4	76.5	14.7
		Zn Cleaner Concentrate	13.13	2.61	53.8	6.0	71.7
		Zn Combined Tailing	77.49	1.30	1.73	17.5	13.6
		Flotation Feed (Calc.)	100.00	5.80	9.95	100.0	100.0
PP46	Recycle 70% *Fresh 30%	Pb Cleaner Concentrate	6.90	64.6	9.25	77.9	6.4
		Zn Cleaner Concentrate	14.69	2.23	55.5	5.7	81.5
		Zn Combined Tailing	78.41	1.19	1.54	16.4	12.1
		Flotation Feed (Calc.)	100.00	5.72	10.00	100.0	100.0

* added to Pb cleaning only

The use of 100 % effluent failed (Test PP45) because of excessive frothing in the lead cleaning which reduced Pb concentrate grade and deteriorated Pb-Zn selectivty. The results indicated that approximately 70 % to 75 % of the recycle water could be used in the grinding and zinc rougher and cleaning circuit. Recycle water could not be used in the lead cleaner circuit.

Summary - Continued

7. Summary of Results

7.1. Variables Investigated

Test No.	Variables
PP1	Preliminary test to fill the circuit, and to evaluate the steel ball load in the grinding circuit and cyclone sizes.
PP2	To adjust grinding and regrinding circuit and to obtain steady recirculation load in the classification. Stabilize reagent additions and pH.
PP3	To produce stable recirculation load in the lead regrind and classification. To lower the zinc and lead losses in the flotation tailing. Zinc collector M-748 was replaced with Z-200. Collectors Z-11 and R-242 in the lead rougher and 1st cleaner were increased slightly.
PP4	Removed collectors R-242 and Z-11 from the Pb cyclone regrinding feed pump. Collector Z-11 was added to the Pb 1st cleaner No. 5 cell and collector R-242 to the regrind mill feed. Replaced 2 inch Goodwin cyclone in the Zn regrind by 2½ inch Goodwin cyclone.
PP5	Omitted $ZnSO_4$ from the lead circuit and increased cyanide additions. Collector R-242 added to the Pb 1st cleaner feed instead of to the Pb regrind. Omitted Zn regrinding stage.
PP6	Decreased collector R-242 additions to the 1st cleaner. Sala mill with overflow discharge was converted to grate mill discharge. Collector Z-11 in the zinc circuit was replaced with collector Z-6. Na_2SO_3 was added in the primary grind mill feed. The lead 1st cleaner feed was conditioned for 16 minutes in the high speed conditioner
PP7	Replaced collector Z-11 in the lead rougher with collector Z-6. Replaced collector R-242 and Z-11 in the lead cleaning with collector Z-6. Introduced aeration step in the Pb circuit. Collector Z-200 in the zinc circuit was replaced with collector M748
PP8	Omitted aeration step from the lead circuit. Replaced collector Z-6 with collector R-242 in the Pb 1st cleaner. Zinc 1st cleaner tail was refloated and discarded. Refloat concentrate returned to the zinc rougher feed.
PP9	Repeated conditions of test PP6 - lead circuit, with $ZnSO_4$ additions to the primary grind and Pb scavenger feed. Added cyanide to the Pb scavenger feed. Repeated conditions of test PP8 zinc circuit at a slightly higher pH
PP10	Omitted Pb rougher concentrate regrinding stage. Removed collector Z-11 from the mill feed and added to the cyclone feed pump at a rate of 0.04 lb/ton. Collector R-242 was added to the mill feed at a rate of 0.03 lb/ton.

Summary - Continued

7. Summary of Results

7.1. Variables Investigated

Test No.	Variables
PP11	Repeated conditions of test PP10 but Pb rougher concentrate reground slightly. Introduced conditioning step with collector M-748 in the Zn rougher circuit.
PP12	Repeated conditions of test PP11 at a finer lead rougher concentrate regrind. In the zinc circuit collector Z-6 was added to the zinc conditioner No. 2 instead to the Zn rougher feed pump.
PP13	Repeated conditions of test PP12 at finer lead concentrate regrind. Increased pH in the Zn 3rd and 4th cleaner from 11.0 to 11.8
PP14	Investigated the effect of multiple stage Pb concentrate regrind on lead cleaning. Pb rougher concentrate reground in the Sala mill as for test PP11 and Pb 1st cleaner concentrate reground in the small Denver mill.
PP15	Repeated conditions of test 14 for the lead circuit. Investigated the effect of zinc scavenger concentrate and Zn 1st cleaner tailing regrind on Zn grade and recovery.
PP16	Increased pH in the zn cleaning from 10.5 - 11.0. Omitted collector Z-6 in the Zn 1st cleaner and Z-200 increased. Collector Z-6 additions to the Zn rougher decreased and collector M-748 increased.
PP17	Repeated conditions of test PP9 for the lead circuit. Repeated conditions of test PP16 for the Zn circuit at a higher pulp density in the zinc concentrate regrind mill.
PP18	Omitted NaCN and $ZnSO_4$ from the Pb scavenger feed. Reduced NaCN additions to the Pb 2nd cleaner. Increased Z-6 additions to the Pb rougher. Decreased $CuSO_4$ in the Zn rougher from 2.0 lb/ton to 1.5 lb/ton. Zn rougher concentrate was reground in the Conical mill. Refloated Zn 1st cleaner tailing as for test PP8.
PP19	Reagent Z-11 added to the Hendy mill feed and reagent 241 to the cyclone feed pump. MIBC omitted from the Pb rougher cell No. 3 feed. Collector Z-200 added to the Zn 3rd cleaner feed. pH to the Zn rougher decreased from 10.5 to 10.0. Collector R-242 added to the Sala mill feed insteadof to the Pb 1st cleaner feed pump.
PP20	Collector Z-11 omitted from the Pb conditioner. Collector R-241 removed from the Hendy mill cyclone pump and added to the Pb conditioner. Omitted NaCN additions to the Pb 3rd and 4th cleaner feed. Omitted lime additions to the Zn 3rd and 4th cleaners.

Summary - Continued

7. Summary of Results

7.1. Variables Investigated

Test No.	Variables
PP21	Increased Z-11 additions to the Hendy mill feed from 0.1 lb/ton to 0.12 lb/ton. Increased Zn flotation time for 6 minutes, and 2nd scavenger concentrate was returned to the Zn scavenger No.1 feed. Omitted Z-200 and M-748 from the zinc circuit. Lead 2nd cleaner tailing recycled to the Pb 1st cleaner feed instead to the lead regrinding cyclone pump.
PP22	Increased Zn additions to the Hendy mill slightly. Pb 2nd cleaner tailing recycled to the Pb regrinding feed pump instead to the Pb 1st cleaner feed. Zn 1st cleaner tailing refloated in open circuit and 1st cleaner scavenger concentrate returned to Zn rougher concentrate regrinding. Reduced Zn flotation time.
PP23	Omitted $ZnSO_4$ from the lead circuit. Added Z-200 to the Zn rougher and cleaning. Increased pH in the Zn cleaning and decreased to the Zn rougher.
PP24	Investigated the effect of Na_2S additions to the Pb circuit. Increased Zn flotation time as for test PP21.
PP25	Omitted Na_2S from the lead circuit and added $ZnSO_4$ at a rate of 0.5 lb/ton.
PP26	Investigated the effect of coarser primary grind on Pb and Zn flotation. Decreased collector additions to the Zn rougher. Decreased Zn flotation time. Varied level of MIBC additions to the lead cleaning. Diluted pulp to the Pb 2nd, 3rd and 4th cleaner.
PP27	Repeated conditions of test PP26 at a higher pulp density in the Pb cleaning
PP28	Repeated conditions of test PP27 at a coarser lead concentrate regrind. Decreased collector additions to the lead rougher.
PP29	Repeated conditions of test PP28 at a lower pulp density in the Pb cleaning. Decreased collector additions to the Pb 1st cleaner.
PP30	Repeated conditions of test PP29 at decreased Pb 1st cleaner time.
PP31	Repeated conditions of test PP30 at a finer primary grind and coarser lead concentrate regrind.
PP32	Repeated conditions of test PP31
PP33	Repeated conditions of test PP32
PP34	Repeated conditions of test PP33
PP35	Repeated conditions of test PP9 for lead circuit. Added H_2SO_4 to the Zn conditioner No. 1

Summary - Continued

7. Summary of Results

7.1. Variables Investigated

Test No.	Variables
PP36	Increased collector Z-11 to the lead rougher and scavenger feed. Increased collectors Z-6 and Z-200 to the zinc rougher and scavenger feed.
PP37	Investigated the effect of collector 404 additions to the Zn rougher. Increased collector R-242 to the Pb cleaner.
PP38	Investigated the effect of coarse lead concentrate regrind using reagent balance as for test PP34.
PP39	Repeated conditions of test PP38
PP40	Repeated conditions of test PP39 but Goodwin 1½ inch cyclone in the Pb regrinding was replaced with 1 inch Krebs cyclone.
PP41	Repeated conditions of test PP4 for lead circuit. Added collector Z-11 to the Zn 1st cleaner. Increased pH to the Zn 3rd and 4th cleaner.
PP42	First of 3 continuous tests (36 hours) using conditions of test PP41.
PP43	Second continuous test. No changes in the circuit were made.
PP44	Third continuous test. No changes in the circuit were made.
PP45	First test from the series of tests using recycle water from the tailing pond. Approximately 95 % of the recycle water was added to the circuit.
PP46	Omitted recycle water from the lead cleaning (recycle water used 69 %). Repeated conditions of test PP39 for Zn circuit.
PP47	Increased additions of fresh water to the Pb cleaning (Recycle water added 60 %).
PP48	Repeated conditions of test PP47 at reduced collector additions to the lead circuit.
PP49	Omitted Z-200 from the Zn circuit. Frother DF-250 replaced with MIBC.
PP50	Repeated conditions of test PP49 but Frother DF-250 returned to the Zn circuit. Omitted $ZnSO_4$ from Pb circuit.
PP51	Repeated conditions of test PP50.
PP52	Investigated the effect of open circuit Pb cleaning.
PP53	Repeated conditions of test PP52.

Summary - Continued

7. Summary of Results

7.2. Grinding and Regrinding Data

Test No. PP	Primary Grind: Cyclone O'flow % Pass -200M	Primary Grind: Cyclone O'flow % Pass -400M	Primary Grind: Power kWh/ton*	Primary Grind: Work Index	Pb Regrind: Pb Ro. Conc. % Passing - 20 µm	Pb Regrind: Cyclone O'flow % Pass -20µm	Pb Regrind: Cyclone O'flow % Pass -10µm	Pb Regrind: Power kWh/ton**	Zn Regrind: Cyclone O'flow % Pass -20µm	Zn Regrind: Cyclone O'flow % Pass -10µm	Zn Regrind: Power kWh/ton**
1	90.9	68.8	16.05	11.38	56.9	88.2	55.0	15.35	90.5	50.0	1.43
2	90.9	68.9	15.88	11.34	56.3	100.0	97.0	17.03	69.4	33.0	0.66
3	91.6	70.2	16.91	11.83	54.7	100.0	77.0	19.09	69.5	38.8	2.17
4	91.3	70.1	15 .20	10.78	59.0	100.0	66.0	19.09	75.0	43.0	1.70
5	93.7	74.0	15.89	11.12	61.5	95.7	82.9	17.03	58.5	-	-
6	89.1	66.7	15.20	11.45	59.0	100.0	77.5	18.74	48.5	-	-
7	89.5	66.9	15.21	11.43	55.5	88.5	64.1	19.43	-	-	-
8	88.5	65.9	14.89	11.48	61.0	100.0	86.7	20.10	-	-	-
9	88.6	65.4	14.89	11.44	64.5	97.0	76.6	20.50	-	-	-
10	87.4	64.7	14.87	11.33	50.1	-	-	-	-	-	-
11	87.0	63.0	14.53	11.11	52.5	76.0	55.2	10.26	-	-	-
12	88.1	64.9	15.54	11.46	50.5	90.2	63.2	15.54	-	-	-
13	87.4	63.3	14.89	11.43	56.5	100.0	81.0	13.30	-	-	-
14	87.6	64.0	14.89	11.23	53.3	89.2	66.7	12.63	-	-	-
15	87.5	64.2	15.54	12.82	48.3	99.2	68.0	13.31	70.5	53.9	5.86
16	86.2	61.9	14.20	11.78	54.5	99.1	70.0	11.63	80.2	56.6	1.11
17	87.6	63.4	14.90	12.08	44.5	100.0	88.0	18.06	83.0	62.0	1.77
18	87.2	63.6	14.96	11.54	60.5	95.4	72.2	17.06	70.3	46.7	1.77
19	88.0	64.6	14.89	11.53	60.0	96.0	90.0	17.74	78.5	48.0	2.11
20	88.0	65.6	14.89	11.53	60.1	98.2	90.0	17.50	75.2	49.0	2.80
21	87.7	64.4	14.54	11.72	61.0	100.0	92.3	17.40	72.0	45.0	1.46
22	88.2	65.3	13.86	10.65	54.2	95.6	81.0	19.68	82.0	59.5	2.80
23	88.0	64.6	14.45	11.31	56.2	98.8	90.0	16.37	58.2	37.0	2.80
24	87.3	63.9	13.86	11.25	60.5	98.9	87.0	16.71	73.3	47.8	3.14
25	88.5	65.2	16.58	11.91	55.0	98.8	77.6	16.71	84.0	43.5	3.82
26	79.9	52.9	12.49	11.65	48.5	100.0	72.3	16.71	47.5	30.4	2.80
27	69.3	45.2	10.34	11.21	50.0	99.0	71.3	16.83	60.3	35.0	4.40
28	82.4	57.9	9.46	8.16	47.2	95.0	70.0	8.23	56.0	31.0	2.80
29	82.7	57.1	11.83	10.15	47.2	96.0	50.0	8.00	50.0	30.3	2.90
30	82.0	56.4	11.87	10.35	50.0	94.0	70.0	7.20	49.6	25.0	3.30
31	89.8	67.0	61.91	12.94	60.0	85.0	50.0	6.89	50.0	30.3	3.49
32	90.3	68.2	17.91	13.70	45.0	90.0	49.2	5.51	63.5	32.0	2.80
33	91.6	71.5	17.60	13.78	55.0	90.0	45.0	6.70	69.8	33.0	3.83
34	90.3	67.9	17.60	13.51	52.0	89.0	44.3	6.20	60.0	28.3	2.80
35	83.0	57.8	20.00	17.18	55.0	95.0	70.2	13.30	80.0	50.2	5.51
36	92.4	71.4	20.31	14.74	55.4	90.0	71.3	11.97	79.6	49.0	4.36
37	91.6	70.3	19.63	13.75	63.0	98.0	70.4	11.63	65.0	38.0	4.40

* kWh per short ton of ½ inch feed
** kWh per ton of flotation feed

Summary - Continued

7. Summary of Results

7.2. Grinding and Regrinding Data

Test	Primary Grind				Pb Regrind				Zn Regrind		
No.	Cycone O'flow		Power kWh/ ton*	Work Index	Pb Ro. Conc. % Passing -20 µm	Cyclone O'flow		Power kWh/ ton**	Cyclone O'flow		Power kWh/ ton**
PP	% Pass -200M	% Pass -400M				% Pass -20µm	% Pass -10µm		% Pass -20µm	% Pass -10µm	
38	91.6	70.3	19.29	14.28	60.0	75.0	35.0	N.D.	53.0	32.0	4.83
39	91.0	69.3	18.26	13.49	70.0	85.0	45.0	N.D.	72.0	45.0	3.85
40	91.5	71.0	18.60	13.74	70.0	85.0	48.2	N.D.	66.5	35.0	4.49
41	91.1	70.0	18.60	13.72	69.8	88.2	55.2	N.D.	75.5	36.0	5.17
42	91.0	69.1	17.71	13.10	69.8	84.0	50.0	N.D.	42.3	22.0	5.26
43	91.0	69.1	17.49	12.94	70.0	85.0	50.5	N.D.	36.0	20.0	3.49
44	89.9	67.4	17.91	13.47	67.2	86.0	49.6	N.D.	39.4	18.6	2.80
45	91.0	69.5	17.91	13.26	62.5	88.3	51.2	N.D.	39.5	23.3	3.86
46	90.3	68.3	16.91	12.50	65.3	82.0	46.0	N.D.	65.0	33.0	4.49
47	89.6	67.9	17.91	13.44	70.0	86.5	51.5	N.D.	80.0	60.0	7.89
48	89.9	65.6	17.60	13.48	75.3	90.0	56.0	N.D.	80.0	45.0	6.89
49	90.0	67.6	17.91	13.47	66.0	80.3	40.2	N.D.	95.0	50.0	7.54
50	88.5	65.6	17.26	13.23	64.0	85.5	52.0	N.D.	86.0	56.0	7.54
51	89.0	66.5	15.89	11.95	65.0	80.5	46.5	N.D.	82.5	53.0	8.23
52	88.3	65.0	16.91	12.96	49.8	80.5	46.5	N.D.	75.2	36.0	7.54
53	87.7	64.0	17.60	13.48	55.5	80.0	45.5	N.D.	58.5	23.0	7.31

* kWh per short ton of ½ inch feed
** kWh per ton of flotation Feed
N.D.Not Determined

Summary - Continued

7. Summary of Results

7.3. Flotation Results

Test No.	Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
1	Pb Concentrate	9.18	49.6	13.8	75.9	12.8
	Zn Concentrate	8.19	1.21	58.9	1.7	48.9
	Zn Flot. Tail.	82.63	1.63	4.56	22.4	38.3
	Cyclone O'flow	100.00	6.02	9.85	100.0	100.0
2	Pb Concentrate	8.56	53.1	11.4	74.3	9.7
	Zn Concentrate	13.12	1.69	56.0	3.6	73.5
	Zn Flot. Tail.	78.32	1.72	2.14	21.1	16.8
	Cyclone O'flow	100.00	6.12	10.00	100.0	100.0
3	Pb Concentrate	10.90	44.7	15.5	80.7	16.7
	Zn Concentrate	12.78	1.79	56.0	3.8	70.9
	Zn Flot. Tail.	76.32	1.23	1.64	15.5	12.4
	Cyclone O'flow	100.00	6.04	10.10	100.0	100.0
4	Pb Concentrate	11.40	44.1	16.0	80.6	17.6
	Zn Concentrate	13.69	1.78	50.2	3.9	66.2
	Zn Flot. Tail.	74.91	1.29	2.25	15.5	16.2
	Cyclone O'flow	100.00	6.22	10.10	100.0	100.0
5	Pb Concentrate	9.75	47.6	14.2	75.6	13.7
	Zn Concentrate	11.97	1.59	55.8	3.1	66.1
	Zn Flot. Tail.	78.28	1.67	2.60	21.3	20.2
	Cyclone O'flow	100.00	6.14	10.10	100.0	100.0
6	Pb Concentrate	8.72	59.0	10.5	81.8	9.2
	Zn Concentrate	14.37	1.88	54.3	4.3	78.5
	Zn Flot. Tail.	76.91	1.14	1.59	13.9	12.3
	Cyclone O'flow	100.00	6.29	9.94	100.0	100.0
7	Pb Concentrate	11.04	46.6	15.4	83.1	17.2
	Zn Concentrate	13.57	1.76	52.6	3.8	72.3
	Zn Flot. Tail.	75.39	1.07	1.37	13.1	10.5
	Cyclone O'flow	100.00	6.19	9.87	100.0	100.0
8	Pb Concentrate	9.89	49.9	12.9	79.7	13.0
	Zn Concentrate	15.42	1.95	49.6	4.9	78.0
	Zn Flot. Tail.	74.69	1.28	1.18	15.4	9.0
	Cyclone O'flow	100.00	6.19	9.80	100.0	100.0
9	Pb Concentrate	7.53	62.4	8.78	77.8	6.5
	Zn Concentrate	13.50	2.03	55.1	4.6	73.8
	Zn Flot. Yail.	78.97	1.35	2.53	17.6	19.7
	Cyclone O'flow	100.00	6.04	10.10	100.0	100.0

Summary - Continued

7. Summary of Results

7.3. Flotation Results

Test No.	Product	Weight %	Assays, %		% Distirbution	
			Pb	Zn	Pb	Zn
10	Pb Concentrate	10.45	44.9	15.2	79.2	16.2
	Zn Concentrate	19.69	2.09	36.9	6.9	74.0
	Zn Flot. Tail.	69.86	1.18	1.38	13.9	9.8
	Cyclone O'flow	100.00	5.96	10.40	100.0	100.0
11	Pb Concentrate	11.44	42.2	16.0	81.6	18.5
	Zn Concentrate	16.89	1.92	42.6	5.4	72.7
	Zn Flot. Tail.	71.67	1.07	1.22	13.0	8.8
	Cylcone O'flow	100.00	5.92	9.90	100.0	100.0
12	Pb Concentrate	9.32	47.9	13.7	74.5	12.4
	Zn Concentrate	20.61	2.34	38.2	8.1	76.4
	Zn Flot. Tail.	70.07	1.49	1.64	17.4	11.2
	Cyclone O'flow	100.00	5.99	10.30	100.0	100.0
13	Pb Concentrate	9.98	46.4	13.6	77.8	13.6
	Zn Concentrate	16.87	3.18	46.0	9.0	77.6
	Zn Flot. Tail.	73.15	1.07	1.21	13.2	8.8
	Cyclone O'flow	100.00	5.95	10.00	100.0	100.0
14	Pb Concentrate	8.99	52.8	13.0	77.3	11.5
	Zn Concentrate	17.06	2.87	47.0	8.0	78.6
	Zn Flot. Tail.	73.95	1.22	1.37	14.7	9.9
	Cyclone O'flow	100.00	6.14	10.20	100.0	100.0
15	Pb Concentrate	7.94	57.2	10.5	74.8	8.2
	Zn Concentrate	18.98	2.24	42.3	7.0	78.7
	Zn Flot. Tail.	73.08	1.51	1.83	18.2	13.1
	Cyclone O'flow	100.00	5.89	10.20	100.0	100.0
16	Pb Concentrate	7.99	56.2	12.1	76.2	9.5
	Zn Concentrate	15.68	1.92	49.3	5.1	75.8
	Zn Flot. Tail.	76.33	1.44	1.97	18.7	14.7
	Cyclone O'flow	100.00	5.90	10.2	100.0	100.0
17	Pb Concentrate	7.78	59.2	9.79	76.2	7.6
	Zn Concentrate	19.00	2.13	43.3	6.7	81.4
	Zn Flot. Tail.	73.22	1.41	1.52	17.1	11.0
	Cyclone O'flow	100.00	6.04	10.10	100.0	100.0
18	Pb Concentrate	7.74	57.5	11.7	74.8	8.7
	Zn Concentrate	16.54	2.82	50.0	7.8	79.9
	Zn Flot. Tail.	72.72	1.42	1.62	17.4	11.4
	Cyclone O'flow	100.00	5.99	10.40	100.0	100.0

Summary - Continued

7. Summary of Results

7.3. Flotation Results

Test No.	Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
19	Pb Concentrate	7.60	57.9	10.4	74.2	7.9
	Zn Concentrate	14.90	2.55	51.5	6.4	76.7
	Zn Flot. Tail.	77.50	1.48	1.98	19.4	15.4
	Cyclone O'flow	100.00	6.15	10.10	100.0	100.0
20	Pb Concentrate	7.29	59.7	8.81	70.8	6.3
	Zn Concentrate	15.66	2.91	48.3	7.4	74.9
	Zn Flot. Tail.	77.05	1.74	2.46	21.8	18.8
	Cyclone O'flow	100.00	6.10	10.10	100.0	100.0
21	Pb Concentrate	8.89	53.6	13.1	78.1	11.2
	Zn Concentrate	14.68	2.39	53.9	5.7	76.1
	Zn Flot. Tail.	76.43	1.29	1.73	16.2	12.7
	Cyclone O'flow	100.00	6.15	10.10	100.0	100.0
22	Pb Concentrate	6.96	62.3	8.99	71.7	6.1
	Zn Concentrate	14.85	2.47	54.2	6.1	78.1
	Zn Flot. Tail.	78.19	1.72	2.08	22.2	15.8
	Cyclone O'flow	100.00	6.05	10.30	100.0	100.0
23	Pb Concentrate	8.05	52.3	12.6	71.0	9.9
	Zn Concentrate	12.59	2.99	56.3	6.3	69.1
	Zn Flot. Tail.	79.36	1.69	2.72	22.6	21.0
	Cyclone O'flow	100.00	5.95	10.3	100.0	100.0
24	Pb Concentrate	6.43	58.4	10.8	63.0	6.8
	Zn Concentrate	15.89	3.81	52.0	10.2	81.0
	Zn Flot. Tail.	77.68	2.06	1.60	26.8	12.2
	Cyclone O'flow	100.00	5.96	10.20	100.0	100.0
25	Pb Concentrate	8.02	59.3	11.1	77.4	8.7
	Zn Concentrate	16.04	2.29	52.1	6.0	81.1
	Zn Flot. Tail.	75.94	1.34	1.39	16.6	10.2
	Cyclone O'flow	100.00	6.14	10.3	100.0	100.0
26	Pb Concentrate	8.20	57.0	12.4	76.0	10.0
	Zn Concentrate	13.75	2.43	56.4	5.4	76.0
	Zn Comb. Tail.	78.05	1.46	1.83	18.6	14.0
	Cyclone O'flow	100.00	6.15	10.20	100.0	100.0
27	Pb Concentrate	8.02	58.4	12.4	77.7	9.8
	Zn Concentrate	16.69	2.47	48.3	6.8	79.8
	Zn Comb. Tail.	75.29	1.24	1.39	15.5	10.4
	Cyclone O'flow	100.00	6.03	10.10	100.0	100.0

Summary - Continued

7. Summary of Results

7.3. Flotation Results

Test No.	Product	Weight %	Assays, %		% Distribution	
			Pb	Zn	Pb	Zn
28	Pb Concentrate	9.30	51.9	15.2	78.0	13.5
	Zn Concentrate	16.97	2.61	46.8	7.2	75.6
	Zn Comb. Tail.	73.73	1.25	1.55	14.8	10.9
	Cyclone O'flow	100.00	5.78	10.30	100.0	100.0
29	Pb Concentrate	7.95	56.4	12.9	77.6	9.9
	Zn Concentrate	14.04	2.39	54.5	5.8	74.2
	Zn Comb. Tail.	78.01	1.23	2.10	16.6	15.9
	Cyclone O'flow	100.00	5.78	10.20	100.0	100.0
30	Pb Concentrate	8.21	54.9	13.1	75.4	10.2
	Zn Concentrate	16.37	2.53	50.0	6.9	78.0
	Zn Comb. Tail.	75.42	1.40	1.64	17.7	11.8
	Cyclone O'flow	100.00	5.98	10.5	100.0	100.0
31	Pb Concentrate	8.47	53.7	13.3	76.3	10.8
	Zn Concentrate	14.25	2.41	55.0	5.8	75.4
	Zn Comb. Tail.	77.28	1.38	1.86	17.9	13.8
	Cyclone O'flow	100.00	5.96	10.40	100.0	100.0
32	Pb Concentrate	6.97	65.4	9.45	78.1	6.6
	Zn Concentrate	14.65	2.16	54.5	5.4	79.8
	Zn Comb. Tail.	78.38	1.23	1.73	16.5	13.6
	Cyclone O'flow	100.00	5.80	10.00	100.0	100.0
33	Pb Concentrate	8.05	59.2	11.9	80.4	9.4
	Zn Concentrate	15.55	2.16	51.8	5.7	79.0
	Zn Comb. Tail.	76.40	1.08	1.55	13.9	11.6
	Cyclone O'flow	100.00	5.95	10.20	100.0	100.0
34	Pb Concentrate	7.04	64.8	9.35	77.6	6.5
	Zn Concentrate	14.63	2.20	53.5	5.5	77.4
	Zn Comb. Tail.	78.33	1.27	2.08	16.9	16.1
	Cyclone O'flow	100.00	5.88	10.20	100.0	100.0
35	Pb Concentrate	6.77	66.6	8.33	75.7	5.8
	Zn Concentrate	12.30	2.06	57.4	4.3	72.0
	Zn Comb. Tail.	80.93	1.47	2.69	20.0	22.2
	Cyclone O'flow	100.00	5.95	9.80	100.0	100.0
36	Pb Concentrate	8.27	54.1	12.8	77.5	10.5
	Zn Concentrate	14.99	2.10	52.6	5.5	78.0
	Zn Comb. Tail.	76.74	1.28	1.51	17.0	11.5
	Cyclone O'flow	100.00	5.77	10.10	100.0	100.0

Summary - Continued

7. Summary of Results

7.3. Flotation Results

Test No.	Product	Weight %	Assays, %		% Distribution	
			Pb	Zn	Pb	Zn
37	Pb Concentrate	7.32	63.1	9.86	78.3	7.1
	Zn Concentrate	16.72	2.33	50.2	6.6	82.3
	Zn Comb. Tail.	75.96	1.17	1.43	15.1	10.6
	Cyclone O'flow	100.00	5.90	10.20	100.0	100.0
38	Pb Concentrate	7.44	60.6	11.3	77.0	8.4
	Zn Concentrate	14.99	2.24	53.3	5.7	79.9
	Zn Comb. Tail.	77.57	1.30	1.51	17.3	11.7
	Cyclone O'flow	100.00	5.85	10.00	100.0	100.0
39	Pb Concentrate	7.66	56.9	12.5	75.3	9.6
	Zn Concentrate	15.31	2.90	50.0	7.7	76.6
	Zn Comb. Tail.	77.03	1.28	1.80	17.0	13.8
	Cyclone O'flow	100.00	5.79	10.10	100.0	100.0
40	Pb Concentrate	7.76	57.2	12.8	75.2	9.8
	Zn Concentrate	13.15	2.26	56.0	5.0	72.9
	Zn Comb. Tail.	79.09	1.43	2.20	19.8	17.3
	Cyclone O'flow	100.00	5.90	10.10	100.0	100.0
41	Pb Concentrate	7.07	62.7	10.4	77.2	7.3
	Zn Concentrate	13.78	2.37	57.4	5.7	79.6
	Zn Comb. Tail.	79.75	1.24	1.65	17.1	13.1
	Cyclone O'flow	100.00	5.74	9.95	100.0	100.0
42	Pb Concentrate	7.18	60.9	10.8	75.6	7.7
	Zn Concentrate	16.66	2.65	48.4	7.6	79.9
	Zn Comb. Tail.	76.16	1.27	1.65	16.8	12.4
	Cyclone O'flow	100.00	5.74	9.55	100.0	100.0
43	Pb Concentrate	7.30	60.7	10.9	75.9	8.0
	Zn Concentrate	14.50	2.64	52.1	6.6	75.5
	Zn Comb. Tail.	78.20	1.30	2.11	17.5	16.5
	Cyclone O'flow	100.00	5.78	10.10	100.0	100.0
44	Pb Concentrate	8.30	54.1	13.2	77.4	11.0
	Zn Concentrate	12.37	2.26	52.4	4.8	65.1
	Zn Comb. Tail.	79.33	1.30	2.99	17.8	23.9
	Cyclone O'flow	100.00	5.83	10.00	100.0	100.0
45	Pb Concentrate	9.38	46.8	15.4	76.5	14.7
	Zn Concentrate	13.13	2.61	53.8	6.0	71.7
	Zn Comb. Tail.	77.49	1.30	1.73	17.5	13.6
	Cyclone O'flow	100.00	5.80	9.95	100.0	100.0

Summary - Continued

7. Summary of Results

7.3. Flotation Results

Test No.	Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
46	Pb Concentrate	8.12	55.2	12.9	76.8	10.3
	Zn Concentrate	14.77	2.25	50.8	5.7	73.6
	Zn Comb. Tail.	77.11	1.33	2.14	17.5	16.1
	Cyclone O'flow	100.00	5.74	9.85	100.0	100.0
47	Pb Concentrate	6.90	64.6	9.25	77.9	6.4
	Zn Concentrate	14.69	2.23	55.5	5.7	81.5
	Zn Comb. Tail.	78.41	1.19	1.54	16.4	12.1
	Cyclone O'flow	100.00	5.72	10.00	100.0	100.0
48	Pb Concentrate	6.75	57.7	12.1	68.5	8.3
	Zn Concentrate	14.63	4.41	53.0	11.3	78.7
	Zn Comb. Tail.	78.62	1.46	1.63	20.2	13.0
	Cyclone O'flow	100.00	5.69	9.85	100.0	100.0
49	Pb Concentrate	6.99	62.70	9.67	76.0	6.7
	Zn Concentrate	14.00	1.97	56.50	4.7	78.3
	Zn Comb. Tail.	79.01	1.41	1.92	19.3	15.0
	Cyclone O'flow	100.00	5.77	10.10	100.0	100.0
50	Pb Concentrate	7.46	60.80	10.9	78.1	8.0
	Zn Concentrate	15.34	2.46	53.6	6.5	80.6
	Zn Comb. Tail.	77.20	1.16	1.51	15.4	11.4
	Cyclone O'flow	100.00	5.81	10.2	100.0	100.0
51	Pb Concentrate	6.86	65.80	8.86	74.4	5.8
	Zn Concentrate	16.48	2.39	52.60	6.5	82.6
	Zn Comb. Tail.	76.66	1.52	1.60	19.1	11.6
	Cyclone O'flow	100.00	6.07	10.50	100.0	100.0
52	Pb Concentrate	7.47	58.3	11.4	77.5	8.7
	Zn Concentrate	14.08	1.89	54.0	4.7	18.0
	Zn Comb. Tail.	78.45	1.27	1.65	17.8	13.3
	Cyclone O'flow	100.00	5.62	9.75	100.0	100.0
53	Pb Concentrate	7.17	60.9	10.6	75.5	7.8
	Zn Concentrate	14.13	2.13	54.7	5.2	78.9
	Zn Comb. Tail.	78.70	1.41	1.67	19.3	13.3
	Cyclone O'flow	100.00	5.78	9.80	100.0	100.0

Summary - Continued

8. Material Mass Balance

A material mass balance was calculated for tests PP41, 43 and 48. This is shown in Figure No. 2.

The calculation mass balance was based on:

1) Known feed rate

2) Chemical Analysis

3) Measured pulp density

4) Measured water rate in the launders

5) Measured specific gravities of the products

6) Time weights of the various products.

Some of the chemical analyses were corrected by using reverse correction formulas. See Metallurgical Calculations

DISCUSSION

1. Primary Grind

1.1. Operation

The primary grinding consisted of a Hendy ball mill in closed-circuit with a 2 inch P50 Dorr Cyclone.

The required fineness of grind was obtained by adjusting the steel ball load, the cyclone apex diameter and/or the pulp density in the cyclone feed. The circuit operated well and no mechanical changes were made during the testwork.

The steel ball consumption, as calculated from 53 pilot plant tests, was 1.30 pounds per ton of ore.

1.2. Fineness of Grind

During the course of the testwork the following grinds were examined:

a) In tests PP10 to PP25 the ore was ground to 87 % minus 200 mesh.

b) In tests PP26 to PP30 the ore was ground to 83 % minus 200 mesh.

c) In tests PP31 to PP53 the ore was ground to 90 % minus 200 mesh.

The power consumption and work index for each series of tests are presented in table No. 2 of summary. For different finenesses of grind the power consumption varied considerably (10 - 19.0 kWh/ton); the lowest power figure of 11.0 kWh/ton was achieved at a grind of 82.3 % minus 200 mesh.

The optimum fineness of grind was considered to be 90 % minus 200 mesh. Typical product size distributions in the classification stage for different grinds are shown in tables No. 1 and No. 2.

Typical product size distribution in the classification stage for coarser primary grinds are shown in table No. 2 below.

Discussion - Continued

1. Primary Grind

1.2. Fineness of Grind

Table No. 1

Product Size Distribution in the Classification Stage

Optimum Fineness of Grind (Average Tests PP32-PP41)

Mesh Size (Tyler)	Cyclone Feed			Cyclone U'Flow			Cyclone O'Flow		
	% Retained		% Pass. Cum.	% Retained		% Pass. Cum.	% Retained		% Pass. Cum.
	Ind.	Cum.		Ind.	Cum.		Ind.	Cum.	
+ 10	-	-	100.0	0.2	0.2	99.8	-	-	-
14	0.2	0.2	99.8	0.2	0.4	99.6	-	-	-
20	0.2	0.4	99.6	0.2	0.6	99.4	-	-	-
28	0.3	0.7	99.3	0.4	1.0	99.0	-	-	-
35	0.5	1.2	98.8	0.7	1.7	98.3	-	-	-
48	1.3	2.5	97.5	2.4	4.1	95.9	-	-	-
65	2.7	5.2	94.8	4.3	8.4	91.6	0.3	0.3	99.7
100	5.0	10.2	89.8	5.8	14.2	85.8	0.7	1.0	99.0
150	9.4	19.6	80.4	10.6	24.8	75.2	2.1	3.1	96.9
200	17.6	37.2	62.8	19.0	43.8	56.2	6.6	9.7	90.3
270	14.6	51.8	48.2	15.3	59.1	40.9	7.5	17.2	82.8
400	20.7	72.5	27.5	20.2	79.3	20.7	15.0	32.2	67.8
- 400	27.5	100.0	-	20.7	100.0	-	67.8	100.0	-
Total	100.0	-	-	100.0	-	-	100.0	-	-

Discussion - Continued

1. Primary Grind

1.2. Fineness of Grind

Table No. 2

Product Size Distribution in the Classification Stage

Medium Grind (Average Tests PP25, 27 and 37)

Mesh Size (Tyler)	Cyclone Feed			Cyclone U'Flow			Cyclone O'Flow		
	% Retained		% Pass Cum.	% Retained		% Pass Cum.	% Retained		% Pass Cum.
	Ind.	Cum.		Ind.	Cum.		Ind.	Cum.	
+ 10	0.1	0.1	99.9	0.1	0.1	99.9	-	-	-
14	0.2	0.3	99.7	0.2	0.3	99.7	-	-	-
20	0.2	0.5	99.5	0.3	0.6	99.4	-	-	-
28	0.4	0.9	99.1	0.6	1.2	98.8	-	-	-
35	0.8	1.7	98.3	1.0	2.2	97.8	-	-	-
48	1.9	3.6	96.4	2.4	4.6	95.4	-	-	-
65	3.6	7.2	92.8	4.5	9.1	90.9	1.7	1.7	98.3
100	6.1	13.3	86.7	7.2	16.3	83.7	2.0	3.7	96.3
150	10.6	23.9	76.1	12.3	28.6	71.4	4.2	7.9	92.1
200	17.5	41.4	58.6	19.9	48.5	51.5	8.9	16.8	83.2
270	13.1	54.5	45.5	14.4	62.9	37.1	8.3	25.1	74.9
400	16.6	71.1	28.9	17.1	80.0	20.0	14.6	39.7	60.3
- 400	28.9	100.0	-	20.0	100.0	-	60.3	100.0	-
Total	100.0	-	-	100.0	-	-	100.0	-	-

Discussion - Continued

1. Primary Grind

1.3. Material Mass Flow Balance

Material mass flow balance was calculated for the fineness of grind 90 % minus 200 mesh (Test PP31 to PP43) and is shown in Figure No. 1 and Table No. 3.

