

An Investigation of
THE RECOVERY OF LEAD AND ZINC

from a Grum Deposit sample

submitted by

KERR ADDISON MINES LIMITED

Progress Report No. 1

014930

Project No. L.R. 1869

NOTE:

This report refers to the samples as received.

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LAKEFIELD RESEARCH OF CANADA LIMITED
Lakefield, Ontario
October 8, 1975

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

In a letter dated July 7, 1975, Mr. M.D. Rowswell of Kerr Addison Mines Limited requested that a program of testwork should be undertaken to investigate the recovery of lead and zinc from a Grum Deposit sample.

Results of the testwork as they became available were discussed in meetings and telephone conversations with Mr. E. Kirkpatrick of Kerr Addison Mines Limited.

LAKEFIELD RESEARCH OF CANADA LIMITED



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S U M M A R Y

1. Head Sample Assays

Composite B

Lead (Pb)	4.75 %, 4.71 %*
Zinc (Zn)	7.36 %, 7.40 %*
Oxide Lead (Pbox)	0.97 %
Oxide Zinc (Znox)	0.26 %
Copper (Cu)	0.137 %
Iron (Fe)	20.0 %
Sulphur (S)	26.0 %
Magnesia (MgO)	1.20 %
Gold (Au)	0.035 oz/ton
Silver (Ag)	2.21 oz/ton

* Average head sample assay as calculated from test results.

2. Lead Flotation

The basic flowsheet investigated for the recovery of a high grade lead concentrate involved:

- a) Grinding the ore with Na_2CO_3 as pH modifier, ZnSO_4 and NaCN as pyrite and sphalerite depressants, and R-242 as the collector for galena.
- b) Flotation of a lead rougher concentrate at pH 9-9.5, with further additions of R-242 and R-404 as collectors.
- c) Regrinding the lead rougher concentrate with Na_2CO_3 , ZnSO_4 , NaCN and R-242.
- d) three to four cleaning stages with further additions of NaCN, ZnSO_4 and R-242.

The primary grind was conducted in both rod and ball mills, and the regrind in rod, ball and pebble mills. Fineness of primary grind and regrind were varied.

Summary - Continued

2.1. Rod Mill Primary Grind

2.1.1. Rougher Flotation

The power input to the primary grind was varied from 3.5 kwh/ton to 13.9 kwh/ton. Other factors investigated were:

- a) Collector type and amount
- b) NaCN addition
- c) Aeration prior to flotation
- d) pH

The results and conditions of this testwork are summarized in Table 1.

Table 1

Rod Mill Primary Grind

Test No.	Grind KWH/ton	NaCN lb/ton	pH	R-404 lb/ton	R-242 lb/ton	Flotation Time min.	Rougher Concentrate			
							Weight %	Assay % Pb	% Distribution Pb Zn	
4	3.5	0.20	8.9	-	0.10	9	32.40	13.8	92.3	43.2
5	4.6	0.20	8.8	-	0.15	9	30.95	14.2	92.9	41.2
6	7.0	0.20	8.6	0.04	0.16	9	34.39	13.5	94.9	42.7
10*	7.0	0.25	9.8	0.03	0.07	7	23.60	17.7	88.9	36.2
20	7.0	0.30	9.3	0.04	0.12	9	32.21	13.6	94.0	36.7
18	9.2	0.30	9.4	0.04	0.14	9	30.10	14.5	94.2	35.9
19	13.9	0.30	9.4	0.04	0.16	9	30.06	15.0	95.3	37.7

* Aeration prior to flotation

Screen analyses were conducted on primary grinds used in Tests 18 and 19, with results as follows:

Test 18 - Grinding time - 40 minutes, Power Consumption - 9.2 kwh/ton,
93.8 % minus 200 mesh

Test 19 - Grinding time - 60 minutes, Power Consumption - 13.9 kwh/ton,
97.4 % minus 200 mesh

Summary - Continued

2.1. Rod Mill Primary Grind

2.1.1. Rougher Flotation

Higher lead recoveries and lower zinc recoveries to the Pb rougher concentrate resulted from increased fineness of primary grind, higher NaCN and Na₂CO₃ additions, and the use of R-404 in conjunction with R-242 as collector. Aeration appeared to have little beneficial effect on pyrite or sphalerite depression.

2.1.2. Cleaner Flotation

The rougher concentrates were reground in the rod mill with further additions of ZnSO₄, NaCN and Na₂CO₃, and cleaned three or four times at pH 9.5-10.0. Variables investigated in the cleaner flotation included:

- a) fineness of regrind
- b) level of NaCN additions
- c) Ca(OH)₂ in place of Na₂CO₃ as pH modifier.

The results and conditions of this testwork are summarized in Table 2.

Table 2 - Cleaner Flotation

Test No.	Primary Grind Kwh/ton	Regrind kwh/ton	NaCN lb/ton (Cl. flot)	pH	No. of Cl. Stages	Pb Cleaner Concentrate				
						Weight %	Assays %		% Dist.	
							Pb	Zn	Pb	Zn
4	3.5	2.3	0.17	9.2-9.7	3	9.02	42.3	10.5	78.7	12.2
5	4.6	3.5	0.18	9.6-9.9	4	8.28	46.6	9.74	81.6	10.9
6	7.0	4.6	0.18	9.5-9.9	4	8.72	47.5	9.35	85.0	11.0
9	7.0	3.0**	0.22	9.9-11.1*	5	8.31	43.4	9.06	76.9	10.1
10	7.0	3.0**	0.18	10.8-11.0*	4	3.62	48.2	9.66	37.1	4.7
17	13.9	7.0	0.40	9.7-9.8	4	6.37	59.3	7.46	81.8	6.5
18	9.2	7.0	0.40	9.6-9.8	4	6.11	63.2	7.29	83.0	6.1
19	13.9	4.6	0.40	9.6-9.8	4	7.37	55.9	8.64	87.0	8.7
20	7.0	9.2	0.40	9.6-9.7	4	6.47	62.0	7.38	86.3	6.6
21	9.2	7.0	0.70	9.6-9.8	5	5.28	68.8	6.44	79.1	4.7

* pH controlled with Ca(OH)₂

** Pebble Mill Regrind

Summary - Continued

2.1. Rod Mill Primary Grind

2.1.2. Cleaner Flotation

The Pb grade-recovery curves for these tests are shown in Figure 1.

The results in Tests 4, 5 and 6 indicated that a finer regrind was necessary to obtain higher-grade Pb concentrates. Increasing the fineness of primary grind or regrind in Test 17 onwards resulted in higher grades and recoveries of lead to the cleaner concentrate. Increasing the cyanide additions in the cleaner flotation could also have been partly responsible for these improvements, particularly in Test 21. In this test with a similar grind to that of Test 18 and with the higher cyanide additions, the grade of the cleaner concentrate was increased from 63.2 to 68.8 % Pb.

The results of Tests 9 and 10 were poor, and this could have been due to an insufficient regrind in the pebble mill or to depression of galena at the high lime pH.

2.2. Ball Mill Primary Grind

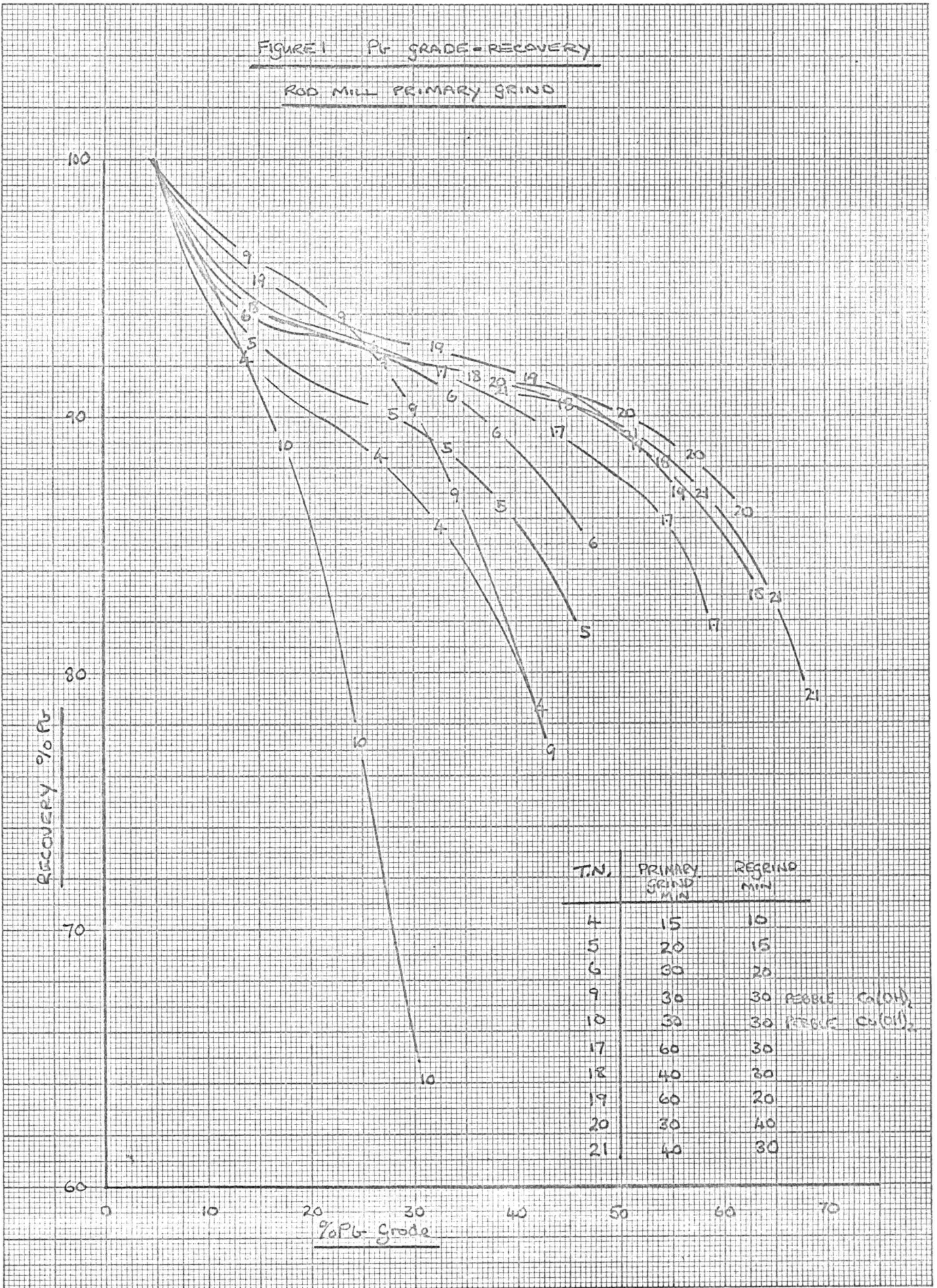
Flotation testwork was conducted to investigate the effect of:

- a) fineness of grind
- b) Collector type and amount
- c) Na_2S and Na_2SO_3 as depression
- d) lime in place of Na_2CO_3 for pH control

on the grade and recovery of lead and zinc in the rougher flotation. The rougher concentrate was reground in a ball or pebble mill prior to cleaning.

The results and conditions of these tests are summarized in Table 3.

FIGURE 1 Pb GRADE-RECOVERY
ROD MILL PRIMARY GRIND



PHIC ROLS DA L
MADE IN CANADA

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Summary - Continued

2.2. Ball Mill Primary Grind

Table 2 - Ball Mill Primary Grind

Test No.	Primary Grind kwh/ton	Regrind kwh/ton	Depressants	Collector	Pb Cleaner Concentrate				
					Weight %	Assays, %		% Dist.	
						Pb	Zn	Pb	Zn
1	9.3	-	Ca(OH) ₂ , ZnSO ₄ , NaCN	R-242	10.95	31.1	11.1	71.7	16.1
11	12.4	2.0	Na ₂ CO ₃ , ZnSO ₄ , NaCN	R-242, R-404	7.85	48.4	8.94	80.4	9.4
12	12.4	2.0	Na ₂ CO ₃ , ZnSO ₄ , Na ₂ S	Mixed	5.44	46.8	8.56	56.1	6.3
13	12.4	2.0	Ca(OH) ₂ , ZnSO ₄ , Na ₂ S	Mixed	4.40	45.9	9.42	43.3	5.6
14	18.7	1.0	Na ₂ CO ₃ , ZnSO ₄ , Na ₂ S	Mixed	6.14	42.0	8.98	56.2	7.5
15	18.7	0.75	Na ₂ S, Na ₂ SO ₃ , NaCN, Ca(OH) ₂	AX-325	4.44	50.7	7.02	47.7	4.2
16	12.4	6.2*	Na ₂ CO ₃ , ZnSO ₄ , NaCN	R-242, R-404	5.42	60.3	7.33	70.6	5.5