Figure No. 1

Material Mass Flowsheet (Average Tests PP32 - PP43)

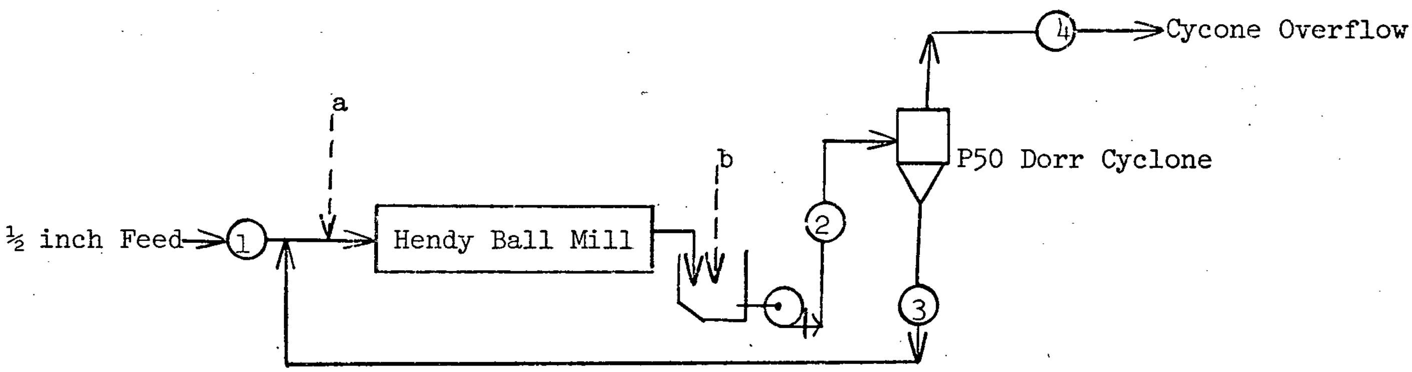


Table No. 3

Material Mass Balance

Point in Flowsheet	Dry Ore lb/hr	Dry Ore* %	Product Size			Water U.S.G.P.M.	Slurry U.S.G.P.M.	Solids %
			Pounds Per Hour		% - 200 Mesh			
			+ 200 M	- 200 M				
1	703	100.0	637.2	65.8	9.36	-	-	-
2	3,947.2	561.5	1,385.5	2,561.7	64.90	4.676	6.726	60.0
3	3,244.2	461.5	1,317.3	1,926.9	59.4	1.828	3.513	78.0
4	703.0	100.0	68.2	634.8	90.3	2,848	3.213	33.0
a	-	-	-	-	-	1.393	-	-
b	-	-	-	-	-	1.455	-	-

Discussion - Continued

2. Lead Concentrate Regrind

2.1. Operation

It was indicated in the batch laboratory testwork that fine regrinding of the lead rougher concentrate (to 70 % passing minus 10 micrometres) would be required to achieve a lead concentrate grade of over 60 % Pb at a recovery of 80 - 82 % of the total lead. Therefore the initial pilot plant testwork was conducted with a fine lead concentrate regrind. In subsequent testwork the fineness of the Pb concentrate regrind was decreased and was established at 43 % passing minus 10 μm with no apparent effect on Pb metallurgical results.

When using the fine lead concentrate regrind the circuit consisted of a Sala mill in closed circuit with a one inch Krebs cyclone. In tests in which the lead rougher concentrate was reground only lightly (Test PP38 to PP53) the circuit consisted of a small Denver mill in closed circuit with a one inch Krebs cyclone. Several tests (PP15 to PP17) were conducted using a two-stage lead concentrate regrind. In the 1st stage the lead rougher concentrate was reground in the Sala mill in closed circuit with a 1½ inch Krebs cyclone. In the 2nd stage the lead 1st cleaner concentrate was reground in the Denver ball mill in closed circuit with a 1 inch Krebs cyclone.

2.2. Finenss of Regrind

The product size distribution using the fine Pb concentrate regrind is summarized in table No. 4.

Discussion - Continued

2. Lead Concentrate Regrind

2.2. Fineness of Regrind

Table No. 4

Product Size Distribution in the Pb Rougher Concentrate

Regrinding and Classification Stages - Fine Regrind (Tests PP25-27)

Particle Size Microns	Pb Rougher Conc.			Cyclone U'Flow			Cyclone O'Flow		
	% Retained		% Pass. Cum.	% Retained		% Pass	% Retained		% Pass
	Ind.	Cum.		Ind.	Cum.		Ind.	Cum.	
+ 74	10.1	10.1	89.9	4.7	4.7	95.3	-	-	-
53	10.0	20.1	79.9	6.3	11.0	89.0	-	-	-
27.1	10.0	30.1	69.9	20.7	31.7	68.3	-	-	-
21.0	18.5	48.6	51.4	14.0	45.7	54.3	-	-	100.0
14.6	10.1	58.7	41.3	27.0	72.7	27.3	3.0	3.0	97.0
10.1	9.4	68.1	31.9	16.6	89.3	10.7	10.6	13.6	86.4
7.8	6.5	74.6	25.4	3.8	93.1	6.9	14.0	27.5	72.4
- 7.8	25.4	100.0	-	6.9	100.0	-	72.4	100.0	-
Total	100.0	-	-	100.0	-	-	100.0	-	-

The product size distribution obtained when using the light lead concentrate regrind is shown in Table No. 15.

Discussion - Continued

2. Leach Concentrate Regrind

2.2. Fineness of Regrind

Table No. 5

Product Size Distribution in the Pb Rougher Concentrate

Regrinding and Classification Stages - Coarse Regrind (PP38-PP44)

Particle Size Microns	Pb Rougher Conc.			Cyclone U'Flow			Cycone O'Flow		
	% Retained		% Pass Cum.	% Retained		% Pass Cum.	% Retained		% Pass Cum.
	Ind.	Cum.		Ind.	Cum.		Ind.	Cum.	
+ 74	2.6	2.6	97.4	6.6	6.6	93.4	-	-	-
53	3.8	6.3	93.6	12.5	19.1	80.9	-	-	-
27.9	9.0	15.4	84.6	20.3	39.4	60.6	2.9	2.9	97.1
21.6	6.3	21.7	78.3	36.1	75.5	24.5	6.9	9.8	90.2
15.1	14.7	36.4	63.6	12.3	87.8	12.2	23.2	33.0	67.0
10.4	16.0	52.4	47.6	2.9	90.7	9.3	20.2	53.2	46.8
8.0	10.3	63.2	36.8	1.5	92.2	7.8	11.4	64.6	35.4
- 8.0	36.8	100.0	-	7.8	100.0	-	35.4	100.0	-
Total	100.0	-	-	100.0	-	-	100.0	-	-

The regrinding products obtained from the batch laboratory and pilot plant are compared in Figure No. 2. It should be noted that the power requirements, found in the details of tests - Summary (Table 8 -2), for the Pb regrinding are not entirely realistic because the Sala mill used in the testwork was too big and gave high power readings and the small Denver mill was not drawing enough power to register on the Energy-Demand meter.

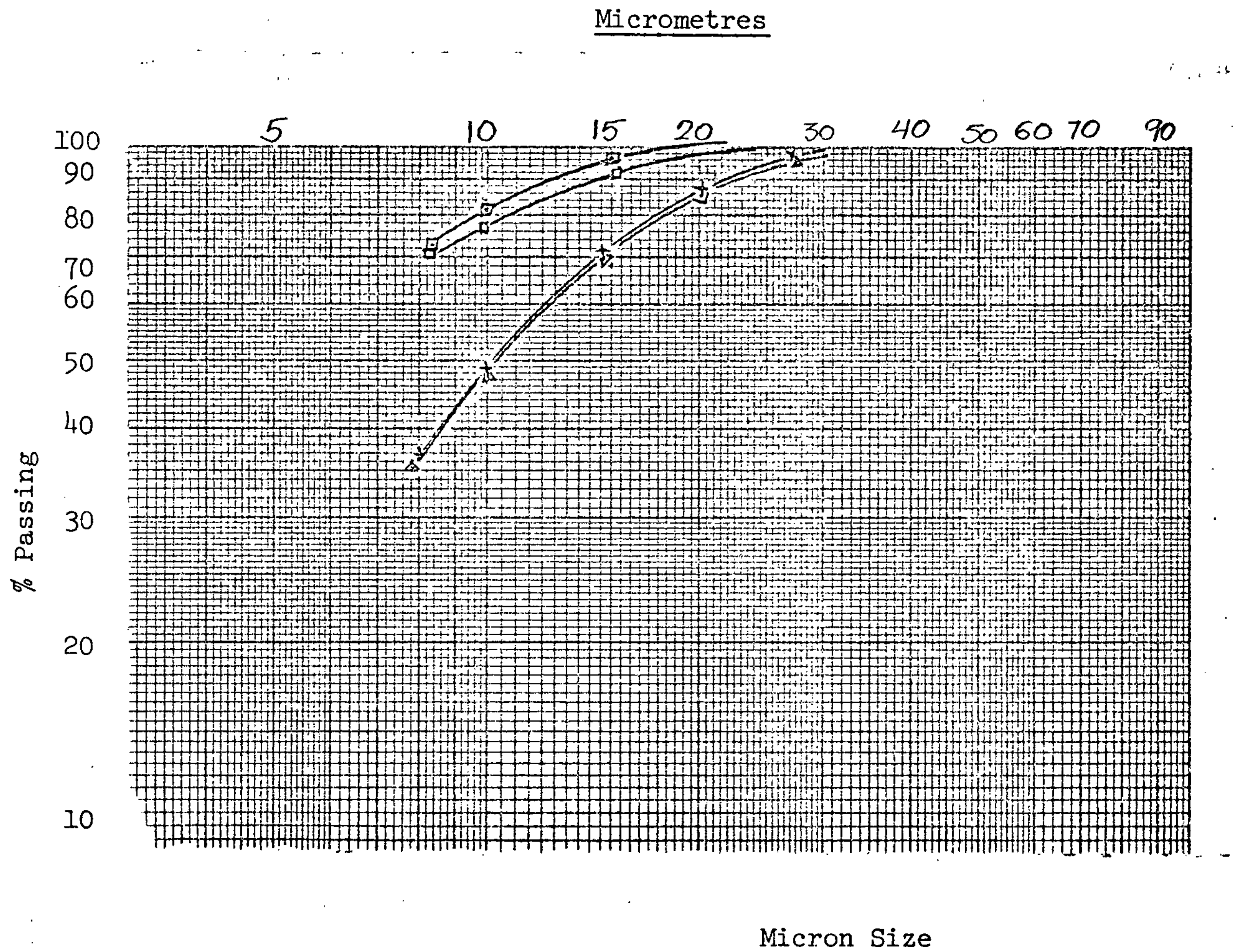
The classification efficiency in all tests averaged 80 - 85 %.

Discussion - Continued

2. Leach Concentrate Regrind

Figure No. 2

Size Distribution as a Function of Regrinding Method



CODE

x lab coarse regrind (Test 46)
△ Pilot Plant coarse regrind (Tests PP38-PP53)
□ lab fine regrind (test 50)
⊡ Pilot Plant Fine Regrind (Tests PP25-PP29)

Discussion - Continued

2. Leach Concentrate Regrind

2.3. Material Mass Balance

The material mass balance in the regrind circuit was calculated for the light lead regrind tests (Test PP38 to PP43) and is shown in Table No. 6 and Figure No. 3.

Figure No. 3

Material Mass Flowsheet

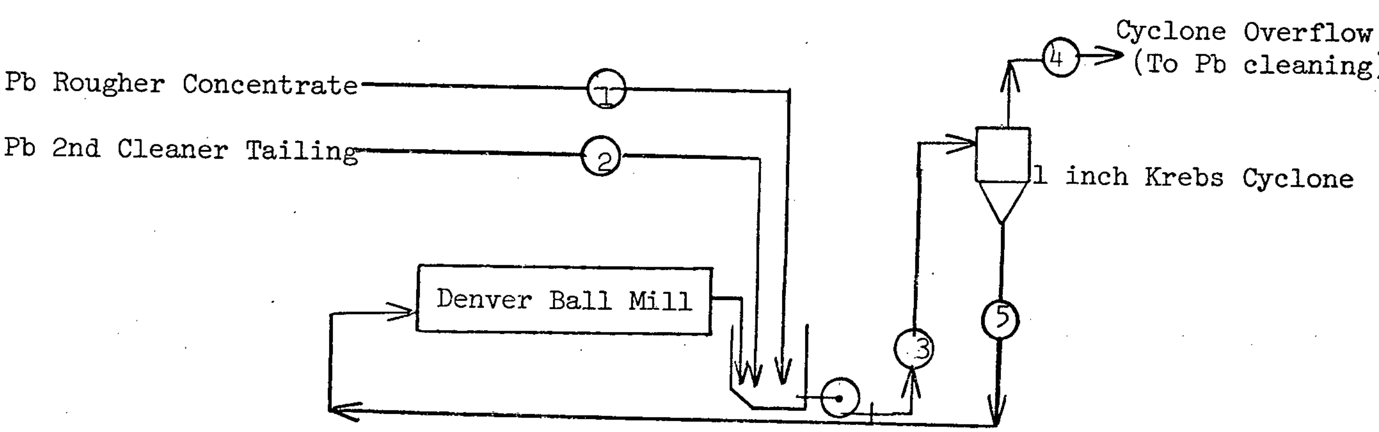


Table No. 6

Material Mass Balance

Point in Flowsheet	Dry Product		Product Size			U.S.G.P.M.	
	lb/hour	%*	Pounds Per Hour		% -20 µm	Water	Slurry
			+20 µm	-20 µm			
1	220.4	31.35	45.2	175.2	79.5	1.776	1.874
2	107.3	15.26	10.7	96.6	90.1	3.284	3.334
3	892.7	126.98	506.4	386.3	43.3	5.616	6.022
4	327.7	46.61	55.9	271.8	83.5	5.250	5.398
5	565.0	80.37	450.5	114.5	20.3	0.366	0.624

* percent of flotation feed

Discussion - Continued

3. Zinc Regrind

3.1. Operation

The combined zinc rougher concentrate, zinc 2nd cleaner tailing and zinc 1st cleaner scavenger concentrate were reground in a Conical ball mill containing 1080 pounds mixed 1 and 2 inch steel balls in test PP46 to PP53. The steel load had been increased from 600 pounds in early tests in which fine lead rougher concentrate was used. The effect of this change was to optimize liberation of the zinc minerals and stabilize recirculation of middlings in the various stages. This increased power input from 2.8 to 3.5 kilowatt-hours to a calculated figure of 8 - 8.3 kilowatt hours per ton of flotation feed.

It should be noted that the feed rate in the mill was varied from 280 pounds per hour (test PP18 to PP30) to 600 pounds per hour (test PP42 to PP53) which resulted in a significant fluctuation in the circulation load (300 - 1200 %). The cyclone overflow product, therefore, ranged from between 35 % to 80 % minus 20 µm.

3.2. Product Size Distribution

Typical product size distribution in the classification stage for the tests in which reasonable zinc cleaning was obtained are summarized in table No. 7.

Discussion - Continued

3. Zinc Regrind

3.2. Product Size Distribution

Table No. 7

Product Size Distribution in the Zn Rougher Concentrate

Regrinding and Classification Stages - Optimum Regrind (Tests PP41, 47 and 49)

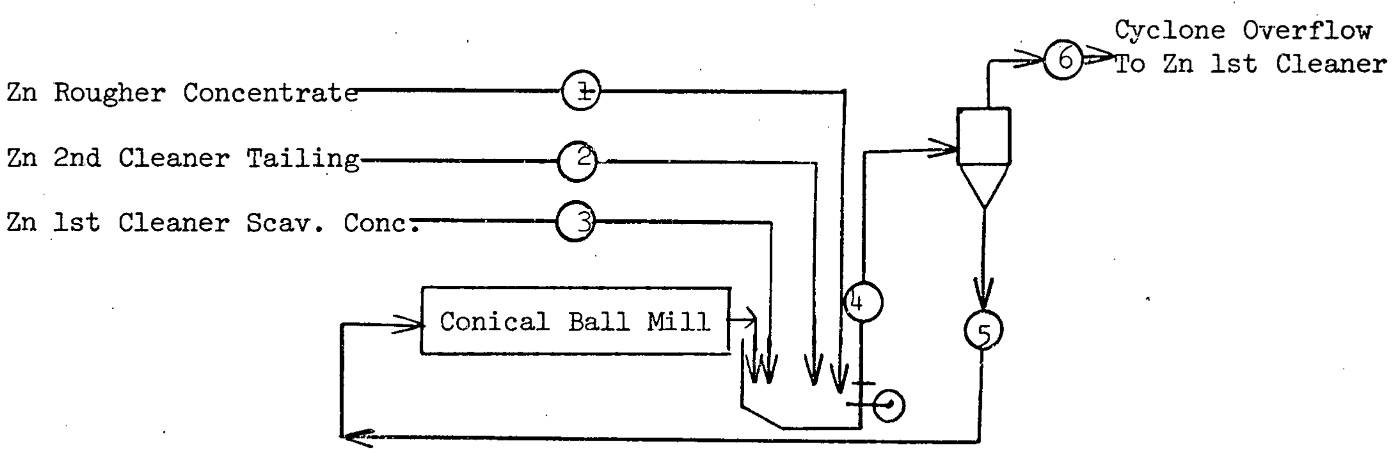
Particle Size Microns	Zn Rougher Conc. % Retained Ind.	Zn Rougher Conc. % Retained Cum.	Zn Rougher Conc. % Pass Cum.	Zn Cyclone U'Flow % Retained Ind.	Zn Cyclone U'Flow % Retained Cum.	Zn Cyclone U'Flow % Pass Cum.	Zn Cyclone O'Flow % Retained Ind.	Zn Cyclone O'Flow % Retained Cum.	Zn Cyclone O'Flow % Pass Cum.
+ 74	5.9	5.9	94.1	5.8	5.8	94.2	-	-	-
53	6.1	12.0	88.0	11.4	17.2	82.8	-	-	-
31.3	11.8	23.8	76.2	7.1	24.3	75.7	6.2	6.2	93.8
24.1	9.3	33.1	66.9	42.4	66.7	33.3	12.2	18.4	81.6
16.9	17.4	50.5	49.5	26.0	92.7	7.3	28.4	46.8	53.2
11.6	13.5	64.0	36.0	2.7	95.4	4.6	17.5	64.3	35.7
9.0	7.5	71.5	28.5	0.8	96.2	3.8	8.2	72.5	27.5
- 9.0	28.5	100.0	-	3.8	100.0	-	27.5	100.0	-
Total	100.0	-	-	100.0	-	-	100.0	-	-

3.3. Material Mass Balance

The material mass balance was calculated for tests PP41, PP47 and PP49, and is shown in Figure No. 4 and Table No. 8.

Figure No. 4

Material Mass Flowsheet



Discussion - Continued

3. Zinc Regrind

3.3. Material Mass Balance

Table No. 8

Mass Balance

Point in Flowsheet	Dry Product		Product Size			U.S.G.P.M.	
	lb/hour	% *	Pounds Per Hour		% - 20 µm	Water	Slurry
			+ 20 µm	- 20 µm			
1	200.2	28.48	64.2	136.0	66.4	1.103	1.196
2	108.8	15.48	27.9	80.9	74.4	3.504	3.557
3	61.4	8.73	10.4	51.0	83.1	0.669	0.698
4	1006.0	143.10	637.7	368.3	41.5	5.770	6.232
5	635.6	90.41	535.2	100.4	15.8	0.493	0.781
6	370.4	52.69	102.5	26.79	72.3	5.277	5.451

* percent of flotation feed

4. Flotation

4.1. General

The main objectives of the investigation were a) to confirm the flowsheet and reagent balance established in the laboratory with the batch sample, b) to evaluate primary grinding and Pb and Zn concentrate regrind requirements.

Although the laboratory tests on pilot plant samples clearly indicated that the lead rougher concentrate required fine regrinding in order to achieve high grade lead concentrates (Table No. 9), the pilot plant results showed that the response of the ore to continuous pilot plant flotation was different from that obtained in the batch tests.

Discussion - Continued

4. Flotation

4.1. General

Table No. 9

Effect of Fineness of Lead Concentrate Regrind-

Laboratory Test Results on Pilot Plant Bulk Composite

Test No.	Regr. Time Min.	Cleaning Feed		Product	Weight %	Assays, %		% Distribution	
		% Pass -20 µm	% Pass -10 µm			Pb	Zn	Pb	Zn
45	30	88.5	48.1	Pb Cleaner Conc. Pb Rougher Conc.	8.75 28.25	51.6 19.1	11.3 13.1	76.1 90.7	9.9 37.3
46	40	93.2	55.0	Pb Cleaner Conc. Pb Rougher Conc.	7.97 29.97	54.6 17.9	10.4 13.3	73.4 90.3	8.1 39.6
47	50	95.0	59.0	Pb Cleaner Conc. Pb Rougher Conc.	7.96 28.50	59.7 18.8	9.53 13.00	79.9 90.3	7.6 37.3
50	60*	98.0	72.2	Pb Cleaner Conc. Pb 1st Cl. Conc.	7.54 17.35	62.7 29.3	8.28 13.6	81.2 87.4	6.1 23.2

* multiple stage regrind

The following differences, based on laboratory and pilot plant results and observations during the testwork were significant.

1) The pilot plant results indicated that the fineness of regrind, in the range tested (see table 14) had no appreciable effect on the final lead grade and recovery. However, under laboratory conditions (see table 9) the effect of the reduced regrind fineness was clearly demonstrated. The concentrate grade dropped from 62.7 % Pb (test 50) to 51.6 % (test 45) and the recovery from 81.2 % Pb to 76.1 % Pb when optimum pilot plant regrind fineness was applied in the laboratory.

Discussion - Continued

4. Flotation

4.1. General

2) Lead flotation in the pilot plant cleaning was much stronger than in the laboratory. It was necessary to adjust (decrease to one-eighth) the collector additions to the cleaners in order to achieve selectivity.
3) The pH in the zinc circuit in the pilot plant was critical. Even small variations in pH (11 - 11.5) decreased zinc concentrate grade by 5 - 8 % Zn. Under laboratory conditions, however, the variation in pH from 10.5 to 11.5 did not affect zinc grade or recovery. (See Progress Report No. 10 - Discussion)

The most important factor in achieving satisfactory results in the pilot plant cleaning circuits was the mode of operation. In fact, the lead rougher concentrate was in reality a bulk Pb-Zn pyrite concentrate. Therefore, a satisfactory final concentrate could only be produced with detailed control of the cleaning conditions. Typical examples of the effect of operation on lead cleaning are tests PP36 and PP37.

In test No. 37 the froth discharge, water flow in the launders and recirculation load in the cleaning were closely controlled during the test run. In test PP36 the water flow and froth discharge were adjusted at the beginning of the test, but were not adjusted during the test run. For this reason a number of tests in which collector and flowsheet changes were made were excluded from evaluation. Selection of the tests that were included in the discussion in the individual sections was made on the basis of partial statistical analyses of the most critical parameter as well as on observations made during the testwork.

Discussion - Continued

4. Flotation

4.1. General

Table No. 10

Effect of Operation on Pb Cleaning

Test No.	Product	Weight %	Assays, %		% Distribution	
			Pb	Zn	Pb	Zn
36	Pb Cl. Conc.	8.27	54.1	12.8	77.5	10.5
	Pb Ro. Conc.	22.33	19.7	16.4	80.5	31.3
	Pb Flot. Tail.	88.67	1.29	13.1	19.5	68.7
37	Pb Cl. Conc.	7.32	63.1	9.86	78.3	7.1
	Pb Ro. Conc.	19.38	20.8	15.8	78.7	27.7
	Pb Flot. Tail.	80.62	1.35	9.93	21.3	72.3

4.2. Lead Flotation

4.2.1. Flowsheet Evaluation

In the majority of the testwork the flowsheet was similar to the final flowsheet (Figure No. 5). This flowsheet was maintained unchanged in order to properly evaluate the effects of the changes made in the primary grinding circuit and in the lead concentrate regrinding circuit. Twomodifications were tested in a short series of tests, a) open circuit lead cleaning (Figure No. 6) and, b) multiple stage lead concentrate regrind (Figure No. 7).

Discussion - Continued

4. Flotation

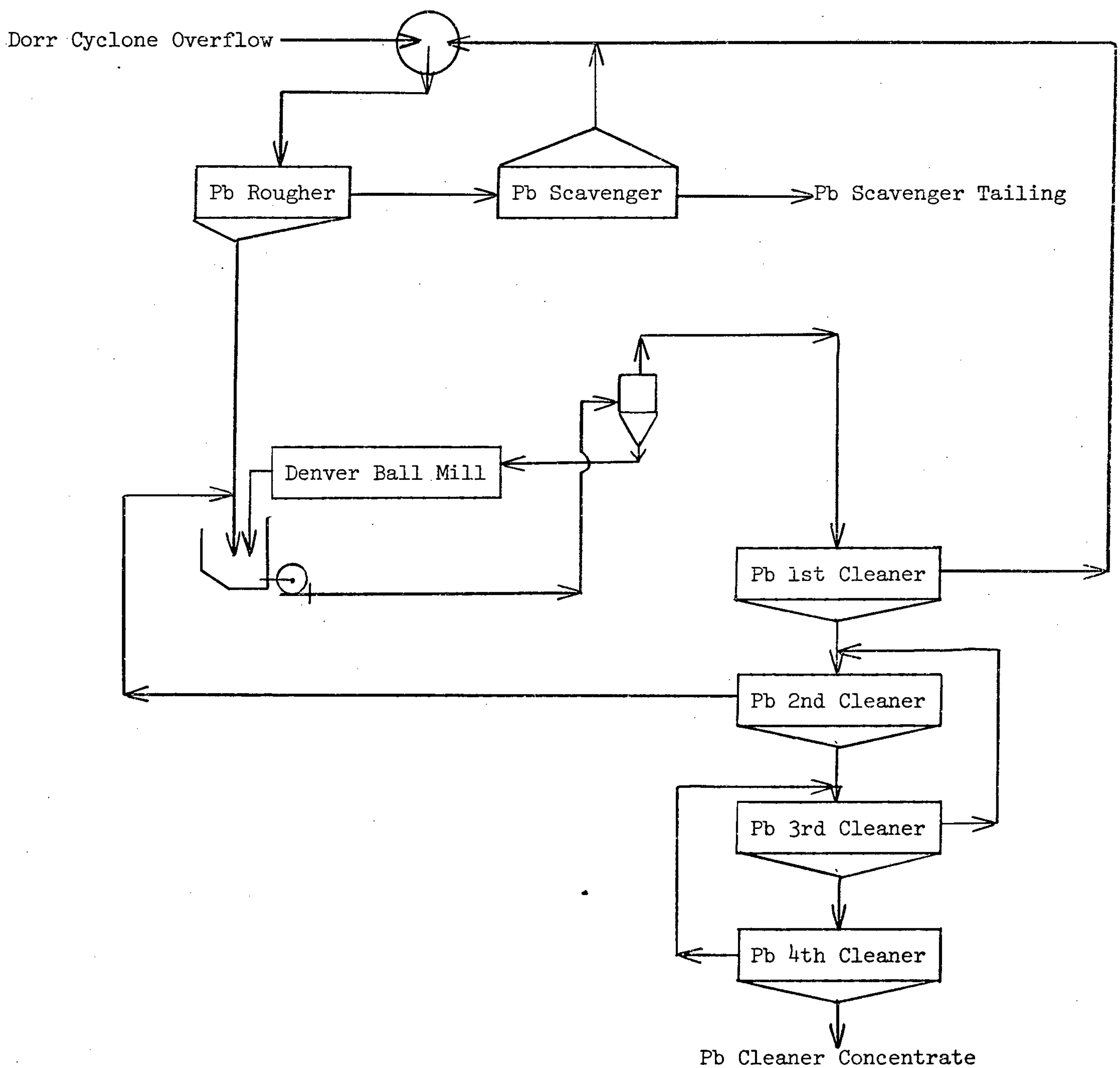
4.2. Lead Flotation

4.2.1. Flowsheet Evaluation

Figure No. 5

Flowsheet A

Closed Circuit Lead Flotation



Discussion - Continued

4. Flotation

4.2. Lead Flotation

4.2.1.1. Open Circuit Lead Cleaning

In tests PP52 and PP53 the lead 1st cleaner tailing was scavenged in open circuit (Flowsheet - Figure No. 6). The results obtained from these tests are compared in table No. 11 below.

Table No. 11

Open and Closed Lead Cleaning - Comparison of Results

Test No.	Circuit Flowsheet	Product	Weight %	Assays, %		% Distribution	
				Pb	Zn	Pb	Zn
PP477	Closed Flowsheet A	Pb Cl. Conc. Pb Ro. Conc. Pb Flot. Tail.	6.90 30.74 69.27	64.6 19.0 1.30	9.25 19.40 9.17	77.9 86.6 13.4	6.4 48.4 51.6
PP51	Open Flowsheet B	Pb Cl. Conc. Pb Ro. Conc. Pb Flot. Tail.	7.47 27.88 72.12	58.3 15.7 1.28	11.4 16.5 9.31	77.5 82.6 17.4	8.7 40.7 59.3

The results indicated that lead rougher concentrate could be cleaned in open circuit with no deterioration in the Pb metallurgical results. However, optimization of this flowsheet would be necessary to improve zinc and pyrite rejection in the Pb 1st cleaner scavenger stage in order to achieve full benefit of the flowsheet.

Discussion - Continued

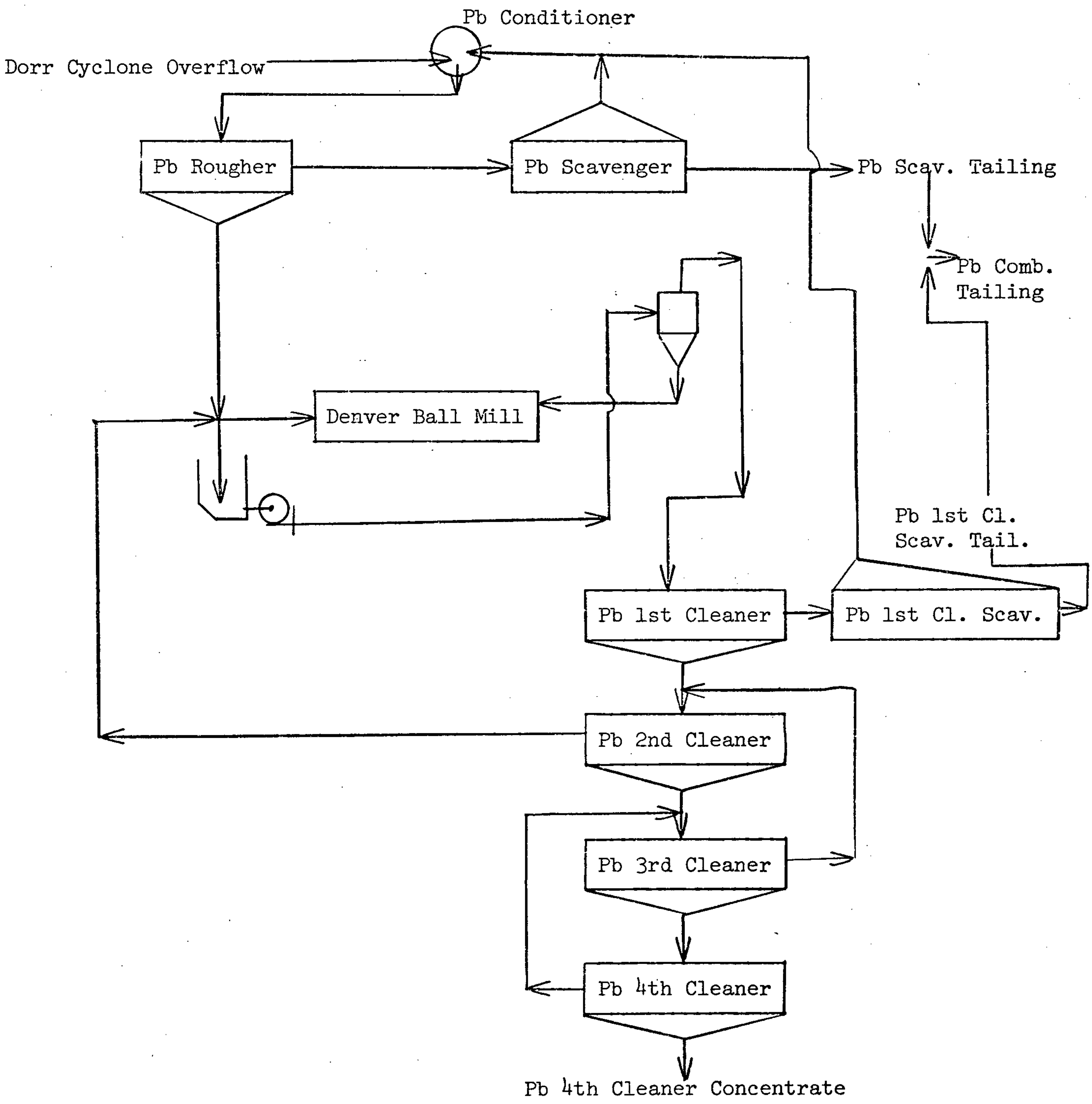
4. Flotation

4.2. Lead Flotation

Figure No. 6

Flowsheet B

Open Circuit Lead Flotation



Discussion - Continued

4. Flotation

4.2. Lead Flotation

4.2.1.2. Multiple Stage Lead Concentrate Regrind

In tests PP14 to PP17 the flowsheet, illustrated in Figure No. 7, was tested. This modified flowsheet was designed to lower the power consumption in the regrind and to decrease the recirculation load in the lead rougher and cleaning circuits. The best results from this series of tests are summarized in table No. 12 below.

Table No. 12

Effect of Multiple Stage Lead Concentrate Regrind

Test No.	Product	Weight %	Assays, %		% Distribution	
			Pb	Zn	Pb	Zn
PP15	Pb Cl. Conc.	7.94	57.2	10.5	74.8	8.2
	Pb Ro. Conc.	19.65	23.2	14.9	78.3	27.1
	Pb Flot. Tail.	80.35	1.57	9.79	21.7	72.9
PP16	Pb Cl. Conc.	7.99	56.2	12.1	76.2	9.5
	Pb Ro. Conc.	20.65	21.2	15.0	78.7	28.9
	Pb Flot. Tail.	79.35	1.49	9.60	21.3	71.1

The lead concentrate grade in the above tests was 56-57 % Pb at 75 to 76 % Pb recovery. It is interesting to note that the circulation load (time weight) in the Pb cleaning decreased sharply when using multiple stage regrind.

Pb Concentrate Regrind

Three main series of tests were conducted in which the fineness of the primary grind was varied from 70 % to 90 % minus 200 mesh. In these tests the lead concentrate was reground very fine. The results of the representative tests are summarized in table No. 13.

The results indicated that the fineness of grind, in the range tested, had no effect on lead rougher concentrate grade and recovery.