* Ball Mill Regrind, remainder Pebble Mill Regrind

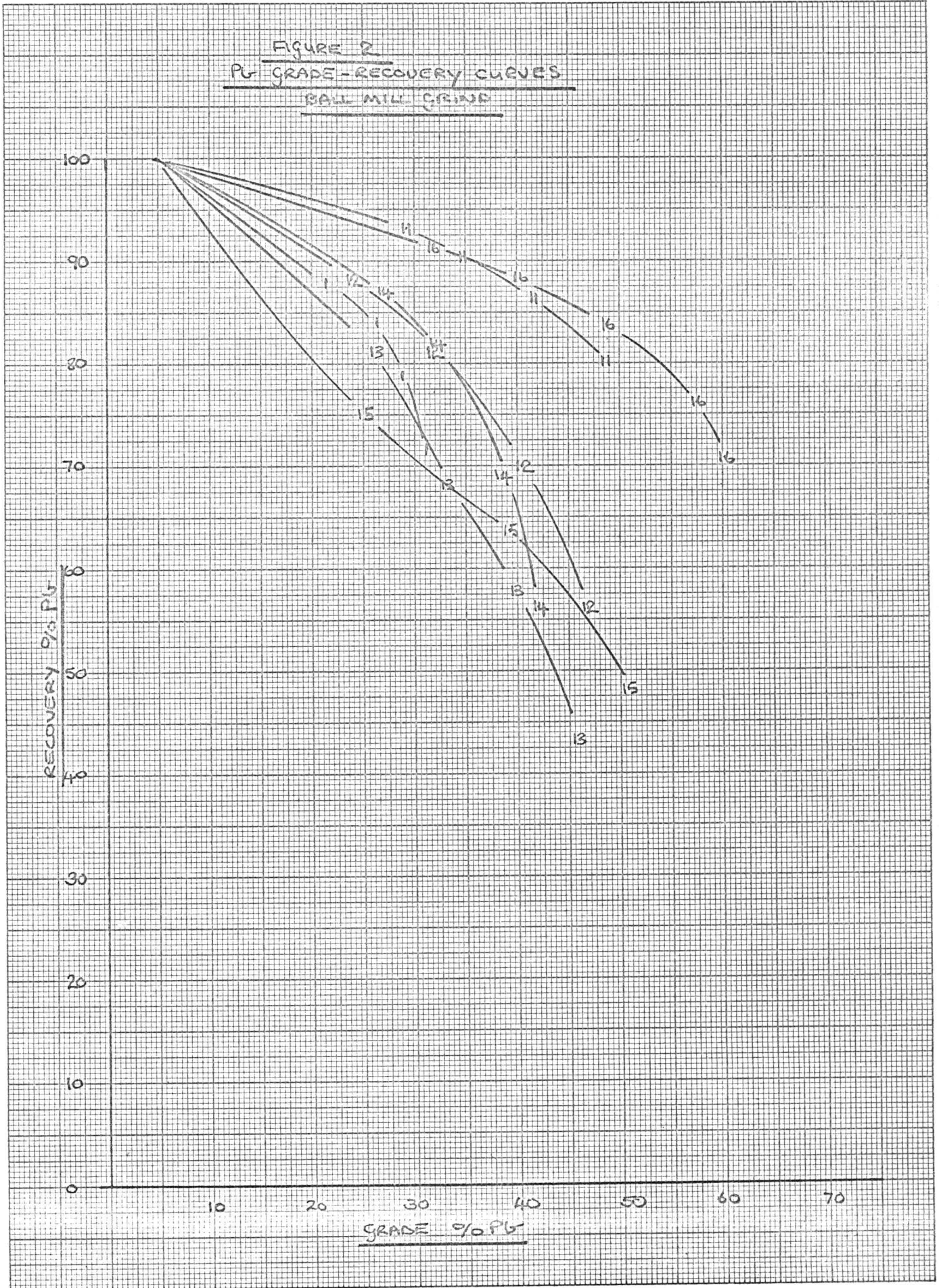
The Pb grade-recovery curves for these tests are shown in Figure 2.

The mixed collector used consisted of a 4:2:1:1 mixture of AF208, AF242, Z-4 and Z-6.

Lead grade and recovery was generally low in these tests. The mixed collector used in Tests 13, 14 and 15 was too weak, and low lead recoveries resulted. No improvement in the grade of Pb concentrate or zinc depression resulted with the use of Ca(OH)₂, Na₂S or Na₂SO₃. Pb recovery was generally low when using these depressants.

The best results were achieved in Tests 11 and 16, in which similar reagent conditions to those of the rod mill primary grind tests were used i.e. Na₂CO₃, ZnSO₄ and NaCN as depressants, R-242 and R-404 as collectors.

FIGURE 2
P₆ GRADE-RECOVERY CURVES
BALL MILL GRIND



PHIC ROLS DA L
MADE IN CANADA

CM

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Summary - Continued

2.3. SO₂ for Sphalerite and Pyrite Depression

Testwork was conducted to investigate the effect of conditioning with SO₂ prior to flotation on the grade and recovery of lead and the depression of sphalerite and pyrite. The results and conditions of this testwork are summarized in Table 4.

Table 4 - SO₂ Conditioning

Test No.	pH with SO ₂	pH Ca(OH) ₂	Z-4 lb/ton	242 lb/ton	Flotation Time min.	Rougher Concentrate				
						Weight %	Assays %		% Dist.	
							Pb	Pb	Zn	
2	5.5	9.5	0.04	0.06	9	13.08	29.6	78.4	20.2	
7	5.5	-	-	0.16	12	19.92	20.6	84.9	28.8	
8	5.0	6.5*	-	0.16	12	10.57	22.2	50.6	13.1	

* With Na₂CO₃

Low recoveries of lead were obtained with no improvement in zinc rejection.

2.4. Flotation with no Depressants

In Test 22 the flotation of lead after grinding with no depressants or pH control was investigated. A rougher concentrate was recovered using R-242 and Z-4 as collectors. This concentrate amounted to 25.64 % weight assayed 14.2 % Pb and 8.92 % Zn, with recoveries of 80.2 % Pb and 32.0 % Zn. On regrinding and cleaning there was a high lead loss in the 1st cleaner tailing.

The results of this test indicated that the sphalerite did not appear to be naturally pre-activated, and that the problem of zinc rejection was mainly one of liberation. Further testwork will be conducted to investigate the recovery of Pb with reduced depressant additions in the rougher flotation.

Summary - Continued

3. Zinc Flotation

Zinc flotation was investigated in several of the tests. In some of these tests the Pb 1st cleaner tailing was combined with the Pb rougher tailing as feed to the zinc circuit. Zn recovery was largely dependent on the amount of zinc reporting to the zinc circuit.

In this testwork the pulp pH was raised to pH 10.5-11.0 with Ca(OH)_2 and conditioned with 1.0 lb/ton CuSO_4 . A zinc rougher concentrate was then recovered using Z-200, AX343 or the mixed collector as collector. The rougher concentrate was then either reground and cleaned, or merely cleaned.

The results and conditions of this testwork are summarized in Table 5.

Table 5 - Zinc Flotation

Test No.	Primary Grind		Regrind Time min.	Collector	Product	Weight %	Assay %		% Dist. Zn
	Mill	% -200m					Pb	Zn	
1	B.M.	30	-	Z-200	Zn Cl. Conc.	7.41	0.99	55.7	54.8
					Zn Ro. Tail.	66.42	0.51	0.68	6.0
11*	B.M.	40	-	Z-200	Zn Cl. Conc.	8.15	0.57	57.5	62.5
					Zn Ro. Tail.	69.81	0.30	0.65	5.9
12*	B.M.	40	-	Mixed	Zn Cl. Conc.	7.17	0.84	57.6	56.2
					Zn Ro. Tail.	71.68	0.53	0.79	7.8
13*	B.M.	40	10	Mixed	Zn Cl. Conc.	5.48	1.30	56.7	42.0
					Zn Ro. Tail.	74.30	0.80	1.94	19.5
14*	B.M.	60	-	Mixed	Zn Cl. Conc.	8.05	1.04	56.5	61.9
					Zn Ro. Tail.	70.80	0.51	0.55	5.2
15*	B.M.	60	7.5	AX343	Zn Cl. Conc.	5.68	1.47	58.0	48.0
					Zn Ro. Tail.	75.29	1.25	3.18	31.9
17*	R.M.	60	-	Z-200	Zn Cl. Conc.	9.52	0.86	55.1	71.8
					Zn Ro. Tail.	67.54	0.30	0.43	3.9
20	R.M.	30	15	Z-200	Zn Cl. Conc.	6.35	0.74	56.9	50.2
					Zn Ro. Tail.	52.94	0.33	0.63	4.6
21*	R.M.	40	-	Z-200	Zn Cl. Conc.	8.82	0.65	56.6	68.8
					Zn Ro. Tail.	73.41	0.39	0.74	7.5

* Pb 1st cleaner tailing included in feed to Pb flotation.

Summary - Continued

3. Zinc Flotation

Regrinding the zinc rougher concentrate did not result in any improvement in the grade of zinc concentrate recovered.

At the finer primary grinds the Zn tailing assays were slightly lower; the lowest tailing assay was 0.43 % Zn in Test 17. Z-200 appeared to be a more suitable collector than the mixed collector or AX343.

Cycle testwork in which the Pb and Zn cleaner tailings are recirculated is necessary to determine the grade and recovery of a zinc concentrate, and to establish the required fineness of primary grind, or the necessity of a regrind.

4. Silver Recovery

The products from Test 17 were assayed for silver. The results are summarized below.

Table 6 - Silver Distribution

Product	Weight %	Assays, %			% Distribution		
		Pb	Zn	Ag*	Pb	Zn	Ag
Pb Cleaner Concentrate	6.37	59.3	7.46	19.52	81.8	6.5	59.7
Zn Cleaner Concentrate	9.52	0.86	55.1	3.20	1.8	71.8	14.6
Zn Rougher Tailing	67.54	0.30	0.43	0.20	4.4	3.9	6.5
Head (Calculated)	100.00	4.62	7.31	2.08	100.0	100.0	100.0

* ounces per ton

Summary - Continued

5. Work Indices and Power Consumption

5.1. Primary Grind

Mill	Grinding Time min./2000 g	% Passing 200 mesh	K ₈₀ micro- meters	Surface Area cm ² /g	Power Consumption kwh/ton	Work Index
	-10 mesh head	19.7	886	-	-	-
Ball Mill	20	79.6	76.6	1354	6.2	7.7
Ball Mill	30	88.7	55.8	1743	9.3	9.3
Ball Mill	40	94.4	47.0	2020	12.4	11.0
Ball Mill	60	98.1	37.0	2495	18.7	14.2
Rod Mill	40	93.8	52.0	1665	9.2	9.1
Rod Mill	60	97.4	42.4	2085	13.9	11.9

5.2. Pb Concentrate Re grind

Mill	Grind Time minutes	Power Consumption	
		kwh/ton ore	kwh/ton Rougher Conc.*
Rod Mill	10	2.3	7.7
Rod Mill	15	3.5	11.7
Rod Mill	20	4.6	15.3
Rod Mill	30	6.9	23.0
Rod Mill	40	9.2	30.7
Pebble Mill	7½	0.75	2.5
Pebble Mill	10	1.0	3.3
Peb le Mill	20	2.0	6.7
Pebble Mill	30	3.0	10.0
Ball Mill	20	6.2	20.7

* Assuming 30 % weight recovery in rougher concentrate

Summary - Continued

5. Work Indices and Power Consumption

5.3. Zinc Concentrate Regrind

Mill	Grinding Time Minutes	Power Consumption	
		kwh/ton ore	kwh/ton* Rougher Concentrate
Pebble Mill	7½	0.75	5.0
Pebble Mill	10	1.0	6.7
Pebble Mill	15	1.5	10.0

* Assuming 15 % weight recovery to Zn rougher concentrate.

6. Further Testwork

Cycle testwork will commence to investigate the effect of recirculation of cleaner tailings. Various primary grind and regrind combinations will be investigated. Regrinding of the zinc rougher concentrate may not be necessary at the finer primary grinds.

The effect of conducting the lead rougher flotation at natural pH, and with smaller amounts of depressants will also be investigated.

SAMPLE PREPARATION

Four drums, weighing approximately 300 pounds, containing crushed drill core samples were received at Lakefield on August 13th, 1975, and given our Reference No. 7520755. The drums were described as B-1 to B-4.

The contents of each drum were jaw and cone-crushed to minus 1/4 inch, and one-quarter of each sample was riffled out. These one-quarter splits were then mixed, roll-crushed to minus 10 mesh, and riffled into 2 kg. charges for testwork, and a sample for screen analyses and head analysis.

Later the remainder of the minus 1/4 inch material was combined, crushed to minus 10 mesh and riffled into 2 kg. charges for further testwork.

Screen Analysis

Minus 10 Mesh Head Sample

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 14	5.4	5.4	94.6
20	16.1	21.5	78.5
28	15.5	37.0	63.0
35	11.5	48.5	51.5
48	9.3	57.8	42.2
65	6.5	64.3	35.7
100	6.0	70.3	29.7
150	4.9	75.2	24.8
200	5.1	80.3	19.7
270	3.7	84.0	16.0
400	4.2	88.2	11.8
- 400	11.8	100.0	-
Total	100.0	-	-

DETAILS OF TESTS

Test No. 1

Purpose: A preliminary test to investigate the flotation of lead and zinc when using standard lead-zinc flotation procedure.

Procedure: Grind and float a lead concentrate and a zinc concentrate. Clean each concentrate three times.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 30 minutes at 65 percent solids in the laboratory ball mill.