Discussion - Continued

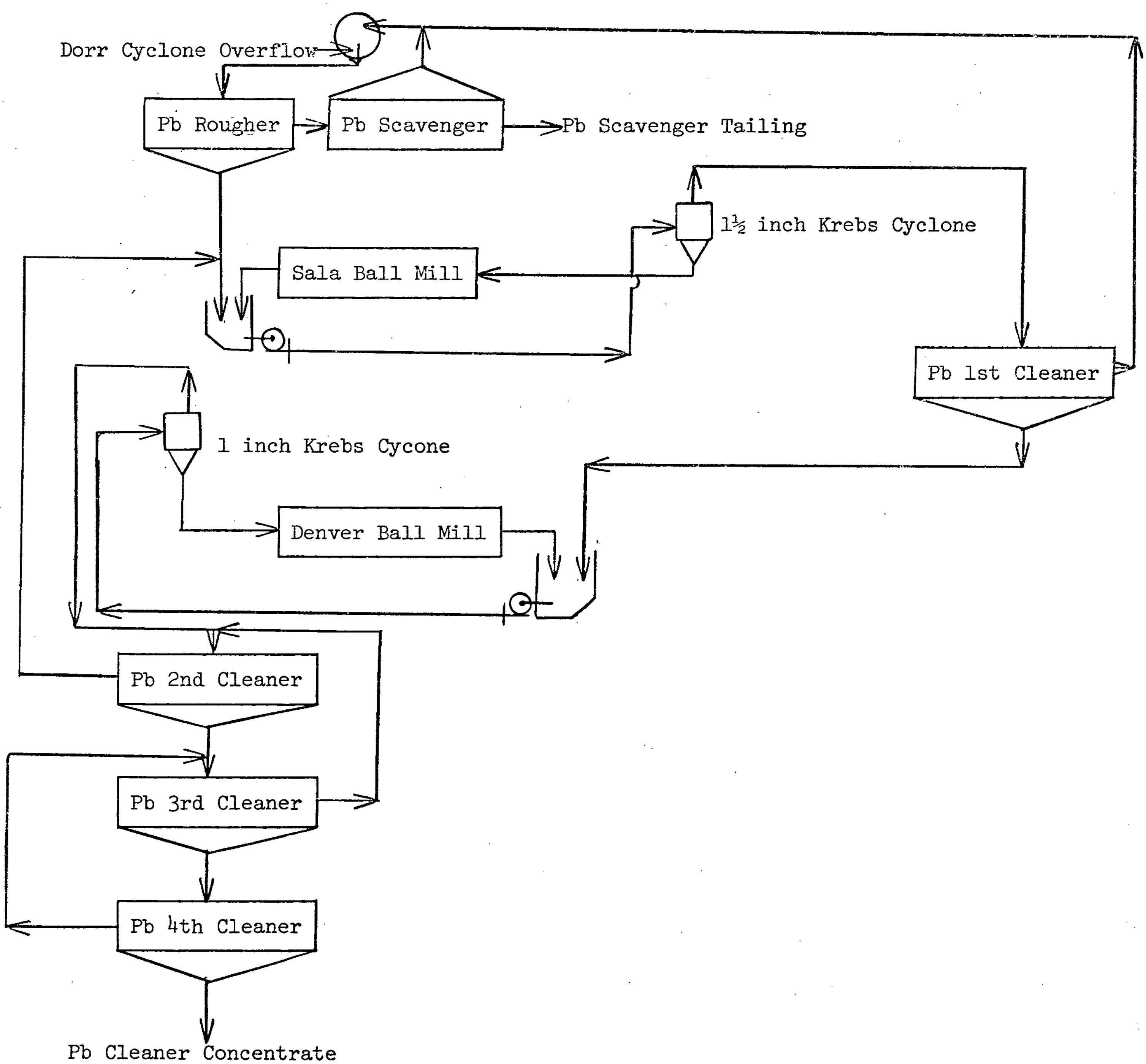
4. Flotation

4.2. Lead Flotation

Figure No. 7

Flowsheet C

Multiple Stage Lead Concentrate Regrind



Discussion - Continued

4. Flotation

4.2. Lead Flotation

4.2.1.2. Multiple Stage Lead Concentrate Regrind

Table No. 13

Effect of Fineness of Primary Grind Using Fine Pb Concentrate Regrinding

Test No.	Flot. Feed %Pass -200m	Pb Regrind		Product	Weight %	Assays, %		% Distribution	
		% Pass -20μm	% Pass -10μm			Pb	Zn	Pb	Zn
PP26	79.9	100.0	72.3	Pb Cl. Conc.	8.20	57.0	12.4	76.0	10.0
				Pb Ro. Conc.	19.95	23.6	15.8	77.6	28.8
				Pb Flot. Tail.	80.05	1.70	9.74	22.4	71.2
PP27	69.3	99.0	71.3	Pb Cl. Conc.	8.02	58.4	12.4	77.7	9.8
				Pb Ro. Conc.	22.45	20.3	15.2	79.7	30.3
				Pb Flot. Tail.	77.55	1.50	10.1	20.3	69.7
PP35	83.0	95.0	70.2	Pb Cl. Conc.	6.77	66.6	8.33	75.7	5.8
				Pb Ro. Conc.	23.32	19.70	16.4	79.8	33.7
				Pb Flot. Tail.	76.68	1.52	9.80	20.2	66.3
PP37	91.6	98.0	70.4	Pb Cl. Conc.	7.32	63.1	9.86	78.3	7.1
				Pb Ro. Conc.	19.38	20.8	15.8	78.7	27.7
				Pb Flot. Tail.	80.62	1.35	9.93	21.3	72.3

4.2.3. Effect of Fineness of Lead Concentrate Regrind Using Fine Primary Grind

Two main series of tests were conducted in which a fine and a light lead concentrate regrind weretested. In tests PP1 to 27 and PP35 to PP38 fine regrinding was tested. In tests PP29 to PP34 and PP39 to PP53 the lead concentrate was reground lightly while the primary grind was kept at 90 % minus 200 mesh. The results obtained using fine and coarse lead concentrate regrinds are compared in table No. 14.

Discussion - Continued

4. Flotation

4.2. Lead Flotation

4.2.3. Effect of Fineness of Lead Concentrate Regrind Using Fine Primary Grind

Table No. 14

Test No.	Flot. Feed % Pass -20 M	Pb Regrind % Pass*	Pb Regrind % Pass**	Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
PP34	90.3	90.0	49.2	Pb Cl. Conc.	7.04	64.8	9.35	77.6	6.5
				Pb Ro. Conc.	27.47	16.6	19.0	80.4	41.4
				Pb Flot. Tail.	75.23	1.53	10.2	19.6	58.6
PP37	91.6	98.0	70.4	Pb Cl. Conc.	7.32	63.1	9.86	78.3	7.1
				Pb Ro. Conc.	19.38	20.8	15.8	78.7	27.7
				Pb Flot. Tail.	80.62	1.35	9.93	21.3	72.3

* 20 µm ** 10 µm

Applying an identical primary grind, the lead rougher concentrate weight increased by 8 - 10 % and the zinc content of the rougher concentrate increased also with decreasing fineness of lead concentrate regrind. The reduced fineness of lead concentrate regrind, however, had no pronounced effect on final lead grade and recovery.

4.2.4. Zinc and Pyrite Depressants

4.2.4.1. Effect of $ZnSO_4$ Additions

In the early pilot plant testwork, $ZnSO_4$ was added to the mill at a rate of 1.0 lb/ton and to the Pb regrind at a rate of 0.5 lb/ton. In tests PP20 to PP53 several attempts were made to eliminate or to reduce $ZnSO_4$ from the circuit. In tests PP21 to PP25 the $ZnSO_4$ addition to the primary mill varied from 0 to 0.95 lb/ton; these results are summarized in table No. 15.

Reducing the $ZnSO_4$ from 0.95 to 0.52 lb/ton in test PP25 completely omitting it it as in test PP24, had no significant effect on product grade and recovery.

In tests PP50 and PP51 the $ZnSO_4$ was also omitted from the circuit. These results are compared in table No. 16.

The results indicated that $ZnSO_4$ could be omitted from the circuit.

Discussion - Continued

4. Flotation

4.2. Lead Flotation

4.2.4.1. Effect of $ZnSO_4$ Additions

Table No. 15

Effect of $ZnSO_4$ Additions - Results From Selected Tests

Test No.	$ZnSO_4$* Added lb/t	Product	Weight %	Assays, %		% Distribution	
				Pb	Zn	Pb	Zn
PP21	0.95	Pb Ro. Conc. Pb Flot. Tail.	21.56 78.44	23.1 1.58	15.3 9.90	80.1 19.9	30.0 70.0
PP23	Nil	Pb Ro. Conc. Pb Flot. Tail.	19.65 80.35	25.6 1.89	15.40 9.76	76.8 23.2	27.8 72.2
PP25	0.52	Pb Ro. Conc. Pb Flot. Tail.	21.05 78.95	20.9 1.42	14.9 9.52	79.7 20.3	28.3 71.7

* $ZnSO_4$ added to Hendy Mill

Table No. 16

Effect of $ZnSO_4$ in the Pb Rougher and Cleaning

Test No.	$ZnSO_4$ added lb/t		Product	Weight %	Assays, %		% Distribution	
	Ro.	Cl.			Pb	Zn	Pb	Zn
PP49	0.95	0.56	Pb Cl. Conc. Pb Ro. Conc. Pb Flot. Tail.	6.99 29.76 70.24	62.70 15.8 1.35	9.67 16.6 9.46	76.0 83.2 16.8	6.7 42.7 57.3
PP50	Nil	Nil	Pb Cl. Conc. Pb Ro. Conc. Pb Flot. Tail.	7.46 29.86 70.14	60.80 15.50 1.40	10.9 16.9 9.18	78.1 82.5 17.5	8.0 43.9 56.1

Discussion - Continued

4. Flotation

4.2. Lead Flotation

4.2.4.2. Cyanide Additions

The beneficial effect of the higher level of NaCN additions was observed in laboratory testwork. In the pilot plant the cyanide additions to the primary grind were varied from 0.18 to 0.45 pounds per ton (Test PP5, 6, 7, 8, 25, 26, and 27), and in the Pb cleaning from 0.4 to 0.7 pounds per ton. No beneficial effects in the lead rougher flotation and cleaning circuit were detected when using more then 0.6 lb/ton total cyanide.

4.2.4.3. Effect of Na_2SO_3 and Na_2S Additions

Four tests were carried out in which Na_2SO_3 or Na_2S was added to the primary mill. In these tests $ZnSO_4$ was omitted from the circuit. The results are shown in table No. 17 below.

Table No. 17

Effect of Na_2SO_3 and Na_2S Additions on Lead Flotation

Test No.	Reagent added lb/ton			Product	Weight %	Assays, %		% Distribution	
	Na_2SO_3	Na_2S	$ZnSO_4$			Pb	Zn	Pb	Zn
PP7	0.98	-	-	Pb Ro. Conc.	20.77	23.3	15.5	83.0	30.1
	-	-	-	Pb Flot. Tail.	79.23	1.25	9.44	17.0	69.9
PP8	0.98	-	-	Pb Ro. Conc.	23.14	21.4	15.7	84.1	37.0
				Pb Flot. Tail.	76.86	1.22	8.5	15.9	63.0
PP19	-	-	0.95	Pb Ro. Conc.	19.85	24.5	16.3	79.3	29.8
				Pb Flot. Tail.	80.15	1.58	9.53	20.7	70.2
PP24	-	0.54	-	Pb Ro. Conc.	19.43	25.1	15.6	75.3	28.3
				Pb Flot. Tail.	80.57	1.99	9.55	24.7	71.8

The Na_2SO_3 additions increased lead rougher concentrate recovery slightly, whereas Na_2S additions increased Pb rougher grade but at the expense of lead recovery.

Discussion - Continued

4. Flotation

4.2. Lead Flotation

4.2.5. Collector Additions

4.2.5.1. Rougher Circuit

Several tests were conducted in which type, level, and point of collector additions were varied. These tests were carried out when using a fine lead concentrate regrind.

The results indicated that the only significant variables were point and level of collector additions. Large quantities of collector (0.9 - 0.12 lb/ton) had to be added to the mill feed in order to increase the rate of Pb flotation.

When the collector was removed from the mill (Tests PP15 to 18) poor lead rougher recoveries were obtained.

Collector Z-11, as primary collector, and R-242, as a secondary collector, were considered to be more manageable collectors and were used throughout the remainder of the testwork.

4.2.5.2. Pb Cleaning

In the initial testwork collectors R-242, R-241, Z-11, and Z-6 alone or in combination were examined. Conditions and results for these tests are shown in table No. 18.

Discussion - Continued

4. Flotation

4.2. Lead Flotation

4.2.5.2. Pb Cleaning

Table No. 18

Effect of Collector in the Pb Cleaning

Test No.	Reagent Added, pounds per ton					pH
	$ZnSO_4$	NaCN	R-242	Z-11	Z-6	
PP6	0.54	0.31	0.02	0.01	-	9.2
PP7	0.54	0.31	-	-	0.04	9.3
PP8	0.56	0.29	0.02	-	0.02	9.2
PP9	0.54	0.31	0.02	-	-	9.2

Test No.	Product	Weight %	Assays, %		% Distribution	
			Pb	Zn	Pb	Zn
PP6	Pb Cl. Conc.	8.72	59.0	10.5	81.8	9.2
	Pb Ro. Conc.	20.70	23.5	15.3	84.1	30.2
PP7	Pb Cl. Conc.	11.04	46.6	15.4	83.1	17.2
	Pb Ro. Conc.	20.77	23.3	15.5	83.0	30.1
PP8	Pb Cl. Conc.	9.89	49.9	12.9	79.7	13.0
	Pb Ro. Conc.	23.14	21.4	15.7	84.1	37.0
PP9	Pb Cl. Conc.	7.53	62.4	8.78	77.8	6.5
	Pb Ro. Conc.	21.17	23.4	16.0	81.3	31.0

The results indicated that higher levels of collector 242 additions or additions of collector Z-6 had a negative effect on the lead grade and recovery. Only low additions of collector R-242 or Z-11 (0.01 lb/ton) to the lead regrinding cyclone pump were required.

Discussion - Continued

4. Flotation

4.3. Zinc Flotation

The successful flotation and upgrading of zinc concentrate was determined by a number of signigicant factors. These are: a) Conditions under which the lead rougher and cleaning were carried out (i.e. fineness of Pb concentrate regrind), b) Stability of the recirculation load in the lead cleaning, c) Flowsheet used, d) Finenss of zinc rougher concentrate regrind, e) pH in the zinc cleaning, f) stability of the recirculation load in the zinc cleaning circuit.

It should be pointed out that in order to obtain acceptable zinc recovery in the zinc rougher circuit, a bulk zinc-pyrite concentrate was produced in most of the tests (16 - 25 % Zn). Successful upgrading of the zinc concentrate could only be obtained by close control of the above parameters.

4.3.1. Flowsheet Evaluation

Two main flowsheets were employed during the testwork. Flowsheet figure No. 8 was tested in the initial testwork, tests PP1 - PP15. Flowsheet Figure No. 9 was used in tests PP18 to PP53. Modifications in the above flowsheets involved regrinding of different products or omission of the regrinding stage (PP5 to PP8). The modified flowsheets did not produce improvements in the zinc flotation results. The results obtained in the later tests suggested that zinc cleaning in open circuit had a beneficial effect on the stability of the Zn rougher flotation and thus lowered the circulation load in the circuit. The discard product (scavenger 1st cleaner tailing), represented 16 - 25 % of the weight of flotation feed and contained 1.7 - 3.0 % of the total zinc.

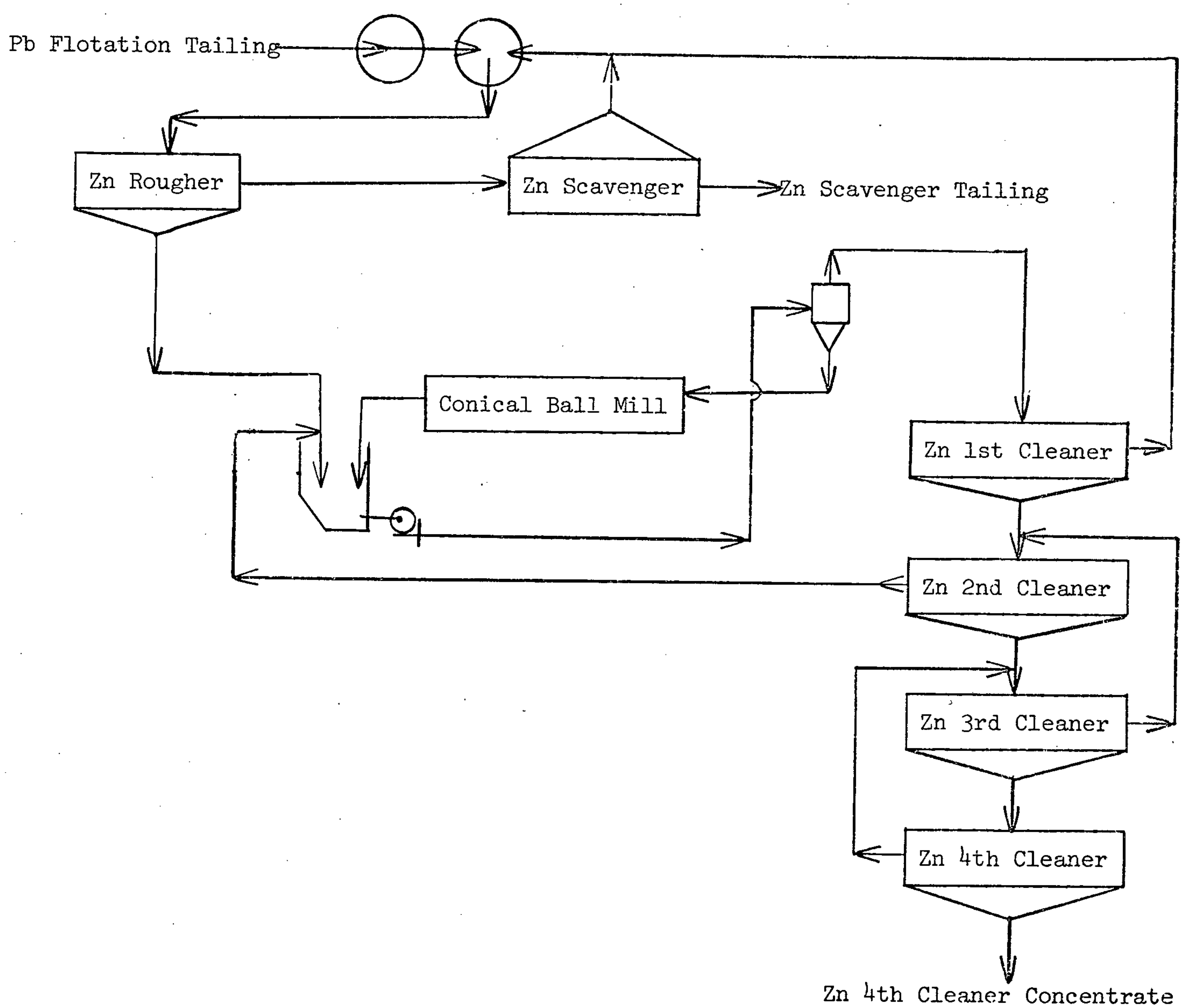
Discussion - Continued

4. Flotation

4.3. Zinc Flotation

Figure No. 8

Closed Circuit Zinc Flotation



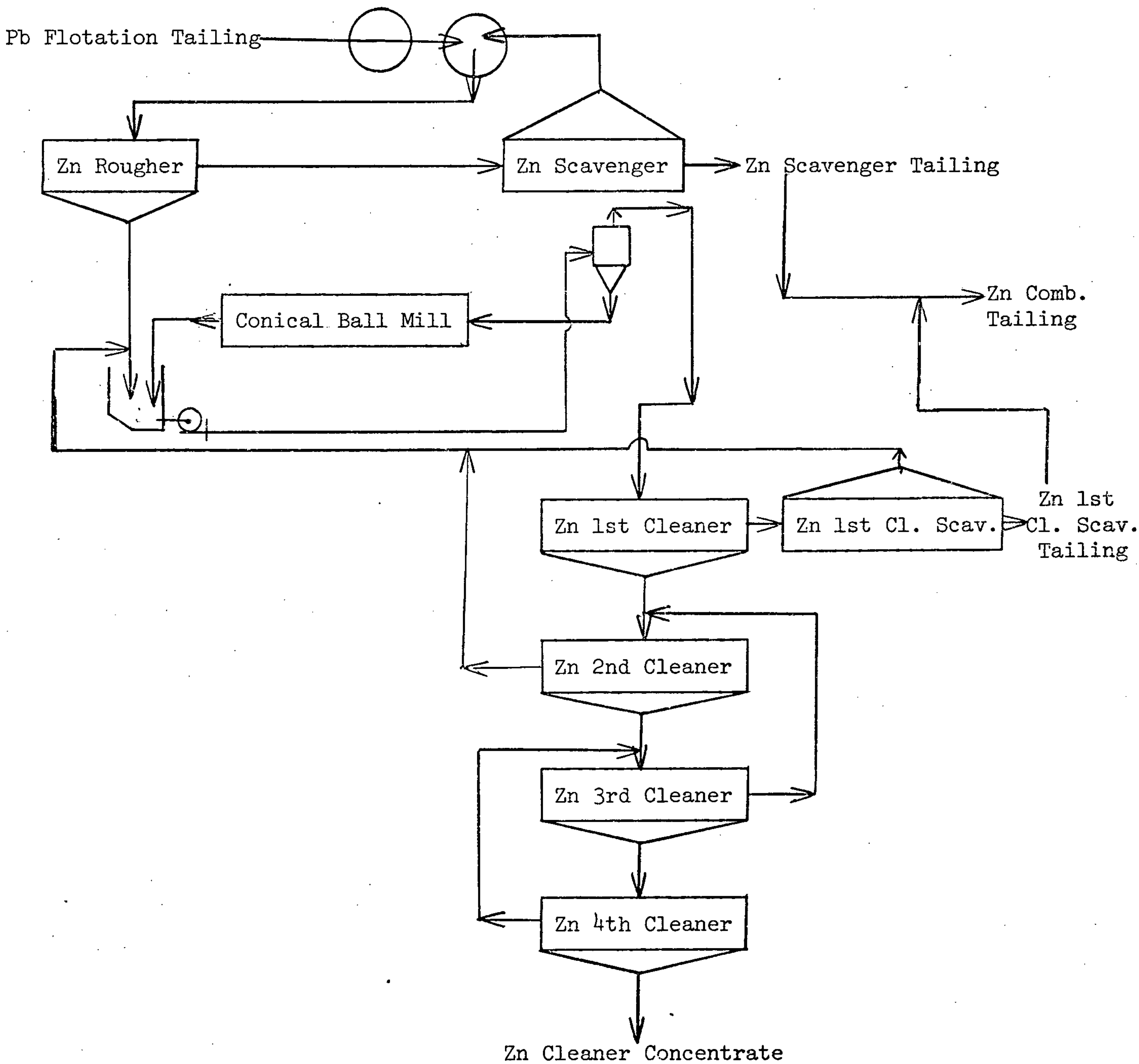
Discussion - Continued

4. Flotation

4.3. Zinc Flotation

Figure No. 9

Open Circuit Zinc Flotation



Discussion - Continued

4. Flotation

4.3. Zinc Flotation

4.3.2. Effect of Fineness of Primary Grind

To confirm the effect of the primary grind on the zinc rougher flotation, the fineness of lead rougher concentrate regrind must be included in the evaluation because the size of the feed to the zinc rougher flotation was controlled by the fineness of primary grind and by the extent of the Pb concentrate regrind. Since about 35 - 45 % of the total zinc was floated in the Pb rougher concentrate and passed through the Pb regrinding circuit, the fineness of that regrind, strongly affected zinc rougher flotation and cleaning. The effect of fine lead concentrate regrinding on zinc flotation is best illustrated in tests PP6 and PP7. In these tests the zinc concentrate regrinding stage was omitted. In test PP6 Zn concentrate grade was 54.3 % Zn at 78.5 % Zn recovery. The zinc assay of the flotation tailing was the lowest from all tests in which a high-grade zinc concentrate was obtained. A number of tests were selected in which the fineness of primary grinding was varied from 69 - 91 % minus 200 mesh. The results and conditions for these tests are presented in table No. 19. The results indicated that the zinc rougher grade or recovery were not affected by the fineness of primary grind in the range tested.

Discussion - Continued

4. Flotation

4.3. Zinc Flotation

4.3.2. Effect of Fineness of Primary Grind

Table No. 19 - Effect of Primary Grind on Zn Rougher Flotation

Test No.	Primary Grind %-200M	Primary Grind %-400M	Lead Regrind	Zn Flowsheet
14	87.6	64.0	Fine	open circuit
15	87.5	64.2	Fine	open circuit
26	79.9	52.9	Fine	closed circuit
27	69.3	45.2	Fine	open circuit
28	82.4	57.9	Fine	open circuit
32	90.3	68.2	coarse	open circuit
34	91.6	71.5	coarse	open circuit
41	91.6	70.3	coarse	open circuit

Test No.	Product	Weight %	Assays, %		% Distribution	
			Pb	Zn	Pb	Zn
14	Zn Ro. Conc.	36.11	2.23	19.8	11.3	66.5
	Zn Comb. Tail.	73.95	1.22	1.37	14.7	9.9
15	Zn Ro. Conc.	21.63	2.83	33.3	10.5	66.8
	Zn Comb. Tail.	73.08	1.51	1.83	18.2	13.1
26	Zn Ro. Conc.	27.96	2.29	24.9	10.5	63.6
	Zn Comb. Tail.	78.02	1.42	1.60	14.5	9.1
27	Zn Ro. Conc.	42.55	1.46	17.1	10.9	64.7
	Zn Comb. Tail.	75.29	1.24	1.39	16.3	9.3
28	Zn Ro. Conc.	47.37	1.52	14.8	12.3	64.4
	Zn Comb. Tail.	73.73	1.25	1.55	15.8	10.5
32	Zn Ro. Conc.	32.35	1.45	18.8	7.8	50.1
	Zn Comb. Tail.	78.38	1.23	1.73	16.5	13.6
34	Zn Ro. Conc.	17.94	2.07	35.6	6.6	50.6
	Zn Comb. Tail.	78.34	1.27	2.08	16.9	16.1
41	Zn Ro. Conc.	18.80	1.49	22.2	4.7	37.1
	Zn Comb. Tail.	79.13	1.24	1.65	17.1	13.1

Discussion - Continued

4. Flotation

4.3. Zinc Flotation

4.3.3. Reagent

A number of reagent variations were studied in the testwork in an attempt to improve selectivity and product grade. These included the use of different collectors (i.e. Z-11, Z-200, M-748 and R-404), MIBC in place of DF-250, and H_2SO_4 to acidfy the pulp prior to zinc flotation. In the latest tests only Z-11 was tested in order to simplifiy the circuit. None of the changes in reagent additions improved significantly the flotation results. High collector additions, over 0.3 lt/ton, were required to float the zinc. Dowfroth 250 produced a more manageable froth than MIBC with no deterioration in the product grade. (tests PP49 and PP50).

4.3.4. Zinc Cleaning

4.3.4.1. Effect of Fineness of Zinc Concentrate Regrind

The effect of zinc concentrate regrinding was best observed in the series of tests in which a fine primary grind and a light Pb concentrate regrind was used. The results for these tests are summarized in table No. 20.

As can be seen from the table, a coarse zinc concentrate regrind affected both the zinc concentrate grade and the zinc recovery.

Discussion - Continued

4. Flotation

4.3. Zinc Flotation

4.3.4. Zinc Cleaning

4.3.4.1. Effect of Fineness of Zinc Concentrate Regrind

Table No. 20

Effect of Fineness of Zinc Concentrate Regrind on Zn Cleaning

Test No.	Zn 1st Cl. Feed		Product	Weight %	Assays, %		% Distribution	
	% Pass -20μm	% Pass -10μm			Pb	Zn	Pb	Zn
41	75.5	36.0	Zn Cl. Conc. Zn Flot. Tail.	13.78 79.15	2.37 1.24	57.4 1.65	5.7 17.1	79.6 13.1
42	42.3	22.0	Zn Cl. Conc. Zn Flot. Tail.	16.66 76.16	2.65 1.27	48.4 1.65	7.6 16.8	79.9 12.4
43	36.0	20.0	Zn Cl. Conc. Zn Flot. Tail.	14.50 78.20	2.64 1.30	52.1 2.11	6.6 17.5	75.5 16.5
44	39.4	23.3	Zn Cl. Conc. Zn Flot. Tail.	12.37 79.33	2.26 1.30	52.4 2.99	4.8 17.8	65.1 23.9
47	80.0	60.0	Zn Cl. Conc. Zn Flot. Tail.	14.69 78.41	2.23 1.19	55.5 1.54	5.7 16.4	81.5 12.1

4.3.4.2. Effect of pH on Zinc Cleaning

The effect of pH on the zinc concentrate grade is illustrated in figure No. 10. As can be seen from the graph, the pH in the cleaning was critical and at a pH below 11.2 the zinc concentrate grade dropped sharply. Laboratory test results have not indicated deteriorations in zinc flotation within the pH range of 10.5 to 12.0 (see Progress Report No. 10). It is likely that the sensitivity of the zinc flotation to the pH is the result of depressing fine pyrite-zinc middlings.

Discussion - Continued

4. Flotation

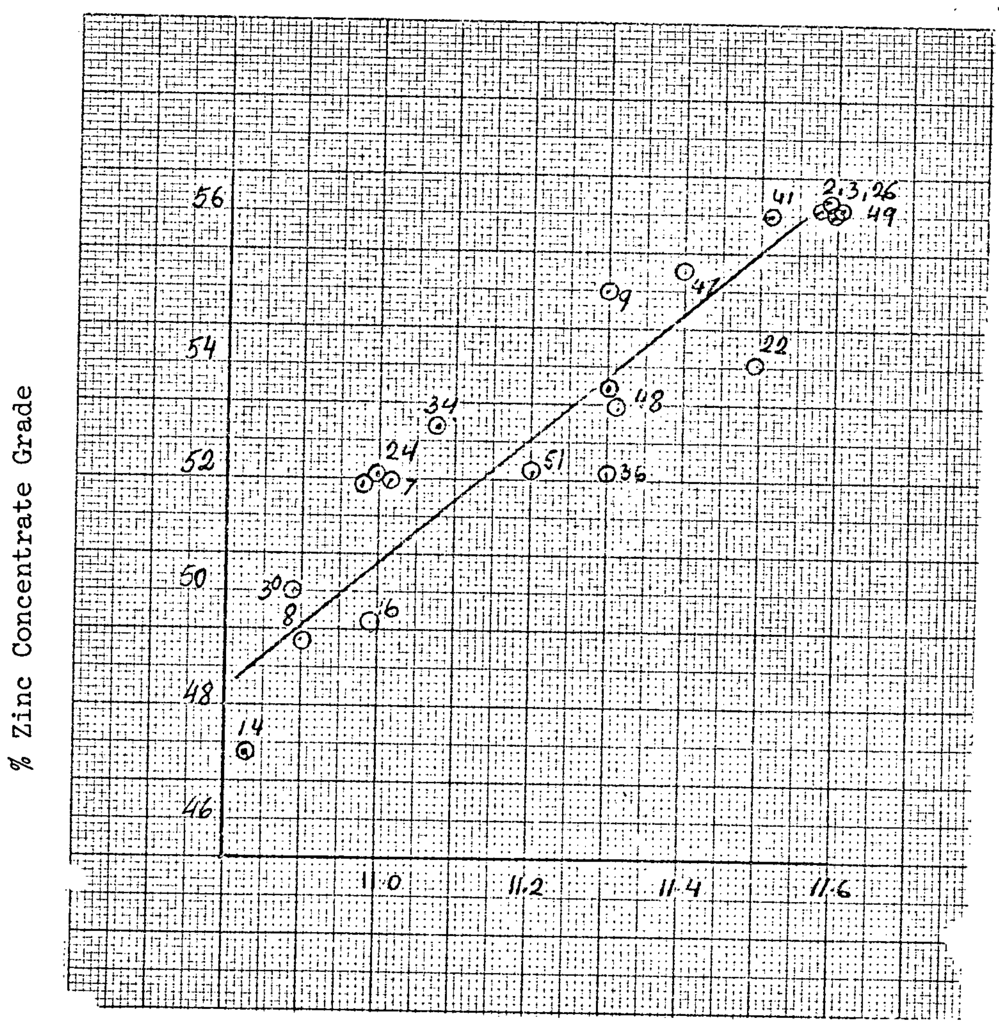
4.3. Zinc Flotation

4.3.4. Zinc Cleaning

4.3.4.2. Effect of pH on Zinc Cleaning

Figure No. 10

Effect of pH on Zinc Concentrate Grade at Similar Zn Recovery



pH (2nd, 3rd and 4th cleaner)

Discussion - Continued

4. Flotation

4.3. Zinc Flotation

4.3.5. Zinc Scavenger Cleaning Circuit

It was observed that the overall zinc circuit performance improved with cleaning the zinc rougher concentrate in open circuit. The performance of the scavenger cleaner circuit was largely dependent on the amount of zinc retained in the zinc 1st cleaner tailing. Higher zinc assays in the zinc 1st cleaner tailing (Figure No. 11) resulted in higher assays in the 1st cleaner scavenger tailing. It should be pointed out that variations of the zinc assays in the zinc 1st cleaner scavenger feed resulted in the variation of the weight recovery of scavenger concentrate which subsequently affected the recirculation load in the zinc regrind and classification stage.

5. Recycle Water

5.1. Tailing Pond Preparation

The tailing pond was constructed at the beginning of the pilot plant operation to collect tailing and later to recycle tailings water back to grinding and flotation circuits. The zinc combined tailing was pumped into the tailing pond from test PP3 to PP53 and the tailing water was recycled in tests PP45 to PP53.

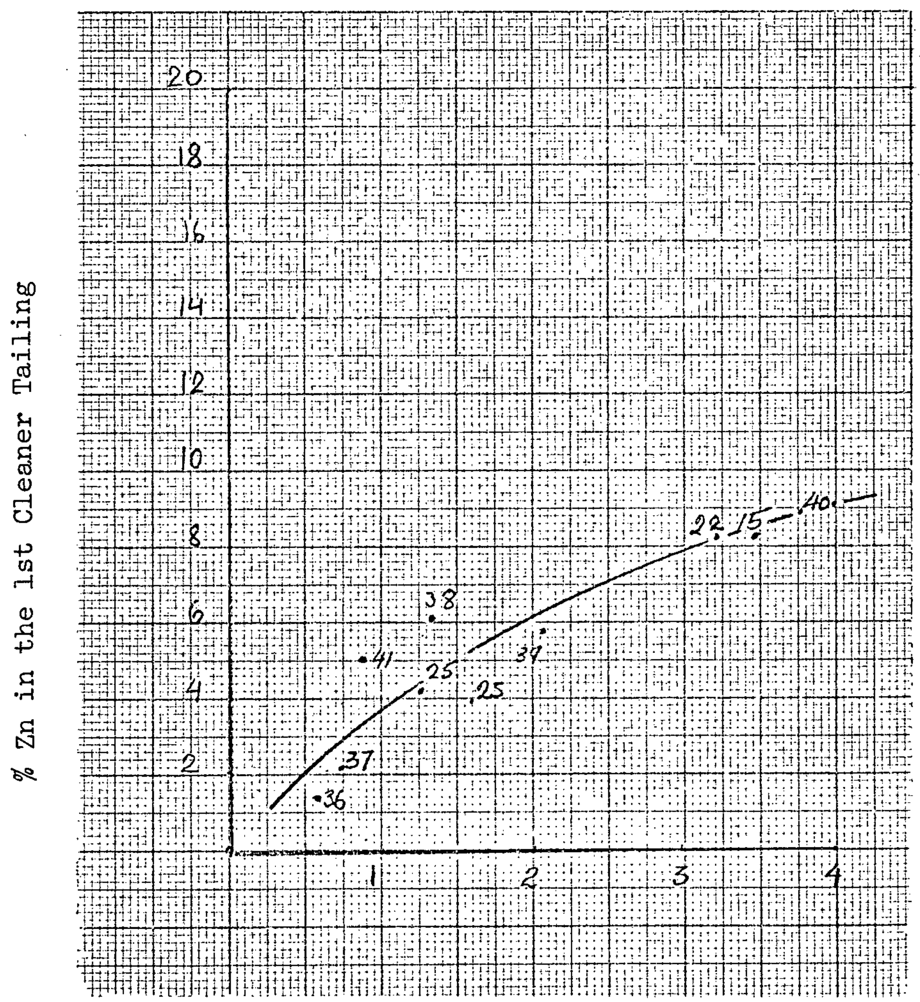
A schematic flowsheet of the recycle water circuit is illustrated in figure No. 12.

Discussion - Continued

4.3.5. Zinc Scavenger Cleaning Circuit

Figure No. 11

Zn Assays in the Zn 1st Cleaner Tailing Versus Zn Assays in the Zn 1st Cleaner Scavenger Tailing



% Zn in the 1st Cleaner Scavenger Tail.

Discussion - Continued

5. Recycle Water

5.2. Water Analysis

Water samples from cyclone overflow, Pb tailing, zinc tailing and tailing pond were taken periodically and analysed for $S_2O_3^{=}$ and NaCN. These results are summarized in table No. 21.

Table No. 21

Test No.	Water Sample	Assays, P.P.M.				pH
		$S_2O_3^{=}$	CN^{-}	Na_2CO_3	$NaHCO_3$	
PP17	Hendy Cyclone O/F	124	-	-	-	8.8
	Pb Scav. Tail.	116	-	-	-	10.5
	Zn Scav. Tail.	86	-	-	-	8.85
	Tailing Pond	59	<0.1	-	-	8.53
PP22	Hendy Cyclone O/F	134.5	-	67	537.0	8.55
	Pb Scav. Tail.	97.9	-	22	260.0	8.45
	Zn Scav. Tail.	117.1	-	-	-	8.89
	Tailing Pond	86.7	0.270	-	-	8.40
PP27	Hendy Cyclone O/F	63.9	-	86	150.0	8.9
	Pb Scav. Tail.	53.0	-	28	327.0	8.65
	Zn Scav. Tail.	61.2	-	-	-	9.05
	Tailing Pond	63.4	0.143	-	-	8.75
PP31	Hendy Cyclone O/F	68.5	-	-	-	8.9
	Pb Scav. Tail.	60.0	0.13	-	-	8.6
	Zn Scav. Tail.	61.1	-	-	-	8.9
	Tailing Pond	63.1	<0.1	-	-	8.6
PP37	Hendy Cyclone O/F	53.8	-	33	600	8.60
	Pb Scav. Tail.	49.4	-	22	380	8.45
	Zn Scav. Tail.	57.4	-	-	-	9.00
	Tailing Pond	34.7	<0.1	-	-	8.55

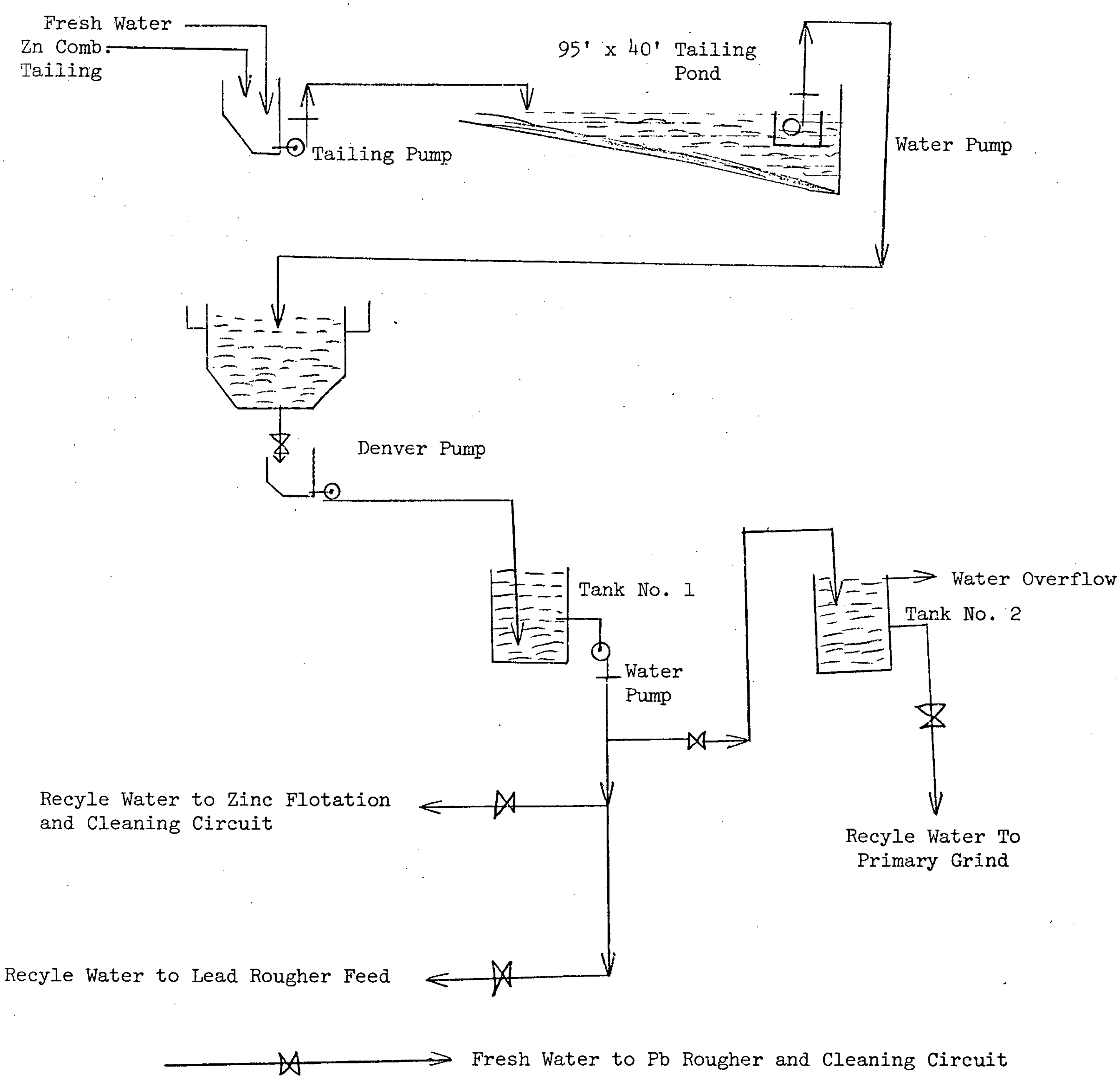
Discussion - Continued

5. Recycle Water

5.2. Water Analysis

Figure No. 12

Tailing Recycle Water Flowsheet



Discussion - Continued

5. Recycle Water

5.3. Effect of Recycle Water on Pb and Zn Flotation

The effect of recycle water on Pb and Zn metallurgical results are compared in table No. 22.