Conditions:

Stage	Reagents Added, pounds per ton							Time, minutes		pH
	Ca-(OH) ₂	ZnSO ₄	NaCN	R-242	MIBC	Cu-SO ₄	Z-200	Cond.	Froth	
Grind	1.0	1.0	0.10	-	-	-	-	-	-	-
Pb Rougher	-	-	-	0.03	0.02	-	-	1	3	8.8
	-	-	-	0.02	-	-	-	1	3	-
	-	-	-	0.02	-	-	-	1	3	-
Condition	1.5	-	-	-	-	1.0	-	2	-	10.9
Zn Rougher	-	-	-	-	-	-	0.06	1	3	10.9
	-	-	-	-	-	-	0.02	1	2	-
Pb 1st Cleaner	0.1	0.1	0.02	-	-	-	-	2	3	9.6
	-	-	-	0.005	-	-	-	1	2	-
Pb 2nd Cleaner	0.05	0.05	0.01	-	0.005	-	-	1	3	9.8
	-	-	-	0.003	-	-	-	1	1	-
Pb 3rd Cleaner	0.05	0.05	0.01	-	0.005	-	-	1	3	9.7
Zn 1st Cleaner	0.20	-	-	-	-	-	-	2	2	11.1
	-	-	-	-	-	-	0.005	1	1	-
Zn 2nd Cleaner	0.10	-	-	-	-	-	-	2	2½	11.2
Zn 3rd Cleaner	0.10	-	-	-	-	-	-	1	2	11.2

Stage	Rougher	Pb Cleaners	Zn Cleaners
Flotation Cell	1000 gram D-1	250 gram D-1	250 gram D-1
Speed rpm	1800	1000	1000
% Solids	33	-	-

Test No. 1 - Continued

Metallurgical Results

Product	Weight	Assays, %		% Distribution	
	%	Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	10.95	31.1	11.1	71.7	16.1
2. Pb 3rd Cl. Tail.	2.07	16.5	11.8	7.2	3.2
3. Pb 2nd Cl. Tail.	2.17	11.2	11.2	5.1	3.2
4. Pb 1st Cl. Tail.	4.34	4.29	9.76	3.9	5.6
5. Zn Cleaner Conc.	7.41	0.99	55.7	1.5	54.8
6. Zn 3rd Cl. Tail.	1.18	2.49	27.2	0.6	4.3
7. Zn 2nd Cl. Tail.	1.93	2.41	14.6	1.0	3.7
8. Zn 1st Cl. Tail.	3.53	2.38	6.56	1.8	3.1
9. Zn Rougher Tail.	66.42	0.51	0.68	7.2	6.0
Head (Calculated)	100.00	4.75	7.54	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	13.02	28.8	11.2	78.9	19.3
Products 1 to 3	15.19	26.3	11.2	84.0	22.5
Products 1 to 4	19.53	21.4	10.9	87.9	28.1
Products 5 and 6	8.59	1.20	51.8	2.1	59.1
Products 5 to 7	10.52	1.42	45.0	3.1	62.8
Products 5 to 8	14.05	1.66	35.3	4.9	65.9

Test No. 2

Purpose: To investigate the effect of SO₂ conditioning prior to Pb flotation on the depression of zinc and pyrite.

Procedure: Grind, condition and float a lead concentrate and a zinc concentrate. Clean the lead concentrate twice.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 30 minutes at 65 percent solids in the laboratory ball mill.

Conditions:

Stage	Reagents Added, pounds per ton							Time, minutes		pH
	NaCN	SO ₂	Ca-(OH) ₂	R-242	Z-14	MIBC	Cu-SO ₄	Cond.	Froth	
Grind	0.20	-	-	-	-	-	-	-	-	-
Condition	-	6.0	-	-	-	-	-	3	-	8.0-5.5
	-	-	8.0	-	-	-	-	2	-	9.5
Pb Rougher	-	-	-	0.03	0.02	0.02	-	1	3	-
	-	-	-	0.02	0.01	-	-	1	3	-
	-	-	-	0.01	0.01	-	-	1	3	-
Condition	-	-	1.5	-	-	-	0.5	3	-	10.8
Zn Rougher	-	-	-	-	0.04	0.01	-	1	3	-
	-	-	-	-	0.02	-	-	1	2	-
Pb 1st Cleaner	0.05	-	-	0.005	-	-	-	1	3	9.0
	-	-	-	0.005	-	-	-	1	2	-
Pb 2nd Cleaner	0.02	-	-	-	-	-	-	1	2	8.8
	-	-	-	0.003	-	-	-	1	1	-

Test No. 2 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	7.19	42.8	11.9	62.4	11.3
2. Pb 2nd Cl. Tail.	1.53	21.9	13.2	6.8	2.7
3. Pb 1st Cl. Tail.	4.36	10.4	10.8	9.2	6.2
4. Zn Rougher Conc.	14.52	2.68	32.8	7.9	62.6
5. Zn Rougher Tail.	72.40	0.93	1.81	13.7	17.2
Head (Calculated)	100.00	4.93	7.60	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	8.72	39.1	12.1	69.2	14.0
Products 1 to 3	13.08	29.6	11.7	78.4	20.2

Test No. 3

Purpose: To investigate the removal of a series of lead concentrates at various pH after SO₂ conditioning.

Procedure: Grind, condition and float three lead concentrates.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 30 minutes at 65 percent solids in the laboratory ball mill.

Conditions:

Stage	Reagents Added, pounds per ton				Time, minutes			pH
	SO ₂	Ca(OH) ₂	R-242	Z-14	Grind	Cond.	Froth	
Grind	-	-	-	-	30	-	-	-
Condition	7.5	-	-	-	-	15	-	5.0
	-	4.0	-	-	-	2	-	6.5
Pb Conc. No. 1	-	-	0.05	0.03	-	1	3	-
Condition	-	1.5	-	-	-	2	-	7.5
Pb Conc. No. 2	-	-	0.02	-	-	1	3	-
Condition	-	0.7	-	-	-	2	-	8.5
Pb Conc. No. 3	-	-	0.02	0.01	-	1	3	-

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Conc. No. 1	15.20	19.0	5.41	59.7	11.0
2. Pb Conc. No. 2	5.40	15.8	15.5	17.6	11.2
3. Pb Conc. No. 3	4.00	9.56	12.4	7.9	6.7
4. Pb Rougher Tail.	75.40	0.95	7.02	14.8	71.1
Head (Calculated)	100.00	4.84	7.45	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	20.60	18.2	8.05	77.3	22.2
Products 1 to 3	24.60	16.8	8.76	85.2	28.9

Test No. 4

Purpose: To investigate the effect on the lead circuit of flotation after a coarse primary grind, followed by a regrind of the Pb rougher concentrate.

Procedure: Grind and float Pb rougher and scavenger concentrates. Regrind the rougher concentrate and clean three times.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 15 minutes at 67 percent solids in the laboratory rod mill.

Conditions:

Stage	Reagents Added, pounds per ton						Time, minutes			pH
	Na ₂ - CO ₃	Zn-SO ₄	NaCN	R-242	MIBC	Z-14	Grind	Cond.	Froth	
Primary Grind	2.0	1.0	0.20	0.05	-	-	15	-	-	-
Pb Rougher	-	-	-	-	0.01	-	-	1	3	8.9
	-	-	-	0.03	-	-	-	1	3	-
	-	-	-	0.02	-	-	-	1	3	-
Pb Scavenger	-	-	-	-	0.01	0.02	-	1	2	-
Pb Ro. Conc. Regrind	1.0	0.5	0.10	0.025	-	-	10	-	-	-
Pb 1st Cleaner	-	-	-	-	-	-	-	1	3	9.6
	-	-	-	0.005	-	-	-	1	2	-
Pb 2nd Cleaner	-	-	0.05	-	-	-	-	2	3	9.2
Pb 3rd Cleaner	0.2	-	0.02	-	-	-	-	2	2	9.7

Stage	Rougher	Ro. Conc. Regrind	Pb 1st Cleaner	Pb 2nd & 3rd Cl.
Equipment	1000 g D-1	Rod Mill	500 gram D-1	250 gram D-1
Speed rpm	1900	-	1300	1000
% Solids	33	-	-	-

Test No. 4 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	9.02	42.3	10.5	78.7	12.2
2. Pb 3rd Cl. Tail.	3.69	9.23	12.3	7.0	5.8
3. Pb 2nd Cl. Tail.	3.31	4.10	12.0	2.8	5.1
4. Pb 1st Cl. Tail.	16.38	1.12	9.56	3.8	20.1
5. Pb Scavenger Conc.	4.39	2.26	8.36	2.0	4.7
6. Pb Scavenger Tail.	63.21	0.44	6.41	5.7	52.1
Head (Calculated)	100.00	4.85	7.78	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	12.71	32.7	11.0	85.7	18.0
Products 1 to 3	16.02	26.8	11.2	88.5	23.1
Products 1 to 4	32.40	13.8	10.4	92.3	43.2
Products 1 to 5	36.79	12.4	10.1	94.3	47.9

Test No. 5

Purpose: To repeat test No. 4, but with finer primary grind and finer regrind.

Procedure: Grind and float lead rougher and scavenger concentrates. Regrind the rougher concentrate and clean four times.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 20 minutes at 67 percent solids in the laboratory rod mill.

Conditions:

Stage	Reagents Added, pounds per ton				Time, minutes			pH
	Na ₂ CO ₃	ZnSO ₄	NaCN	R-242	Grind	Cond.	Froth	
Primary Grind	2.0	1.0	0.20	0.075	20	-	-	-
<u>Pb Circuit</u>								
Pb Rougher	-	-	-	0.025	-	1	3	8.8
	-	-	-	0.025	-	1	3	-
	-	-	-	0.025	-	1	3	-
Pb Scavenger	-	-	-	0.03	-	1	3	-
Pb Ro. Conc. Regrind	1.0	0.5	0.10	0.04	15	-	-	-
Pb 1st Cleaner	-	-	-	-	-	1	3	9.8
	-	-	-	0.02	-	1	3	-
Pb 2nd Cleaner	0.1	0.1	0.05	-	-	1	3	9.8
	-	-	-	0.005	-	1	1	-
Pb 3rd Cleaner	0.1	-	0.02	0.003	-	1	3	9.6
Pb 4th Cleaner	0.1	-	0.01	-	-	1	2	9.9

Test No. 5 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	8.28	46.6	9.74	81.6	10.9
2. Pb 4th Cl. Tail.	2.36	9.95	13.3	5.0	4.2
3. Pb 3rd Cl. Tail.	1.95	5.33	12.7	2.2	3.3
4. Pb 2nd Cl. Tail.	2.60	2.43	12.0	1.3	4.2
5. Pb 1st Cl. Tail.	15.76	0.85	8.77	2.8	18.6
6. Pb Scavenger Conc.	1.84	2.22	9.01	0.9	2.2
7. Pb Scavenger Tail.	67.21	0.44	6.23	6.2	56.6
Head (Calculated)	100.00	4.73	7.42	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	10.64	38.5	10.5	86.6	15.1
Products 1 to 3	12.59	33.3	10.9	88.8	18.4
Products 1 to 4	15.19	28.0	11.1	90.1	22.6
Products 1 to 5	30.95	14.2	9.89	92.9	41.2
Products 1 to 6	32.79	13.5	9.84	93.8	43.4

Test No. 6

Purpose: To repeat Tests No. 4 and 5, but with a still finer grind and regrind.

Procedure: As for Tests No. 4 and 5.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 30 minutes at 67 percent solids in the laboratory rod mill.

Conditions:

Stage	Reagents Added, pounds per ton					Time, minutes			pH
	Na ₂ CO ₃	ZnSO ₄	NaCN	R-242	404	Grind	Cond.	Froth	
Primary Grind	2.0	1.0	0.20	0.10	-	30	-	-	-
<u>Pb Circuit</u>									
Pb Rougher	-	-	-	0.02	0.02	-	1	3	8.6
	-	-	-	0.02	0.01	-	1	3	-
	-	-	-	0.02	0.01	-	1	3	-
Pb Scavenger	-	-	-	0.03	0.02	-	1	3	-
Pb Ro. Conc. Regrind	1.0	0.5	0.10	0.05	-	20	-	-	-
Pb 1st Cleaner	-	-	-	-	-	-	1	3	9.5
	-	-	-	0.01	0.01	-	1	3	-
Pb 2nd Cleaner	0.2	0.1	0.05	-	-	-	1	3	9.8
	-	-	-	0.005	-	-	1	1	-
Pb 3rd Cleaner	0.1	-	0.02	-	-	-	1	3	9.8
Pb 4th Cleaner	0.2	-	0.01	-	-	-	1	2	9.9

Test No. 6 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	8.72	47.5	9.35	85.0	11.0
2. Pb 4th Cl. Tail.	2.68	8.01	12.8	4.4	4.6
3. Pb 3rd Cl. Tail.	1.65	4.10	11.6	1.4	2.6
4. Pb 2nd Cl. Tail.	4.23	2.19	10.8	1.9	6.2
5. Pb 1st Cl. Tail.	17.11	0.64	7.89	2.2	18.3
6. Pb Scavenger Conc.	2.32	1.41	8.61	0.7	2.7
7. Pb Scavenger Tail.	63.29	0.34	6.37	4.4	54.6
Head (Calculated)	100.00	4.87	7.39	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	11.40	38.2	10.2	89.4	15.6
Products 1 to 3	13.05	33.9	10.3	90.8	18.2
Products 1 to 4	17.28	26.1	10.5	92.7	24.4
Products 1 to 5	34.39	13.5	9.18	94.9	42.7
Products 1 to 6	36.71	12.7	9.14	95.6	45.4

Test No. 7

Purpose: To investigate the flotation of lead at low pH after SO₂ conditioning.

Procedure: Grind, condition and float a series of lead concentrates.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 30 minutes at 65 percent solids in the laboratory ball mill.

Conditions:

Stage	Reagents Added, pounds per ton			Time, minutes		pH
	SO ₂	R-242	R-404	Cond.	Froth	
Condition	3.0	-	-	10	-	5.5
Pb Conc. No. 1	-	0.05	0.02	1	3	5.8
Pb Conc. No. 2	-	0.03	0.01	1	3	-
Pb Conc. No. 3	-	0.03	0.01	1	3	5.7
Pb Conc. No. 4	-	0.05	0.01	1	3	-

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Conc. No. 1	6.00	39.5	10.8	49.1	8.6
2. Pb Conc. No. 2	5.34	18.4	12.1	20.4	8.6
3. Pb Conc. No. 3	3.91	11.1	10.9	9.0	5.7
4. Pb Conc. No. 4	4.67	6.62	9.58	6.4	5.9
5. Pb Rougher Tail.	80.08	0.91	6.71	15.1	71.2
Head (Calc.)	100.00	4.82	7.54	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	11.34	29.6	11.4	69.5	17.2
Products 1 to 3	15.25	24.8	11.3	78.5	22.9
Products 1 to 4	19.92	20.6	10.9	84.9	28.8

Test No. 8

Purpose: To repeat Test No. 7, but condition at lower pH and raise pH to 6.5 prior to lead flotation.

Procedure: As for Test No. 7.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 30 minutes at 65 percent solids in the laboratory ball mill.

Conditions:

Stage	Reagents Added, pounds per ton				Time, minutes		pH
	SO ₂	Na ₂ CO ₃	R-242	R-404	Cond.	Froth	
Condition	7.0	-	-	-	10	-	5.0
	-	1.5	-	-	2	-	6.5
Pb Conc. No. 1	-	-	0.05	0.02	1	3	-
Pb Conc. No. 2	-	-	0.03	0.01	1	3	-
Pb Conc. No. 3	-	-	0.03	0.01	1	3	6.0
Pb Conc. No. 4	-	-	0.05	0.01	1	3	-

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Conc. No. 1	6.05	27.1	8.55	35.4	7.2
2. Pb Conc. No. 2	2.30	25.4	9.97	12.6	3.2
3. Pb Conc. No. 3	1.01	6.01	9.23	1.3	1.3
4. Pb Conc. No. 4	1.21	4.86	8.27	1.3	1.4
5. Pb Rougher Tail.	89.43	2.56	6.98	49.4	86.9
Head (Calc.)	100.00	4.63	7.18	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	8.35	26.6	8.94	48.0	10.4
Products 1 to 3	9.36	24.4	8.97	49.3	11.7
Products 1 to 4	10.57	22.2	8.89	50.6	13.1

Test No. 9

Purpose: To repeat Test No. 6, but regrind in a pebble mill and clean at higher pH.

Procedure: Grind and float a lead rougher concentrate. Regrind the concentrate in the pebble mill and clean five times.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 30 minutes at 67 percent solids in the laboratory rod mill.

Conditions:

Stage	Reagents Added, pounds per ton						Time, minutes			pH
	Na ₂ - CO ₃	Zn - SO ₄	NaCN	R-242	404	Ca - (OH) ₂	Grind	Cond.	Froth	
Primary Grind <u>Pb Circuit</u>	3.0	1.0	0.25	0.10	-	-	30	-	-	-
Pb Rougher	-	-	-	0.02	0.02	-	-	1	4	9.3
	-	-	-	0.03	0.01	-	-	1	3	-
Pb Conc. Regrind	-	0.5	0.10	0.05	-	0.5	30	-	-	-
Pb 1st Cleaner	-	-	-	-	-	-	-	1	3	9.9
	-	-	-	0.01	0.01	-	-	1	3	-
Pb 2nd Cleaner	-	0.2	0.05	-	-	0.2	-	1	3	10.5
	-	-	-	0.005	-	-	-	1	1	-
Pb 3rd Cleaner	-	0.1	0.02	-	-	0.15	-	1	3	10.7
Pb 4th Cleaner	-	-	0.01	-	-	0.10	-	1	2½	10.9
Pb 5th Cleaner	-	-	0.02	-	-	0.15	-	1	2	11.1

Stage	Rougher	Pb Conc. Regrind	1st & 2nd Cl.	3rd to 5th Cl.
Equipment	1000 g D-1	Pebble Mill	500 g D-1	250 g D-1
Speed rpm	1800	(10 lb. Flint pebbles)	1300	1000
% Solids	33	-	-	-

Test No. 9 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	8.31	43.4	9.06	76.9	10.1
2. Pb 5th Cl. Tail.	3.63	13.1	11.1	10.1	5.4
3. Pb 4th Cl. Tail.	2.21	7.24	10.9	3.4	3.2
4. Pb 3rd Cl. Tail.	1.82	4.91	11.3	1.9	2.8
5. Pb 2nd Cl. Tail.	3.04	2.53	10.7	1.6	4.3
6. Pb 1st Cl. Tail.	19.80	0.56	7.49	2.4	19.8
7. Pb Rougher Tail.	61.19	0.28	6.65	3.7	54.4
Head (Calculated)	100.00	4.69	7.48	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	11.94	34.2	9.68	87.0	15.5
Products 1 to 3	14.15	30.0	9.87	90.4	18.7
Products 1 to 4	15.97	27.1	10.0	92.3	21.5
Products 1 to 5	19.01	23.2	10.1	93.9	25.8
Products 1 to 6	38.81	11.6	8.79	96.3	45.6

Test No. 10

Purpose: To investigate the effect of aeration on the selectivity in the lead circuit.

Procedure: Grind, aerate and float a lead concentrate. Re grind the lead concentrate and clean four times.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 30 minutes at 67 percent solids in the laboratory rod mill.

Conditions:

Stage	Reagents Added, pounds per ton						Time, minutes			pH
	Na ₂ - CO ₃	Zn- SO ₄	NaCN	R-242	R-404	Ca- (OH) ₂	Grind	Cond.	Froth	
Primary Grind	5.0	-	-	-	-	-	30	-	-	-
<u>Pb Circuit</u>										
Aeration	-	-	-	-	-	-	-	30	-	-
Condition	-	1.0	0.25	-	-	-	-	5	-	9.8
Pb Rougher	-	-	-	0.05	0.02	-	-	1	3	9.6
	-	-	-	0.07	0.01	-	-	1	4	-
Pb Conc. Re grind	-	0.5	0.10	0.02	-	0.75	30	-	-	-
Pb 1st Cleaner	-	-	-	0.005	-	-	-	1	3	10.8
	-	-	-	0.005	0.005	-	-	1	2	-
Pb 2nd Cleaner	-	0.2	0.05	-	-	0.20	-	1	3	10.9
	-	-	-	0.003	-	-	-	1	1	-
Pb 3rd Cleaner	-	0.1	0.02	-	-	0.15	-	1	3	11.0
Pb 4th Cleaner	-	-	0.01	-	-	0.10	-	1	2	11.0

Stage	Aeration	Rougher	Pb Conc. Re grind
Equipment	1000 gram D-1	1000 gram D-1	Pebble Mill
Speed rpm	1800	1800	-
% Solids	40	33	-

Test No. 10 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	3.62	48.2	9.66	37.1	4.7
2. Pb 4th Cl. Tail.	3.33	25.6	12.1	18.1	5.4
3. Pb 3rd Cl. Tail.	2.77	15.2	12.6	8.9	4.7
4. Pb 2nd Cl. Tail.	5.08	12.2	12.2	13.2	8.3
5. Pb 1st Cl. Tail.	8.80	6.22	11.1	11.6	13.1
6. Pb Rougher Tail.	76.40	0.68	6.23	11.1	63.8
Head (Calculated)	100.00	4.71	7.46	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	6.95	37.4	10.8	55.2	10.1
Products 1 to 3	9.72	31.1	11.3	64.1	14.8
Products 1 to 4	14.80	24.6	11.6	77.3	23.1
Products 1 to 5	23.60	17.7	11.4	88.9	36.2

Test No. 11

Purpose: To investigate the effect of returning to a ball mill grind, with increased cyanide additions to primary grind and regrind.

Procedure: Grind and float a lead concentrate. Regrind the concentrate and clean four times. Combine the Pb rougher and 1st cleaner tailings and float a zinc concentrate. Clean the Zn concentrate three times.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 40 minutes at 65 percent solids in the laboratory ball mill.
12.4 kwh/ton. 94.4 % -200 mesh.

Conditions:

Stage	Reagents Added, pounds per ton					Time, minutes			pH
	Na ₂ CO ₃	ZnSO ₄	NaCN	R-242	R-404	Grind	Cond.	Froth	
Primary Grind	3.0	1.0	0.30	0.10	-	40	-	-	-
<u>Pb Circuit</u>									
Pb Rougher	-	-	-	0.02	0.02	-	1	3	9.5
	-	-	-	0.02	0.01	-	1	3	-
	-	-	-	0.02	0.01	-	1	3	-
Pb Conc. Regrind	1.0	0.5	0.20	0.03	-	20	-	-	-
Pb 1st Cleaner	-	-	-	-	-	-	1	3	9.7
	-	-	-	0.01	0.01	-	1	3	-
Pb 2nd Cleaner	0.2	0.2	0.10	-	-	-	1	3	-
	-	-	-	0.005	-	-	1	1	-
Pb 3rd Cleaner	0.1	0.1	0.05	-	-	-	1	3	9.6
Pb 4th Cleaner	0.2	-	0.03	-	-	-	1	2	9.8
	Ca-(OH) ₂	CuSO ₄		Z-200	MIBC				
<u>Zn Circuit</u> (Pb rougher and Pb 1st cleaner tailings)									
Condition	1.5	1.0	-	-	-	-	2	-	10.6
Zn Rougher	-	-	-	0.06	0.02	-	1	3	-
	-	-	-	0.02	0.01	-	1	2	-
Zn 1st Cleaner	0.20	-	-	-	0.005	-	1	2	11.0
	-	-	-	0.005	-	-	1	1	-
Zn 2nd Cleaner	0.15	-	-	-	0.005	-	1	2½	11.2
Zn 3rd Cleaner	0.10	-	-	-	0.005	-	1	2	11.3

Stage	Pb Rougher	Pb Regrind	Pb 1st & 2nd Cl.	Pb 3rd & 4th Cl.	Zn Rougher
Equipment	1000 g D-1	Pebble Mill	500 g D-1	250 g D-1	1000 g D-1
Speed rpm	1800	-	1300	1000	1800
% Solids	33	-	-	-	-

Stage	Zn Cleaners
Equipment	250 g D-1
Speed rpm	1000

Test No. 11 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	7.85	48.4	8.94	80.4	9.4
2. Pb 4th Cl. Tail.	1.94	15.2	12.3	6.2	3.2
3. Pb 3rd Cl. Tail.	2.46	7.30	12.3	3.8	4.0
4. Pb 2nd Cl. Tail.	2.81	4.50	11.9	2.7	4.5
5. Zn Cleaner Conc.	8.15	0.57	57.5	1.0	62.5
6. Zn 3rd Cl. Tail.	1.04	1.43	32.9	0.3	4.6
7. Zn 2nd Cl. Tail.	1.64	1.18	14.5	0.4	3.2
8. Zn 1st Cl. Tail.	4.30	0.77	4.68	0.7	2.7
9. Zn Rougher Tail.	69.81	0.30	0.65	4.5	5.9
Head (Calculated)	100.00	4.72	7.50	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	9.79	41.8	9.61	86.6	12.6
Products 1 to 3	12.25	34.9	10.2	90.4	16.6
Products 1 to 4	15.06	29.2	10.5	93.1	21.1
Products 5 and 6	9.19	0.67	54.7	1.3	67.1
Products 5 to 7	10.83	0.75	48.6	1.7	70.3
Products 5 to 8	15.13	0.75	36.1	2.4	73.0

Test No. 12

Purpose: To investigate the effect of Na₂S in the grind, and of floating with a Mixed Collector*.

Procedure: As for Test No. 11.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 40 minutes at 65 percent solids in the laboratory ball mill.

Conditions:

Stage	Reagents Added, pounds per ton						Time, minutes			pH
	Na ₂ CO ₃	Zn-SO ₄	Na ₂ S	M.C.*	MIBC	NaCN	Grind	Cond.	Froth	
Primary Grind <u>Pb Circuit</u>	3.0	1.0	1.0	0.10	-	-	40	-	-	-
Pb Rougher	-	-	-	0.02	0.02	-	-	1	3	9.6
	-	-	-	0.03	0.01	-	-	1	3	-
	-	-	-	0.05	-	-	-	1	3	-
Pb Conc. Re grind	1.0	0.5	0.25	0.03	-	-	20	-	-	-
Pb 1st Cleaner	-	-	-	-	0.005	-	-	1	3	9.8
	-	-	-	0.02	-	-	-	1	3	-
Pb 2nd Cleaner	0.2	0.2	-	-	-	0.05	-	1	3	-
	-	-	-	0.005	-	-	-	1	1	-
Pb 3rd Cleaner	0.2	0.1	-	-	-	0.03	-	1	3	9.8
Pb 4th Cleaner	0.2	-	-	-	-	0.02	-	1	2	9.9
	Ca-(OH) ₂	Cu-SO ₄								
<u>Zn Circuit.</u> (Pb rougher and 1st cleaner tailings)										
Zn Rougher	2.0	1.0	-	-	-	-	-	2	-	10.8
	-	-	-	0.06	0.04	-	-	1	3	-
	-	-	-	0.04	0.02	-	-	1	2	-
Zn 1st Cleaner	0.20	-	-	-	0.005	-	-	1	2	11.0
	-	-	-	0.005	-	-	-	1	1	-
Zn 2nd Cleaner	0.15	-	-	-	0.005	-	-	1	2½	11.1
Zn 3rd Cleaner	0.10	-	-	-	0.005	-	-	1	2	11.1

*AF-208, AF-242, Z-4, Z-6:4,2,1,1

Test No. 12 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	5.44	46.8	8.56	56.1	6.3
2. Pb 4th Cl. Tail.	2.42	26.1	11.2	13.9	3.7
3. Pb 3rd Cl. Tail.	3.77	13.5	12.1	11.2	6.2
4. Pb 2nd Cl. Tail.	5.25	6.05	12.0	7.1	8.6
5. Zn Cleaner Conc.	5.59	0.72	59.2	0.9	45.0
6. Zn 3rd Cl. Tail.	1.58	1.27	52.1	0.4	11.2
7. Zn 2nd Cl. Tail.	1.55	1.84	37.4	0.6	7.9
8. Zn 1st Cl. Tail.	2.72	2.34	9.04	1.4	3.3
9. Zn Rougher Tail.	71.68	0.53	0.79	8.4	7.8
Head (Calculated)	100.00	4.54	7.35	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	7.86	40.4	9.37	70.0	10.0
Products 1 to 3	11.63	31.7	10.3	81.2	16.2
Products 1 to 4	16.88	23.7	10.8	88.3	24.8
Products 5 and 6	7.17	0.84	57.6	1.3	56.2
Products 5 to 7	8.72	1.02	54.0	1.9	64.1
Products 5 to 8	11.44	1.33	43.3	3.3	67.4

Test No. 13

Purpose: To repeat Test No. 12, but substitute Ca(OH)_2 for Na_2CO_3 in the lead circuit, and regrind the Zn concentrate prior to cleaning.