Table No. 22

Test No.	Water Used	Product	Weight %	Assays, %		% Distribution	
				Pb	Zn	Pb	Zn
PP41	Fresh 100 %	Pb Cl. Conc. Zn Cl. Conc. Zn Comb. Tail.	7.07 13.78 79.15	62.70 2.37 1.24	10.40 57.40 1.65	77.2 5.7 17.1	7.3 79.6 13.1
PP45	Recycle Water 100 %	Pb Cl. Conc. Zn Cl. Conc. Zn Comb. Tail.	9.38 13.13 77.49	46.81 2.61 1.30	15.40 53.80 1.74	76.5 6.0 17.5	14.7 17.7 13.6
PP47	Fresh Water 30* Recycle Water 70	Pb Cl. Conc. Zn Cl. Conc. Zn Comb. Tail.	6.90 14.69 78.41	64.60 2.23 1.19	9.25 55.50 1.54	77.9 5.7 16.4	6.4 81.5 12.1

* Added to the Pb cleaners

The results indicated that recycle water could be used in the grinding and zinc rougher and cleaning circuits. The use of recycle water in the Pb cleaning circuit resulted in uncontrollable froth and deterioration in the selectivity (Test PP45).

A total of 70 % effluent was recycled to the circuit with no noticeable effect on Pb and Zn metallurgical results.

Discussion - Continued

6. Tailing Treatment

6.1. Desliming

Several desliming tests were conducted on the zinc flotation tailing from tests PP34, 35, 36 and 37 in order to remove minus 10 micron slime and produce material for percolation tests. Typical size distribution of the desliming products are presented in table No. 23 below.

Table No. 23

Distribution of the Zinc Combined Tailing Desliming Products - Test PP34

Particle Size	Cyclone Feed			Cyclone U'Flow			Cyclone O'Flow		
	% Retained		% Pass	% Retained		% Pass	% Retained		% Pass
	Ind.	Cum.	Cum.	Ind.	Cum.	Cum.	Ind.	Cum.	Cum.
+ 200m	10.2	10.2	89.8	9.7	9.7	90.3	-	-	-
+ 30μm	17.0	27.2	72.8	9.8	19.5	80.5	-	-	-
+ 23μm	10.6	37.8	62.2	32.2	51.7	48.3	2.0	2.0	98.0
+ 16.3μm	14.2	52.0	48.0	22.7	74.4	25.6	0.6	2.6	97.4
+ 11.2μm	10.7	62.7	37.3	14.6	89.0	11.0	5.9	8.5	91.5
+ 8.7μm	6.2	68.9	31.1	3.9	92.9	7.1	10.9	19.4	80.6
- 8.7μm	31.1	100.0	-	7.1	100.0	-	80.6	100.0	-
Total	100.0	-	-	100.0	-	-	100.0	-	-

* Desliming

6.2. Percolation Tests

Several percolation tests on the deslimed cyclone underflow (Test PP34 and PP36) and the spigot tailing sand removed from the tailing pond were performed. These tests are summarized in table No. 24.

Discussion - Continued

6. Tailing Treatment

6.2. Percolation Tests

Table No. 24

Test No.	Product Used	Time Interval Hours	Weight Fraction*		Percolation Rate Inch/Hour	Height Inches	
			Ind.*	O'all**		Total	Pulp
1-22	Spigot Tailing Sand	1 - 6 6 - 48	- -	- -	3.3 2.0	14	5¼
34	Desliming Cyclone U'Flow	1 - 6 -	68.3 -	53.5 -	2.3 -	14	7½
36	Desliming Cyclone Underflow	1 - 6 -	63.6 -	52.0 -	2.3 -	14	5½

* Of Tailing
** Of Flotation Feed

7. Flotation Times and Conditioning Capacity

The pilot plant flotation times and conditioning capacity for the lead and zinc circuits are summarized in table No. 25.

Discussion - Continued

7. Flotation Times and Conditioning Capacity

Table No. 25

Lead and Zinc Flotation Times and Conditioning Capacity

Stage	Conditioning or Flotation Time Minutes	Retention Time Min./Cell
Pb Conditioning	5.0	-
Pb Rougher Flotation	10.0	2.5
Pb Scavenger Flotation	8.0	1.3
Pb 1st Cleaner	9.0	2.1
Pb 2nd Cleaner	3.5	0.6
Pb 3rd Cleaner	2.5	1.2
Pb 4th Cleaner	2.0	1.0
Zn Conditioning	12.0	-
Zn Rougher Flotation	11.0	2.8
Zn Scavenger Flotation	12.5	3.2
Zn 1st Cleaner	8.5	1.4
Zn 1st Cleaner Scavenger	11.5	2.0
Zn 2nd Cleaner	6.5	1.7
Zn 3rd Cleaner	6.0	2.0
Zn 4th Cleaner	5.5	2.8

The above pilot plant flotation and retention times were calculated from material mass balance Figure No. 2. The flotation time calculations were based on:

1) Known pulp flow U.S.G.P.M.

2) Known cell volume U.S.G.

3) Known correction coefficient for each type of cell (K).

8. Analyses of Size Fraction

Size fractions from the zinc scavenger tailing, the Pb cleaner concentrate and the zinc cleaner concentrate were analysed in tests PP13 to PP35 and the results are shown in Appendix No. 1.

Discussion - Continued

9. Sample Disposition

The following ore samples remaining in the drums are available:

Ore Samples Remaining in Drums

Sample No.	No. Drums Remaining	Approximate Weight Tons
A-2	0	0
B-5	21	10.0
C-4	17	7.5
D-4	0	0
FV-4	1	0.5
FQ-4	1	0.5
G-4	18	8.5
H-4	20	9.0
J76-1	10	4.5
K68-1	5	2.2
K76-1	20	9.5
K80-1	1	0.5

9.1. Lead Concentrate

The following lead final concentrate samples were collected during the pilot plant operation and stored in separate plastic-lined 45 gallon drums.

Drum No.	Approximate Weight lb	Assays, %	
		Pb	Zn
1	900	55.8	12.3
2	960	64.3	9.7
3	1000	59.3	11.6
4	800	58.3	11.7
5	850	62.9	10.1

Discussion - Continued

9. Sample Disposition

9.2. Zinc Concentrate

The following zinc concentrate samples were collected and stored in plastic-lined 45 gallon drums.

Drum No.	Approximate Weight Pound	Assays, %		
		Pb	Zn	As
1	940	2.80	51.1	0.105
2	700	2.75	52.5	0.100
3	820	2.81	52.4	0.103
4	760	2.39	52.1	0.090
5	746	2.50	52.7	0.102
6	700	2.62	50.1	0.113
7	700	2.81	50.7	0.106
8	800	2.99	50.4	0.100
9	700	2.74	50.2	0.103
10	800	2.44	51.3	0.102
11	600	2.62	51.4	0.100
12	800	2.40	52.7	0.095
13	900	2.40	52.3	0.098
14	900	2.40	52.8	0.090

ORE SAMPLE PREPARATION

1. Receipt of Samples

During the August 9 to 31 a total 485 drums of Grum ore were received at Lakefield by transport trucks. The shipment consisted of 18 drums sample A-2, 57 drums sample B-5, 57 drums sample C-4, 18 drums sample D-4, 18 drums sample FQ-4, 18 drums sample FV-4, 57 drums sample G-4, 57 drums sample H-4, 75 drums sample J-76, 40 drums sample K-68, 35 drums sample K-76 and 35 drums sample K-80.

Table No. 1

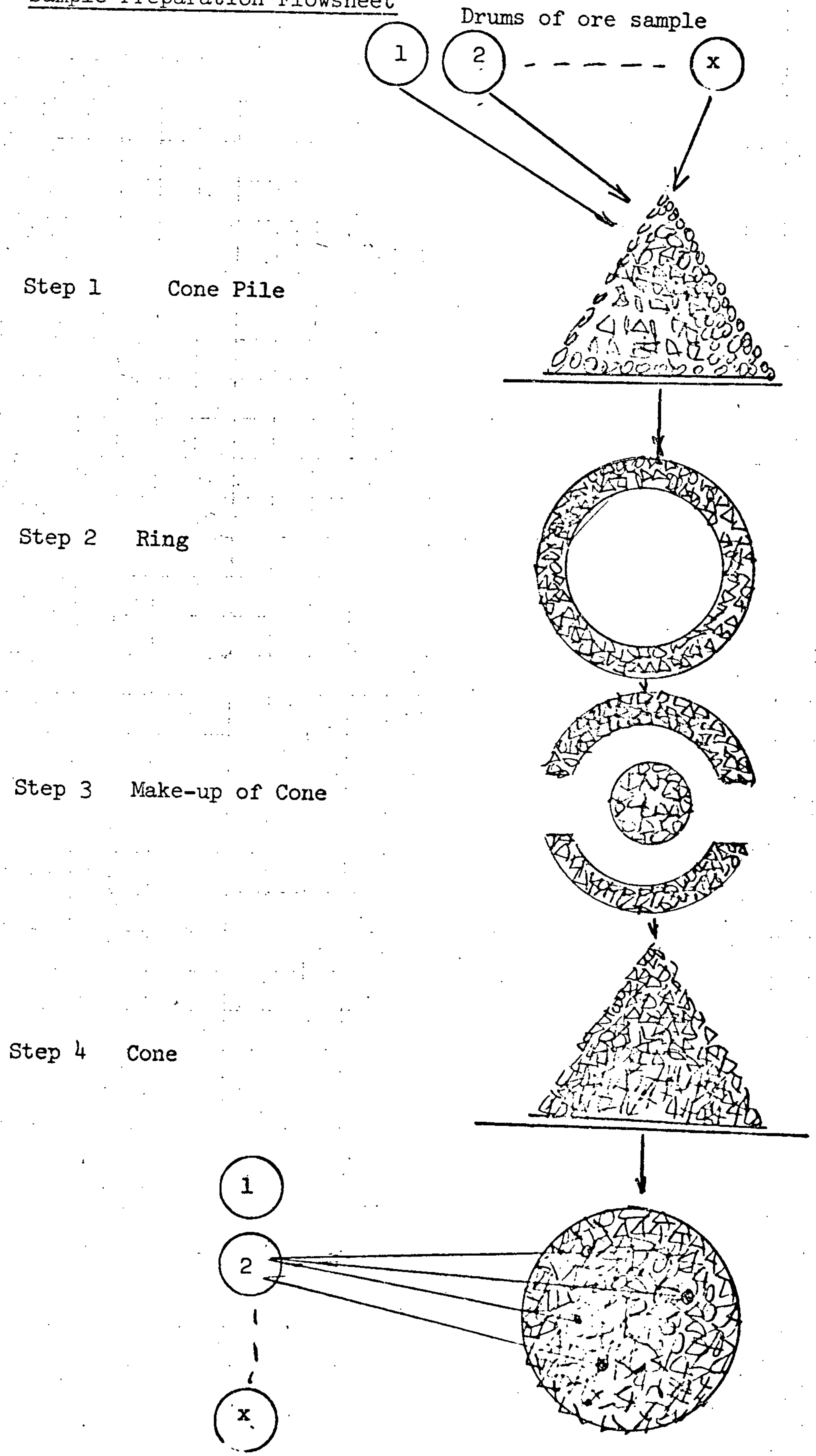
Sample Shipment Data

Date	Waybill No.	A-2	B-5	C-4	D-4	FQ-4	FV-4	G-4	H-4	J76-1	K68-1	K76-1	K80-1	Total Drums
Aug. 9	8605987	-	-	3	-	-	-	-	-	-	-	33	-	36
16	8606019	-	-	40	-	-	-	-	-	-	-	-	-	40
18	8606113	-	-	-	-	-	-	-	20	-	-	-	20	40
18	8606098	18	-	-	7	-	-	-	-	-	-	-	15	40
18	8606144	-	-	-	-	-	4	-	37	-	-	-	-	41
19	8606096	-	-	2	11	-	-	29	-	-	-	2	-	44
19	8606126	-	-	12	-	-	-	-	-	-	28	-	-	40
19	8606071	-	-	-	-	-	-	28	-	-	12	-	-	40
22	8606156	-	-	-	-	-	-	-	-	41	-	-	-	41
22	8606139	-	-	-	-	18	14	-	-	9	-	-	-	41
29	8606173	-	16	-	-	-	-	-	-	25	-	-	-	41
31	8606222	-	41	-	-	-	-	-	-	-	-	-	-	41

Approximately 275 tons of ore were received.

Figure No. 1

Sample Preparation Flowsheet



Ore Sample Preparation - Continued

2. Sample Mixing Procedure

Before the ore was composited, each type sample was homogenized by mixing. The mixed lot was then returned to the drums. For the mixing, the cone-ring method was used (Figure No. 1) and consisted of the following steps: a) Dumping from the drums into cone-shaped pile, b) the pile was then transformed into the ring by going around the pile and taking portions of the ore from different points, c) from the ring the pile was again transformed into a cone-pile. This procedure was repeated three times. After mixing the cone shaped pile was flattened to a thickness of 1 to 2 feet, and was returned to the drums by taking the ore from different points.

3. Preparation of Ball Mill Feed

The composition of mill feed sample was defined in Dr. D.Carson's letter dated October 13, 1978 and the following samples were included.

Sample No.	Weight Tons*	Assays, %								Specific Gravity
		Cu	Pb	Zn	Fe	S	As	Hg	Ag**	
K76-1	16.5	0.25	6.95	10.30	26.8	38.5	0.13	0.0094	3.11	4.76
K80-1	17.0	0.16	5.18	9.38	19.3	26.1	0.47	0.0073	2.34	3.75
K68-1	19.0	0.20	5.42	11.30	31.3	36.9	0.11	0.0048	2.59	4.57
J76-1	36.6	0.20	6.38	8.81	28.5	35.9	0.34	0.0050	2.55	4.30
B-5	26.5	0.13	8.96	15.50	22.6	34.9	0.33	0.0121	4.40	4.30
C-4	25.0	0.04	4.20	8.26	15.5	21.2	0.30	0.0084	1.93	3.45
FV-4	8.8	0.062	6.88	16.80	18.1	27.9	0.36	0.0160	3.34	3.91
D-4	7.0	0.035	4.10	8.44	6.98	11.6	0.29	0.0088	2.04	3.12
H-4	25.0	0.072	3.78	8.20	14.4	17.0	0.31	0.0078	1.89	3.40
G-4	25.0	0.032	1.49	3.40	5.56	6.87	0.12	0.0027	0.68	2.95
FQ-4	8.8	0.081	7.81	14.10	17.80	26.90	0.38	0.0124	3.60	3.88
A-2	8.8	0.17	9.23	6.15	23.70	29.20	0.075	0.0022	3.01	4.25

* Estimated Weight
** oz/ton

Ore Sample Preparation - Continued

3. Preparation of Ball Mill Feed

The required number of drums (estimated weight) from each sample was dumped and mixed. The composite was jaw-crushed to minus 4 inches and impact-crushed in a Hazemag crusher. The Hazemag product was screened on a ½ inch Kason screen to provide a screened minus ½ inch ball mill feed. The Kason screen oversize was returned to the Hazemag crusher.

The first 75 tons of the composite sample was sampled to obtain material for laboratory testwork and head analyses.

SAMPLING

1. Grinding and Flotation Circuits

The grinding and flotation circuits were operated 5 to 6 hours to obtain equilibrium conditions before samples were removed for analyses.

2. Assay Samples

Composite samples of the grinding and flotation circuit products were taken at 20 to 30 minute intervals during the test period. The sampling was conducted with individual sample cutters of approximately 400 milliliters capacity with ½ inch by 6 inch openings. Several of the circuit products were sampled with 250 ml. or 500 ml. capacity plastic cups. The samples were accumulated for the duration of the sample period, and were then filtered and dried.

3. Pulp Density Samples

Pulp density samples were taken every 30 minutes in the grinding circuit and every hour in the flotation circuit. A direct-reading Marcy pulp balance, equipped with a one litre sample container was employed for these tests. The pulp densities were recorded in grams per litre.

4. Sample Preparation

The composite pulp samples were filtered in Denver vacuum filters. The filter cakes were transferred to pans, and oven-dried overnight at 80°C. The minus ½ inch ball mill feed sample was weighed prior to drying to obtain the moisture content.

The following procedure was employed in the assay sample preparation:

1. Weigh sample
2. Break up sample on 10 mesh screen
3. Riffle down to manageable size
4. Bag the reject portion
5. Pulverize in disc mill for 2-3 minutes

Sampling - Continued

4. Sample Preparation

6. Screen sample on 100 mesh screen
7. Plus 100 mesh fraction ground with pestle and mortar, screened to 100 % passing 100 mesh, and mixed with remainder of minus 100 mesh fraction.
8. Minus 100 mesh fraction reduced by coning and quartering, and submitted for assays.

REAGENTS

1. Reagent Suppliers and Preparation Procedure

Common Name	Supplier	Preparation Procedure
Soda Ash	Allied Chemicals	5 kg of Na_2CO_3 diluted to 50 liters volume cold water (10 % solution)
Lime	Dominion Cisco	2.5 kg of CaO diluted to 50 liters volume cold water (5 % solution)
NaCN	Nymoc Products Company	100 grams NaCN diluted to 10 liters volume cold water (1 % solution)
$ZnSO_4$	Nordman Chemicals Pty Ltd.	2.5 kg of $ZnSO_4 x 7H_2O$ diluted to 50 liters volume with cold water (5 % solution)
AX-343	Cyanamid	200 grams AX-343 diluted to 10 liters volume with cold water (2 % solution)
Z-200	Dow Chemicals	100 % solution
MIBC	The Chemical and Industrial Solvent Composite	100 % solution
DF-250	Dow Chemicals	100 % solution

2. Reagent Feeders

Model E Clarkson feeders equipped with head tanks and automatic level control valves, and gravity feeders were used to add reagents to the circuit.

The frothers, collectors Z-200 and Cyanide were added in drops from gravity feeder bottles of 1 to 10 litre capacities.

The reagent rate was measured in milliliters per minute and converted to pounds per ton of ball mill feed. The reagents added in drops were measured in drops per minute and converted to pounds per ton of mill feed, using a factor of grams per drop of each reagent.

METALLURGICAL CALCULATIONS

1. Two Product Formula

The metallurgical balances for the Pb and Zn rougher circuit, the scavenger circuit and for intermediate products were calculated using two-product formula:

$$C = F \frac{(f - t)}{(c - t)}$$

Where - C = Concentrate, weight %
F - Feed weight %
f = Feed assay (%)
c = Concentrate assay (%)
t = Tailing assay (%)

2. Three Product Formula

Overall metallurgical balance was calculated for each test, using three product formula.

Product	Weight %	Assays, %	
		Pb	Zn
Feed	F	I_1	Z_1
Pb Concentrate	L	I_2	Z_2
Zn Concentrate	Z	I_3	Z_3
Tailing	T	I_4	Z_4

$$L = F \times \frac{(I_1 - I_4)(Z_3 - Z_4) - (Z_1 - Z_4)(I_3 - I_4)}{(I_2 - I_4)(Z_3 - Z_4) - (Z_2 - Z_4)(I_3 - I_4)}$$

$$Z = F \times \frac{(I_2 - I_4)(Z_1 - Z_4) - (I_1 - I_4)(Z_2 - Z_4)}{(I_2 - I_4)(Z_3 - Z_4) - (Z_2 - Z_4)(I_3 - I_4)}$$

3. Work Index

Work indices were calculated using the relationship established by F.C. Bond in his Third Theory of Comminution. In order to obtain the 80 % passing size, the size analyses were plotted and the size moduli K_{80} were determined graphically.

$$\text{Work Index} = \frac{E}{10\left(\frac{1}{\sqrt{P}} - \frac{1}{\sqrt{F}}\right)}$$

Where: E - Grinding energy (kilowatt-hours per short ton) consumed to grind material from F to P.

P - Size modulus K_{80} (i.e. size of aperture which would just allow 80 % of the material to pass through the aperture) of ground product.

F - Size modulus K_{80} of feed to grinding.

4. Recirculating Load

The recirculating load was calculated from the screen analyses of the cyclone feed, the cyclone underflow and overflow, using the following mathematical method:

Mesh	f (Feed) Retained	U (U'Flow) Retained	O (O'Flow) Retained	f - o	u - o	$(U-O)^2$	(u-o) (f-o)
+ fn ↓ + Ni	fn ↓ fi	Un ↓ Ni	On ↓ Oi	Fn - On ↓ Fi - Oi	Un - On ↓ Un - Oi	$(Un - On)^2$ ↓ $(Ui - Oi)^2$	(Un-On)(fn-On) ↓ (Un-On)(fn-On)

$$U = \frac{\sum_{n}^{1} (u - o)(f - o)}{\sum_{N}^{1} (u - o)^2} \times 100$$

Where: u - underflow weight %

5. Mass Balance Calculation

The mass balance was calculated using the three-product formula, incorporated with correlation formulas. The general equation used to correct assays of unbalanced products was as follows:

$$F = C + T$$

$$F.f = C.c + T.t$$

$$F + \Delta f = C + \Delta C + T + \Delta T$$

$$(F + \Delta F)(f + \Delta F) = (C + \Delta C)(c + \Delta c) + (T + \Delta T)(f + \Delta t)$$

$$\Delta X = \frac{X_1 - X_2}{\sigma X}$$

$$\Delta x = \frac{x_1 - x_2}{\sigma x}$$

$$\sigma x = \frac{x_1}{n}$$

Where:

- F = feed weight calculated using Pb and Zn Assays
- C = concentrate weight calculated using Pb and Zn assays
- T = tailing weight calculated using Pb and Zn assays
- f = feed assays (%) - Pb or Zn
- c = concentrate assays (%) - Pb or Zn
- t = tailing assays (%) - Pb or Zn
- Δ F = corrected feed weight
- Δ C = corrected concentrate weight
- Δ T = corrected tailing weight
- Δ f = corrected feed assays - Pb or Zn
- Δ c = corrected concentrate assay - Pb or Zn
- Δ t = corrected tailing assay - Pb or Zn
- Δ X = correction factor for feed, concentrate and tailing weight (Pb or Zn)
- Δ x = correction factor for feed, concentrate and tailing assays (Pb or Zn)

6. Flotation Time Calculation

Flotation time in the pilot plant was calculated by using the following formula.

$$t = \frac{N \times Vc}{Vs} \times K = \left[\frac{\text{U.S. Gallons}}{\text{U.S. Gallons/minute}} \right] = \text{minutes}$$

Where: N = number of cells

Vc = Volume of cell (U.S. gallons)

Vs = Volume of slurry (U.S. gallons/minute)

K = Correlation coefficient for cell volume (0.884 Denver cell, 0.85 Fagergren cell, 0.80 Agitair cell)

t = Flotation time

DESCRIPTION OF EQUIPMENT

1. Crushing

1.1. Primary Crusher

The primary crusher was a 10 inch by 16 inch Buchanan Jaw Crusher, driven by a 25 horsepower motor. The feed was reduced from minus 10 inches to minus 4 inches in the primary crusher.

1.2. Secondary Crusher

The secondary crusher was a Hazemag Model A.P.K. 20, impact crusher, driven by a 25 horsepower motor through pulleys and v-belts. The gap between the impact plate and the rotor blades was adjusted to obtain the required discharge particle size.

1.3. Screen

A 48 inch Kason Vibrating Separator equipped with a ½ inch screen was used to screen the crushed ore. The oversize was recycled to the crusher.

2. Grinding

2.1. Hendy Mill

a) Dimension and Operation

The Joshua Hendy ball mill was a grate discharge mill, with inside dimensions of 44.5 inches diameter and 33 1/4 inches in length. The grate had an open area of 16 percent of the total grate area in the form of slots, 5/16 inches wide. Pulp passing through the grate was conveyed by radial lifters and discharged through the trunnion. One inch square lifter bars were installed at intervals of 8 inches. The mill was driven by a 15 horsepower motor; through sheaves, v-belts, pinion and bull gears. The speed of the mill was 32 revolutions per minute or 80.5 percent of critical speed. The mill was equipped with a 3 mesh trommel.

Description of Equipment - Continued

2. Grinding

2.1. Hendy Mill

b) Power Calculations

The gross power was measured by a Sangamo Type ED30 Demand Energy Meter, equipped with a rate meter and a cumulative meter. A nominal efficiency of 95 % was assumed for the power transmission. The no-load power of the mill was calculated in the same manner, but with the mill operating empty. The net power consumption was equal to the gross minus the no load power.

c) Ball Charge

The steel charge consisted of forged steel balls, with diameters ranging from 3 inches to 3/4 inches.

d) Mill Feeder

The feed rate to the Hendy Mill was controlled by an automatic weightometer (Gravimerrick Model 960), manufactured by the Merrick Scale Manufacturing Company.

The Gravimerrick was equipped with a feed control gate, which maintained a constant belt loading (4.2 lb/foot). The feed rate was directly proportional to the belt speed which was controlled by a direct current variable speed motor through a potentiometer controlled S.C.R.

2.2. Sala Mill

a) Dimension and Operation

A Sala Mill with inside dimensions of 34 inches diameter and 48 inches length was used.

The rubber lining was smooth and there were no lifter bars. The rubber grate had an open area of 26 % of the total grate in the form of 1 inch by 1/4 inch tapered slots. Pulp passing through the grate was conveyed by 12 radial lifters and discharged through the trunnion. The mill was run on rubberized rollers, which were driven by torque-arm speed reducers and v-belts from two 7.5 horsepower A.S.E.A. motors. The speed of the mill was 31 r.p.m. or 67 % of critical speed.

Description of Equipment - Continued

2. Grinding

2.2. Sala Mill

b) Power Calculation

The gross power was measured by a Sangamo type 4L2 demand energy-meter equipped with a rate meter and a cumulative meter. A nominal efficiency of 95 % was assumed for the power transmission. The net power consumption was equal to the gross power minus the no-load power.

c) Ball Charge

The mill load consisted of 1 inch and 2 inch steel balls.

2.3. Hardinge Conical Mill

a) Dimension and Operation

The Hardinge conical mill consisted of two conical end-sections, and 8 inch long cylindrical centre section. The diameter of the centre section was 34½ inches between liners. The liners were smooth, without wave or lifter bars. Pulp was discharged from the mill by gravity through the trunnion. The mill drive consisted of 7.5 H.P. motor with sheaves v-belts, pinion and bull gears. The speed was 36 r.p.m. or 80 % of critical speed. The mill was equipped with a 3 mesh trommel screen. It was used in the zinc regrinding.

b) Power Calculation

The gross power measured by a Sangamo Type KYWP Demand Energy Meter, equipped with a rate meter and a cumulative meter. A nominal efficiency of 95 % was assumed for the power transmission. The no-load power of the mill was calculated in the same manner, but with the mill operating empty. The net power consumption was equal to the gross power minus the no-load power.

c) Ball Charge

The steel charge consisted of 1 and 2 inch forged steel balls, with diameter ranging from ½ to 1 inch.

Description of Equipment - Continued

2.4. Denver Mill

A Denver mill with inside dimensions of 12 inches diameter and 24 inches length was used in the lead regrind circuit. The mill shell was constructed of one-half inch steel plate, and had no liners. The mill was driven by a 2 H.P. motor at 40 r.p.m., or 71 % of critical speed. The power consumption in the mill was not recorded. The mill was charged with 300 lb 1 inch forged balls.

3. Hydrocyclones

3.1. P-50 Dorr Cyclone

A two inch P-50 Dorr Cyclone was used to classify the Hendy mill discharge in Tests PP-1 to PP-53. The following dimensions were selected:

Inside Diameter	2 inches
Inside Height	12 inches
Vortex Finder	5/8 inch
Apex Nozzle	1/2 inch

3.2. D-15-774 Krebs Cyclone

A 1½ inch Krebs cyclone was used to classify the zinc regrind mill discharge in Tests PP-20 to PP-53. The cyclone dimensions were:

Inside Diameter	1½ inch
Inside Height	11½ inches
Vortex Finder	½ inch
Apex Nozzle	1/4 inch

3.3. PC-1-832 Krebs Cyclone

A 1 inch Krebs cyclone was used to classify the Pb regrinding mill discharge in most of the pilot plant tests. The cyclone dimensions were:

Inside Diameter	1 inch
Inside Height	11 inches
Vortex Finder	1/4 inch
Apex Nozzle	1/8 inch

Description of Equipment - Continued

4. Flotation Cells

4.1. Denver No. 8 Cells

Three banks of 4 Denver No. 8 cells were used in the following stages:

Lead Rougher	4 cells	(Test PP-1 to PP-53)
Zinc Rougher	4 cells	(Test PP-1 to PP-53)
Zinc Scavenger	4 cells	(Test PP-1 to PP-53)

Each cell had a volume of 2.75 cubic feet. Air was supplied by a Roots-Connersville blower.

4.2. Fagergren No. 12 Cells

One bank of six cells was employed in the lead scavenger flotation in Tests PP-1 to PP-53, one bank of six cells was used in the zinc 1st cleaner scavenger circuit and one bank of six cells was used in the lead 1st cleaner scavenger circuit in Tests PP-52 and PP-53. The bank consisted of an open tank with six individual agitators. Each cell had a volume of 1.2 cubic feet.

4.3. Agitair No. 15 Cells

One bank of six cells was employed in the lead 1st cleaner circuit. Each cell had a volume of 1.5 cubic feet.

4.4. Denver No. 7 Cells

Three banks of 6 Denver No. 7 cells were used in the following stages.

Zinc 1st Cleaner	6 cells	(Test PP-1 to PP-53)
Zinc 2nd Cleaner	4 cells	(Test PP-1 to PP-53)
Zinc 3rd Cleaner	3 cells	(Test PP-1 to PP-53)
Zinc 4th Cleaner	2 cells	(Test PP-1 to PP-53)

Each cell had a volume of 1.0 cubic feet.

Description of Equipment - Continued

4. Flotation Cells

4.4. Denver No. 5 Cells

Twobanks of 6 individual Denver No. 5 cells were used for cleaning of the lead rougher concentrate. The cells were connected in such a manner that the second cleaning stage consisted of four cells, the third cleaning stage of three cells and the 4th cleaning stage of 2 cells. Each cell had volume of 0.4 cubic feet.

5. Conditions

5.1. Denver 40 Gallon Conditioner

Three Denver conditioners, 24 inches in diameter and 36 inches in height were employed in the circuit. The conditioning tank had three pulp discharge levels, offering a volume choice of 25, 32 and 40 imperial gallons. (static volume) The pulp agitation was imparted by two, three bladed propellers. A 5 inch diameter propeller was located at the bottom of the tank, with a 8 inch propeller located 12 inches above it. The conditioner drive unit consisted of a 3 H.P. motor, equipped with v-belts and pulleys.

The lead rougher conditioner was operated at 40 gallons capacity. The zinc rougher conditioner was operated at 32 gallons capacity and the lead 1st cleaner conditioner at 25 gallons capacity.

6. Pumps

6.1. Linatex

A 1 inch linatex pump was used as the cyclone feed pump in the primary grind. The pump was powered by a 1½ H.P. direct current, variable speed motor, controlled by a Boston gear Ratiotrol unit. The pump speed was varied according to the desired operating conditions.

Description of Equipment - Continued

6. Pumps

6.2. Sala

Two 1½ inch Sala pumps were used as the lead and zinc regrind cyclone feed pump. Several 1½ inch Sala pumps were employed as transfer pumps for pulp in the circuit.

6.3. Denver

Several 3/4 inch and 1 inch Denver vertical sand pumps were also used as pulp transfer pumps throughout the circuit.

7. Thickener

A six foot Sala conical thickener was used to collect and thicken the zinc cleaner concentrate. The unit had the following dimensions:

Diameter	69 inches
Depth	24 inches
Cone Angle	37°
Rake Speed	2 r.p.m.
Feed Well Diameter	16 inches

The rake mechanism was driven by à 1 H.P. motor through a speed reducer and chain-drive and clutch assembly.