Procedure: As for Test No. 11, but regrind the zinc rougher concentrate prior to cleaning.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 40 minutes at 65 percent solids in the laboratory ball mill.

Conditions:

Stage	Reagents Added, pounds per ton						Time, minutes			pH
	Ca(OH)_2	Zn- SO_4	Na_2S	M.C.*	MIBC	NaCN	Grind	Cond.	Froth	
Primary Grind	1.0	1.0	1.0	0.10	-	-	40	-	-	-
<u>Pb Circuit</u>										
Pb Rougher	-	-	-	0.02	0.02	-	-	1	3	9.0
	-	-	-	0.03	0.01	-	-	1	3	-
	-	-	-	0.05	-	-	-	1	3	-
Pb Conc. Regrind	0.5	0.5	0.25	0.03	-	-	20	-	-	-
Pb 1st Cleaner	-	-	-	-	0.005	-	-	1	3	9.9
	-	-	-	0.02	-	-	-	1	3	-
Pb 2nd Cleaner	0.1	0.2	-	-	-	0.05	-	1	3	10.1
	-	-	-	0.005	-	-	-	1	1	-
Pb 3rd Cleaner	0.1	0.1	-	-	-	0.03	-	1	3	10.5
Pb 4th Cleaner	0.1	-	-	-	0.005	0.02	-	1	2	10.8
		Cu- SO_4								
<u>Zn Circuit (Pb rougher and 1st cleaner tailings)</u>										
Zn Rougher	2.0	1.0	-	-	-	-	-	2	-	10.9
	-	-	-	0.06	0.02	-	-	1	3	-
	-	-	-	0.04	-	-	-	1	2	-
Zn Conc. Regrind	0.5	-	-	0.03	-	-	10	-	-	-
Zn 1st Cleaner	-	-	-	-	-	-	-	1	2	11.0
	-	-	-	0.02	-	-	-	1	2	-
Zn 2nd Cleaner	0.2	-	-	-	-	-	-	1	2	11.2
	-	-	-	0.005	-	-	-	1	1	-
Zn 3rd Cleaner	0.1	-	-	-	-	-	-	1	2	11.3

*Mixed Collectors

Stage Zn Conc. Regrind
Equipment Pebble Mill

Test No. 13 - Continued

Metallurgical Results

Product	Weight	Assays, %		% Distribution	
	%	Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	4.40	45.9	9.42	43.3	5.6
2. Pb 4th Cl. Tail.	2.36	28.8	11.4	14.6	3.6
3. Pb 3rd Cl. Tail.	2.88	17.4	12.3	10.7	4.8
4. Pb 2nd Cl. Tail.	4.72	12.4	12.2	12.6	7.8
5. Zn Cleaner Conc.	5.48	1.30	56.7	1.5	42.0
6. Zn 3rd Cl. Tail.	1.54	2.86	43.6	0.9	9.1
7. Zn 2nd Cl. Tail.	0.92	4.73	21.0	0.9	2.6
8. Zn 1st Cl. Tail.	3.40	3.69	10.8	2.7	5.0
9. Zn Rougher Tail.	74.30	0.80	1.94	12.8	19.5
Head (Calculated)	100.00	4.66	7.39	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	6.76	39.9	10.1	57.9	9.2
Products 1 to 3	9.64	33.2	10.8	68.6	14.0
Products 1 to 4	14.36	26.4	11.2	81.2	21.8
Products 5 and 6	7.02	1.64	53.8	2.4	51.1
Products 5 to 7	7.94	2.00	50.0	3.3	53.7
Products 5 to 8	11.34	2.51	38.3	6.0	58.7

Test No. 14

Purpose: To investigate the effect of a finer primary grind, when following the reagent balance of Test No. 12.

Procedure: As for Test No. 11.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 60 minutes at 65 percent solids in the laboratory ball mill.

Conditions:

Stage	Reagents Added, pounds per ton						Time, minutes			pH
	Na ₂ CO ₃	Zn-SO ₄	Na ₂ S	M.C.*	MIBC	NaCN	Grind	Cond.	Froth	
Primary Grind	3.0	1.0	1.0	0.10	-	-	60	-	-	-
<u>Pb Circuit</u>										
Pb Rougher	-	-	-	0.02	0.02	-	-	1	3	9.6
	-	-	-	0.03	0.01	-	-	1	3	-
	-	-	-	0.05	-	-	-	1	3	-
Pb Conc. Re grind	1.0	0.5	-	0.02	-	0.10	10	-	-	-
Pb 1st Cleaner	-	-	-	-	0.005	-	-	1	3	9.5
	-	-	-	0.02	-	-	-	1	3	-
Pb 2nd Cleaner	0.2	0.2	-	-	-	0.05	-	1	3	9.7
	-	-	-	0.005	-	-	-	1	1	-
Pb 3rd Cleaner	0.2	0.1	-	-	-	0.03	-	1	3	9.8
Pb 4th Cleaner	0.2	-	-	-	-	0.05	-	1	2	9.8
	Ca-(OH) ₂	Cu-SO ₄								
<u>Zn Circuit (Pb rougher and 1st cleaner tailings)</u>										
Zn Rougher	2.0	1.0	-	-	-	-	-	2	-	10.8
	-	-	-	0.06	0.04	-	-	1	3	-
	-	-	-	0.04	0.02	-	-	1	2	-
Zn 1st Cleaner	0.20	-	-	-	0.005	-	-	1	2	11.1
	-	-	-	0.005	-	-	-	1	1	-
Zn 2nd Cleaner	0.15	-	-	-	-	-	-	1	2½	11.2
Zn 3rd Cleaner	0.10	-	-	-	-	-	-	1	2	11.2

*Mixed Collectors

Test No. 14 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	6.14	42.0	8.98	56.2	7.5
2. Pb 4th Cl. Tail.	2.09	28.2	10.4	12.9	3.0
3. Pb 3rd Cl. Tail.	3.59	16.1	12.0	12.6	5.9
4. Pb 2nd Cl. Tail.	3.09	7.85	13.0	5.3	5.5
5. Zn Cleaner Conc.	8.05	1.04	56.5	1.8	61.9
6. Zn 3rd Cl. Tail.	0.69	2.67	35.5	0.4	3.3
7. Zn 2nd Cl. Tail.	2.03	2.83	21.3	1.3	5.9
8. Zn 1st Cl. Tail.	3.52	2.15	3.76	1.7	1.8
9. Zn Rougher Tail.	70.80	0.51	0.55	7.8	5.2
Head (Calculated)	100.00	4.59	7.35	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	8.23	38.5	9.34	69.1	10.5
Products 1 to 3	11.82	31.7	10.1	81.7	16.4
Products 1 to 4	14.91	26.8	10.7	87.0	21.9
Products 5 and 6	8.74	1.17	54.8	2.2	65.2
Products 5 to 7	10.77	1.48	48.5	3.5	71.1
Products 5 to 8	14.29	1.65	37.5	5.2	72.9

Test No. 15

Purpose: To perform a test employing the Noranda reagent balance and procedure.

Procedure: Grind two charges and float a lead rougher concentrate and a zinc rougher concentrate from each charge. Combine the lead rougher concentrates, regrind and clean three times. Combine the zinc rougher concentrates, regrind and clean three times.

Feed: Two 2000 gram charges minus 10 mesh Composite B.

Grind: 60 minutes per charge at 65 percent solids in the laboratory ball mill.

Conditions:

Stage	Reagents Added, pounds per ton							Time, minutes			pH
	Na ₂ S	Na ₂ -SO ₃	NaCN	Ca-(OH) ₂	AX-325	MIBC	ZnSO ₄	Grind	Cond.	Froth	
Primary Grind	0.5	1.0	0.30	-	-	-	-	60	-	-	-
<u>Pb Circuit</u>											
Pb Rougher	-	-	-	-	0.03	0.04	-	-	2	3	9.0
	-	1.0	-	-	0.04	0.02	-	-	1	3	-
	-	-	-	-	0.03	0.02	-	-	1	3	-
Combine the Pb rougher concentrates from the two charges.											
Pb Conc. Regrind	-	-	0.08	0.25	-	-	-	15	-	-	-
Pb 1st Cleaner	-	-	-	0.15	0.01	0.005	0.30	-	1	4	10.8
	-	-	-	-	0.01	-	-	-	1	3	-
Pb 2nd Cleaner	-	-	0.06	0.15	-	-	0.20	-	1	3	11.0
	-	-	-	-	0.01	0.003	-	-	1	3	-
Pb 3rd Cleaner	-	-	0.04	0.10	-	-	0.10	-	1	2	11.0
	-	-	-	-	0.005	0.003	-	-	1	2	-

Stage	Pb Rougher	Pb Conc. Regrind	Pb 1st & 2nd Cl.	Pb 3rd Cleaner
Equipment	1000 g D-1	Pebble Mill	500 g D-1	250 g D-1
Speed rpm	1800	-	1300	1000
% Solids	33	-	-	-

Test No. 15 - Continued

Conditions:

Stage	Reagents Added, pounds per ton					Time, minutes			pH
	Ca(OH) ₂	CuSO ₄	AX-343	MIBC	K ₂ Cr ₂ O ₇	Grind	Cond.	Froth	
<u>Zn Circuit</u> (Pb rougher tailings)									
Zn Conditioner	2.5	1.0	-	-	-	-	2	-	11.0
Zn Rougher	-	-	0.05	0.02	-	-	1	3	-
	-	-	0.02	0.01	-	-	1	3	-
	-	-	0.01	0.01	-	-	1	3	-
Combine Zn rougher concentrates from two charges.									
Zn Conc. Re grind	0.5	-	-	-	1.5	15	-	-	-
Zn 1st Cleaner	0.25	0.3	0.01	0.005	-	-	1	4	11.0
	-	-	0.01	-	-	-	1	3	-
Zn 2nd Cleaner	0.15	-	-	-	0.10	-	1	2½	11.0
	-	-	0.01	-	-	-	1	2	-
Zn 3rd Cleaner	0.10	-	0.01	-	0.05	-	1	3	11.0

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	4.44	50.7	7.02	47.7	4.2
2. Pb 3rd Cl. Tail.	1.15	32.4	10.3	7.9	1.6
3. Pb 2nd Cl. Tail.	2.10	18.2	10.0	8.1	2.8
4. Pb 1st Cl. Tail.	6.31	8.44	9.88	11.3	8.3
5. Zn Cleaner Conc.	5.68	1.47	58.0	1.8	44.0
6. Zn 3rd Cl. Tail.	0.58	5.13	33.3	0.6	2.6
7. Zn 2nd Cl. Tail.	1.07	4.45	18.1	1.0	2.6
8. Zn 1st Cl. Tail.	3.38	2.36	4.47	1.7	2.0
9. Zn Rougher Tail.	75.29	1.25	3.18	19.9	31.9
Head (Calculated)	100.00	4.72	7.49	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	5.59	46.9	7.70	55.6	5.8
Products 1 to 3	7.69	39.1	8.33	63.7	8.6
Products 1 to 4	14.00	25.3	9.03	75.0	16.9
Products 5 and 6	6.26	1.81	55.7	2.4	46.6
Products 5 to 7	7.33	2.20	50.2	3.4	49.2
Products 5 to 8	10.71	2.25	35.8	5.1	51.2

Test No. 16

Purpose: To repeat Test No. 11, but regrind the lead rougher concentrate in the ball mill.

Procedure: As for Test No. 11.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 40 minutes at 65 percent solids in the laboratory ball mill.

Conditions:

Stage	Reagents Added, pounds per ton						Time, minutes			pH
	Na ₂ CO ₃	Zn-SO ₄	NaCN	R-242	R-404	MIBC	Grind	Cond.	Froth	
<u>Primary Grind</u>	3.0	1.0	0.30	0.10	-	-	40	-	-	-
<u>Pb Circuit</u>										
Pb Rougher	-	-	-	0.02	0.02	-	-	1	3	9.2
	-	-	-	0.02	0.01	-	-	1	3	-
	-	-	-	0.02	0.01	-	-	1	3	-
Pb Conc. Regrind	1.0	0.5	0.20	0.03	-	-	20	-	-	-
Pb 1st Cleaner	-	-	-	-	-	-	-	1	3	9.5
	-	-	-	0.01	0.01	0.005	-	1	3	-
Pb 2nd Cleaner	0.2	0.2	0.10	-	-	-	-	1	3	-
	-	-	-	0.005	-	-	-	1	1	-
Pb 3rd Cleaner	0.2	0.1	0.05	-	-	-	-	1	3	9.6
Pb 4th Cleaner	0.2	-	0.05	-	-	-	-	1	2	-
Pb 5th Cleaner	0.2	-	0.05	-	-	0.005	-	1	2	9.7
	Ca-(OH) ₂	Cu-SO ₄			Z-200					
<u>Zn Circuit (Pb rougher and Pb 1st cleaner tailings)</u>										
Condition	2.0	1.0	-	-	-	-	-	2	-	10.7
Zn Rougher	-	-	-	-	0.06	0.02	-	1	3	-
	-	-	-	-	0.02	0.01	-	1	2	-
Zn Conc. Regrind	0.5	-	-	-	0.02	-	10	-	-	-
Zn 1st Cleaner	-	-	-	-	-	0.01	-	1	2	10.9
	-	-	-	-	0.01	-	-	1	2	-
Zn 2nd Cleaner	0.2	-	-	-	-	0.005	-	1	2	11.1
	-	-	-	-	0.005	-	-	1	1	-
Zn 3rd Cleaner	0.2	-	-	-	-	-	-	1	2	11.2

Stage	Pb Rougher	Pb Regrind	Pb 1st & 2nd Cl.	Pb 3rd & 5th Cl.
Equipment	1000 g D-1	Lab. Ball Mill	500 g D-1	250 g D-1
Speed rpm	1800	-	1300	1000
% Solids	33	-	-	-
Stage	Zn Rougher	Zn Conc. Regrind	Zn 1st & 2nd Cl.	Zn 3rd Cleaner
Equipment	1000 g D-1	Pebble Mill	500 g D-1	250 g D-1
Speed rpm	1800	-	1300	1000

Test No. 16 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	5.42	60.3	7.33	70.6	5.5
2. Pb 5th Cl. Tail.	0.71	36.2	10.2	5.6	1.0
3. Pb 4th Cl. Tail.	1.83	19.3	12.7	7.6	3.2
4. Pb 3rd Cl. Tail.	2.17	9.64	13.2	4.5	3.9
5. Pb 2nd Cl. Tail.	3.29	4.51	12.2	3.2	5.5
6. Zn Cleaner Conc.	9.25	0.82	54.6	1.6	69.4
7. Zn 3rd Cl. Tail.	0.96	1.51	24.9	0.3	3.3
8. Zn 2nd Cl. Tail.	1.30	1.27	7.77	0.4	1.4
9. Zn 1st Cl. Tail.	5.63	0.60	2.55	0.7	2.0
10. Zn Rougher Tail.	69.44	0.36	0.51	5.5	4.8
Head (Calculated)	100.00	4.63	7.28	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	6.13	57.5	7.66	76.2	6.5
Products 1 to 3	7.96	48.7	8.82	83.8	9.7
Products 1 to 4	10.13	40.4	9.76	88.3	13.6
Products 1 to 5	13.42	31.6	10.4	91.5	19.1
Products 6 and 7	10.21	0.88	51.8	1.9	72.7
Products 6 to 8	11.51	0.93	46.8	2.3	74.1
Products 6 to 9	17.14	0.82	32.3	3.0	76.1

Test No. 17

Purpose: To repeat the procedure of Test No. 6 (rod mill grind and regrind) but with finer primary grind and finer lead regrind.

Procedure: Grind and float a lead rougher concentrate. Regrind the concentrate and clean four times. Combine the lead rougher and 1st cleaner tailings and float a zinc concentrate. Clean the zinc concentrate three times.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 60 minutes at 65 percent solids in the laboratory rod mill.

Conditions:

Stage	Reagents Added, pounds per ton					Time, minutes			pH
	Na ₂ CO ₃	ZnSO ₄	NaCN	R-242	R-404	Grind	Cond.	Froth	
<u>Primary Grind</u> <u>Pb Circuit</u>	3.0	1.0	0.30	0.10	-	60	-	-	-
Pb Rougher	-	-	-	0.02	0.02	-	1	3	9.2
	-	-	-	0.02	0.01	-	1	3	-
	-	-	-	0.02	0.01	-	1	3	-
Pb Conc. Regrind	1.0	0.5	0.20	0.03	-	30	-	-	-
Pb 1st Cleaner	-	-	-	-	-	-	1	3	9.7
	-	-	-	0.01	0.01	-	1	3	-
Pb 2nd Cleaner	0.2	0.2	0.10	-	-	-	1	3	9.7
	-	-	-	0.005	-	-	1	1	-
Pb 3rd Cleaner	0.2	0.1	0.05	-	-	-	1	3	9.7
Pb 4th Cleaner	0.2	-	0.05	-	-	-	1	2	9.8
	Ca-(OH) ₂	CuSO ₄	Z-200	MIBC					
<u>Zn Circuit (Pb rougher and 1st cleaner tailings)</u>									
Condition	2.0	1.0	-	-	-	-	2	-	-
Zn Rougher	-	-	0.06	0.02	-	-	1	3	10.3
	-	-	0.04	0.01	-	-	1	2	-
Zn 1st Cleaner	0.3	-	-	0.005	-	-	1	2	11.1
	-	-	0.01	-	-	-	1	1	-
Zn 2nd Cleaner	0.2	-	-	0.005	-	-	1	1½	11.2
	-	-	0.005	-	-	-	1	1	-
Zn 3rd Cleaner	0.2	-	-	0.005	-	-	1	2	11.3

Stage	Rougher	Pb Conc. Regrind	Pb 1st & 2nd Cl.	Pb 3rd & 4th Cl.
Equipment	1000 g D-1	Rod Mill	500 g D-1	250 g D-1
Speed rpm	1800	-	1300	1000
% Solids	33	-	-	-

Test No. 17 - Continued

Metallurgical Results

Product	Weight %	Assays, %			% Distribution		
		Pb	Zn	Ag*	Pb	Zn	Ag
1. Pb Cleaner Conc.	6.37	59.3	7.46	19.52	81.8	6.5	59.7
2. Pb 4th Cl. Tail.	0.81	17.7	14.5	8.55	3.1	1.6	3.3
3. Pb 3rd Cl. Tail.	2.20	9.36	13.9	6.40	4.5	4.2	6.8
4. Pb 2nd Cl. Tail.	3.57	3.10	11.8	3.07	2.4	5.8	5.3
5. Zn Cleaner Conc.	9.52	0.86	55.1	3.20	1.8	71.8	14.6
6. Zn 3rd Cl. Tail.	0.93	1.61	23.3	1.82	0.3	3.0	0.8
7. Zn 2nd Cl. Tail.	1.25	1.18	6.01	0.97	0.3	1.0	0.6
8. Zn 1st Cl. Tail.	7.81	0.82	2.02	0.65	1.4	2.2	2.4
9. Zn Rougher Tail.	67.54	0.30	0.43	0.20	4.4	3.9	6.5
Head (Calculated)	100.00	4.62	7.31	2.08	100.0	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	7.18	54.6	8.25	18.28	84.9	8.1	63.0
Products 1 to 3	9.38	44.0	9.58	15.50	89.4	12.3	69.8
Products 1 to 4	12.95	32.7	10.2	12.07	91.8	18.1	75.1
Products 5 and 6	10.45	0.93	52.3	3.08	2.1	74.8	15.4
Products 5 to 7	11.70	0.95	47.3	2.85	2.4	75.8	16.0
Products 5 to 8	19.51	0.90	29.2	1.97	3.8	78.0	18.4

*oz/ton

Size Analysis - Pb Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 22.0 µm	9.4	9.4	90.6
17.1	16.4	25.8	74.2
11.9	21.6	47.4	52.6
8.2	20.8	68.2	31.8
6.3	8.7	76.9	23.1
- 6.3	23.1	100.0	-
Total	100.0	-	-

Specific Gravity = 6.21

Test No. 18 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	6.11	63.2	7.29	83.0	6.1
2. Pb 4th Cl. Tail.	1.46	16.5	15.8	5.2	3.2
3. Pb 3rd Cl. Tail.	1.85	5.74	14.4	2.3	3.6
4. Pb 2nd Cl. Tail.	2.41	2.03	11.6	1.1	3.8
5. Pb 1st Cl. Tail.	18.27	0.66	7.66	2.6	19.2
6. Pb Rougher Tail.	69.90	0.39	6.70	5.8	64.1
Head (Calculated)	100.00	4.65	7.31	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	7.57	54.2	8.93	88.2	9.3
Products 1 to 3	9.42	44.7	10.0	90.5	12.9
Products 1 to 4	11.83	36.0	10.3	91.6	16.7
Products 1 to 5	30.10	14.5	8.71	94.2	35.9

Test No. 19

Purpose: To again repeat the lead circuit of Test No. 17, but with a coarser regrind.

Procedure: As for Test No. 18.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 60 minutes at 65 percent solids in the laboratory rod mill.

Conditions:

Stage	Reagents Added, pounds per ton					Time, minutes			pH
	Na ₂ CO ₃	ZnSO ₄	NaCN	R-242	R-404	Grind	Cond.	Froth	
Primary Grind	3.0	1.0	0.30	0.10	-	60	-	-	-
<u>Pb Circuit</u>									
Pb Rougher	1.0	-	-	0.02	0.02	-	1	3	9.4
	-	-	-	0.02	0.01	-	1	3	-
	-	-	-	0.02	0.01	-	1	3	-
Pb Conc. Regrind	1.0	0.5	0.20	0.02	-	20	-	-	-
Pb 1st Cleaner	-	-	-	-	-	-	1	3	9.6
	-	-	-	0.01	0.01	-	1	3	-
Pb 2nd Cleaner	0.2	0.2	0.10	-	-	-	1	3	-
	-	-	-	0.005	-	-	1	1	-
Pb 3rd Cleaner	0.2	0.1	0.05	-	-	-	1	3	9.8
Pb 4th Cleaner	0.2	-	0.05	-	-	-	1	2	-

Stage Pb Regrind
 Equipment Rod Mill

Test No. 19 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	7.37	55.9	8.64	87.0	8.7
2. Pb 4th Cl. Tail.	0.76	11.9	15.1	1.9	1.6
3. Pb 3rd Cl. Tail.	2.36	5.12	13.4	2.6	4.3
4. Pb 2nd Cl. Tail.	3.18	1.93	11.0	1.3	4.8
5. Pb 1st Cl. Tail.	16.39	0.73	8.17	2.5	18.3
6. Pb Rougher Tail.	69.94	0.32	6.51	4.7	62.3
Head (Calculated)	100.00	4.74	7.31	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	8.13	51.8	9.24	88.9	10.3
Products 1 to 3	10.49	41.3	10.2	91.5	14.6
Products 1 to 4	13.67	32.1	10.4	92.8	19.4
Products 1 to 5	30.06	15.0	9.17	95.3	37.7

Test No. 20

Purpose: To repeat the previous tests, but investigate the effect of a coarser primary grind and finer lead regrind.

Procedure: As for Test No. 18.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 30 minutes at 65 percent solids in the laboratory rod mill.

Conditions:

Stage	Reagents Added, pounds per ton					Time, minutes			pH
	Na ₂ CO ₃	ZnSO ₄	NaCN	R-242	R-404	Grind	Cond.	Froth	
<u>Primary Grind</u> <u>Pb Circuit</u>	3.0	1.0	0.30	0.10	-	30	-	-	-
Pb Rougher	1.0	-	-	-	0.02	-	1	3	9.3
	-	-	-	0.01	0.01	-	1	3	-
	-	-	-	0.01	0.01	-	1	3	-
Pb Conc. Regrind	1.0	0.5	0.20	0.04	-	40	-	-	-
Pb 1st Cleaner	-	-	-	-	-	-	1	3	9.6
	-	-	-	0.01	0.01	-	1	3	-
Pb 2nd Cleaner	0.2	0.2	0.10	-	-	-	1	3	-
	-	-	-	0.005	-	-	1	1	-
Pb 3rd Cleaner	0.2	0.1	0.05	-	-	-	1	3	9.7
Pb 4th Cleaner	0.2	-	0.05	-	-	-	1	2	-
	Ca-(OH) ₂	CuSO ₄	Z-200	MIBC					
<u>Zn Circuit</u>									
Condition	2.0	1.0	-	-	-	-	2	-	10.6
Zn Rougher	-	-	0.06	0.02	-	-	1	3	-
	-	-	0.02	0.01	-	-	1	2	-
Zn Conc. Regrind	0.5	-	0.02	-	-	15	-	-	-
Zn 1st Cleaner	0.5	-	-	0.01	-	-	1	2	10.9
	-	-	0.01	-	-	-	1	2	-
Zn 2nd Cleaner	0.5	-	-	0.005	-	-	1	2	10.8
	-	-	0.005	-	-	-	1	1	-
Zn 3rd Cleaner	0.3	-	-	-	-	-	1	2	10.8

Stage	Pb Regrind	Zn Rougher	Zn Ro. Conc. Regrind	Zn 1st & 2nd Cl.
Equipment	Rod Mill	1000 g D-1	Pebble Mill	500 g D-1
Speed rpm	-	1800	-	1300

Test No. 20 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	6.47	62.0	7.38	86.3	6.6 ←
2. Pb 4th Cl. Tail.	0.70	14.4	16.17	2.2	1.6
3. Pb 3rd Cl. Tail.	1.06	6.83	15.03	1.6	2.2
4. Pb 2nd Cl. Tail.	2.73	2.27	11.52	1.3	4.4
5. Pb 1st Cl. Tail.	21.25	0.56	7.43	2.6	21.9
6. Zn Cleaner Conc.	6.35	0.74	56.9	1.0	50.2 ←
7. Zn 3rd Cl. Tail.	0.95	1.43	38.4	0.3	5.1
8. Zn 2nd Cl. Tail.	0.85	1.49	12.0	0.3	1.4
9. Zn 1st Cl. Tail.	6.70	0.51	2.11	0.7	2.0
10. Zn Rougher Tail.	52.94	0.33	0.63	3.7	4.6
Head (Calculated)	100.00	4.65	7.20	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	7.17	57.4	8.24	88.5	8.2
Products 1 to 3	8.23	50.8	9.11	90.1	10.4
Products 1 to 4	10.96	38.7	9.71	91.4	14.8
Products 1 to 5	32.21	13.6	8.21	94.0	36.7
Products 6 and 7	7.30	0.83	54.5	1.3	55.3
Products 6 to 8	8.15	0.90	50.1	1.6	56.7
Products 6 to 9	14.85	0.72	28.4	2.3	58.7

Test No. 21

Purpose: To repeat the procedure of the previous tests, but attempt to improve the grade of the final lead concentrate by increasing cyanide additions.

Procedure: Grind and float a lead concentrate. Regrind the concentrate and clean five times. Combine the lead rougher and 1st cleaner tailings and float a zinc concentrate. Clean the zinc concentrate three times.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 40 minutes at 65 percent solids in the laboratory rod mill.