APPENDIX

No. 1

Fraction Analyses of the Zinc Final Tailing, Lead Concentrate and Zinc Concentrate

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Test No. PP-14

1A - Zn Flotation Tail - Fraction Analyses

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
+ 200 mesh	10.5	0.69	1.30	5.7	9.6
270 mesh	9.0	0.55	1.05	3.9	6.6
32.2 µm	13.7	0.45	0.90	4.8	8.6
25.0 µm	9.7	0.41	0.80	3.1	5.4
17.5 µm	13.5	0.43	0.80	4.6	7.6
12.0 µm	10.6	0.52	0.84	4.3	6.2
9.3 µm	6.2	0.73	0.98	3.5	4.2
- 9.3 µm	26.8	3.33	2.76	70.1	51.8
Head (Calc.)	100.0	1.27	1.43	100.0	100.0

1B - Pb 4th Cleaner Concentrate - Fraction Analyses

+ 20.2 µm	1.8	65.0	7.1	2.1	1.3
14.1 µm	8.2	65.8	7.0	9.5	5.7
9.7 µm	22.1	52.6	14.9	20.5	32.5
7.5 µm	16.7	51.1	15.2	15.1	25.1
- 7.5 µm	51.2	58.3	7.0	52.8	35.4
Head (Calc.)	100.0	56.57	10.12	100.0	100.0

Test No. PP-15

2A - Zinc Flotation Tail - Fraction Analyses

+ 200 mesh	9.2	0.63	1.13	3.7	5.3
270 mesh	7.4	0.50	1.03	2.4	3.9
32.3 µm	11.2	0.48	0.93	3.5	5.3
25.0 µm	9.7	0.45	0.86	2.8	4.2
17.5 µm	13.6	0.46	0.82	4.0	5.7
12.0 µm	11.3	0.58	0.90	4.2	5.1
9.3 µm	6.6	0.91	1.13	3.9	3.8
- 9.3 µm	31.0	3.79	4.24	75.5	66.7
Head (Calc.)	100.0	1.56	1.97	100.0	100.0

Test No. PP-16

3A - Zinc Flotation Tail - Fraction Analyses

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
+ 200 mesh	12.2	0.73	1.80	5.7	10.8
270 mesh	8.7	0.61	1.48	3.4	6.3
32.3 μm	12.0	0.44	1.15	3.4	6.8
25.0 μm	9.6	0.48	0.97	2.9	4.6
17.6 μm	13.1	0.47	0.91	3.9	5.8
12.0 μm	10.4	0.58	0.97	3.8	4.9
9.3 μm	6.1	0.82	1.33	3.2	4.0
- 9.3 μm	27.9	4.14	4.15	73.7	56.8
Head (Calc.)	100.0	1.57	2.04	100.0	100.0

3B - Lead 4th Cleaner Concentrate - Fraction Analyses

+ 20.2 μm	1.2	53.1	11.0	1.1	1.2
14.1 μm	5.6	53.0	13.1	5.3	6.4
9.7 μm	21.6	48.9	16.5	19.0	31.3
7.5 μm	18.0	50.1	15.7	16.2	24.8
- 7.5 μm	53.6	60.7	7.7	58.4	36.3
Head (Calc.)	100.0	55.72	11.38	100.0	100.0

Test PP-17 - 4A - Zinc Flotation Tailing - Fraction Analyses

+ 200 mesh	9.0	0.62	1.03	3.6	5.9
270 mesh	6.9	0.54	0.93	2.4	4.1
32.2 μm	11.0	0.39	0.78	2.8	5.4
25.0 μm	9.0	0.38	0.76	2.2	4.3
17.5 μm	12.9	0.37	0.72	3.1	5.9
12.0 μm	11.0	0.43	0.77	3.0	5.4
9.3 μm	6.8	0.59	0.92	2.6	4.0
- 9.3 μm	33.4	3.73	3.07	80.3	65.0
Head (Calc.)	100.0	1.55	1.58	100.0	100.0

Test No.PP-18

5A - Zinc Flotation Tailing - Fraction Analyses

Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
+ 200 mesh	10.6	0.60	1.12	4.1	7.4
270 mesh	8.0	0.46	0.97	2.4	4.8
32.2 µm	11.4	0.36	0.86	2.6	6.1
25.0 µm	10.0	0.42	0.84	2.7	5.2
17.5 µm	13.2	0.41	0.76	3.5	6.2
12.0 µm	10.8	0.51	0.79	3.5	5.3
9.3 µm	6.3	0.76	0.94	3.1	3.7
- 9.3 µm	29.7	4.12	3.33	78.1	61.3
Head (Calc.)	100.0	1.56	1.61	100.0	100.0

Test No. PP-19

Zinc Flotation Tailing - Fraction Analyses

+ 200 mesh	10.5	0.63	1.37	4.23	7.33
270 mesh	7.6	0.58	1.23	2.82	4.76
32.4 µm	12.6	0.47	1.09	3.78	7.00
25.2 µm	10.0	0.46	0.98	2.94	5.00
17.6 µm	12.9	0.46	0.85	3.79	5.59
12.1 µm	10.4	0.56	0.94	3.72	4.98
9.3 µm	6.3	0.76	1.21	3.05	3.88
- 9.3 µm	29.7	3.99	4.06	75.67	61.46
Head (Calc.)	100.0	1.57	1.96	100.00	100.00

Test No. PP-20

Zinc Flotation Tail - Fraction Analyses

+ 200 mesh	10.8	0.76	1.62	4.43	6.74
270 mesh	7.8	0.56	1.30	2.35	3.91
32.3 µm	11.4	0.46	1.21	2.83	5.31
25.1 µm	9.6	0.47	1.08	2.43	3.99
17.5 µm	13.0	0.50	1.05	3.51	5.26
12.0 µm	10.3	0.79	1.26	4.39	5.00
9.2 µm	6.4	1.35	1.78	4.67	4.39
- 9.2 µm	30.7	4.54	5.53	75.39	65.40
Head (Calc.)	100.0	1.85	2.60	100.00	100.00

Test No. PP-21

Zinc Flotation Tail - Fraction Analyses

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
+ 200 mesh	11.3	0.70	1.40	5.50	8.98
270 mesh	8.1	0.53	1.13	2.98	5.19
32.5 µm	11.7	0.43	0.93	3.49	6.17
25.2 µm	10.0	0.60	0.86	4.17	4.88
17.6 µm	13.6	0.49	0.80	4.63	6.17
12.1 µm	10.6	0.71	0.88	5.23	5.29
9.3 µm	6.2	0.95	1.08	4.09	3.80
- 9.3 µm	28.5	3.53	3.68	69.91	59.52
Head (Calc.)	100.0	1.44	1.76	100.00	100.00

Lead 4th Cleaner - Fraction Analyses

+ 24.6 µm	4.3	42.4	13.8	3.35	4.81
19.0 µm	3.0	41.2	16.9	2.27	4.11
13.3 µm	9.8	43.5	18.5	7.83	14.69
9.1 µm	16.5	46.3	19.1	14.02	25.54
7.1 µm	14.0	49.8	16.9	12.80	19.17
- 7.1 µm	52.4	62.1	7.46	59.73	31.68
Head (Calc.)	100.0	54.5	12.3	100.00	100.00

Test No. PP-22

Lead 4th Cleaner - Fraction Analyses

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
+ 23.2 μm	2.4	49.5	11.5	1.89	3.09
18.0 μm	1.6	52.5	12.5	1.34	2.24
12.6 μm	6.2	53.1	14.4	5.24	10.02
8.6 μm	12.5	54.2	15.6	10.78	21.88
6.7 μm	12.0	57.4	13.9	10.95	18.72
- 6.7 μm	65.3	67.2	6.01	69.80	44.05
Head (Calc.)	100.0	62.9	8.91	100.00	100.00

Zinc Combined Tailing - Fraction Analyses

+ 200 mesh	12.2	0.86	1.69	6.20	11.18
270 mesh	8.5	0.52	1.20	2.61	5.53
31.9 μm	11.7	0.50	1.01	3.46	6.40
24.7 μm	9.4	0.57	0.94	3.16	4.79
17.3 μm	12.6	0.57	0.85	4.24	5.81
11.9 μm	10.3	0.91	0.94	5.54	5.25
9.2 μm	6.3	1.56	1.34	5.81	4.58
- 9.2 μm	29.0	4.02	3.59	68.98	56.46
Head (Calc.)	100.0	1.69	1.84	100.00	100.00

Test No. PP-23

Lead 4th Cleaner Concentrate - Fraction Analyses

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
+ 13.7 µm	3.2	35.2	20.0	2.3	5.8
9.4 µm	13.3	43.5	18.8	11.8	22.8
7.3 µm	17.5	47.2	16.3	16.9	26.0
- 7.3 µm	66.0	50.8	7.52	69.0	45.4
Head (Calc.)	100.0	48.7	11.0	100.0	100.0

Zinc Combined Tail - Fraction Analyses

+ 200 mesh	10.9	0.82	1.31	5.7	5.6
270 mesh	7.8	0.65	1.58	3.2	4.8
32.7 µm	13.3	0.56	3.37	4.7	17.7
25.4 µm	11.4	0.62	3.78	4.5	17.0
17.7 µm	13.6	0.61	2.37	5.2	12.7
12.2 µm	9.8	0.78	1.42	4.8	5.4
9.4 µm	5.8	1.15	1.40	4.2	3.2
- 9.4 µm	27.4	3.85	3.06	67.7	33.6
Head (Calc.)	100.0	1.57	2.53	100.0	100.0

Test No. PP-24

Lead 4th Cleaner Concentrate - Fraction Analyses

Product	Weight	Assays, %		% Distribution	
	%	Pb	Zn	Pb	Zn
+ 24.1 μm	4.0	44.8	13.9	3.2	5.5
18.7 μm	2.8	49.3	15.0	2.4	4.2
13.0 μm	10.2	53.6	14.1	9.7	14.4
8.9 μm	16.4	53.7	14.6	15.7	24.0
6.9 μm	13.6	53.8	14.5	13.0	19.7
- 6.9 μm	53.0	58.7	5.99	56.0	32.2
Head (Calc.)	100.0	55.9	9.96	100.0	100.0

Zinc Combined Tail - Fraction Analyses

+ 200 mesh	10.0	0.75	0.98	4.05	6.66
270 mesh	6.6	0.59	1.02	2.10	4.57
33.2 μm	7.3	0.57	1.42	2.25	7.04
25.7 μm	9.0	0.66	1.11	3.21	6.79
17.9 μm	14.1	0.53	0.83	4.04	7.95
12.3 μm	11.8	0.66	0.84	4.20	6.73
9.5 μm	7.0	0.93	0.98	3.52	4.66
- 9.5 μm	34.2	4.14	2.39	76.63	55.60
Head (Calc.)	100.0	1.85	1.47	100.00	100.00

Test No. PP-25

Lead 4th Cleaner Concentrate - Fraction Analyses

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
+ 23.8 µm	2.2	40.9	12.1	1.6	2.6
18.5 µm	1.8	44.8	13.8	1.4	2.4
12.9 µm	7.3	47.9	15.8	6.2	11.4
8.9 µm	20.2	51.4	16.2	18.4	32.3
6.9 µm	12.9	55.2	14.5	15.6	22.8
- 6.9 µm	52.6	60.5	5.45	56.8	28.5
Head (Calc.)	100.0	56.2	10.1	100.0	100.0

Zinc Combined Tailings - Fraction Analyses

+ 200 mesh	10.0	0.80	0.96	6.4	7.7
270 mesh	6.0	0.58	1.09	2.8	5.2
33.5 µm	8.6	0.47	1.26	3.2	8.5
25.9 µm	10.4	0.51	0.88	4.2	7.3
18.1 µm	14.3	0.45	0.74	5.2	8.5
12.4 µm	11.4	0.56	0.74	5.1	6.8
9.6 µm	6.6	0.81	0.83	4.3	4.4
- 9.6 µm	32.7	2.63	1.94	68.8	51.6
Head (Calc.)	100.0	1.25	1.24	100.0	100.0

Test No. PP26

Zinc Scavenger Tailing - Fraction Analyses

Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
+ 100 mesh	4.6	1.04	2.05	3.5	6.1
150 mesh	6.0	0.98	1.73	4.3	6.8
200 mesh	8.5	0.73	1.58	4.6	8.8
34.3 μm	11.1	0.48	1.02	3.9	7.4
26.6 μm	20.2	0.50	0.92	7.5	12.1
18.5 μm	9.4	0.58	0.98	4.0	6.0
12.8 μm	7.8	0.85	1.00	4.9	5.1
9.9 μm	5.0	1.16	1.13	4.3	3.7
- 9.9 μm	27.4	3.07	2.43	63.0	44.0
Head (Calc.)	100.0	1.34	1.52	100.0	100.0

Lead 4th Cleaner Concentrate - Analyses

+ 13.1 μm	7.9	47.7	17.0	7.2	11.8
9.0 μm	23.2	49.8	17.7	22.2	36.1
7.0 μm	17.9	51.9	15.9	17.7	25.0
- 7.0 μm	51.0	54.1	6.03	52.9	27.1
Head (Calc.)	100.0	52.2	11.4	100.0	100.0

Test No. PP-27

Lead 4th Cleaner Concentrate - Fraction Analyses

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
+ 13.3 µm	8.5	49.2	15.1	7.6	11.6
9.1 µm	18.6	50.6	16.9	17.2	28.5
7.1 µm	15.3	51.5	16.0	14.4	22.2
- 7.1 µm	57.6	57.4	7.17	60.8	37.7
Head (Calc.)	100.0	54.5	11.0	100.0	100.0

Zinc Scavenger Tail - Fraction Analyses

+ 100 mesh	5.0	0.90	1.74	3.1	5.4
150 mesh	6.2	0.71	1.13	3.0	4.3
200 mesh	9.0	0.59	1.15	3.6	6.4
36.6 µm	9.3	0.56	1.68	3.5	9.7
28.4 µm	7.6	0.48	1.01	2.5	4.8
19.8 µm	10.0	0.51	1.08	3.5	6.7
13.6 µm	8.4	0.63	1.22	3.6	6.4
10.5 µm	5.4	0.91	1.36	3.3	4.6
- 10.5 µm	39.1	2.73	2.09	73.9	51.7
Head (Calc.)	100.0	1.45	1.59	100.0	100.0

Test No. PP-28

Lead Cleaner Concentrate - Fraction Analyses

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
+ 19.8 µm	3.3	40.3	17.6	2.7	4.2
13.8 µm	15.6	43.4	18.6	13.7	21.1
9.5 µm	23.2	45.3	18.8	21.2	31.7
7.3 µm	14.2	46.8	18.1	13.4	18.7
- 7.3 µm	43.7	55.6	7.70	49.0	24.3
Head (Calc.)	100.0	49.6	13.8	100.0	100.0

Zinc Scavenger Tailing - Fraction Analyses

+ 65 mesh	2.4	1.13	2.19	1.9	2.8
100 mesh	5.3	0.86	1.39	3.2	4.0
150 mesh	8.1	0.79	1.19	4.5	5.2
200 mesh	9.0	0.74	1.47	4.7	7.1
38.0 µm	3.4	1.12	2.84	2.7	5.2
29.5 µm	17.9	0.58	1.07	7.3	10.3
20.6 µm	10.3	0.60	1.19	4.4	6.6
14.2 µm	8.3	0.80	1.30	4.7	5.8
10.9 µm	5.1	1.14	1.53	4.1	4.2
- 10.9 µm	30.2	2.92	2.98	62.5	48.8
Head (Calc.)	100.0	1.41	1.85	100.0	100.0

Test No. PP-29

Lead 4th Cleaner Concentrate - Fraction Analyses

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
+ 25.0 µm	1.8	44.2	13.1	1.4	1.9
19.4 µm	2.8	46.9	16.5	2.4	3.7
13.5 µm	17.0	49.4	16.9	15.1	23.0
9.3 µm	22.4	49.7	17.5	20.0	31.4
7.1 µm	13.0	52.0	16.8	12.1	17.5
- 7.1 µm	43.0	63.4	6.54	49.0	22.5
Head (Calc.)	100.0	55.7	12.5	100.0	100.0

Zinc Scavenger Tailing - Fraction Analyses

Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
+ 65 mesh	2.5	1.11	2.17	1.9	2.8
100 mesh	5.0	0.97	1.82	3.3	4.7
150 mesh	7.6	0.83	1.61	4.3	6.4
200 mesh	8.8	0.73	1.65	4.4	7.6
37.3 µm	5.2	0.67	2.17	2.4	5.9
28.9 µm	18.0	0.54	1.44	6.6	13.5
20.2 µm	10.1	0.58	1.30	4.0	6.8
13.9 µm	8.2	0.76	1.31	4.2	5.6
10.7 µm	5.2	1.05	1.48	3.7	4.0
- 10.7 µm	29.4	3.28	2.78	65.2	42.7
Head (Calc.)	100.0	1.48	1.92	100.0	100.0

Test No. PP-30

Zinc Scavenger Tailing - Fraction Analyses

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
+ 65 mesh	1.6	1.13	2.27	1.0	2.0
100 mesh	4.5	0.92	1.64	2.4	4.0
150 mesh	7.4	0.87	1.42	3.7	5.8
200 mesh	8.5	0.73	1.54	3.6	7.2
37.3 μm	4.6	0.62	2.31	1.6	5.8
28.9 μm	18.6	0.59	1.21	6.3	12.3
20.2 μm	10.1	0.71	1.32	4.1	7.3
13.9 μm	8.0	0.78	1.31	3.6	5.7
10.7 μm	5.2	1.04	1.41	3.1	4.0
- 10.7 μm	31.5	3.87	2.65	70.6	45.9
Head (Calc.)	100.0	1.73	1.82	100.0	100.0

Lead 4th Cleaner Concentrate - Fraction Analyses

+ 25.0 μm	2.6	45.7	13.9	2.2	2.8
19.4 μm	4.3	46.6	15.8	3.6	5.3
13.5 μm	16.4	47.6	17.9	14.2	22.8
9.3 μm	22.8	49.9	17.5	20.7	30.9
7.1 μm	14.0	52.5	15.8	13.4	17.1
- 7.1 μm	39.9	63.3	6.83	45.9	21.1
Head (Calc.)	100.0	55.0	12.9	100.0	100.0

Test No. PP-31

Zinc Scavenger Tailing - Fraction Analyses

Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
+ 100 mesh	1.5	1.40	3.04	1.5	2.7
150 mesh	3.0	0.97	1.95	2.1	3.5
200 mesh	8.7	0.79	1.52	5.1	8.0
34.7 µm	19.7	0.63	1.25	9.2	14.9
26.9 µm	10.4	0.71	1.03	5.4	6.5
18.7 µm	13.3	0.58	0.96	5.7	7.7
12.9 µm	10.0	0.67	0.95	4.9	5.7
10.0 µm	5.9	0.95	1.16	4.1	4.1
- 10.0 µm	27.5	3.02	2.78	62.0	46.9
Head (Calc.)	100.0	1.35	1.65	100.0	100.0

Lead 4th Cleaner Concentrate - Fraction Analyses

+ 25.2 µm	3.2	60.3	9.27	0.3	2.2
19.5 µm	6.6	53.2	12.9	6.5	6.4
13.6 µm	21.4	48.4	16.2	19.3	26.3
9.4 µm	20.8	46.5	18.1	18.0	28.6
7.2 µm	12.0	48.5	17.5	10.8	15.9
- 7.2 µm	36.0	61.9	7.43	45.1	20.6
Head (Calc.)	100.0	53.6	13.2	100.0	100.0

Test No. PP-32

Lead 4th Cleaner Concentrate - Fraction Analyses

Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
+ 24.1 µm	3.2	67.7	7.56	3.4	2.7
18.7 µm	6.0	63.1	9.89	5.9	6.7
13.0 µm	20.9	61.4	11.8	20.1	27.8
8.9 µm	21.2	60.1	13.5	20.0	32.3
6.9 µm	12.2	63.5	12.3	12.1	16.9
- 6.9 µm	36.5	66.8	3.23	38.5	13.6
Head (Calc.)	100.0	63.7	8.84	100.0	100.0

Zinc 4th Cleaner Concentrate - Fraction Analyses

+ 31.3 µm	8.2	2.23	52.6	8.7	8.2
24.3 µm	11.4	2.26	50.8	12.2	11.1
17.0 µm	19.4	2.24	50.8	20.6	18.9
11.7 µm	15.4	2.21	54.7	16.2	16.1
9.0 µm	9.3	1.97	57.2	8.7	10.2
- 9.0 µm	36.3	1.93	50.7	33.6	35.5
Head (Calc.)	100.0	2.10	52.1	100.0	100.0

Test No. PP-33

Zinc 4th Cleaner Concentrate - Fraction Analyses

Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
+ 31.2 µm	10.6	2.02	49.1	9.6	10.4
24.2 µm	12.2	2.12	46.6	11.6	11.4
16.9 µm	19.2	2.16	47.3	18.6	18.2
11.6 µm	14.4	2.12	52.4	13.7	15.1
9.0 µm	8.6	2.06	56.2	7.9	9.7
- 9.0 µm	35.0	2.43	49.5	38.6	35.2
Head (Calc.)	100.0	2.22	49.7	100.0	100.0

Lead 4th Cleaner Concentrate - Fraction Analyses

+ 24.8 µm	3.4	63.6	8.69	3.8	2.6
19.2 µm	7.2	59.1	10.8	7.5	6.9
13.4 µm	21.6	51.9	14.8	19.9	28.3
9.3 µm	20.4	51.0	17.5	18.5	31.6
7.1 µm	11.4	54.5	15.8	11.0	15.9
- 7.1 µm	36.0	60.6	4.50	39.3	14.7
Head (Calc.)	100.0	56.1	11.3	100.0	100.0

Test No. PP-35

Lead 4th Cleaner Concentrate - Fraction Analyses

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
+ 24.5 µm	1.6	61.6	8.55	1.5	1.8
19.0 µm	1.6	61.4	9.51	1.5	1.9
13.2 µm	10.6	62.1	11.3	9.9	15.3
9.1 µm	22.0	61.6	12.0	20.5	33.8
7.0 µm	16.1	63.1	10.3	15.3	21.2
- 7.0 µm	48.1	68.5	4.20	51.3	26.0
Head (Calc.)	100.0	66.2	7.81	100.0	100.0

Zinc 4th Cleaner Concentrate - Fraction Analyses

+ 31.3 µm	1.4	2.84	47.9	2.0	1.2
24.3 µm	2.7	2.18	50.2	3.0	2.4
17.0 µm	9.9	1.82	53.6	9.1	9.6
11.7 µm	20.6	1.60	56.0	16.6	20.8
9.0 µm	14.6	1.48	57.9	10.9	15.2
- 9.0 µm	50.8	2.30	55.5	58.4	50.8
Head (Calc.)	100.0	1.99	55.5	100.0	100.0

Test No. PP-36

Lead 4th Cleaner Concentrate - Fraction Analyses

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
+ 25.3 µm	5.6	43.1	10.9	4.5	4.5
19.6 µm	4.6	44.3	13.8	3.8	4.7
13.7 µm	15.0	47.3	15.3	13.3	17.0
9.4 µm	19.0	47.7	17.0	16.9	24.0
7.3 µm	12.7	49.6	16.1	11.8	15.2
- 7.3 µm	43.1	61.3	10.7	49.7	34.6
Head (Calc.)	100.0	53.3	13.4	100.0	100.0

Zinc 4th Cleaner Concentrate - Fraction Analyses

+ 31.2 µm	6.7	1.61	47.2	5.6	6.1
24.2 µm	8.2	1.57	47.2	6.2	7.5
16.9 µm	16.8	1.66	47.5	13.6	15.5
11.6 µm	15.0	1.80	52.0	13.1	15.2
9.0 µm	9.8	1.65	54.2	7.9	10.3
- 9.0 µm	43.5	2.51	53.2	53.6	45.4
Head (Calc.)	100.0	2.05	51.3	100.0	100.0

Test No. PP-37

Lead 4th Cleaner Concentrate - Fraction Analyses

Product	Weight	Assays, %		% Distribution	
	%	Pb	Zn	Pb	Zn
+ 25.3 µm	3.9	59.5	10.8	3.7	4.5
19.6 µm	2.0	57.4	10.7	1.8	2.3
13.7 µm	9.8	58.3	12.0	9.2	12.4
9.4 µm	18.3	57.3	14.2	16.9	27.5
7.3 µm	14.7	57.4	14.0	13.6	21.8
- 7.3 µm	51.3	66.4	5.82	54.8	31.5
Head (Calc.)	100.0	62.2	9.45	100.0	100.0

Zinc 4th Cleaner Concentrate - Fraction Analyses

+ 31.5 µm	2.1	-	-*	-	-
24.4 µm	5.9	1.57	49.6	4.0	6.1
17.0 µm	16.6	1.71	48.7	12.5	16.9
11.7 µm	15.4	1.78	51.3	12.0	16.5
9.0 µm	10.2	1.68	53.1	7.5	11.3
- 9.0 µm	49.8	2.90	46.9	64.0	49.2
Head (Calc.)	100.0	2.27	47.7	100.0	100.0

* Sample was misplaced, head was calculated using available assays.

APPENDIX NO. 2

Percolation Tests

Test No. 1

Purpose: To conduct percolation tests on a sample of spigoted tailing sand (Nov. 2).

Method: Approximately 50 pounds of tailing sand was collected on November 2. The sample was spread out on a concentre floor to partially air dry prior to bagging.

A small sample was removed from the pile and pulped to approximately 40 percent solids. Three percolation tubes (1.0 inch I.D. by 17 inches long) were filled with the pulp to a level of 14 inches. This level was maintained for a period of 48 hours. The percolated water, collected in beakers below the tubes, was measured in milliliters at frequent intervals.

Results:

Time	Percolated Water in Ml./Hour			Average	Perc. Rate
Hours	Column 1	Column 2	Column 3	Ml.	Inches/Hour
1	36	42	41	40	3.3
2	44	43	42	43	3.5
4	38	38	38	38	3.1
5	38	38	38	38	3.1
8	34	34	35	34	2.9
21	23	27	28	26	2.1
24	16	21	23	20	1.7
48	8	16	20	15	1.2

Final Settled Interface: 5 1/4 inches solids : 8 3/4 inches hydraulic head.

Test No. 2

Purpose: To investigate the percolation characteristics of a sample of zinc tailing cyclone underflow.

Method: Three percolation columns were filled with zinc tailing cyclone underflow pulp from test No. 34. The underflow pulp density was approximately 1800 grams per liter. The percolated water was measured hourly over a period of six hours.

Zinc Tailing Cyclone:

3 inch diameter Bauer
32 inch long barrel
3/4 inch vortex finder
1/8 inch apex spigot

Results:

Time Hours	Percolated Water in Ml/Hour		
	Tube 1	Tube 2	Tube 3
1	34	35	41
2	24	27	26
3	24	27	27
4	24	27	26
5	26	30	28
6	25	29	28
Average (Last 5 Hours)	25	28	27
Percolation Rate (Inches/ Hour)	2.0	2.3	2.2
Hydraulic Head(Inches)	5 7/8	6 1/2	6 1/4
Solids Depth (Inches)	8 1/8	7 1/2	7 3/4

Test No. 3

Purpose: To investigate the percolation characteristics of a sample of zinc tailing cyclone underflow.

Method: Three percolation tubes were filled with zinc tailing cyclone underflow pulp from test No. 36.

The percolated water was measured hourly over a period of six hours.

Zinc Tailing Cyclone:

3 inch diameter Bauer
32 inch long barrel
3/4 inch vortex finder
1/8 inch apex spigot

Results:

Time No.	Percolated Water in Ml/Hour		
	Tube 1	Tube 2	Tube 3
1	31	37	36
2	25	29	27
3	24	28	26
4	25	29	27
5	24	28	26
6	24	28	26
Average (Last 5 hours)	24	28	26
Percolation Rate (Inches/Hour)	1.9	2.3	2.1
Hydraulic Head (Inches)	8 1/4	8 1/2	7 3/8
Solids Depth (Inches)	5 3/4	5 1/2	6 5/8

DETAILS OF TESTS

Test No. PP1

1. Grinding Circuit

1.1. Purpose: A preliminary grinding test to evaluate the steel ball load in the mill and the cyclone size. The grind was to be 95 % minus 200 mesh.

1.2. Method: The minus 1/2 inch ore was ground in a 4' by 3' Hendy ball mill containing 2000 pounds of steel balls, The ball mill discharge was pumped to a P-50 Dorr cyclone. The cyclone underflow was returned to the mill, and the overflow was fed to the flotation circuit. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 700 pounds per hour. Samples were taken every 20 minutes in the last 2 hours of operation.

1.2.1. Flowsheet Equipment

Ore bin, Merrick weightometer, feed conveyor, 4' x 3' Hendy mill, Linatex pump, P-50 Dorr cyclone.

Hendy Mill: P-50 Dorr Cyclone

- 1½ inch Diameter
- 5/8 inch Vortex-finder
- 1/2 inch Apex

Lead Regrind:

Sala Mill: 1½ inch Krebs Cyclone:

- 1½ inch Diameter
- ½ inch Vortex-finder
- 1/4 inch Apex

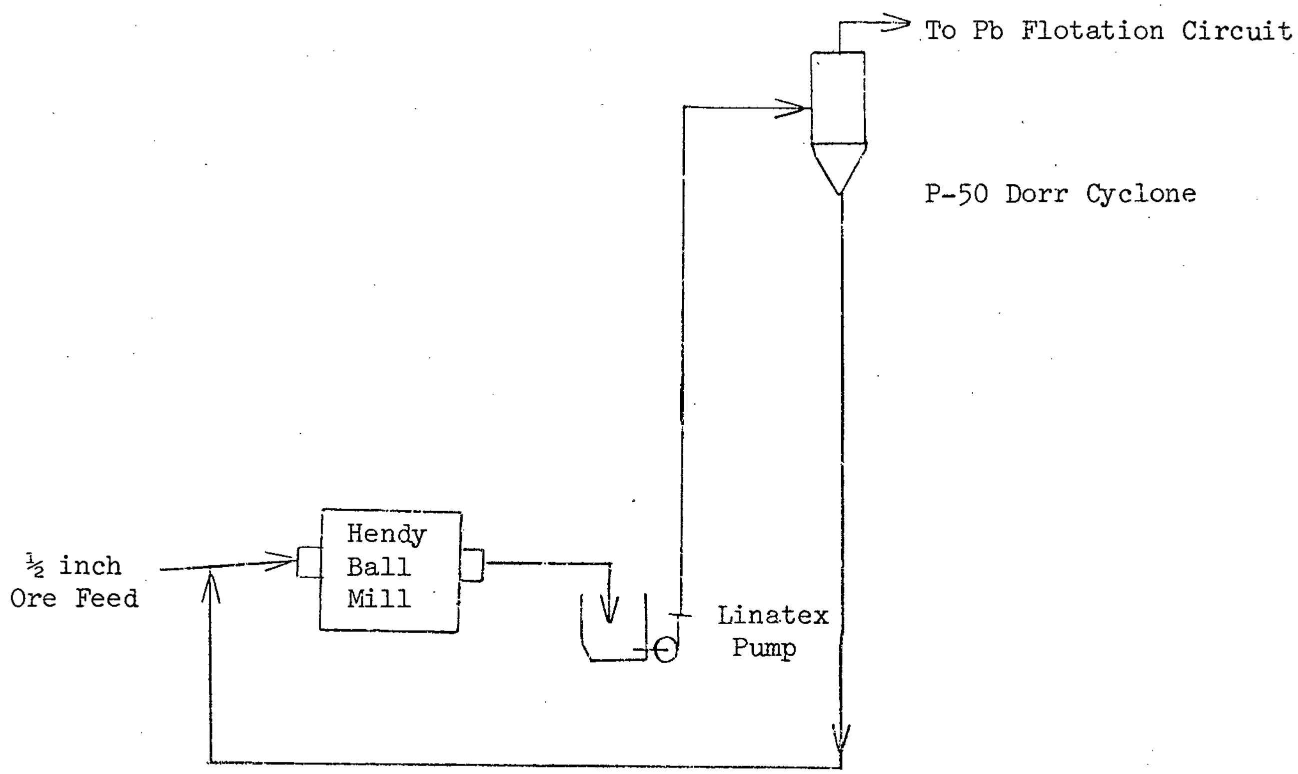
Zinc Regrind:

Conical Mill: 1 inch Cyclone

- 1 inch Diameter
- 1/2 inch Vortex-finder
- 1/2 inch Apex

Test No. PP-1 - Continued

1.3. Flowsheet



Test No. PP-1 - Continued

1.4. Results: The grinding circuit was stable during the test period. However, the recirculation load of the cyclone overflow did not stabilize during the test period. The cyclone overflow was 90.9 % minus 200 mesh. The power consumption in the primary grind was 16.05 kilowatt-hours per ton of minus 1/2 inch feed. The power consumption in the lead regrind was 5.33 kilowatt-hours per ton of flotation feed.

1.4.1. Ball Mill Report

Feed:	Minus ½ inch ore at 1.5 percent moisture content		
Feed Rate:	700 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	1½ inch balls	600 pounds	
	1 inch balls	400 pounds	
	Total	2000 pounds	
Operating Time:	Total 7 hours, test period 2 hours		
Mill Feed:	Total 4900 pounds, test period 1400 pounds		
Circulating Load:	Cyclone underflow 605 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2168	70.5
	Cyclone Overflow	1296	30.6
	Cyclone Underflow	2538	78.5
Average Power:	Gross	7.54 kilowatts	
	No Load	1.92 kilowatts	
	Net	5.62 kilowatts	

Net Power Consumption: 16.05 kilowatt-hours per ton of 1/2 inch feed

Work Index: 11.38

Test No. PP-1 - Continued

1.4. Results: 1.4.2. Lead Regrind Mill Report

Regrind Mill:	Sala ball mill		
Feed:	Lead Rougher Concentrate and Pb 2nd Cleaner Tailing		
Feed Rate:	90.16 pounds per hour, 12.88 percent of mill feed		
Mill Speed:	31 r.p.m., 73 percent of critical speed		
Mill Load:	2 inch balls	480 pounds	
	1 inch balls	720 pounds	
	Total	1200 pounds	
Operating Time:	Total 7 hours, test period 2 hours		
Pulp Densities:		gpl	% Solids
	Mill Discharge	1305	30.5
	Cyclone Feed	1120	14.2
	Cyclone Overflow	1080	9.8
	Cyclone Underflow	1305	30.5
Average Power:	Gross	2.80 kilowatts	
	No Load	0.93 kilowatts	
	Net	1.87 kilowatts	
Net Power Consumption:	5.35 kilowatt-hours per ton of feed		
	40.65 kilowatt-hours per ton of concentrate		

Test No. PP-1 - Continued

1.4. Results:

1.4.3. Zinc Regrind Mill Report

Regrind Mill:	Conical mill		
Feed:	Zinc Rougher Concentrate and Zn 2nd Cleaner Tail		
Feed Rate:	44.80 pounds per hour, 6.40 percent of mill feed		
Mill Speed:	30 r.p.m., 65 percent of critical speed		
Mill Load:	2 inch balls	100 pounds	
	1/2 inch balls	220 pounds	
	Total	320 pounds	
Operating Time:	Total 7 hours, test period 2 hours		
Pulp Densities:		gpl	% Solids
	Mill Discharge	1248	26.1
	Cyclone Overflow	1060	7.4
	Cyclone Underflow	1248	26.1
Average Power:	Gross	1.42 kilowatts	
	No Load	0.95 kilowatts	
	Net	0.47 kilowatts	
Net Power Consumption:	1.43 kilowatt-hours per ton of feed		
	21.36 kilowatt-hours per ton of concentrate		

Test No. PP-1 - Continued

1.4.4. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	3.0	3.0	97.0
3	10.2	13.2	86.8
4	10.1	23.3	76.7
6	10.2	33.5	66.5
8	9.8	43.3	56.7
10	7.6	50.9	49.1
14	7.0	57.9	42.1
20	5.4	63.3	36.7
28	4.3	67.6	32.4
35	3.6	71.2	28.8
48	3.8	75.0	25.0
65	3.5	78.5	21.5
100	2.8	81.3	18.7
- 100	18.7	100.0	-
Total	100.0	-	-

Cyclone Underflow

+ 10	0.2	0.2	99.8
14	0.2	0.4	99.6
20	0.3	0.7	99.3
28	0.5	1.2	98.8
35	0.9	2.1	97.9
48	1.9	4.0	96.0
65	3.5	7.5	92.5
100	5.9	13.4	86.6
150	10.9	24.3	75.7
200	19.7	44.0	56.0
270	16.0	60.0	40.0
400	20.0	80.0	20.0
- 400	20.0	100.0	-
Total	100.0	-	-

Test No. PP-1 - Continued

1.4.4. Screen Analyses

Hendy Mill Discharge

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.3	0.6	99.4
28	0.4	1.0	99.0
35	0.7	1.7	98.3
48	1.6	3.3	96.7
65	3.1	6.4	93.6
100	5.2	11.6	88.4
150	9.7	21.3	78.7
200	17.7	39.0	61.0
270	14.5	53.5	46.5
400	19.5	73.0	27.0
- 400	27.0	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.3	0.3	99.7
100	0.7	1.0	99.0
150	2.0	3.0	97.0
200	6.1	9.1	90.9
270	7.3	16.4	83.6
400	14.8	31.2	68.8
- 400	68.8	100.0	-
Total	100.0	-	-

Test No. PP-1 - Continued

1.4.4. Screen Analyses

Lead Rougher Concentrate

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	2.4	2.4	97.6
270 mesh	5.9	8.3	91.7
26.6 µm	23.6	31.9	68.1
20.6 µm	11.2	43.1	56.9
14.4 µm	15.6	58.7	41.3
9.9 µm	12.6	71.3	28.7
7.7 µm	7.2	78.5	21.5
- 7.7 µm	21.5	100.0	-
Total	100.0	-	-

Specific Gravity: 4.70

Lead Regrind Cyclone Underflow

+ 200 mesh	1.2	1.2	98.8
270 mesh	4.4	5.6	94.4
26.6 µm	29.0	34.6	65.4
20.6 µm	16.8	51.4	48.6
14.4 µm	20.6	72.0	28.0
9.9 µm	10.6	82.6	17.4
7.7 µm	4.3	86.9	13.1
- 7.7	13.1	100.0	-
Total	100.0	-	-

Specific Gravity - 4.70

Test No. PP-1 - Continued

1.4.4. Screen Analyses

Lead Regrind Discharge

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 200 mesh	0.2	0.2	99.8
270 mesh	1.0	1.2	98.8
26.2 μm	20.8	22.0	78.0
20.4 μm	14.9	36.9	63.1
14.2 μm	22.2	59.1	40.9
9.8 μm	13.2	72.3	27.7
7.5 μm	5.9	78.2	21.8
- 7.5 μm	21.8	100.0	-
Total	100.0	-	-

Specific Gravity - 4.81

Lead Regrind Cyclone Overflow

+ 26.6 μm	5.7	5.7	94.3
20.6 μm	6.1	11.8	88.2
14.4	16.4	28.2	71.8
9.9 μm	18.8	47.0	53.0
7.7 μm	11.9	58.9	41.1
- 7.7 μm	41.1	100.0	-
Total	100.0	-	-

Specific Gravity - 4.64

Test No. PP-1 - Continued

1.4.4. Screen Analyses

Zinc Rougher Concentrate

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	2.5	2.5	97.5
270 mesh	3.4	5.9	94.1
29.4 µm	15.2	21.1	78.9
22.8 µm	10.8	31.9	68.1
15.9 µm	17.2	49.1	50.9
10.9 µm	14.8	63.9	36.1
8.4 µm	8.6	72.5	27.5
- 8.4 µm	27.5	100.0	-
Total	100.0	-	-

Specific Gravity - 4.08

Zinc Regrind Cyclone Underflow

+ 200 mesh	2.1	2.1	97.9
270 mesh	5.1	7.2	92.8
29.4 µm	23.6	30.8	69.2
22.8 µm	17.1	47.9	52.1
15.9 µm	20.7	68.6	31.4
10.9 µm	11.7	80.3	19.7
8.4 µm	5.2	85.5	14.5
- 8.4 µm	14.5	100.0	-
Total	100.0	-	-

Specific Gravity - 4.06

Test No. PP-1 - Continued

1.4.4. Screen Analyses

Zinc Regrind Discharge

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 200 mesh	1.5	1.5	98.5
270 mesh	5.5	7.0	93.0
29.4 µm	23.6	30.6	69.4
22.8 µm	17.1	47.7	52.3
15.9 µm	20.9	68.6	31.4
10.9 µm	12.0	80.6	19.4
8.4 µm	5.3	85.9	14.1
- 8.4 µm	14.1	100.0	-
Total	100.0	-	-

Specific Gravity - 4.05

Zinc Regrind Cyclone Overflow

+ 29.4 µm	3.0	3.0	97.0
22.8 µm	4.5	7.5	92.5
15.9 µm	16.2	23.7	76.3
10.9 µm	21.4	45.1	54.9
8.4 µm	13.6	58.7	41.3
- 8.4 µm	41.3	100.0	-
Total	100.0	-	-

Specific Gravity - 4.07

1.4.5. Specific Gravity

Sample	Specific Gravity
Hendy Mill Discharge	4.18
Cyclone Overflow	3.86
Cyclone Underflow	4.24

Test No. PP-1 - Continued

2. Flotation

2.1. Purpose: A preliminary test to fill the circuit and to test the mechanical operation of the equipment.

2.2. Method: The flotation circuit consisted of a lead flotation circuit, followed by a zinc flotation circuit. The flotation feed was conditioned, and lead rougher and scavenger concentrates were floated with R-343 in a soda ash circuit. The lead rougher concentrate was reground in the Sala mill, with soda ash, $ZnSO_4$ and NaCN, and cleaned four times with collectors R-242 and Z-11. The lead scavenger tailing was conditioned with lime and $CuSO_4$, and zinc rougher and scavenger concentrates were floated with M-748 and Z-11. The zinc rougher concentrate was reground in the Conical mill and additions of $CuSO_4$, $Ca(OH)_2$ and was cleaned four times. The zinc scavenger concentrate was recycled to the zinc rougher feed.