Conditions:

Stage	Reagents Added, pounds per ton						Time, minutes			pH
	Na ₂ -CO ₃	Zn-SO ₄	NaCN	R-242	R-404	MIBC	Grind	Cond.	Froth	
<u>Primary Grind</u>	3.0	1.0	0.40	0.10	-	-	40	-	-	-
<u>Pb Circuit</u>										
Pb Rougher	1.0	-	-	-	0.02	-	-	1	3	9.3
	-	-	-	0.01	0.01	-	-	1	3	-
	-	-	-	0.01	0.01	-	-	1	3	-
Pb Conc. Regrind	1.0	0.5	0.30	0.02	-	-	30	-	-	-
Pb 1st Cleaner	-	-	-	-	-	-	-	1	3	9.6
	-	-	-	0.005	0.005	-	-	1	3	-
Pb 2nd Cleaner	0.2	0.2	0.15	-	-	-	-	1	3	-
	-	-	-	0.005	-	-	-	1	1	-
Pb 3rd Cleaner	0.2	0.1	0.10	-	-	-	-	1	3	9.8
Pb 4th Cleaner	0.2	-	0.10	-	-	-	-	1	2½	-
Pb 5th Cleaner	0.2	-	0.05	-	-	0.005	-	1	2	9.8
	Ca-(OH) ₂	Cu-SO ₄	Z-200							
<u>Zn Circuit</u> (Pb rougher and 1st cleaner tailings)										
Condition	2.0	1.0	-	-	-	-	-	2	-	10.6
Zn Rougher	-	-	0.06	-	-	0.02	-	1	3	-
	-	-	0.02	-	-	0.01	-	1	2	-
Zn 1st Cleaner	0.3	-	-	-	-	-	-	1	2	11.1
	-	-	0.005	-	-	0.005	-	1	1	-
Zn 2nd Cleaner	0.2	-	-	-	-	-	-	1	2½	11.2
	-	-	-	-	-	0.005	-	-	-	-
Zn 3rd Cleaner	0.2	-	-	-	-	0.005	-	1	2	11.2

LAKEFIELD RESEARCH OF CANADA LIMITED

Test No: 28 Project No: 1869 Date: Oct. 15/75 Operator: CPYAE

Purpose: To repeat test No. 23, but extend the test to six cycles to reach equilibrium.

Procedure: Flowsheet as for test No. 23

Feed: Six 2000 gram charges minus 10 mesh Composite B.

Grind: 40 minutes per charge at 65% solids in the laboratory rod mill.

Conditions:

	Reagents Added, pounds per ton					Time, minutes			pH
	Na ₂ CO ₃	ZnSO ₄	NaCN	R-242	R-404	Grind	Cond.	Froth	
Primary Grind	3.0	1.0	0.30	0.08		40			
Pb Circuit									
Pb Rougher	1.0			0.01	0.02		1	3	9.2
				0.01	0.01		1	3	
				0.01	0.01		1	3	
Pb Conc. Re-grind	1.0	0.5	0.20	0.03		40			
Pb 1st Cleaner				0.01	0.01		1	3	9.5
Pb 2nd Cleaner	0.2	0.2	0.10				1	3	9.5
Pb 3rd Cleaner	0.2	0.1	0.05				1	2½	9.7
Pb 4th Cleaner	0.2		0.05				1	2	9.7

Stage	Pb Rougher	Pb Conc. Re-grind	Pb 1st + 2nd Cleaner	Pb 3rd + 4th Cleaner
Flotation Cell	1000 g D-1	Rod Mill	500 g D-1	250 g D-1
Speed: r. p. m.	1800		1300	1000
% Solids				

LAKEFIELD RESEARCH OF CANADA LIMITED

Test No: 28 Project No: 1869 Date: Oct. 15/75 Operator: _____

Purpose: _____

Procedure: _____

Feed: _____

Grind: _____

Conditions: _____

	Reagents Added, pounds per ton						Time, minutes			pH
	Ca(OH) ₂	CaSO ₄	Z-200	MIBC	Z-11	MIBC (res)	Grind	Cond.	Froth	
Zn Circuit										
Condition	4.0 3.0	1.0						2		10.9
Zn Rougher			0.06 0.02	0.02				1 1	3 2	
Zn 1 st Cleaner	0.4							1	4	11.0
Zn 2 nd Cleaner	0.3							1	3	11.1
Zn 3 rd Cleaner	0.2							1	2 1/2	11.1

Stage	Rougher	Zn Cleaners.		
Flotation Cell	1000g. D-1	500g. D-1		
Speed: r. p. m.	1800	1300		
% Solids				

LAKEFIELD RESEARCH OF CANADA LIMITED

Test No. 28

Project No. _____

Date: _____

Metallurgical Results

Product	Weight		Assays, %		% Distribution		Metal Units	
	g	%	Pb	Zn	Pb	Zn	Pb	Zn
1. Pb Cleaner Conc. A	119.0	0.98	66.4	6.53	14.0	.9		
2. Pb Cleaner Conc. B	127.0	1.05	62.0	7.39	14.0	1.1		
3. Pb Cleaner Conc. C	120.5	0.99	64.4	6.99	13.7	1.0		
4. Pb Cleaner Conc. D	127.5	1.05	62.2	7.26	14.0	1.0		
5. Pb Cleaner Conc. E	141.1	1.16	61.7	7.73	15.4	1.2		
6. Pb Cleaner Conc. F	136.4	1.12	62.0	7.72	14.9	1.2		
7. Pb 4th Cleaner Tail F	44.5	0.37	16.2	16.8	1.3	.9		
8. Pb 3rd Cleaner Tail F	79.8	0.66	8.32	16.8	1.2	1.5		
9. Pb 2nd Cleaner Tail F	187.0	1.54	4.78	14.5	1.6	3.1		
10. Pb 1st Cleaner Tail F	365.1	3.01	.86	9.16	.5	3.7		
11. Zn Cleaner Conc. A	155.2	1.28	.51	53.9	.1	9.5		
12. Zn Cleaner Conc. B	207.5	1.71	.84	49.8	.3	11.7		
13. Zn Cleaner Conc. C	140.5	1.16	.65	56.3	.2	9.0		
14. Zn Cleaner Conc. D	142.5	1.17	.84	55.3	.2	8.9		
15. Zn Cleaner Conc. E	165.5	1.36	.97	56.4	.3	10.6		
6. Zn Cleaner Conc. F	181.2	1.49	.98	56.6	.3	11.6		
7. Zn 3rd Cleaner Tail F	80.1	0.66	1.54	47.9	.2	4.4		
8. Zn 2nd Cleaner Tail F	181.9	1.50	1.41	37.4	.5	7.7		
9. Zn 1st Cleaner Tail F	237.1	1.95	1.29	10.7	.5	2.9		
10. Zn Rougher Tail A	1197.0	9.86	.33	.67	.7	.9		
11. Zn Rougher Tail B	1460.0	12.02	.35	.72	.9	1.2		
12. Zn Rougher Tail C	1595.0	13.14	.45	.79	1.3	1.4		
13. Zn Rougher Tail D	1636.0	13.47	.43	1.14	1.2	2.1		
14. Zn Rougher Tail E	1658.0	13.65	.50	.68	1.5	1.3		
15. Zn Rougher Tail F	1657.0	13.65	.42	.62	1.2	1.2		
Head (Calculated)	12142.1	100.00	4.66	7.26				

Calculated Grades and Recoveries

LAKEFIELD RESEARCH OF CANADA LIMITED

Test No: 23 Project No: 1869 Date: 24 Sept. 75 Operator: CP + A.C.

Purpose: To perform a four stage locked-cycle test using the procedure of test No. 20.

Procedure: See flowsheet.

Feed: Four 2000 gram charges minus 10 mesh Composite B.

Grind: 40 minutes per charge at ^{35%} solids in the laboratory rod mill.

Conditions:

	Reagents Added, pounds per ton						Time, minutes			pH
	Na ₂ CO ₃	ZnSO ₄	NaCN	R-242	R-404		Grind	Cond.	Froth	
Primary Grind	3.0	1.0	0.30	0.08			40			
P.B Circuit										
P.B Rougher	1.0			0.01	0.02			1	3	9.3
				0.01	0.01			1	3	
				0.01	0.01			1	3	
P.B Conc. Regrind	1.0	0.5	0.20	0.03			40			
P.B 1st Cleaner				0.01	0.01			1	3	9.5
								1	3	
P.B 2nd Cleaner	0.2	0.2	0.10					1	3	9.6
P.B 3rd Cleaner	0.2	0.1	0.05					1	2½	9.7
P.B 4th Cleaner	0.2		0.05					1	2	9.6

Stage	Rougher	1st & 2nd Cleaners	3rd & 4th Cleaners	P.B. Conc. Regrind
Flotation Cell	1000g D-1	500g D-1	250g D-1	Rod Mill
Speed: r. p. m.	1800	1300	1000	
% Solids	33			

LAKEFIELD RESEARCH OF CANADA LIMITED

Test No: 23 (Cont'd) Project No: 1869 Date: Sept. 24/75 Operator: _____

Purpose: _____

Procedure: _____

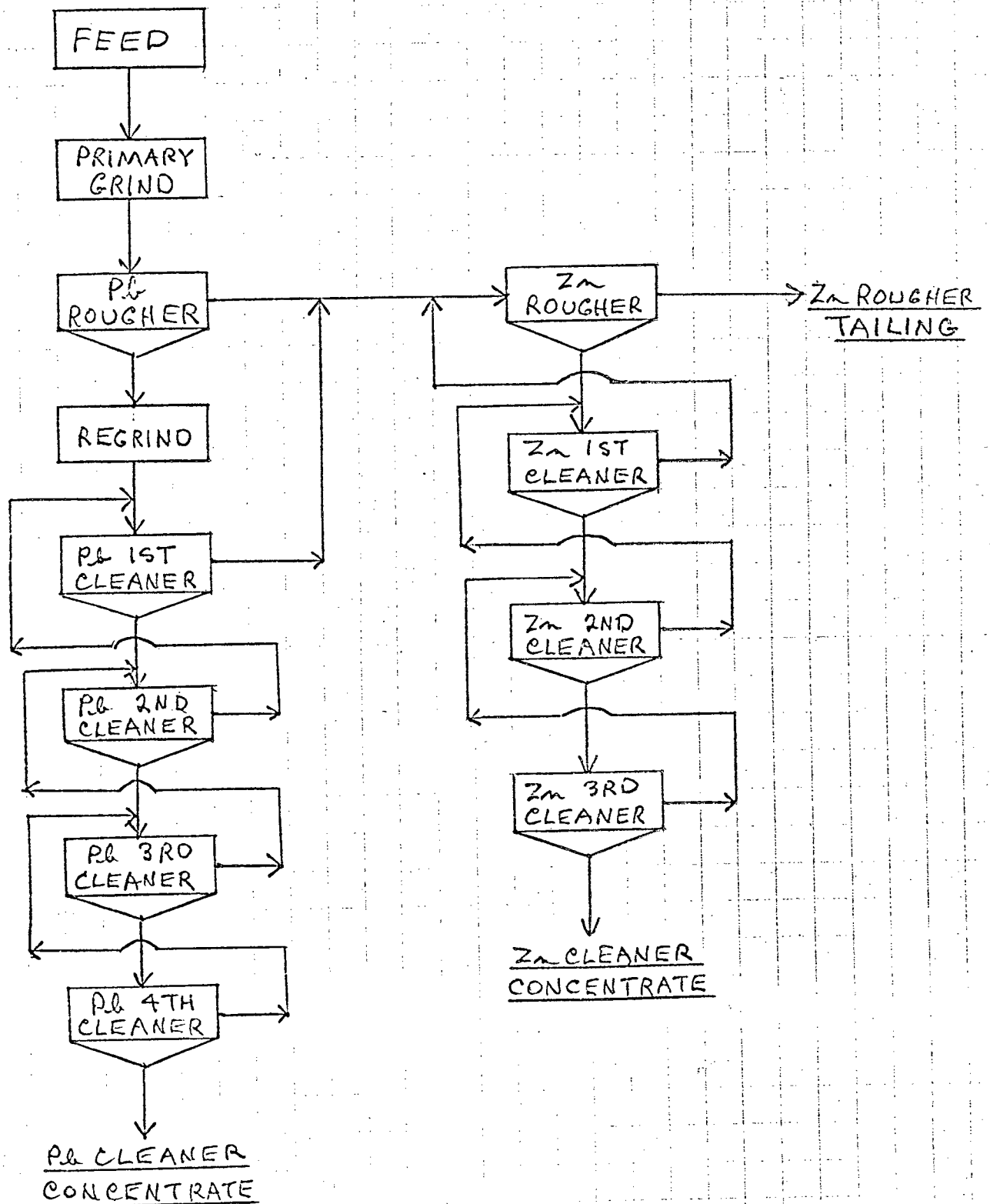
Feed: _____

Grind: _____

Conditions: _____

	Reagents Added, pounds per ton						Time, minutes			pH
	Co(OH) ₂	CuSO ₄	Z-200	MIBC			Grind	Cond.	Froth	
<u>Zn Circuit</u>										
<u>Condition</u>	^{3.0} 2.0	1.0						2		
<u>Zn Rougher</u>			^{0.05} 0.08	0.02				1	3	10.5
			0.02	0.01				1	2	
<u>Zn 1st Cleaner</u>	0.4							1	3	11.0
<u>Zn 2nd Cleaner</u>	0.3							1	2½	11.0
<u>Zn 3rd Cleaner</u>	0.3							1	2	11.0

Stage	Rougher	Zn Cleaners		
Flotation Cell	1000 g D-1	500 g D-1		
Speed: r. p. m.	1800	1300		
% Solids				