2.2.1. Flotation Equipment

Lead Circuit

Conditioner	20 gallon Denver
Roughers	4 Denver No. 8 cells
Scavenger	6 Fagergren No. 12 cells
Pb 1st Cleaner	6 Agitair No. 15 cells
Pb 1st Cleaner Conditioner	5 gallon Denver
Pb 2nd Cleaner	6 Denver No. 5 Cells
Pb 3rd Cleaner	4 Denver No. 5 cells
Pb 4th Cleaner	2 Denver No. 5 cells

Zinc Circuit

Conditioner	60 gallon Denver
Zn Rougher	4 Denver No. 8 cells
Zn Scavenger	4 Denver No. 8 cells
Zn 1st Cleaner	6 Denver No. 7 cells
Zn 2nd Cleaner	4 Denver No. 7 cells
Zn 3rd Cleaner	3 Denver No. 7 cells
Zn 4th Cleaner	3 Denver No. 7 cells

2.2.2. Flotation Reagents - See following Pages

2.3. Flowsheets: See following pages.

Test No. PP-1 - Continued

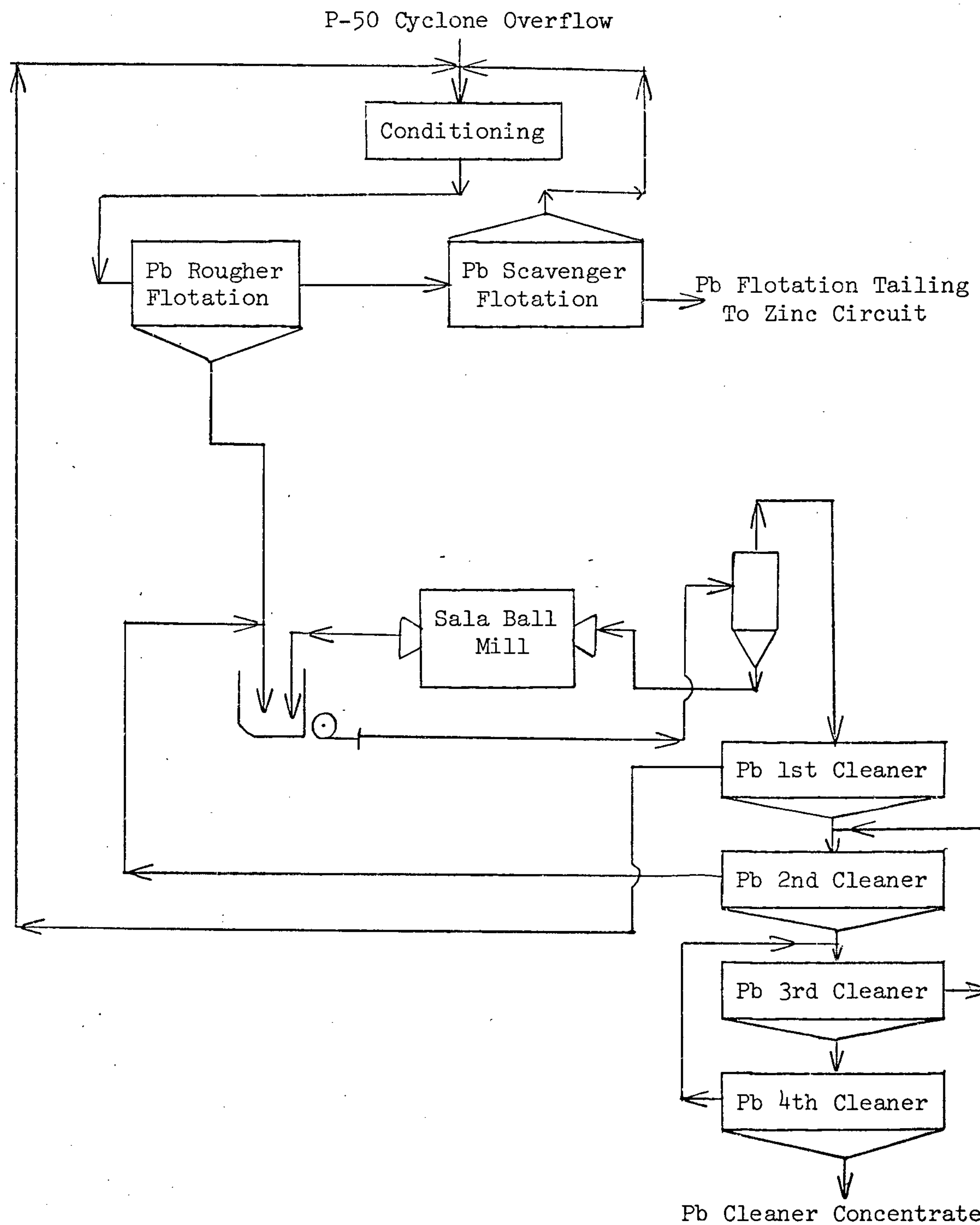
2.2.2. Reagent Additions

Type	Pounds per Short ton	
Na_2CO_3	3.8	Ball Mill Feed
NaCN	0.35	Ball Mill Feed
$ZnSO_4$	0.70	Ball Mill Feed
R-343	0.042	Ball Mill Feed
R-343	0.02	Pb Conditioner
MIBC	0.152	Pb Rougher Feed Pump
R-343	0.02	Pb Scavenger Feed
MIBC	0.023	Pb Scavenger Feed
NaCN	0.20	Pb Regrind Mill Feed
Na_2CO_3	0.60	Pb Regrind Mill Feed
$ZnSO_4$	0.58	Pb Regrind Mill Feed
R-242	0.035	Pb Cyclone Pump
Z-11	0.010	Pb Cyclone Pump Conditioner
MIBC	0.010	Pb 1st Cleaner Conditioner
NaCN	0.11	Pb 1st Cleaner Launder
NaCN	0.06	Pb 2nd Cleaner Launder
Na_2CO_3	0.12	Pb 2nd Cleaner Launder
NaCN	0.06	Pb 3rd Cleaner Launder
$Ca(OH)_2$	3.0	Pb Tailing Pump
$CuSO_4$	2.3	Zn Conditioner No. 1
M-748	0.093	Zn Rougher Feed Pump
D-250	0.073	Zn Rougher Feed Pump
R-343	0.04	Zn Rougher Feed Pump
R-343	0.02	Zn Scavenger Feed
M-748	0.021	Zn Scavenger Feed
$Ca(OH)_2$	0.95	Zn Regrind Mill Feed
$CuSO_4$	0.36	Zn Regrind Mill Feed
M-748	0.012	Zn Regrind Mill Feed
R-343	0.015	Zn 1st Cleaner Feed Pump
DF-250	0.027	Zn 1st Cleaner Feed Pump
$Ca(OH)_2$	0.3	Zn 1st Cleaner Launder
D-250	0.01	Zn 1st Cleaner Launder
$Ca(OH)_2$	0.3	Zn 2nd Cleaner Launder
$Ca(OH)_2$	0.3	Zn 3rd Cleaner Launder

Test No. PP-1 - Continued

2.3. Flowsheet

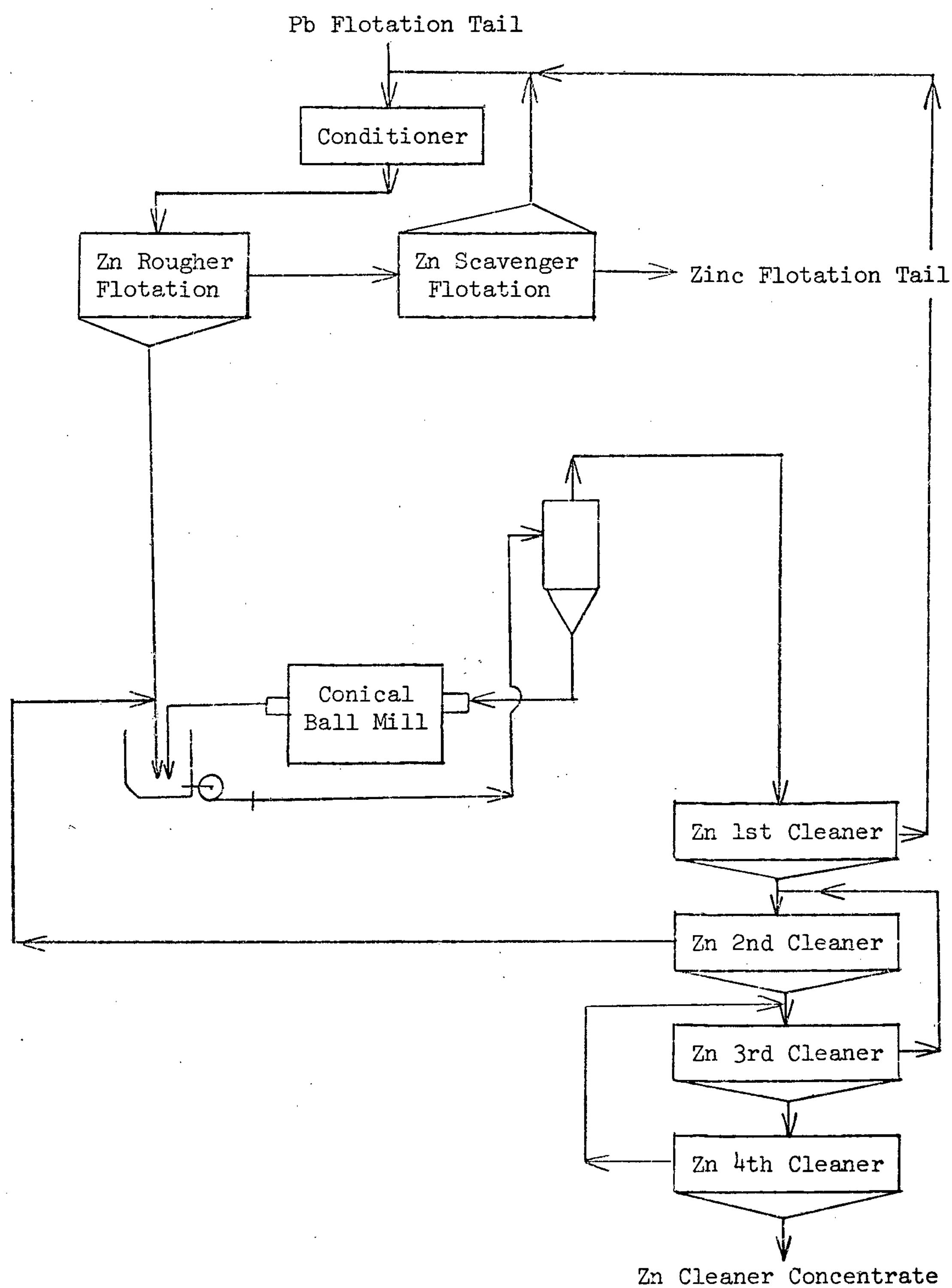
a) Lead Circuit



Test No. PP-1 - Continued

2.3. Flowsheet

b) Zinc Circuit



Test No. PP-1 - Continued

2.4. Results: The flotation circuit was not stabilized during the operation period. Grab samples from the lead and zinc rougher and cleaner concentrates were taken.

2.4.1. pH

Product	pH
Cyclone Overflow	9.3
Pb Rougher Feed	9.4
Pb Scavenger Tailing	9.3
Pb Regrind Mill Discharge	10.3
Pb 1st Cleaner Feed	9.6
Pb 2nd Cleaner Feed	9.5
Pb 3rd Cleaner Feed	9.6
Pb 4th Cleaner Feed	9.3
Zn Rougher Feed	10.7
Zn Scavenger Tailing	10.4
Zn Regrind Mill Feed	11.7
Zn 1st Cleaner Feed	11.6
Zn 2nd Cleaner Feed	11.6
Zn 3rd Cleaner Feed	11.7
Zn 4th Cleaner Feed	11.6

2.4.2. Densities

Product	Pulp Densities gpl
Pb Rougher Feed	1200
Pb Scavenger Tailing	1183
Pb 1st Cleaner Feed	1073
Zn Rougher Feed	1105
Zn Scavenger Tailing	1100
Zn 1st Cleaner Feed	1055

2.4.3. Temperature

Product	°C
Pb Rougher Feed	25
Pb Regrind Mill Discharge	30
Zn Rougher Feed	24
Zn Regrind Mill Discharge	25

Test No. PP-1 - Continued

2.4. Results:

2.4.4. Chemical Analyses

Product	Assays, % Pb	Assays, % Zn
Cyclone Overflow	6.02	9.85
Pb Rougher Concentrate	27.7	15.0
Pb Rougher Tailing	2.85	10.1
Pb Scavenger Concentrate	11.50	15.9
Pb Scavenger Tailing	1.75	9.42
Pb Regrind Cyclone O/F	29.4	13.8
Pb Regrind Cyclone U/F	26.5	14.6
Pb Regrind Mill Discharge	29.6	13.3
Pb Cleaner Concentrate	49.6	13.8
Zn Rougher Concentrate	2.28	51.4
Zn Rougher Tailing	1.94	6.55
Zn Scavenger Concentrate	3.65	24.20
Zn Scavenger Tailing	1.63	4.56
Zn Regrinding Cyclone O/F	2.14	54.6
Zn Regrinding Cyclone U/F	2.26	49.2
Zn Cleaner Concentrate	1.21	58.9

Test No. PP-1 - Continued

2.4. Results:

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
Pb Rougher Concentrate	12.88	27.7	15.0	58.9	18.0
Pb Rougher Tailing	87.12	2.85	10.1	41.1	82.0
Cyclone Overflow (meas)	100.00	6.02	9.85	-	-
(calc)	100.00	6.05	10.73	100.0	100.0
Pb Scav. Conc.	11.28	11.5	15.90	21.4	18.2
Pb Scav. Tail.	75.84	1.75	9.42	21.9	72.6
Pb Rougher Tail (meas)	87.12	2.85	10.1	41.1	82.0
(calc)		2.62	8.94	43.3	90.8
Zn Rougher Conc.	6.40	2.28	51.4	2.4	33.4
Zn Rougher Tail.	69.44	1.94	6.55	22.4	46.2
Pb Scav. Tail. (meas)	75.84	1.75	9.42	21.9	72.6
(calc)		1.97	10.33	24.8	79.6
Zn Scav. Conc.	10.13	3.65	24.2	6.1	24.9
Zn Scav. Tail.	59.31	1.63	4.56	16.1	27.5
Zn Rougher Tail. (meas)	69.44	1.94	6.55	22.4	46.2
(Calc.)		1.92	7.42	22.2	52.4

Three-Product Formula

Pb Cleaner Conc.	9.18	49.6	13.8	75.9	12.8
Zn Cleaner Concentrate	8.19	1.21	58.9	1.7	48.9
Zn Flotation Tail.	82.63	1.63	4.56	22.4	38.3
Head (Calculated)	100.00	6.02	9.85	100.0	100.0

Test No. PP-2

1. Grinding Circuit

1.1. Purpose: To obtain steady grinding conditions.

1.2. Method: As for Test No. 1, but attempt to stabilize the cyclone recirculation load. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 690 pounds per hour. Samples were taken every 30 minutes in the last 3 hours of operation.

1.2.1. Classification Equipment

Hendy Mill: P-50 Dorr Cyclone - 1½ inch diameter
5/8 inch vortex
1/2 inch apex

Lead Regrind

Sala Mill: 1 inch Krebs Cyclone - 1 inch diameter
1/4 inch vortex
1/8 inch apex

Zinc Regrind

Conical Mill: 1 inch Goodwin Cyclone - 1 inch diameter
1/2 inch vortex
1/2 inch apex

1.3. Flowsheet: As for Test PP-1.

1.4. Results: The grinding circuit was stable during operation. Net power consumption in the Hendy mill was 15.9 kilowatt-hours per ton of 1/2 inch feed. The Dorr Cyclone overflow was 90.9 percent minus 200 mesh. The power consumption in the Sala mill was 17.0 kilowatt hours per ton of flotation feed. The effect of the smaller cyclone in the Pb regrind circuit was a sharp increase in the classification efficiency.

Test No. PP-2 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus 1/2 inch ore at 1.6 percent moisture content		
Feed Rate:	690 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	1½ inch balls	600 pounds	
	1 inch balls	400 pounds	
	Total	2000 pounds	
Operatimg Time:	Total 7.5 hours, test period 2.5 hours		
Mill Feed:	Total 5175 pounds, test period 1725 pounds		
Circulating Load:	Cyclone underflow 530 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2136	70.2
	Cyclone Overflow	1298	30.2
	Cyclone Underflow	2472	76.5
Average Power:	Gross	7.48 kilowatts	
	No Load	1.92 kilowatts	
	Net	5.56 kilowatts	
Net Power Consumption:	15.88 kilowatt-hours per ton of 1/2 inch feed		
Work Index:	11.34		

Test No. PP-2 - Continued

1.4. Results

1.4.2. Lead Regrind Mill Report

Regrind Mill:	Sala Ball Mill		
Feed:	Lead Rougher Concentrate and Lead 2nd Cleaner Tailing		
Feed Rate:	97.42 pounds per hour, 14.12 percent of mill feed		
Mill Speed:	31 r.p.m., 73 percent of critical speed		
Mill Load:	2 inch balls	480 pounds	
	1 inch balls	720 pounds	
	Total	1200 pounds	
Operating Time:	Total 7.5 hours, test period 2 hours		
Pulp Densities:		gpl	% Solids
	Mill Discharge	1920	63
	Cyclone Feed	1160	17.5
	Cyclone Overflow	1060	7.5
	Cyclone Underflow	1920	63
Average Power:	Gross	6.88 kilowatts	
	No Load	0.92 kilowatts	
	Net	5.96 kilowatts	
Net Power Consumption:	17.03 kilowatt-hours per ton of feed		
	121.6 kilowatt-hours per ton of concentrate		

Test No. PP-2 - Continued

1.4. Results:

1.4.3. Zinc Regrind Mill Report

Regrind Mill:	Conical Mill		
Feed:	Zinc Rougher Concentrate and Zinc 2nd Cleaner Tail		
Feed Rate:	74.79 pounds per hour, 10.84 percent of mill feed		
Mill Speed:	30 r.p.m., 65 percent of critical speed		
Mill Load:	1 inch balls	100 pounds	
	½ inch balls	220 pounds	
	Total	320 pounds	
Operatimg Time:	Total 7.5 hours, test period 2.0 hours		
Pulp Densities:		gpl	% Solids
	Mill Discharge	1788	57.3
	Cyclone Overflow	1100	12.2
	Cyclone Underflow	1788	57.3
Average Power:	Gross	1.18 kilowatts	
	No Load	0.95 kilowatts	
	Net	0.23 kilowatts	
Net Power Consumption:	0.66 kilowatt-hours per ton of feed		
	6.21 kilowatt-hours per ton of concentrate		

Test No. PP-2 - Continued

1.4.4. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	3.0	3.0	97.0
3	10.8	13.8	86.2
4	14.7	28.5	71.5
6	11.2	39.7	60.3
8	8.9	48.6	51.4
10	7.0	55.6	44.4
14	6.2	61.8	38.2
20	4.7	66.5	33.5
28	3.8	70.3	29.7
35	3.2	73.5	26.5
48	3.4	76.9	23.1
65	3.4	80.3	19.7
100	2.8	83.1	16.9
150	2.6	85.7	14.3
200	2.8	88.5	11.5
- 200	11.5	100.0	-
Total	100.0	-	-

Cyclone Underflow

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.4	0.8	99.2
35	0.7	1.5	98.5
48	1.6	3.1	96.9
65	3.1	6.2	93.8
100	5.3	11.5	88.5
150	10.1	21.6	78.4
200	19.5	41.1	58.9
270	16.1	57.2	42.8
400	19.4	76.6	23.4
- 400	23.4	100.0	-
Total	100.0	-	-

Test No. PP-2 - Continued

1.4.4. Screen Analyses

Hendy Mill Discharge

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.4	0.8	99.2
35	0.6	1.4	98.6
48	1.4	2.8	97.2
65	2.8	5.6	94.4
100	4.7	10.3	89.7
150	8.8	19.1	80.9
200	16.8	35.9	64.1
270	14.5	50.4	49.6
400	19.6	70.0	30.0
- 400	30.0	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.3	0.3	99.7
100	0.7	1.0	99.0
150	2.1	3.1	96.9
200	6.0	9.1	90.9
270	7.3	16.4	83.6
400	14.7	31.1	68.9
- 400	68.9	100.0	-
Total	100.0	-	-

Test No. PP-2 - Continued

1.4.4. Screen Analyses

Pb Rougher Concentrate

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	4.6	4.6	95.4
270 mesh	7.2	11.8	88.2
25.8 µm	22.0	33.8	66.2
20.0 µm	9.9	43.7	56.3
14.0 µm	14.3	58.0	42.0
9.6 µm	11.3	69.3	30.7
7.4 µm	6.9	76.2	23.8
- 7.4 µm	23.8	100.0	-
Total	100.0	-	-

Specific Gravity - 4.84

Pb Regrind Cyclone Underflow

+ 200 mesh	1.6	1.6	98.4
270 mesh	3.8	5.4	94.6
26.0 µm	21.2	26.6	73.4
20.1 µm	11.3	37.9	62.1
14.0 µm	25.3	63.2	36.8
9.7 µm	20.0	83.2	16.8
7.5 µm	8.3	91.5	8.5
- 7.5 µm	8.5	100.0	-
Total	100.0	-	-

Specific Gravity - 4.95

Test No. PP-2 - Continued

1.4.4. Screen Analyses

Pb Regrind Discharge

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	0.3	0.3	99.7
270 mesh	1.0	1.3	98.7
26.0 µm	15.3	16.6	83.4
20.1 µm	11.8	28.4	71.6
14.0 µm	22.1	50.5	49.5
9.7 µm	19.8	70.3	29.7
7.5 µm	9.3	79.6	20.4
- 7.5 µm	20.4	100.0	-
Total	100.0	-	-

Specific Gravity - 4.92

Pb Regrind Cyclone Overflow

+ 14.4 µm	0.9	0.9	99.1
9.9 µm	2.0	2.9	97.1
7.7 µm	10.2	13.1	86.9
- 7.7 µm	86.9	100.0	-
Total	100.0	-	-

Specific Gravity - 4.69

Zinc Rougher Concentrate

+ 200 mesh	5.8	5.8	94.2
270 mesh	6.8	12.6	87.4
29.0 µm	18.4	31.0	69.0
22.5 µm	12.0	43.0	57.0
15.7 µm	14.9	57.9	42.1
10.8 µm	9.8	67.7	32.3
8.3 µm	5.9	73.6	26.4
- 8.3 µm	26.4	100.0	-
Total	100.0	-	-

Specific Gravity - 4.12

Test No. PP-2 - Continued

1.4.4. Screen Analyses

Zinc Regrind Cyclone Overflow

Mesh Size (Tyler)	% Retained Individual	% Retained Cumualtive	% Passing Cumulative
+ 200 mesh	0.2	0.2	99.8
270 mesh	0.8	1.0	99.0
29.0 µm	14.1	15.1	84.9
22.5 µm	15.5	30.6	69.4
15.7 µm	23.4	54.0	46.0
10.8 µm	14.0	68.0	32.0
8.3 µm	6.6	74.6	25.4
- 8.3 µm	25.4	100.0	-
Total	100.0	-	-

Specific Gravity - 4.13

Test No. PP-2 - Continued

1.4.4. Screen Analyses

Zinc Regrind Cyclone Underflow

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	4.7	4.7	95.3
270 mesh	9.6	14.3	85.7
28.8 μm	13.6	27.9	72.1
22.3 μm	46.9	74.8	25.2
15.6 μm	16.1	90.9	9.1
10.7 μm	4.2	95.1	4.9
8.3 μm	1.2	96.3	3.7
- 8.3 μm	3.7	100.0	-
Total	100.0	-	-

Specific Gravity - 4.19

Zinc Regrind Discharge

+ 200 mesh	4.1	4.1	95.9
270 mesh	8.6	12.7	87.3
28.8 μm	13.6	26.3	73.7
22.3 μm	45.8	72.1	27.9
15.6 μm	16.8	88.9	11.1
10.7 μm	4.8	93.7	6.3
8.3 μm	1.5	95.2	4.8
- 8.3 μm	4.8	100.0	-
Total	100.0	-	-

Specific Gravity - 4.18

Test No. PP-2 - Continued

2. Flotation

2.1. Purpose:

1) To stabilize the circuit and adjust pH values and reagent additions.

2) To increase pulp density in the Pb regrind mill.

2.2. Method:

The pH in the Pb rougher and cleaning circuit was adjusted to pH 9.0-9.3, and in the zinc rougher to pH 10.5. The pH in the zinc cleaning was adjusted to pH 11.0-11.6.

The reagent additions were initially adjusted to correspond to those used in the laboratory (Progress Report No. 8).

In the lead regrind circuit the 1½ inch Krebs cyclone was replaced by a 1 inch Krebs cyclone.

2.2.1. Flotation Equipment

As for Test PP-1.

2.2.2. Flotation Reagents

See Following Pages

2.3. Flowsheet:

As for Test PP-1.

2.4. Results:

The flotation circuits were quite stable during the test run. The amount of lead which was lost in the lead 1st cleaner tailing, and the zinc losses in the zinc 1st cleaning were unacceptably high. Therefore, the losses of lead and zinc in the final tailing were high. It was observed that there was slow zinc flotation in both zinc rougher and cleaning stages. For the next test it was decided to increase the level of collector in the Pb 1st cleaner, and to replace Minerec 743 with Z-200.

Test No. PP-2 - Continued

2.4. Results:

2.2.2. Reagent Additions

Type	Pounds per Short ton	Point of Addition
Na_2CO_3	3.20	Ball Mill Feed
NaCN	0.33	Ball Mill Feed
$ZnSO_4$	0.76	Ball Mill Feed
Z-11	0.06	Ball Mill Feed
Z-11	0.02	Pb Conditioner
MIBC	0.13	Pb Rougher Feed Pump
Z-11	0.03	Pb Scavenger Feed
MIBC	0.023	Pb Scavenger Feed
NaCN	0.20	Pb Regrind Mill Feed
Na_2CO_3	0.20	Pb Regrind Mill Feed
$ZnSO_4$	0.58	Pb Regrind Mill Feed
R-242	0.04	Pb Regrind Cyclone
Z-11	0.01	Pb Regrind Cyclone
MIBC	0.01	Pb 1st Cleaner Conditioner
NaCN	0.11	Pb 2nd Cleaner Feed
MIBC	0.01	Pb 2nd Cleaner Feed
Na_2CO_3	0.16	Pb 3rd Cleaner Feed
NaCN	0.06	Pb 3rd Cleaner Feed
NaCN	0.06	Pb 4th Cleaner Feed
$Ca(OH)_2$	2.82	Zn Conditioner
$CuSO_4$	2.20	Zn Conditioner
Z-11	0.18	Zn Rougher Feed Pump
M-748	0.035	Zn Rougher Feed Pump
DF-250	0.065	Zn Rougher Feed Pump
Z-11	0.035	Zn Scavenger Feed
M-748	0.046	Zn Scavenger Feed
DF-250	0.070	Zn Scavenger Feed
$Ca(OH)_2$	0.80	Zn Regrind Mill Feed
$CuSO_4$	0.28	Zn Regrind Mill Feed
M-748	0.02	Zn Regrind Mill Feed
Z-11	0.02	Zn 1st Cleaner Feed
DF-250	0.035	Zn 1st Cleaner Feed
$Ca(OH)_2$	0.46	Zn 2nd Cleaner Feed
Z-11	0.03	Zn 2nd Cleaner Feed
$Ca(OH)_2$	0.42	Zn 3rd Cleaner Feed
$Ca(OH)_2$	0.04	Zn 4th Cleaner Feed

Test No. PP-2 - Continued

2.4. Results:

2.4.1. pH

Product	pH
Cyclone Overflow	9.2
Pb Rougher Feed	9.1
Pb Scavenger Tailing	8.8
Pb Regrind Mill Discharge	8.0
Pb 1st Cleaner Feed	8.4
Pb 2nd Cleaner Feed	9.2
Pb 3rd Cleaner Feed	9.4
Pb 4th Cleaner Feed	9.3
Zn Rougher Feed	10.5
Zn Scavenger Tailing	10.0
Zn Regrind Mill Feed	11.7
Zn 1st Cleaner Feed	11.6
Zn 2nd Cleaner Feed	11.6
Zn 3rd Cleaner Feed	11.7
Zn 4th Cleaner Feed	11.5

2.4.2. Pulp Densities

Product	Pulp Density gpl
Pb Rougher Feed	1180
Pb Scavenger Tailing	1160
Pb 1st Cleaner Feed	1060
Zn Rougher Feed	1100
Zn Scavenger Tailing	1080
Zn 1st Cleaner Feed	1100

2.4.3. Pulp Temperature

Product	°C
Pb Rougher Feed	24
Pb Regrind Mill Discharge	37
Zn Rougher Feed	25
Zn Regrind Mill Discharge	25

Test No. PP-2 - Continued

2.4. Results:

2.4.4. Chemical Analyses

Product	Assays, % Pb	Zn
Cyclone Overflow	6.12	10.0
Pb Rougher Concentrate	27.9	15.0
Pb Rougher Tailing	10.0	2.54
Pb Scavenger Concentrate	8.17	14.50
Pb Scavenger Tailing	1.79	9.12
Pb 1st Cleaner Concentrate	45.20	12.50
Pb 1st Cleaner Tailing	17.70	16.20
Pb Regrind Cyclone Overflow	29.7	13.7
Pb Regrind Mill Discharge	25.7	15.0
Pb Cleaner Concentrate	53.1	11.4
Zn Rougher Concentrate	2.60	42.5
Zn Rougher Tailing	2.19	5.06
Zn Scavenger Concentrate	3.15	10.80
Zn Scavenger Tailing	1.72	2.14
Zn 1st Cleaner Tailing	4.55	28.20
Zn 1st Cleaner Concentrate	2.75	51.40
Zn Regrind Cyclone Overflow	2.71	46.8
Zn Regrind Cyclone Underflow	2.59	40.5
Zn Cleaner Concentrate	1.69	56.0

Test No. PP-2 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
Pb Rougher Concentrate	14.12	27.9	15.0	64.4	21.2
Pb Rougher Tailing	85.88	2.54	10.0	35.6	85.9
Cyclone Overflow (meas)	100.0	6.12	10.0	100.0	100.0
(calc)		6.12	10.7	100.0	107.1
Pb Scavenger Concentrate	11.76	8.17	14.50	15.2	15.9
Pb Scavenger Tailing	74.12	1.79	9.12	21.7	63.1
Pb Rougher Tailing (meas)	85.88	2.54	10.0	35.6	85.9
(calc)		2.66	9.86	36.9	79.0
Pb 1st Cleaner Conc.	5.23	45.2	12.50	38.6	6.1
Pb 1st Cleaner Tail.	8.89	17.7	16.20	25.7	13.5
Pb Rougher Conc. (meas)	14.12	27.9	15.0	64.4	21.2
(calc)		27.88	14.85	64.3	19.6
Zn Rougher Concentrate	10.84	2.60	42.5	4.6	43.0
Zn Rougher Tailing	63.28	2.19	5.06	22.6	29.9
Pb Scavenger Tailing (meas)	74.12	1.79	9.12	21.7	63.1
(calc)		2.25	10.53	27.2	72.9
Zn Scavenger Concentrate	28.50	3.15	10.86	14.7	28.9
Zn Scavenger Tailing	34.78	1.72	2.14	9.8	6.9
Zn Rougher Tailing (meas)	63.28	2.19	5.06	22.6	29.9
(calc)		2.36	6.06	24.50	35.8
Zn 1st Cleaner Concentrate	4.13	2.75	51.4	1.9	19.8
Zn 1st Cleaner Tailing	6.71	4.55	28.20	5.0	17.7
Zn Rougher Conc. (meas)	10.84	2.60	42.5	4.6	43.0
(calc)		3.85	37.03	6.9	37.5

Three-Product Formula

Pb Concentrate	8.56	53.1	11.4	74.3	9.7
Zn Concentrate	13.12	1.69	56.0	3.6	73.5
Zn Flotation Tailing	78.32	1.72	2.14	22.1	16.8
Head (Assays)	100.00	6.12	100.00	100.0	100.0

Test No. PP-3

1. Grinding Circuit

1.1. Purpose: To repeat conditions of Test PP-2.

1.2. Method: As for Test PP-2. The grinding circuit was operated for a period of 7.75 hours, at a feed rate of 700 pounds per hour. Samples were taken every 20 minutes in the last 3 hours of operation.

1.2.1. Classification Equipment

Hendy Mill: P-50 Dorr Cyclone: 1½ inch diameter
5/8 inch vortex
1/2 inch apex

Pb Regrind

Sala Mill: 1 inch Krebs Cyclone: 1 inch diameter
1/4 inch vortex
1/8 inch apex

Zn Regrind

Conical Mill: 1 inch Goodwin Cyclone: 1 inch diameter
1/2 inch vortex
1/2 inch apex

1.3. Flowsheet: As for Test PP-1.

1.4. Results: The grinding circuit was stable during the test period. Net power consumption in the Hendy mill was 16.9 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow assayed 91.6 % minus 200 mesh.

The operation of the lead and zinc regrind circuits were stable during the test run.

Test No. PP-3 - Continued

1.4. Results

1.4.1. Ball Mill Report

Feed:	Minus 1/2 inch ore at 0.95 percent moisture content		
Feed Rate:	700 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	$1\frac{1}{2}$ inch balls	600 pounds	
	1 inch balls	400 pounds	
	Total	2000 pounds	
Operating Time:	Total 7.75 hours, test period 2.5 hours		
Mill Feed:	Total 5425 pounds, test period 1750 pounds		
Circulating Load:	Cyclone underflow 580 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2106	69.3
	Cyclone Overflow	1300	30.9
	Cyclone Underflow	2448	76.1
Average Power:	Gross	7.84 kilowatts	
	No Load	1.92 kilowatts	
	Net	5.92 kilowatts	
Net Power Consumption:	16.91 kilowatt-hours per ton of 1/2 inch feed		

Test No. PP-3 - Continued

1.4. Results

1.4.2. Lead Regrind Mill Report

Regrind Mill:	Sala Ball Mill		
Feed:	Lead Rougher Concentrate and Lead 2nd Cleaner Tailing		
Feed Rate:	124.88 pounds per hour, 17.84 percent of mill feed		
Mill Speed:	31 r.p.m., 73 percent of critical speed		
Mill Load:	2 inch balls	480 pounds	
	1 inch balls	720 pounds	
	Total	1200 pounds	
Operating Time:	Total 7.75 hours, test period 2.5 hours		
Pulp Densities		gpl	% Solids
	Mill Discharge	2338	73.5
	Cyclone Feed	1300	30.6
	Cyclone Overflow	1085	11.4
	Cyclone Underflow	2338	73.5
Average Power:	Gross	7.60 kilowatts	
	No Load	0.92 kilowatts	
	Net	6.68 kilowatts	
Net Power Consumption:	19.09 kilowatt-hours per ton of feed		
	107.7 kilowatt-hours per ton of concentrate		

Test No. PP-3 - Continued

1.4. Results

1.4.3. Zinc Regrind Mill Report

Regrind Mill:	Conical Ball Mill		
Feed:	Zinc Rougher Concentrate and Zinc 2nd Cleaner Tailing		
Feed Rate:	128.10 pounds per hour. 18.30 percent of the mill feed		
Mill Speed:	30 r.p.m., 65 percent of critical speed		
Mill Load:	1 inch balls	100 pounds	
	1/2 inch balls	220 pounds	
	Total	320 pounds	
Operating Time:	Total 7.75 hours, test period 2.5 hours		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2030	66.1
	Cyclone Overflow	1110	13.2
	Cyclone Underflow	2030	66.1
Average Power:	Gross	1.71 kilowatts	
	No Load	0.95 kilowatts	
	Net	0.76 kilowatts	
Net Power Consumption:	2.17 kilowatt-hours per ton of feed		
	11.87 kilowatt-hours per ton of concentrate		

Test No. PP-3 - Continued

1.4.4. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	3.9	3.9	96.1
3	13.5	17.4	82.6
4	9.4	26.8	73.2
6	10.0	36.8	63.2
8	9.8	46.6	53.4
10	7.5	54.1	45.9
14	6.1	60.2	39.8
20	4.7	64.9	35.1
28	4.0	68.9	31.1
35	3.4	72.3	27.7
48	3.6	75.9	24.1
65	3.5	79.4	20.6
100	2.8	82.2	17.8
150	2.7	84.9	15.1
200	2.9	87.8	12.2
- 200	12.2	100.0	-
Total	100.0	-	-

Cyclone Underflow

+ 10	0.2	0.2	99.8
14	0.2	0.4	99.6
20	0.3	0.7	99.3
28	0.4	1.1	98.9
35	0.7	1.8	98.2
48	1.6	3.4	96.6
65	3.1	6.5	93.5
100	5.3	11.8	88.2
150	10.0	21.8	78.2
200	19.5	41.3	58.7
270	15.5	56.8	43.2
400	19.3	76.1	23.9
- 400	23.9	100.0	-
Total	100.0	-	-

Test No. PP-3 - Continued

1.4.4. Screen Analyses

Hendy Mill Discharge

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.3	0.7	99.3
35	0.5	1.2	98.8
48	1.3	2.5	97.5
65	2.5	5.0	95.0
100	4.5	9.5	90.5
150	8.7	18.2	81.8
200	17.2	35.4	64.6
270	14.5	49.9	50.1
400	18.6	68.5	31.5
- 400	31.5	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.2	0.2	99.8
100	0.6	0.8	99.2
200	5.6	8.4	91.6
270	6.9	15.3	84.7
400	14.5	29.8	70.2
- 400	70.2	100.0	-
Total	100.0	-	-

Test No. PP-3 - Continued

1.4.4. Screen Analyses

Lead Rougher Concentrate

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 200 mesh	6.0	6.0	94.0
270 mesh	7.0	13.0	87.0
25.8 μm	22.6	35.6	64.4
20.0 μm	9.7	45.3	54.7
14.0 μm	13.9	59.2	40.8
9.6 μm	11.3	70.5	29.5
7.4 μm	6.8	77.3	22.7
- 7.4 μm	22.7	100.0	-
Total	100.0	-	-

Specific Gravity - 4.89

Lead Regrind Cyclone Underflow

+ 200 mesh	3.6	3.6	96.4
270 mesh	5.4	9.0	91.0
25.8 μm	24.8	33.8	66.2
20.0 μm	17.0	50.8	49.2
14.0 μm	26.5	77.3	22.7
9.6 μm	12.2	89.5	10.5
7.4 μm	2.4	91.9	8.1
- 7.4 μm	8.1	100.0	-
Total	100.0	-	-

Specific Gravity - 4.97

Test No. PP-3 - Continued

1.4.4. Screen Analyses

Lead Regrind Discharge

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	0.6	0.6	99.4
270 mesh	1.5	2.1	97.9
25.8 µm	18.4	20.5	79.5
20.0 µm	13.8	34.3	65.7
14.0 µm	25.4	59.7	40.3
9.6 µm	16.6	76.3	23.7
7.4 µm	5.6	81.9	18.1
- 7.4 µm	18.1	100.0	-
Total	100.0	-	-

Specific Gravity - 4.95

Lead Regrind Cyclone Overflow

+ 14.2 µm	6.1	6.1	93.9
9.8 µm	20.6	26.7	73.3
7.5 µm	15.2	41.9	58.1
- 7.5 µm	58.1	100.0	-
Total	100.0	-	-

Specific Gravity - 4.79

Zinc Rougher Concentrate

+ 200 mesh	5.0	5.0	95.0
270 mesh	5.3	10.3	89.7
29.4 µm	17.5	27.8	72.2
22.8 µm	14.9	42.7	57.3
15.9 µm	17.2	59.9	40.1
10.9 µm	9.6	69.5	30.5
8.4 µm	5.4	74.9	25.1
- 8.4 µm	25.1	100.0	-
Total	100.0	-	-

Specific Gravity - 4.09

Test No. PP-3 - Continued

1.4.4. Screen Analyses

Zinc Regrind Cyclone Underflow

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	7.9	7.9	92.1
270 mesh	13.5	21.4	78.6
28.6 µm	13.2	34.6	65.4
22.2 µm	47.0	81.6	18.4
15.5 µm	10.4	92.0	8.0
10.6 µm	2.7	94.7	5.3
8.2 µm	1.0	95.7	4.3
- 8.2 µm	4.3	100.0	-
Total	100.0	-	-

Specific Gravity - 4.22

Zinc Regrind Discharge

+ 200 mesh	8.4	8.4	91.6
270 mesh	12.8	21.2	78.8
28.6 µm	16.6	37.8	62.2
22.2 µm	46.6	84.4	15.6
15.5 µm	10.4	94.8	5.2
10.6 µm	2.8	97.6	2.4
8.2 µm	1.1	98.7	1.3
- 8.2 µm	1.3	100.0	-
Total	100.0	-	-

Specific Gravity - 4.19

Test No. PP-3 - Continued

1.4.4. Screen Analyses

Zinc Regrind Cyclone Overflow

Particle Size (Size)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	0.4	0.4	99.6
270 mesh	1.2	1.6	98.4
29.4 µm	12.7	14.3	85.7
22.8 µm	15.2	29.5	70.5
15.9 µm	20.5	50.0	50.0
10.9 µm	11.7	61.7	38.3
8.4 µm	6.5	68.2	31.8
- 8.4 µm	31.8	100.0	-
Total	100.0	-	-

Specific Gravity - 4.08

Test No. PP-3 - Continued

2. Flotation

2.1. Purpose: To attempt to improve Pb and Zn recoveries.

2.2. Method: The following changes in the circuits were carried out.

A. Pb Circuit

1) The level of collectors in the Pb rougher and Pb 1st cleaner was increased.
2) Slightly increased cyanide additions to the 2nd and 3rd cleaner.

B. Zn Circuit

1) Collector Minerec 748 was replaced by Z-200
2) The additions of collectors Z-11 and Z-200 to the Zn 1st cleaner were increased.

2.2.1. Flotation Equipment

As for Test PP-1.

2.2.2. Flotation Reagents

See following Pages

2.3. Flowsheet: As for Test PP-1.

2.4. Results: Improvement in the lead 1st cleaning was obtained with the above changes. However, high collector additions in the Pb 1st cleaning resulted in a poor lead concentrate grade. A large amount of zinc reported to the lead final concentrate. Changes in the zinc circuit resulted in a slight improvement in the zinc cleaning.

Test No. PP-3 - Continued

2.2.2. Reagent Additions

Type	Pounds per Short Ton	Point of Addition
Na_2CO_3	3.20	Ball Mill Feed
NaCN	0.31	Ball Mill Feed
$ZnSO_4$	0.65	Ball Mill Feed
Z-11	0.08	Ball Mill Feed
Z-11	0.04	Pb Conditioner
MIBC	0.12	Pb Rougher Feed Pump
Z-11	0.04	Pb Scavenger Feed
MIBC	0.038	Pb Scavenger Feed
NaCN	0.24	Pb Regrind Mill Feed
Na_2CO_3	0.85	Pb Regrind Mill Feed
$ZnSO_4$	0.62	Pb Regrind Mill Feed
R-242	0.075	Pb Regrind Cyclone
Z-11	0.02	Pb Regrind Cyclone
MIBC	0.01	Pb 1st Cleaner Conditioner
NaCN	0.11	Pb 2nd Cleaner Feed
MIBC	0.007	Pb 2nd Cleaner Feed
Na_2CO_3	0.12	Pb 3rd Cleaner Feed
NaCN	0.06	Pb 3rd Cleaner Feed
NaCN	0.06	Pb 4th Cleaner Feed
$Ca(OH)_2$	2.98	Zn Conditioner
$CuSO_4$	2.10	Zn Conditioner
Z-11	0.15	Zn Rougher Feed Pump
Z-200	0.075	Zn Rougher Feed Pump
DF-250	0.090	Zn Rougher Feed Pump
Z-11	0.04	Zn Scavenger Feed
Z-200	0.02	Zn Scavenger Feed
DF-250	0.03	Zn Scavenger Feed
$Ca(OH)_2$	0.76	Zn Regrind Mill Feed
$CuSO_4$	0.42	Zn Regrind Mill Feed
Z-200	0.034	Zn Regrind Mill Feed
Z-11	0.03	Zn 1st Cleaner Feed
DF-250	0.030	Zn 1st Cleaner Feed
$Ca(OH)_2$	0.50	Zn 2nd Cleaner Feed
Z-11	0.04	Zn 2nd Cleaner Feed
$Ca(OH)_2$	0.54	Zn 3rd Cleaner Feed
$Ca(OH)_2$	0.02	Zn 4th Cleaner Feed

Test No. PP-3 - Continued

2.4. Results

2.4.1. pH

Product	pH
Cyclone Overflow	9.2
Pb Rougher Feed	9.1
Pb Scavenger Tailing	8.8
Pb Regrind Mill Discharge	9.4
Pb 1st Cleaner Feed	9.0
Pb 2nd Cleaner Feed	9.3
Pb 3rd Cleaner Feed	9.4
Pb 4th Cleaner Feed	9.3
Zn Rougher Feed	10.6
Zn Scavenger Tailing	10.0
Zn Regrind Mill Feed	11.7
Zn 1st Cleaner Feed	11.5
Zn 2nd Cleaner Feed	11.6
Zn 3rd Cleaner Feed	11.7
Zn 4th Cleaner Feed	11.6

2.4.2. Pulp Densities

Product	Pulp Density gpl
Pb Rougher Feed	1215
Pb Scavenger Tailing	1187
Pb 1st Cleaner Feed	1085
Zn Rougher Feed	1127
Zn Scavenger Tailing	1140
Zn 1st Cleaner Feed	1116

2.4.3. Pulp Temperature

Product	°C
Pb Rougher Feed	24
Pb Regrind Mill Discharge	37
Zn Rougher Feed	27
Zn Regrind Mill Discharge	27

Test No. PP-3 - Continued

2.4. Results

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Underflow	6.15	10.0
Pb Rougher Concentrate	26.0	14.7
Pb Rougher Tailing	1.84	9.98
Pb Scavenger Concentrate	4.59	13.20
Pb Scavenger Tailing	1.26	8.94
Pb 1st Cleaner Concentrate	35.8	16.20
Pb 1st Cleaner Tailing	6.38	16.20
Pb Regrind Cyclone Underflow	22.8	14.0
Pb Regrind Cyclone Overflow	26.0	16.0
Pb Cleaner Concentrate	44.9	15.3
Zn Rougher Concentrate	2.29	39.9
Zn Rougher TAiling	1.55	3.28
Zn Scavenger Concentrate	3.09	11.50
Zn Scavenger Tailing	1.23	1.69
Zn 1st Cleaner Tailing	2.96	30.1
Zn 1st Cleaner Concentrate	3.09	44.3
Zn Regrind Cyclone Overflow	2.90	37.4
Zn Regrind Cyclone Underflow	2.29	32.0
Zn Cleaner Concentrate	1.79	56.0

Test No. PP-3 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
Pb Rougher Concentrate	17.84	26.0	14.7	75.4	24.2
Pb Rougher Tailing	82.16	1.84	9.98	24.6	75.8
Cyclone Overflow (meas.)	100.00	6.15	10.0	100.0	100.0
(calc)		6.15	10.82	100.0	100.0
Pb Scavenger Conc.	17.42	4.59	13.20	13.0	21.2
Pb Scavenger Tail	64.74	1.26	8.94	13.3	53.5
Pb Rougher Tail (meas)	82.16	1.84	9.98	24.6	75.8
(calc)		1.96	9.84	26.3	74.7
Pb 1st Cleaner Conc.	11.90	35.80	16.20	69.3	17.8
Pb 1st Cleaner Tail.	5.94	6.38	16.20	6.1	8.9
Pb Rougher Conc. (meas)	17.84	26.0	14.7	75.4	24.2
(calc)		26.0	16.20	75.40	26.7
Zn Rougher Concentrate	18.30	2.29	39.9	6.8	67.5
Zn Rougher Tail.	63.86	1.55	3.28	16.1	19.3
Pb Rougher Tail. (meas)	82.16	1.84	9.98	24.6	75.8
(Calc.)		1.71	11.43	22.9	86.8
Zn Scav. Concentrate	10.34	3.09	11.5	5.2	11.0
Zn Scavenger Tail.	53.52	1.23	1.69	10.7	8.3
Zn Rougher Tail.	63.86	1.55	3.28	16.1	19.3
		1.45	3.28	15.9	19.3
Zn 1st Cleaner Conc.	12.62	3.09	44.3	6.5	51.6
Zn 1st Cleaner Tail.	5.68	2.96	30.1	2.7	15.8
Zn Rougher Conc. (meas)	18.30	2.29	39.9	6.8	67.5
(calc)		3.04	39.9	9.2	67.4

Three-Product Formula

Pb Cleaner Concentrate	10.90	44.7	15.5	80.67	16.73
Zn Cleaner Concentrate	12.78	1.79	56.0	3.79	70.87
Zn Flotation Tail	76.32	1.23	1.64	15.54	12.40
Cyclone Overflow	100.0	6.04	10.1	100.0	100.0

Test No. PP-4

1. Grinding

1.1. Purpose: To repeat conditions of Test PP-1, but reduce pulp density to the cyclone feed.

1.2. Method: As for Test PP-1, except that pulp density in the cyclone feed was reduced from 1950 gpl to 1700 gpl. The grinding circuit was operated for a period of 7.5 hours, at a feed rate of 699 pounds per hour. Samples were taken every 20 minutes in the last 2.5 hours of operation.

1.2.1. Classification Equipment

Hendy Mill:	P-50 Dorr Cyclone:	1½ inch diameter 5/8 inch vortex 1/2 inch apex

Pb Regrind

Sala Mill:	1 inch Krebs Cyclone:	1 inch diameter 1/4 inch vortex 1/8 inch apex

Zn Regrind

Conical Mill:	2 inch Goodwin Cyclone:	2 inch diameter 3/4 inch vortex 1/2 inch apex

1.3. Flowsheet: As for Test PP-1.

1.4. Results: The grinding circuit was stable during the test period. Net power consumption in the Hendy mill was 15.2 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow assayed 91.3 % minus 200 mesh.

Test No. PP-4 - Continued

1.4. Results:

1.4.1. Ball Mill Report:

Feed:	Minus 1/2 inch ore at 1.0 percent moisture content		
Feed Rate:	699. dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	1½ inch balls	600 pounds	
	1 inch balls	400 pounds	
	Total	2000 pounds	
Operating Time:	Total 7.5 hours, test period 2.5 hours		
Mill Feed:	Total 5242 pounds, test period 1747.5 pounds		
Circulating Load:	Cyclone underflow	540.7 percent	
Pulp Densities:		gpl	% Solids
	Mill Discharge	2100	69.2
	Cyclone Overflow	1298	30.5
	Cyclone Underflow	2450	76.0
Average Power:	Gross	7.24 kilowatts	
	No Load	1.92 kilowatts	
	Net	5.32 kilowatts	
Net Power Consumption:	15.20 kilowatt-hours per ton of 1/2 inch feed		
Work Index:	10.78		

Test No. PP-4 - Continued

1.4. Results

1.4.2. Lead Regrind Mill Report

Regrind Mill:	Sala ball mill		
Feed:	Lead Rougher Concentrate and Pb 2nd Cleaner Tail		
Feed Rate:	135.52 pounds per hour 19.50 percent of the mill feed		
Mill Speed:	31 r.p.m., 73 percent of critical speed		
Mill Load:	2 inch balls	480 pounds	
	1 inch balls	720 pounds	
		1200 pounds	
Operating Time:	Total 7.5 hours, test period 2.5 hours		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2250	70.5
	Cyclone Feed	1313	31.0
	Cyclone Overflow	1155	17.1
	Cyclone Underflow	2250	70.5
Average Power:	Gross	7.60 kilowatts	
	No Load	0.92 kilowatts	
	Net	6. 68 kilowatts	
Net Power Consumption:	19.09 kilowatt-hours per ton of feed		

Test No. PP-4 - Continued

1.4. Results

1.4.3. Zinc Regrind Mill Report

Regrind Mill:	Conical Ball Mill		
Feed:	Zinc Rougher Concentrate and Zinc 2nd Cleaner Tailing		
Feed Rate:	97.9 pounds per hour 13.98 percent of the mill feed		
Mill Speed:	30 r.p.m., 65 percent of critical speed		
Mill Load:	1 inch balls	100 pounds	
	1/2 inch balls	220 pounds	
	Total	320 pounds	
Operating Time:	Total 7.5 hours, test period 2.5 hours		
Pulp Densities:		gpl	% Solids
	Mill Discharge	1950	64.4
	Cyclone Overflow	1065	7.9
	Cyclone Underflow	1956	64.4
Average Power:	Gross	1.54 kilowatts	
	No Load	0.95 kilowatts	
	Net	0.59 kilowatts	
Net Power Consumption:	1.70 kilowatt-hours per ton of feed		

Test No. PP-4 - Continued

1.4. Results

1.4.4. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	3.8	3.8	96.2
3	12.3	16.1	83.9
4	11.9	28.0	72.0
6	11.4	39.4	60.6
8	9.6	49.0	51.0
10	8.0	57.0	43.0
14	6.5	63.5	36.5
20	4.8	68.3	31.7
28	3.9	72.2	27.8
35	3.1	75.3	24.7
48	3.4	78.7	21.3
65	3.1	81.8	18.2
100	2.5	84.3	15.3
150	2.4	86.7	13.3
200	2.5	89.2	10.8
- 200	10.8	100.0	-
Total	100.0	-	-

Cyclone Underflow

+ 14	0.2	0.2	99.8
20	0.2	0.4	99.6
28	0.3	0.7	99.3
35	0.6	1.3	98.7
48	1.6	2.9	97.1
65	3.1	6.0	94.0
100	5.5	11.5	88.5
150	10.6	22.1	77.9
200	20.0	42.1	57.9
270	15.7	57.8	42.2
400	18.7	76.5	23.5
- 400	23.5	100.0	-
Total	100.0	-	-

Test No. PP-4 - Continued

1.4.4. Screen Analyses

Hendy Mill Discharge

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.3	0.7	99.3
35	0.6	1.3	98.7
48	1.4	2.7	97.3
65	2.8	5.5	94.5
100	4.8	10.3	89.7
150	9.3	19.6	80.4
200	17.5	37.1	62.9
270	14.4	51.5	48.5
400	18.8	70.3	29.7
- 400	29.7	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.3	0.3	99.7
100	0.7	1.0	99.0
150	2.0	3.0	97.0
200	5.7	8.7	91.3
270	6.9	15.6	84.4
400	14.3	29.9	70.1
- 400	70.1	100.0	-
Total	100.0	-	-

Test No. PP-4 - Continued

1.4.4. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	4.1	4.1	95.9
270 mesh	5.7	9.8	90.2
26.6 µm	20.8	30.6	69.4
20.6 µm	9.7	40.3	59.7
14.4 µm	14.8	55.1	44.9
9.9 µm	13.2	68.3	31.7
7.7 µm	7.5	75.8	24.2
- 7.7 µm	24.2	100.0	-
Total	100.0	-	-

Specific Gravity - 4.68

Pb Regrind Discharge

+ 200 mesh	0.5	0.5	99.5
270 mesh	1.3	1.8	98.2
25.0 µm	20.7	22.5	77.5
19.4 µm	16.8	39.3	60.7
13.5 µm	27.0	66.3	33.7
9.3 µm	13.2	79.5	20.5
7.2 µm	4.4	83.9	16.1
- 7.2 µm	16.1	100.0	-
Total	100.0	-	-

Specific Gravity - 4.93

Test No. PP-4 - Continued

1.4.4. Screen Analyses

Pb Regrind Cyclone Underflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	3.8	3.8	96.2
270 mesh	5.4	9.2	90.8
25.8 µm	25.0	34.2	65.8
20.0 µm	16.6	50.8	49.2
13.9 µm	26.7	77.5	22.5
9.6 µm	13.2	90.7	9.3
7.4 µm	2.8	93.5	6.5
- 7.4 µm	6.5	100.0	-
Total	100.0	-	-

Specific Gravity - 4.85

Pb Regrind Cyclone Overflow

+ 14.4 µm	13.0	13.0	87.0
9.9 µm	22.8	35.8	64.2
7.7 µm	13.8	49.6	50.4
- 7.7 µm	50.4	100.0	-
Total	100.0	-	-

Specific Gravity - 4.63

Zn Rougher Concentrate

+ 200 mesh	6.1	6.1	93.9
270 mesh	6.2	12.3	87.7
29.4 µm	16.6	28.9	71.1
22.8 µm	9.5	38.4	61.6
15.9 µm	12.7	51.1	48.9
10.9 µm	10.5	61.6	38.4
8.4 µm	6.4	68.0	32.0
- 8.4 µm	32.0	100.0	-
Total	100.0	-	-

Specific Gravity - 4.12

Test No. PP-4 - Continued

1.4.4. Screen Analyses

Zn Regrind Discharge

Particle Size	% Retained Individual	% Retained Cumulative	% Retained Cumulative
+ 200 mesh	8.8	8.8	91.2
270 mesh	15.0	23.8	76.2
28.1 µm	15.8	39.6	60.4
21.8 µm	46.2	85.8	14.2
15.2 µm	6.0	91.8	8.2
10.4 µm	2.1	93.9	6.1
8.1 µm	1.0	94.9	5.1
- 8.1 µm	5.1	100.0	-
Total	100.0	-	-

Specific Gravity - 4.21

Zn Regrind Cyclone Underflow

+ 200 mesh	12.8	12.8	87.2
270 mesh	18.6	31.4	68.6
27.7 µm	16.4	47.8	52.2
21.5 µm	45.3	93.1	6.9
15.0 µm	2.8	95.9	4.1
10.3 µm	0.8	96.7	3.3
8.0 µm	0.3	97.0	3.0
- 8.0	3.0	100.0	-
Total	100.0	-	-

Specific Gravity - 4.25

Test No. PP-4 - Continued

1.4.4. Screen Analyses

Zn Regrind Cyclone Overflow

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	0.5	0.5	99.5
270 mesh	1.7	2.2	97.8
29.4 µm	13.7	15.9	84.1
22.8 µm	12.0	27.9	72.1
15.9 µm	15.6	43.5	56.5
10.9 µm	12.1	55.6	44.4
8.4 µm	7.3	62.9	37.1
- 8.4 µm	37.1	100.0	-
Total	100.0	-	-

Specific Gravity - 4.05

Test No. PP-4 - Continued

2. Flotation

2.1. Purpose: To investigate the effect of the following reagent changes on the concentrate grades and recoveries of lead and zinc.

2.2. Method:

A. Lead Circuit

1. Collectors R-242 and Z-11 were removed from the Pb cyclone feed pump. Collector R-242 was added to the regrind mill feed, and Z-11 to the 1st cleaner cell No. 5.
2. Increased NaCN addition to the Sala Mill

B. Zinc Circuit

1. The 1 inch Goodwin cyclone was replaced by a 2 inch Goodwin cyclone.
2. Lowered pH in the Zn cleaner from 11.5 to 10.5

2.2.1. Flotation Equipment

As for Test PP-1

2.2.2. Flotation Reagents

See following page

2.3. Flowsheet: As for Test PP-1.

2.4. Results: The higher cyanide additions to the Sala mill and stage collector additions to the Pb 1st cleaner appeared to have improved the lead recovery slightly; however, the lead concentrate grade was low.

Test No. PP-4 - Continued

2.2.2. Reagent Additions

Type	Pounds Per Short Ton	Point of Addition
Na_2CO_3	3.20	Ball Mill Feed
NaCN	0.31	Ball Mill Feed
$ZnSO_4$	0.66	Ball Mill Feed
Z-11	0.09	Ball Mill Feed
Z-11	0.04	Pb Conditioner
MIBC	0.150	Pb Rougher Feed Pump
Z-11	0.03	Pb Scavenger Feed
MIBC	0.023	Pb Scavenger Feed
NaCN	0.31	Pb Regrind Mill Feed
Na_2CO_3	0.50	Pb Regrind Mill Feed
$ZnSO_4$	0.58	Pb Regrind Mill Feed
R-242	0.04	Pb Regrind Mill Feed
MIBC	0.21	Pb 1st Cleaner Conditioner
Z-11	0.01	Pb 1st Cleaner 5th Cell
NaCN	0.12	Pb 2nd Cleaner Feed
MIBC	0.008	Pb 2nd Cleaner Feed
Na_2CO_3	0.12	Pb 3rd Cleaner Feed
NaCN	0.06	Pb 3rd Cleaner Feed
MIBC	0.008	Pb 3rd Cleaner Feed
NaCN	0.06	Pb 4th Cleaner Feed
$Ca(OH)_2$	2.10	Zn Conditioner
$CuSO_4$	2.12	Zn Conditioner
Z-11	0.18	Zn Rougher Feed Pump
Z-200	0.078	Zn Rougher Feed Pump
DF-250	0.063	Zn Rougher Feed Pump
Z-11	0.04	Zn Scavenger Feed
Z-200	0.018	Zn Scavenger Feed
DF-250	0.030	Zn Scavenger Feed
$Ca(OH)_2$	0.50	Zn Regrind Mill Feed
$CuSO_4$	0.54	Zn Regrinding Mill Feed
Z-200	0.029	Zn Regrinding Mill Feed
Z-11	0.03	Zn 1st Cleaner Feed
DF-250	0.030	Zn 1st Cleaner Feed
$Ca(OH)_2$	0.22	Zn 2nd Cleaner Feed
Z-11	0.02	Zn 2nd Cleaner Feed
DF-250	0.02	Zn 2nd Cleaner Feed
$Ca(OH)_2$	0.08	Zn 3rd Cleaner Feed
DF-250	0.004	Zn 3rd Cleaner Feed
$Ca(OH)_2$	0.07	Zn 4th Cleaner Feed

Test No. PP-4 - Continued

2.4. Results:

2.4.1. pH

Product	pH
Cyclone Overflow	9.4
Pb Rougher Feed	9.3
Pb Scavenger Tailing	9.1
Pb Regrinding Mill Discharge	9.1
Pb 1st Cleaner Feed	9.1
Pb 2nd Cleaner Feed	9.6
Pb 3rd Cleaner Feed	9.9
Pb 4th Cleaner Feed	9.8
Zn Rougher Feed	10.2
Zn Scavenger Tailing	9.8
Zn Regrinding Mill Feed	11.5
Zn 1st Cleaner Feed	10.7
Zn 2nd Cleaner Feed	10.5
Zn 3rd Cleaner Feed	10.7
Zn 4th Cleaner Feed	10.8

2.4.2. Pulp Densities

Product	Pulp Density gpl
Pb Rougher Feed	1190
Pb Scavenger Tailing	1187
Pb 1st Cleaner Feed	1155
Zn Rougher Feed	1090
Zn Scavenger Tailing	1103
Zn 1st Cleaner Feed	1065

2.4.3. Pulp Temperature

Product	°C
Pb Rougher Feed	25
Pb Regrinding Mill Discharge	36
Zn Rougher Feed	25
Zn Regrinding Mill Discharge	27

Test No. PP-4 - Continued

2.4. Results

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	6.22	10.1
Pb Rougher Concentrate	23.4	15.5
Pb Rougher Tailing	2.06	10.2
Pb Scavenger Concentrate	4.97	14.5
Pb Scavenger Tailing	1.57	9.4
Pb 1st Cleaner Concentrate	36.6	15.5
Pb 1st Cleaner Tailing	7.11	15.9
Pb Regrinding Cyclone Overflow	23.4	16.3
Pb Regrinding Cycone Underflow	23.4	15.5
Pb Cleaner Concentrate	44.1	16.0
Zn Rougher Concentrate	1.98	30.4
Zn Rougher Tailing	1.56	4.10
Zn Scavenger Concentrate	2.32	10.0
Zn Scavenger Tailing	1.29	2.25
Zn 1st Cleaner Tailing	2.94	6.87
Zn 1st Cleaner Concentrate	2.16	38.6
Zn Regrinding Cyclone Overflow	3.34	29.0
Zn Regrinding Cyclone Underflow	1.94	18.5
Zn Cleaner Concentrate	1.78	50.2

Test No. PP-4 - Continued

2.4. Results

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
Pb Rougher Concentrate	19.50	23.4	15.5	73.3	26.9
Pb Rougher Tailing	80.50	2.06	10.2	26.7	73.1
Cyclone Overflow (meas)	100.00	6.22	10.10	100.0	100.0
(calc)		6.22	11.23	100.0	100.0
Pb Scavenger Conc.	11.60	4.97	14.5	9.3	15.0
Pb Scavenger Tail.	68.90	1.57	9.40	17.4	57.7
Pb Rougher Tail. (meas)	80.50	2.06	10.2	26.7	73.1
(calc)		2.06	10.1	26.7	72.7
Pb 1st Cleaner Conc.	10.76	36.6	15.9	63.3	15.2
Pb 1st Cleaner Tail.	8.74	7.11	15.9	10.0	12.3
Pb Rougher Conc. (meas)	19.50	23.4	15.5	73.3	26.9
(calc)		23.40	15.9	73.3	27.5
Zn Rougher Concentrate	13.88	1.98	30.4	4.4	37.6
Zn Rougher Tailing	55.02	1.56	4.10	13.8	20.1
Pb Scav. Tail. (meas)	68.90	1.57	9.40	17.4	57.7
(calc)		1.64	9.40	18.2	57.7
Zn Scavenver Conc.	13.13	2.32	10.0	4.9	11.7
Zn Scavenger Tail.	41.89	1.29	2.25	8.7	8.4
Zn Rougher Tail. (meas)	55.02	1.56	4.10	13.8	20.1
(calc)		1.53	4.10	13.6	20.1

Three-Product Formula

Pb Concentrate	11.40	44.1	16.0	80.6	17.6
Zn Concentrate	13.69	1.78	50.2	3.9	66.2
Zn Flotation Tail.	74.91	1.29	2.25	15.5	16.2
Cyclone Overflow	100.00	6.22	10.1	100.0	100.0

Test No. PP-5

1. Grinding

1.1. Purpose: To repeat conditions of Test PP-1, but with the cyclone overflow density reduced from 1300 gpl to 1200 gpl.

1.2. Method: As for Test PP-1, except that cyclone feed was diluted to 1700 gpl. The grinding circuit was operated for a period of 7.5 hours at a feed rate of 690 pounds per hour. Samples were taken every 30 minutes in the last 2 hours of operation,

1.2.1. Classification Equipment

Hendy Mill: P-50 Dorr Cyclone: 1 1/2 inch diameter
5/8 inch vortex
1/2 inch apex

Pb Regrind

Sala Mill: 1 inch Krebs Cyclone - 1 inch diameter
1/4 inch vortex
1/8 inch apex

1.3. Flowsheet: As for Test PP-1.

1.4. Results: The grinding circuit was stable during the test period. Net power consumption in the Hendy Mill was 15.9 kilowatt hours per ton of 1/2 inch feed. The cyclone overflow assayed 93.7 % minus 200 mesh.

Test No. PP-5 - Continued

1.4. Results

1.4.1. Ball Mill Report

Feed:	Minus 1/2 inch ore at 1.6 percent moisture content		
Feed Rate:	690 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	1½ inch balls	600 pounds	
	1 inch balls	400 pounds	
	Total	2000 pounds	
Operating Time:	Total 7.5 hours, test period 2.0 hours		
Mill Feed:	Total 5175 pounds, test period 3450 pounds		
Circulating Load:	Cyclone underflow 563.5 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2106	68.5
	Cyclone Overflow	1200	22.0
	Cyclone Underflow	2546	68.5
Average Power:	Gross	7.48 kilowatts	
	No Load	1.92 kilowatts	
	Net	5.56 kilowatts	
Net Power Consumption:	15.89 kilowatt-hours per ton of 1/2 inch feed		
Work Index:	11.12		

Test No. PP-5 - Continued

1.4. Results

1.4.2. Lead Regrinding Mill Report

Regrinding Mill:	Sala Ball Mill		
Feed:	Lead Rougher Concentrate and Pb 2nd Cleaner Tail		
Feed Rate:	121.6 pounds per hour, 17.49 percent of the mill feed		
Mill Speed:	31 r.p.m., 73 percent of critical speed		
Mill Load:	2 inch balls	480 pounds	
	1 inch balls	720 pounds	
	Total	1200 pounds	
Operating Time:	Total 7.5 hours, test period 2 hours		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2260	70
	Cyclone Feed	1160	17.8
	Cyclone Overflow	1100	11.7
	Cyclone Underflow	2260	70
Average Power:	Gross	6.89 kilowatts	
	No Load	0.92 kilowatts	
	Net	5.97 kilowatts	
Net Power Consumption:	17.03 kilowatt-hours per ton of feed		

Test No. PP-5 - Continued

1.4.3. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	2.5	2.5	97.5
3	10.4	12.9	87.1
4	10.1	23.0	77.0
6	11.2	34.2	65.8
8	8.6	42.8	57.2
10	7.5	50.3	49.7
14	6.5	56.8	43.2
20	4.9	61.7	38.3
28	4.2	65.9	34.1
35	3.6	69.5	30.5
48	4.0	73.5	26.5
65	3.8	77.3	22.7
100	3.1	80.4	19.6
150	3.1	83.5	16.5
200	3.3	86.8	13.2
- 200	13.2	100.0	-
Total	100.0	-	-

Cyclone Underflow

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.4	0.8	99.2
35	0.6	1.4	98.6
48	1.6	3.0	97.0
65	3.0	6.0	94.0
100	5.4	11.4	88.6
150	10.7	22.1	77.9
200	21.4	43.5	56.5
270	18.0	61.5	38.5
400	21.2	82.7	17.3
- 400	17.3	100.0	-
Total	100.0	-	-

Test No. PP-5 - Continued

1.4.3. Screen Analyses

Hendy Mill Discharge

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.3	0.7	99.3
35	0.5	1.2	98.8
48	1.3	2.5	97.5
65	2.7	5.2	94.8
100	4.8	10.0	90.0
150	9.5	19.5	80.5
200	18.7	38.2	61.8
270	15.8	54.0	46.0
400	20.0	74.0	26.0
- 400	26.0	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.1	0.1	99.9
100	0.4	0.5	99.5
150	1.3	1.8	98.2
200	4.5	6.3	93.7
270	6.2	12.5	87.5
400	13.5	26.0	74.0
- 400	74.0	100.0	-
Total	100.0	-	-

Test No. PP-5 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Retained Individual
+ 200 mesh	2.6	2.6	97.4
270	4.5	7.1	92.9
26.7 µm	21.0	28.1	71.9
20.7	11.0	39.1	60.9
14.5	15.2	54.3	45.7
9.9	12.0	66.3	33.7
7.7	7.2	73.5	26.5
- 7.7	26.5	100.0	-
Total	100.0	-	-

Specific Gravity - 4.80

Pb Regrind Cyclone Underflow

+ 200 mesh	2.0	4.0	96.0
270	3.6	5.6	94.4
26.3 µm	22.0	27.6	72.4
20.4	15.1	42.7	57.3
14.2	25.5	68.2	31.8
9.8	18.2	86.4	13.6
7.6	6.3	92.7	7.3
- 7.6	7.3	100.0	-
Total	100.0	-	-

Specific Gravity - 4.88

Test No. PP-5 - Continued

1.4.3. Screen Analyses

Pb Regrind Discharge

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	0.5	0.5	99.5
270	1.4	1.9	98.1
26.3 µm	14.9	16.8	83.2
20.4	13.2	30.0	70.0
14.2	25.6	55.6	44.4
9.8	18.4	74.0	26.0
7.6	7.2	81.2	18.8
- 7.6	18.8	100.0	-
Total	100.0	-	-

Specific Gravity - 4.92

Pb Regrind Cyclone Overflow

+ 27.1 µm	3.0	3.0	97.0
21.0	1.3	4.3	95.7
14.7	3.3	7.6	92.4
10.1	9.5	17.1	82.9
7.8	12.8	29.9	70.1
- 7.8	70.1	100.0	-
Total	100.0	-	-

Specific Gravity = 4.70

Test No. PP-5 - Continued

1.4.3. Screen Analyses

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	20.2	20.2	79.8
270	10.1	30.3	69.7
29.6 µm	7.2	37.5	62.5
22.9	23.6	61.4	38.6
16.0	8.6	69.7	30.3
11.0	6.1	75.8	24.2
8.5	3.8	79.6	20.4
- 8.5	20.4	100.0	-
Total	100.0	-	-

Specific Gravity = 4.11

1.4.4. Specific Gravity

Sample	Specific Gravity
Cyclone Overflow	3.91
Head P.P. Bulk Sample No. 1	3.93

Test No. PP-5 - Continued

2. Flotation

2.1. Purpose:

1) To study the effect of $ZnSO_4$ omission from the lead circuit.
2) To modify collector additions to the Pb 1st cleaner stage.
3) To study the effect of omitting the zinc concentrate regrind stage.

2.2. Method:

The mechanical circuits were similar to Test PP-4; except that zinc regrind stage was omitted and the reagent additions were changed as follows:

Pb Circuit

1) The $ZnSO_4$ was omitted from the lead rougher and 1st cleaner circuit.
2) Collectors R-242 and Z-11 were added to the Pb 1st cleaner conditions instead of to the Pb regrind feed pump.
3) The MIBC was added to the feed to the Pb rougher 3rd flotation cell.

Zn Circuit

1) Zinc rougher regrind stage was omitted from the circuit.
2) The addition of $CuSO_4$ to the Zn 1st cleaner was omitted.
3) pH in the Zn cleaning was lowered to 11.0.

2.2.1. Flotation Equipment

As for Test PP-1.