LAKEFIELD RESEARCH OF CANADA LIMITED

Test No. 23

Project No. _____

Date: _____

Metallurgical Results

Product	Weight		Assays, %		% Distribution			Metal Units		
	g	%	Pb	Zn	Pb	Zn		Pb	Zn	
1. Pb Cleaner Conc. A	105.3	1.31	71.8	5.30	19.9	0.9		94	26	694
2. Pb Cleaner Conc. B	109.5	1.36	72.2	5.38	20.7	1.0		98	19	732
3. Pb Cleaner Conc. C	121.9	1.52	69.6	6.29	22.3	1.3		105	79	956
4. Pb Cleaner Conc. D	138.6	1.72	64.4	7.70	23.4	1.8		110	77	1324
5. Pb 4th Cleaner Tail D	30.0	0.37	17.1	18.8	1.3	0.9		6	33	696
6. Pb 3rd Cleaner Tail D	52.5	0.65	9.92	19.2	1.4	1.7		6	45	1248
7. Pb 2nd Cleaner Tail D	144.4	1.79	4.86	16.6	1.8	4.0		8	70	2971
8. Pb 1st Cleaner Tail D	401.1	4.99	0.71	9.48	0.8	6.4		3	54	4731
9. Zn Cleaner Conc. A	125.9	1.56	0.54	57.6	0.2	12.1		0	34	8986
10. Zn Cleaner Conc. B	141.0	1.75	0.54	58.0	0.2	13.7		0	95	10150
11. Zn Cleaner Conc. C	111.3	1.38	0.76	56.0	0.2	10.5		1	05	7728
12. Zn Cleaner Conc. D	152.1	1.89	0.86	57.0	0.3	14.6		1	63	16773
13. Zn 3rd Cleaner Tail D	90.1	1.12	1.02	16.0	0.2	7.0		1	14	5152
14. Zn 2nd Cleaner Tail D	520.9	6.47	0.59	9.87	0.8	8.6		3	32	6386
15. Zn 1st Cleaner Tail D	1011.0	12.57	0.63	5.77	1.7	9.8		7	92	7253
Head (Calculated)	856.9	10.65	0.31	0.50	0.7	0.7		3	30	533
17. Zn Rougher Tail B	1606.0	19.96	0.39	0.68	1.6	1.8		7	78	1357
Calculated Grades and Recoveries			0.36	0.75	1.1	1.4		4	87	1016
19. Zn Rougher Tail D	1239.0	15.40	0.41	0.85	1.3	1.8		6	31	1309
Head Calc.	8045.8	100.00	4.73	7.40	100.0	100.0		47	346	73994
<u>Calculated Grades and Recoveries</u>										
Combined Pb Cleaner Conc.	5.91		69.2	6.27	86.3	5.0		408	81	3706
Combined Pb Cleaner Tails	7.80		3.21	12.37	5.4	13.0		25	02	9646
Combined Zn Cleaner Conc.	6.58		0.68	57.2	0.9	50.9		4	47	37637
Combined Zn Cleaner Tails	20.16		0.44	9.32	2.7	25.4		12	88	18791
Combined Zn Rougher Tails	59.55		0.37	0.71	4.7	5.7		22	26	18215

Test No. 21 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	5.28	68.8	6.44	79.1	4.7
2. Pb 5th Cl. Tail.	0.54	32.0	14.1	3.8	1.0
3. Pb 4th Cl. Tail.	1.03	18.2	15.4	4.1	2.2
4. Pb 3rd Cl. Tail.	1.16	8.83	15.6	2.2	2.5
5. Pb 2nd Cl. Tail.	2.86	3.19	12.6	2.0	5.0
6. Zn Cleaner Conc.	8.82	0.65	56.6	1.2	68.8
7. Zn 3rd Cl. Tail.	0.48	1.55	26.2	0.2	1.7
8. Zn 2nd Cl. Tail.	1.56	1.14	14.1	0.4	3.0
9. Zn 1st Cl. Tail.	4.86	0.78	5.37	0.8	3.6
10. Zn Rougher Tail.	73.41	0.39	0.74	6.2	7.5
Head (Calculated)	100.00	4.59	7.26	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	5.82	65.4	7.15	82.9	5.7
Products 1 to 3	6.85	58.3	8.39	87.0	7.9
Products 1 to 4	8.01	51.1	9.43	89.2	10.4
Products 1 to 5	10.87	38.5	10.3	91.2	15.4
Products 6 and 7	9.30	0.70	55.0	1.4	70.5
Products 6 to 8	10.86	0.76	49.2	1.8	73.5
Products 6 to 9	15.72	0.77	35.6	2.6	77.1

Test No. 22

Purpose: To investigate the effect of grinding with no depressants or collector, and floating at natural pH.

Procedure: Grind and float a lead rougher concentrate. Regrind the concentrate and clean three times.

Feed: 2000 grams minus 10 mesh Composite B.

Grind: 40 minutes at 65 percent solids in the laboratory rod mill.

Conditions:

Stage	Reagents Added, pounds per ton					Time, minutes			pH
	R-242	Z-4	MIBC	NaCN	H ₂ SO ₄	Grind	Cond.	Froth	
Primary Grind	-	-	-	-	-	40	-	-	-
<u>Pb Circuit</u>									
Pb Rougher	0.03	0.01	0.02	-	-	-	1	2	6.9
	0.02	0.01	0.01	-	-	-	1	3	-
	0.02	0.01	-	-	-	-	1	3	-
Pb Conc. Regrind	-	-	-	-	-	-	20	-	-
Pb 1st Cleaner	0.02	0.005	0.005	-	-	-	1	2	7.4
	0.01	0.005	0.005	-	-	-	1	2	-
	0.01	-	-	-	-	-	1	2	-
Pb 2nd Cleaner	0.01	-	-	0.02	-	-	1	1	7.9
	-	0.01	0.005	-	0.06	-	1	1	6.2
	0.01	-	-	-	-	-	1	1	-
Pb 3rd Cleaner	-	-	0.005	-	-	-	1	1	6.8
	0.005	-	-	-	-	-	1	1	-

Stage	Rougher	Pb Regrind	1st Cleaner	2nd & 3rd Cl.
Equipment	1000 g D-1	Rod Mill	500 g D-1	250 g D-1
Speed rpm	1800	-	1300	1000
% Solids	33	-	-	-

Test No. 22 - Continued

Metallurgical Results

Product	Weight %	Assays, %		% Distribution	
		Pb	Zn	Pb	Zn
1. Pb Cleaner Conc.	2.45	49.6	7.34	26.7	2.5
2. Pb 3rd Cl. Tail.	0.89	15.1	6.69	3.9	0.8
3. Pb 2nd Cl. Tail.	1.82	16.2	7.63	6.5	1.9
4. Pb 1st Cl. Tail.	20.48	9.78	9.32	44.0	26.8
5. Pb Rougher Tail.	74.36	1.21	6.51	19.8	68.0
Head (Calculated)	100.00	4.55	7.13	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	3.34	40.4	7.16	29.7	3.3
Products 1 to 3	5.16	31.9	7.33	36.2	5.2
Products 1 to 4	25.64	14.2	8.92	80.2	32.0

WORK INDEX CALCULATIONS

The Work Indices were calculated in accordance with Bond's "Third Theory of Comminution" from the following formula:

$$\text{Work Index} = \frac{C \times T}{W} \times \frac{1}{\frac{10}{\sqrt{P}} - \frac{10}{\sqrt{F}}}$$

Where C = mill constant

T = grinding time in minutes

W = weight of feed in grams

P = size modulus K_{80} of product

F = size modulus K_{80} of feed

The mill constant C was determined by grinding a reference ore of known work index.

Grinding Data - Ball Mill

Grinding Time (min/2000 g)	Product Size		Surface Area cm ² /gram	Power Consumption kwh/ton	Bond Work Index
	Minus 200 mesh	K_{80} Micrometers			
-10 mesh Head	19.7	886	-	-	-
20	79.6	76.6	1354	6.2	7.7
30	88.7	55.8	1743	9.3	9.3
40	94.4	47.0	2020	12.4	11.0
60	98.1	37.0	2495	18.7	14.2

Rod Mill

40	93.8	52.0	1665	9.2	9.1
60	97.4	42.4	2085	13.9	11.9

MICROMETERS

MESH SIZE : TYLER

- 57 -

9.3 13.0 18.5 26 37 400 270 200 150 100 65 48 35 28 20 14

% PASSING
CUMULATIVE

60 MIN. GRIND

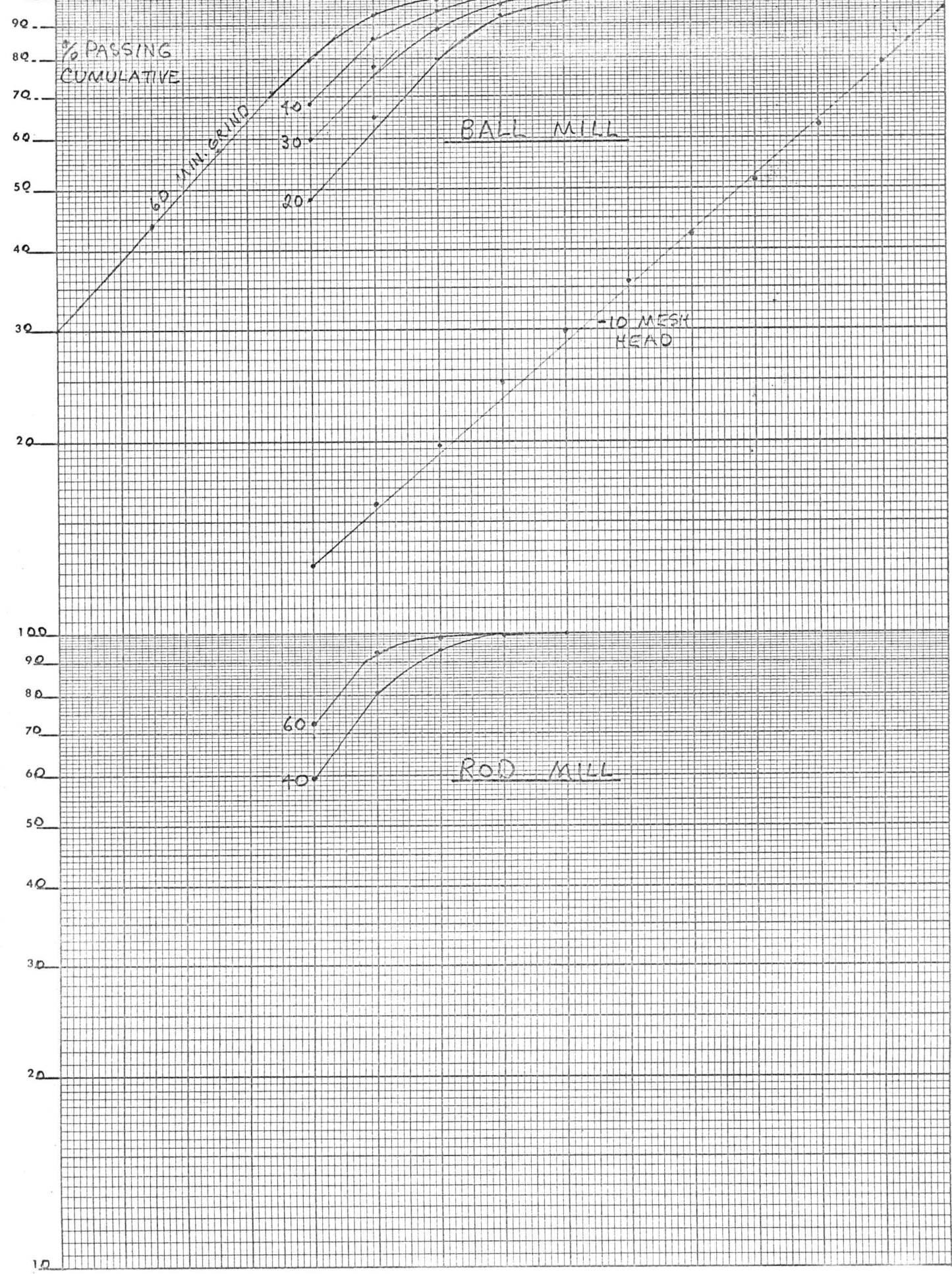
BALL MILL

- 10 MESH
HEAD

ROD MILL

GRAF-TIL CONTROLS CANADA LTD.
MADE IN CANADA

- 63 SEMI-AUTOMATIC, 2 CYCLES X 10 IN. HE. HORN, 100 CH



Screen Analyses

20 Minute Ball Mill

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65	0.2	0.2	99.8
100	1.5	1.7	98.3
150	5.5	7.2	92.8
200	13.2	20.4	79.6
270	14.6	35.0	65.0
400	16.9	51.9	48.1
- 400	48.1	100.0	-
Total	100.0	-	-

30 Minute Ball Mill

+ 65	0.1	0.1	99.9
100	0.3	0.4	99.6
150	2.4	2.8	97.2
200	8.5	11.3	88.7
270	11.0	22.3	77.7
400	17.8	40.1	59.9
- 400	59.9	100.0	-
Total	100.0	-	-

40 Minute Ball Mill

+ 100	0.1	0.1	99.9
150	0.8	0.9	99.1
200	4.7	5.6	94.4
270	8.5	14.1	85.9
400	17.5	31.6	68.4
- 400	68.4	100.0	-
Total	100.0	-	-

Screen Analyses - Continued

60 Minute Ball Mill

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 200 mesh	1.3	1.3	98.7
29.2 μ m	28.0	29.3	70.7
22.6	13.2	42.5	57.5
15.8	13.6	56.1	43.9
10.8	14.3	70.4	29.6
8.4	6.8	77.2	22.8
- 8.4	22.8	100.0	-
Total	100.0	-	-

Specific Gravity = 3.68

40 Minute Rod Mill Grind

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100	0.2	0.2	99.8
150	0.9	1.1	98.9
200	5.1	6.2	93.8
270	13.2	19.4	80.6
400	21.6	41.0	59.0
- 400	59.0	100.0	-
Total	100.0	-	-

60 Minute Rod Mill Grind

+ 100	0.1	0.1	99.9
150	0.7	0.8	99.2
200	1.8	2.6	97.4
270	4.1	6.7	93.3
400	20.7	27.4	72.6
- 400	72.6	100.0	-
Total	100.0	-	-