2.2.2. Flotation Reagents

See following page

Test No. PP-5 - Continued

2.2.2. Reagent Additions

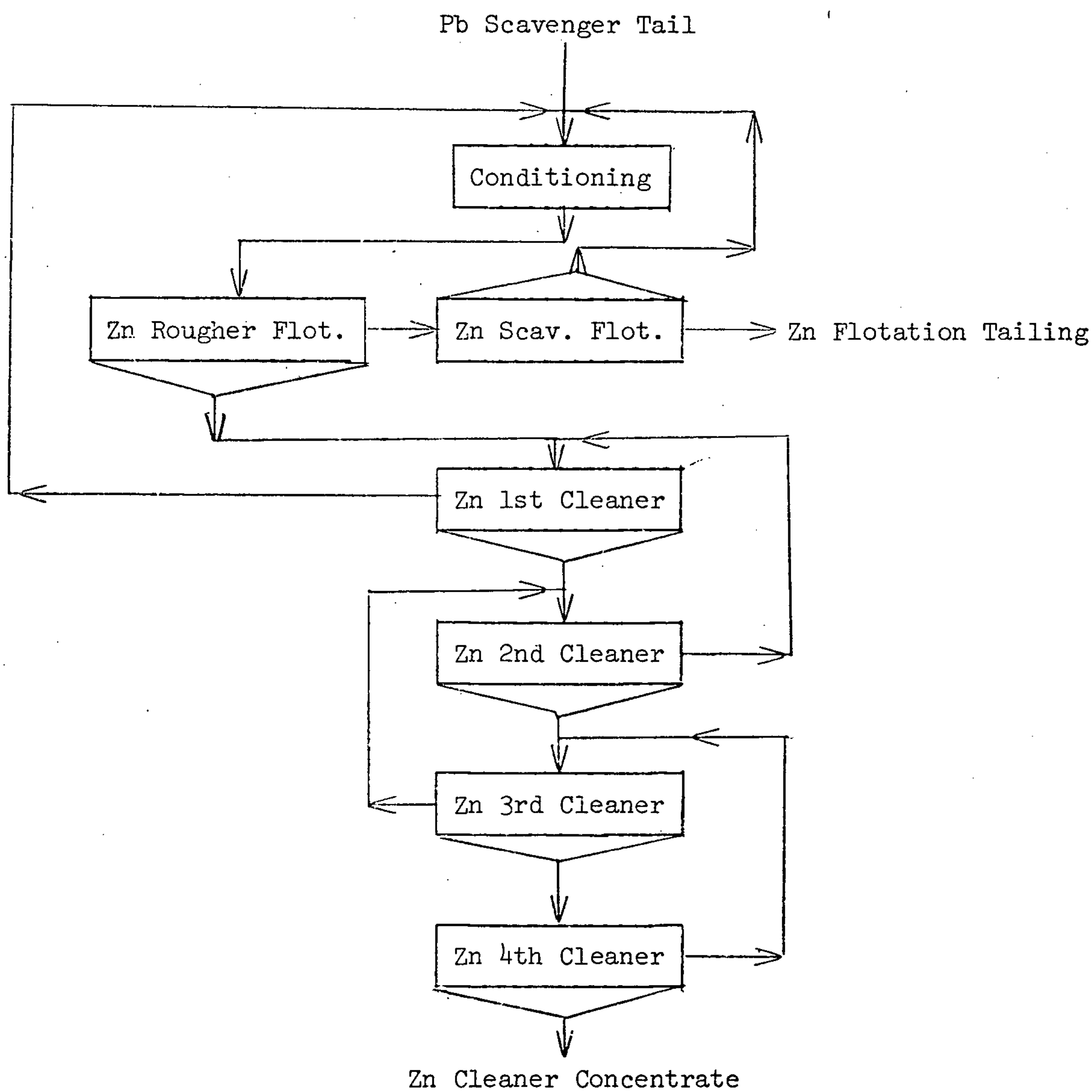
Type	Pounds per Short Ton	Point of Addition
Na_2CO_3	2.85	Ball Mill Feed
NaCN	0.45	Ball Mill Feed
Z-11	0.09	Ball Mill Feed
Z-11	0.03	Pb Conditioner
MIBC	0.075	Pb Rougher Feed Pump
MIBC	0.075	Pb Rougher 3rd Cell
Z-11	0.03	Pb Scavenger Feed
MIBC	0.024	Pb Scavenger Feed
NaCN	0.31	Pb Regrind Mill Feed
Na_2CO_3	0.84	Pb Regrind Mill Feed
$ZnSO_4$	0.54	Pb Regrind Mill Feed
R-242	0.03	Pb Regrind Cyclone
Z-11	0.01	Pb Regrind Cyclone
Z-11	0.01	Pb 1st Cleaner 5th Cell
NaCN	0.10	Pb 2nd Cleaner
MIBC	0.006	Pb 2nd Cleaner
Na_2CO_3	0.12	Pb 3rd Cleaner
NaCN	0.06	Pb 3rd Cleaner
MIBC	0.006	Pb 3rd Cleaner
NaCN	0.06	Pb 4th Cleaner
$Ca(OH)_2$	2.96	Zn Conditioner
$CuSO_4$	2.10	Zn Conditioner
Z-11	0.18	Zn Rougher Feed Pump
Z-200	0.075	Zn Rougher Feed Pump
DF-250	0.063	Zn Rougher Feed Pump
Z-11	0.03	Zn Scavenger Feed
Z-200	0.018	Zn Scavenger Feed
DF-250	0.030	Zn Scavenger Feed
$Ca(OH)_2$	0.66	Zn 1st Cleaner Feed
Z-200	0.030	Zn 1st Cleaner Feed
Z-11	0.03	Zn 1st Cleaner Feed
DF-250	0.030	Zn 1st Cleaner Feed
$Ca(OH)_2$	0.44	Zn 2nd Cleaner Feed
Z-11	0.02	Zn 2nd Cleaner Feed
DF-250	0.021	Zn 2nd Cleaner Feed
$Ca(OH)_2$	0.32	Zn 3rd Cleaner Feed
DF-250	0.004	Zn 3rd Cleaner Feed
$Ca(OH)_2$	0.32	Zn 4th Cleaner Feed

Test No. PP-5 - Continued

2.3. Flowsheet

a) Pb Circuit - As for Test PP-1

b) Zn Circuit -



Test No. PP-5 - Continued

2.4. Results: The lead and zinc metallurgical results were not satisfactory. In the lead circuit frequent plugging of the lead regrind cyclone occurred, and the cleaning of the reground Pb concentrate was slow and unselective. The pulp in the Pb regrind mill reached a temperature of 47°C, which may have affected the lead cleaning. In the zinc circuit the froth conditions were poor and slow zinc flotation was observed.

2.4.1. pH

Product	pH
Cyclone Overflow	9.0
Pb Rougher Feed	8.9
Pb Scavenger Tailing	8.7
Pb Regrinding Mill Discharge	8.7
Pb 1st Cleaner Feed	8.6
Pb 2nd Cleaner Feed	9.2
Pb 3rd Cleaner Feed	9.5
Pb 4th Cleaner Feed	9.2
Zn Rougher Feed	10.4
Zn Scavenger Tailing	10.1
Zn Regrinding Mill Feed	-
Zn 1st Cleaner Feed	11.2
Zn 2nd Cleaner Feed	11.2
Zn 3rd Cleaner Feed	11.4
Zn 4th Cleaner Feed	11.5

2.4.2. Pulp Densities

Product	Pulp Density gpl
Pb Rougher Feed	1113
Pb Scavenger Tailing	1097
Pb 1st Cleaner Feed	1100
Pb Cleaner Foncentrate	-
Zn Rougher Feed	1063
Zn Scavenger Tailing	1077
Zn 1st Cleaner Feed	1153
Zn Cleaner Concentrate	-

2.4.3. Pulp Temperature

Product	°C
Pb Rougher Feed	21
Pb Regrinding Mill Discharge	37
Zn Rougher Feed	22

Test No. PP-5 - Continued

2.4. Results:

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	6.14	10.1
Pb Rougher Concentrate	25.2	15.0
Pb Rougher Tailing	2.10	9.71
Pb Scavenger Concentrate	5.99	14.90
Pb Scavenger Tailing	1.69	9.14
Pb 1st Cleaner Concentrate	38.60	15.20
Pb 1st Cleaner Tailing	11.5	16.4
Pb Regrinding Mill Discharge	21.8	14.4
Pb Regrinding Cyclone Underflow	21.4	14.3
Pb Regrinding Cyclone Overflow	24.2	15.4
Pb Cleaner Concentrate	47.6	14.2
Zn Rougher Concentrate	2.43	23.5
Zn Rougher Tailing	1.91	4.10
Zn Scavenger Concentrate	2.88	13.2
Zn Scavenger Tailing	1.67	2.60
Zn 1st Cleaner Tailing	2.79	8.44
Zn 1st Cleaner Concentrate	2.29	29.50
Zn Cleaner Concentrate	1.59	55.8

Test No. PP-5 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
Pb Rougher Concentrate	17.49	25.2	15.0	71.8	24.7
Pb Rougher Tailing	82.51	2.10	9.71	28.2	75.3
Cyclone Overflow (meas)	100.00	6.14	10.1	100.0	100.0
(calc)	100.00	6.14	10.6	100.0	100.0
Pb Scavenger Conc.	7.86	5.99	14.9	7.8	11.0
Pb Scavenger Tailing	74.65	1.69	9.14	20.5	64.2
Pb Rougher Tail. (meas)	82.51	2.10	9.71	28.2	75.3
(calc)		2.10	9.69	28.3	75.2
Pb 1st Cleaner Conc.	8.84	38.60	15.20	55.6	12.6
Pb 1st Cleaner Tail.	8.65	11.5	16.4	16.2	13.3
Pb Rougher Conc. (meas)	17.49	25.2	15.0	71.8	24.7
(calc)		25.20	15.79	71.8	25.9
Zn Rougher Conc.	19.39	2.43	23.5	7.7	42.8
Zn Rougher Tailing	55.26	1.91	4.10	17.2	21.3
Pb Scav. Tail. (meas)	74.65	1.69	9.14	20.5	64.2
(calc)		2.04	9.14	24.9	64.10
Zn Scavenger Conc.	7.82	2.88	13.2	3.7	9.7
Zn Scavenger Tail.	47.44	1.67	2.60	12.9	11.6
Zn Rougher Tail. (meas)	55.26	1.91	4.10	17.2	21.3
(calc)		1.84	4.10	16.6	21.3
Zn 1st Cleaner Conc.	13.86	2.29	29.5	5.2	38.4
Zn 1st Cleaner Tail.	5.53	2.79	8.44	2.5	4.4
Zn Rougher Conc. (meas)	19.39	2.43	23.5	7.7	42.8
(calc)		2.43	23.5	7.7	42.8

Three-Product Formula

Pb Cleaner Concentrate	9.75	47.6	14.2	75.60	13.71
Zn Cleaner Concentrate	11.97	1.59	55.8	3.10	66.14
Zn Flotation Tail.	78.28	1.67	2.60	21.30	20.15
Cyclone Overflow	100.00	6.14	10.1	100.00	100.00

Test No. PP-6

1. Grinding

1.1. Purpose: To repeat conditions of Test PP-5, but at a higher pulp density in the cyclone overflow (i.e. 1400 gpl).

1.2. Method: As for Test PP-5, except that the cyclone overflow density was increased from 1200 gpl to 1400 gpl. The grinding circuit was operated for a period of 7 hours at a feed rate of 696 pounds per hour. Samples were taken every 20 minutes in the last 2 hours of operation.

1.2.1. Classification Equipment

Hendy Mill - P-50 Dorr Cyclone - 1 1/2 inch diameter
5/8 inch vortex
1/2 inch apex

Pb Regrind

Sala Mill - 1 inch Krebs Cyclone - 1 inch diameter
1/4 inch vortex
1/8 inch apex

1.3. Flowsheet: As for Test PP-1.

1.4. Results: The grinding circuit was very stable during the test run. Net power consumption in the Hendy mill was 15.2 kilowatt-hours per ton of 1/2 inch feed. The cyclone overflow assayed 89.1 % minus 200 mesh.

Test No. PP-6 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus 1/2 inch ore at 1.6 percent moisture content		
Feed Rate:	696 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	1½ inch balls	600 pounds	
	1 inch balls	400 pounds	
	Total	2000 pounds	
Operating Time:	Total 6.5 hours, test period 2 hours		
Mill Feed:	Total 4524 pounds, test period 1392 pounds		
Circulating Load:	Cyclone underflow 597.4 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2086	69.0
	Cyclone Overflow	1416	39.0
	Cyclone Underflow	2446	77.7
Average Power:	Gross	7.24 kilowatts	
	No Load	1.92 kilowatts	
	Net	5.32 kilowatts	
Net Power Consumption:	15.20 kilowatt-hours per ton of 1/2 inch feed		
Work Index:	11.45		

Test No. PP-6 - Continued

1.4.2. Lead Regrinding Mill Report

Regrind Mill:	Sala Ball Mill		
Feed:	Lead Rougher Concentrate and Lead 2nd Cleaner Tail		
Feed Rate:	128.7 pounds per hour. 18.49 percent of the mill feed		
Mill Speed:	31 r.p.m., 73 percent of critical speed		
Mill Load:	2 inch balls	480 pounds	
	1 inch balls	720 pounds	
	Total	1200 pounds	
Operating Time:	Total 6.5 hours, test period 2 hours		
Pulp Densites:		gpl	% Solids
	Mill Discharge	2430	74.0
	Cyclone Feed	1258	26.0
	Cyclone Overflow	1130	14.5
	Cyclone Underflow	2430	74.0
Average Power:	Gross	7.48 kilowatts	
	No Load	0.92 kilowatts	
	Net	6.56 kilowatts	
Net Power Consumption:	18.74 kilowatt-hours per ton of feed		

Test No. PP-6 - Continued

1.4.3. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained		% Passing
	Individual	Cumulative	Cumulative
+ 3/8	2.4	2.4	97.6
3	10.3	12.7	87.3
4	10.3	23.0	77.0
6	9.5	32.5	67.5
8	9.2	41.7	58.3
10	8.3	50.0	50.0
14	7.1	57.1	42.9
20	5.4	62.5	37.5
28	4.4	66.9	33.1
35	3.5	70.4	29.6
48	3.9	74.3	25.7
65	3.7	78.0	22.0
100	3.0	81.0	19.0
150	3.0	84.0	16.0
200	3.1	87.1	12.9
- 200	12.9	100.0	-
Total	100.0	-	-

Cyclone Underflow

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.4	0.8	99.2
35	0.7	1.5	98.5
48	1.8	3.3	96.7
65	3.5	6.8	93.2
100	5.9	12.7	87.3
150	11.0	23.7	76.3
200	19.4	43.1	56.9
270	15.2	58.3	41.7
400	19.0	77.3	22.7
- 400	22.7	100.0	-
Total	100.0	-	-

Test No. PP-6 - Continued

1.4.3. Screen Analyses

Hendy Mill Discharge

Mesh Mesh (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.3	0.7	99.3
35	0.6	1.3	98.7
48	1.4	2.7	97.3
65	2.9	5.6	94.4
100	5.2	10.8	89.2
150	9.7	20.5	79.5
200	17.9	38.4	61.6
270	14.4	52.8	47.2
400	18.3	71.1	28.9
- 400	28.9	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.4	0.4	99.6
100	1.0	1.4	98.6
150	2.6	4.0	96.0
200	6.9	10.9	89.1
270	7.6	18.5	81.5
400	14.8	33.3	66.7
- 400	66.7	100.0	-
Total	100.0	-	-

Test No. PP-6 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	5.6	5.6	94.4
270 mesh	7.0	12.6	87.4
26.7 µm	20.2	32.8	67.2
20.7 µm	8.6	41.4	58.6
14.5 µm	12.7	54.1	45.9
9.9 µm	11.7	65.8	34.2
7.7 µm	7.6	73.4	26.6
- 7.7 µm	26.6	100.0	-
Total	100.0	-	-

Specific Gravity - 4.78

Pb Regrind Cyclone Underflow

+ 200 mesh	3.4	3.4	96.6
270 mesh	5.0	8.4	91.6
26.7 µm	21.9	30.3	69.7
20.7 µm	14.0	44.3	55.7
14.5 µm	27.0	71.3	28.7
9.9 µm	17.0	88.3	11.7
7.7 µm	4.3	92.6	7.4
- 7.7 µm	7.4	100.0	-
Total	100.0	-	-

Specific Gravity - 4.88

Test No. PP-6 - Continued

1.4.3. Screen Analyses

Pb Regrind Discharge

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	0.4	0.4	99.6
270 mesh	1.0	1.4	98.6
26.3 µm	14.2	15.6	84.4
20.4 µm	12.5	28.1	71.9
14.2 µm	26.8	54.9	45.1
9.8 µm	17.0	71.9	28.1
7.6 µm	6.0	77.9	22.1
- 7.6 µm	22.1	100.0	-
Total	100.0	-	-

Specific Gravity - 4.93

Pb Regrind Cyclone Overflow

+ 14.7 µm	5.2	5.2	94.8
10.1 µm	17.3	22.5	77.5
7.8 µm	15.2	37.7	62.3
- 7.8	62.3	100.0	-
Total	100.0	-	-

Specific Gravity - 4.64

Test No. PP-6 - Continued

1.4.3. Screen Analyses

Zn Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	21.6	21.6	78.4
270 mesh	16.0	37.6	62.4
30.0 µm	8.4	46.0	54.0
23.2 µm	28.0	74.0	26.0
16.2 µm	5.5	79.5	20.5
11.1 µm	3.4	82.9	17.1
8.6 µm	2.4	85.3	14.7
- 8.6 µm	14.7	100.0	-
Total	100.0	-	-

Specific Gravity - 4.07

1.4.4. Specific Gravity

Sample	Specific Gravity
Cyclone Overflow	3.89

Test No. PP-6 - Continued

2. Flotation

2.1. Purpose: Attempt to improve lead and zinc metallurgical results.

2.2. Method: The following changes in the circuit were carried out.

Pb Circuit

1. The lead regrind mill was converted from an overflow mill to grate discharge mill.
2. The regrind cyclone overflow was conditioned in a high-speed conditioner.
3. The lead 2nd cleaner time was decreased by 1/3, and 3rd cleaner time by 1/4 of the total cleaning time.
4. The R-242 additions to the Pb 1st cleaner was decreased from 0.04 to 0.02 lb/ton, and Z-11 was omitted.

Zn Circuit

1. Collector Z-11 was replaced with collector Z-6.

2.2.1. Flotation Equipment:

As for Test PP-1, except that 2 Denver No. 5 cells were removed from the Pb 2nd cleaner stage and 1 Denver No. 5 cell was removed from the Pb 3rd cleaner.

2.2.2. Flotation Reagents

See following page

Test No. PP-6 - Continued

2.2.2. Reagent Additions

Type	Pounds Per Short Ton	Point of Addition
Na_2CO_3	2.92	Ball Mill Feed
NaCN	0.45	Ball Mill Feed
Na_2SO_3	0.98	Ball Mill Feed
Z-11	0.08	Ball Mill Feed
Z-11	0.03	Pb Conditioner
MIBC	0.073	Pb Rougher Feed Pump
MIBC	0.075	Pb Rougher 3rd Cell
Z-11	0.03	Pb Scavenger Feed
MIBC	0.023	Pb Scavenger Feed
NaCN	0.31	Pb Regrind Mill Feed
Na_2CO_3	0.46	Pb Regrind Mill Feed
$ZnSO_4$	0.58	Pb Regrind Mill Feed
MIBC	0.021	Pb 1st Cleaner Feed Pump
R-242	0.02	Pb 1st Cleaner Feed Pump
Z-11	0.01	Pb 1st Cleaner 5th Cell
NaCN	0.10	Pb 2nd Cleaner Feed
NaCN	0.05	Pb 3rd Cleaner Feed
MIBC	0.006	Pb 3rd Cleaner Feed
NaCN	0.05	Pb 4th Cleaner Feed
$Ca(OH)_2$	2.60	Zn Conditioner
$CuSO_4$	2.10	Zn Conditioner
Z-6	0.175	Zn Rougher Feed Pump
Z-200	0.075	Zn Rougher Feed Pump
DF-250	0.063	Zn Rougher Feed Pump
Z-11	0.030	Zn Scavenger Feed
Z-200	0.018	Zn Scavenger Feed
DF-250	0.030	Zn Scavenger Feed
$Ca(OH)_2$	0.58	Zn 1st Cleaner Pump
Z-200	0.030	Zn 1st Cleaner Pump
Z-6	0.030	Zn 1st Cleaner Feed
DF-250	0.030	Zn 1st Cleaner Feed
$Ca(OH)_2$	0.22	Zn 2nd Cleaner Feed
Z-6	0.015	Zn 2nd Cleaner Feed
$Ca(OH)_2$	0.36	Zn 3rd Cleaner Feed
DF-250	0.006	Zn 3rd Cleaner Feed
$Ca(OH)_2$	0.12	Zn 4th Cleaner Feed

Test No. PP-6 - Continued

2.4. Results: Lead and zinc flotation results improved with the above changes. The lead concentrate assayed 59.0 % Pb at 81.8 % recovery of the total lead. The additions of Z-6 to the zinc rougher feed improved zinc concentrate grade.

2.4.1. pH

Product	pH
Cyclone Overflow	9.1
Pb Rougher Feed	8.9
Pb Scavenger Tailing	8.6
Pb Regrinding Mill Discharge	9.0
Pb 1st Cleaner Feed	9.2
Pb 2nd Cleaner Feed	9.3
Pb 3rd Cleaner Feed	9.3
Pb 4th Cleaner Feed	9.3
Zn Rougher Feed	10.1
Zn Scavenger Tailing	9.7
Zn Regrinding Mill Feed	–
Zn 1st Cleaner Feed	11.0
Zn 2nd Cleaner Feed	10.8
Zn 3rd Cleaner Feed	11.1
Zn 4th Cleaner Feed	11.2

2.4.2. Pulp Densities

Product	Pulp Density gpl
Pb Rougher Feed	1232
Pb Scavenger Tailing	1225
Pb 1st Cleaner Feed	1130
Pb Cleaner Concentrate	-
Zn Rougher Feed	1177
Zn Scavenger Tailing	1130
Zn 1st Cleaner Feed	1202

2.4.3. Temperature

Product	°C
Pb Rougher Feed	26
Pb Regrinding Mill Discharge	29
Zn Rougher Feed	25

Test No. PP-6 - Continued

2.4. Results

2.4.4. Chemical Analyses

Product	Assays, %		
	Pb	Zn	As
Cyclone Overflow	6.29	9.94	0.30
Pb Rougher Concentrate	24.8	15.8	-
Pb Rougher Tailing	2.09	10.3	-
Pb Scavenger Concentrate	5.53	15.5	-
Pb Scavenger Tailing	1.36	9.22	-
Pb 1st Cleaner Concentrate	33.5	17.3	-
Pb 1st Cleaner Tailing	6.35	18.5	-
Pb Regrinding Cyclone Underflow	21.3	14.2	-
Pb Regrinding Cyclone Overflow	22.0	18.0	-
Pb Cleaner Concentrate	59.0	10.5	0.25
Zn Rougher Concentrate	2.44	25.3	-
Zn Rougher Tailing	1.49	3.70	-
Zn Scavenger Concentrate	2.65	10.30	-
Zn Scavenger Tailing	1.14	1.59	0.32
Zn 1st Cleaner Tailing	2.76	17.1	-
Zn 1st Cleaner Concentrate	2.27	34.4	-
Zn Cleaner Concentrate	1.88	54.3	0.097

Test No. PP-6 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
Pb Rougher Concentrate	18.49	24.8	15.8	72.9	25.8
Pb Rougher Tailing	81.51	2.09	10.3	27.1	74.2
Cyclone Overflow (meas)	100.00	6.29	9.94	100.0	100.0
(calc)		6.29	11.32	100.0	100.0
Pb Scavenger Concentrate	14.26	5.53	15.5	12.5	19.5
Pb Scavenger Tailing	67.25	1.36	9.22	14.6	54.7
Pb Rougher Tailing (meas)	81.51	2.09	10.3	27.1	74.2
(calc)		2.09	10.3	27.1	74.2
Pb 1st Cleaner Concentrate	12.57	33.5	17.3	67.0	19.2
Pb 1st Cleaner Tailing	5.92	6.35	18.5	6.0	9.5
Pb Rougher Conc. (meas)	18.49	24.8	15.8	72.9	25.8
(calc)		24.8	17.57	73.0	28.7
Zn Rougher Concentrate	17.19	2.44	25.3	6.7	38.4
Zn Rougher Tailing	50.04	1.49	3.70	11.9	16.3
Pb Scavenger Tailing (meas)	67.25	1.36	9.22	14.6	54.7
(calc)		1.73	9.22	18.6	54.7
Zn Scavenger Concentrate	12.12	2.65	10.3	5.1	11.0
Zn Scavenger Tailing	37.94	1.14	1.59	6.9	5.3
Zn Rougher Tailing (meas)	50.06	1.49	3.70	11.9	16.3
(calc)		1.50	3.70	12.0	16.3

Test No. PP-6 - Continued

2.4.5. Metallurgical Results

Product	Weight %	Assays, %				% Distribution			
		Pb	Zn	Hg	As	Pb	Zn	Hg	As
Pb 4th Cleaner Conc.	8.72	59.0	10.5	0.0085	0.25	81.77	9.21	10.3	7.7
Zn 4th Cleaner Conc.	14.37	1.88	54.3	0.039	0.097	4.29	78.49	77.9	4.9
Zn Scavenger Tailing	76.91	1.14	1.59	0.0011	0.32	13.94	12.30	11.8	87.4
Cyclone Overflow	100.00	6.29	9.94	0.0072	0.28	100.00	100.00	100.0	100.0

Product	Weight %	Assays, % Ag*	% Distribution Ag
Pb Concentrate	8.72	23.95	75.9
Zn Concentrate	14.37	2.00	10.4
Zn Flotation Tail.	76.91	0.49	13.7
Cyclone Overflow	100.00	2.75	100.0

* Ounces per ton

Test No. PP7

1. Grinding

1.1. Purpose: To repeat conditions of test PP6.

1.2. Method: As for test PP6. The grinding circuit was operated for a period of 7.75 hours at a feed rate of 691 pounds per hour. Samples were taken every 30 minutes in the last 3 hours of operation.

1.2.1. Classification Equipment

Hendy Mill; P-50 Dorr Cyclone:

1 1/2 inch diameter
5/8 inch vortex
1/2 inch apex

Pb Regrind

Sala Mill; Krebs Cyclone:

1 inch diameter
1/4 inch vortex
1/8 inch apex

1.3. Flowsheet: As for test PP1

1.4. Results: The grinding circuit was stable throughout the test run. Net power consumption in the Hendy mill was 15.2 kilowatt-hours per ton of ½ inch feed. The cyclone overflow assayed 89.5 % minus 200 mesh.

Test No. PP7 - Continued

1.4. Results:

1.4.1. Ball Mill Report

Feed:	Minus ½ inch ore at 1.6 percent moisture content		
Feed Rate:	691 dry pounds per hour		
Mill Speed:	32 r.p.m., 80.5 percent of critical speed		
Mill Load:	3 inch balls	1000 pounds	
	1½ inch balls	600 pounds	
	1 inch balls	400 pounds	
	Total	2000 pounds	
Operating Time:	Total 7.75 hours, test period 3.0 hours		
Mill Feed:	Total 5355 pounds, test period 2073 pounds		
Circulating Load:	Cyclone underflow 567.5 percent		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2088	68
	Cyclone Overflow	1380	36
	Cyclone Underflow	2416	76
Average Power:	Gross	7.24 kilowatts	
	No Load	1.92 kilowatts	
	Net	5.32 kilowatts	
Net Power Consumption:	15.21 kilowatt-hours per ton of ½ inch feed		
Work Index:	11.43		

Test No. PP7 - Continued

1.4. Results:

1.4.2. Lead Regrinding Mill Report

Regrinding Mill:	Sala ball mill		
Feed:	Lead Rougher Concentrate and Pb 2nd Cl. Tail.		
Feed Rate:	145.6 pounds per hours, 21.01 percent of the mill feed		
Mill Speed:	31 r.p.m., 73 percent of critical speed		
Mill Load:	2 inch balls	480 pounds	
	1 inch balls	720 pounds	
	Total	1200 pounds	
Operating Time:	Total 7.75 hours, test period 3 hours		
Pulp Densities:		gpl	% Solids
	Mill Discharge	2466	74
	Cyclone Feed	1225	23.0
	Cyclone Overflow	1093	10.5
	Cyclone Underflow	2466	74
Average Power:	Gross	7.72 kilowatts	
	No Load	0.92 kilowatts	
	Net	6.80 kilowatts	
Net Power Consumption:	19.43 kilowatt-hours per ton of feed		

Test No. PP7 - Continued

1.4.3. Screen Analyses

Hendy Mill Feed

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 3/8	2.9	2.9	97.1
3	13.5	16.4	83.6
4	11.7	28.1	71.9
6	9.4	37.5	62.5
8	9.1	46.6	53.4
10	7.9	54.5	45.5
14	6.5	61.0	39.0
20	4.5	65.5	34.5
28	4.2	69.7	30.3
35	3.5	73.2	26.8
48	3.9	77.1	22.9
65	3.8	80.9	19.1
100	3.0	83.9	16.1
150	3.0	86.9	13.1
200	3.2	90.1	9.9
- 200	9.9	100.0	-
Total	100.0	-	-

Hendy Mill Discharge

+ 10	0.1	0.1	99.9
14	0.1	0.2	99.8
20	0.2	0.4	99.6
28	0.3	0.7	99.3
35	0.6	1.3	98.7
48	1.5	2.8	97.2
65	2.9	5.7	94.3
100	5.0	10.7	89.3
150	9.4	20.1	79.9
200	17.4	37.5	62.5
270	14.2	51.7	48.3
400	18.9	70.6	29.4
- 400	29.4	100.0	-
Total	100.0	-	-

Test No. PP7 - Continued

1.4.3. Screen Analyses

Cyclone Underflow

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 10	0.1	0.1	99.9
14	0.2	0.3	99.7
20	0.3	0.6	99.4
28	0.5	1.1	98.9
35	0.8	1.9	98.1
48	1.8	3.7	96.3
65	3.5	7.2	92.8
100	5.8	13.0	87.0
150	10.7	23.7	76.3
200	19.3	43.0	57.0
270	15.2	58.2	41.8
400	19.0	77.2	22.8
- 400	22.8	100.0	-
Total	100.0	-	-

Cyclone Overflow

+ 65	0.4	0.4	99.6
100	0.9	1.3	98.7
150	2.5	3.8	96.2
200	6.7	10.5	89.5
270	7.7	18.2	81.8
400	14.9	33.1	66.9
- 400	66.9	100.0	-
Total	100.0	-	-

Test No. PP7 - Continued

1.4.3. Screen Analyses

Pb Rougher Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	6.6	6.6	93.4
270	7.5	14.1	85.9
26.3 µm	21.6	35.7	64.3
20.4	8.8	44.5	55.5
14.2	13.3	57.8	42.2
9.8	11.8	69.6	30.4
7.6	7.0	76.6	23.4
- 7.6	23.4	100.0	-
Total	100.0	-	-

Specific Gravity 4.88

Pb Reground Cyclone Underflow

+ 200 mesh	3.8	3.8	96.2
270	5.4	9.2	90.8
26.3µm	23.2	32.4	67.6
20.4	15.5	47.9	52.1
14.2	27.0	74.9	25.1
9.8	13.8	88.7	11.3
7.6	3.7	92.4	7.6
- 7.6	7.6	100.0	-
Total	100.0	-	-

Specific Gravity 4.94

Test No. PP7 - Continued

1.4.3. Screen Analyses

Pb Regrind Discharge

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 200 mesh	0.4	0.4	99.6
270	1.2	1.6	98.4
26.3 µm	14.9	16.5	83.5
20.4	13.0	29.5	70.5
14.2	26.0	55.5	44.5
9.8	15.5	71.0	29.0
7.6	4.7	75.7	24.3
- 7.6	24.3	100.0	-
Total	100.0	-	-

Specific Gravity 4.90

Pb Regrind Cyclone Overflow

+ 27.5 µm	1.0	1.0	99.0
21.3	2.2	3.2	96.8
14.9	12.1	15.3	84.7
10.2	20.6	35.9	64.1
7.9	13.3	49.2	50.8
- 7.9	50.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.60

Test No. PP7 - Continued

1.4.3. Screen Analyses

Pb 4th Cleaner Concentrate

Particle Size	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 24.7 µm	1.6	1.6	98.4
19.1	1.6	3.2	96.8
13.4	9.0	12.2	87.8
9.2	21.1	33.3	66.7
7.1	15.5	48.8	51.2
- 7.1	51.2	100.0	-
Total	100.0	-	-

Specific Gravity 5.40

Zn Scavenger Tailing

+ 200 mesh	10.5	10.5	89.5
270	8.5	19.0	81.0
31.6 µm	13.8	32.8	67.2
24.1	9.6	42.4	57.6
17.1	12.8	55.2	44.8
11.8	10.3	65.5	34.5
9.1	6.0	71.5	28.5
- 9.1	28.5	100.0	-
Total	100.0	-	-

Specific Gravity 3.69

Specific Gravity

Sample	Specific Gravity
Cyclone Overflow	3.99

Test No. PP7 - Continued

2. Flotation

2.1. Purpose:

To investigate the effects of the following circuit changes:

Pb Circuit

1) Reagent Z-11 was replaced with Z-6 in the Pb rougher and scavenger circuits.
2) Reagents R-242 and Z-11 were replaced with Z-6 in the Pb 1st cleaning.
3) High speed conditioner in the lead 1st cleaner was omitted from the circuit.
4) Aeration of the pulp before lead flotation was carried out.

Zinc Circuit

The collector Z-200 was replaced with collector Minerec M748 in the zinc rougher circuit.

2.2.1. Flotation Equipment

As for test PP6, except thtat 2 forty gallon aerators were installed in the lead circuit, and the high speed conditioner was removed from the lead 1st cleaner.

2.2.2. Flotation Reagents

See following page.

2.4. Results:

Frequent plugging of Pb regrinding cyclone disturbed the lead cleaning circuits, consequently the lead metallurgical results were poor. An unselective froth in the Pb 1st cleaner was observed when collector 242 was replaced with collector Z-6.

Test No. PP7 - Continued

2.2.2. Reagent Additions

Type	Pounds Per Short Ton	Point of Addition
Na_2CO_3	3.08	Ball Mill Feed
NaCN	0.44	Ball Mill Feed
Na_2SO_3	0.95	Ball Mill Feed
Z-6	0.09	Ball Mill Feed
Z-6	0.03	Pb Conditioner
MIBC	0.075	Pb Ro. Feed Pump
MIBC	0.075	Pb Ro. 3rd Cell
Z-6	0.03	Pb Scavenger Feed
MIBC	0.021	Pb Scavenger Feed
NaCN	0.31	Pb Regrind Mill Feed
Na_2CO_3	0.68	Pb Regrind Mill Feed
$ZnSO_4$	0.54	Pb REgrind Mill Feed
Z-6	0.02	Pb Cyclone Feed Pump
MIBC	0.043	Pb 1st Cl. Feed Pump
Z-6	0.02	Pb 1st Cl. 4th Cell
NaCN	0.03	Pb 2nd Cl. Feed
MIBC	0.005	Pb 3rd Cl. Feed
NaCN	0.05	Pb 3rd Cl. Feed
NaCN	0.05	Pb 4th Cl. Feed
$Ca(OH)_2$	2.80	Zn Conditioner
$CuSO_4$	2.10	Zn Conditioner
M748	0.074	Zn Conditioner
Z-6	0.180	Zn Ro. Feed Pump
DF-250	0.063	Zn Ro. Feed Pump
Z-6	0.04	Zn Scavenger Feed
Z-200	0.019	Zn Scavenger Feed
DF-250	0.030	Zn Scavenger Feed
$Ca(OH)_2$	0.55	Zn 1st Cleaner Pump
Z-200	0.030	Zn 1st Cleaner Pump
Z-6	0.03	Zn 1st Cleaner Feed
DF-250	0.033	Zn 1st Cleaner Feed
$Ca(OH)_2$	0.36	Zn 2nd Cleaner Feed
Z-6	0.018	Zn 2nd Cleaner Feed
$Ca(OH)_2$	0.24	Zn 3rd Cleaner Feed
DF-250	0.004	Zn 3rd Cleaner Feed
$Ca(OH)_2$	0.12	Zn 4th Cleaner Feed

Test No. PP7 - Continued

2.4. Results:

2.4.1. pH

Product	pH
Cyclone Overflow	9.0
Pb Rougher Feed	8.9
Pb Scavenger Tailing	8.7
Pb Regrinding Mill Discharge	9.5
Pb 1st Cleaner Feed	9.2
Pb 2nd Cleaner Feed	9.2
Pb 3rd Cleaner Feed	9.2
Pb 4th Cleaner Feed	9.2
Zn Rougher Feed	10.5
Zn Scavenger Tailing	10.7
Zn 1st Cleaner Feed	11.1
Zn 2nd Cleaner Feed	11.1
Zn 3rd Cleaner Feed	11.1
Zn 4th Cleaner Feed	11.1

2.4.2. Pulp Densities

Product	Pulp Density gpl
Pb Rougher Feed	1225
Pb Scavenger Tailing	1192
Pb 1st Cleaner Feed	1093
Zn Rougher Feed	1182
Zn Scavenger Tailing	1110
Zn 1st Cleaner Feed	1223

2.4.3. Pulp Temperature

Product	°C
Pb Rougher Feed	25
Pb Regrinding Mill Discharge	28
Zn Rougher Feed	25

Test No. PP7 - Continued

2.4.4. Chemical Analyses

Product	Assays, %	
	Pb	Zn
Cyclone Overflow	6.19	9.87
Pb Rougher Feed	5.83	11.3
Pb Rougher Concentrate	23.3	15.5
Pb Rougher Tailing	1.64	9.88
Pb Scavenger Concentrate	4.16	14.4
Pb Scavenger Tailing	1.25	9.44
Pb 1st Cleaner Concnetrate	31.2	18.0
Pb 1st Cleaner Tailing	4.06	16.4
Pb Regrind Discharge	18.8	13.5
Pb Regrind Cyclone Underflow	18.5	14.4
Pb Regrind Cyclone Overflow	19.6	17.2
Pb Cleaner Concentrate	46.6	15.4
Zn Rougher Feed	1.79	12.6
Zn Rougher Concentrate	2.29	24.7
Zn Rougher Tailing	1.41	4.10
Zn Scavenger Concentrate	2.28	9.90
Zn Scavenger Tailing	1.07	1.37
Zn 1st Cleaner Tailing	2.41	19.4
Zn 1st Cleaner Concentrate	2.22	31.7
Zn Cleaner Concentrate	1.76	52.6

Test No. PP7 - Continued

2.4.5. Metallurgical Results

Two-Product Formula

Product	Weight %	Assays, % Pb	Assays, % Zn	% Distribution Pb	% Distribution Zn
Pb Ro. Concentrate	21.01	23.3	15.5	79.08	29.44
Pb Ro. Tailing	78.99	1.64	9.88	20.92	70.56
Cyclone Overflow (meas)	100.00	6.19	9.87	100.0	100.0
(Calc.)	-	6.19	11.06	100.0	100.0
Pb Scav. Concentrate	10.58	4.16	14.4	7.11	13.77
Pb Scav. Tailing	68.41	1.25	9.44	13.81	58.39
Pb Ro. Tailing (meas)	78.99	1.64	9.88	20.92	70.56
(Calc.)	-	1.64	10.10	20.92	72.16
Zn Ro. Concentrate	17.73	2.29	24.7	6.56	39.59
Zn Ro. Tailing	50.68	1.41	4.10	11.54	18.79
Pb Scav. Tailing (meas)	68.41	1.25	9.44	13.81	58.39
(Calc.)	-	1.64	9.44	18.10	58.38
Zn Scav. Concentrate	16.22	2.28	9.90	6.0	14.6
Zn Scav. Tailing	34.46	1.07	1.37	5.9	4.2
Zn Ro. Tailing (meas)	50.68	1.41	4.10	11.5	18.8
(Calc.)	-	1.46	4.10	11.9	18.8
Zn 1st Cl. Concentrate	7.65	2.21	31.7	2.7	21.9
Zn 1st Cl. Tailing	10.08	2.41	19.4	3.9	18.0
Zn Ro. Concentrate (meas)	17.73	2.29	24.7	6.6	39.6
(Calc.)	-	2.32	24.7	6.6	39.9
Pb 1st Cl. Concentrate	14.89	31.2	18.0	75.0	24.2
Pb 1st Cl. Tailing	6.12	4.06	16.4	4.0	9.0
Pb Ro. Concentrate (meas)	21.01	23.3	15.5	79.0	29.4
(Calc.)	-	23.30	17.53	79.0	33.2

Three-Product Formula

Pb Cleaner Concentrate	11.04	46.6	15.4	83.11	17.22
Zn Cleaner Concentrate	13.57	1.76	52.6	3.85	72.31
Zn Scav. Tailings	75.39	1.07	1.37	13.04	10.46
Cyclone Overflow	100.0	6.19	9.87	100.0	100.0

Figure No. 2 - Material Mass Balance (Test P.P. 41, 43 and 48)